# CATEGORY 1

REGULAT[?] INFORMATION DISTRIBUTION [?]YSTEM (RIDS)

ACCESSION NBR:9710240236 DOC.DATE: 97/10/21 NOTARIZED: YES DOCKET #
FACIL:50-315 Donald C. Cook Nuclear Power Plant, Unit 1, Indiana M 05000315
50-316 Donald C. Cook Nuclear Power Plant, Unit 2, Indiana M 05000316
AUTH.NAME AUTHOR AFFILIATION
FITZPATRICK,E. Indiana Michigan Power Co. (formerly Indiana & Michigan Ele
RECIP.NAME RECIPIENT AFFILIATION
Document Control Branch (Document Control Desk)

See Proposed Change to Tech Specs

SUBJECT: Transmits data which supports proposed license amend, increasing min ice mass required in ice condenser during operation.Encl contains code input parameters & matl presented at 971009 meeting.

DISTRIBUTION CODE: A001D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 500+70
TITLE: OR Submittal: General Distribution

NOTES:

| | RECIPIENT ID CODE/NAME | COPIES LTTR | COPIES ENCL | RECIPIENT ID CODE/NAME | COPIES LTTR | COPIES ENCL |
|---|---|---|---|---|---|---|
| | PD3-3 LA | 1 | 1 | PD3-3 PD | 1 | 1 |
| | HICKMAN,J | 1 | 1 | | | |
| INTERNAL: | FILE CENTER 01 | 1 | 1 | NRR/DE/ECGB/A | 1 | 1 |
| | NRR/DE/EMCB | 1 | 1 | NRR/DRCH/HICB | 1 | 1 |
| | NRR/DSSA/SPLB | 1 | 1 | NRR/DSSA/SRXB | 1 | 1 |
| | NUDOCS-ABSTRACT | 1 | 1 | OGC/HDS2 | 1 | 0 |
| EXTERNAL: | NOAC | 1 | 1 | NRC PDR | 1 | 1 |

C A T E G O R Y 1 D O C U M E N T

NOTE TO ALL "RIDS" RECIPIENTS:
PLEASE HELP US TO REDUCE WASTE. TO HAVE YOUR NAME OR ORGANIZATION REMOVED FROM DISTRIBUTION LISTS OR REDUCE THE NUMBER OF COPIES RECEIVED BY YOU OR YOUR ORGANIZATION, CONTACT THE DOCUMENT CONTROL DESK (DCD) ON EXTENSION 415-2083

TOTAL NUMBER OF COPIES REQUIRED: LTTR 13 ENCL 12

Indiana Michigan
Power Company
500 Circle Drive
Buchanan, MI 49107 1395

INDIANA
MICHIGAN
POWER

October 21, 1997

AEP:NRC:0900M
10 CFR 50.90

Docket Nos.: 50-315
50-316

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

Donald C. Cook Nuclear Plant Units 1 and 2
REQUEST FOR ADDITIONAL INFORMATION
TECHNICAL SPECIFICATION 3/4.6.5 AND
TECHNICAL SPECIFICATION BASIS 3/4.5.5
PROPOSED CHANGES

Reference: AEP:NRC:0900K, Donald C. Cook Nuclear Plant Units 1 and 2, Request for Exigent Technical Specification Amendment, Technical Specification 3/4.6.5, Ice Weight and Surveillance Requirement and Technical Specification 3/4.5.5 Basis, Refueling Water Storage Tank Change, dated October 8, 1997.

This letter transmits data supporting our proposed technical specification change to increase the minimum ice mass required in the ice condenser during operation (referenced letter). The total minimum ice mass listed in the request has been analyzed by Fauske and Associates, using the MAAP4 computer code, and a presentation was made to your staff on October 9, 1997, providing the results of the analyses.

During the meeting, we were asked to provide a copy of the code input parameters, and a non-proprietary version of the material that was presented at the meeting. Attachment 1 to this letter contains the code input parameters. Attachment 2 contains a non-proprietary version of Fauske and Associates' presentation.

Sincerely,

E. E. Fitzpatrick
Vice President

vlb

Attachments

SWORN TO AND SUBSCRIBED BEFORE ME

THIS 21 DAY OF OCTOBER, 1997

Linda L. Boelcke
Notary Public

My Commission Expires 1-21-2001

LINDA L. BOELCKE
Notary Public, Berrien County, MI
My Commission Expires January 21, 2001

A001

c: A. A. Blind
A. B. Beach
MDEQ - DW & RPD
NRC Resident Inspector
J. R. Padgett

50-315 D.C. COOK IMPC

REQUEST FOR ADDITIONAL INFORMATION ON T/S
ATTACHMENT 1: MAAP4 INPUT PARAMETERS USED FOR
UNITS 1 & 2 ANALYSES

Rec'd w/ ltr dtd 10/21/97......9710240236

Attachment 1 to AEP:NRC:0900M

# MAAP4 INPUT PARAMETERS USED FOR DONALD C. COOK NUCLEAR PLANT UNITS 1 AND 2 ANALYSES

```
******************************************************************************
**      D. C. COOK UNIT 1: DRAFT PARAMETER FILE FOR MAAP 4
**                     PREPARED FOR
**           THE AMERICAN ELECTRIC POWER SERVICE COMPANY
**                           BY
**             FAUSKE & ASSOCIATES, BURR RIDGE, IL.
**
**
** IMPORTANT NOTES ON THIS SPECIFIC PARAMETER FILE:
**
** 1. This parameter file was created by taking the current COOK_IPE
**    MAAP 3.0B parameter file and using the information in the D.C.
**    Cook Containment Data Collection Notebook.
**    Unless otherwise marked, values are specifically for D C COOK.
**    Single values taken from from ZION plant data are identified in
**    in the appropriate calculation sheets.
**
*************************************************************************
*************************************************************************
**
**THIS DECK IS IN BR UNITS (FT-LBM-HOUR-DEGF-GPM)
**
*BR
*************************************************************************
*CONCRETE AND CONTAINMENT SHELL  (PARAMETER GROUP #1)
*************************************************************************
**  UNLESS OTHERWISE STATED, CONCRETE PROPERTIES ARE FOR "PURE"
**
**  NOTE: CONSTITUENT MASS FRACTION (NOS. 05 - 15) SHOULD SUM TO 1.
**
**  D.C. CONTAINMENT EMPLOYS LIMESTONE/COMMON SAND
**
CPCN0  0.341   AVERAGE SPECIFIC HEAT OF CONCRETE
TCNMP  2546.6  MELTING TEMPERATURE OF CONCRETE
LHDEC  401.88  ENERGY ABSORBED IN ENDOTHERMIC CHEMICAL REACTIONS
**             DURING CONCRETE DECOMPOSITION
LHCN   274.    LATENT HEAT OF MELTING
**
**ALL THE CONCRETE MASS FRACS SHOULD ADD UP TO ROUGHLY 1.;
**
MFCN(1)  0.2576  MASS FRACTION OF CONCRETE THAT IS SIO2
MFCN(2)  0.2733  MASS FRACTION OF CONCRETE THAT IS CAO
MFCN(3)  0.0144  MASS FRACTION OF CONCRETE THAT IS AL2O3
MFCN(4)  0.0016  MASS FRACTION OF CONCRETE THAT IS K2O
MFCN(5)  0.0005  MASS FRACTION OF CONCRETE THAT IS NA2O
MFCN(6)  0.1201  MASS FRACTION OF CONCRETE THAT IS MGO,MNO,OR TIO2
MFCN(7)  0.0062  MASS FRACTION OF CONCRETE THAT IS FE2O3
MFCN(8)  0.0     MASS FRACTION OF CONCRETE THAT IS FE
MFCN(9)  0.0     MASS FRACTION OF CONCRETE THAT IS CR2O3
MFCN(10) 0.053   MASS FRACTION OF CONCRETE THAT IS H2O
MFCN(11) 0.2687  MASS FRACTION OF CONCRETE THAT IS CO2
DCSRCN   4.088   REBAR DENSITY (MASS OF REBAR PER UNIT VOLUME OF
**               REINFORCED CONCRETE)
TLIQCN   2546.   LIMESTONE/COMMON SAND CONCRETE LIQUIDUS - 1670 K
```

```
TSOLCN    2096.   LIMESTONE/COMMON SAND CONCRETE SOLIDUS - 1420 K
**
** DEFAULT VALUES TAKEN FROM ZION SAMPLE PARAMETER FILE
**
FCNSOL    0.1     CN SOLID FRACTION FOR SOLIDUS PLATEAU
FLCNSO    0.1     LIQUID FRACTION AT FCNSOL (0 IS IDEAL)
FLCNSL    0.1     LIQUID FRACTION FOR PURE CN+SO SOLID
FLCNLQ    0.9     LIQUID FRACTION FOR PURE CN+SO LIQUID
FCNSO1    0.49    FIRST CN COMPOSITION TO DECIDE UZR-CN LIQUIDUS
**              FOR LIMESTONE/COMMON SAND CONCRETE
FCNSO2    0.5     SECOND CN COMPOSITION TO DECIDE UZR-CN LIQUIDUS
**              FOR LIMESTONE/COMMON SAND CONCRETE
FCNSO3    0.51    THIRD CN COMPOSITION TO DECIDE UZR-CN LIQUIDUS
**
TCNLI1    3716.   LIMESTONE/COMMON SAND CN LIQUIDUS CORRESPONING TO FCNSO1
TCNLI2    3680.   LIMESTONE/COMMON SAND CN LIQUIDUS CORRESPONING TO FCNSO2
TCNLI3    3644.   LIMESTONE/COMMON SAND CN LIQUIDUS CORRESPONING TO FCNSO3
**
NIWALD    -1      WALL ORIENTATION FOR DOWNWARD WALL IN CONTACT CORIUM
POOL
NIWALS    1       WALL ORIENTATION FOR SIDEWALL WALL IN CONTACT CORIUM POOL
XWCNS     9.0     THICKNESS OF SIDEWARD WALL IN CONTACT WITH CORIUM POOL
XWCND     10.0    THICKNESS OF DOWNWARD WALL IN CONTACT WITH CORIUM POOL
FGMCCI    1       GEOMETERY FLAG: 1 = ROUND; 2 = ROUND NO SIDE EROSION
**              3 = SQUARE NO SIDE EROSION
**
** FOLLOWING QUANTITIES ARE USED IN THE DETAILED CONTAINMENT FAILURE
**  MODEL. THESE VALUES NEED NOT BE SUPPLIED IF THE "SIMPLE" MODEL IS
**  USED. (SEE *DETAILED CONTAINMENT FAILURE SECTION BELOW FOR OTHER
**  VALUES REQUIRED FOR THIS MODEL AND FOR DEFINITION OF THE "SIMPLE"
**  CONTAINMENT FAILURE MODEL).
**
** NOTE: FOR FREE-STANDING STEEL CONTAINMENTS. SUPPLY ONLY REBAR
**  PROPERTIES AND STEEL ("LINER") THICKNESS
**
** D.C. COOK IS NOT USING THE DETAILED CONTAINMENT FAILURE MODEL
**
PETEN     0.0   ELASTIC YOUNGS MODULUS FOR TENDONS
PEREB     0.0   ELASTIC YOUNGS MODULUS FOR REBAR
PEPTEN    0.0   PLASTIC YOUNGS MODULUS FOR TENDONS
PEPREB    0.0   PLASTIC YOUNGS MODULUS FOR REBAR
PSSPH     0.0   PRESTRESS ON HOOP TENDONS
PSSPZ     0.0   PRESTRESS ON AXIAL TENDONS
PSSYHT    0.0   TENDON YIELD STRESS
PSSYHR    0.0   REBAR YIELD STRESS
PSSFHT    0.0   TENDON ULTIMATE STRESS
PSSFHR    0.0   REBAR ULTIMATE STRESS
PEL       0.0   ELASTIC YOUNGS MODULUS FOR LINER
PEPL      0.0   PLASTIC YOUNGS MODULUS FOR LINER
PSSYHL    0.0   LINER YIELD STRESS
PSSFHL    0.0   LINER FAILURE STRESS
**
**
*************************************************************************
```

```
*ENGINEERED SAFEGUARDS
*******************************************************************
**
XDACUM  0.729   ACCUMULATOR PIPE DIAMETER
PLPI0   614.7   PRESSURE SETPOINT FOR RHR
PHPI0   1764.7  PRESSURE SETPOINT FOR SI
PACUM0  636.2   INITIAL PRESSURE OF ACCUMULATORS
TRWST   100.    TEMPERATURE OF REFUELING WATER STORAGE TANK (RWST)--IE
**              THE TANK FROM WHICH THE CHARGING, SI, RHR, AND SPRAYS
**              DRAW THEIR WATER DURING THE INJECTION PHASE
TACUM   150.    TEMPERATURE OF ACCUMULATORS
MRWST0  2900856. INITIAL MASS IN RWST (Basis=350000 gal)
MACUM0  57895.  INITIAL MASS PER COLD LEG ACCUMULATOR
ARWST   1809.56 AREA OF BASE OF RWST
XLACUM  81.32   LENGTH OF AN ACCUMULATOR PIPE
PSP0    17.6    PRESSURE SETPOINT OF BLDG SPRAYS
PFAN0   17.6    PRESSURE SETPOINT OF BLDG FANS
NFN     2       NUMBER OF OPERATING FANS, 1 OF 2
WVFN0   304810. VOLUMETRIC FLOW THROUGH ONE FAN
**              MAX/MIN=41800CFM.=39000 AIR RECIRC., 2800 SKIMMER/39700.=
**              37040 AIR RECIR., 2660 SKIMMER
XDSP    2.297D-3 NOMINAL DIAMETER OF CONTAINMENT SPRAY DROPLETS AS THEY
**              LEAVE THE SPRAY HEADER
VACUM   1350.   VOLUME OF ONE COLD LEG ACCUMULATOR
NACUM   4       NUMBER OF OPERATIONAL COLD LEG ACCUMULATORS
NHPI    2       NUMBER OF OPERATIONAL SI PUMPS 1 OF 2
NLPI    2       NUMBER OF OPERATIONAL  RHR PUMPS 1 OF 2
NHPIPT  5       NUMBER OF ENTRIES IN SI PUMP-HD CURVE TABLE(5 MAX)
ZHDHPI(1) 3277. HIGHEST HEAD IN TABLE (UNITS ARE FEET)
ZHDHPI(2) 3073. NEXT HIGHEST HEAD IN SI PUMP-HEAD CURVE TABLE
ZHDHPI(3) 2966. NEXT HIGHEST HEAD IN SI PUMP-HEAD CURVE TABLE
ZHDHPI(4) 2304. NEXT HIGHEST HEAD IN SI PUMP-HEAD CURVE TABLE
ZHDHPI(5) 1382. LOWEST HEAD IN SI PUMP-HEAD CURVE TABLE
WVHPI(1) 0.0    VOLUMETRIC FLOWRATE CORESPONDING TO FIRST ENTRY IN
**              THE PRESSURE TABLE
WVHPI(2) 148.   NEXT VOL. FLOWRATE
WVHPI(3) 242.   NEXT VOL. FLOWRATE
WVHPI(4) 454.   NEXT VOL. FLOWRATE
WVHPI(5) 650.   EXT VOL. FLOWRATE
NLPIPT  5       NUMBER OF ENTRIES IN RHR PUMP-HEAD CURVE TABLE
ZHDLPI(1) 410.  HIGHEST HEAD IN RHR PUMP-HEAD CURVE TABLE
ZHDLPI(2) 390.  NEXT HIGHEST HEAD IN RHR PUMP-HEAD CURVE TABLE
ZHDLPI(3) 370.  NEXT HIGHEST HEAD IN RHR PUMP-HEAD CURVE TABLE
ZHDLPI(4) 335.  NEXT HIGHEST HEAD IN RHR PUMP-HEAD CURVE TABLE
ZHDLPI(5) 305.  LOWEST HEAD IN RHR PUMP-HEAD CURVE TABLE
WVLPI(1) 0.0    VOLUMETRIC FLOWRATE CORRESPONDING TO FIRST ENTRY IN
**              THE RHR PUMP-HEAD TABLE
WVLPI(2) 2000.  NEXT VOL. FLOWRATE
WVLPI(3) 3000.  NEXT VOL. FLOWRATE
WVLPI(4) 4000.  NEXT VOL. FLOWRATE
WVLPI(5) 4500.  HIGHEST VOL. FLOWRATE IN RHR PUMP-HEAD CURVE TABLE
PCHP0   2754.7  CHARGING PUMP PRESSURE SETPOINT; CHARGING PUMPS ARE ASSUMED
**              TO BE OPERATING UNLESS MANUALLY LOCKED OFF
NCHP    2       NUMBER OF WORKING CHARGING PUMPS, 1 OF 2
```

```
NCHPPT     5      NUMBER OF ENTRIES IN CHARGING PUMP HEAD CURVE TABLE
ZHDCHP(1) 5880.  HIGHEST HEAD IN CHARGING PUMP-HEAD CURVE TABLE
ZHDCHP(2) 5570.  NEXT HIGHEST HEAD IN CHARGING PUMP-HEAD CURVE TABLE
ZHDCHP(3) 5040.  NEXT HIGHEST HEAD IN CHARGING PUMP-HEAD CURVE TABLE
ZHDCHP(4) 3005.  NEXT HIGHEST HEAD IN CHARGING PUMP-HEAD CURVE TABLE
ZHDCHP(5) 1431.  LOWEST HEAD IN CHARGING PUMP-HEAD CURVE TABLE
WVCHP(1)  0.0    VOLUMETRIC FLOWRATE CORRESPONDING TO FIRST ENTRY IN
**               THE CHARGING PUMP-HEAD TABLE
WVCHP(2)  192.   NEXT VOL. FLOWRATE
WVCHP(3)  257.   NEXT VOL. FLOWRATE
WVCHP(4)  450.   NEXT VOL. FLOWRATE
WVCHP(5)  550.   HIGHEST VOL. FLOWRATE IN CHARGING PUMP-HEAD CURVE TABLE
ACS      189.    AREA OF BASE OF CONTMT RECIRC SUMP (10.5 x 18.0)
**               SD-DCC-PM108 Rev 6. pg 4
ZCS      6.0     DEPTH OF CONTMT RECIRC SUMP, SD-DCC-PM108 Rev 6. pg 4
**NOTE, IF DESIRED YOU CAN SUPPLY ONE NUMBER--IF DO SO GIVE IT A LARGE
**HEAD. THEN A CONSTANT FLOW MODEL WILL BE USED
NSPPT    5       NUMBER OF USED ENTRIES IN SPRAY PUMP HEAD CURVES (5 MAX)
**               PUMP DESIGN PRESSURE IS > THE CONTAINMENT DESIGN PRESSURE
**               SPRAY PUMPS MAYBE REPRESENTED BY A SINGLE SET OF POINTS
ZHDSP(1)  560.   FIRST ENTRY IN SPRAY PUMP HEAD TABLE
ZHDSP(2)  535.   NEXT ENTRY IN SPRAY PUMP HEAD TABLE
ZHDSP(3)  515.   NEXT ENTRY IN SPRAY PUMP HEAD TABLE
ZHDSP(4)  480.   NEXT ENTRY IN SPRAY PUMP HEAD TABLE
ZHDSP(5)  425.   LAST ENTRY IN SPRAY PUMP HEAD TABLE
WVSP(1)   0.0    FIRST VOLUMETRIC FLOW ENTRY IN SPRAY PUMP TABLE
WVSP(2)   300.   NEXT VOLUMETRIC FLOW ENTRY IN SPRAY PUMP TABLE
WVSP(3)   400.   NEXT VOLUMETRIC FLOW ENTRY IN SPRAY PUMP TABLE
WVSP(4)   500.   NEXT VOLUMETRIC FLOW ENTRY IN SPRAY PUMP TABLE
WVSP(5)   600.   LAST VOLUMETRIC FLOW ENTRY IN SPRAY PUMP TABLE
** FOR NPSH TABLES, THE SAME FLOWS AS WERE GIVEN FOR HEAD CURVES ARE
** ASSUMED TO CORRESPOND TO THE NPSH HEADS GIVEN
ZHDRCH(1) 9.0    NPSH (UNITS OF LENGTH) REQ'D FOR CHARGING PUMP
**               AT FIRST FLOW IN TABLE
ZHDRCH(2) 11.5   NEXT NPSH ENTRY FOR CHARGING PUMPS
ZHDRCH(3) 13.5   NEXT NPSH ENTRY FOR CHARGING PUMPS
ZHDRCH(4) 19.0   NEXT NPSH ENTRY FOR CHARGING PUMPS
ZHDRCH(5) 22.5   NEXT NPSH ENTRY FOR CHARGING PUMPS
ZHDRLP(1)  9.0   FIRST NPSH ENTRY FOR RHR
ZHDRLP(2)  9.0   NEXT ENTRY FOR RHR
ZHDRLP(3) 11.0   NEXT ENTRY FOR RHR
ZHDRLP(4) 16.0   NEXT ENTRY FOR RHR
ZHDRLP(5) 19.0   NEXT ENTRY FOR RHR
ZHDRHP(1)  9.0   FIRST NPSH ENTRY FOR SI
ZHDRHP(2)  9.0   NEXT ENTRY FOR SI
ZHDRHP(3)  9.0   NEXT ENTRY FOR SI
ZHDRHP(4) 15.0   NEXT ENTRY FOR SI
ZHDRHP(5) 22.0   NEXT ENTRY FOR SI
ZHDRSP(1)  5.0   FIRST NPSH ENTRY FOR SPRAY PUMPS
ZHDRSP(1)  7.0   NEXT ENTRY FOR SPRAY PUMPS
ZHDRSP(1)  9.0   NEXT ENTRY FOR SPRAY PUMPS
ZHDRSP(1) 11.0   NEXT ENTRY FOR SPRAY PUMPS
ZHDRSP(1) 15.0   NEXT ENTRY FOR SPRAY PUMPS
NSPA     1       NUMBER OF OPERATING SPRAY PUMPS FOR UPPER COMPARTMENT
```

** NUMBER OF PUMPS = 5 REPRESENTS 5/8 OF 1 SPRAY TRAIN
NSPB 1 NUMBER OF OPERATING SPRAY PUMPS FOR LOWER COMPARTMENT
** NUMBER OF PUMPS = 3 REPRESENTS 3/8 OF 1 SPRAY TRAIN
** THE FOLLOWING 3 PARAMETERS WILL DETERMINE NPSH REQUIRED
ZESPRW 34.25 HEIGHT OF BOTTOM OF RWST ABOVE THE ENG SAFE PUMPS
ZESPCS 20.5 HEIGHT OF BOTTOM OF CONTAIN SUMP ABOVE THE ENG SAFE PUMPS
ZESPSI 39. HEIGHT OF THE RV INJECTION NOZZLES ABOVE THE SI PUMPS
WSPNZ0 1.5913D6 MASS FLOW THROUGH 1 SPRAY PUMP WHEN PSPNZ0 IS MEASURED
PSPNZ0 80. DIFFERENTIAL PRESSURE ACROSS THE SPRAY NOZZLES
** 80 PSID ACROSS UPPER CONTAINMENT SPRAY
** 40 PSID ACROSS LOWER CONTAINMENT SPRAY
WRWSTX 0.0 MASS FLOWRATE OF EXTERNAL RWST REPLACEMENT WATER, IF ANY
**
TDHPI 0.0003139 TIME DELAY FOR SI (IE TIME BETWEEN THE ACTUATION AND WHEN
** ACTUAL OPERATION BEGINS)
TDLPI 0.0001955 TIME DELAY FOR RHR PUMPS
TDCHP 0.0003167 TIME DELAY FOR CHARGING PUMPS
TDSPA 0.0125 TIME DELAY FOR UPPER COMPARTMENT SPRAYS
** MAX/MIN=45/25 SEC
TDSPB 0.0125 TIME DELAY FOR LOWER COMPARTMENT SPRAYS
** MAX/MIN=45/25 SEC
TDFAN 0.1667 TIME DELAY FOR FAN COOLERS
** MAX/MIN=600/480 SEC
** Input Parameters 102 thru 112 and 114 not applicable to D C Cook
** parameters are used to model fan ( with heat exchangers) cooler
** not recirculation fans
NTFC 0 NUMBER OF TUBES IN A FAN COOLER
ATFC 1.0D-10 OUTSIDE AREA OF ALL TUBES IN A FAN COOLER
AFINFC 1.0D-10 AREA OF ALL FINS IN A FAN COOLER
FFINFC 1.0D-10 FAN COOLER FIN EFFICIENCY
RGFLHX 1.0D-10 FAN COOLER INSIDE FOULING FACTOR
XDFNFC 1.0D-10 FAN COOLER FIN DIAMETER
XTTFC 1.0D-10 FAN COOLER TUBE THICKNESS
KTFC 1.0D-10 FAN COOLER TUBE THERMAL CONDUCTIVITY
AFLMNF 1.0D-10 MINIMUM FLOW AREA THROUGH FAN COOLER
XIDTFC 1.0D-10 FAN COOLER TUBE ID
NREGFC 0 NUMBER OF NODES USED TO MODEL FAN COOLER (5 MAX)
TCWHX 100. INLET COOLING WATER TEMP TO FAN COOLER--NOTE THIS IS
** ALSO USED AS THE COOLING WATER TEMP FOR ALL OTHER
** SAFEGUARDS HEAT EXCHANGERS -- range 100max/70min
** (Attachments to NSTD-SI-598/88)
WCWFC 1.0D-10 INLET COOLING WATER FLOW TO A FAN COOLER
NLPSP0 2 NUMBER OF RHR PUMPS USED FOR RHR SPRAYS WHEN VALVE OPEN
**
**ESF HX'S
**CALCULATIONS CONTROLLED BY HEAT EXCHANGER TYPE
**HEAT EXCHANGER TYPE:
** -1 SET OUTLET TEMP OF HX TO RWST TEMPERATURE
** 0 IS NO HX--OUTLET TEMP IS CONTMT SUMP TEMP
** 1 STRAIGHT TUBE HX
** 2 U-TUBE HX
**
**IMPORTANT NOTE:
**FOR HX TYPES 1 AND 2 EITHER SUPPLY ALL GEOMETRIC PARAMETERS

**OR THE NTU (NUMBER OF TRANSFER UNITS) PER HX--ALL KNOWN USERS DO
**THE LATTER--NTUS ARE AVAILABLE BY CONSULTING NAMEPLATE DATA AND
**USING GRAPHS IN, FOR EXAMPLE, HOLMAN, HEAT TRANSFER
**ALL PARAMETERS ARE ON A PER HX BASIS
**
** CONTAINMENT SPRAY HEAT EXCHANGERS
FHXSP 2 TYPE OF HX FOR SPRAY
NTSP 1150. NUMBER OF TUBES IN SPRAY HXS
NBSP 15 NUMBER OF SHELL SIDE BAFFLES IN SPRAY HXS
** assumed to be at approximately 2 ft intervals
XIDTSP 0.0462 SPRAY HX TUBE ID
XTTSP 0.00294 SPRAY HX TUBE THICKNESS
XTCSP 0.06771 TUBE TO TUBE SEPARATION IN SPRAY HX
XSSP 29.5833 SHELL LENGTH IN SPRAY HX
KTSP 375. THERMAL CONDUCTIVITY OF SPRAY HX TUBES
XBCRH 2.5 LARGEST PERP DISTANCE FROM SHELL TO BAFFLE ("BAFFLE CUT")
XSTSP 0.0475 SHELL TO TUBE CLEARANCE AT OUTSIDE OF SPRAY HX TUBE BDL
WCWSP 1650000. SPRAY HX COOLING WATER MASS FLOWRATE
ZWPZMU 1.D10 PRESSURIZER LEVEL SETPOINT FOR MAKEUP CONTROL SYSTEM, OR
** A LARGE NO. IF YOU DON'T WANT TO CONTROL MAKEUP AND/OR
** CHARGING PUMP FLOW ON PRESSURIZER LEVEL
** RHR HEAT EXCHANGERS
FHXRH 2 TYPE OF HX FOR RHR
NTRH 727. NUMBER OF TUBES IN RHR HXS
NBRH 29. NUMBER OF BAFFLES IN RHR HXS
XIDTRH 0.03576 TUBE ID IN RHR HXS
XTTRH 0.00816 TUBE THICKNESS IN RHR HXS
XTCRH 0.07292 TUBE TO TUBE SEPERATION IN RHR HXS
XSRH 58. SHELL LENGTH IN RHR HXS
KTRH 341. TUBE THERMAL CONDUCTIVITY IN RHR HXS
XBCRH 1.5833 BAFFLE CUT DISTANCE IN RHR HXS (SEE 125)
XSTRH 0.0242 SHELL TO TUBE CLEARANCE AT OUTSIDE OF RHR HX TUBE BUNDLE
** used to calculate a by-pass area between the sheel and tubes
WCWRH 2477835. RHR HX COOLING WATER MASS FLOWRATE
NTUSP 0.0 SPRAY HX NTU
NTURH 0.0 RHR HX NTU
XIDSSP 5.0 SHELL ID OF SPRAY RECIRC HX
XIDSRH 3.1667 SHELL ID OF RHR RECIRC HX
**ENTER ZERO VOLUME FOR ITEM 148 IF NO UHI SYSTEM
**144 INITIAL MASS IN THE UHI WATER ACCUMULATOR
**145 LENGTH OF THE UHI PIPE TO THE RV
**146 DIAMETER OF THE UHI PIPE
**147 INTIAL PRESSURE OF THE UHI ACCUMULATOR
VUHI 0.D0 TOTAL (WATER + GAS) VOLUME IN THE UHI ACCUMULATORS
**149 FAILURE DIFFERENTIAL PRESSURE OF THE UHI PIPE RUPTURE DISK
**THE "CAVITY INJECTION SYSTEM" IS (RARELY) USED TO SIMULATE A
**PROPOSED DEDICATED ESF WHICH MERELY DUMPS WATER INTO THE CAVITY
MWCIT0 0.D0 TOTAL MASS IN THE CAVITY INJECTION SYSTEM TANK
WWCI0 0.D0 MASS FLOWRATE OF THE CAV INJ SYSTEM WHEN ACTIVATED
** USER HAS THE OPTION TO THROTTLE ESF SYSTEMS AT LESS THAN
** THEIR FULL FLOW GIVEN THE CONDITIONS EXISTING--TO DO THIS,
** ENTER FOR THE APPROPRIATE SYSTEM (AND FOR THE AFW IN THE STM
** GENERATOR SECTION) A TOTAL FLOWRATE DESIRED; THE CODE WILL USE
** THE MINIMUM OF THIS FLOW AND THAT CALCULATED FROM THE HEAD CURVES

```
**   AND THE NO. OF OPERATIONAL PUMPS;IF OPERATOR ISN'T THROTTLING,
**   ENTER A LARGE NO.;IF HE CHANGES THE DEGREE OF THROTTLING, ENTER
**   PARAMETER CHANGES USING INTERVENTION NO. 1000 IN CONTROL CARDS
**   D C COOK UNIT 1 - NO THROTTLED FLOW
WLPIX   1.D10   THROTTLED FLOW FOR RHR SYSTEM (TOTAL)
WHPIX   1.D10   SAME FOR SI
WCHPX   1.D10   SAME FOR CHARGING PUMPS
WSPAX   1.D10   SAME FOR UPPER COMPT NORMAL SPRAYS
WLPSPX  1.D10   SAME FOR UPPER COMPT RHR SPRAYS (WHEN ACTIVATED)
WSPBX   1.D10   SAME FOR LOWER COMPT SPRAYS
** AFW PUMP HEAD CURVES (1MDAFW PUMP)
NAFWPT    5     NO. OF POINTS USED IN AFW PUMP-HEAD CURVE (5 MAX)
WVAFW(1)  0.0   FIRST VOL FLOW IN PUMP-HEAD CURVE
WVAFW(2)  150.  NEXT VOL FLOW IN PUMP-HEAD CURVE
WVAFW(3)  300.  NEXT VOL FLOW IN PUMP-HEAD CURVE
WVAFW(4)  450.  NEXT VOL FLOW IN PUMP-HEAD CURVE
WVAFW(5)  600.  LAST VOL FLOW IN PUMP-HEAD CURVE
ZHDAFW(1)  3300.  FIRST HEAD IN AFW PUMP-HEAD CURVE
ZHDAFW(2)  3250.  NEXT HEAD IN AFW PUMP-HEAD CURVE
ZHDAFW(3)  3100.  NEXT HEAD IN AFW PUMP-HEAD CURVE
ZHDAFW(4)  2800.  NEXT HEAD IN AFW PUMP-HEAD CURVE
ZHDAFW(5)  2300.  LAST HEAD IN AFW PUMP-HEAD CURVE
** AFW PUMP HEAD CURVES (1TDAFW PUMP)
**158  5      NO. OF POINTS USED IN AFW PUMP-HEAD CURVE (5 MAX)
**159  0.0    FIRST VOL FLOW IN PUMP-HEAD CURVE
**160  250.   NEXT VOL FLOW IN PUMP-HEAD CURVE
**161  500.   NEXT VOL FLOW IN PUMP-HEAD CURVE
**162  750.   NEXT VOL FLOW IN PUMP-HEAD CURVE
**163  1000.  LAST VOL FLOW IN PUMP-HEAD CURVE
**164  3550.  FIRST HEAD IN AFW PUMP-HEAD CURVE
**165  3550.  NEXT HEAD IN AFW PUMP-HEAD CURVE
**166  3400.  NEXT HEAD IN AFW PUMP-HEAD CURVE
**167  3000.  NEXT HEAD IN AFW PUMP-HEAD CURVE
**168  2500.  LAST HEAD IN AFW PUMP-HEAD CURVE
** NPSH REQUIREMENTS ARE MUCH HIGHER FOR TDAFW THEN FOR THE MDAFW-CHECK
ACST   2123.72  AREA OF BASE OF CST
ZCSTAF  14.98   HEIGHT THAT CST IS ABOVE AFW PUMPS
ZSGAFW  19.8    HEIGHT THAT S/G IS ABOVE AFW PUMPS
**
TDLP2  0.0     TIME DELAY FOR LPI TRAIN 2
TDSPC  0.0     TIME DELAY FOR CONTAINMENT SPRAY PUMPS TRAIN C
WSPCX  1.E10   TOTAL CONT SPRAY TRAIN C THROTTLED FLOW
WLP2X  1.E10   TOTAL LPPI TRAIN 2 THROTTLED FLOW
**
ZSPA    2.125   HEIGHT OF UPPER COMPT SPRAYS ABOVE BOTTOM OF JNUCS COMPT
ZSPA2   2.125   HEIGHT OF CNTMT SPRAY HEAD 2 ABOVE BOTTOM OF JNUCS COMPT
ZSPB   50.9687  HEIGHT OF CNTMT SPRAY HEAD ABOVE BOTTOM OF JNLCS COMPT
**
** NOTE: THESE ARE USED FOR SPRAY FALL HEIGHT & FOR HEAD FROM PUMP
**  DISCHARGE TO SPRAY HEADER IN AUXESF & SETPMP.
**
MWBAG0   0.0   THE MASS OF WATER IN NEUTRON BAGS
**
FBAACU   0.0   H3BO3 MASS FRACTION IN THE ACCUMULATOR WATER
```

```
FBARWS    0.0    H3BO3 MASS FRACTION IN THE RWST
**
*********************************************************************
*ICE CONDENSER   (PARAMETER GROUP #24)
*********************************************************************
**
MICE0   2.37D6    INITIAL MASS OF ICE
TWICE   15.       INITIAL TEMPERATURE OF ICE
VWICE   1.75D-2   SPECIFIC VOLUME OF ICE
AICE0   1.D-10    INITIAL SURFACE AREA OF ICE (unneeded if FHTICE > 1)
FHTICE  2         TYPE OF HEAT TRANSFER CALC'S TO DO
**                = 0, MECHANISTIC HT CALCS (still to be implemented)
**                  1, INPUT NOMINIAL HT COEFF.
**                  2, INPUT NOMINIAL EXIT TEMP, (MAAP 3.0B METHOD)
HTICE0  1.D-10    NOMINAL HT COEFFICIENT OF ICE (unneeded if FHTICE > 1)
**
**
*********************************************************************
*********************************************************************
**                                         **
**            DC COOK MAAP4 PARAMETER FILE               **
**                                         **
**            10 NODE CONTAINMENT MODEL                  **
**                                         **
**                                         **
*********************************************************************
*********************************************************************
**THIS DECK IS IN BR UNITS (FT-LBM-HOUR-DEGF-GPM)
*BR
*********************************************************************
*AUXILIARY BUILDING   (PARAMETER GROUP #19)
*********************************************************************
**
** COMPARTMENTS ARE CURRENTLY SET UP AS:
**
**    1) CAVITY
**    2) LOWER COMPARTMENT
**    3) ANNULAR-DEAD END COMPARTMENT
**    4) ICE CONDENSER COMPARTMENT
**    5) ICE CONDENSER UPPER PLENUM
**    6) UPPER COMPARTMENT CYLINDRICAL SECTION
**    7) UPPER COMPARTMENT LOWER DOME REGION
**    8) UPPER COMPARTMENT UPPER DOME REGION
**    9) PRESSURIZER ENCLOSURE
**   10) STEAM GENERATOR ENCLOSURE
**   11) ENVIRONMENT ( =COMPT INODRB+1)
**
VOLRB(1)    16339.   TOTAL FREE VOLUME OF COMPT 1  [3.0B:  VC0]
VOLRB(2)   306800.   TOTAL FREE VOLUME OF COMPT 2  [3.0B:  VB0]
VOLRB(3)    61702.   TOTAL FREE VOLUME OF COMPT 3  [3.0B:  VD0]
VOLRB(4)   126878.   TOTAL FREE VOLUME OF COMPT 4  [3.0B:  VI0]
VOLRB(5)    54988.   TOTAL FREE VOLUME OF COMPT 5  [3.0B:  VU]
VOLRB(6)   347732.   TOTAL FREE VOLUME OF COMPT 6
VOLRB(7)   334285.   TOTAL FREE VOLUME OF COMPT 7
```

VOLRB(8) 63879. TOTAL FREE VOLUME OF COMPT 8
VOLRB(9) 2700. TOTAL FREE VOLUME OF COMPT 9
VOLRB(10) 31000. TOTAL FREE VOLUME OF COMPT 10
**
ZFRB(1) -31.8 ELEV. OF FLOOR ABOVE GROUND LEVEL IN COMPT 1
ZFRB(2) 0.0 ELEV. OF FLOOR ABOVE GROUND LEVEL IN COMPT 2
ZFRB(3) -0.481 ELEV. OF FLOOR ABOVE GROUND LEVEL IN COMPT 3
ZFRB(4) 42.9 ELEV. OF FLOOR ABOVE GROUND LEVEL IN COMPT 4
ZFRB(5) 99.84 ELEV. OF FLOOR ABOVE GROUND LEVEL IN COMPT 5
ZFRB(6) 22.2 ELEV. OF FLOOR ABOVE GROUND LEVEL IN COMPT 6
ZFRB(7) 116.8 ELEV. OF FLOOR ABOVE GROUND LEVEL IN COMPT 7
ZFRB(8) 149.2 ELEV. OF FLOOR ABOVE GROUND LEVEL IN COMPT 8
ZFRB(9) 53.8 ELEV. OF FLOOR ABOVE GROUND LEVEL IN COMPT 9
ZFRB(10) 53.8 ELEV. OF FLOOR ABOVE GROUND LEVEL IN COMPT 10
**
AGKEY(1) 284.33 LARGEST CROSS-SECTIONAL GAS FLOW AREA IN COMPT 1
AGKEY(2) 3728. LARGEST CROSS-SECTIONAL GAS FLOW AREA IN COMPT 2
AGKEY(3) 3297. LARGEST CROSS-SECTIONAL GAS FLOW AREA IN COMPT 3
AGKEY(4) 2937. LARGEST CROSS-SECTIONAL GAS FLOW AREA IN COMPT 4
AGKEY(5) 1326. LARGEST CROSS-SECTIONAL GAS FLOW AREA IN COMPT 5
AGKEY(6) 6239. LARGEST CROSS-SECTIONAL GAS FLOW AREA IN COMPT 6
AGKEY(7) 10387. LARGEST CROSS-SECTIONAL GAS FLOW AREA IN COMPT 7
AGKEY(8) 5969. LARGEST CROSS-SECTIONAL GAS FLOW AREA IN COMPT 8
AGKEY(9) 100. LARGEST CROSS-SECTIONAL GAS FLOW AREA IN COMPT 9
AGKEY(10) 1256. LARGEST CROSS-SECTIONAL GAS FLOW AREA IN COMPT 10
**
XDGKEY(1) 16.9 HYDRAULIC DIAMETER ASSOCIATED W/ AGKEY IN COMPT 1
** IF ZERO, IT IS COMPUTED ASSUMING CIRCULAR CROSS-SECTION
XDGKEY(2) 0.0 HYDRAULIC DIAMETER ASSOCIATED W/ AGKEY IN COMPT 2
XDGKEY(3) 41.6 HYDRAULIC DIAMETER ASSOCIATED W/ AGKEY IN COMPT 3
XDGKEY(4) 43.1 HYDRAULIC DIAMETER ASSOCIATED W/ AGKEY IN COMPT 4
XDGKEY(5) 19.5 HYDRAULIC DIAMETER ASSOCIATED W/ AGKEY IN COMPT 5
XDGKEY(6) 0.0 HYDRAULIC DIAMETER ASSOCIATED W/ AGKEY IN COMPT 6
XDGKEY(7) 0.0 HYDRAULIC DIAMETER ASSOCIATED W/ AGKEY IN COMPT 7
XDGKEY(8) 0.0 HYDRAULIC DIAMETER ASSOCIATED W/ AGKEY IN COMPT 8
XDGKEY(9) 0.0 HYDRAULIC DIAMETER ASSOCIATED W/ AGKEY IN COMPT 9
XDGKEY(10) 0.0 HYDRAULIC DIAMETER ASSOCIATED W/ AGKEY IN COMPT 10
**
ASEDRB(1) 729.9 AEROSOL SEDIMENTATION AREA IN COMPT 1 [3.0B: ASEDC]
ASEDRB(2) 3728. AEROSOL SEDIMENTATION AREA IN COMPT 2 [3.0B: ASEDB]
ASEDRB(3) 6596. AEROSOL SEDIMENTATION AREA IN COMPT 3 [3.0B: ASEDD]
ASEDRB(4) 2995. AEROSOL SEDIMENTATION AREA IN COMPT 4 [3.0B: ASEDI]
ASEDRB(5) 1468.5 AEROSOL SEDIMENTATION AREA IN COMPT 5 [3.0B: ASEDU]
ASEDRB(6) 10387. AEROSOL SEDIMENTATION AREA IN COMPT 6
ASEDRB(7) 6132. AEROSOL SEDIMENTATION AREA IN COMPT 7
ASEDRB(8) 0. AEROSOL SEDIMENTATION AREA IN COMPT 8
ASEDRB(9) 46. AEROSOL SEDIMENTATION AREA IN COMPT 9
ASEDRB(10) 680. AEROSOL SEDIMENTATION AREA IN COMPT 10
**
AIMPRB(1) 0.0 IMPACTION AREA IN COMPT 1
AIMPRB(2) 0.0 IMPACTION AREA IN COMPT 2
AIMPRB(3) 0.0 IMPACTION AREA IN COMPT 3
** impaction is not modelled in the annular compartment because there is
** no gas flow from annular compartment into upper compartment.

** Fans take suction from upper regions & discharge into annular region.
AIMPRB(4) 0.0 IMPACTION AREA IN COMPT 4
** an impaction area in the ice condenser will be created once
** the ice melts (see *USEREVT section)
AIMPRB(5) 0.0 IMPACTION AREA IN COMPT 5
AIMPRB(6) 0.0 IMPACTION AREA IN COMPT 6
AIMPRB(7) 0.0 IMPACTION AREA IN COMPT 7
AIMPRB(8) 0.0 IMPACTION AREA IN COMPT 8
AIMPRB(9) 0.0 IMPACTION AREA IN COMPT 9
AIMPRB(10) 0.0 IMPACTION AREA IN COMPT 10
**
XDIMRB(1) 0.0208 IMPACTION DIAMETER FOR COMPT 1 [3.0B: XDIMP]
XDIMRB(2) 0.0208 IMPACTION DIAMETER FOR COMPT 2 [3.0B: XDIMP]
XDIMRB(3) 0.0208 IMPACTION DIAMETER FOR COMPT 3 [3.0B: XDIMP]
XDIMRB(4) 0.0208 IMPACTION DIAMETER FOR COMPT 4 [3.0B: XDIMP]
XDIMRB(5) 0.0208 IMPACTION DIAMETER FOR COMPT 5 [3.0B: XDIMP]
XDIMRB(6) 0.0208 IMPACTION DIAMETER FOR COMPT 6
XDIMRB(7) 0.0208 IMPACTION DIAMETER FOR COMPT 7
XDIMRB(8) 0.0208 IMPACTION DIAMETER FOR COMPT 8
XDIMRB(9) 0.0208 IMPACTION DIAMETER FOR COMPT 9
XDIMRB(10) 0.0208 IMPACTION DIAMETER FOR COMPT 10
**
AGRARB(1) 0.0 FLOW AREA AT ELEVATION OF GRATING THRU COMPT 1
AGRARB(2) 0.0 FLOW AREA AT ELEVATION OF GRATING THRU COMPT 2
AGRARB(3) 2995. FLOW AREA AT ELEVATION OF GRATING THRU COMPT 3
AGRARB(4) 2937. FLOW AREA AT ELEVATION OF GRATING THRU COMPT 4
AGRARB(5) 0.0 FLOW AREA AT ELEVATION OF GRATING THRU COMPT 5
AGRARB(6) 0.0 FLOW AREA AT ELEVATION OF GRATING THRU COMPT 6
AGRARB(7) 0.0 FLOW AREA AT ELEVATION OF GRATING THRU COMPT 7
AGRARB(8) 0.0 FLOW AREA AT ELEVATION OF GRATING THRU COMPT 8
AGRARB(9) 0.0 FLOW AREA AT ELEVATION OF GRATING THRU COMPT 9
AGRARB(10) 0.0 FLOW AREA AT ELEVATION OF GRATING THRU COMPT 10
**
WSPRB(1) 0.0 NON-SAFETY SPRAY MASS FLOW RATE FOR COMPT 1
WSPRB(2) 0.0 NON-SAFETY SPRAY MASS FLOW RATE FOR COMPT 2
WSPRB(3) 0.0 NON-SAFETY SPRAY MASS FLOW RATE FOR COMPT 3
WSPRB(4) 0.0 NON-SAFETY SPRAY MASS FLOW RATE FOR COMPT 4
WSPRB(5) 0.0 NON-SAFETY SPRAY MASS FLOW RATE FOR COMPT 5
WSPRB(6) 0.0 NON-SAFETY SPRAY MASS FLOW RATE FOR COMPT 6
WSPRB(7) 0.0 NON-SAFETY SPRAY MASS FLOW RATE FOR COMPT 7
WSPRB(8) 0.0 NON-SAFETY SPRAY MASS FLOW RATE FOR COMPT 8
WSPRB(9) 0.0 NON-SAFETY SPRAY MASS FLOW RATE FOR COMPT 9
WSPRB(10) 0.0 NON-SAFETY SPRAY MASS FLOW RATE FOR COMPT 10
**
XHSPRB(1) 0.0 NON-SAFETY SPRAY FALL HEIGHT FOR COMPT 1
XHSPRB(2) 0.0 NON-SAFETY SPRAY FALL HEIGHT FOR COMPT 2
XHSPRB(3) 0.0 NON-SAFETY SPRAY FALL HEIGHT FOR COMPT 3
XHSPRB(4) 0.0 NON-SAFETY SPRAY FALL HEIGHT FOR COMPT 4
XHSPRB(5) 0.0 NON-SAFETY SPRAY FALL HEIGHT FOR COMPT 5
XHSPRB(6) 94.0 NON-SAFETY SPRAY FALL HEIGHT FOR COMPT 6
XHSPRB(7) 32.4 NON-SAFETY SPRAY FALL HEIGHT FOR COMPT 7
XHSPRB(8) 2.125 NON-SAFETY SPRAY FALL HEIGHT FOR COMPT 8
XHSPRB(9) 0.0 NON-SAFETY SPRAY FALL HEIGHT FOR COMPT 9
XHSPRB(10) 0.0 NON-SAFETY SPRAY FALL HEIGHT FOR COMPT 10

```
**
FIDRRB(1)  0   IF POSITIVE INSTANTLY DRAIN ALL WATER
**              TO COMPARTMENT IV;
**           IF 0, DRAIN WATER NORMALLY THROUGH COMPT 1 OPENINGS
**                (GAS/WATER FLOW PATHS)
FIDRRB(2)  0   WATER DRAINAGE MODELLED AS FLOW JUNCTION IN COMPT 2
FIDRRB(3)  0   WATER DRAINAGE MODELLED AS FLOW JUNCTION IN COMPT 3
FIDRRB(4)  0   WATER DRAINAGE MODELLED AS FLOW JUNCTION IN COMPT 4
FIDRRB(5)  0   WATER DRAINAGE MODELLED AS FLOW JUNCTION IN COMPT 5
FIDRRB(6)  0   WATER DRAINAGE MODELLED AS FLOW JUNCTION IN COMPT 6
FIDRRB(7)  0   WATER DRAINAGE MODELLED AS FLOW JUNCTION IN COMPT 7
FIDRRB(8)  0   WATER DRAINAGE MODELLED AS FLOW JUNCTION IN COMPT 8
FIDRRB(9)  0   WATER DRAINAGE MODELLED AS FLOW JUNCTION IN COMPT 9
FIDRRB(10) 0   WATER DRAINAGE MODELLED AS FLOW JUNCTION IN COMPT 10
**
** PARAMETERS FOR SPRAY FALLING THROUGH COMPARTMENT JUNCTIONS BELOW
SPRAY HEADER
** SPRAY HEADER IS IN COMPARTMENT 8 BUT CAN ALSO FALL FROM 8 TO 7 AND FROM 7
** TO 6
NSPS(1)   8    SOURCE COMPARTMENT FOR SPRAY FLOW
NSPR(1)   7    RECEIVER COMPARTMENT FOR SPRAY FLOW
FSPR(1)   1.0  FRACTION OF SPRAY FLOW ENTERING RECEIVER COMPARTMENT
NSPS(2)   7    SOURCE COMPARTMENT FOR SPRAY FLOW
NSPR(2)   6    RECEIVER COMPARTMENT FOR SPRAY FLOW
FSPR(2)   1.0  FRACTION OF SPRAY FLOW ENTERING RECEIVER COMPARTMENT
**
WC2RB(1)  0.0    CO2 MASS FLOW FROM FIRE SUPP SYSTEM INTO COMPT 1
WC2RB(2)  0.0    CO2 MASS FLOW FROM FIRE SUPP SYSTEM INTO COMPT 2
WC2RB(3)  0.0    CO2 MASS FLOW FROM FIRE SUPP SYSTEM INTO COMPT 3
WC2RB(4)  0.0    CO2 MASS FLOW FROM FIRE SUPP SYSTEM INTO COMPT 4
WC2RB(5)  0.0    CO2 MASS FLOW FROM FIRE SUPP SYSTEM INTO COMPT 5
WC2RB(6)  0.0    CO2 MASS FLOW FROM FIRE SUPP SYSTEM INTO COMPT 6
WC2RB(7)  0.0    CO2 MASS FLOW FROM FIRE SUPP SYSTEM INTO COMPT 7
WC2RB(8)  0.0    CO2 MASS FLOW FROM FIRE SUPP SYSTEM INTO COMPT 8
WC2RB(9)  0.0    CO2 MASS FLOW FROM FIRE SUPP SYSTEM INTO COMPT 9
WC2RB(10) 0.0    CO2 MASS FLOW FROM FIRE SUPP SYSTEM INTO COMPT 10
**
TGRB0(1)   120.   INITIAL GAS TEMPERATURE IN COMPT 1 (= TGB0)
TGRB0(2)   120.   INITIAL GAS TEMPERATURE IN COMPT 2 (= TGB0)
TGRB0(3)   120.   INITIAL GAS TEMPERATURE IN COMPT 3 (= TGB0)
TGRB0(4)   15.    INITIAL GAS TEMPERATURE IN COMPT 4 (= TGI0)
TGRB0(5)   15.    INITIAL GAS TEMPERATURE IN COMPT 5 (= TGI0)
TGRB0(6)   100.   INITIAL GAS TEMPERATURE IN COMPT 6 (= TGA0)
TGRB0(7)   100.   INITIAL GAS TEMPERATURE IN COMPT 7 (= TGA0)
TGRB0(8)   100.   INITIAL GAS TEMPERATURE IN COMPT 8 (= TGA0)
TGRB0(9)   120.   INITIAL GAS TEMPERATURE IN COMPT 9 (= TGB0)
TGRB0(10)  120.   INITIAL GAS TEMPERATURE IN COMPT 10(= TGB0)
**
PRB0(1)   14.7    INITIAL PRESSURE IN COMPT 1
PRB0(2)   14.7    INITIAL PRESSURE IN COMPT 2
PRB0(3)   14.7    INITIAL PRESSURE IN COMPT 3
PRB0(4)   13.85   INITIAL PRESSURE IN COMPT 4
PRB0(5)   13.85   INITIAL PRESSURE IN COMPT 5
PRB0(6)   14.7    INITIAL PRESSURE IN COMPT 6
```

```
PRB0(7)     14.7    INITIAL PRESSURE IN COMPT 7
PRB0(8)     14.7    INITIAL PRESSURE IN COMPT 8
PRB0(9)     14.7    INITIAL PRESSURE IN COMPT 9
PRB0(10)    14.7    INITIAL PRESSURE IN COMPT 10
**
FRHB0(1)    0.7     INITIAL RELATIVE HUMIDITY IN COMPT 1
FRHB0(2)    0.7     INITIAL RELATIVE HUMIDITY IN COMPT 2
FRHB0(3)    0.7     INITIAL RELATIVE HUMIDITY IN COMPT 3
FRHB0(4)    0.2     INITIAL RELATIVE HUMIDITY IN COMPT 4
FRHB0(5)    0.2     INITIAL RELATIVE HUMIDITY IN COMPT 5
FRHB0(6)    0.7     INITIAL RELATIVE HUMIDITY IN COMPT 6
FRHB0(7)    0.7     INITIAL RELATIVE HUMIDITY IN COMPT 7
FRHB0(8)    0.7     INITIAL RELATIVE HUMIDITY IN COMPT 8
FRHB0(9)    0.7     INITIAL RELATIVE HUMIDITY IN COMPT 9
FRHB0(10)   0.7     INITIAL RELATIVE HUMIDITY IN COMPT 10
**
NIGRB(1)    0.0     NUMBER OF IGNITERS IN COMPT 1  [3.0B:  NIGC]
NIGRB(2)    7.0     NUMBER OF IGNITERS IN COMPT 2  [3.0B:  NIGB]
NIGRB(3)    5.0     NUMBER OF IGNITERS IN COMPT 3  [3.0B:  NIGD]
NIGRB(4)    0.0     NUMBER OF IGNITERS IN COMPT 4
NIGRB(5)    7.0     NUMBER OF IGNITERS IN COMPT 5  [3.0B:  NIGU]
NIGRB(6)    9.0     NUMBER OF IGNITERS IN COMPT 6
NIGRB(7)    0.0     NUMBER OF IGNITERS IN COMPT 7
NIGRB(8)    6.0     NUMBER OF IGNITERS IN COMPT 8
NIGRB(9)    1.0     NUMBER OF IGNITERS IN COMPT 9
NIGRB(10)   0.0     NUMBER OF IGNITERS IN COMPT 10
**
XIGRB(1)    1.E-10   AVG. EL. OF IGNITERS OFF FLOOR OF COMPT 1  [3.0B:  XIGC]
XIGRB(2)    49.2     AVG. EL. OF IGNITERS OFF FLOOR OF COMPT 2  [3.0B:  XIGB]
XIGRB(3)    21.6     AVG. EL. OF IGNITERS OFF FLOOR OF COMPT 3  [3.0B:  XIGD]
XIGRB(4)    1.E-10   AVG. EL. OF IGNITERS OFF FLOOR OF COMPT 4
XIGRB(5)    10.4     AVG. EL. OF IGNITERS OFF FLOOR OF COMPT 5  [3.0B:  XIGU]
XIGRB(6)    9.4      AVG. EL. OF IGNITERS OFF FLOOR OF COMPT 6
XIGRB(7)    1.E-10   AVG. EL. OF IGNITERS OFF FLOOR OF COMPT 7
XIGRB(8)    1.E-10   AVG. EL. OF IGNITERS OFF FLOOR OF COMPT 8
XIGRB(9)    33.4     AVG. EL. OF IGNITERS OFF FLOOR OF COMPT 9
XIGRB(10)   1.E-10   AVG. EL. OF IGNITERS OFF FLOOR OF COMPT 10
**
** EVEN IF A COMPARTMENT MAY HAVE NO IGNITERS, INPUTS TO XRBRRB AND
**  XHBRRB ARE STILL REQUIRED, SINCE GLOBAL BURN MAY OCCUR AND BURN
**  MODEL NEEDS THESE PARAMETERS.
**
XRBRRB(1)    6.0     EFFECTIVE BURN RADIUS IN COMPT 1  [3.0B:  XRBRC]
XRBRRB(2)    21.5    EFFECTIVE BURN RADIUS IN COMPT 2  [3.0B:  XRBRB]
XRBRRB(3)    11.0    EFFECTIVE BURN RADIUS IN COMPT 3  [3.0B:  XRBRD]
XRBRRB(4)    5.5     EFFECTIVE BURN RADIUS IN COMPT 4
XRBRRB(5)    13.0    EFFECTIVE BURN RADIUS IN COMPT 5  [3.0B:  XRBRU]
XRBRRB(6)    44.5    EFFECTIVE BURN RADIUS IN COMPT 6
XRBRRB(7)    41.5    EFFECTIVE BURN RADIUS IN COMPT 7
XRBRRB(8)    43.6    EFFECTIVE BURN RADIUS IN COMPT 8
XRBRRB(9)    5.5     EFFECTIVE BURN RADIUS IN COMPT 9
XRBRRB(10)   10.5    EFFECTIVE BURN RADIUS IN COMPT 10
**
XHBRRB(1)    16.67   EFFECTIVE BURN HEIGHT IN COMPT 1  [3.0B:  XHBRC]
```

XHBRRB(2) 50.97 EFFECTIVE BURN HEIGHT IN COMPT 2 [3.0B: XHBRB]
XHBRRB(3) 45.17 EFFECTIVE BURN HEIGHT IN COMPT 3 [3.0B: XHBRD]
XHBRRB(4) 56.94 EFFECTIVE BURN HEIGHT IN COMPT 4
XHBRRB(5) 17.0 EFFECTIVE BURN HEIGHT IN COMPT 5 [3.0B: XHBRU]
XHBRRB(6) 94.6 EFFECTIVE BURN HEIGHT IN COMPT 6
XHBRRB(7) 32.4 EFFECTIVE BURN HEIGHT IN COMPT 7
XHBRRB(8) 20.0 EFFECTIVE BURN HEIGHT IN COMPT 8
XHBRRB(9) 37.4 EFFECTIVE BURN HEIGHT IN COMPT 9
XHBRRB(10) 37.4 EFFECTIVE BURN HEIGHT IN COMPT 10
**
XWRB0(1) 0.0 INITIAL HEIGHT OF WATER IN COMPT 1
XWRB0(2) 0.0 INITIAL HEIGHT OF WATER IN COMPT 2
XWRB0(3) 0.0 INITIAL HEIGHT OF WATER IN COMPT 3
XWRB0(4) 0.0 INITIAL HEIGHT OF WATER IN COMPT 4
XWRB0(5) 0.0 INITIAL HEIGHT OF WATER IN COMPT 5
XWRB0(6) 0.0 INITIAL HEIGHT OF WATER IN COMPT 6
XWRB0(7) 0.0 INITIAL HEIGHT OF WATER IN COMPT 7
XWRB0(8) 0.0 INITIAL HEIGHT OF WATER IN COMPT 8
XWRB0(9) 0.0 INITIAL HEIGHT OF WATER IN COMPT 9
XWRB0(10) 0.0 INITIAL HEIGHT OF WATER IN COMPT 10
**
TWRB0(1) 70.0 INITIAL TEMPERATURE OF WATER IN COMPT 1
TWRB0(2) 70.0 INITIAL TEMPERATURE OF WATER IN COMPT 2
TWRB0(3) 70.0 INITIAL TEMPERATURE OF WATER IN COMPT 3
TWRB0(4) 70.0 INITIAL TEMPERATURE OF WATER IN COMPT 4
TWRB0(5) 70.0 INITIAL TEMPERATURE OF WATER IN COMPT 5
TWRB0(6) 70.0 INITIAL TEMPERATURE OF WATER IN COMPT 6
TWRB0(7) 70.0 INITIAL TEMPERATURE OF WATER IN COMPT 7
TWRB0(8) 70.0 INITIAL TEMPERATURE OF WATER IN COMPT 8
TWRB0(9) 70.0 INITIAL TEMPERATURE OF WATER IN COMPT 9
TWRB0(10) 70.0 INITIAL TEMPERATURE OF WATER IN COMPT 10
**
*********************************************************************
*********************************************************************
**
** XRBLK(I,IV)= ITH HEIGHT LOOKUP ENTRY FOR IV'TH COMPT
** VRBLK(I,IV)= ITH VOLUME LOOKUP ENTRY FOR IV'TH COMPT
**
** MAX OF 10 LOOKUP ENTRIES ARE ALLOWED
** IF ONLY TWO ENTRIES ARE USED, IT IS EQUIVALENT TO CONSTANT AREA ASSUMPTION
** IN 3B MODEL
**
*********************************************************************
** CAVITY COMPT
*********************************************************************
**
XRBLK(1,1) 0.0 (ELEV. 566'-11 3/4")
VRBLK(1,1) 0.0
XRBLK(2,1) 17.4 (ELEV. 584'-3 1/2")
VRBLK(2,1) 11546.3
XRBLK(3,1) 26.98 (ELEV. 593'-10 15/32")
VRBLK(3,1) 13586.7
XRBLK(4,1) 29.90 (ELEV. 596'-9 3/4")

```
VRBLK(4,1)   14282.0
XRBLK(5,1)    54.0   (ELEV. 621'-0")
VRBLK(5,1)   16336.9
**
*********************************************************************
** LOWER COMPT
*********************************************************************
**
XRBLK(1,2)     0.0  (ELEV. 598'-9 3/8")
VRBLK(1,2)     0.0
XRBLK(2,2)    15.0
VRBLK(2,2)   55905.
XRBLK(3,2)    50.9  (BOTTOM OF OPERATING DECK)
VRBLK(3,2)   306800.
**
*********************************************************************
** ANNULAR COMPT
*********************************************************************
**
XRBLK(1,3)     0.0  (FLOOR OF ANNULAR COMPARTMENT)
VRBLK(1,3)     0.0
XRBLK(2,3)    15.0
VRBLK(2,3)   49455.
XRBLK(3,3)    39.8  (ELEV. 638' - 2" -  TOP OF ANNULAR COMPT)
VRBLK(3,3)   61702.
**
*********************************************************************
** ICE COND COMPT
*********************************************************************
**
XRBLK(1,4)     0.0  (BOTTOM  OF ICE BOX - ELEV. 641' - 8-1/4")
VRBLK(1,4)     0.0
XRBLK(2,4)    56.94  (TOP OF ICE BOX - ELEV. 698' - 7-1/2")
VRBLK(2,4)   126878.
**
*********************************************************************
** ICE CONDENSER UPPER PLENUM
*********************************************************************
**
XRBLK(1,5)     0.0  (BOTTOM OF UPPER PLENUM IC - ELEV. 698' - 7-1/2")
VRBLK(1,5)     0.0
XRBLK(2,5)    17.0  (TOP OF UPPER PLENUM IC - ELEV. 715'  - 7 1/2")
VRBLK(2,5)   61098.
**
*********************************************************************
** UPPER COMPARTMENT CYLINDRICAL SECTION, NODE 6
*********************************************************************
**
XRBLK(1,6)     0.0   (BOTTOM OF REFUELING POOL  ELEV. 621' - 1 1/2")
VRBLK(1,6)     0.0
XRBLK(2,6)    31.5   (OPERATING DECK  ELEV. 652' - 7 1/2")
VRBLK(2,6)   24919.
XRBLK(3,6)   68.90   (TOP OF SG CUBICLES  ELEV. 690' - 0")
VRBLK(3,6)   204068.
```

```
XRBLK(4,6)   94.0  (TOP OF ICE BOX VENT DOORS  ELEV. 715' - 1 1/2")
VRBLK(4,6)  380523.
**
**********************************************************************
** UPPER COMPARTMENT LOWER DOME REGION, NODE 7
**********************************************************************
**
XRBLK(1,7)    0.0
VRBLK(1,7)    0.0
XRBLK(2,7)   32.4
VRBLK(2,7)  301494.
**
**********************************************************************
** UPPER COMPARTMENT UPPER DOME REGION, NODE 8
**********************************************************************
**
XRBLK(1,8)    0.0
VRBLK(1,8)    0.0
XRBLK(2,8)   20.0
VRBLK(2,8)   63879.
**
**********************************************************************
** PRESSURIZER ENCLOSURE, NODE 9
**********************************************************************
**
XRBLK(1,9)    0.0
VRBLK(1,9)    0.0
XRBLK(2,9)   37.4
VRBLK(2,9)  2700.
**
**********************************************************************
** STREAM GENERATOR ENCLOSURE, NODE 10
**********************************************************************
**
XRBLK(1,10)   0.0
VRBLK(1,10)   0.0
XRBLK(2,10)  37.4
VRBLK(2,10) 31000.
**
**
** INITIAL CONDITION DATA AND OTHER DATA WHICH APPLY TO ALL COMPTS
**
MSPRB0    0.0     INITIAL MASS OF WATER AVAILABLE FOR FIRE SPRAY
MC2RB0    0.0     INITIAL MASS OF CO2 IN FIRE SUPPRESSION SYSTEM
TWSPRB     70     AUX BLDG SPRAY WATER TEMPERATURE
XDSPRB    3.D-3    AUX BLDG SPRAY DROP DIAMETER (1 mm)
TFDAMP     1.D10    FIRE DAMPER ACTIVATION TEMP
TSPRB     1.D10    FIRE SPRAY ACTIVATION TEMP
TC2RB     1.D10    CO2 INJECTION ACTIVATION TEMP
**
WNAOH(1)   0.0     INJECTION NAOH MASS FLOW RATE TO COMPT NODE 1
WNAOH(2)   0.0     INJECTION NAOH MASS FLOW RATE TO COMPT NODE 2
WNAOH(3)   0.0     INJECTION NAOH MASS FLOW RATE TO COMPT NODE 3
WNAOH(4)   0.0     INJECTION NAOH MASS FLOW RATE TO COMPT NODE 4
```

```
WNAOH(5)   0.0     INJECTION NAOH MASS FLOW RATE TO COMPT NODE 5
WNAOH(6)   0.0     INJECTION NAOH MASS FLOW RATE TO COMPT NODE 6
WNAOH(7)   0.0     INJECTION NAOH MASS FLOW RATE TO COMPT NODE 7
WNAOH(8)   0.0     INJECTION NAOH MASS FLOW RATE TO COMPT NODE 8
WNAOH(9)   0.0     INJECTION NAOH MASS FLOW RATE TO COMPT NODE 9
WNAOH(10)  0.0     INJECTION NAOH MASS FLOW RATE TO COMPT NODE 10
**
** WACID(I) - EQUIVALENT HNO3 OF any acid MASS FLOW INTO THE CONTAINMENT
**         NODE I (KG/SEC)
**         FOR EXAMPLE, TO INJECT 0.1 K-MOLE/SEC OF HCL INTO NODE 1
**         WACID(1)=0.1*Mhno3/Mhcl kg/sec,
**
WACID(1)   0.0   EQ. HNO3 OF ANY ACID MASS FLOW INTO COMPT 1
WACID(2)   0.0   EQ. HNO3 OF ANY ACID MASS FLOW INTO COMPT 2
WACID(3)   0.0   EQ. HNO3 OF ANY ACID MASS FLOW INTO COMPT 3
WACID(4)   0.0   EQ. HNO3 OF ANY ACID MASS FLOW INTO COMPT 4
WACID(5)   0.0   EQ. HNO3 OF ANY ACID MASS FLOW INTO COMPT 5
WACID(6)   0.0   EQ. HNO3 OF ANY ACID MASS FLOW INTO COMPT 6
WACID(7)   0.0   EQ. HNO3 OF ANY ACID MASS FLOW INTO COMPT 7
WACID(8)   0.0   EQ. HNO3 OF ANY ACID MASS FLOW INTO COMPT 8
WACID(9)   0.0   EQ. HNO3 OF ANY ACID MASS FLOW INTO COMPT 9
WACID(10)  0.0   EQ. HNO3 OF ANY ACID MASS FLOW INTO COMPT 10
**
** SGTS FILTER MODEL INPUT PER JUNCTION, J=1 THRU 120
**
MAERFF(1)   1.D10   MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
MAERFF(2)   1.D10   MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
MAERFF(3)   1.D10   MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
MAERFF(4)   1.D10   MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
MAERFF(5)   1.D10   MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
MAERFF(6)   1.D10   MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
MAERFF(7)   1.D10   MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
MAERFF(8)   1.D10   MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
MAERFF(9)   1.D10   MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
MAERFF(10)  1.D10   MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
**
FDFFIL(1)   1.0   DF USED FILTERING EFFECT WHEN THEY ARE INTACT
FDFFIL(2)   1.0   DF USED FILTERING EFFECT WHEN THEY ARE INTACT
FDFFIL(3)   1.0   DF USED FILTERING EFFECT WHEN THEY ARE INTACT
FDFFIL(4)   1.0   DF USED FILTERING EFFECT WHEN THEY ARE INTACT
FDFFIL(5)   1.0   DF USED FILTERING EFFECT WHEN THEY ARE INTACT
FDFFIL(6)   1.0   DF USED FILTERING EFFECT WHEN THEY ARE INTACT
FDFFIL(7)   1.0   DF USED FILTERING EFFECT WHEN THEY ARE INTACT
FDFFIL(8)   1.0   DF USED FILTERING EFFECT WHEN THEY ARE INTACT
FDFFIL(9)   1.0   DF USED FILTERING EFFECT WHEN THEY ARE INTACT
FDFFIL(10)  1.0   DF USED FILTERING EFFECT WHEN THEY ARE INTACT
**
JSGTS(1)   1   FLAG FOR FILTERING CONTROL;
**             =0 OPERATIVE, =1 FAILED/INOPERATIVE
**             BY DEFAULT, JSTGS IS = 1, SET IT TO 0 TO TURN ON FILTER
**             JSGTS IS SET = 1 WHEN MAERFF > MAERF (MASS COLLECTED)
**
JSGTS(2)   1   FLAG FOR FILTERING CONTROL;
JSGTS(3)   1   FLAG FOR FILTERING CONTROL;
```

```
JSGTS(4)    1     FLAG FOR FILTERING CONTROL;
JSGTS(5)    1     FLAG FOR FILTERING CONTROL;
JSGTS(6)    1     FLAG FOR FILTERING CONTROL;
JSGTS(7)  . 1     FLAG FOR FILTERING CONTROL;
JSGTS(8)    1     FLAG FOR FILTERING CONTROL;
JSGTS(9)    1     FLAG FOR FILTERING CONTROL;
JSGTS(10)   1     FLAG FOR FILTERING CONTROL;
**
***********************************************************************
*INTERFACES   (PARAMETER GROUP #4)
***********************************************************************
** HEIGHTS OF INTERFACES BETWEEN PS & CONTAINMENT OR AUXILIARY BUILDING
**
ZNRV     6.78    HEIGHT OF SRV PIPE EXIT ABOVE FLOOR OF QT OR COMPT
**               RECEIVING SRV EFFLUENT
** assumes that the SRVs discharge at approximately the PRT
** centerline
**
ZNBB    12.87    HEIGHT OF PS BL BREAK ABOVE FLOOR OF RECEIVING COMPT
ZNUB    12.87    HEIGHT OF PS UL BREAK ABOVE FLOOR OF RECEIVING COMPT
ZNVP   18.4761   HEIGHT OF RPV FAILURE ABOVE FLOOR OF RECEIVING COMPT
**               [3.0B: ZBV]
ZNMSLB   81.1    HEIGHT OF SG BREAK ABOVE FLOOR OF RECEIVING COMPT
** the above break elevation is an estimate for the height of the
** steam line above the floor of the lower compartment
**
ZNGO(1)   0.0    HEIGHT OF GEN. OPENING 1 ABOVE FLOOR OF REC. COMPT
ZNGO(2)   0.0    HEIGHT OF GEN. OPENING 2 ABOVE FLOOR OF REC. COMPT
ZNGO(3)   0.0    HEIGHT OF GEN. OPENING 3 ABOVE FLOOR OF REC. COMPT
**
**@@@M4.0  KYS  8/10/93  ADDED PARAMETER GROUP POINTERS
***********************************************************************
*POINTERS   (PARAMETER GROUP #5)
***********************************************************************
** THESE POINTERS IDENTIFY CONTAINMENT LOCATIONS OF PS COMPTS,
** SPECIALIZED CONTAINMENT COMPT ID NOS, ID NOS OF CONTAINMENT
** COMPTS THAT CAN CONTAIN CORIUM, AND ID NOS OF CONTAINMENT
** FLOW PATHS ON WHICH CORIUM MAY FLOW
**
** PRIMARY SYSTEM LOCATIONS IN CONTAINMENT
**
JNPS(1)    2    ID NO OF CTMT COMPT CONTAINING CORE REGION
JNPS(2)    2    ID NO OF CTMT COMPT CONTAINING UPPER PLENUM
JNPS(3)    2    ID NO OF CNTMT COMPT CONTAINING BROKEN HOT LEG
JNPS(4)    2    ID NO OF CNTMT COMPT CONTAINING BROKEN HOT LEG TUBES
JNPS(5)    2    ID NO OF CNTMT COMPT CONTAINING BROKEN COLD LEG TUBES
JNPS(6)    2    ID NO OF CNTMT COMPT CONTAINING BROKEN INTERMEDIATE LEG
JNPS(7)    2    ID NO OF CNTMT COMPT CONTAINING BROKEN COLD LEG
JNPS(8)    1    ID NO OF CNTMT COMPT CONTAINING DOWNCOMER
JNPS(9)    2    ID NO OF CNTMT COMPT CONTAINING UNBROKEN HOT LEG
JNPS(10)   2    ID NO OF CNTMT COMPT CONTAINING UNBROKEN HOT LEG TUBES
JNPS(11)   2    ID NO OF CNTMT COMPT CONTAINING UNBROKEN COLD LEG TUBES
JNPS(12)   2    ID NO OF CNTMT COMPT CONTAINING UNBROKEN INTERMEDIATE LEG
JNPS(13)   2    ID NO OF CNTMT COMPT CONTAINING UNBROKEN COLD LEG
```

```
JNPS(14)  6    ID NO OF CNTMT COMPT CONTAINING REACTOR DOME
JNPZ      9    ID NO OF CNTMT COMPT CONTAINING PZR
JNSR      2    ID NO OF CNTMT COMPT CONTAINING SURGE LINE
JNBSG     10   ID NO OF CNTMT COMPT CONTAINING BROKEN SG
JNUSG     10   ID NO OF CNTMT COMPT CONTAINING UNBROKEN SG
**
** SPECIAL COMPTS IN CONTAINMENT
**
JNRV      2    ID NO OF CNTMT COMPT RECEIVING SRV EFFLUENT (IQT=0)
**             OR ID NO OF CNTMT COMPT CONTAINING QT (IQT=1)
JNMSLB    2    ID NO OF CNTMT/AUX COMPT RECEIVING SG EFFLUENT
JNBB      2    ID NO OF CNTMT COMPT RECEIVING BL BREAK EFFLUENT
JNUB      2    ID NO OF CNTMT COMPT RECEIVING UL BREAK EFFLUENT
JNICE     4    ID NO OF CNTMT COMPT CONTAINING ICE CONDENSER
JNCSMP    2    ID NO OF CNTMT COMPT CONTAINING CNTMT SUMP
JNASMP    0    ID NO OF CNTMT COMPT CONTAINING ANNULAR COMPT SUMP
JNUCS     8    ID NO OF CNTMT COMPT CONTAINING UPPER COMPT SPRAYS
JNLCS     2    ID NO OF CNTMT COMPT CONTAINING LOWER COMPT SPRAYS
JNFCS     6    ID NO OF CNTMT COMPT CONTAINING FAN COOLER SUCTION
JNFCD     3    ID NO OF CNTMT COMPT CONTAINING FAN COOLER DISCH
JNCHS     0    ID NO OF CNTMT COMPT CONTAINING CHILLER SUCTION
JNCHD     0    ID NO OF CNTMT COMPT CONTAINING CHILLERS DISCH
JNVP      1    ID NO OF CNTMT COMPT RECEIVING RPV EFFLUENT
JNCIN     0    ID NO OF CNTMT COMPT CONTAINING CNTMT INSTRUMENTS
**
** THE FOLLOWING ARE FOR GENERALIZED ENGSAF FOR FAN COOLERS TO IDENTIFY
** COMPARTMENTS. THESE ARE USED IN ROUTINE ENGSAF ONLY
**
IQT       1    1 - S/RVS DISCHARGE TO QUENCH TANK (CONTAINED IN
**             COMPT# JNRV; 0 - S/RVs DISCHARGE TO COMPT# JNRV
ICMAX     10   LARGEST ID NO FOR COMPTS IN CONTMT (ID NOS. GREATER
**             THAN THIS ARE ASSUMED TO BE IN THE AUX BUILDING)
**
** COMPTS IN CONTAINMENT THAT MAY CONTAIN CORIUM (MAX 10)
**
JNCM(1)   1    ID NO OF FIRST CNTMT COMPT THAT MAY HAVE CORIUM
JNCM(2)   2    ID NO OF SECOND CNTMT COMPT THAT MAY HAVE CORIUM
JNCM(3)   0    ID NO OF THIRD CNTMT COMPT THAT MAY HAVE CORIUM
JNCM(4)   0    ID NO OF FOURTH CNTMT COMPT THAT MAY HAVE CORIUM
JNCM(5)   0    ID NO OF FIFTH CNTMT COMPT THAT MAY HAVE CORIUM
JNCM(6)   0    ID NO OF SIXTH CNTMT COMPT THAT MAY HAVE CORIUM
JNCM(7)   0    ID NO OF SEVENTH CNTMT COMPT THAT MAY HAVE CORIUM
JNCM(8)   0    ID NO OF EIGHTH CNTMT COMPT THAT MAY HAVE CORIUM
JNCM(9)   0    ID NO OF NINTH CNTMT COMPT THAT MAY HAVE CORIUM
JNCM(10)  0    ID NO OF LAST CNTMT COMPT THAT MAY HAVE CORIUM
**
** FLOW PATHS IN CONTAINMENT THAT MAY HAVE CORIUM TRANSPORT (MAX 20)
**
JCMW(1)   1    ID NO OF 1ST JUNCTION WHERE CORIUM MAY FLOW
JCMW(2)   0    ID NO OF 2ND JUNCTION WHERE CORIUM MAY FLOW
JCMW(3)   0    ID NO OF 3RD JUNCTION WHERE CORIUM MAY FLOW
JCMW(4)   0    ID NO OF 4TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(5)   0    ID NO OF 5TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(6)   0    ID NO OF 6TH JUNCTION WHERE CORIUM MAY FLOW
```

```
JCMW(7)    0    ID NO OF 7TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(8)    0    ID NO OF 8TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(9)    0    ID NO OF 9TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(10)   0    ID NO OF 10TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(11)   0    ID NO OF 11TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(12)   0    ID NO OF 12TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(13)   0    ID NO OF 13TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(14)   0    ID NO OF 14TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(15)   0    ID NO OF 15TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(16)   0    ID NO OF 16TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(17)   0    ID NO OF 17TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(18)   0    ID NO OF 18TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(19)   0    ID NO OF 19TH JUNCTION WHERE CORIUM MAY FLOW
JCMW(20)   0    ID NO OF 20TH JUNCTION WHERE CORIUM MAY FLOW
JENTR      1    ID NO OF CNTMT FLOW PATH WHICH CAN HAVE ENTRAINMENT
**              OF CORIUM OR WATER = 1 (CAVITY)
**
** FLOW PATHS FOR DETAILED CONTAINMENT FAILURE MODEL (MAX 4)
**
JDCF(1)   0    ID NO OF 1ST JUNCTION USED BY DETAILED CF MODEL
JDCF(2)   0    ID NO OF 2ND JUNCTION USED BY DETAILED CF MODEL
JDCF(3)   0    ID NO OF 3RD JUNCTION USED BY DETAILED CF MODEL
JDCF(4)   0    ID NO OF 4TH JUNCTION USED BY DETAILED CF MODEL
**
** GENERALIZED OPENING FOR THE PRIMARY SYSTEM
** POINTER  /PSCPTR/INGO() : PRIMARY SYSTEM COMPT # FOR THE OPENING
**                  JNGO() : CONTAINMENT COMPT # FOR THE OPENING
** INGO(1)= 6
** INGO(2)= 6
** INGO(3)= 6
** JNGO(1)= 2
** JNGO(2)= 2
** JNGO(3)= 2
**
** JNERT(IV)= IV'TH COMPT INITIAL GAS STATE
**       =0, AIR   (DEFAULT)
**       =1, INERT
**       =2, STEAM
**
**
*******************************************************************
*TOPOLOGY   (PARAMETER GROUP #20)
*******************************************************************
**
** THIS SECTION DEFINES THE WAYS THAT THE VARIOUS AUXILIARY BUILDING
**  COMPTS ARE CONNECTED TOGETHER.
**
** THERE ARE TWO CARDS REQUIRED FOR ENTERING DATA FOR EACH JUNCTION
**  THAT ARE DESCRIBED NEXT; THE LAST CARD IN THIS SECTION MUST BE "END"
**
** THE FIRST CARD, DEFINE THE JUNCTION TYPE:
**
**  1. "JUNCTION" CARDS, THIS IS DEFINED BY A CARD WITH A "J" IN
**     COLUMN 1, IFRB(J)= 1
```

```
**  2. "FAILURE" JUNCTION CARDS, THIS IS DEFINED BY A CARD WITH AN "F"
**      COLUMN 1, IFRB(J)= 0
**  3. "VACUUM BREAKER/CHECK VALVE" JUNCTION CARDS, THIS IS DEFINED
**      BY A CARD WITH AN "V" OR "C" IN COLUMN 1, IFRB(J)= -2
**  4. "LOOP SEAL" JUNCTION CARDS, THIS IS DEFINED BY A CARD WITH AN
**     "L" IN COLUMN 1, IFRB(J)= -3
**
**     NOTE: IMAXJ= MAX(J,IMAXJ) ALWAYS
**
** THE SECOND CARD, DEFINE THE JUNCTION CHARACTERISTICS:
**
**  A. IVOL(J,1), COMPT NO. OF THE VOLUME ON THE UPSTREAM SIDE OF JUNCTION;
**  B. IVOL(J,2), COMPT NO. OF DOWNSTREAM VOLUME;
**  C. IHRB(J), 1 IF JUNCTION IS IN A HORIZONTAL WALL (IE, FLOW IS VERTICAL)
**       USE 0 IF JUNCTION IS IN A VERTICAL WALL;
**  D. ZJUNC(J,1), ELEVATION OF THE BOTTOM OF THE JUNCTION ABOVE THE FLOOR
**       OF THE UPSTREAM COMPT;
**  E. XWJUNC(J), FACING THE HOLE, THE WIDTH OF JUNCION;
**  F. XHJUNC(J), FACING THE HOLE, THE HEIGHT OF JUNCTION;
**  G. XLJUNC(J), LENGTH OF JUNCTION;
**  H. AJUNC0(J), AREA OF JUNCTION
**  I. XOJUNC(J), WATER HEIGHT ABOVE WHICH JUNCTION IS CONSIDERED SHUT FOR
**       GAS FLOW; FOR JUNCTIONS IN VERTICAL WALLS, THIS IS
**       OVERWRITTEN WITH THE VALUE IN ITEM F
**
** IF THE JUNCTION IS A FAILURE TYPE, ADD THE NEXT TWO ITEMS
**
**  J. DIFFERENTIAL PRESSURE REQUIRED TO FAIL OR OPEN THE JUNCTION
**       IF THE UPSTREAM COMPT HAS THE HIGHEST PRESSURE
**  K. DIFFERENTIAL PRESSURE REQUIRED TO FAIL OR OPEN THE JUNCTION
**       IF THE DOWNSTREAM COMPT HAS THE HIGHEST PRESSURE
**
** IF THE JUNCTION IS A VACCUM BREAKER/CHECK VALVE TYPE, ADD THE NEXT
**     TWO ITEMS
**
**  J. DIFFERENTIAL PRESSURE REQUIRED TO OPEN THE VACUUM BREAKERS
**       JUNCTION GIVEN THAT THE UPSTREAM COMPT HAS THE HIGHER PRESSURE
**  K. DIFFERENTIAL PRESSURE REQUIRED TO CLOSE THE VACUUM BREAKERS ONCE
**       OPENED.
**
**  NOTE: THE FLOWS ARE ONE DIRECTIONAL FROM UPSTREAM COMPT TO
**       DOWNSTREAM COMPT.
**
** IF THE JUNCTION IS A LOOP SEAL TYPE, ADD THE NEXT TWO ITEMS
**
**  J. DIFFERENTIAL PRESSURE REQUIRED TO CLEAR OR OPEN THE JUNCTION
**       IF THE UPSTREAM COMPT HAS THE HIGHEST PRESSURE
**  K. DIFFERENTIAL PRESSURE REQUIRED TO CLEAR OR OPEN THE JUNCTION
**       IF THE DOWNSTREAM COMPT HAS THE HIGHEST PRESSURE
**
**
**  GENERAL NOTE: IF WIDTH=HEIGHT, THE JUNCTION IS ASSUMED CIRCULAR,
**     OTHERWISE JUNCTION IS ASSUMED RECTANGULAR (USE WIDTH SLIGHTLY
**     DIFFERENT THAN HEIGHT FOR SQUARE).  EVEN IF THE JUNCTION IS
```

** RECTANGULAR, THE AREA CAN BE DIFFERENT THAN THE PRODUCT OF
** LENGTH AND WIDTH IF THE JUNCTION REPRESENTS THE SUM OF SEVERAL
** HOLES WHICH HAVE THE SAME ELEVATION, ETC.
**
*******************************************************************
**
** JUNCTIONS CURRENTLY DEFINED AREA:
**
** 1) CAVITY - LOWER COMPARTMENT VIA INSTRUMENT TUNNEL
** 2) CAVITY - LOWER COMPARTMENT VIA ANNULAR GAP
** 3) LOWER COMPARTMENT - UPPER COMPARTMENT VIA REFUEL CAVITY DRAINS
** 4) LOWER COMPARTMENT - ICE CONDENSER
** 5) LOWER COMPARTMENT - ANNULAR COMPARTMENT
** 6) ICE CONDENSER - ICE CONDENSER UPPER PLENUM
** 7) ANNULAR TO UPPER LEAKAGE
** 8) UPPER TO ANNULAR - AIR RECIRC HEADER
** 9) ICE CONDENSER UPPER PLENUM - UPPER COMPARTMENT LOWER DOME REGION
** 10) NORMAL CONTAINMENT LEAKAGE FROM ANNULAR TO ENVIRONMENT
** 11) CONTAINMENT FAILURE IN ANNULAR NEAR BASEMAT CYLINDER JUNCTION
** 12) LOWER TO PZR ENCLOSURE
** 13) LOWER TO SG ENCLOSURE
** 14) LOWER DOME TO UPPER DOME REGION
** 15) LOWER DOMW TO UPPER COMPT CYLINDRICAL SECTION
** 16) H2 SKIMMER FORCED FLOW FROM PZR ENCLOSURE TO ANNULAR
** 17) H2 SKIMMER FORCED FLOW FROM SG ENCLOSURE TO ANNULAR
** 18) H2 SKIMMER FORCED FLOW FROM TOP OF DOME TO ANNULAR
**
*******************************************************************
**
JUNCTION #1 CONNECTING COMPTS 1-2; CAVITY THRU TUNNEL - LOWER COMPT
1 2 1 16.67 16.0 10.5 26.3 168.0 1.0
**
JUNCTION #2 CONNECTING COMPTS 1-2; CAVITY THRU BYPASS - LOWER COMPT
1 2 1 18.5 0.30 0.60 28.5 15.85 1.0
**
JUNCTION #3 CONNECTING COMPTS 2-6; LOWER - UPPER COMPARTMENT
2 6 1 6.0 1.0 1.0 17.5 2.22 1.E-3
**
** MODEL ICE CONDENSER DOORS AS NORMALLY CLOSED FAILURE JUNCTION AND
** CONTROL JUNCTION OPENING THROUGH USER DEFINED FUNCTION IN INCLUDE FILE
FAILURE #4 CONNECTING COMPTS 2-4; LOWER COMPT - ICE CONDENSER
2 4 0 45.3 6.8 7.5 3.0 1000 7.5 0.001 1.E10
**
JUNCTION #5 CONNECTING COMPTS 2-3; LOWER - ANNULAR COMPARTMENT
2 3 0 2.0 15.1 20.0 3.0 302.1 20.0
**
JUNCTION #6 CONNECTING COMPTS 4-5; ICE COND. - ICE COND. UPPER PLENUM
** SMD 4 5 1 56.94 267.0 11.0 0.1 2937.0 10.0
4 5 1 57.04 267.0 11.0 0.1 2937.0 10.0
**
JUNCTION #7 CONNECTING COMPTS 3-6; ANNULAR TO UPPER LEAKAGE
3 6 1 39.6 0.34 0.34 0. 0.36 0.34
**
** RECIRC FAN OPERATION CONTROLLED THROUGH INPUT DECK

```
FAILURE #8  UPPER TO ANNULAR FORCED AIR FLOW
6 3 0 8.  3.  4.  4.5 1.E-3 2.8 1.E10 1.E10
**
** MODEL ICE CONDENSER DOORS AS NORMALLY CLOSED FAILURE JUNCTION AND
** CONTROL JUNCTION OPENING THROUGH USER DEFINED FUNCTION IN INCLUDE FILE
FAILURE #9  CONNECTING COMPTS 5-7;  ICE UPPER PLENUM - UPPER COMPT LOWER DOME
5 7 1 17.0 8.0 2.0 0.0  1326.0 7.0 0.01 1.E10
**
JUNCTION #10  CONNECTING COMPTS  3-11; NORMAL CONTAINMENT LEAKAGE
3 11 0 20. 5.19E-3 5.19E-3 3.5 2.1156E-5 5.19E-3
**
FAILURE #11 CONNECTING COMPTS 3-11; CONTAINMENT FAILURE - ENVIRONMENT
3 11 0 0.5 1.7 0.1 3.5 0.17 0.1 36.0 1.E10
**
JUNCTION #12 CONNECTING 2-9; LOWER COMPT TO PZR ENCLOSURE
2 9 1 50.9 3.7 3.65 2.93 54.3 2.93
**
JUNCTION #13 CONNECTING 2-10; LOWER COMPT TO SG ENCLOSURE
2 10 1 50.9 5.2 5.28 2.93 576. 2.93
**
JUNCTION #14 CONNECTING 7-8; LOWER DOME TO UPPER DOME
7 8 1 32.4 43.6 43.6 0. 5969. 1.0
**
JUNCTION #15  CONNECTING 7-6; LOWER DOME TO UPPER COMPT CYLINDRICAL SECTION
7 6 1 0. 57.5 57.5 0. 10387. 1.0
**
FAILURE #16 CONNECTING 9-3; H2 SKIMMER FROM PZR ENCLOSURE TO ANNULAR COMPT
9 3 0 37.3 3. 4. 56.5 1.E-3 1.0 1.E10 1.E10
**
FAILURE #17 CONNECTING 10-3; H2 SKIMMER FROM SG ENCLOSURE TO ANNULAR COMPT
10 3 0 37.3 3. 4. 56.5 1.E-3 1.0 1.E10 1.E10
**
FAILURE #18 CONNECTING 8-3; H2 SKIMMER FROM TOP OF DOME TO ANNULAR COMPT
8 3 0 20. 3. 4. 134.5 1.E-3 1.0 1.E10 1.E10
**
END
** ENTER FORCED FLOW RATES HERE, GPM
PFAN(8)   291720.  JUNCTION 8 - UPPER TO ANNULAR
PFAN(16)  3740.    JUNCTION 16 - H2 SKIMMER FROM PZR
PFAN(17)  7480.    JUNCTION 17 - H2 SKIMMER FROM SG
PFAN(18)  7480.    JUNCTION 18 - H2 SKIMMER FROM TOP OF DOME
**
*************************************************************************
*MATERIAL TYPE DEFINITIONS FOR HEAT SINKS   (PARAMETER GROUP #9)
*************************************************************************
** INPUT MATERIAL PROPERTIES (DENSITY, SPECIFIC HEAT, & THERMAL
**  CONDUCTIVITY) FOR DISTRIBUTED HEAT SINKS TYPE 1 THRU 5, AND
**  INPUT EQUIPMENT PROPERTIES (SPECIFIC HEAT) FOR LUMPED MASS
**  HEAT SINKS TYPE 1 THRU 5.
**
** HEAT SINK DENSITY
DHSM(1)   149.78   DENSITY OF MATERIAL 1 (CONCRETE)
**DHSM(2)      DENSITY OF MATERIAL 2 (BRICK) (= 1373.6 kg/m3 from Zion)
**DHSM(3)      DENSITY OF MATERIAL 3 (STEEL) (= 7840 kg/m3 from Zion)
```

```
**DHSM(4)      DENSITY OF MATERIAL 4
**DHSM(5)      DENSITY OF MATERIAL 5
**
** HEAT SINK THERMAL CONDUCTIVITY
KHSM(1)    0.8    THERMAL CONDUCTIVITY OF MATERIAL 1 (CONCRETE)
**KHSM(2)     THERMAL CONDUCTIVITY OF MATERIAL 2 (BRICK) (= 0.6 W/mK)
**KHSM(3)     THERMAL CONDUCTIVITY OF MATERIAL 3 (STEEL) (= 50 W/mK)
**KHSM(4)     THERMAL CONDUCTIVITY OF MATERIAL 4
**KHSM(5)     THERMAL CONDUCTIVITY OF MATERIAL 5
**
** HEAT SINK SPECIFIC HEAT
CPHSM(1)    0.151     SPECIFIC HEAT OF MATERIAL 1 (CONCRETE)
**CPHSM(2)    SPECIFIC HEAT OF MATERIAL 4
**CPHSM(3)    SPECIFIC HEAT OF MATERIAL 4
**CPHSM(4)    SPECIFIC HEAT OF MATERIAL 4
**CPHSM(5)    SPECIFIC HEAT OF MATERIAL 5
**
** EQUIPMENT (LUMPED MASS) SPECIFIC HEAT
CPEQM(1)    0.110   SPECIFIC HEAT OF MATERIAL 1 (STEEL) (= 460.5 J/kg/K)
**CPEQM(2)        SPECIFIC HEAT OF MATERIAL 2 (ALUMINUM) (= 896 J/kg/K)
**CPEQM(3)        SPECIFIC HEAT OF MATERIAL 3 (COPPER) (= 383.1 J/kg/K)
**CPEQM(4)        SPECIFIC HEAT OF MATERIAL 4 (LEAD) (= 130 J/kg/K)
**CPEQM(5)        SPECIFIC HEAT OF MATERIAL 5 (STEEL) (= 500 J/kg/K)
**
**@@@M4.0  KYS  8/10/93  ADDED PARAMETER GROUP DISTRIBUTED HEAT SINKS
*************************************************************************
*DISTRIBUTED HEAT SINKS IN CONTAINMENT   (PARAMETER GROUP #8)
*************************************************************************
**
** UP TO 200 DISTRIBUTED HEAT SINKS ARE ALLOWED
**
**  1) CAVITY FLOOR
**  2) CAVITY OUTER WALL
**  3) BIOLOGICAL SHIELD WALL BELOW THE BOTTOM OF THE REFUELING POOL AT
**     THE 621'-1.5" EL.
**  4) BIOLOGICAL SHIELD WALL ABOVE THE 621'-1.5" EL.
**  5) PRESSURIZER DOGHOUSE ABOVE THE OPERATING DECK (EL. 652'-7.5")
**  6) STEAM GENERATOR CUBICLES ABOVE THE OPERATING DECK
**  7) LOWER COMPARTMENT FLOOR
**  8) CRANE WALL (INTERFACE BETWEEN LOWER AND ANNULAR COMPARTMENTS)
**  9) ANNULAR COMPARTMENT FLOOR
** 10) ANNULAR COMPARTMENT OUTER WALLS
** 11) ICE UPPER PLENUM INNER WALLS (INTERFACE WITH UPPER COMPARTMENT)
** 12) ICE UPPER PLENUM OUTER WALLS
** 13) UPPER COMPARTMENT OPERATING DECK AND MISSILE SHIELD
** 14) UPPER COMPARTMENT OUTER WALLS AND DOME ABOVE THE 715' EL.
** 15) UPPER COMPARTMENT OUTER WALLS AND DOME ABOVE THE 748' EL.
**
HSTYP(1)   1       HS 1 MATERIAL TYPE DEFINED IN *MATERIAL
HSTYP(2)   1
HSTYP(3)   1
HSTYP(4)   1
HSTYP(5)   1
HSTYP(6)   1
```

```
HSTYP(7)   1
HSTYP(8)   1
HSTYP(9)   1
HSTYP(10)  1
HSTYP(11)  1
HSTYP(12)  1
HSTYP(13)  1
HSTYP(14)  1
HSTYP(15)  1
**
** NIWALL= FLAG INDICATING WALL TYPE;
**     = 1 OR -1; ONE FACE WALL (OUTER FACE BURIED IN INFINITE SLAB
**           OR ON OUTSIDE OF CONTAINMENT)
**     = 2 OR -2; TWO FACED WALL
** (POSITIVE MEANS VERTICAL WALL, NEGATIVE MEANS HORIZONTAL WALL)
**
** NOTE THAT FACE 1 BY CONVENTION ALWAYS FACES UPWARDS IF NIWALL IS
**         HORIZONTAL, EG., FLOOR OR DECK
**
NIWALL(1)  -1      ORIENTATION DESIGNATOR FOR HS 1
NIWALL(2)  1
NIWALL(3)  2
NIWALL(4)  2
NIWALL(5)  2
NIWALL(6)  2
NIWALL(7)  -1
NIWALL(8)  2
NIWALL(9)  -1
NIWALL(10) 1
NIWALL(11) 2
NIWALL(12) 1
NIWALL(13) -2
NIWALL(14) 1
NIWALL(15) 1
**
AHSRB(1)    664.    ONE-SIDED WALL AREA OF HS 1
AHSRB(2)   1939.
AHSRB(3)   2748.
AHSRB(4)   3513.
AHSRB(5)   1501.
AHSRB(6)   8722.
AHSRB(7)   3728.
AHSRB(8)  12280.
AHSRB(9)   3298.
AHSRB(10) 12757.
AHSRB(11)  3694.
AHSRB(12)  4568.
AHSRB(13)  6239.
AHSRB(14) 17341.
AHSRB(15)  7226.
**
XTHSRB(1)  12.5    THICKNESS OF HS 1
XTHSRB(2)  12.5
XTHSRB(3)  11.
```

XTHSRB(4) 5.6
XTHSRB(5) 2.
XTHSRB(6) 2.
XTHSRB(7) 12.5
XTHSRB(8) 3.0
XTHSRB(9) 12.5
XTHSRB(10) 3.5
XTHSRB(11) 3.0
XTHSRB(12) 3.5
XTHSRB(13) 2.875
XTHSRB(14) 3.0
XTHSRB(15) 3.0
**
XHSRB(1) 0.0 XHSRB(I) AVERAGE HEIGHT OF HS I OR 0.E0 IF MODELED
** AS FLOOR OR UPWARD FACING SURFACE (EG, DECK)
XHSRB(2) 15.
XHSRB(3) 11.
XHSRB(4) 16.
XHSRB(5) 7.7
XHSRB(6) 7.7
XHSRB(7) 0.0
XHSRB(8) 27.
XHSRB(9) 0.0
XHSRB(10) 27.0
XHSRB(11) 8.5
XHSRB(12) 8.5
XHSRB(13) 0.0
XHSRB(14) 16.2
XHSRB(15) 10.
**
ZHSRB(1) -31.8 ZHSRB(I) ELEV. OF I'TH HEAT SINK RELATIVE
ZHSRB(2) -31.8 TO GROUND LEVEL
ZHSRB(3) 0.0
ZHSRB(4) 22.3
ZHSRB(5) 53.3
ZHSRB(6) 53.3
ZHSRB(7) 0.0
ZHSRB(8) 0.0
ZHSRB(9) -0.481
ZHSRB(10) -0.481
ZHSRB(11) 99.84
ZHSRB(12) 99.84
ZHSRB(13) 53.3
ZHSRB(14) 116.8
ZHSRB(15) 149.2
**
N1HSRB(1) 1 ID NO. OF COMPT FACING SIDE 1 OF HS 1
N1HSRB(2) 1
N1HSRB(3) 1
N1HSRB(4) 6
N1HSRB(5) 9
N1HSRB(6) 10
N1HSRB(7) 2
N1HSRB(8) 2

N1HSRB(9) 3
N1HSRB(10) 3
N1HSRB(11) 6
N1HSRB(12) 5
N1HSRB(13) 6
N1HSRB(14) 7
N1HSRB(15) 8
**
** NOTE FOR WALL ORIENTATION DESIGNATOR (NIWALL) OF 1 OR -1,
** N2HSRB= ENVIRONMENT COMPT #
**
N2HSRB(1) 11 ID NO. OF COMPT FACING SIDE 2 OF HS 1
N2HSRB(2) 11
N2HSRB(3) 2
N2HSRB(4) 2
N2HSRB(5) 6
N2HSRB(6) 6
N2HSRB(7) 11
N2HSRB(8) 3
N2HSRB(9) 11
N2HSRB(10) 11
N2HSRB(11) 5
N2HSRB(12) 11
N2HSRB(13) 2
N2HSRB(14) 11
N2HSRB(15) 11
**
XLN1(1) 0. LINER THICKNESS ON SIDE 1 FOR HS 1
XLN1(2) 0.
XLN1(3) 0.
XLN1(4) 0.
XLN1(5) 0.
XLN1(6) 0.
XLN1(7) 0.
XLN1(8) 0.
XLN1(9) 0.
XLN1(10) .03125
XLN1(11) 0.
XLN1(12) .03125
XLN1(13) 0.
XLN1(14) .03125
XLN1(15) .03125
**
XLN2(1) 0. LINER THICKNESS ON SIDE 2 FOR HS 1
XLN2(2) 0.
XLN2(3) 0.
XLN2(4) 0.
XLN2(5) 0.
XLN2(6) 0.
XLN2(7) 0.
XLN2(8) 0.
XLN2(9) 0.
XLN2(10) 0.
XLN2(11) 0.

XLN2(12) 0.
XLN2(13) 0.
XLN2(14) 0.
XLN2(15) 0.
**
RG1(1) 0. SURFACE-TO-LINE RESISTANCE GAP FOR HS 1 FACE 1
RG1(2) 0.
RG1(3) 0.
RG1(4) 0.
RG1(5) 0.
RG1(6) 0.
RG1(7) 0.
RG1(8) 0.
RG1(9) 0.
RG1(10) 0.054
RG1(11) 0.
RG1(12) 0.054
RG1(13) 0.
RG1(14) 0.054
RG1(15) 0.054
**
RG2(1) 0. SURFACE-TO-LINE RESISTANCE GAP FOR HS 1 FACE 2
RG2(2) 0.
RG2(3) 0.
RG2(4) 0.
RG2(5) 0.
RG2(6) 0.
RG2(7) 0.
RG2(8) 0.
RG2(9) 0.
RG2(10) 0.
RG2(11) 0.
RG2(12) 0.
RG2(13) 0.
RG2(14) 0.
RG2(15) 0.
**
** WWSP1 - SPRAY FLOW RATE TO SIDE ONE OF HEAT SINK
**
WWSP1(1) 0.0
WWSP1(2) 0.0
WWSP1(3) 0.0
WWSP1(4) 0.0
WWSP1(5) 0.0
WWSP1(6) 0.0
WWSP1(7) 0.0
WWSP1(8) 0.0
WWSP1(9) 0.0
WWSP1(10) 0.0
WWSP1(11) 0.0
WWSP1(12) 0.0
WWSP1(13) 0.0
WWSP1(14) 0.0
WWSP1(15) 0.0

**
** TWSP1 - TEMPERATURE OF SPRAY FLOW TO SIDE ONE OF HEAT SINK
**
TWSP1(1) 70.0
TWSP1(2) 70.0
TWSP1(3) 70.0
TWSP1(4) 70.0
TWSP1(5) 70.0
TWSP1(6) 70.0
TWSP1(7) 70.0
TWSP1(8) 70.0
TWSP1(9) 70.0
TWSP1(10) 70.0
TWSP1(11) 70.0
TWSP1(12) 70.0
TWSP1(13) 70.0
TWSP1(14) 70.0
TWSP1(15) 70.0
**
** WWSP2 - SPRAY FLOW RATE TO SIDE TWO OF HEAT SINK
**
WWSP2(1) 0.0
WWSP2(2) 0.0
WWSP2(3) 0.0
WWSP2(4) 0.0
WWSP2(5) 0.0
WWSP2(6) 0.0
WWSP2(7) 0.0
WWSP2(8) 0.0
WWSP2(9) 0.0
WWSP2(10) 0.0
WWSP2(11) 0.0
WWSP2(12) 0.0
WWSP2(13) 0.0
WWSP2(14) 0.0
WWSP2(15) 0.0
**
** TWSP2 - TEMPERATURE OF SPRAY FLOW TO SIDE TWO OF HEAT SINK
**
TWSP2(1) 70.0
TWSP2(2) 70.0
TWSP2(3) 70.0
TWSP2(4) 70.0
TWSP2(5) 70.0
TWSP2(6) 70.0
TWSP2(7) 70.0
TWSP2(8) 70.0
TWSP2(9) 70.0
TWSP2(10) 70.0
TWSP2(11) 70.0
TWSP2(12) 70.0
TWSP2(13) 70.0
TWSP2(14) 70.0
TWSP2(15) 70.0

```
**
** XPERHS - PERIMERTER OF HEAT SINK, USED FOR FILM FLOW ACROSS IT
**
XPERHS(1)  0.
XPERHS(2)  0.
XPERHS(3)  0.
XPERHS(4)  0.
XPERHS(5)  0.
XPERHS(6)  0.
XPERHS(7)  0.
XPERHS(8)  0.
XPERHS(9)  0.
XPERHS(10) 0.
XPERHS(11) 0.
XPERHS(12) 0.
XPERHS(13) 0.
XPERHS(14) 0.
XPERHS(15) 0.
**
**  NOTE FOR PCCS MODEL:
**
**    INPUT:
**
**    IN ORDER TO ACTIVATE THE PCCS MODEL, FLAG "NIWALL" SHOULD BE SET
**    EQUAL TO ZERO FOR THE HEAT SINKS ON THE CONTAINMENT WALL. THE
**    ORDER OF THE HEAT SINKS ON THE CONTAINMENT WALL SHOULD BE ARRANGED
**    ACCORDING TO THE DIRECTION OF FILM FLOW. WHEN NIWALL=0, THE
**    WALL IS TREATED AS VERTICAL HEAT SINK.
**
**    THE SPRAY FLOW RATE AND TEMPERATURE CAN BE SPECIFIED WITH
**    WWSP1, TWSP1 FOR IH'TH HEAT SINK FACE #1 & WWSP2, TWSP2
**    FOR IH'TH HEAT SINK FACE #2
**
**    OUTPUT:
**
**    THE FILM FLOW RATE AND THE ENERGY CARRIED BY THE FILM THAT LEAVES
**    HEAT SINK I ARE STORED IN WWF1(I) AND QWF1(I) FOR HS FACE #1,
**    WWF2(I) AND QWF2(I) FOR HEAT SINK FACE #2.
**
**
HTEXT      10.0     HTC TO BE USED ON FACE 2 WHEN IWALL 1 IS
**                  SPECIFIED.  HTEXT IS ASSUMED 0.E0 FOR IWALL=-1.
**                  TYPICALLY, IWALL=-1 IS SPECIFIED FOR "INFINITELY"
**                  THICK FLOORS, AND IWALL=1 SPECIFIED FOR WALLS
**                  INTERFACING THE ENVIRONMENT COMPT, WITH FACE #2
**                  FACING THE ENVIRONMENT.
**
**********************************************************************
**
*LUMPED HEAT SINKS IN CONTAINMENT
**
**********************************************************************
**
** UP TO 200 LUMPED HEAT SINKS ARE ALLOWED
```

```
**
** USE 1 LUMPED HEAT SINK FOR EACH CONTAINMENT COMPARTMENT CONTAINING
** METAL EQUIPMENT
**
**   ID   DESCRIPTION
**   1    METAL EQUIPMENT IN COMPARTMENT 2 (LOWER)
**   2    METAL EQUIPMENT IN COMPARTMENT 6 (UPPER CYLINDRICAL SECTION)
**   3    METAL EQUIPMENT IN COMPARTMENT 7 (UPPER LOWER DOME REGION)
**
EQTYP(1)   1        HS 1 MATERIAL TYPE
EQTYP(2)   1
EQTYP(3)   1
**
MEQRB(1)   4.3215E6  EQUIP MASS
MEQRB(2)   108819.
MEQRB(3)   108819.
**
AEQRB(1)   65616.   EQUIP HEAT TRANSFER AREA
AEQRB(2)   19217.
AEQRB(3)   19217.
**
ZEQRB(1)   0.       ELEVATION OF BOTTOM OF EQUIP. WRT FLOOR
ZEQRB(2)   0.
ZEQRB(3)   0.
**
XHEQRB(1)  10.      HEIGHT OF EQUIPMENT I
XHEQRB(2)  10.
XHEQRB(3)  10.
**
NEQRB(1)   2        ID NO. OF COMPT CONTAINING HS 1
NEQRB(2)   6
NEQRB(3)   7
**
```

```
**************************************************************************
**          D. C. COOK UNIT 1 MAAP 4.0.3 PARAMETER FILE          **
**                      REV. 1                      **
**                    PREPARED FOR                    **
**          THE AMERICAN ELECTRIC POWER SERVICE COMPANY          **
**                      BY                      **
**                TOM ELICSON, 10-13-97                **
**          FAUSKE & ASSOCIATES, BURR RIDGE, IL.          **
**                                                **
** MODEL INCLUDES LICENSING CODE ASSUMPTIONS, UPGRADES FOR 4.0.3      **
** COMPATIBILITY AND GENERALIZED ESF                    **
**                                                **
**************************************************************************
** THIS MODEL IS IN BRITISH UNITS (FT-LBM-HR-BTU-PSIA-GPM)
*BR
** ----------------------------------------------------------------
** -- CHANGES TO JUNCTION DEFINITIONS
** ----------------------------------------------------------------
**  JUNCTIONS CURRENTLY DEFINED AREA:
**
**  1)  CAVITY - LOWER COMPARTMENT VIA INSTRUMENT TUNNEL
**  2)  CAVITY - LOWER COMPARTMENT VIA ANNULAR GAP
**  3)  LOWER COMPARTMENT - UPPER COMPARTMENT VIA REFUEL CAVITY DRAINS
**  4)  LOWER COMPARTMENT - ICE CONDENSER
**  5)  LOWER COMPARTMENT - ANNULAR COMPARTMENT
**  6)  ICE CONDENSER - ICE CONDENSER UPPER PLENUM
**  7)  ANNULAR TO UPPER LEAKAGE
**  8)  UPPER TO ANNULAR - AIR RECIRC HEADER
**  9)  ICE CONDENSER UPPER PLENUM - UPPER COMPARTMENT LOWER DOME REGION
** 10)  NORMAL CONTAINMENT LEAKAGE FROM ANNULAR TO ENVIRONMENT
** 11)  CONTAINMENT FAILURE IN ANNULAR NEAR BASEMAT CYLINDER JUNCTION
** 12)  LOWER TO PZR ENCLOSURE
** 13)  LOWER TO SG ENCLOSURE
** 14)  LOWER DOME TO UPPER DOME REGION
** 15)  LOWER DOMW TO UPPER COMPT CYLINDRICAL SECTION
** 16)  H2 SKIMMER FORCED FLOW FROM PZR ENCLOSURE TO ANNULAR
** 17)  H2 SKIMMER FORCED FLOW FROM SG ENCLOSURE TO ANNULAR
** 18)  H2 SKIMMER FORCED FLOW FROM TOP OF DOME TO ANNULAR
** 19)  ICE CONDENSER DRAINS TO LOWER COMPT
** ADJUST JUNCTION 2 TO REPRESENT FLOW PATH AROUND RCS PIPING PENETRATIONS
** IN BIOLOGICAL SHIELD WALL

IHRB(2)    0          FLOW IS HORIZONTAL
ZJUNC(2,1)  44.9 FT       ELEVATION AT BOTTOM OF JUNC = ZNOZ-XTHL+XTRV+ZNVP
**                  APPROX HEIGHT OF PIPING PENETRATION THROUGH
**                  BIOLOGICAL SHEILD WALL ABOVE LOWER COMPARTMENT
**                  FLOOR AT 598'-9 3/8"
XLJUNC(2)  3.5 FT       JUNCTION LENGTH: APPROX THICKNESS OF BIO SHIELD
**                  WALL

** REFINE PARAMETERS FOR JUNCTION REPRESENTING REFUELING CAVITY DRAINS
ZJUNC(3,1)  6.0 FT       HEIGHT OF BOTTOM OF THE DRAINS RELATIVE TO
**                 THE LOWER COMPARTMENT FLOOR.  THIS VALUE WAS
**                 REFINED BASED UPON VISUAL INSPECTION DURING
```

```
**                 FAI WALKDOWN OF UNIT 1.
AJUNC0(3)  2.2 FT**2    FLOW AREA THROUGH REFUELING CAVITY DRAINS.
**                 FAI WALKDOWN CONFIRMED TWO 12" (NOM.) DRAINS AND
**                 ONE 10" (NOM.) DRAIN.
XOJUNC(3)  1.5 FT      REFUEL CAVITY DRAIN FLOOD HEIGHT TO BLOCK GAS
**                 TRANSPORT. ADJUST REFUEL CAVITY DRAIN FLOOD
**                 HEIGHT WHICH STOPS GAS TRANSPORT: USE
**                 1.5 x DIAMETER
XLJUNC(3)  17.690 FT
** ADJUST REFUEL CAVITY JUNCTION LENGTH (JUNCTION 3) TO ENSURE 9500 GAL
** RETAINED IN REFUEL CAVITY PRIOR TO SPILL OVER INTO DRAIN LINE
**  REFUEL CAV (COMPT 6) FLOOR AREA IS
**   VRBLK(2,6)/XRBLK(2,6) = 24919/31.5 = 791. FT^2
**  REQUIRED WEIR HEIGHT IS 9500/7.48/791 = 1.606 FT
**  DEDUCT APPROX. 1.5 IN (0.12 FT)      = 1.49 FT
**  TO ACCOUNT FOR STATIC HEAD DRIVING
**  WEIR FLOW.
**  JUNCTION LENGTH IS THEREFORE,
**   XLJUNC(3) = [ZFRB(6) - ZFRB(2)] - ZJUNC(3,1) + 1.49
**         = [22.2 - 0] - 6.0 + 1.49 = 17.690 FT

** REFINE PARAMETERS FOR SPILLWAY JUNCTION BETWEEN DEAD-ENDED AND LOWER
** COMPARTMENTS
ZJUNC(5,1)  13.2 FT    JUNCTION HEIGHT RELATIVE TO FLOOR OF THE
**                 ANNULAR COMPARTMENT. FOR CONSISTENCY, THIS
**                 MUST BE THE SAME AS XRBLK(2,3)
XWJUNC(5)   15.1 FT    WIDTH OF THE SPILLWAY WEIR BETWEEN THE LOWER
**                 COMPARTMENT AND THE ANNULUAR COMPARTMENT.
AJUNC0(5)   302.1 FT**2   TOTAL FLOW AREA OF THE TWO KEYWAYS THAT SERVE
**                 AS THE SPILLWAY BETWEEN THE LOWER
**                 COMPARTMENT AND THE ANNULUAR COMPARTMENT.
XLJUNC(5)   1.0 FT     HORIZONTAL FLOW LENGTH OVER THE SPILLWAY WEIR

** FAI WALKDOWN CONFIRMED THAT THERE IS A TECH. SPEC. MAXIMUM OF 5 FT**2
** BYPASS AROUND ICE CONDENSER BETWEEN UPPER AND LOWER VOLUMES.
** AJUNC0(3) ACCOUNTS FOR THE REFUELING CAVITY DRAINS, AND AJUNC0(7)
** ACCOUNTS FOR THE BALANCE.
AJUNC0(7)  2.8 FT**2    FLOW PATH 7 AREA ACCOUNTING FOR BALANCE OF
**                 TOTAL ICE CONDENSER BYPASS AREA.

** ADJUST DISCHARGE LOCATIONS FOR JUNCTIONS COMMUNICATING WITH
ENVIRONMENT
** ENVIRONMENT IS NOW LOCATION 12
** -- JUNCTION 10  CONNECTING COMPT  3 TO ENVIRONMENT: NORMAL LEAKAGE
IVOL(10,2)  12          DISCHARGE TO ENVIRONMENT

** -- FAILURE JUNCTION 11 CONNECTING COMPT 3 TO ENVIRONMENT: OVER PRESS.
FAILURE
IVOL(11,2)  12          DISCHARGE TO ENVIRONMENT

** ADD AN ICE CONDENSER DRAIN JUNCTION.  THIS REPRESENTS THE 21  12" DRAINS.
** FLAPPER VALVES REQUIRE 18" HEAD TO OPEN.
IMAXJ      19        TOTAL NUMBER OF JUNCTION IS NOW 19
IFRB(19)   -2        DEFINE JUNCTION AS CHECK VALVE
```

```
IVOL(19,1)  4        JUNCTION UPSTREAM COMPARTMENT IS ICE CONDENSER
IVOL(19,2)  2        JUNCTION DOWNSTREAM COMPARTMENT IS LOWER COMPT
IHRB(19)    0        DRAIN DISCHARGE IS HORIZONTAL
ZJUNC(19,1) 0.01 FT    ELEVATION OF THE BOTTOM OF THE JUNCTION ABOVE THE FLOOR
**                  OF THE UPSTREAM COMPT
XWJUNC(19)  1.0 FT    FACING THE HOLE, THE WIDTH OF JUNCION;
XHJUNC(19)  1.0 FT    FACING THE HOLE, THE HEIGHT OF JUNCTION;
XLJUNC(19)  1.0 FT    LENGTH OF JUNCTION;
AJUNC0(19)  13. FT**2  AREA OF JUNCTION: COMBINED AREA FOR 21 DRAINS
XOJUNC(19)  1.0 FT    WATER HEIGHT ABOVE WHICH JUNCTION IS CONSIDERED SHUT
**                  FOR GAS FLOW
PFFJ(19)    0.65 PSI  CHECK VALVE  OPENS WITH 18" STATIC HEAD
PFBJ(19)    0.60 PSI  BACK PRESSURE TO CLOSE VALVE

** IN EACH 12" DRAIN LINE, THERE IS A 1.5" DRAIN LINE IN THE BOTTOM
** OF THE DRAIN PIPE IMEDIATELY UPSTREAM OF THE FLAPPER VAVLE. THIS
** DRAINS RISIDUAL WATER IN THE DRAIN LINE INTO THE ACTIVE SUMP.
IMAXJ       20       TOTAL NUMBER OF JUNCTION IS NOW 20
IFRB(20)    1        DEFINE AS OPEN JUNCTION
IVOL(20,1)  4        JUNCTION UPSTREAM COMPARTMENT IS ICE CONDENSER
IVOL(20,2)  2        JUNCTION DOWNSTREAM COMPARTMENT IS LOWER COMPT
IHRB(20)    1        DRAIN DISCHARGE IS VERTICAL
ZJUNC(20,1) 0.01 FT    ELEVATION OF THE BOTTOM OF THE JUNCTION ABOVE THE FLOOR
**                  OF THE UPSTREAM COMPT
XWJUNC(20)  0.125 FT  FACING THE HOLE, THE WIDTH OF JUNCION
XHJUNC(20)  0.125 FT  FACING THE HOLE, THE HEIGHT OF JUNCTION
XLJUNC(20)  1.0 FT    LENGTH OF JUNCTION (APPROXIMATE)
AJUNC0(20)  2.06 FT**2  AREA OF JUNCTION: COMBINED AREA FOR 21 DRAINS
XOJUNC(20)  0.125 FT  WATER HEIGHT ABOVE WHICH JUNCTION IS CONSIDERED SHUT
**                  FOR GAS FLOW


**
** DEFINE ICE CONDENSER FLOOR AS BOTTOM OF DRAIN PIPE
ZFRB(4)     38.8 FT    ICE CONDENSER BOTTOM
** ADJUST JUNCTION ELEVATION TO ICE UPPER PLENUM TO ACCOUNT FOR 4.1 CHANGE
** IN FLOOR EL.
ZJUNC(6,1)  61.14 FT
**
** INCREASE ICE CONDENSER TOTAL COLUME TO INCLUDE PIPE VOLUME:
** PIPE VOL IS 54 FT^3
VOLRB(4)    108779 FT**2  TOTAL VOLUME OF ICE CONDENSER
**
** MODIFY ICE CONDENSER VOLUME VS HEIGHT TO ACCOUNT FOR WATER HOLD UP IN
** 20  12" DRAIN PIPES
XRBLK(1,4)  0.  FT       HEIGHT AT BOTTOM OF DRAIN PIPE
VRBLK(1,4)  0.0 FT**3      ZERO HEIGHT IS ZERO VOLUME
XRBLK(2,4)  1.  FT       HEIGHT AT TOP OF DRAIN PIPE
VRBLK(2,4)  62.8 FT**3     VOLUME TO FILL APPROX. 4 FT
**                     HORIZONTAL RUN TO FLAPPER VALVE.
XRBLK(3,4)  5.7 FT       HEIGHT UP TO ICE CONDENSER FLOOR
**                     (AS TAKEN FROM AEP, 5.2 FT FROM FLAPPER
**                     VALVE CENTERLINE TO I.C. FLOOR. ALSO,
**                     ADD 0.5 FT PIPE RADIUS FROM CENTERLINE
```

```
**                    TO BOTTOM OF PIPE, WHICH IS REF. ZERO.)
VRBLK(3,4)  181. FT**3    VOLUME TO FILL DRAIN PIPES TO I.C. FLOOR
XRBLK(4,4)  61.14 FT      HEIGHT UP TO TOP OF ICE CONDENSER
VRBLK(4,4)  108779 FT**3  TOTAL ICE CONDENSER VOLUME

** MODIFY FORCED FAN JUNCTION AREAS. CODE MOD PREVENTS CCF IN FAN JUNCTIONS
** SO REALISTIC AREA CAN BE USED
AJUNC0(8)   1.0 FT**2
AJUNC0(16)  0.1 FT**2
AJUNC0(17)  0.1 FT**2
AJUNC0(18)  0.1 FT**2

** ---------------------------------------------------------------
** -- CHANGES TO COMPARTMENT DRAIN MODEL. INSTANTLY DRAIN THOSE
COMPARMENTS
** -- WITHOUT FLOORS. COMPARTMENTS DRAIN TO COMPARTMENT BELOW.
** ---------------------------------------------------------------
FIDRRB(7)   6    MID DOME DRAINS TO CYLINDRICAL SECTION
FIDRRB(8)   7    UPPER DOME DRAINS TO MID DOME
FIDRRB(9)   2    PZR ENCLOSURE DRAINS TO LOWER
FIDRRB(10)  2    SG ENCLOSURES DRAIN TO LOWER

** ---------------------------------------------------------------
** -- CHANGES TO CONTAINMENT COMPARTMENT GEOMETRY DEFINITIONS
** ---------------------------------------------------------------
** -- ADJUST CONTAINMENT VOLUMES TO MATCH WCAP-14286, APPENDIX A, TABLE 3.5-1
** -- AND WCAP-14488, APPENDIX A, TABLE 3.5-1
** UPPER: 734829 FT^3
** LOWER: 304269 FT^3
** DEAD-ENDED: 61340 FT^3
** ICE BOX: 163713 FT^3

** COMPARTMENTS ARE CURRENTLY SET UP AS:
**
**    1) CAVITY
**    2) LOWER COMPARTMENT
**    3) ANNULAR-DEAD END COMPARTMENT
**    4) ICE CONDENSER COMPARTMENT
**    5) ICE CONDENSER UPPER PLENUM
**    6) UPPER COMPARTMENT CYLINDRICAL SECTION
**    7) UPPER COMPARTMENT LOWER DOME REGION
**    8) UPPER COMPARTMENT UPPER DOME REGION
**    9) PRESSURIZER ENCLOSURE
**   10) STEAM GENERATOR ENCLOSURE
**   11) SPRAY HEADER LEADING TO LOWER AND DEAD-ENDED COMPARTMENTS
**   12) ENVIRONMENT ( =COMPT INODRB+1)
**
** -- SPRAY HEADER DEFINITION
*****************************************************************************
** SPRAY HEADER LEADING TO LOWER AND DEAD-ENDED COMPARTMENTS
** DEFINE DUMMY VOLUME TO ACCEPT WATER FROM A SINGLE PUMP AND
REDISTRIBUTE
** THE FLOW TO TWO SEPARATE LOCATIONS (LOWER COMPARTMENT AND DE-AD-
ENDED
```

```
** COMPARTMENT RING HEADERS). SINCE THE HEADER VOLUME DOES NOT
PARTICIPATE IN
** THERMODYNAMIC CALCULATIONS, ALL NOMINAL VALUES CAN BE USED FOR
COMPARTMENT
** PARAMETERS.
*****************************************************************************

VOLRB(11)  100.  FT**3    TOTAL FREE VOLUME OF HEADER: NOMINAL VALUE
ZFRB(11)   50.0 FT        ELEV. OF HEADER ABOVE GROUND LEVEL: ASSUME AT TOP OF
**                        LOWER COMPT
AGKEY(11)  1.0 FT**2      LARGEST CROSS-SECTIONAL GAS FLOW AREA IN COMPT 11
XDGKEY(11)  0.0 FT        HYDRAULIC DIAMETER ASSOCIATED W/ AGKEY IN COMPT 11
**                        IF ZERO, IT IS COMPUTED ASSUMING CIRCULAR GEOMETRY
ASEDRB(11)  1.0 FT**2     AEROSOL SEDIMENTATION AREA IN COMPT 11
**
AIMPRB(11)  0.0 FT**2     IMPACTION AREA IN COMPT 11
XDIMRB(11)  0.0 FT        IMPACTION DIAMETER FOR COMPT 11
AGRARB(11)  0.0 FT**2     FLOW AREA AT ELEVATION OF GRATING THRU COMPT 11
WSPRB(11)  0.0 LB/HR      NON-SAFETY SPRAY MASS FLOW RATE FOR COMPT 11
**
XHSPRB(11)  0.0 FT        NON-SAFETY SPRAY FALL HEIGHT FOR COMPT 11
**
FIDRRB(11)  0             IF POSITIVE INSTANTLY DRAIN ALL WATER
**                        TO COMPARTMENT IV;
**                        IF 0, DRAIN WATER NORMALLY THROUGH COMPT 11 OPENINGS
**                        (GAS/WATER FLOW PATHS)
WC2RB(11)  0.0 LB/HR      CO2 MASS FLOW FROM FIRE SUPP SYSTEM INTO COMPT 11
**
TGRB0(11)  105. F         INITIAL GAS TEMPERATURE IN COMPT 11; NOMINAL
**
PRB0(11)   14.7 PSI       INITIAL PRESSURE IN COMPT 11
**
FRHB0(11)  1.0            INITIAL RELATIVE HUMIDITY IN COMPT 11
**
NIGRB(11)  0.0            NUMBER OF IGNITERS IN COMPT 11
**
XIGRB(11)  1.E-10 FT      AVG. EL. OF IGNITERS OFF FLOOR OF COMPT 11
**
XRBRRB(11)  1.0 FT        EFFECTIVE BURN RADIUS IN COMPT 11
XHBRRB(11)  1.0 FT        EFFECTIVE BURN HEIGHT IN COMPT 11
XWRB0(11)  0.0 FT         INITIAL HEIGHT OF WATER IN COMPT 11
**
TWRB0(11)  105. F         INITIAL TEMPERATURE OF WATER IN COMPT 11
**
** VOLUME VS HEIGHT FOR HEADER COMPARTMENT: NOMINAL VAULES
XRBLK(1,11) 0.0 FT        HEADER EMPTY HEIGHT AND VOLUME
VRBLK(1,11) 0.0 FT**3
XRBLK(2,11) 1.0 FT        HEADER FULL HEIGHT AND VOLUME
VRBLK(2,11) 100.0 FT**3
**
WNAOH(11)  0.0 LB/HR      INJECTION NAOH MASS FLOW RATE TO COMPT NODE 1
WACID(11)  0.0 LB/HR      EQ. HNO3 OF ANY ACID MASS FLOW INTO COMPT 11
MAERFF(11)  1.D10 LB      MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
FDFFIL(11)  1.0           DF USED FILTERING EFFECT WHEN THEY ARE INTACT
```

```
JSGTS(11)  1          FLAG FOR FILTERING CONTROL;
**                    =0 OPERATIVE, =1 FAILED/INOPERATIVE
**                    BY DEFAULT, JSTGS IS = 1, SET IT TO 0 TO TURN ON FILTER
**                    JSGTS IS SET = 1 WHEN MAERFF > MAERF (MASS COLLECTED)
INODRB 11             TOTAL NUMBER OF CONTAINMENT+AUX COMPARTMENTS
MODELED
ICMAX  11             HIGHEST COMPARTMENT NUMBER THAT IS IN CONTAINMENT


** -- LOWER COMPARTMENT VOLUMES:
** LEAVE MAAP VOLUMES FOR SG ENCLOSURE, PZ ENCLOSURE, AND RX CAV AS THEY
ARE
** AND ADJUST LOWER COMPT VOL: VOLRB(2) = 304269 - VOLRB(1+9+10)
  VOLRB(1)    15748. FT**3   TOTAL FREE VOLUME OF COMPT 1
  VOLRB(2)   254821. FT**3   TOTAL FREE VOLUME OF COMPT 2
  VOLRB(9)     2700. FT**3   TOTAL FREE VOLUME OF COMPT 9
  VOLRB(10)   31000. FT**3   TOTAL FREE VOLUME OF COMPT 10
**           -------
** TOTAL LOWER: 304269. FT^3
**
** DEAD-ENDED VOLUME
  VOLRB(3)    61340. FT**3   TOTAL FREE VOLUME OF COMPT 3
**
** -- ICE BOX: LEAVE ICE UPPER PLENUM VOL AS IS AND ADJUST FREE VOL IN ICE BED
** VOLRB(4) = 163713 - VOLRB(5) = 163713 - 54988 = 108725 FT^3
  VOLRB(4)   108725. FT**3   TOTAL FREE VOLUME OF COMPT 4
  VOLRB(5)    54988. FT**3   TOTAL FREE VOLUME OF COMPT 5
**           -------
** TOTAL ICE:  163713. FT^3
**
** -- UPPER: VOLRB(6)+VOLRB(7)+VOLRB(8) = 734829 FT^3
** REDUCE VOLRB(6) TO ACCOUNT FOR VOLUME OCCUPIED BY EQUIP:
** VOLRB(6) = 734829 - VOLRB(7) - VOLRB(8)
**
  VOLRB(6)   336665. FT**3   TOTAL FREE VOLUME OF COMPT 6
  VOLRB(7)   334285. FT**3   TOTAL FREE VOLUME OF COMPT 7
  VOLRB(8)    63879. FT**3   TOTAL FREE VOLUME OF COMPT 8
**           -------
** TOTAL UPPER: 734829. FT^3
**
** -- ADJUST VOLUME VS HEIGHT LOOKUP TABLES
**
** -- LOWER COMPARTMENT:
** MODIFY LOWER COMPT VOL VS HEIGHT TO ACCOUNT FOR RECIRC SUMP AND
** NET FREE VOL.  ESTIMATE BASED ON PLANT WALKDOWN IS THAT AT LEAST 1% OF
** ACTIVE SUMP BELOW 602'-10" IS OCCUPIED BY EQUIPMENT.  1% OF 117,320 GAL IS
** 1173.2 GAL (157 FT**3). ADJUST ALL VOLUMES ACCORDINGLY
**
XRBLK(1,2)  -7.7 FT      7.7 ft deep sump = ZCS
VRBLK(1,2)  0.0 FT**3

XRBLK(2,2)  0.0 FT       (ELEV. 598'-9 3/8")
VRBLK(2,2)  954. FT**3   WATER VOL TO FILL SUMP IS 7136 GAL OUT TO FIRST
**                  ISOLATION VALVE (AEP)
```

```
XRBLK(3,2)  4.05 FT       DEFINED AS THE MINIMUM SAFE WATER LEVEL
**                  FOR SUFFICIENT NPSH IN THE ACTIVE SUMP
**                  (ELEV. 602'-10")
VRBLK(3,2)  15527. FT**3   CUMULATIVE VOLUME IN THE LOWER COMPARTMENT
**                  AT ELEV. 602'-10". ESTIMATE 1% OF VOLUME BELOW
**                  602'-10" OCCUPIED BY EQUIPMENT, THEREFORE
**                  NET FREE VOLUME IS 0.99*15684 = 15527 FT**3

XRBLK(4,2)  11.19 FT      HEIGHT OF SPILLWAY WEIR BETWEEN LOWER
**                  COMPARTMENT AND CAVITY INSTRUMENT TUNNEL.
**                  (ELEV. 610'-0")
VRBLK(4,2)  40532 FT**3    CUMULATIVE VOLUME IN THE LOWER COMPARTMENT
**                  AT ELEV. 610'-0". 40689 - 157 = 40532 FT**3
XRBLK(5,2)  13.2 FT       HEIGHT OF SPILLWAY WEIR BETWEEN LOWER
**                  COMPARTMENT AND ANNULAR COMPARTMENT
**                  (ELEV. 612'-0").
VRBLK(5,2)  48577  FT**3   CUMULATIVE VOLUME IN THE LOWER COMPARTMENT
**                  AT ELEV. 612'-0". 48734 - 157 = 48577 FT**3
XRBLK(6,2)  50.9 FT       BOTTOM OF OPERATING DECK
VRBLK(6,2)  254821. FT**3  TOTAL COMPARTMENT VOLUME: THIS NUMBER ALREADY
**                  INCLUDES EQUIP VOL REDUCTION

** -- CAVITY:
**
** REFINE VALUES BASED UPON AEP SPECIFIED VALUES FOR CAVITY VOLUME
** UP TO ELEV. 612'-0".  THE BALANCE OF THE CAVITY VOLUME IS SIMPLY THE
** ANNULAR REGION BETWEEN THE BIO. SHIELD WALL AND THE VESSEL FROM THE
** 612'-0" ELEV. TO THE VESSEL FLANGE AT THE 621'-1.5" ELEV.
**
XRBLK(1,1)  0.0 FT        FLOOR OF CAVITY
VRBLK(1,1)  0.0 FT**3      CUMULATIVE VOLUME

XRBLK(2,1)  43.0 FT       HEIGHT OF SPILLWAY BETWEEN CAVITY AND LOWER
**                  COMPARTMENT.  DIFFERENCE BETWEEN ELEV. 610'
**                  AND ELEV. 566'-11.75".
VRBLK(2,1)  15748. FT**3   CUMULATIVE VOLUME IN THE CAVITY AT 610'-0" ELEV.

XRBLK(3,1)  45.0 FT       HEIGHT OF THE CAVITY ANNULAR REGION AROUND
**                  THE VESSEL UP TO ELEV. 612'-0".
VRBLK(3,1)  16797. FT**3   CUMULATIVE VOLUME IN THE CAVITY AT 612'-0" ELEV.

XRBLK(4,1)  54.0 FT       HEIGHT OF THE CAVITY ANNULAR REGION AROUND
**                  THE VESSEL UP TO THE VESSEL FLANGE AT
**                  ELEV. 621'-1.5".
VRBLK(4,1)  20019. FT**3   CUMULATIVE VOLUME IN THE CAVITY AT 621'-1.5" ELEV.
XRBLK(5,1)  54.001 FT
VRBLK(5,1)  20019.5 FT**3  DUMMY LAST ENTRY TO SIMPLY OVERWRITE THE
**                  CORRESPONDING ENTRY IN THE BASE PARAMETER FILE.


** -- DEAD-ENDED COMPARTMENT:
XRBLK(2,3)  13.2 FT       HEIGHT UP TO BOTTOM OF SPILLWAY
**                  FOR CONSISTENCY, THIS MUST BE
```

```
**                THE SAME AS ZJUNC(5,1).
VRBLK(2,3)  42669. FT**3    VOLUME UP TO BOTTOM OF SPILLWAY
**                (95% OF 44915 FT**3 EMPTY VOLUME TO ACCOUNT
**                 FOR 5% EQUIPMENT VOLUME.)
VRBLK(3,3)  61702. FT**3    DEAD-ENDED COMPT TOTAL VOL.: NO ADJSUTMENT FOR EQUIP
**                VOL.

** -- UPPER COMPARTMENT:
VRBLK(4,6) 336665. FT**3    UPPER COMPT CYLINDRICAL SECTION

** ----------------------------------------------------------------
** -- CHANGES TO CONTAINMENT INITIAL CONDITIONS
** ----------------------------------------------------------------
FRHB0(1)  0.0          COMPARTMENT INITIAL RELATIVE HUMIDITY
FRHB0(2)  0.0          COMPARTMENT INITIAL RELATIVE HUMIDITY
FRHB0(3)  0.0          COMPARTMENT INITIAL RELATIVE HUMIDITY
FRHB0(6)  0.0          COMPARTMENT INITIAL RELATIVE HUMIDITY
FRHB0(7)  0.0          COMPARTMENT INITIAL RELATIVE HUMIDITY
FRHB0(8)  0.0          COMPARTMENT INITIAL RELATIVE HUMIDITY
FRHB0(9)  0.0          COMPARTMENT INITIAL RELATIVE HUMIDITY
FRHB0(10) 0.0          COMPARTMENT INITIAL RELATIVE HUMIDITY
FRHB0(11) 0.0          COMPARTMENT INITIAL RELATIVE HUMIDITY
** ----------------------------------------------------------------
** -- CHANGES TO MISCELLANEOUS PARAMETERS
** ----------------------------------------------------------------
QCR0    1.10884D10 BTU/HR  FULL REACTOR POWER, (3250 MWt)
TRWST   105. F          TEMPERATURE OF RWST: LOTIC
TACUM   120. F          INITIAL ACCUMULATOR TEMPERATURE.  VALUE IS
**               TECH. SPEC. MINIMUM.
TCWHX   87.5 F          COOLING WATER TEMPERATURE; MAX LAKE TEMP.
MACUM0  56957. LB       INITIAL MASS PER COLD LEG ACCUMULATOR
**               ACCUMULATOR MASS IS BASED UPON 921 FT**3
**               AT 120 F PER TECH. SPEC. MINIMUM.
**
PACUM0  600 PSI         INITIAL ACCUMULATOR PRESSURE.  VALUE IS
**               TECH. SPEC. MINIMUM.
MICE0   2.43D6 LB       INITIAL MASS OF ICE
TWPSNM  556.0 F         NOMINAL FULL POWER PRIMARY SYSTEM WATER TEMPERATURE
TWPS0   556.0 F         INITIAL PRIMARY SYSTEM WATER TEMPERATURE
PPS0    2250. PSI       INITIAL PRIMARY SYSTEM PRESSURE (UNIT 2)
PLPI0   1764.7 PSI      PRESSURE SETPOINT FOR RHR (SET SAME AS SI SIGNAL)
PCHP0   1764.5 PSI      CHARGING PUMP PRESSURE SETPOINT; SAME AS SI

MU20    213387 LB       TOTAL UO2 MASS
MZR0C   52303  LB       TOTAL MASS OF ZIRCALLOY IN CLAD
XDPIN   0.0300 FT       FUEL PIN OUTER DIAMETER
XRPEL   0.01314 FT      FUEL PELLET RADIUS
XTZR    0.001860 FT     CLAD THICKNESS
NPIN    50952           NUMBER OF FUEL PINS
MRWST0  2.897E06 LB     INITIAL MASS IN RWST.  THIS CORRESPONDS TO
**               THE TECH. SPEC. MINIMUM 350,000 GAL. AT A
**               TEMPERATURE OF 105 F.
**               FOR INSTRUMENT ERROR
**
```

```
** NOTE, THE CONTAINMENT SPRAY FLOW DISTRIBUTION BETWEEN THE UPPER
** AND LOWER SPRAYS IS BASED UPON AEP RECOMMENDATION AND IT WAS
** CONFIRMED DURING FAI WALKDOWN OF UNIT 1. THIS INCLUDES AN
** ADJUSTMENT FOR 139 GPM OF REDIRECTED FLOW TO THE ANNULAR COMPT.
** DUE TO SPRAY FLOW FALLING THROUGH TWO STAIR WELLS AT THE REFUELING
** FLOOR AND DRAINING INTO THE ANNULAR COMPT.
**
** MAXIMIZE SPRAY FLOW TO GET MINIMUM TIME TO LOW SUMP LEVEL, AND
** HENCE MINIMUM TIME FOR OPERATOR ACTIONS. DBA MAX SPRAY FLOW IS 3600 GPM
** WITH 63.45% GOING TO UPPER SPRAY HEADER. ALSO ACCOUNT FOR 45 GPM
** LEAKAGE FROM UPPER TO ANNULUS VIA STAIRWELL:
** TOTAL UPPER SPRAY FLOW: 3600*.6345 - 45 = 2239.2 GPM = 1.1196E6 LB/HR
** LOWER + ANNULUS IS THEN: 3600 - 2239.2 = 1360.8 GPM = 680,400 LB/HR
WSPAX  1.1196E6 LB/HR     // 3600*.6345 - 45 GPM TO UPPER
WSPBX  680400. LB/HR      // 3600 - 2239.2 GPM TO LOWER AND ANNULUS
**
** NOTE, THE SPLIT FRACTIONS FOR THE LOWER VOLUME SPRAYS BETWEEN THE
** LOWER COMPARTMENT AND THE FAN/ACCUMULATOR ROOM IN THE ANNULAR
** COMPARTMENT IS BASED UPON AEP RECOMMENDATION AND IT WAS
** CONFIRMED DURING FAI WALKDOWN OF UNIT 1. SINCE ALL LOWER VOLUME
** SPRAY FLOW STEMS FROM ONE RING HEADER (PER TRAIN), THE SPLIT
** IS DETERMINED BY THE FRACTION OF NOZZLES IN THE RESPECTIVE
** COMPARTMENTS.
**
** SPLIT THE TOTAL LOWER+ANNULUS FLOW:
**   TOTAL ANNULUS FLOW IS 3600*.0609 + 45 =   264.24 GPM
**   TOTAL LOWER + ANNULUS = WSPBX =         1360.8  GPM
**   ANNULUS SPLIT FRACTION = 264.24/1360.8 = 0.1942
**   LOWER COMPT SPLIT FRACT = 1-.1942 = 0.8058
NSPS(3)  11          SOURCE COMPT FOR SPLIT 1: HEADER COMPARTMENT
NSPR(3)   2          RECEIVER COMPT FOR SPLIT 1: LOWER COMPT
FSPR(3)  0.8058      SPLIT FRACTION FOR SPLIT 1
NSPS(4)  11          SOURCE COMPT FOR SPLIT 2: HEADER COMPARTMENT
NSPR(4)   3          RECEIVER COMPT FOR SPLIT 2: FAN/ACCUM. ROOM
**                   IN ANNULAR COMPT.
FSPR(4)  0.1942      SPLIT FRACTION FOR SPLIT 2
ZSPB     1.0         SPRAY HEADER HEIGHT IN HEADER COMPARTMENT
JNLCS    11          SPB DISCHARGE TO HEADER COMPARTMENT


C REFINE SPRAY FALL HEIGHTS FOR UPPER VOLUME NODES 6,7, AND 8.
C NOTE, ZSPA+XHSPRB(7)+XHSPRB(6) = 80.2 FT, WHICH IS THE TAKEN FROM
C THE AEP VALUE FOR SPRAY FALL HEIGHT IN THE UPPER VOLUME.

ZSPA      2.125 FT      SPRAY FALL HEIGHT IN NODE 8, WHICH IS
**                      ASSUMED TO BE THE SOURCE FOR ALL UPPER
**                      VOLUME SPRAY.
XHSPRB(7) 32.4 FT       SPRAY FALL HEIGHT IN NODE 7, WHICH IS
**                      ASSUMED TO RECEIVE SPRAY FROM NODE 8.
XHSPRB(6) 45.7 FT       SPRAY FALL HEIGHT IN NODE 6, WHICH IS
**                      ASSUMED TO RECEIVE SPRAY FROM NODE 7.

C -- DEFINE SPRAY HEADER TO ALLOW FLOW SPLIT TO LOWER (COMPT 2) AND
C -- DEAD-ENDED (COMPT 3): 900 GPM LOWER, 275 GPM DEAD-ENDED
```

```
XHSPRB(2)  50.9 FT        SPRAY FALL HEIGHT FOR THE LOWER COMPT.
**                    THE FALL HEIGHT CORRESPONDS TO THE FULL
**                    HEIGHT OF THE COMPARTMENT.
XHSPRB(3)  36.75 FT      SPRAY FALL HEIGHT FOR THE FAN/ACCUMULATOR
**                    ROOM, WHICH IS PART OF THE ANNULAR
**                    COMPARTMENT.

** ------------------------------------------------------------------
** CHANGES TO MODEL PARAMETERS FOR 4.0.3 COMPATIBILITY
** ------------------------------------------------------------------
*SI
** -- MODEL PARAMETERS IN SI UNITS
FCDBRK   1.00         DISCHARGE COEFFICIENT FOR PRIMARY SYSTEM BREAK(S)
STOX     0.1          SURFACE TENSION OF OXIDIC DEBRIS
STML     0.1          SURFACE TENSION OF METAL LAYER
XGAPPB   1000.E-6        RESISTANCE GAP BETWEEN METAL AND PARTICULATE BED
ICRBAL   1            ENERGY BALANCE OUTPUT OPTION
FCRDR    0.1
*BR
**
*****************************************************************************
**          D. C. COOK UNIT 1: GENERALIZED ESF MODEL            **
**                  PREPARED FOR                     **
**          THE AMERICAN ELECTRIC POWER SERVICE COMPANY              **
**                 BY                          **
**               TOM ELICSON, 10-13-97                 **
**          FAUSKE & ASSOCIATES, BURR RIDGE, IL.              **
**                              **
** MODEL ALLOWS INDEPENDENT SWITCH TO RECIRCULATION FOR EACH OF TWO
**
** ESF TRAINS.  TRAIN 1 SWITCHES AT LOW LEVEL, TRAIN 2 SWITCHES AT  **
** LOW LOW LEVEL.  USE DCC_GENESF.INC IN CONJUNCTION WITH THIS GENESF   **
** PARAMETER FILE TO OBTAIN ESF CONTROL LOGIC.  ALSO, IN INPUT DECK,    **
** MUST SPECIFY  "NUMBER OF ESF TRAINS IS 2" TO ACTIVATE GENESF MODELS   **
**                                                  **
*****************************************************************************
** THIS MODEL IS IN BRITISH UNITS
*BR
**
*****************************************************************************
**
*GENERALIZED ENGINEERED SAFEGUARDS  (PARAMETER GROUP #21)
**
*****************************************************************************
**NOTE TO MAAP/BWR USERS--GPM IS USED IN MAAP/PWR INSTEAD OF FT**3/HR
**
**IN THE FOLLOWING,"FANS"REFER TO FAN COOLERS--(AIR RETURN FANS IN
**CONDENSER PLANTS)
**
**FOR BETTER ACCURACY, YOU MAY ELECT TO INPUT "SYSTEM" PUMP HEAD CURVES
WHICH
**INCLUDE THE EFFECTS OF FRICTION IN THE INLET AND OUTLET PIPING (WHICH IS
**IGNORED IN MAAP); IF YOU DO SO, BE SURE THE ASSUMPTIONS ON STATIC HEAD
```

**WHICH ARE USED IN THEIR CALCULATION ARE CONSISTENT WITH THE PUMP ELEVATIONS
**ETC. WHICH ARE INPUT BELOW--THIS IS GENERALLY A FACTOR ONLY IN CRITICAL
**APPLICATIONS SUCH AS FEED AND BLEED WHERE THE CHARGING PUMP FLOW IS
**BARELY (OR NOT) ADEQUATE TO MATCH DECAY HEAT
**
**THIS PARAMETER FILE SECTION IS REQUIRED ONLY IF NEW ESF MODELS ARE DESIRED
**
NESF 0 NESF: ESF MODEL SELECTION
** = 0 FOR OLD ESF MODEL ONLY
** = 1 FOR GENERALIZED ESF MODEL ONLY
**
*******************************************************************
*** UPPER COMPARTMENT CONTAINMENT SPRAY SYSTEM ***
*******************************************************************
**
NSPAG 8 NSPAG: NUMBER OF OPERATIONAL UPPER COMPT SPRAY PUMPS
** REPRESENTED BY THIS SYSTEM
**
NORSPA 1 NORSPA: UPPER COMPT CONTAINMENT SPRAY PUMP
** CHARACTERISTICS SELECTION FOR NORMAL LINEUP;
** THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
** CHARACTERISTICS SETS DEFINED IN *PUMP #1-40
**
NSSPA 3 NSSPA: WATER SOURCE UNDER NORMAL PUMP LINEUP FOR UPPER
** COMPT SPRAY PUMPS
** = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
** = 1: HOT LEG
** = 2: COLD LEG
** = 3: RWST
** = 4: LOWER COMPARTMENT SUMP
** = 5: ANNULAR COMPARTMENT SUMP
**
NDSPA 4 NDSPA: DISCHARGE LOCATION UNDER NORMAL PUMP LINEUP FOR UPPER
** COMPT SPRAY PUMPS
** = 1: HOT LEG
** = 2: COLD LEG
** = 3: DOWNCOMER
** = 4: UPPER COMPARTMENT SPRAY HEADER #1
** = 5: LOWER COMPARTMENT SPRAY HEADER
** = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
RECSPA 1 RECSPA: UPPER COMPT CONTAINMENT SPRAY PUMP
** CHARACTERISTICS SELECTION FOR RECIRC LINEUP;
** THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
** CHARACTERISTICS SETS DEFINED IN *PUMP #1-40
**
RSSPA 3 RSSPA: WATER SOURCE UNDER RECIRC PUMP LINEUP FOR UPPER
** COMPT SPRAY PUMPS
** = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
** = 1: HOT LEG
** = 2: COLD LEG
** = 3: RWST

```
**              = 4: LOWER COMPARTMENT SUMP
**              = 5: ANNULAR COMPARTMENT SUMP
**
RDSPA    4      RDSPA: DISCHARGE LOCATION UNDER RECIRC PUMP LINEUP FOR UPPER
**              COMPT SPRAY PUMPS
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: DOWNCOMER
**              = 4: UPPER COMPARTMENT SPRAY HEADER #1
**              = 5: LOWER COMPARTMENT SPRAY HEADER
**              = 6: INLET OF HPI PUMP
**              = 7: INLET OF CHARGING PUMP
**              = 8: DISCHARGE TO BOTH HPI AND CHARGING PUMP INLET
**              = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
SNPSPA   0      SNPSPA: NPSH ENHANCEMENT FLOW SOURCE FOR SPA
**              = 0: NO ENHANCEMENT FLOW
**              = 1: NPSH ENHANCEMENT RECIRCULATION FLOW;
**                 NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**                 DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**                 EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**              = 2: NPSH ENHANCEMENT FLOW FROM SPA OUTLET
**              = 3: NPSH ENHANCEMENT FLOW FROM EXTERNAL WATER STORAGE
**                 TANK
**
WESPA    0.E0   WESPA: NPSH ENHANCEMENT RECIRCULATION FLOW RATE;
**              SET = 0 IF NO NPSH ENHANCEMENT IN LINEUP
**
TDNSPA   10.E0  TDNSPA: TIME TO UPPER COMPARTMENT SPRAY PUMP FAILURE
**              ONCE HAVE INSUFFICIENT NPSH.  PUMPS WILL CONTINUE TO
**              OPERATE WITH DEGRADED PERFORMANCE (SEE *GENERALIZED #12)
**              UNTIL TIME ELAPSED SINCE LOSS OF SUFFICIENT NPSH EXCEEDS
**              TINSPA. IF TINSPA EXCEEDED BEFORE RE-ACQUIRING SUFFICIENT
**              NPSH, THEN PUMP WILL BE LOST FOR DURATION OF SEQUENCE.
**              IF RE-ACQUIRE SUFFICIENT NPSH THEN TIME COUNTER RESET.
**
DEGSPA   1      DEGSPA: UPPER COMPT CONTAINMENT SPRAY PUMP
**              CHARACTERISTICS SELECTION FOR DEGRADED PERFORMANCE;
**              THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**              CHARACTERISTICS SETS DEFINED IN *PUMP #1-40.
**              THIS SET OF PUMP CHARACTERISTICS IS AUTOMATICALLY
**              SELECTED WHEN HAVE INSUFFICIENT NPSH.
**              THIS CHARACTERISTIC SET CAN BE THE
**              SAME AS THAT SPECIFIED FOR NORMAL LINEUP (SEE
**              *GENERALIZED 04) IF NO DEGRADED PERFORMANCE WILL BE
**              CONSIDERED.  ALSO, CAN SPECIFY AN "ALTERNATIVE" PUMP
**              RATHER THAN A "DEGRADED" PUMP.
**
ZSPARW   34.25  ZSPARW: HEIGHT OF BOTTOM OF RWST ABOVE THE SPA PUMPS
**
ZSPACS   20.5   ZSPACS: HEIGHT OF BOTTOM OF CONTAINMENT SUMP ABOVE THE
**              SPAPUMPS.
**
ZSPASI   190.   ZSPASI: ELEVATION OF THE RV INJECTION NOZZLES ABOVE THE
```

```
**          SPA PUMPS.  768'-0" - (598-9 3/8 - 20.5') = 190.
**
*****************************************************************
***     LOWER COMPARTMENT CONTAINMENT SPRAY SYSTEM        ***
*****************************************************************
NSPBG      4      NSPBG: NUMBER OF OPERATIONAL LOWER COMPT SPRAY PUMPS
**                REPRESENTED BY THIS SYSTEM
NORSPB     1      NORSPB: LOWER COMPT CONTAINMENT SPRAY PUMP
**                CHARACTERISTICS SELECTION FOR NORMAL LINEUP;
**                THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**                CHARACTERISTICS SETS DEFINED IN *PUMP #241-280
**
NSSPB      3      NSSPB: WATER SOURCE UNDER NORMAL PUMP LINEUP FOR LOWER
**                COMPT SPRAY PUMPS
**                = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**                = 1: HOT LEG
**                = 2: COLD LEG
**                = 3: RWST
**                = 4: LOWER COMPARTMENT SUMP
**                = 5: ANNULAR COMPARTMENT SUMP
**
NDSPB      5      NDSPB: DISCHARGE LOCATION UNDER NORMAL PUMP LINEUP FOR
LOWER
**                COMPT SPRAY PUMPS
**                = 1: HOT LEG
**                = 2: COLD LEG
**                = 3: DOWNCOMER
**                = 4: UPPER COMPARTMENT SPRAY HEADER #1
**                = 5: LOWER COMPARTMENT SPRAY HEADER
**                = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
RECSPB     1      RECSPB: LOWER COMPT CONTAINMENT SPRAY PUMP
**                CHARACTERISTICS SELECTION FOR RECIRC LINEUP;
**                THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**                CHARACTERISTICS SETS DEFINED IN *PUMP #241-280
**
RSSPB      3      RSSPB: WATER SOURCE UNDER RECIRC PUMP LINEUP FOR LOWER
**                COMPT SPRAY PUMPS
**                = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**                = 1: HOT LEG
**                = 2: COLD LEG
**                = 3: RWST
**                = 4: LOWER COMPARTMENT SUMP
**                = 5: ANNULAR COMPARTMENT SUMP
**
RDSPB      5      RDSPB: DISCHARGE LOCATION UNDER RECIRC PUMP LINEUP FOR LOWER
**                COMPT SPRAY PUMPS
**                = 1: HOT LEG
**                = 2: COLD LEG
**                = 3: DOWNCOMER
**                = 4: UPPER COMPARTMENT SPRAY HEADER #1
**                = 5: LOWER COMPARTMENT SPRAY HEADER
**                = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
```

```
SNPSPB    0      SNPSPB: NPSH ENHANCEMENT FLOW SOURCE FOR SPB
**           = 0: NO ENHANCEMENT FLOW
**           = 1: NPSH ENHANCEMENT RECIRCULATION FLOW;
**              NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**              DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**              EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**           = 2: NPSH ENHANCEMENT FLOW FROM SPA OUTLET
**           = 3: NPSH ENHANCEMENT FLOW FROM EXTERNAL WATER STORAGE
**              TANK
**
WESPB     0.E0   WESPB: NPSH ENHANCEMENT RECIRCULATION FLOW RATE;
**           SET = 0 IF NO NPSH ENHANCEMENT IN LINEUP
**
**           NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**           DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**           EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**
TDNSPB    10.E0   TDNSPB: TIME TO LOWER COMPARTMENT SPRAY PUMP FAILURE
**           ONCE HAVE INSUFFICIENT NPSH. PUMPS WILL CONTINUE TO
**           OPERATE WITH DEGRADED PERFORMANCE (SEE *GENERALIZED #26)
**           UNTIL TIME ELAPSED SINCE LOSS OF SUFFICIENT NPSH EXCEEDS
**           TINSPB. IF TINSPB EXCEEDED BEFORE RE-ACQUIRING SUFFICIENT
**           NPSH, THEN PUMP WILL BE LOST FOR DURATION OF SEQUENCE.
**           IF RE-ACQUIRE SUFFICIENT NPSH THEN TIME COUNTER RESET.
**
DEGSPB    1      DEGSPB: LOWER COMPT CONTAINMENT SPRAY PUMP
**           CHARACTERISTICS SELECTION FOR DEGRADED PERFORMANCE;
**           THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**           CHARACTERISTICS SETS DEFINED IN GENESF #241-280.
**           THIS SET OF PUMP CHARACTERISTICS IS AUTOMATICALLY
**           SELECTED WHEN HAVE INSUFFICIENT NPSH.
**           THIS CHARACTERISTIC SET CAN BE THE
**           SAME AS THAT SPECIFIED FOR NORMAL LINEUP (SEE
**           *GENERALIZED 17) IF NO DEGRADED PERFORMANCE WILL BE
**           CONSIDERED. ALSO, CAN SPECIFY AN "ALTERNATIVE" PUMP
**           RATHER THAN A "DEGRADED" PUMP
**
ZSPBRW    34.25   ZSPBRW: HEIGHT OF BOTTOM OF RWST ABOVE THE SPB PUMPS.
**
ZSPBCS    20.5    ZSPBCS: HEIGHT OF BOTTOM OF CONTAINMENT SUMP ABOVE THE
**           SPB PUMPS.
**
ZSPBSI    190    ZSPBSI: ELEVATION OF THE RV INJECTION NOZZLES ABOVE THE
**           SPB PUMPS. (SAME AS ZSPASI)
**
*****************************************************************
***       LOW PRESSURE INJECTION (TRAIN 1) SYSTEM        ***
*****************************************************************
NLP1G     2      NLP1G: NUMBER OF OPERATIONAL LPI1 PUMPS
**           REPRESENTED BY THIS SYSTEM
NORLP1    2      NORLP1: LPI1 PUMP
**           CHARACTERISTICS SELECTION FOR NORMAL LINEUP;
**           THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**           CHARACTERISTICS SETS DEFINED IN *PUMP #41-80
```

```
**
NSLP1      3      NSLP1: WATER SOURCE UNDER NORMAL PUMP LINEUP FOR LPI1 PUMPS
**                = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**                = 1: HOT LEG
**                = 2: COLD LEG
**                = 3: RWST
**                = 4: LOWER COMPARTMENT SUMP
**                = 5: ANNULAR COMPARTMENT SUMP
**                = 6: LPI 1
**                = 7: LPI 2
**
NDLP1      2      NDLP1: DISCHARGE LOCATION UNDER NORMAL PUMP LINEUP FOR LPI1
**                PUMPS
**                = 1: HOT LEG
**                = 2: COLD LEG
**                = 3: DOWNCOMER
**                = 4: UPPER COMPARTMENT SPRAY HEADER #1
**                = 5: LOWER COMPARTMENT SPRAY HEADER
**                = 6: INLET OF HPI PUMP
**                = 7: INLET OF CHARGING PUMP
**                = 8: DISCHARGE TO BOTH HPI AND CHARGING PUMP INLET
**                = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
RECLP1     2      RECLP1: LPI1 PUMP
**                CHARACTERISTICS SELECTION FOR RECIRC LINEUP;
**                THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**                CHARACTERISTICS SETS DEFINED IN *PUMP #41-80
**
RSLP1      3      RSLP1: WATER SOURCE UNDER RECIRC PUMP LINEUP FOR LPI1 PUMP
**                = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**                = 1: HOT LEG
**                = 2: COLD LEG
**                = 3: RWST
**                = 4: LOWER COMPARTMENT SUMP
**                = 5: ANNULAR COMPARTMENT SUMP
**                = 6: LPI 1
**                = 7: LPI 2
**
RDLP1      2      RDLP1: DISCHARGE LOCATION UNDER RECIRC PUMP LINEUP FOR
**                LPI1 PUMP
**                = 1: HOT LEG
**                = 2: COLD LEG
**                = 3: DOWNCOMER
**                = 4: UPPER COMPARTMENT SPRAY HEADER #1
**                = 5: LOWER COMPARTMENT SPRAY HEADER
**                = 6: INLET OF HPI PUMP
**                = 7: INLET OF CHARGING PUMP
**                = 8: DISCHARGE TO BOTH HPI AND CHARGING PUMP INLET
**                = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
SNPLP1     0      SNPLP1: NPSH ENHANCEMENT FLOW SOURCE FOR LP1
**                = 0: NO ENHANCEMENT FLOW
**                = 1: NPSH ENHANCEMENT RECIRCULATION FLOW;
**                  NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
```

```
**                 DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**                 EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**              = 2: NPSH ENHANCEMENT FLOW FROM SPA OUTLET
**              = 3: NPSH ENHANCEMENT FLOW FROM EXTERNAL WATER STORAGE
**                 TANK
**
WELP1     0.E0    WELP1: NPSH ENHANCEMENT RECIRCULATION FLOW RATE;
**              SET = 0 IF NO NPSH ENHANCEMENT IN LINEUP
**
**              NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**              DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**              EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**
TDNLP1    10.E0    TDNLP1: TIME TO LPI1 PUMP FAILURE
**              ONCE HAVE INSUFFICIENT NPSH, PUMPS WILL CONTINUE TO
**              OPERATE WITH DEGRADED PERFORMANCE (SEE *GENERALIZED #40)
**              UNTIL TIME ELAPSED SINCE LOSS OF SUFFICIENT NPSH EXCEEDS
**              TINLP1. IF TINLP1 EXCEEDED BEFORE RE-ACQUIRING SUFFICIENT
**              NPSH, THEN PUMP WILL BE LOST FOR DURATION OF SEQUENCE.
**              IF RE-ACQUIRE SUFFICIENT NPSH THEN TIME COUNTER RESET.
**
DEGLP1    2       DEGLP1: LPI1 PUMP
**              CHARACTERISTICS SELECTION FOR DEGRADED PERFORMANCE;
**              THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**              CHARACTERISTICS SETS DEFINED IN GENESF #201-240.
**              THIS SET OF PUMP CHARACTERISTICS IS AUTOMATICALLY
**              SELECTED WHEN HAVE INSUFFICIENT NPSH.
**              THIS CHARACTERISTIC SET CAN BE THE
**              SAME AS THAT SPECIFIED FOR NORMAL LINEUP (SEE
**              *GENERALIZED 31) IF NO DEGRADED PERFORMANCE WILL BE
**              CONSIDERED.  ALSO, CAN SPECIFY AN "ALTERNATIVE" PUMP
**              RATHER THAN A "DEGRADED" PUMP
**
ZLP1RW    34.25    ZLP1RW: HEIGHT OF BOTTOM OF RWST ABOVE THE LP1 PUMPS.
**
ZLP1CS    20.5    ZLP1CS: HEIGHT OF BOTTOM OF CONTAINMENT SUMP ABOVE THE
**              LP1 PUMPS.
**
ZLP1SI    39.0    ZLP1SI: ELEVATION OF THE RV INJECTION NOZZLES ABOVE THE
**              LP1 PUMPS.
**
*****************************************************************
***      LOW PRESSURE INJECTION (TRAIN 2) SYSTEM       ***
*****************************************************************
NLP2G     1      NLP2G: NUMBER OF OPERATIONAL LPI2 PUMPS
**              REPRESENTED BY THIS SYSTEM
NORLP2    5      NORLP2: LPI2 PUMP
**              CHARACTERISTICS SELECTION FOR NORMAL LINEUP;
**              THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**              CHARACTERISTICS SETS DEFINED IN *PUMP #41-80
**
NSLP2     0      NSLP2: WATER SOURCE UNDER NORMAL PUMP LINEUP FOR LPI2 PUMPS
**              = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**              = 1: HOT LEG
```

```
**              = 2: COLD LEG
**              = 3: RWST
**              = 4: LOWER COMPARTMENT SUMP
**              = 5: ANNULAR COMPARTMENT SUMP
**              = 6: LPI 1
**              = 7: LPI 2
**
NDLP2     2       NDLP2: DISCHARGE LOCATION UNDER NORMAL PUMP LINEUP FOR LPI2
**              PUMPS
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: DOWNCOMER
**              = 4: UPPER COMPARTMENT SPRAY HEADER #1
**              = 5: LOWER COMPARTMENT SPRAY HEADER
**              = 6: INLET OF HPI PUMP
**              = 7: INLET OF CHARGING PUMP
**              = 8: DISCHARGE TO BOTH HPI AND CHARGING PUMP INLET
**              = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
RECLP2    5       RECLP2: LPI2 PUMP
**              CHARACTERISTICS SELECTION FOR RECIRC LINEUP;
**              THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**              CHARACTERISTICS SETS DEFINED IN *PUMP #41-80
**
RSLP2     4       RSLP2: WATER SOURCE UNDER RECIRC PUMP LINEUP FOR LPI2 PUMP
**              = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: RWST
**              = 4: LOWER COMPARTMENT SUMP
**              = 5: ANNULAR COMPARTMENT SUMP
**              = 6: LPI 1
**              = 7: LPI 2
**
RDLP2     2       RDLP2: DISCHARGE LOCATION UNDER RECIRC PUMP LINEUP FOR
**              LPI2 PUMP
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: DOWNCOMER
**              = 4: UPPER COMPARTMENT SPRAY HEADER #1
**              = 5: LOWER COMPARTMENT SPRAY HEADER
**              = 6: INLET OF HPI PUMP
**              = 7: INLET OF CHARGING PUMP
**              = 8: DISCHARGE TO BOTH HPI AND CHARGING PUMP INLET
**              = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
SNPLP2    0       SNPLP2: NPSH ENHANCEMENT FLOW SOURCE FOR LP2
**              = 0: NO ENHANCEMENT FLOW
**              = 1: NPSH ENHANCEMENT RECIRCULATION FLOW;
**                  NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**                  DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**                  EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**              = 2: NPSH ENHANCEMENT FLOW FROM SPA OUTLET
**              = 3: NPSH ENHANCEMENT FLOW FROM EXTERNAL WATER STORAGE
```

```
**              TANK
**
WELP2     0.E0    WELP2: NPSH ENHANCEMENT RECIRCULATION FLOW RATE;
**                SET = 0 IF NO NPSH ENHANCEMENT IN LINEUP
**
**                NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**                DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**                EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**
TDNLP2    10.E0   TDNLP2: TIME TO LPI2 PUMP FAILURE
**                ONCE HAVE INSUFFICIENT NPSH.  PUMPS WILL CONTINUE TO
**                OPERATE WITH DEGRADED PERFORMANCE (SEE *GENERALIZED #54)
**                UNTIL TIME ELAPSED SINCE LOSS OF SUFFICIENT NPSH EXCEEDS
**                TINLP2. IF TINLP2 EXCEEDED BEFORE RE-ACQUIRING SUFFICIENT
**                NPSH, THEN PUMP WILL BE LOST FOR DURATION OF SEQUENCE.
**                IF RE-ACQUIRE SUFFICIENT NPSH THEN TIME COUNTER RESET.
**
DEGLP2    5       DEGLP2: LPI2 PUMP
**                CHARACTERISTICS SELECTION FOR DEGRADED PERFORMANCE;
**                THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**                CHARACTERISTICS SETS DEFINED IN GENESF #41-80.
**                THIS SET OF PUMP CHARACTERISTICS IS AUTOMATICALLY
**                SELECTED WHEN HAVE INSUFFICIENT NPSH.
**                THIS CHARACTERISTIC SET CAN BE THE
**                SAME AS THAT SPECIFIED FOR NORMAL LINEUP (SEE
**                *GENERALIZED 45) IF NO DEGRADED PERFORMANCE WILL BE
**                CONSIDERED.  ALSO, CAN SPECIFY AN "ALTERNATIVE" PUMP
**                RATHER THAN A "DEGRADED" PUMP
**
ZLP2RW    34.25   ZLP2RW: HEIGHT OF BOTTOM OF RWST ABOVE THE LP2 PUMPS.
**
ZLP2CS    20.5    ZLP2CS: HEIGHT OF BOTTOM OF CONTAINMENT SUMP ABOVE THE
**                LP2 PUMPS.
**
ZLP2SI    39.0    ZLP2SI: ELEVATION OF THE RV INJECTION NOZZLES ABOVE THE
**                LP2 PUMPS.
**
******************************************************************
***           HIGH PRESSURE INJECTION SYSTEM           ***
******************************************************************
NHPIG     2       NHPIG: NUMBER OF OPERATIONAL HPI PUMPS
**                REPRESENTED BY THIS SYSTEM
NORHPI    3       NORHPI: HPI PUMP
**                CHARACTERISTICS SELECTION FOR NORMAL LINEUP;
**                THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**                CHARACTERISTICS SETS DEFINED IN *PUMP #81-120
**
NSHPI     3       NSHPI: WATER SOURCE UNDER NORMAL PUMP LINEUP FOR HPI PUMPS
**                = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**                = 1: HOT LEG
**                = 2: COLD LEG
**                = 3: RWST
**                = 4: LOWER COMPARTMENT SUMP
**                = 5: ANNULAR COMPARTMENT SUMP
```

```
**              = 6: LPI 1
**              = 7: LPI 2
**
NDHPI     2       NDHPI: DISCHARGE LOCATION UNDER NORMAL PUMP LINEUP FOR HPI
**              PUMPS
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: DOWNCOMER
**              = 4: UPPER COMPARTMENT SPRAY HEADER #1
**              = 5: LOWER COMPARTMENT SPRAY HEADER
**              = 6: INLET OF HPI PUMP
**              = 7: INLET OF CHARGING PUMP
**              = 8: DISCHARGE TO BOTH HPI AND CHARGING PUMP INLET
**              = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
RECHPI    3       RECHPI: HPI PUMP
**              CHARACTERISTICS SELECTION FOR RECIRC LINEUP;
**              THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**              CHARACTERISTICS SETS DEFINED IN *PUMP #81-120
**
RSHPI     3       RSHPI: WATER SOURCE UNDER RECIRC PUMP LINEUP FOR HPI PUMP
**              = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: RWST
**              = 4: LOWER COMPARTMENT SUMP
**              = 5: ANNULAR COMPARTMENT SUMP
**              = 6: LPI 1
**              = 7: LPI 2
**
RDHPI     2       RDHPI: DISCHARGE LOCATION UNDER RECIRC PUMP LINEUP FOR
**              HPI PUMP
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: DOWNCOMER
**              = 4: UPPER COMPARTMENT SPRAY HEADER #1
**              = 5: LOWER COMPARTMENT SPRAY HEADER
**              = 6: INLET OF HPI PUMP
**              = 7: INLET OF CHARGING PUMP
**              = 8: DISCHARGE TO BOTH HPI AND CHARGING PUMP INLET
**              = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
SNPHPI    0       SNPHPI: NPSH ENHANCEMENT FLOW SOURCE FOR HPI
**              = 0: NO ENHANCEMENT FLOW
**              = 1: NPSH ENHANCEMENT RECIRCULATION FLOW;
**                 NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**                 DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**                 EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**              = 2: NPSH ENHANCEMENT FLOW FROM SPA OUTLET
**              = 3: NPSH ENHANCEMENT FLOW FROM EXTERNAL WATER STORAGE
**                 TANK
**
WEHPI     0.E0    WEHPI: NPSH ENHANCEMENT RECIRCULATION FLOW RATE;
**              SET = 0 IF NO NPSH ENHANCEMENT IN LINEUP
```

```
**
**          NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**          DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**          EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**
TDNHPI    10.E0    TDNHPI: TIME TO HPI PUMP FAILURE
**          ONCE HAVE INSUFFICIENT NPSH.  PUMPS WILL CONTINUE TO
**          OPERATE WITH DEGRADED PERFORMANCE (SEE *GENERALIZED #68)
**          UNTIL TIME ELAPSED SINCE LOSS OF SUFFICIENT NPSH EXCEEDS
**          TINHPI. IF TINHPI EXCEEDED BEFORE RE-ACQUIRING SUFFICIENT
**          NPSH, THEN PUMP WILL BE LOST FOR DURATION OF SEQUENCE.
**          IF RE-ACQUIRE SUFFICIENT NPSH THEN TIME COUNTER RESET.
**
DEGHPI    3      DEGHPI: HPI PUMP
**          CHARACTERISTICS SELECTION FOR DEGRADED PERFORMANCE;
**          THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**          CHARACTERISTICS SETS DEFINED IN *PUMP #81-120.
**          THIS SET OF PUMP CHARACTERISTICS IS AUTOMATICALLY
**          SELECTED WHEN HAVE INSUFFICIENT NPSH.
**          THIS CHARACTERISTIC SET CAN BE THE
**          SAME AS THAT SPECIFIED FOR NORMAL LINEUP (SEE
**          *GENERALIZED 58) IF NO DEGRADED PERFORMANCE WILL BE
**          CONSIDERED.  ALSO, CAN SPECIFY AN "ALTERNATIVE" PUMP
**          RATHER THAN A "DEGRADED" PUMP
**
ZHPIRW    34.25    ZHPIRW: HEIGHT OF BOTTOM OF RWST ABOVE THE HPI PUMPS.
**
ZHPICS    20.5    ZHPICS: HEIGHT OF BOTTOM OF CONTAINMENT SUMP ABOVE THE
**          HPI PUMPS.
**
ZHPISI    39.    ZHPISI: ELEVATION OF THE RV INJECTION NOZZLES ABOVE THE
**          HPI PUMPS.
**
*****************************************************************
***          CHARGING PUMP SYSTEM          ***
*****************************************************************
NCHPG    2      NCHPG: NUMBER OF OPERATIONAL CHARGING PUMPS
**          REPRESENTED BY THIS SYSTEM
NORCHP    4      NORCHP: CHARGING PUMP
**          CHARACTERISTICS SELECTION FOR NORMAL LINEUP;
**          THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**          CHARACTERISTICS SETS DEFINED IN *PUMP #121-160
**
NSCHP    3      NSCHP: WATER SOURCE UNDER NORMAL PUMP LINEUP FOR CHARGING
PUMPS
**          = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**          = 1: HOT LEG
**          = 2: COLD LEG
**          = 3: RWST
**          = 4: LOWER COMPARTMENT SUMP
**          = 5: ANNULAR COMPARTMENT SUMP
**          = 6: LPI 1
**          = 7: LPI 2
**
```

```
NDCHP     2     NDCHP: DISCHARGE LOCATION UNDER NORMAL PUMP LINEUP FOR
CHARGING
**              PUMPS
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: DOWNCOMER
**              = 4: UPPER COMPARTMENT SPRAY HEADER #1
**              = 5: LOWER COMPARTMENT SPRAY HEADER
**              = 6: INLET OF HPI PUMP
**              = 7: INLET OF CHARGING PUMP
**              = 8: DISCHARGE TO BOTH HPI AND CHARGING PUMP INLET
**              = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
RECCHP    4     RECCHP: CHARGING PUMP
**              CHARACTERISTICS SELECTION FOR RECIRC LINEUP;
**              THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**              CHARACTERISTICS SETS DEFINED IN *PUMP #121-160
**
RSCHP     3     RSCHP: WATER SOURCE UNDER RECIRC PUMP LINEUP FOR CHARGING
PUMP
**              = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: RWST
**              = 4: LOWER COMPARTMENT SUMP
**              = 5: ANNULAR COMPARTMENT SUMP
**              = 6: LPI 1
**              = 7: LPI 2
**
RDCHP     2     RDCHP: DISCHARGE LOCATION UNDER RECIRC PUMP LINEUP FOR
**              CHARGING PUMP
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: DOWNCOMER
**              = 4: UPPER COMPARTMENT SPRAY HEADER #1
**              = 5: LOWER COMPARTMENT SPRAY HEADER
**              = 6: INLET OF HPI PUMP
**              = 7: INLET OF CHARGING PUMP
**              = 8: DISCHARGE TO BOTH HPI AND CHARGING PUMP INLET
**              = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
SNPCHP    0     SNPCHP: NPSH ENHANCEMENT FLOW SOURCE FOR CHP
**            = 0: NO ENHANCEMENT FLOW
**            = 1: NPSH ENHANCEMENT RECIRCULATION FLOW;
**                NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**                DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**                EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**            = 2: NPSH ENHANCEMENT FLOW FROM SPA OUTLET
**            = 3: NPSH ENHANCEMENT FLOW FROM EXTERNAL WATER STORAGE
**                TANK
**
WECHP     0.E0  WECHP: NPSH ENHANCEMENT RECIRCULATION FLOW RATE;
**            SET = 0 IF NO NPSH ENHANCEMENT IN LINEUP
**
```

```
**            NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**            DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**            EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**
TDNCHP   10.E0   TDNCHP: TIME TO CHARGING PUMP FAILURE
**            ONCE HAVE INSUFFICIENT NPSH.  PUMPS WILL CONTINUE TO
**            OPERATE WITH DEGRADED PERFORMANCE (SEE *GENERALIZED #82)
**            UNTIL TIME ELAPSED SINCE LOSS OF SUFFICIENT NPSH EXCEEDS
**            TINCHP. IF TINCHP EXCEEDED BEFORE RE-ACQUIRING SUFFICIENT
**            NPSH, THEN PUMP WILL BE LOST FOR DURATION OF SEQUENCE.
**            IF RE-ACQUIRE SUFFICIENT NPSH THEN TIME COUNTER RESET.
**
DEGCHP   4      DEGCHP: CHARGING PUMP
**            CHARACTERISTICS SELECTION FOR DEGRADED PERFORMANCE;
**            THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**            CHARACTERISTICS SETS DEFINED IN *PUMP #121-160.
**            THIS SET OF PUMP CHARACTERISTICS IS AUTOMATICALLY
**            SELECTED WHEN HAVE INSUFFICIENT NPSH.
**            THIS CHARACTERISTIC SET CAN BE THE
**            SAME AS THAT SPECIFIED FOR NORMAL LINEUP (SEE
**            *GENERALIZED 73) IF NO DEGRADED PERFORMANCE WILL BE
**            CONSIDERED.  ALSO, CAN SPECIFY AN "ALTERNATIVE" PUMP
**            RATHER THAN A "DEGRADED" PUMP
**
ZCHPRW   34.25   ZCHPRW: HEIGHT OF BOTTOM OF RWST ABOVE THE CHARGING
PUMPS.
**
ZCHPCS   20.5   ZCHPCS: HEIGHT OF BOTTOM OF CONTAINMENT SUMP ABOVE THE
**            CHARGING PUMPS.
**
ZCHPSI   39.    ZCHPSI: ELEVATION OF THE RV INJECTION NOZZLES ABOVE THE
**            CHARGING PUMPS.
**
******************************************************************
***      CONTAINMENT SPRAY SYSTEM TRAIN C              ***
******************************************************************
**
NSPCG    6      NSPCG: NUMBER OF OPERATIONAL TRAIN C SPRAY PUMPS
**            REPRESENTED BY THIS SYSTEM
**
NORSPC   1      NORSPC: TRAIN C CONTAINMENT SPRAY PUMP
**            CHARACTERISTICS SELECTION FOR NORMAL LINEUP;
**            THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**            CHARACTERISTICS SETS DEFINED IN *PUMP #1-40
**
NSSPC    0      NSSPC: WATER SOURCE UNDER NORMAL PUMP LINEUP FOR TRAIN C
**            SPRAY PUMPS
**            = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**            = 1: HOT LEG
**            = 2: COLD LEG
**            = 3: RWST
**            = 4: LOWER COMPARTMENT SUMP
**            = 5: ANNULAR COMPARTMENT SUMP
**            = 6: LPI 1
```

```
**              = 7: LPI 2
**
NDSPC     5      NDSPC: DISCHARGE LOCATION UNDER NORMAL PUMP LINEUP FOR
TRAIN C
**              SPRAY PUMPS
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: DOWNCOMER
**              = 4: UPPER COMPARTMENT SPRAY HEADER #1
**              = 5: LOWER COMPARTMENT SPRAY HEADER
**              = 6: INLET OF HPI PUMP
**              = 7: INLET OF CHARGING PUMP
**              = 8: DISCHARGE TO BOTH HPI AND CHARGING PUMP INLET
**              = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
RECSPC    6      RECSPC: TRAIN C CONTAINMENT SPRAY PUMP
**              CHARACTERISTICS SELECTION FOR RECIRC LINEUP;
**              THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**              CHARACTERISTICS SETS DEFINED IN *PUMP #1-40
**
RSSPC     4      RSSPC: WATER SOURCE UNDER RECIRC PUMP LINEUP FOR TRAIN C
**              SPRAY PUMPS
**              = 0: NO SOURCE (I.E., SYSTEM NOT FUNCTIONAL)
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: RWST
**              = 4: LOWER COMPARTMENT SUMP
**              = 5: ANNULAR COMPARTMENT SUMP
**              = 6: LPI 1
**              = 7: LPI 2
**
RDSPC     5      RDSPC: DISCHARGE LOCATION UNDER RECIRC PUMP LINEUP FOR TRAIN
C
**              SPRAY PUMPS
**              = 1: HOT LEG
**              = 2: COLD LEG
**              = 3: DOWNCOMER
**              = 4: UPPER COMPARTMENT SPRAY HEADER #1
**              = 5: LOWER COMPARTMENT SPRAY HEADER
**              = 6: INLET OF HPI PUMP
**              = 7: INLET OF CHARGING PUMP
**              = 8: DISCHARGE TO BOTH HPI AND CHARGING PUMP INLET
**              = 9: UPPER COMPARTMENT SPRAY HEADER #2
**
SNPSPC    0      SNPSPC: NPSH ENHANCEMENT FLOW SOURCE FOR SPC
**              = 0: NO ENHANCEMENT FLOW
**              = 1: NPSH ENHANCEMENT RECIRCULATION FLOW;
**                 NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**                 DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**                 EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**              = 2: NPSH ENHANCEMENT FLOW FROM SPA OUTLET
**              = 3: NPSH ENHANCEMENT FLOW FROM EXTERNAL WATER STORAGE
**                 TANK
**
```

```
WESPC     0.E0    WESPC: NPSH ENHANCEMENT RECIRCULATION FLOW RATE;
**                SET = 0 IF NO NPSH ENHANCEMENT IN LINEUP
**
**                NPSH ENHCANCEMENT RECIRCULATION FLOW IS DRAWN FROM
**                DISCHARGE SIDE PUMP DOWNSTREAM OF HX OUTLET (IF HX
**                EXISTS), AND RECIRCULATED TO INLET SIDE OF PUMP
**
TDNSPC    10.E0   TDNSPC: TIME TO TRAIN C CONTAINMENT SPRAY PUMP FAILURE
**                ONCE HAVE INSUFFICIENT NPSH. PUMPS WILL CONTINUE TO
**                OPERATE WITH DEGRADED PERFORMANCE (SEE *GENERALIZED #96)
**                UNTIL TIME ELAPSED SINCE LOSS OF SUFFICIENT NPSH EXCEEDS
**                TINSPC. IF TINSPC EXCEEDED BEFORE RE-ACQUIRING SUFFICIENT
**                NPSH, THEN PUMP WILL BE LOST FOR DURATION OF SEQUENCE.
**                IF RE-ACQUIRE SUFFICIENT NPSH THEN TIME COUNTER RESET.
**
DEGSPC    1       DEGSPC: TRAIN C CONTAINMENT SPRAY PUMP
**                CHARACTERISTICS SELECTION FOR DEGRADED PERFORMANCE;
**                THIS CORRESPONDS TO ID NUMBER OF VARIOUS PUMP
**                CHARACTERISTICS SETS DEFINED IN *PUMP #1-40.
**                THIS SET OF PUMP CHARACTERISTICS IS AUTOMATICALLY
**                SELECTED WHEN HAVE INSUFFICIENT NPSH.
**                THIS CHARACTERISTIC SET CAN BE THE
**                SAME AS THAT SPECIFIED FOR NORMAL LINEUP (SEE
**                *GENERALIZED 87) IF NO DEGRADED PERFORMANCE WILL BE
**                CONSIDERED. ALSO, CAN SPECIFY AN "ALTERNATIVE" PUMP
**                RATHER THAN A "DEGRADED" PUMP.
**
ZSPCRW    34.25   ZSPCRW: HEIGHT OF BOTTOM OF RWST ABOVE THE SPC PUMPS.
**
ZSPCCS    20.5    ZSPCCS: HEIGHT OF BOTTOM OF CONTAINMENT SUMP ABOVE THE
**                SPC PUMPS.
**
ZSPCSI    190     ZSPCSI: ELEVATION OF THE RV INJECTION NOZZLES ABOVE THE
**                SPC PUMPS. (SAME AS ZSPASI)
**
******************************************************************
***          ANNULAR COMPARTMENT SUMP                   ***
******************************************************************
** ACSD   0.E0    ACSD: AREA OF BASE OF ANNULAR COMPARTMENT SUMP
**                = 0 IF NO SUMP AVAILABLE
** ZCSD   0.E0    ZCSD: DEPTH OF ANNULAR COMPARTMENT SUMP
**
******************************************************************
***     EXTERNAL NPSH ENHANCEMENT WATER STORAGE TANK      ***
******************************************************************
TWEXT     0.E0    TWEXT: WATER TEMPERATURE IN EXTERNAL STORAGE TANK
**
MWEXT0    0.E0    MWEXT0: INITIAL WATER MASS IN EXTERNAL STORAGE TANK
**
******************************************************************
***          CONTAINMENT CHILLERS                       ***
******************************************************************
NCHILL    0       NCHILL: NUMBER OF OPERATING CONTAINMENT CHILLERS
TCWCH     310.    TCWCH: INLET COOLING WATER TEMP TO CHILLER--NOTE THIS IS
```

```
**        ALSO USED AS THE COOLING WATER TEMP FOR ALL OTHER
**        SAFEGUARDS HEAT EXCHANGERS
**
*******************************************************************
**
*PUMP CHARACTERISITCS: (PARAMETER GROUP #22)
**
*******************************************************************
***
*** THIS SECTION ONLY APPLIES IF GENERALIZED ESF SECTION IS USED
***
*** PUMP CHARACTERISTICS REFER TO:
***
*** 1) THE PUMPING CAPACITY OF A PUMP IN A PARTICULAR
***    LINE-UP (FLOW VS HEAD); THIS CAN BE OBTAINED FROM
***    SYSTEM CURVES
***
*** 2) NPSH REQUIREMENTS
***
*** 3) HEAT EXCHANGER ATTRIBUTES IF A HEAT EXCHANGER EXITS
***    DOWNSTREAM OF THE PUMP
***
*** NOTE THAT PUMP DATA ARE ENTERED IN GROUPS OF FORTY, IE.,
***
***  1-40  DEFINES PUMP CHARACTERISTIC 1,
*** 41-80  DEFINES PUMP CHARACTERISTIC 2,
*** 81-120 DEFINES PUMP CHARACTERISTIC 3, ETC..
***
*** THE GROUP OF FORTY PARAMETERS NEEDED TO DEFINE THE
*** PUMP CHARACTERISTICS (DEFINED BELOW) ARE:
***
*** NPOINT, ZHDPMP(5), WVPMP(5), ZHDREQ(5).
*** FHXPMP, NTPMP, NBPMP, XIDT, XTT, XTC, XS, RGFLHX, KT, XBC, XIDS, XSTR,
*** NWCW, TIWCW(5), WCWPMP(5), NTU
***
*** THE CURRENT SCHEME HAS SIX SETS OF PUMP CHARACTERISTICS DEFINED AS:
***
*** PUMP 1, CT SPRAY INJECTION: A, B
*** PUMP 2, LPI INJECTION
*** PUMP 3, NORMAL HPI INJECTION
*** PUMP 4, NORMAL CHP INJECTION
*** PUMP 5, ECCS RECIRC EQUIVALENT CURVF WITH RHR HX
**** PUMP 6, SPRAY RECIRC WITH SPRAY HX
***
*** MAXIMUM OF 21 PUMP CHARACTERISTICS CAN BE DEFINED
***
***
************************    PUMP 1    ************************
******************** SPRAY INJECTION ONLY ********************
**
**
** DEFINE PUMP FLOW CHARACTERISITCS AND NPSH REQUIREMENTS
**
**NOTE, IF DESIRED YOU CAN SUPPLY ONE NUMBER--IF DO SO GIVE IT A LARGE
```

```
**HEAD, THEN A CONSTANT FLOW MODEL WILL BE USED
COMPMP(1)  5        NPOINT: NUMBER OF ENTRIES IN PUMP1 HEAD CURVES (5 MAX)
**
** =============== HEADS ===============
**
COMPMP(2)  560.     ZHDPMP(1): FIRST ENTRY IN PUMP1 HEAD TABLE
COMPMP(3)  535.
COMPMP(4)  515.
COMPMP(5)  480.
COMPMP(6)  425.
**
** =============== VOLUMETRIC FLOWS ===============
**
COMPMP(7)  0.0   WVPMP(1): FIRST VOLUMETRIC FLOW ENTRY IN PUMP1 TABLE
COMPMP(8)   300.
COMPMP(9)   400.
COMPMP(10)   500.
COMPMP(11)   600
**VOLUMETRIC FLOW VALUES 08-11 NOT USED IN THIS SCHEME
**
** =============== REQUIRED NPSH ===============
**
** FOR NPSH TABLES, THE SAME FLOWS AS WERE GIVEN FOR HEAD CURVES ARE
** ASSUMED TO CORRESPOND TO THE NPSH HEADS GIVEN
COMPMP(12)  9.0     ZHDREQ(1): FIRST NPSH ENTRY FOR PUMP1
COMPMP(13)  11.5     ZHDREQ(2): NEXT ENTRY FOR PUMP1
COMPMP(14)  13.5     ZHDREQ(3): NEXT ENTRY FOR PUMP1
COMPMP(15)  19.0     ZHDREQ(4): NEXT ENTRY FOR PUMP1
COMPMP(16)  22.5     ZHDREQ(5): NEXT ENTRY FOR PUMP1
**
** =============== HEAT EXCHANGER SPECIFICATIONS (IF ONE EXISTS) ========
**
**CALCULATIONS CONTROLLED BY HEAT EXCHANGER TYPE
**HEAT EXCHANGER TYPE:
**   -1   SET OUTLET TEMP OF HX TO RWST TEMPERATURE
**    0   IS NO HX--OUTLET TEMP IS CONTMT SUMP TEMP
**    1   STRAIGHT TUBE HX
**    2   U-TUBE HX
**
**IMPORTANT NOTE:
**FOR HX TYPES 1 AND 2 EITHER SUPPLY ALL GEOMETRIC PARAMETERS
**OR THE NTU (NUMBER OF TRANSFER UNITS) PER HX--ALL KNOWN USERS DO
**THE LATTER--NTUS ARE AVAILABLE BY CONSULTING NAMEPLATE DATA AND
**USING GRAPHS IN, FOR EXAMPLE, HOLMAN, HEAT TRANSFER
**ALL PARAMETERS ARE ON A PER HX BASIS
**
COMPMP(17)  0        FHXPMP: TYPE OF HX FOR PUMP1
COMPMP(18)  1150     NTPMP: NUMBER OF TUBES IN PUMP1 HXS
COMPMP(19)  15       NBPMP: NUMBER OF SHELL SIDE BAFFLES IN PUMP1 HXS
COMPMP(20)  .0462    XIDT: PUMP1 HX TUBE ID
COMPMP(21)  .00294   XTT: PUMP1 HX TUBE THICKNESS
COMPMP(22)  .06771   XTC: TUBE TO TUBE PITCH IN PUMP1 HX
COMPMP(23)  29.5833  XS: SHELL LENGTH IN PUMP1 HX
**24          RGFLHX:
```

```
COMPMP(25)  375      KT: THERMAL CONDUCTIVITY OF PUMP1 HX TUBES
COMPMP(26)  2.5     XBC: LARGEST PERP DISTANCE FROM SHELL TO BAFFLE
("BAFFLECUT")
**27          XIDS:
COMPMP(28)  .0475   XSTR: SHELL TO TUBE CLEARANCE AT OUTSIDE OF PUMP1 HX TUBE
BDL
COMPMP(29)  1       NWCW: NUMBER OF POINTS IN COOLING WATER FLOW CURVE
COMPMP(30)  0.E0    TIWCW(1): FIRST TIME IN COOLING WATER FLOW CURVE; COOLING
WATER
**                FLOW CAN BE SPECIFIED AS A FUNCTION OF TIME, OR IT
**                CAN BE CONSTANT. FOR A CONDSTANT COOLING WATER FLOW
**                RATE, USE A 1 PINT CURVE WITH THE FIRST TIME POINT
**                = 0 AND THE FIRST FLOW POINT EQUAL TO THE DESIRED
**                FLOW
**31  0.E0     TIWCW(2): NEXT TIME IN COOLING WATER FLOW CURVE
**32  0.E0     TIWCW(3): NEXT TIME IN COOLING WATER FLOW CURVE
**33  0.E0     TIWCW(4): NEXT TIME IN COOLING WATER FLOW CURVE
**34  0.E0     TIWCW(5): LAST TIME IN COOLING WATER FLOW CURVE
COMPMP(35)  1.65E6   WCWPMP(1): FIRST MASS FLOW RATE IN COOLING WATER FLOW
CURVE
**36  0.E0     WCWPMP(2): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**37  0.E0     WCWPMP(3): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**38  0.E0     WCWPMP(4): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**39  0.E0     WCWPMP(5): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
COMPMP(40)  0.0    NTU: PUMP1 HX NTU
**
*********************     PUMP 2     *********************
*********************   LPI1 INJECTION FLOW   *********************
**
**
** DEFINE PUMP FLOW CHARACTERISITCS AND NPSH REQUIREMENTS
**
**NOTE, IF DESIRED YOU CAN SUPPLY ONE NUMBER--IF DO SO GIVE IT A LARGE
**HEAD, THEN A CONSTANT FLOW MODEL WILL BE USED
COMPMP(41)  5      NPOINT: NUMBER OF ENTRIES IN PUMP2 HEAD CURVES (5 MAX)
**
** ===============  HEADS  ===============
**
COMPMP(42)  410.0    ZHDPMP(1): FIRST ENTRY IN PUMP2 HEAD TABLE
COMPMP(43)  390.0    ZHDPMP(2): NEXT HEAD
COMPMP(44)  370.0    ZHDPMP(3): NEXT HEAD
COMPMP(45)  335.0    ZHDPMP(4): NEXT HEAD
COMPMP(46)  305.0    ZHDPMP(5): NEXT HEAD
**
** ===============  VOLUMETRIC FLOWS  ===============
**
COMPMP(47)  0.0      WVPMP(1): FIRST VOLUMETRIC FLOW ENTRY IN PUMP2 TABLE
COMPMP(48)  2000.    WVPMP(2): NEXT VOL. FLOWRATE
COMPMP(49)  3000.    WVPMP(3): NEXT VOL. FLOWRATE
COMPMP(50)  4000.    WVPMP(4): NEXT VOL. FLOWRATE
COMPMP(51)  4500.    WVPMP(5): NEXT VOL. FLOWRATE
**
** ===============  REQUIRED NPSH  ===============
**
```

```
** FOR NPSH TABLES, THE SAME FLOWS AS WERE GIVEN FOR HEAD CURVES ARE
** ASSUMED TO CORRESPOND TO THE NPSH HEADS GIVEN
COMPMP(52) 9.0    ZHDREQ(1): FIRST NPSH ENTRY FOR PUMP2
COMPMP(53) 9.0    ZHDREQ(2): NEXT ENTRY FOR PUMP2
COMPMP(54) 11.0    ZHDREQ(3): NEXT ENTRY FOR PUMP2
COMPMP(55) 16.0    ZHDREQ(4): NEXT ENTRY FOR PUMP2
COMPMP(56) 19.0    ZHDREQ(5): NEXT ENTRY FOR PUMP2
**
** ============== HEAT EXCHANGER SPECIFICATIONS (IF ONE EXISTS) ========
**
**CALCULATIONS CONTROLLED BY HEAT EXCHANGER TYPE
**HEAT EXCHANGER TYPE:
**   -1   SET OUTLET TEMP OF HX TO RWST TEMPERATURE
**    0   IS NO HX--OUTLET TEMP IS CONTMT SUMP TEMP
**    1   STRAIGHT TUBE HX
**    2   U-TUBE HX
**
**IMPORTANT NOTE:
**FOR HX TYPES 1 AND 2 EITHER SUPPLY ALL GEOMETRIC PARAMETERS
**OR THE NTU (NUMBER OF TRANSFER UNITS) PER HX--ALL KNOWN USERS DO
**THE LATTER--NTUS ARE AVAILABLE BY CONSULTING NAMEPLATE DATA AND
**USING GRAPHS IN, FOR EXAMPLE, HOLMAN, HEAT TRANSFER
**ALL PARAMETERS ARE ON A PER HX BASIS
**
COMPMP(57) 0.E0    FHXPMP: TYPE OF HX FOR PUMP2
COMPMP(58) 0.E0    NTPMP: NUMBER OF TUBES IN PUMP2 HXS
COMPMP(59) 0.E0    NBPMP: NUMBER OF SHELL SIDE BAFFLES IN PUMP2 HXS
COMPMP(60) 0.E0    XIDT: PUMP2 HX TUBE ID
COMPMP(61) 0.E0    XTT: PUMP2 HX TUBE THICKNESS
COMPMP(62) 0.E0    XTC: TUBE TO TUBE PITCH IN PUMP2 HX
COMPMP(63) 0.E0    XS: SHELL LENGTH IN PUMP2 HX
**64        RGFLHX:
COMPMP(65) 0.E0    KT: THERMAL CONDUCTIVITY OF PUMP2 HX TUBES
COMPMP(66) 0.E0    XBC: LARGEST PERP DISTANCE FROM SHELL TO BAFFLE
("BAFFLECUT")
**67        XIDS:
COMPMP(68) 0.E0    XSTR: SHELL TO TUBE CLEARANCE AT OUTSIDE OF PUMP2 HX TUBE
BDL
COMPMP(69) 1      NWCW: NUMBER OF POINTS IN COOLING WATER FLOW CURVE
COMPMP(70) 0.E0    TIWCW(1): FIRST TIME IN COOLING WATER FLOW CURVE; COOLING
WATER
**              FLOW CAN BE SPECIFIED AS A FUNCTION OF TIME, OR IT
**              CAN BE CONSTANT. FOR A CONDSTANT COOLING WATER FLOW
**              RATE, USE A 1 PINT CURVE WITH THE FIRST TIME POINT
**              = 0 AND THE FIRST FLOW POINT EQUAL TO THE DESIRED
**              FLOW
**71  0.E0    TIWCW(2): NEXT TIME IN COOLING WATER FLOW CURVE
**72  0.E0    TIWCW(3): NEXT TIME IN COOLING WATER FLOW CURVE
**73  0.E0    TIWCW(4): NEXT TIME IN COOLING WATER FLOW CURVE
**74  0.E0    TIWCW(5): LAST TIME IN COOLING WATER FLOW CURVE
COMPMP(75) 311.9   WCWPMP(1): FIRST MASS FLOW RATE IN COOLING WATER FLOW
CURVE
**76  0.E0    WCWPMP(2): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**77  0.E0    WCWPMP(3): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
```

```
**78  0.E0     WCWPMP(4): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**79  0.E0     WCWPMP(5): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
COMPMP(80)  0.989    NTU: PUMP2 HX NTU
**
********************     PUMP 3     ********************
********************   HPI INJECTION FLOW   ********************
**
**
** DEFINE PUMP FLOW CHARACTERISITCS AND NPSH REQUIREMENTS
**
**NOTE, IF DESIRED YOU CAN SUPPLY ONE NUMBER--IF DO SO GIVE IT A LARGE
**HEAD, THEN A CONSTANT FLOW MODEL WILL BE USED
COMPMP(81)  5      NPOINT: NUMBER OF ENTRIES IN PUMP3 HEAD CURVES (5 MAX)
**
** =============== HEADS ===============
**
COMPMP(82)  3277.   ZHDPMP(1): FIRST ENTRY IN PUMP3 HEAD TABLE
COMPMP(83)  3073.   ZHDPMP(2): NEXT HEAD
COMPMP(84)  2966.   ZHDPMP(3): NEXT HEAD
COMPMP(85)  2304.   ZHDPMP(4): NEXT HEAD
COMPMP(86)  1382.   ZHDPMP(5): NEXT HEAD
**
** =============== VOLUMETRIC FLOWS ===============
**
COMPMP(87)  0.0     WVPMP(1): FIRST VOLUMETRIC FLOW ENTRY IN PUMP3 TABLE
COMPMP(88)  148.    WVPMP(2): NEXT VOL. FLOWRATE
COMPMP(89)  242.    WVPMP(3): NEXT VOL. FLOWRATE
COMPMP(90)  454.    WVPMP(4): NEXT VOL. FLOWRATE
COMPMP(91)  650.    WVPMP(5): NEXT VOL. FLOWRATE
**
** =============== REQUIRED NPSH ===============
**
** FOR NPSH TABLES, THE SAME FLOWS AS WERE GIVEN FOR HEAD CURVES ARE
** ASSUMED TO CORRESPOND TO THE NPSH HEADS GIVEN
COMPMP(92)  9.0     ZHDREQ(1): FIRST NPSH ENTRY FOR PUMP3
COMPMP(93)  9.0     ZHDREQ(2): NEXT ENTRY FOR PUMP3
COMPMP(94)  9.0     ZHDREQ(3): NEXT ENTRY FOR PUMP3
COMPMP(95)  15.0    ZHDREQ(4): NEXT ENTRY FOR PUMP3
COMPMP(96)  22.0    ZHDREQ(5): NEXT ENTRY FOR PUMP3
**
** =============== HEAT EXCHANGER SPECIFICATIONS (IF ONE EXISTS) ========
**
**CALCULATIONS CONTROLLED BY HEAT EXCHANGER TYPE
**HEAT EXCHANGER TYPE:
**   -1  SET OUTLET TEMP OF HX TO RWST TEMPERATURE
**    0  IS NO HX--OUTLET TEMP IS CONTMT SUMP TEMP
**    1  STRAIGHT TUBE HX
**    2  U-TUBE HX
**
**IMPORTANT NOTE:
**FOR HX TYPES 1 AND 2 EITHER SUPPLY ALL GEOMETRIC PARAMETERS
**OR THE NTU (NUMBER OF TRANSFER UNITS) PER HX--ALL KNOWN USERS DO
**THE LATTER--NTUS ARE AVAILABLE BY CONSULTING NAMEPLATE DATA AND
**USING GRAPHS IN, FOR EXAMPLE, HOLMAN, HEAT TRANSFER
```

```
**ALL PARAMETERS ARE ON A PER HX BASIS
**
COMPMP(97)  0.E0     FHXPMP: TYPE OF HX FOR PUMP3
COMPMP(98)  0.E0     NTPMP: NUMBER OF TUBES IN PUMP3 HXS
COMPMP(99)  0.E0     NBPMP: NUMBER OF SHELL SIDE BAFFLES IN PUMP3 HXS
COMPMP(100) 0.E0     XIDT: PUMP3 HX TUBE ID
COMPMP(101) 0.E0     XTT: PUMP3 HX TUBE THICKNESS
COMPMP(102) 0.E0     XTC: TUBE TO TUBE PITCH IN PUMP3 HX
COMPMP(103) 0.E0     XS: SHELL LENGTH IN PUMP3 HX
**104         RGFLHX:
COMPMP(105) 0.E0     KT: THERMAL CONDUCTIVITY OF PUMP3 HX TUBES
COMPMP(106) 0.E0     XBC: LARGEST PERP DISTANCE FROM SHELL TO BAFFLE
("BAFFLECUT")
**107         XIDS:
COMPMP(108) 0.E0     XSTR: SHELL TO TUBE CLEARANCE AT OUTSIDE OF PUMP3 HX TUBE
BDL
COMPMP(109) 1       NWCW: NUMBER OF POINTS IN COOLING WATER FLOW CURVE
COMPMP(110) 0.E0     TIWCW(1): FIRST TIME IN COOLING WATER FLOW CURVE; COOLING
WATER
**              FLOW CAN BE SPECIFIED AS A FUNCTION OF TIME, OR IT
**              CAN BE CONSTANT. FOR A CONDSTANT COOLING WATER FLOW
**              RATE, USE A 1 PINT CURVE WITH THE FIRST TIME POINT
**              = 0 AND THE FIRST FLOW POINT EQUAL TO THE DESIRED
**              FLOW
**111  0.E0     TIWCW(2): NEXT TIME IN COOLING WATER FLOW CURVE
**112  0.E0     TIWCW(3): NEXT TIME IN COOLING WATER FLOW CURVE
**113  0.E0     TIWCW(4): NEXT TIME IN COOLING WATER FLOW CURVE
**114  0.E0     TIWCW(5): LAST TIME IN COOLING WATER FLOW CURVE
COMPMP(115) 311.9    WCWPMP(1): FIRST MASS FLOW RATE IN COOLING WATER FLOW
CURVE
**116  0.E0     WCWPMP(2): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**117  0.E0     WCWPMP(3): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**118  0.E0     WCWPMP(4): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**119  0.E0     WCWPMP(5): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
COMPMP(120) 0.E0     NTU: PUMP3 HX NTU
**
*********************     PUMP 4     *********************
*********************   NORMAL CHP FLOW   *********************
*********************   CHP INJECTION FLOW   *********************
**
** DEFINE PUMP FLOW CHARACTERISITCS AND NPSH REQUIREMENTS
**
**NOTE, IF DESIRED YOU CAN SUPPLY ONE NUMBER--IF DO SO GIVE IT A LARGE
**HEAD, THEN A CONSTANT FLOW MODEL WILL BE USED
COMPMP(121) 5       NPOINT: NUMBER OF ENTRIES IN PUMP4 HEAD CURVES (5 MAX)
**
** ============== HEADS ==============
**
COMPMP(122) 1620.0   ZHDPMP(1): FIRST ENTRY IN PUMP4 HEAD TABLE
COMPMP(122) 5580.    ZHDPMP(1): FIRST ENTRY IN PUMP4 HEAD TABLE
COMPMP(123) 5570.    ZHDPMP(2): NEXT HEAD
COMPMP(124) 5040.    ZHDPMP(3): NEXT HEAD
COMPMP(125) 3005.    ZHDPMP(4): NEXT HEAD
COMPMP(126) 1431.    ZHDPMP(5): NEXT HEAD
```

```
** =============== VOLUMETRIC FLOWS ===============
**
COMPMP(127) 0.0      WVPMP(1): FIRST VOLUMETRIC FLOW ENTRY IN PUMP4 TABLE
COMPMP(128) 4.60E-3  WVPMP(2): NEXT VOL. FLOWRATE
COMPMP(128) 192.     WVPMP(2): NEXT VOL. FLOWRATE
COMPMP(129) 257.     WVPMP(3): NEXT VOL. FLOWRATE
COMPMP(130) 450.     WVPMP(4): NEXT VOL. FLOWRATE
COMPMP(131) 550.     WVPMP(5): NEXT VOL. FLOWRATE
** =============== REQUIRED NPSH ===============
**
** FOR NPSH TABLES, THE SAME FLOWS AS WERE GIVEN FOR HEAD CURVES ARE
** ASSUMED TO CORRESPOND TO THE NPSH HEADS GIVEN
COMPMP(132) 3.05     ZHDREQ(1): FIRST NPSH ENTRY FOR PUMP4
COMPMP(132) 9.0      ZHDREQ(1): FIRST NPSH ENTRY FOR PUMP4
COMPMP(133) 11.5     ZHDREQ(2): NEXT ENTRY FOR PUMP4
COMPMP(134) 13.5     ZHDREQ(3): NEXT ENTRY FOR PUMP4
COMPMP(135) 19.0     ZHDREQ(4): NEXT ENTRY FOR PUMP4
COMPMP(136) 22.5     ZHDREQ(5): NEXT ENTRY FOR PUMP4
** =============== HEAT EXCHANGER SPECIFICATIONS (IF ONE EXISTS) ========
**
**CALCULATIONS CONTROLLED BY HEAT EXCHANGER TYPE
**HEAT EXCHANGER TYPE:
**   -1   SET OUTLET TEMP OF HX TO RWST TEMPERATURE
**    0   IS NO HX--OUTLET TEMP IS CONTMT SUMP TEMP
**    1   STRAIGHT TUBE HX
**    2   U-TUBE HX
**
**IMPORTANT NOTE:
**FOR HX TYPES 1 AND 2 EITHER SUPPLY ALL GEOMETRIC PARAMETERS
**OR THE NTU (NUMBER OF TRANSFER UNITS) PER HX--ALL KNOWN USERS DO
**THE LATTER--NTUS ARE AVAILABLE BY CONSULTING NAMEPLATE DATA AND
**USING GRAPHS IN, FOR EXAMPLE, HOLMAN, HEAT TRANSFER
**ALL PARAMETERS ARE ON A PER HX BASIS
**
COMPMP(137) 0.E0     FHXPMP: TYPE OF HX FOR PUMP4
COMPMP(138) 0.E0     NTPMP: NUMBER OF TUBES IN PUMP4 HXS
COMPMP(139) 0.E0     NBPMP: NUMBER OF SHELL SIDE BAFFLES IN PUMP4 HXS
COMPMP(140) 0.E0     XIDT: PUMP4 HX TUBE ID
COMPMP(141) 0.E0     XTT: PUMP4 HX TUBE THICKNESS
COMPMP(142) 0.E0     XTC: TUBE TO TUBE PITCH IN PUMP4 HX
COMPMP(143) 0.E0     XS: SHELL LENGTH IN PUMP4 HX
**144         RGFLHX:
COMPMP(145) 0.E0     KT: THERMAL CONDUCTIVITY OF PUMP4 HX TUBES
COMPMP(146) 0.E0     XBC: LARGEST PERP DISTANCE FROM SHELL TO BAFFLE
("BAFFLECUT")
**147         XIDS:
COMPMP(148) 0.E0     XSTR: SHELL TO TUBE CLEARANCE AT OUTSIDE OF PUMP4 HX TUBE
BDL
COMPMP(149) 1        NWCW: NUMBER OF POINTS IN COOLING WATER FLOW CURVE
COMPMP(150) 0.E0     TIWCW(1): FIRST TIME IN COOLING WATER FLOW CURVE; COOLING
WATER
**               FLOW CAN BE SPECIFIED AS A FUNCTION OF TIME, OR IT
**               CAN BE CONSTANT. FOR A CONDSTANT COOLING WATER FLOW
**               RATE, USE A 1 PINT CURVE WITH THE FIRST TIME POINT
```

```
**              = 0 AND THE FIRST FLOW POINT EQUAL TO THE DESIRED
**              FLOW
**151  0.E0     TIWCW(2): NEXT TIME IN COOLING WATER FLOW CURVE
**152  0.E0     TIWCW(3): NEXT TIME IN COOLING WATER FLOW CURVE
**153  0.E0     TIWCW(4): NEXT TIME IN COOLING WATER FLOW CURVE
**154  0.E0     TIWCW(5): LAST TIME IN COOLING WATER FLOW CURVE
COMPMP(155) 311.9    WCWPMP(1): FIRST MASS FLOW RATE IN COOLING WATER FLOW
CURVE
**156  0.E0     WCWPMP(2): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**157  0.E0     WCWPMP(3): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**158  0.E0     WCWPMP(4): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**159  0.E0     WCWPMP(5): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
COMPMP(160) 0.E0     NTU: PUMP4 HX NTU
**
*********************     PUMP 5     *********************
********************* ECCS RECIRC EQUIVALENT CURVE *********************
**
** DEFINE PUMP FLOW CHARACTERISITCS AND NPSH REQUIREMENTS
**
**NOTE, IF DESIRED YOU CAN SUPPLY ONE NUMBER--IF DO SO GIVE IT A LARGE
**HEAD, THEN A CONSTANT FLOW MODEL WILL BE USED
COMPMP(161) 1       NPOINT: NUMBER OF ENTRIES IN PUMP5 HEAD CURVES (5 MAX)
COMPMP(161) 5       NPOINT: NUMBER OF ENTRIES IN PUMP5 HEAD CURVES (5 MAX)
** =============== HEADS ===============
**
COMPMP(162) 1000     ZHDPMP(1): FIRST ENTRY IN PUMP5 HEAD TABLE
COMPMP(162)  6290.    ZHDPMP(1): FIRST ENTRY IN PUMP5 HEAD TABLE
COMPMP(163)  3683.
COMPMP(164)  3369.
COMPMP(165)  2705.
COMPMP(166)  1780.
** =============== VOLUMETRIC FLOWS ===============
**
COMPMP(167) 1.65D-1  WVPMP(1): FIRST VOLUMETRIC FLOW ENTRY IN PUMP5 TABLE
COMPMP(167)  0  WVPMP(1): FIRST VOLUMETRIC FLOW ENTRY IN PUMP5 TABLE
COMPMP(168)  424.
COMPMP(169)  694.
COMPMP(170)  948.
COMPMP(171)  1200.
**168 6.86D-2   WVPMP(2): NEXT VOL. FLOWRATE
**169 1.14D-1   WVPMP(3): NEXT VOL. FLOWRATE
**170 2.06D-1   WVPMP(4): NEXT VOL. FLOWRATE
**171 2.74D-1   WVPMP(5): NEXT VOL. FLOWRATE
**
** =============== REQUIRED NPSH ===============
** =============== REQUIRED NPSH: USE LPI SINCE IT GOES TO SUMP =========
** FOR NPSH TABLES, THE SAME FLOWS AS WERE GIVEN FOR HEAD CURVES ARE
** ASSUMED TO CORRESPOND TO THE NPSH HEADS GIVEN
COMPMP(172) 3.05     ZHDREQ(1): FIRST NPSH ENTRY FOR PUMP5
COMPMP(172) 19.0 .   ZHDREQ(1): FIRST NPSH ENTRY FOR PUMP5
COMPMP(173) 19.0     ZHDREQ(2): NEXT ENTRY FOR PUMP5
COMPMP(174) 19.0     ZHDREQ(3): NEXT ENTRY FOR PUMP5
COMPMP(175) 19.0     ZHDREQ(4): NEXT ENTRY FOR PUMP5
COMPMP(176) 19.0     ZHDREQ(5): NEXT ENTRY FOR PUMP5
```

```
** =============== HEAT EXCHANGER SPECIFICATIONS (IF ONE EXISTS) ========
**
**CALCULATIONS CONTROLLED BY HEAT EXCHANGER TYPE
**HEAT EXCHANGER TYPE:
**   -1   SET OUTLET TEMP OF HX TO RWST TEMPERATURE
**    0   IS NO HX--OUTLET TEMP IS CONTMT SUMP TEMP
**    1   STRAIGHT TUBE HX
**    2   U-TUBE HX
**
**IMPORTANT NOTE:
**FOR HX TYPES 1 AND 2 EITHER SUPPLY ALL GEOMETRIC PARAMETERS
**OR THE NTU (NUMBER OF TRANSFER UNITS) PER HX--ALL KNOWN USERS DO
**THE LATTER--NTUS ARE AVAILABLE BY CONSULTING NAMEPLATE DATA AND
**USING GRAPHS IN, FOR EXAMPLE, HOLMAN, HEAT TRANSFER
**ALL PARAMETERS ARE ON A PER HX BASIS
**
COMPMP(177) 2.E0     FHXPMP: TYPE OF HX FOR PUMP5
COMPMP(178) 727.     NTPMP: NUMBER OF TUBES IN PUMP5 HXS
COMPMP(179) 29.      NBPMP: NUMBER OF SHELL SIDE BAFFLES IN PUMP5 HXS
COMPMP(180) .03576   XIDT: PUMP5 HX TUBE ID
COMPMP(181) .00816   XTT: PUMP5 HX TUBE THICKNESS
COMPMP(182) .07279   XTC: TUBE TO TUBE PITCH IN PUMP5 HX
COMPMP(183) 58.      XS: SHELL LENGTH IN PUMP5 HX
COMPMP(184) 0.00     RGFLHX: FOULING FACTOR
COMPMP(185) 341.     KT: THERMAL CONDUCTIVITY OF PUMP5 HX TUBES
COMPMP(186) 1.5833   XBC: LARGEST PERP DISTANCE FROM SHELL TO BAFFLE
("BAFFLECUT")
COMPMP(187) 3.1667   XIDS: HX SHELL ID
COMPMP(188) 0.0242   XSTR: SHELL TO TUBE CLEARANCE AT OUTSIDE OF PUMP5 HX TUBE
BDL
COMPMP(190) 0.E0     TIWCW(1): FIRST TIME IN COOLING WATER FLOW CURVE; COOLING
WATER
**                   FLOW CAN BE SPECIFIED AS A FUNCTION OF TIME, OR IT
**                   CAN BE CONSTANT. FOR A CONDSTANT COOLING WATER FLOW
**                   RATE, USE A 1 PINT CURVE WITH THE FIRST TIME POINT
**                   = 0 AND THE FIRST FLOW POINT EQUAL TO THE DESIRED
**                   FLOW
**191  0.E0      TIWCW(2): NEXT TIME IN COOLING WATER FLOW CURVE
**192  0.E0      TIWCW(3): NEXT TIME IN COOLING WATER FLOW CURVE
**193  0.E0      TIWCW(4): NEXT TIME IN COOLING WATER FLOW CURVE
**194  0.E0      TIWCW(5): LAST TIME IN COOLING WATER FLOW CURVE
COMPMP(195) 311.9    WCWPMP(1): FIRST MASS FLOW RATE IN COOLING WATER FLOW
CURVE
COMPMP(195) 2477835.  WCWPMP(1): FIRST MASS FLOW RATE IN COOLING WATER FLOW
CURVE
**197  0.E0      WCWPMP(3): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**198  0.E0      WCWPMP(4): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**159  0.E0      WCWPMP(5): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
COMPMP(200) 0.0    NTU: PUMP5 HX NTU

*********************        PUMP 6       *********************
*********************   SPRAY RECIRC + HX  *********************
**
**
```

```
** DEFINE PUMP FLOW CHARACTERISITCS AND NPSH REQUIREMENTS
**
**NOTE, IF DESIRED YOU CAN SUPPLY ONE NUMBER--IF DO SO GIVE IT A LARGE
**HEAD, THEN A CONSTANT FLOW MODEL WILL BE USED
COMPMP(201)  5      NPOINT: NUMBER OF ENTRIES IN PUMP1 HEAD CURVES (5 MAX)
**
** =============== HEADS ===============
**
COMPMP(202)  560.   ZHDPMP(1): FIRST ENTRY IN PUMP1 HEAD TABLE
COMPMP(203)  535.
COMPMP(204)  515.
COMPMP(205)  480.
COMPMP(206)  425.
**
** =============== VOLUMETRIC FLOWS ===============
**
COMPMP(207)  0.0  WVPMP(1): FIRST VOLUMETRIC FLOW ENTRY IN PUMP1 TABLE
COMPMP(208)  300.
COMPMP(209)  400.
COMPMP(210)  500.
COMPMP(211)  600
**VOLUMETRIC FLOW VALUES 08-11 NOT USED IN THIS SCHEME
**
** =============== REQUIRED NPSH ===============
**
** FOR NPSH TABLES, THE SAME FLOWS AS WERE GIVEN FOR HEAD CURVES ARE
** ASSUMED TO CORRESPOND TO THE NPSH HEADS GIVEN
COMPMP(212)  9.0   ZHDREQ(1): FIRST NPSH ENTRY FOR PUMP1
COMPMP(213)  11.5   ZHDREQ(2): NEXT ENTRY FOR PUMP1
COMPMP(214)  13.5   ZHDREQ(3): NEXT ENTRY FOR PUMP1
COMPMP(215)  19.0   ZHDREQ(4): NEXT ENTRY FOR PUMP1
COMPMP(216)  22.5   ZHDREQ(5): NEXT ENTRY FOR PUMP1
**
** =============== HEAT EXCHANGER SPECIFICATIONS (IF ONE EXISTS) ========
**
**CALCULATIONS CONTROLLED BY HEAT EXCHANGER TYPE
**HEAT EXCHANGER TYPE:
**  -1  SET OUTLET TEMP OF HX TO RWST TEMPERATURE
**   0  IS NO HX--OUTLET TEMP IS CONTMT SUMP TEMP
**   1  STRAIGHT TUBE HX
**   2  U-TUBE HX
**
**IMPORTANT NOTE:
**FOR HX TYPES 1 AND 2 EITHER SUPPLY ALL GEOMETRIC PARAMETERS
**OR THE NTU (NUMBER OF TRANSFER UNITS) PER HX--ALL KNOWN USERS DO
**THE LATTER--NTUS ARE AVAILABLE BY CONSULTING NAMEPLATE DATA AND
**USING GRAPHS IN, FOR EXAMPLE, HOLMAN, HEAT TRANSFER
**ALL PARAMETERS ARE ON A PER HX BASIS
**
COMPMP(217)  2      FHXPMP: TYPE OF HX FOR PUMP1
COMPMP(218)  1150   NTPMP: NUMBER OF TUBES IN PUMP1 HXS
COMPMP(219)  15     NBPMP: NUMBER OF SHELL SIDE BAFFLES IN PUMP1 HXS
COMPMP(220)  .0462   XIDT: PUMP1 HX TUBE ID
COMPMP(221)  .00294  XTT: PUMP1 HX TUBE THICKNESS
```

```
COMPMP(222) .06771   XTC: TUBE TO TUBE PITCH IN PUMP1 HX
COMPMP(223) 29.5833  XS: SHELL LENGTH IN PUMP1 HX
COMPMP(224) 0.00     RGFLHX: FOULING FACTOR
COMPMP(225) 375      KT: THERMAL CONDUCTIVITY OF PUMP1 HX TUBES
COMPMP(226) 2.5      XBC: LARGEST PERP DISTANCE FROM SHELL TO BAFFLE
("BAFFLECUT")
COMPMP(227) 5.0      XIDS: HX SHELL ID
COMPMP(228) .0475    XSTR: SHELL TO TUBE CLEARANCE AT OUTSIDE OF PUMP1 HX TUBE
BDL
COMPMP(229) 1        NWCW: NUMBER OF POINTS IN COOLING WATER FLOW CURVE
COMPMP(230) 0.E0     TIWCW(1): FIRST TIME IN COOLING WATER FLOW CURVE; COOLING
WATER
**                   FLOW CAN BE SPECIFIED AS A FUNCTION OF TIME, OR IT
**                   CAN BE CONSTANT. FOR A CONDSTANT COOLING WATER FLOW
**                   RATE, USE A 1 PINT CURVE WITH THE FIRST TIME POINT
**                   = 0 AND THE FIRST FLOW POINT EQUAL TO THE DESIRED
**                   FLOW
**231  0.E0     TIWCW(2): NEXT TIME IN COOLING WATER FLOW CURVE
**232  0.E0     TIWCW(3): NEXT TIME IN COOLING WATER FLOW CURVE
**233  0.E0     TIWCW(4): NEXT TIME IN COOLING WATER FLOW CURVE
**234  0.E0     TIWCW(5): LAST TIME IN COOLING WATER FLOW CURVE
COMPMP(235) 1.65E6    WCWPMP(1): FIRST MASS FLOW RATE IN COOLING WATER FLOW
CURVE
**236  0.E0     WCWPMP(2): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**237  0.E0     WCWPMP(3): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**238  0.E0     WCWPMP(4): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
**239  0.E0     WCWPMP(5): NEXT MASS FLOW RATE IN COOLING WATER FLOW CURVE
COMPMP(240) 0.0   NTU: PUMP1 HX NTU
**
** *PUMP #281-840 ARE NOT USED HERE, BUT ARE AVAILABLE TO
** DEFINE CHARACTERISITCS FOR ADDITIONAL PUMPS
**
*****************************************************************
***       STEAM DRIVEN AUXILIARY FEEDWATER SYSTEM        ***
*****************************************************************
NIPTS 5     NUMBER OF POINTS IN TURBINE DRIVEN AUX FEED SYSTEM
**          FLOW CURVE (5 MAX)
**
PSG(1) 1215    1ST PRESSURE
PSG(2) 915     4TH PRESSURE
PSG(3) 615     7TH PRESSURE
PSG(4) 265     8TH PRESSURE
PSG(5) 264.9   9TH PRESSURE
**
WSTSGT(1)  0.0      STEAM FLOW RATE THROUGH TURBINE CORRESPONDING
**                  TO THE FIRST STEAM GENERATOR PRESSURE
WSTSGT(2)  0.0      STEAM FLOW RATE THROUGH TURBINE CORRESPONDING
**                  TO THE SECOND STEAM GENERATOR PRESSURE
WSTSGT(3)  0.0      STEAM FLOW RATE THROUGH TURBINE CORRESPONDING
**                  TO THE THIRD STEAM GENERATOR PRESSURE
WSTSGT(4)  0.0      STEAM FLOW RATE THROUGH TURBINE CORRESPONDING
**                  TO THE FOURTH STEAM GENERATOR PRESSURE
WSTSGT(5)  0.0      STEAM FLOW RATE THROUGH TURBINE CORRESPONDING
**                  TO THE FIFTH STEAM GENERATOR PRESSURE
```

```
WWTDFW(1)  185.E3       WATER FLOW RATE THROUGH TURBINE DRIVEN AUX
**                      FEEDWATER PUMP CORRRESPONDING TO THE FIRST
** **                      STEAM FLOW RATE
WWTDFW(2)  325.E3       WATER FLOW RATE THROUGH TURBINE DRIVEN AUX
**                      FEEDWATER PUMP CORRRESPONDING TO THE FOURTH
**                      STEAM FLOW RATE
WWTDFW(3)  425.E5       WATER FLOW RATE THROUGH TURBINE DRIVEN AUX
**                      FEEDWATER PUMP CORRRESPONDING TO THE SEVENTH
**                      STEAM FLOW RATE
WWTDFW(4)  425.E5       WATER FLOW RATE THROUGH TURBINE DRIVEN AUX
**                      FEEDWATER PUMP CORRRESPONDING TO THE EIGHTH
**                      STEAM FLOW RATE
WWTDFW(5)   0.0       WATER FLOW RATE THROUGH TURBINE DRIVEN AUX
**                      FEEDWATER PUMP CORRRESPONDING TO THE NINETH
**                      STEAM FLOW RATE
*BR
```

```
** ********************************************************************
** ********************************************************************
**
**        Westinghouse PWR/Ice Condenser - Like Parameter File
**        ---------------------------------------------
**                 MAAP 4.0.3 Parameter File
**
** ********************************************************************
** ********************************************************************
**
** This parameter file is the MAAP4 Parameter File/User's Guide and
** contains the names, descriptions, and typical values of all the MAAP
** input parameter file variables (parameters). This file should be used
** as the reference for constructing a new plant parameter file. The MAAP4
** User's Manual is an additional resource document for the models and
** corresponding input parameters.
**
** The general layout of the Parameter File/User's Guide is shown in the
** General Order of the Parameter Sections discussion below. Starting with
** MAAP 4.0.3, there is no distinction between the Parameter File/User's
** Guide, i.e., the parameter file is the user's guide and contains the
** complete descriptions of the parameters.
**
** Note, this parameter file does not explain how to use or how to set up
** the input file. Consult Section 3 of Volume I of the MAAP4 User's
** Manual for information on the input file setup and usage.
**
** In MAAP4 the use of the MAAP4 variable naming convention is required.
** The naming rules and the correct associated units labels are decribed in
** the Naming Rules section below.
**
** A sample include file to activate MAAP4-GRAAPH is shown in the How to
** Activate and Use MAAP4-GRAAPH section below.
**
** The strict ordering of the parameter variables by common block variable
** location required for MAAP 3.0B is no longer required for MAAP4. As a
** result, many input parameter variables were reorganized by functional
** descriptions, e.g., all related input parameters for a specific
** engineered safeguards systems or for the generalized openings between
** the primary system and the containment were grouped together. The
** reorganized groupings of related parameters should make it easier to
** understand the input requirements of the corresponding MAAP model.
**
** The units for parameter inputs are specified by either a *SI (metric) or
** *BR (British) units line. All parameters following such a line in the
** parameter file are assumed to have these units until the next units line
** is read. Every parameter section now has a units label specification
** right after the parameter section header - a line having either *SI or
** *BR. However, note that *SI or *BR cannot be placed in the following
** parameter sections: *Integration, *Userevt and *Evtmes. This is because
** all the values in both the *Integration and *Userevt parameter sections
** must be in SI units and the *Evtmes parameter section is used only to
** define the MAAP event code messages. The default for the parameter file
** is SI units. SI units (M-KG-SEC-DEGK) will be used unless a *BR line is
```

** inserted; British Units (FT-LB-HR-DEGF) must then follow. The last
** units line in a parameter file controls the units of other inputs in the
** input file unless the input statement BRITISH or METRIC is used in the
** input file. The last read units line determines the units of the output
** files.
**
** Note that the explicit use of valid unit labels supersedes the units
** specific by *SI or *BR lines. See the Naming Rules section below for
** the exact metric and British unit labels to be used.
**
** The user should specify all the input values they need for their plant
** and system configurations and should not rely on default block data
** values. If a specific system is not used or needed then the user should
** set the corresponding mass, number or pointers to appropriate values so
** that the system in question will not be used (and not activated by
** default). It is recommended that all values be specified whether they
** are used or not to override the default values. This parameter file has
** the complete specification of all the input parameter.
**
** The MAAP 3.0B recommendation to represent a free standing steel
** containment with a shield building by treating the shield building as
** the wall and the containment pressure boundary as a "liner" no longer
** applies. The MAAP4 recommendation is to represent the free standing
** steel containment wall and the shield building wall as two distinct
** walls with the gap between them modeled as a compartment. Be sure to
** set up the radiation links between the walls as discussed in the
** *Distributed Heat Sink parameter section.
**
** Containment failure by overpressure is set up by using junction failure
** statements as discussed in the *Topology parameter section. Containment
** failure by the stress/strain mechanistic model can be set up as discussed
** in the *Containment Stress/Strain parameter section.
**
** In the past, users have often neglected to adjust *Model parameters
** likely based on the assumption that none of these are related to
** plant-specific features. On the contrary, a few of them are effectively
** plant-specific in the sense that some of the physics depends on plant
** geometry, though not yet in ways that can always be precisely related to
** numerical inputs. Consequently, the *Model parameter section should be
** reviewed by the users.
**
** If there are any questions or comments about the MAAP4 Parameter File /
** User's Guide, please contact:
**
**     Barbara Schlenger-Faber at FAI
**     Phone: 708/887-5238 or 708/323-8750
**     Fax: 708/986-5481
**     E-Mail: fai@xnet.com
**
** ======================================================================
** General Order of the Parameter Sections
**
** The parameter sections are grouped under the following major categories.
** The section names begin with a single asterisk.

**
** 1) Control Parameters
** 2) Reactor Core Parameters
** 3) Primary System / Safety System Parameters
** 4) Containment / Auxiliary Building Parameters
** 5) Specific Plant Feature Parameters
** 6) Event Code Parameters
**
** 1) Control Parameters ***************************************************
**
** *Control - Input parameters for model selection and program
** control.
**
** *Model - Input parameters for key phenomenlogical models.
**
** *Concrete - Input parameters for defining the thermophysical
** properties of concrete.
**
** *Timing - Input parameters for timing control.
**
** *Integration - Input parameters for integration control.
**
** *Pltmap - Input parameters for selection of variables to be written
** to data files for plotting.
**
** *Prtlis - Input parameters for selection of variables to be written
** to the tabular and/or log files.
**
** *Pltdos - Input parameters that activate the generation of data
** files for the MAAP4-DOSE program.
**
** 2) Reactor Core Parameters ***********************************************
**
** *Core - Input parameters for reactor core setup
**
** *Fission - Input parameters for fission products
**
** 3) Primary System / Safety System Parameters ****************************
**
** *Initial - Input parameters for initial conditions
**
** *Primary System - Input parameters for the reactor pressure vessel
** geometry and setup.
**
** *Pressurizer - Input parameters for pressurizer geometry and setup
**
** *Steam Generator - Input parameters for steam generator geometry
** and setup
**
** *Engineered Safeguards - Input parameters for the engineered
** safeguards safety systems
**
** *Generalized Engineered Safeguards - Input parameters for the
** generalized engineered safeguards safety systems

**
** *Pump Characteristics - Input parameters for the generalized
** engineered safeguards safety system pump properties
**
** 4) Containment / Auxiliary Building Parameters *************************
**
** *Pointers - Input parameters to assign the compartment indices.
**
** *Interface - Input parameters to assign the elevations for primary
** system - containment interfaces
**
** *Auxiliary - Input parameters to set up the containment/auxiliary
** building compartment geometry
**
** *Topology - Input parameters to set up the containment/auxiliary
** building flow paths between compartments
**
** *Debris - Input parameters for the corium debris pools in the
** containment
**
** *Material - Input parameters for heat sink thermal properties
** used for distributed and lumped heat sinks
**
** *Distributed - Input parameters for distributed heat sinks such as
** walls and floors
**
** *Lumped - Input parameters for lumped heat sinks such as
** structural materials
**
** *Containment - Input parameters for modeling the containment outer
** wall stress/strain
**
** 5) Specific Plant Features Parameters ***********************************
**
** *Quench - Input parameters to model the quench tank
**
** *Ice - Input parameters to model the ice box in the containment
**
** *Ap600 - Input parameters for AP600-specific systems
**
** *Spain - Input parameters for Spanish-specific systems, except for
** the spent fuel pool which can be used by any PWR plants
**
** 6) Event Code Parameters ***********************************************
**
** *Evtmes - Input parameters defining the event code messages
**
** *Userevt - Input parameters defining the user-defined event codes
**
**
** ======================================================================
** Parameter Variable Naming Rules and Corresponding Units Labels
**
** The MAAP4 hash table generator uses the following naming convention list

```
** to determine the units conversion factors for the MAAP input and output
** common block variables. This is a general list - there are a number of
** exceptions that are handled in the conversion code. The expected units
** for each input parameter are listed next to its name in the parameter
** file. The user can explicitly specify the units of any parameter by
** using the unit label, typed excatly as listed here after the parameter's
** value. The explicit use of valid units labels supersedes the units
** specific by *SI or *BR lines. If the units label is British, the code
** will convert the corresponding value to equivalent Metric value for use
** within the code. Likewise, if the units label is Metric, the code
** will not convert the corresponding value but use it as is.
**
**   Parameter Names
**   starting with   Quantity                    SI Units   BR Units
**   the letters                                 Label      Label
**
**   A               Area                        M**2       FT**2
**   CV, CP          Specific Heat               J/KG-C     BTU/LB-F
**   D               Density                     KG/M**3    LB/FT**3
**   (1)             Dimensionless
**   H               Enthalpy                    J/KG       BTU/LB
**   HT              Heat Transfer Coef.         W/M**2-C   BTU/FT**2-HR-F
**   K               Thermal Conductivity        W/M-C      BTU/FT-HR-F
**   M               Mass                        KG         LB
**   P               Pressure                    PA         PSI
**   Q               Power                       W          BTU/HR
**   U               Energy                      J          BTU
**   TT, TD, TI      Time                        S          HR
**   T               Temperature                 K          F
**   V               Volume                      M**3       FT**3
**   W               Flow                        KG/S       LB/HR
**   X, Z            Length                      M          FT
**   RG              Thermal Resistance          M**2-C/W   FT**2-HR-F/BTU
**   (2)             Specific Power              W/KG       BTU/HR-LB
**   VW, VG, VST     Specific Volume             M**3/KG    FT**3/LB
**   WV              Volumetric Flow             M**3/S     GPM
**   LH, UST         Specific Energy             J/KG       BTU/LB
**   (2)             Velocity                    M/S        FT/HR
**   TDIF            Differential Temperature    DEG-K      DEG-F
**   WV              Volumetric Flow             M**3/S     FT**3/HR
**   VSC             Viscosity                   KG/M-S     LB/FT-S
**
** Note that valid units labels for the volumetric flow rates are GPM,
** FT**3/HR, and M**3/S in either the BWR or PWR MAAP4 codes. When using
** British units, CFM can be converted to GPM using the multiplication
** factor of 7.4805.
**
** (1) Dimensionless names begin with MF (mass fraction), VF (void
** fraction), DF (decontamination factor) and generally any names not
** conforming to the naming rules above. Often, the names of dimensionless
** terms such as multiplication factors begin with F. Note that names
** begining with MFP are mass (fission product masses).
**
** (2) Currently there are no specific power or velocity input parameters.
```

```
**
** ========================================================================
** How to Activate and Use MAAP4-GRAAPH
**
** This section shows how to set up and activate MAAP4-GRAAPH.  MAAP4-
** GRAAPH is available only for VAX/VMS, PC-DOS, and HP-Unix operating
** systems.  The input file should include the MAAP4-GRAAPH include file
** supplied with the MAAP4 code distribution set.  The content of the
** include file is shown below.  The include file instructs the MAAP4 code
** to run in either the MAAP4-GRAAPH or PLAYBACK mode, sets the display
** update frequency, makes some necessary local parameter changes, and
** opens needed files.
**
** The content of the example MAAP4-GRAAPH include files:
** ---------------------------------------------------
** c include file for ice maap4-graaph
**
**  maap4graaph
** c for playback mode, comment above line and uncomment next line
** // playback
**
** c set refresh interval
**
**  display every 1 minute
**
** c set movie write interval
**
**  initial
**   tdmvie= 300 s     // movie playback write interval
**   imvunt= 27        // movie playback file unit
**  imgpic= 2          // select ice picture
**   ixpic=  640       // set the horizontal picture size
**   iypic=  480       // set the vertical picture size
**   imgdly= 0         // delay counter
**  end
**
** c open needed files
**
**  file io
**     62 wice.pic
**     63 wice.txt
*****************************************************************************
*Control Parameters
*****************************************************************************
*BR
**
** The *Control parameters are used to specify the plant type and general
** configuration information, to select integration and model options, and
** to direct input and output.
**
** ========================================================================
** ========================================================================
** PLANT TYPE AND CONFIGURATION PARAMETERS
**
```

```
**
** ========================================================================
** ========================================================================
IBW            0          // Dimensionless
**
** IBW specifies the type of steam generator.
**
**  = 1: steam generator is a once-through type.
**  = 0: steam generator is a U-tube type.
**
** ========================================================================
ISPAIN         0          // Dimensionless
**
** ISPAIN indicates if the Spanish-specific coding is to be used.  This
** coding was added in MAAP4.0.1.
**
**  = 0: not a Spanish plant.
**  = 1: parameter file is for a Spanish plant, Spanish-specific coding
**       will be used.
**
** ========================================================================
** If the hardwired ESF model is selected by setting parameter NESF to 0,
** then IRECIR and IDISCH are used by subroutine ENGSAF to determine the
** ESF lineup.  These two parameters are not used with the Generalized ESF
** model, i.e., when parameter NESF is set to 1.
**
IRECIR         2          // Dimensionless
**
** IRECIR specifies the ESF pump lineup in the recirculation mode.   See
** the description of subroutine ENGSAF in the MAAP4 User's Manual for
** further information about these recirculation lineups.
**
**  = 1: Zion-like plant - no containment spray heat exchangers.
**  = 2: Sequoyah-like plant - all pumped systems have heat exchangers.
**  = 3: Calvert Cliffs-like plant - only the containment spray has a
**       heat exchanger.
**
IDISCH         1          // Dimensionless
**
** IDISCH specifies the ESF pump discharge alignment.
**
**  = 1: all ESF systems, except accumulators, discharge to the cold leg.
**       This is the normal case for plants like Zion, Sequoyah, and
**       Calvert Cliffs.
**  = 2: all ESF systems, except accumulators, discharge to the hot leg.
**       This is an alternative to designs for plants like Zion and
**       Sequoyah.
**  = 3: all ESF systems, except accumulators, discharge to the downcomer
**       before filling up the cold leg.  This is for plants like Oconee.
**
** Accumulators always discharge to the downcomer, both for the hardwired
** and the generalized ESF models.
**
** ========================================================================
```

ISSCL 0 // Dimensionless
**
** ISSCL specifies the type of cladding.
**
** = 1: cladding is stainless steel.
** = 0: cladding is Zr.
**
** ==================================================================
IBCCR 0 // Dimensionless
**
** IBCCR specifies the type of control material.
**
** = 1: control material is B4C.
** = 0: control material is Ag-In-Cd.
**
** ==================================================================
INODRB 9 // Dimensionless
**
** INODRB specifies the total number of compartments (nodes) in the
** containment and auxiliary/reactor building. A maximum of 29
** compartments may be used. The INODRB+1 node is the environment. If a
** value of 0 is used, only the primary system will be analyzed. The
** specifications of each compartment are included in the *Auxiliary
** Building section of the parameter file. The specifications of the
** flowpaths between compartments are included in the *Topology section of
** the parameter file.
**
** ==================================================================
** @@@ 4.0.3 CYP 8/15/96 - Added JNUTUB and JNBTUB as part of the hot leg
** natural circulation enhancements.
**
** JNUTUB and JNBTUB are the steam generator tube node numbers for tube
** rupture calculations in the unbroken and broken steam generators,
** respectively. These parameters allow the model to use the appropriate
** temperatures in the creep rupture calculations. The nodes are discussed
** in the PSHS-P subroutine description in the User's Manual.
**
** For U-tube steam generators the values can be 1 through 20, with the
** recommended value being 1, i.e., the lowest and hence hottest node on
** the hot-side "out" flow tubes.
**
** For once-through steam generators (IBW=1) the values can be 1 through 5,
** with the recommended value being 5, i.e., the highest and hence hottest
** node.
**
** If no values are specified the code will use the recommended values
** depending on the value of IBW.
**
** See the associated *Model parameters FERSGT and FBVSGT for specification
** of the tube thickness for the creep calculations.
**
JNUTUB 1 // Dimensionless
**
JNBTUB 1 // Dimensionless

```
**
** ===========================================================================
IBCHX          0          // Dimensionless
**
** @@@ 4.0.3 SMD 8/2/96 - Add new parameter IBCHX
**
** IBCHX is a control parameter for the benchmark capability of MAAP4.
**
** MAAP4 dynamic benchmarks can be divided into the following categories:
**
**    1) Plant experience benchmarks,
**    2) Large-scale integral experiment benchmarks, and
**    3) Separate effects benchmarks
**
** For plant experience benchmarks, the entire MAAP4 code is exercised.
** However, for the latter two benchmark types, only selected
** phenomenological models are used, as dictated by the specific benchmark.
** In such cases, generic subroutine BENCH uses control parameter IBCHX to
** dictate the specific benchmark subroutine to be called.  For example, in
** the CRUST separate effects benchmark, IBCHX is set to 101, which results
** in subroutine BENCH calling subroutine BCRUST, the specific benchmark
** subroutine.  BCRUST then calls selected subroutines to perform the
** benchmark.
**
** Thus, for plant experience benchmarks, IBCHX=0, and for all other
** benchmarks, each has a unique non-zero IBCHX value, as defined in the
** individual benchmark subroutine descriptions in the User's Manual.
** Values of IBCHX which are less than 100 will be used for the large-scale
** integral experiment benchmarks.  Values of IBCHX which are greater than
** or equal to 100 will be used for separate effects benchmarks. The current
** values are:
**
**   IBCHX= 0:  Do not run a dynamic benchmark (default value in the code).
**   IBCHX= 1:  Run the HDR E11.2 benchmark (Must also set additional
**              parameters as defined in the BENCH1 subroutine description
**              in Volume II of the User's Manual and use proprietary
**              parameter file).
**   IBCHX= 2:  Run the CORA benchmark (Must also set additional parameters
**              as defined in the BENCH1 subroutine description in Volume
**              II of the User's Manual).
**   IBCHX= 3:  Run the HDR T31.5 benchmark (Must also set additional
**              parameters as defined in the BCHDRT subroutine description
**              in Volume II of the User's Manual and use proprietary
**              parameter file).
**
**   IBCHX=101: Run the CRUST benchmark - see subroutine BCRUST in the manual.
**   IBCHX=102: Run the ORNL VI fission product benchmark - see subroutine
**              BCHFPV in the manual.
**   IBCHX=103: Run the hot leg creep rupture benchmark - see subroutine
**              BCREEP in the manual.
**   IBCHX=104: Run the Westinghouse SF6 hot leg natural circulation
**              benchmark - see subroutine BCHLNC in the manual.
**
**
```

```
** The results of the dynamic benchmarks available in the code are described
** in the following volumes of the MAAP4 User's Manual:
**
**   Volume III-A:  Key benchmarks, such as HDR, CORA, and TMI-2
**   Volume III-B:  Plant experience benchmarks
**   Volume III-C:  Large-scale integral experiment benchmarks
**   Volume III-D:  Separate effects benchmarks
**
** The actual benchmarking subroutines are included in Volume II of the
** manual.
**
** As the benchmarking capability is expanded descriptions of the specific
** benchmarks will be added or updated in these volumes.
**
** ======================================================================
** ======================================================================
** INTEGRATION PARAMETERS
** ======================================================================
** ======================================================================
IRUNG          1          // Dimensionless
**
** IRUNG specifies the type of Runge-Kutta integration method to be used.
** A value of 1 selects the first-order integration, i.e., the Euler
** method.  The second-order integration method originally available in
** MAAP 3B was used for the purpose of numerical performance is not fully
** functional in MAAP4 and is not recommended.
**
** ======================================================================
JNTGRT         1          // Dimensionless
**
** JNTGRT indicates if consistent timesteps are to be used for the
** calculation of the rates-of-change of the state variables (the ICALL = 3
** calculations) and the integration of these variables.  The use of
** consistent timesteps generally involves iteration on the rates-of-
** change calculations.  These ICALL = 3 calculations are initiated in
** subroutines DIFFUN and DIFFP, and the corresponding integration
** calculations are done in subroutines INTGRT and INTGFP.
**
**   = 1  Use consistent timesteps for the calculations.
**   = 0  Use the smaller of the timestep used for the rates-of-change
**        calculations and the limiting timestep for the integration of
**        the state variables.
**
** ======================================================================
ISORT          0          // Dimensionless
**
** ISORT indicates if the integration diagnostic figures-of-merit for the
** thermal-hydraulic state variables are to be sorted in terms of their
** average fractional changes and the frequency of sign changes of their
** rates.  This information is written to the log file at the end of each
** print interval.
**
**   =1: sort out integration diagnostic figures-of-merit.
**   =0: no sorting.
```

```
**
** ========================================================================
** ========================================================================
** MODEL CONTROL PARAMETERS
** ========================================================================
** ========================================================================
** CORE HEATUP AND MELT PROGRESSION OPTIONS
**
** See the description of subroutine HEATUP in the MAAP4 User's Manual for
** an overview of the heatup and melt progression models.
**
** ========================================================================
ISIDRL          0          // Dimensionless
**
** ISIDRL is used to enable/disable sideward relocation within the core.
** The option to bypass sideward relocation was added to the code to
** evaluate the impact of this mode of relocation on the code's numerical
** performance.  It is recommended that sideward relocation always be
** considered.
**
**   = 0: do sideward relocation.
**   = 1: bypass this calculation.
**
** ========================================================================
ICANDL          0          // Dimensionless
**
** ICANDL is used to enable/disable the mechanistic melt candling model
** (subroutine CANDLE).  If the model is bypassed the MAAP3B model for
** relocating molten material to the next lower node will be used.  The
** option to bypass the model was added to the code to evaluate the impact
** of the model on numerical performance.  It is recommended that the
** candling model always be used.
**
**   = 0: use the mechanistic model.
**   = 1: bypass this model.
**
** ========================================================================
IDISSV          0          // Dimensionless
**
** IDISSV is used to enable/disable the fuel-cladding dissolution
** calculations (subroutine FDISS).  The option to bypass the calculations
** was added to the code to study the sensitivity of overall core heatup to
** dissolution.  Bypassing these calculations essentially bypasses material
** interactions between fuel and cladding.  Hence, it is recommended that
** the dissolution calculations always be used.
**
**   = 0: do the dissolution calculations.
**   = 1: bypass the calculations.
**
** ========================================================================
IDISSB          0          // Dimensionless
**
** IDISSB is used to enable/disable the fuel can - control blade
** dissolution calculations.  The option to bypass the calculations was
```

** added to the code to study the sensitivity of core heatup to the
** material interactions between fuel cans and control blades. It is
** recommended that the calculations always be used.
**
** = 0: do the dissolution calculations.
** = 1: do not do the calculations.
**
** @@@ 4.0.3 BJS 11/28/95 - Added missing parameter IDISSB to the PWR
** parameter files.
**
** ======================================================================
IEUTEC 0 // Dimensionless
**
** IEUTEC is used to enable/disable the U-Zr-O eutectic model for
** calculating the melting temperature, melt fraction, and enthalpy of the
** core material. If the model is not used, the eutectic temperature is
** set to 2500 K with a corresponding enthalpy and melt fraction, as is
** done in MAAP3B.
**
** = 0: use the eutectic model.
** = 1: use 2500K for the eutectic temperature.
**
** ======================================================================
IMIX 1 // Dimensionless
**
** IMIX is used to enable/disable inter-channel mixing of the gas flow in
** the core. If fuel cans are modeled and inter-channel mixing is enabled,
** the mixing will not occur until the channel's fuel can has failed
** (ruptured). The calculations are done in subroutine REMIX.
**
** = 1: allow inter-channel mixing.
** = 0: do not allow inter-channel mixing.
**
** ======================================================================
IMPOOL 0 // Dimensionless
**
** IMPOOL is used to enable/disable in-core molten pool calculations. The
** option to bypass the calculations was added to the code to evaluate the
** impact of the calculations on numerical performance. It is recommended
** that the calculations always be used.
**
** = 0: do the molten pool calculations.
** = 1: bypass the calculations.
**
** ======================================================================
IOXIDE 0 // Dimensionless
**
** IOXIDE is used to select the Zr oxidiation model: the MATPRO oxidation
** model, or the IDCOR oxidation model. The default is to use the IDCOR
** oxidation model. The option to use the MATPRO model was added during
** the CORA benchmarking effort to evaluate the impact of the different
** models on the timing of hydrogen generation. The MATPRO model did not
** provide a better prediction. See the description of subroutine COVER in
** the MAAP4 User's Manual for more information.

```
**
**  = 0: use the IDCOR oxidation model
**  = 1: use the MATPRO oxidation model.
**
** @@@ 4.0.3 BJS 10/11/95 - Added missing parameter IOXIDE to PWR parameter
** files.
**
** ====================================================================
IAOXP          0          // Dimensionless
**
** IAOXP is used to enable/disable the enhanced Zr oxidation during
** reflood. It was added to the code during the CORA benchmarking effort
** to determine how much hydrogen was generated prior to reflooding. It
** should only be used to determine this type of information, not to
** control the oxidation during an actual sequence. In order for enhanced
** oxidation to be calculated *Model parameter FPEEL should be set to a
** non-zero value when reflooding occurs.
**
**  = 1: bypass the enhanced oxidation calculations.
**  = 0: calculate enchanced oxidations.
**
** @@@ 4.0.3 BJS 10/11/95 - Added missing parameter IAOXP to the PWR
** parameter files.
**
** ====================================================================
IBALON         0          // Dimensionless
**
** IBALON is used to enable/disable the clad ballooning and rupture model.
** If this model is disabled, fission products are released only after the
** collapse of a core node.
**
**  = 0: do the ballooning and rupture calculations.
**  = 1: bypass the calculations.
**
** @@@ 4.0.3 BJS 10/11/95 - Added missing parameter IBALON to the PWR
** parameter files.
**
** ====================================================================
** LOWER PLENUM DEBRIS BEHAVIOR OPTIONS
**
** See the descriptions of subroutines LPDEB and DBBED in the MAAP4 User's
** Manual for information on the lower plenum models.
** ====================================================================
IUSETD         1          // Dimensionless
**
** IUSETD is used to specify if the material properties of the debris in
** the lower head are to be calculated from user input or from phase
** diagrams. The calculations using user input are done in subroutine
** TMATRL, while those using phase diagrams are done in subroutine TDEBRI.
** The choice will have a slight impact on vessel failure timing. It
** should be noted that there are uncertainties associated with both
** methods of calculation. See the material property parameters in the
** *Model parameter section for more information.
**
```

** = 0: use user input (TMATRL).
** = 1: use phase diagrams (TDEBRI).
**
** @@@ 4.0.3 BJS 9/28/95 - Changed IUSETD to 1 to be consistent with the
** BWR parameter files (Trouble Report 397G).
**
** ==================================================================
IDBLVL 0 // Dimensionless
**
** IDBLVL is used to indicate if the debris level in the lower plenum is
** to be calculated without taking into account structures in the lower
** plenum. If the volume occupied by structures is not considered, the
** calculations are done assuming an open hemisphere. If the volume of
** structures is considered, the calculations use a lookup table of volume
** vs. height. The input table parameters, XZLLPS, XZLLP1, etc., are in
** the *Primary System section of the parameter file. The level
** calculations are done in subroutine DBLVL.
**
** = 0: the debris levels are calculated without structure.
** = 1: lookup tables are used.
**
** The use of lookup tables for the lower plenum debris elevations is not
** recommended for the PWR code until further testing is done.
**
** ==================================================================
IQDPB 1 // Dimensionless
**
** IQDPB is used to specify which model is to be used for heat transfer
** from debris bed particulates to the water in the lower plenum. The
** models are used to calculate quenching of the debris in subroutine
** DBBED. They are discussed in the LPDEB subroutine description.
**
** = 1: use the Lipinski model.
** = 2: use the Henry model.
**
** ==================================================================
IHGRAD 2 // Dimensionless
**
** IHGRAD is used to control radiation heat transfer from the upper crust
** of the debris in the lower plenum to the vessel wall and internal heat
** sinks. The calculations are done in subroutine DBBED. The option to
** bypass the calculations was added to the code to facilitate debugging.
** It is recommended that the calculations always be done.
**
** = 0: always bypass the calculation of radiation heat transfer from the
** crust to the RPV.
** = 1: calculate the radiation heat transfer after RPV failure.
** = 2: calculate the radiation heat transfer all the time.
**
** ==================================================================
IXPSE 1 // Dimensionless
**
** IXPSE is used to indicate if the boundary condition for the embedded
** crust in the lower plenum debris is to be based on gap conductance

** between the crust and the lower plenum internal structures or directly
** on the temperature of the structures. The embedded crust is the crust
** that forms on structures within the lower plenum. If the boundary
** condition is based on the gap conductance then the boiling of water in
** the gap is taken into account in the heat transfer calculations. If the
** temperature of the structures is used then the crust is assumed to be in
** direct contact with the structures. The boundary condition is used in
** subroutine DBBED.
**
** = 1: gap conductance boundary condition.
** = 0: structure temperature boundary condition.
**
** ==================================================================
IGCHF 1 // Dimensionless
**
** IGCHF is used to enable/disable the critical heat flux gap boiling
** model for in-vessel debris cooling. Using this model will cool both
** the crust and the vessel wall by water CHF boiling in the gap. The gap
** is created by initial contact of debris on the wall and subsequent
** growth due to wall strain. The related *Model parameters are XGAPLH,
** FHTGAP, FQUEN and ECREPF. See the *Model parameters section and the
** description of subroutine DBBED in the MAAP4 User's Manual for further
** information.
**
** = 1: use CHF gap boiling model.
** = 0: disable CHF gap boiling model.
**
** ==================================================================
IEXVSL 0 // Dimensionless
**
** IEXVSL is used to enable/disable the ex-vessel cooling model. Because
** ex-vessel cooling is a physically observed phenomena, the recommended
** value for this parameter is 0. However, if the reactor support skirt
** in the cavity/pedestal can trap gases (air and steam) such that water
** cannot reach the vessel bottom wall, then the model should be turned off
** by using a value of 1.
**
** = 0: ex-vessel cooling enabled.
** = 1: ex-vessel cooling disabled.
**
** ==================================================================
IOPTVF 1 // Dimensionless
**
** IOPTVF is used to select the vessel failure mechanisms to be
** considered.
**
** = 0: consider lower head creep rupture only.
** = 1: consider all the failure mechanisms in subroutine RVFLMK.
**
** ==================================================================
IXPSL 0 // Dimensionless
**
** IXPSL is used to indicate if the lower crust drains with the rest of
** the debris after RPV failure or if it sticks on the wall.

```
**
**  = 0: the lower crust drains with the rest of the debris.
**  = 1: the lower crust sticks to the wall.
**
** ======================================================================
IDPQNC           1           // Dimensionless
**
** IDPQNC is used to indicate if the particle temperature will be
** calculated mechanistically during entrainment or if it will be at the
** water saturation temperature after quenching.  This applies to particles
** formed from a corium debris jet that falls through a water pool either
** in the vessel or in the containment.  The calculations are done in
** subroutine DBJET.
**
**  = 1: use mechanistic calculation for particle temperature
**       during entrainment.
**  = 0: assume water saturation temperature after quenching.
**
** ======================================================================
** CONTAINMENT MODEL OPTIONS
**
** ======================================================================
ISBNOD           0           // Dimensionless
**
** @@@ 4.0.3 BJS 12/22/95 - Added ISBNOD to the parameter files.  Prior to
** Rev. 4.0.3 the default value of 0 was used for this parameter.  This
** model has not been extensively tested with different containment
** nodalization schemes.  Difficulties in the application of the model
** will be evident by numerous AUXFLO non-convergence diagnostics.
**
** @@@ 4.0.3 BJS 4/5/96 - Changed the value of ISBNOD for ice condenser
** plants because the subnodal physics model requires further modifications
** for the ice condenser.
**
** ISBNOD is used to enable/disable the containment subnodal physics model
** related to stratification.  This model accounts for the non-homogeneity
** of gas properties in a containment node.  This model was developed as
** part of the HDR benchmarking effort.  It has the largest impact for
** highly compartmentalized containments where there is no forced
** circulation and where lighter gases are released into the containment
** at a relatively high elevation.  See the discussion in Section 3.1.7 of
** the AUXFLO subroutine description in the MAAP4 User's Manual for further
** information about this model.
**
**  = 1: enable the containment stratification subnodal physics model.
**  = 0: disable the containment stratification subnodal physics model.
**
**
** Note that this model is independent of the subnodal physics plume model,
** which was also added to the code for the HDR benchmark.  See the
** *Pointers section of the parameter file for inputs related to the plume
** model.
**
** ======================================================================
```

```
IHTGPL          1          // Dimensionless
**
** IHTGPL is used to enable/disable the subroutine HTGPL model, which
** calculates mass and energy transfer between gases and pools in the
** containment. It is recommended that the model always be used. The
** option to turn off the model was added for HDR benchmarking sensitivity
** analyses.
**
**   = 1: enable HTGPL.
**   = 0: bypass HTGPL.
**
** ======================================================================
IPSPR           1          // Dimensionless
**
** IPSPR is used to specify the version of the steam tables that is to be
** used for primary system calculations.
**
**   = 0: use "fast", approximate steam tables in subroutine SWATR1 when
**        the partial pressure of steam is less than the critical pressure.
**   = 1: use the normal, more exact, steam tables in subroutine SWATER.
**
** ======================================================================
ICPR            1          // Dimensionless
**
** ICPR is used to specify the version of the steam tables that is to be
** used for containment calculations.
**
**   = 0: use "fast", approximate steam tables in subroutine SWATR1 when
**        the partial pressure of steam is less than the critical pressure.
**   = 1: use the normal, more exact, steam tables in subroutine SWATER.
**
** ======================================================================
** ======================================================================
** INPUT AND OUTPUT FILE PARAMETERS
**
** ======================================================================
** ======================================================================
IUXOLD          0          // Dimensionless
**
** IUXOLD specifies the processing order for user-defined event codes.
**
**   = 0: evalute in the order they are read in.
**   = 1: evaluate in numerical order, as is done in MAAP3B.
**
** @@@ 4.0.3 BJS 10/3/95 - Added missing parameter IUXOLD to the BW and ICE
** parameter files.
** ======================================================================
IRSTW           29         // Dimensionless
**
** IRSTW is the Fortran unit number to which the restart file is to be
** written. The restart file is the file that contains periodic
** "snapshots" of the values of the state variables. The frequency at
** which these snapshots are written is specified in the input file. The
** corresponding MAAP variable is TTPRNT.
```

```
**
** ========================================================================
IDBGWF          89          // Dimensionless
**
** IDBGWF is the Fortran unit number to which the debug restart file is to
** be written.  The debug restart file is the file that contains a single
** "snap-shot" of the values of the state variables.  It is over-written
** at a frequency specified with parameter IDBGTD.
**
** ========================================================================
IDBGTD          50          // Dimensionless
**
** IDBGTD is the number of MAAP timesteps between the writing of state
** variables "snapshots" to the debug restart file.  Generally, the
** frequency at which snapshots are written to the debug restart file is
** relatively high so that it can be used to debug sequences just before
** the calculations stop due to numerical problems.
**
** ========================================================================
IRSBAD          1           // Dimensionless
**
** IRSBAD is used to specify the restart file write option when the
** calculated rates being monitored by subroutine XCHK "go bad".  XCHK
** checks selected state variables just prior to integration to determine
** if any rates will result in non-physical integrated variable values.  If
** there are bad values, the diagnostic information is printed in the log
** file to facilitate debugging.  A "snap-shot" can also be written to the
** restart file.
**
**   = 0: don't write to restart file on errors.
**   = 1: write to restart file if there are more than 3 occasions of bad
**        rates in the same routine but continue execution.
**   = 2: write to restart file if there are more than 3 occasions of bad
**        rates in the same routine and stop execution.
**
** ========================================================================
ISUM            39          // Dimensionless
**
** ISUM is the Fortran unit number to which the summary file is to be
** written.  The summary file lists the times that select event codes
** change status, i.e., from true to false or vice versa.  Control over
** which event codes can be written to the summary file is handled in the
** event message section of the parameter file.
**
** ========================================================================
IPOUT           09          // Dimensionless
**
** IPOUT is the Fortran unit number to which miscellaneous tabular output
** is written. The major blocks of tabular output are written to the
** Fortran unit numbers specified in array IPSET1.  Note that ICOUT, the
** Fortran unit number for the containment output, is obsolete as of 4.00.
**
** ========================================================================
** Name: IPSET1(1:40)          Units: [Dimensionless]
```

```
**
** These parameters are the Fortran unit numbers to which blocks of tabular
** output are written.  Using the same number for more than one block will
** result in appended output.
**
**   If IPSET1(I) = 0 --> Suppress block I output, and
**   If IPSET1(I) > 0 --> Unit number to receive output.
**
**    Examples:
**
**      -- IPSET1(6)=40 --> Block #6 sent to unit 40 (tabular output file)
**      -- IPSET1(17)=30--> Block #17 sent to unit 30
**      -- IPSET1(12)=6 --> Block #12 sent to unit 6 (log file)
**      -- IPSET1(8)=0  --> Block #8 not included in any output
**
** The output blocks can be sent to any legal Fortran unit.  Note that
** opening of the corresponding output files is machine-specific and
** should be handled like any other output files.  The unit number should
** never be negative.
**
** -- IPSET1(1) - IPSET1(5) - not used, reserved for first time output only
**
** -- IPSET1(6) - primary system/pressurizer conditions
** -- IPSET1(7) - primary loop details
** -- IPSET1(8) - steam generators
** -- IPSET1(9) - primary system fission product mass
** -- IPSET1(10) - reserved (not used)
**
**   CORE MAPS
**
** -- IPSET1(11) - core node temperatures, TNOD(IJ)
** -- IPSET1(12) - fuel temperatures, TU2N(IJ)
** -- IPSET1(13) - clad temperatures, TCLN(IJ)
** -- IPSET1(14) - control/water rod temperatures, TCRN(IJ)
** -- IPSET1(15) - fuel can temperatures, TCAN(IJ)
** -- IPSET1(16) - control blade temperatures, TCBN(IJ)
** -- IPSET1(17) - core node fuel mass, MU2N(IJ)
** -- IPSET1(18) - unreacted Zr mass, MZRC(IJ) + MZRK(IJ) + MZRR(IJ)
** -- IPSET1(19) - oxidized Zr mass, MZOC(IJ) + MZOK(IJ) + MZOR(IJ)
** -- IPSET1(20) - U-Zr-O mass, MUZC(IJ,1) "U" + MUZC(IJ,2) "Zr" +
**            MUZC(IJ,3) "O"
** -- IPSET1(21) - control rod mass, MAGR(IJ)
** -- IPSET1(22) - control blade mass, MBCB(IJ)
** -- IPSET1(23) - steel mass, MSSC(IJ) + MSSB(IJ)
** -- IPSET1(24) - steel oxide mass, MSOC(IJ) + MSOB(IJ)
** -- IPSET1(25) - molten core mass, MDU2N(IJ) + MDCLN(IJ) + MDCRN(IJ)
** -- IPSET1(26) - core node mass, MNOD(IJ)
** -- IPSET1(27) - core node porosity, EPS(IJ)
** -- IPSET1(28) - core node geometry, IGTYP(IJ)
**            & lowest collapsed row, ICOLAP(J)
**            & lowest crust node, ICRUST(J)
** -- IPSET1(29) - cladding strains, FECL(IJ)
** -- IPSET1(30) - total fission product mass in core
**            & total structural material mass in core
```

```
**          & release rate of material from core
**
**   CONTAINMENT/AUXILIARY COMPARTMENTS
**
** -- IPSET1(31) - compartment conditions
** -- IPSET1(32) - fission product mass release to environment
** -- IPSET1(33) - event codes status
** -- IPSET1(34) - figures of merit
** -- IPSET1(35) - detailed containment response (not used)
** -- IPSET1(36) - lower plenum conditions
** -- IPSET1(37) - IPSET1(40) - reserved (not used)
**
**
IPSET1(1)       0
IPSET1(2)       0
IPSET1(3)       0
IPSET1(4)       0
IPSET1(5)       0
IPSET1(6)       9
IPSET1(7)       9
IPSET1(8)       9
IPSET1(9)       9
IPSET1(10)      0
IPSET1(11)      9
IPSET1(12)      9
IPSET1(13)      9
IPSET1(14)      9
IPSET1(15)      9
IPSET1(16)      9
IPSET1(17)      9
IPSET1(18)      9
IPSET1(19)      9
IPSET1(20)      9
IPSET1(21)      9
IPSET1(22)      9
IPSET1(23)      9
IPSET1(24)      9
IPSET1(25)      9
IPSET1(26)      9
IPSET1(27)      9
IPSET1(28)      9
IPSET1(29)      9
IPSET1(30)      9
IPSET1(31)      9
IPSET1(32)      9
IPSET1(33)      9
IPSET1(34)      9
IPSET1(35)      0
IPSET1(36)      9
IPSET1(37)      0
IPSET1(38)      0
IPSET1(39)      0
IPSET1(40)      0
**
```

```
** ======================================================================
IPLT1          4          // Dimensionless
**
** IPLT1 specifies the format of the plot file output. The output
** consists of the variable count, the variable names and the values of
** the variables. The parameter is used in subroutine PLTMAP.
**
**  = 0: uses I2, A8,  1PE12.3 format; like pre-MAAP3B Rev. 7/17 versions
**  = 1: uses I3, A8,  1PE12.3 format
**  = 2: uses I3, A15, 1PE12.3 format
**  = 3: uses I3, A8,  free format
**  = 4: uses I3, A15, free format
**
** If IPLT1=2 or 4 the count of variables will be negative.
** If IPLT1=3 or 4 plot data is written in free format, which is as
**   accurate as the machine representation of the number, i.e., no
**   truncation or roundoff if the output number is large.
**
** The options for IPLT1 of 0, 3 and 4 were added for Rev. 4.0.1.
**
** ======================================================================
** Plot Data Storage
**
** The next three variables control the plot point storage frequency. Two
** options are available for plot data storage: 1) Store a user-specified
** total number of points per variable at equally spaced time intervals or,
** 2) Invoke an automatic point spacing option. For the latter option, the
** program logic automatically varies the time interval between plot
** points as necessary to resolve rapidly fluctuating phenomena, such as
** steam spikes, with a minimum number of stored points. The equal spacing
** option is invoked by setting IPTSPK to 0 and IPTSAV to the desired num-
** ber of points. MAAP then uses a spacing between points of
** (TILAST-TIM0)/IPTSAV; the run time divided by the number of points.
** IPTSMX must be equal to or greater than IPTSAV. To invoke the
** automatic spacing option a non-zero IPTSPK should be specified. This
** variable is related to the number of plot points stored to trace a
** rapid full range rise of a criterion variable. The criterion variables
** are those used to determine the plot spacing. They are discussed in
** the PLTMAP section of the parameter file. Using a large IPTSPK value is
** necessary to resolve small amplitude spikes, whereas a small value
** filters out small amplitude fluctuations, which is for "noisy"
** variables. For further information about plot files see section 3.2.19
** in Volume 1 of the MAAP4 User's Manual.
**
** ======================================================================
IPTSAV         150        // Dimensionless
**
** IPTSAV is the non-spike number of points (average behavior) stored in a
** plot file.
**
** ======================================================================
IPTSPK         10         // Dimensionless
**
** IPTSPK is the maximum number of plot points traced for a full scale
```

```
** spike.  IPTSPK is used to balance the objective of saving a sufficient
** number of data points for plotting such that peak quantities and
** fluctuations are recorded while keeping the size of the plot files
** within practical limits.  Increasing IPTSPK affects the plot frequency
** algorithm for all frequency criterion variables.  Reducing the criteria
** of particular variables of interest is an alternative way to increase
** the resolution of spikes.
**
** ======================================================================
IPTSMX        500        // Dimensionless
**
** IPTSMX is the maximum number of plotted points saved.  This number can
** be increased for better resolution.  However, this will  increase the
** size of the plot files.
**
** ======================================================================
IEMBAL        09         // Dimensionless
**
** IEMBAL indicates if primary system and containment energy and water mass
** balances are to be calculated.  The output is then written to Fortran
** unit number IEMBAL.
**
** @@@ 4.0.3 BJS 10/10/95 - Added missing parameter IEMBAL to the PWR
** parameter files.
**
** @@@ 4.0.3 BJS 5/9/96 - IEMBAL has been changed from 0 to the Fortran
** unit number for the tabular output so that the mass and energy balances
** will be calculated for all the sample problems.  This will provide
** additional information for the assessment of code performance.
**
** ======================================================================
ICRBAL        1          // Dimensionless
**
** ICRBAL indicates if the core channel energy balance is to be calculated
** and printed in a tabular output file.
**
**    = 1: calculate and print the balance.
**    = 0: do not calculate the balance.
**
** Note that the option to calculate and print out HEATUP diagnostic
** information, set with ICRBAL=3, is for development use only.
**
** ======================================================================
ILPBAL        1          // Dimensionless
**
** ILPBAL indicates if the lower plenum mass and energy balances are to be
** calculated.  The calculations are done in subroutine LPBAL.  The
** output from the routine can be written to an output file for subsequent
** plotting or printing.
**
**    = 1: calculate and print the balances.
**    = 0: do not calculate the balances.
**
** ======================================================================
```

```
IMVUNT          0          // Dimensionless
**
** IMVUNT is the Fortran unit number to which the MAAP4-GRAAPH movie is to
** be written.
**
** ==========================================================================
** ==========================================================================
** OBSOLETE PARAMETERS (as of MAAP4.00)
** ==========================================================================
** ==========================================================================
**
** @@@ 4.0.3 BJS 9/21/95:
**
** The following *Control parameters had been included in the sample
** parameter files that were released with earlier versions of MAAP4.
** They were input in pre-released versions of MAAP4.00, but are now
** either not used or are set in the code.
**
**  IAUXR
**  IAUXW
**  ICOUT
**  IDBGRF
**  IFLOOD
**  IFREEZ
**  IHUW
**  INCIRC
**  IRADIA
**  ISUMM
**  ITDLIM
**
** INPGRP, the number of fission product groups, is still used but should
** not be changed by the user, so it is no longer included in the sample
** parameter files.
**
** JSAVE is for development use only, so it is no longer included in the
** sample parameter files.
**
****************************************************************************
*Model
****************************************************************************
*SI
**
** ==========================================================================
** ==========================================================================
** INTRODUCTION
** ------------
**
** In severe accident analysis there are uncertainties in the physical
** phenomena.  There are also uncertainties in the MAAP models.  Users have
** control over the uncertainties via the *Model parameters.  They are
** either used as an input to a given physical model or to select between
** different physical models.
**
** Where appropriate, the subroutines in which the *Model parameters are
```

```
** used are noted. Users can find more information about the parameters
** in the applicable subroutine descriptions in the MAAP4 User's Manual.
**
** All the values in this section are in SI units. This includes the
** nominal values and the minimum and maximum values. The minimum and
** maximum values are included in subroutine MAAPC to determine if the
** input values are within reasonable ranges. They are listed in this
** section just for information.
**
** @@@ 4.0.3 BJS 5/9/96 - The value of each model parameter is checked
** to see if it is within its allowable range. If the sensitivity
** option is not selected in the input file, the code will write a
** message to the log file and then stop if any of the model parameter
** values are outside of their range. If the sensitivity option is
** selected, the values can be outside their range. This code feature
** is intended to protect against inadvertant use of non-physical values
** of the model parameters per the IDCOR/NRC review of MAAP.
**
** It is recommended that all the values in the parameter file be within
** range, and those values that are out of range be included via local
** parameter changes in the input file. This is because the code will
** process the parameter file prior to processing the input deck when the
** parameter file is specified on the command line when running the code.
** If any values in the parameter file are out of range the code will stop
** because it has not yet processed the sensitivity option in the input
** file. Note that this is not a problem if the parameter file is only
** specified in the input file and not on the command line. In that case,
** it is read in after the sensitivity option is selected, and the code
** will allow values that are out of range.
**
**
** @@@ 4.0.3 BJS 5/9/96 - The minimum and maximum values of each of the
** model parameters were reviewed, and MAAPC was updated to be consistent
** with the User's Guides. As part of this effort, several minimum and
** maximum values listed here were updated.
**
** ======================================================================
** ======================================================================
** PRIMARY SYSTEM PARAMETERS
** ------------------------
**
** ======================================================================
** ======================================================================
VFSEP          0.6          // Dimensionless
** Min = 0.01   Max = 0.65
**
** VFSEP is the void fraction in the primary system above which the
** two-phase mixture characteristics no longer lead to the carrying of
** water over the highest point in the reactor coolant system. Typically
** this is the top of the steam generators for the inverted U-tube designs
** and the top of the hot legs for the B&W designs. As a result, the phases
** separate to a large degree. Two-phase natural circulation can still
** continue but in a different manner, e.g., countercurrent reflux cooling
** between the steam generators and the core. This parameter influences
```

** the time at which the core is uncovered. It also affects the void
** fraction of the break flow for primary system LOCA sequences. In
** addition, the heat transfer to the secondary side is somewhat influenced
** by this parameter. Values between 0.4 and 0.6 are typical of the
** Flecht-Seaset tests.
**
** Data Sources: 1) EPRI Report NP-3497 - Flecht-Seaset experiment.
** 2) Detailed RETRAN or RELAP calculation results.
**
** Used in subroutine EVENTS.
** Use in MAAP4 = use in MAAP3B.
**
** ======================================================================
VFCIRC 0.4 // Dimensionless
** Min = 0.01 Max = 0.6
**
** VFCIRC is the primary system coolant void fraction below which the
** two-phase mixture characteristics enable water to be "pumped" to the
** highest point in the reactor coolant system such that it spills over to
** complete the circulation loop. At this point, MAAP assumes that the
** mixture transitions into a homogeneous two-phase character which
** circulates through the primary system. VFCIRC provides a deadband for
** switching between the homogeneous and separated phase configurations.
** If the subcooling is greater than 10 degrees C, the code uses a
** hardwired value of 0.01 for VFCIRC.
**
** Used in subroutine EVENTS.
** New for MAAP4.
**
** ======================================================================
FACT 0.3 // Dimensionless
** Min = 0.1 Max = 1.0
**
** FACT is a multiplier to reduce the hydraulic diameter and flow area when
** an intact fuel node collapses.
**
** Used in subroutine GNODE.
** New for MAAP4.
**
** ======================================================================
EPSCUT 0.1 // Dimensionless
** Min = 0.0 Max = 0.25
**
** EPSCUT is the cutoff porosity below which the flow area and the
** hydraulic diameter of a core node are zero, i.e., the node is fully
** blocked. It is used to transition between a thickened fuel pin
** (IGTYP=3) and crust (IGTYP=4) configuration in the node. The porosity
** is defined as the ratio of the free volume to the total volume of the
** node. Once the core node becomes a crust (blocked) node, the heat
** transfer area is set to zero so that there is no heat transfer to gas
** or water. The smaller the value of EPSCUT, the more material
** relocation is necessary for a core node to become a crust node,
** generally resulting in longer times for oxidation and heat transfer.
**

```
** Used in subroutines HEATUP, COVER, GNODE.
** New for MAAP4.
**
** ==========================================================================
EPSCU2        0.2          // Dimensionless
** Min = 0.0   Max =0.35
**
** @@@ 4.0.3 BJS 10/1/95 - Changed value from 0.1 to 0.2 for consistency with
** the other parameter files.
**
** EPSCU2 is the cutoff porosity below which the flow area and the
** hydraulic diameter of a collapsed core node (geometry configuration
** IGTYP=2) are zero, i.e., the node is fully blocked. The value should be
** less than *Model Parameter VFCRCO, the porosity of a collapsed core
** region.
**
** Used in subroutines HEATUP, COVER, GNODE.
** New for MAAP4.
**
** ==========================================================================
FFRICR        0.1          // Dimensionless
** Min = -1.0   Max = 1.0
**
** FFRICR is the friction coefficient for axial gas flow between the core
** and the upper plenum. If negative, the in-vessel natural circulation
** model -- core to upper plenum and back down -- will be turned off.
** FFRICR is also used to determine a fictitious hydraulic diameter for
** core nodes that are nearly empty (geometry configuration IGTYP=0).
** Note that for cores with fuel cans natural circulation is calculated
** only after at least one of the cans has ruptured (dissolved).
**
** The value of FFRICR can be estimated for normal operation with all
** reactor coolant pumps on by
**
**    FFRICR = 2.*(DP*RHO/WG**2)*D/L
**
** where DP  = core pressure drop
**       RHO = density of the primary system coolant
**       WG  = core average mass flow per unit area (be sure to make
**             appropriate units conversions to make FFRICR dimensionless)
**       D/L = equivalent diameter to length ratio
**
** @@@ 4.0.3 BJS 10/1/95 - Corrected equation for estimation to include D/L.
** Also, comment in the original parameter file to use a value greater than
** 100 to artificially stop the flow is not a valid option.
**
** Used in subroutines CIRCUP, GNODE, HEATUP and ROW.
** Use in MAAP4 = use in MAAP3B PWR.
**
** ==========================================================================
FFRICX        0.25         // Dimensionless
** Min = 0.0   Max = 1.0
**
** FFRICX is the gas cross-flow friction coefficient in the core for the
```

** in-vessel natural circulation model. Nominal values are generally
** between .25 and .45.
**
** @@@ 4.0.3 BJS 11/15/95 - Comments in previous parameter files about two
** model options based on the sign of FFRICX are obsolete. There is only
** one model, and it uses the absolute value of FFRICX. Negative nominal
** values were changed to positive values.
**
** Data source: Thompson, "Technology of Nuclear Reactor Safety," Volume 2,
** Chapter 15.
**
** Used in subroutine CIRCUP.
** Use in MAAP4 = use in MAAP3B PWR.
**
** ==================================================================
FNCBP 0.0 // Dimensionless
** Min = 0 Max = 1
**
** FNCBP is the reactor vessel natural circulation path selection flag.
** Specify a value of 0 if the in-vessel natural circulation flow return is
** in the outer fuel assemblies or 1 if return is down the outer bypass
** region, i.e., between the fuel cans and the shroud wall in a BWR or
** between the baffle and the core barrel in a PWR. The latter would be
** expected only if there is a large area in the bypass region. If the
** return is in the bypass region then *Core parameter AGBF must be
** non-zero. FNCBP is only used if the natural circulation model is
** invoked via a positive value of parameter FFRICR.
**
** Data Source: Reactor vessel assembly or internals drawings.
**
** Used in subroutines HEATUP and CIRCUP.
** Use in MAAP4 = use in MAAP3B PWR.
**
** ==================================================================
NSAMP 10.0 // Dimensionless
** Min = 1 Max = 20
**
** NSAMP is the number of MAAP time steps over which select gas parameters
** are averaged to stabilize the core - upper plenum natural circulation
** model.
**
** Used in subroutine CIRCUP.
** Use in MAAP4 = use in MAAP3B PWR.
**
** ==================================================================
FWHL 0.115 // Dimensionless
** Min = 0.05 Max = 0.2
**
** FWHL is the hot leg natural circulation flow rate correlation
** coefficient. This parameter is used to attenuate the natural
** circulation induced hot leg counter-current flow rate calculated in
** subroutine HLNC via an experimental correlation. Applying this
** correlation to the experimental data revealed that the flow rates
** calculated with it had to be adjusted linearly, i.e., by a coefficient,

** in order to provide good agreement. A value of 0.115 yields overall
** agreement between the model and experimental results. No plant- or
** sequence-specific reasons to change this value have been identified.
**
** Used in subroutine HLNC.
** Use in MAAP4 = use in MAAP3B.
**
** ======================================================================
FCDDC 1.0 // Dimensionless
** Min = 0 Max = 1
**
** @@@ 4.0.3 BJS 9/29/95 - Changed values for WLD and WICE plants from 0.0
** to 1.0 to be consistent with revised definition of FCDDC. This
** definition was revised as part of the thermal-hydraulic upgrades in
** MAAP4.0.1.
**
** FCDDC is the maximum fraction of perfect condensation allowed for steam
** condensation on the free surface of water in the horizontal portion of
** the cold leg. If a value of 0 is entered no condensation is modeled.
** This is what was assumed in earlier versions of MAAP. If a value of 1
** is entered, which is the best-estimate value, the amount of condensation
** will be the smaller of that computed by a simple Reynold's analogy model
** and that which would saturate the film of water flowing through this
** portion of the cold leg. FCDDC values between 0 and 1 will limit the
** condensation to that which will increase the enthalpy by a fraction
** FCDDC of the total subcooling. Depending on the injection flow rate,
** this parameter can affect the depressurization rate of the primary
** system. Users may want to use a value less than 1 when hydrogen is
** being generated because this reduces the potential for condensation.
**
** Used in subroutine DCCOND.
** Use in MAAP4 = use in MAAP3B.
**
** ======================================================================
FHTPRI 1.0 // Dimensionless
** Min = 0 Max = 2
**
** FHTPRI is the multiplier for the primary side condensation heat transfer
** coefficient during reflux cooling.
**
** Used in subroutine HTCNV.
** Use in MAAP4 similar to use in MAAP3B PWR.
**
** ======================================================================
FROUPZ 0.4 // Dimensionless
** Min = 0.3 Max = 0.8
**
** @@@ 4.0.3 BJS 11/15/95 - Changed values for WICE plants from 0.2 to 0.4.
** The maximum value for sensitivity has been increased to be consistent
** with pressurizer drainage experiments.
**
** FROUPZ is the Froude number used for counter-current draining of the
** pressurizer through the surge line when no loop seal exists. A small
** value is to be used for sharp-edged configurations and a large value is

```
** to be used for smooth inlet configurations.
**
** Used in subroutine DRAIN.
** Use in MAAP4 = use in MAAP3B.
**
** ======================================================================
FHLCRE          0.0          // Dimensionless
** Min = 0.0  Max = 2.0
**
** @@@ 4.0.3 CYP 8/15/96 - Added FHLCRE for new hot leg creep rupture
** model options.
**
** FHLCRE is the flag that selects the model for the hot leg creep rupture
** calculations. Options 1 and 2 are intended for sensitivity analyses. Also,
** see the *Primary System parameter ICRPHL for the hot leg material
** specification. (Note that it is not necessary to set ICRPHL to 1 to
** specify that the hot leg is stainless steel in order to use options 1
** and 2.)
**
**  = 0  Use original model that uses the average hot leg temperature,
**       and does not explicitely assess the potential for the nozzle to
**       rupture.
**
**  = 1  Use the subnodal physics model. This model calculates creep in
**       the carbon steel nozzle and in the stainless steel hot leg.
**
**         It is assumed that the axial temperature gradient in the hot
**         leg itself is similar to the temperature gradient in the gas
**         flowing through the hot leg. The temperatures of the carbon
**         steel nozzle and the stainless steel hot leg that are used in
**         the creep calculations are as follows:
**
**           T       = T    + DELTAT
**            nozzle    avg.
**
**           T       = T    + 0.75*DELTAT
**            hot leg   avg.
**
**         where
**
**           T     = average hot leg temperature
**            avg.
**
**           DELTAT = (gas temperature drop calculated by subroutine
**                  HLNC) / 2.0
**
**  = 2  Use the subnodal physics model, but only calculate creep in the
**       the stainless steel hot leg.
**
**
** Used in subroutine PRISYS.
**
** ======================================================================
** ======================================================================
```

```
** CORE PARAMETERS
** --------------
**
** ======================================================================
** ======================================================================
**
** The parameters TEU and TEUBS are used when the eutectic model is
** disabled by setting *Control parameter IEUTEC to 1.  Otherwise, the code
** uses values in block data for the melting temperatures of each core
** constituent to calculate the eutectic properties.  Disabling the
** eutectic model and using TEU and TEUBS means that the representation of
** the core eutectic is roughly the same as in MAAP3B.  The core melt
** calculations are part of the HEATUP model.
**
.TEU         2500.0  K        // Units: [K,F]
** Min = 2100   Max = 2800
**
** TEU is the core node eutectic melting temperature.
**
** Data Source: IDCOR Report T85.2 - "Technical Support for Issue
** Resolution," 7/85.
**
** -------------------------------------------------------------------
TEUBS        1500.0  K        // Units: [K,F]
** Min = 300.0  Max = 2500.0
**
** TEUBS is the melting temperature for control blades and fuel cans.
**
** ======================================================================
FZRKB          0.5            // Dimensionless
** Min = 0  Max = 1
**
** @@@ 4.0.3 BJS 11/28/95 - Added FZRKB to the PWR parameter files because
** the core model is generalized.
**
** FZRKB is the fraction of the fuel cans that can be dissolved by control
** blades.  The value of 0.5 is based on the fact that half of each fuel
** can is adjacent to a control blade.
**
** Used in subroutine HEATUP.
** New for MAAP4.
**
** ======================================================================
FDISSO         1.0            // Dimensionless
** Min = 1  Max = 10
**
** FDISSO is the multiplier for the contact area between UO2 fuel and Zr
** cladding during dissolution to form a eutectic mixture.  Values greater
** than 1 can be used to account for the increase in the fuel surface area
** due to cracking of the fuel as it is heated.  This results in more
** dissolution, and hence more oxygen in the eutectic.  The leads to a
** higher melting temperature for the eutectic, which delays the onset of
** fuel relocation.
**
```

** Because there was a relatively large amount of dissolution in the PWR
** CORA experiments, a value of FDISSO of 5 was used for the benchmarking
** of the code with these experiments. The impact of the larger value was
** not significant. This is also true for station blackout sequences:
** there is no significant difference in the primary system behavior for
** values of FDISSO equal to 0, 1.0 and 10.
**
** (FDISSO is not used if the cladding is stainless steel.)
**
** Used in subroutine HEATUP.
** New for MAAP4.
**
** ======================================================================
FAOX 1.0 // Dimensionless
** Min = 1.0 Max = 2.0
**
** FAOX is the multiplier for the cladding outside surface area. It is
** used in oxidation calculations to account for steam ingression after
** cladding rupture. Oxidation is calculated once the core is uncovered.
** The use of FAOX is controlled by the value of TDOOXI. This is
** discussed below.
**
** @@@ 4.0.3 BJS 11/16/95 - Previous parameter files indicated that the
** value must be between 1 and 2. Values greater than 2 are allowed. They
** may be used for sensitivity calculations to represent significant
** cracking during reflooding, as was done in the TMI-2 benchmark when the
** value was increased from 2 to 5. FAI plans to redo the TMI-2 benchmark
** with Rev. 4.0.4. The impact and best-estimate value of FAOX will be
** evaluated as part of that effort.
**
** Used in subroutines HEATUP & ROW.
** Use in MAAP4 = use in MAAP3B PWR.
**
** ======================================================================
TDOOXI 0.0 K // Units: [K,F]
** Min = -3000 Max = 3000
**
** @@@ 4.0.2 CYP 9/8/95 - Added TDOOXI to the code and the parameter files.
**
** TDOOXI selects the option for how the cladding oxidation surface area
** will increase.
**
** =0: The oxidation area will be increased by FAOX after the cladding
** has ruptured (IRUPCL(IJ)=1) or after the core node has collapsed.
**
** >0: The oxidation area will be increased by FAOX only after the core
** node temperature exceeds TDOOXI.
**
** <0: The oxidation area will be increased by FAOX only after any core
** node temperature for a given channel exceeds ABS(TDOOXI). This
** option is similar to the model in MAAP 3B.
**
** Used in subroutine HEATUP.
** New for MAAP4.

**
** ======================================================================
FEMBRT 0.75 // Dimensionless
** Min = 0 Max = 1
**
** @@@ 4.0.3 BJS 12/4/95 - Changed the value from 0.1 to 0.75 per the TMI-2
** benchmark.
**
** FEMBRT is the fraction of the total zircalloy (cladding, guide
** tubes/water rods, and fuel cans) that has oxidized that is sufficient to
** cause core collapse on reflood. This condition is used along with
** conditions regarding a minimum core water level and heat transfer from
** the core to the water. If all three conditions are met the core will
** collapse on reflood, and a smaller Kutateladze number will be used to
** determine if water can be entrained by gas. That is, *Model parameter
** FCRHY will be used rather than FFLOOD. These Kutateladze numbers are
** discussed below. FEMBRT does not apply if there is stainless steel
** cladding.
**
** Used in subroutine GENEVT (BWR) and EVENTS (PWR)
** Use in MAAP4 = use in MAAP3B PWR.
**
** ======================================================================
FXEGAP 0.05 // Dimensionless
** Min = 0 Max = 0.25
**
** FXEGAP is the fraction of the xenon inventory in the pellet-cladding gap
** due to long-term operation. Often called the "gap release", FXEGAP is
** used to calculate the pressure inside the fuel pin for ballooning
** calculations and for prompt release of fission products when the
** cladding ruptures.
**
** Used in subroutines HEATFP, STRETH.
** Use in MAAP4 = use in MAAP3B PWR.
**
** ======================================================================
FPEEL 0.0 // Dimensionless
** Min = 0.0 Max = 1.0
**
** @@@4.0.3 BJS 9/19/95 - Added FPEEL to the PWR parameter files.
**
** FPEEL is the fraction of the ZrO2 layer peeled off during reflooding.
** Steam generated during relooding may mechanically knock off portions of
** the oxidized Zr, exposing unoxidized material which can subsequently
** oxidize. This parameter should be set to 0 at the beginning of a
** sequence, and then changed to the desired value via a local parameter
** change when reflooding occurs. Note that for additional oxidation to
** be calculated *Control parameter IAOXP must be set to 0. IF IAOXP is
** not 0 the calculation will be bypassed.
**
** Used in subroutine HEATUP.
** New for MAAP4.
**
** ======================================================================

```
FVISC          1.0          // Dimensionless
** Min = 0.1    Max = 1000.0
**
** FVISC is the multiplier for material viscosity used in the candling
** calculations.
**
** Used in subroutine MOVECR.
** New for MAAP4.
**
** ===========================================================================
TCLMAX        2500.0  K        // Units: [K,F]
** Min = 100  Max = 3000
**
** @@@ 4.0.1 CYP -- A time-at-temperature dependence was added to the
** cladding rupture calculations to eliminate sudden threshold switches due
** to a single temperature criterion for rupture.
**
** TCLMAX is used to calculate when the cladding ruptures.  A Larson-Miller-
** like approach (material creep model) is used to calculate cladding rupture.
** TCLMAX is the temperature that will lead to rupture if the cladding is at
** this temperature for 36 seconds (0.01 hr).  A Larson-Miller parameter is
** calculated from TCLMAX.  This Larson-Miller parameter is then used to
** calculate a cumulative damage fraction.
**
** If the cladding is Zr it will rupture when the cumulative damage
** fraction exceeds 1 provided that the oxide fraction is less than a value
** determined by *Model parameter FZORUP.  See the description of FZORUP.
** If the cladding is stainless steel the only criterion for rupture is that
** the cumulative damage fraction exceed 1.  Rupture is calculated on an
** individual core node basis.  Once the cladding has ruptured the melt can
** flow outside of the cladding and fission products can be released.
**
** Used in subroutines HEATUP, MOVECR, RLOCCL and RLOCU2.
** Use has changed since MAAP 3B.
**
** ===========================================================================
FZORUP        0.675          // Dimensionless
** Min = 0.0   Max = 1.0
**
** @@@ 4.0.1 CYP -- The use of FZORUP was modified in Rev. 4.0.1.  The
** fraction of Zr that must be oxidized to prevent the cladding from
** rupturing is now a function of temperature.  If the cladding in a node
** is at TCLMAX the fraction is FZORUP, as before.  As the temperature
** increases to TZOMP, the melting point, the required fraction increases
** to 100%.
**
** FZORUP is the minimum fraction of Zr that must be oxidized to keep the
** cladding intact if the cladding is at TCLMAX.  The minimum fraction
** increases to 100% as the cladding temperature increases to TZOMP, the
** melting point.  The increase in the fraction represents the fact that
** the oxide layer strength decreases as its temperature increases.  The
** ZrO2 mass has to be less than the original Zr mass times the fraction
** derived from the temperature and FZROUP.  The value of 0.675 represents
** 50% of Zr oxidation (0.5 *(92+32)/92).
```

```
**
** The cladding will rupture if the fraction of Zr that has oxidized is
** less than that calculated with FZORUP and TCLMAX and if the cumulative
** damage fraction is greater than 1. See the description of TCLMAX.
**
** A value of FZORUP of 0.3 was used in the TMI-2 benchmarking runs with
** MAAP4.0 and 4.0.2 to keep the core intact longer. FAI plans to redo the
** TMI-2 benchmark. The impact and best-estimate value will be evaluated as
** part of that effort.
**
** FZROUP is not used for stainless steel cladding.
**
** Used in subroutines HEATUP, RLOCCL and RLOCU2.
** New for MAAP4.
**
** ==========================================================================
TCLRUP        1000.0 K        // Units: [K,F]
** Min = 1000.0  Max = 2300.0
**
** @@@ 4.0.3 BJS 12/4/95 - Changed the nominal value from 1200 K to 1000 K
** based on TMI-2 benchmark.
**
** TCLRUP is the temperature at which cladding fails if it hasn't already
** ruptured. This halts further ballooning and allows fission product
** release. In the PHEBUS FPT0 experiment it was observed that fission
** product release started when the cladding temperature reached about
** 1000 K.
**
** Used in subroutines STRETH and FOMS.
** New for MAAP4.
**
** ==========================================================================
** Larson-Miller Parameters for Core Node Collapse Criteria
** ------------------------------------------------------
**
** Model parameters are used in a Larson-Miller-like approach (material
** creep model) to calculate core node collapse. When a node "collapses"
** its geometry type changes from IGTYP=1 to IGTYP=2. The model accounts
** for the time-at-temperature dependence of node collapse. This reduces
** the impact of thresholds on the calculations, thereby improving the
** code's numerical performance. The code calculates damage fractions
** using the following Larson-Miller parameters. A value of 50 for a
** Larson-Miller parameter means that fuel rods at 2500K would collapse 1
** hour after being at this temperature. The larger the value of the
** parameter the longer it will take for the rod to collapse at a given
** temperature. Similarly, the larger the value of the parameter the
** higher the temperature the rod can be at without collapsing within a
** given time. Hence, larger values of the parameter lead to potentially
** greater oxidation because the rods keep their original geometry longer.
** Due to the logarithmic term in the model, there is a substantial
** variation in rupture time for a small variation in temperature for a
** fixed value of the parameter. The dependence of the failure time and
** temperature on the parameter is shown in the following table:
**
```

```
**              t(sec) if     T(K)
**      LMCOL       T=2500K      if t=1hr
**      ------------------------------------
**      46.          90.          2300.
**      48.          571.         2400.
**      50.          3600.        2500.
**      52.          22714.       2600.
**      54.          143319.      2700.
**
** t - time to fuel rod collapse.
** T - temperature which will cause failure.
**
** For a further discussion of core collapse see the descriptions of
** subroutines HEATUP and MOVECR in the MAAP4 User's Manual.  These
** parameters are new for MAAP4.
**
** -------------------------------------------------------------------
LMCOL0        50.0          // Dimensionless
** Min = 48.0   Max = 54.0
**
** LMCOL0 is the collapse criteria parameter for a Larson-Miller-like
** functional dependence when no core node surrounding the particular core
** node has collapsed.
**
** -------------------------------------------------------------------
LMCOL1        50.0          // Dimensionless
** Min = 48.0   Max = 54.0
**
** LMCOL1 is the collapse criteria parameter for a Larson-Miller-like
** functional dependence for a core node below a collapsed core node.
**
** -------------------------------------------------------------------
LMCOL2        50.0          // Dimensionless
** Min = 48.0   Max = 54.0
**
** LMCOL2 is the collapse criteria parameter for a Larson-Miller-like
** functional dependence for a core node next to an empty core node.
**
** -------------------------------------------------------------------
LMCOL3        50.0          // Dimensionless
** Min = 48.0   Max = 54.0
**
** LMCOL3 is the collapse criteria parameter for a Larson-Miller-like
** functional dependence for a core node surrounded by empty core nodes.
**
** ========================================================================
VFCRCO        0.35          // Dimensionless
** Min = .05  Max = .5
**
** VFCRCO is the porosity of a collapsed core region.
**
** @@@ 4.0.1 CYP 11/30/94  - The previous value of 0.25 was too small.
** The value was increased to be consistent with the value used in the TMI
** benchmark.
```

```
**
** Used in subroutines HEATUP and the relocation subroutines (RLOC**).
** Use in MAAP4 = use in MAAP3B.
**
** ===========================================================================
** The calculation of in-core molten pool crust failure uses an integral
** failure criterion based on a Larson-Miller-like functional dependence to
** represent the strength of the crust. The rupture criterion Larson-
** Miller parameter, L-M, for bending of the crust is a function of LMU2A
** and LMU2B:
**
**    L-M parameter = (LMU2A - ln(A))/LMU2B, where A is the bending stress.
**
** The calculations are done in subroutine MOVECR. See the discussion above
** regarding the Larson-Miller-like approach.
**
** -------------------------------------------------------------------
LMU2A        19.80        // Dimensionless
** Min = 15.0     Max = 25.0
**
** LMU2A is used to calculate the L-M parameter. The nominal value of
** 19.80 was determined based on the tensile strength and rupture strength
** of UO2 at room temperature and observations from TMI-2 data. It is
** suggested that this value be kept constant.
**
** -------------------------------------------------------------------
LMU2B        0.083        // Dimensionless
** Min = 0.04     Max = 0.16
**
** LMU2B is used to calculate the L-M parameter. Large values of LMU2B
** make the L-M parameter small for a given stress level, which leads to
** lower rupture times and temperatures.
**
** ===========================================================================
FSGBEN       0.75         // Dimensionless
** Min = 1.0E-2  Max = 10
**
** @@@ 4.0.3 SMD 1/24/96 -- FSGBEN was added to the code and the parameter
** files.
**
** FSGBEN is the multiplier used in the sideward crust bending stress
** calculation. This bending stress is then used in evaluating the
** failure of the side crust. Larger values of FSGBEN will give a larger
** bending stress and an earlier failure of the side crust.
**
** Used in subroutine MOVECR.
**
** ===========================================================================
** The following parameters are used in the calculations of debris crust
** dynamics in the RPV lower head. They are the minimum and maximum
** allowable thicknesses that the crusts may grow to. They are primarily
** used to set a reasonable crust thickness for the assumed parabolic
** temperature profile and heat transfer calculations. A maximum of 10 cm
** is recommended except when the growth would be limited by geometry
```

```
** constraints such as the gap between CRD housings in BWR lower heads.   A
** value of 1/2 the gap should then be used.
**
** The parameters are used in subroutine DBXST.  XXPSMN is also used in
** subroutines DBPEB and LPDEB.  They are new for MAAP4.
**
** @@@ 4.0.3 BJS 2/29/95 - Added the XXPSM* parameters to the parameter
** files.
**
** ---------------------------------------------------------------------
XXPSMN        0.001  M        // Units: [M,FT]
** Min = 0.001   Max = 0.005
**
** XXPSMN is the minimum lower crust thickness.
**
** ---------------------------------------------------------------------
XXPSML        0.1  M          // Units: [M,FT]
** Min = 0.01  Max = 0.5
**
** XXPSML is the maximum lower crust thickness.
**
** ---------------------------------------------------------------------
XXPSMU        0.1  M          // Units: [M,FT]
** Min = 0.01  Max = 0.5
**
** XXPSMU is the maximum upper crust thickness.
**
** ---------------------------------------------------------------------
XXPSME      0.03421  M        // Units: [M,FT]
** Min = 0.01   Max = 0.5
**
** XXPSME is the maximum embedded crust thickness.
**
** ======================================================================
XLFALS        0.03  M         // Units: [M,FT]
** Min = 0.01  Max = 10.0
**
** @@@ 4.0.3 BJS 12/22/95 - Corrected definition of XLFALS.  It is the
** width, not the perimeter of the opening.
**
** XLAFLS is the width of the failure opening when the in-core molten pool
** side crust has failed such that sideward relocation to the lower head
** is possible.
**
** Used in the relocation subroutines (RLOC**).
** New for MAAP4.
**
** ======================================================================
FMOVE         1.0             // Dimensionless
** Min = 1  Max = 5
**
** @@@ 4.0.2 CDW 7/12/95 - FMOVE was slightly redefined.
**
** FMOVE controls the relocation of solid U-Zr-O material embedded in
```

** liquid U-Zr-O. It affects the composition of molten pools and the
** debris in the lower head. If FMOVE is set to 1.0 no solid material
** is embedded. If FMOVE is greater than 1.0 (FMOVE-1.0) kg of solid
** material is embedded in every kg of liquid material.
**
** Used in subroutine TCLAD.
** New for MAAP4.
**
** ==========================================================================
TSPFAL 1650.0 K // Units: [K,F]
** Min = 1000.0 Max = 3113.0
**
** TSPFAL is the core support plate failure temperature. This temperature
** is used to calculate the Larson-Miller (L-M) parameter for failure. The
** value of the L-M parameter is calculated in the code such that the
** support plate will fail at the temperature TSPFAL in 0.01 hr.
**
** Used in subroutine HEATUP.
** New for MAAP4.
**
** ==========================================================================
ASPFAL 0.1 M**2 // Units: [M**2,FT**2]
** Min = 0.01 Max = 1.0
**
** ASPFAL is the cross-sectional area used to calculate drainage of corium
** when the support plate fails. The area is per radial ring (channel).
**
** Used in the relocation subroutines (RLOC**).
** New for MAAP4.
**
** ==========================================================================
XDJETO 0.1 M // Units: [M,FT]
** Min = 0.01 Max = 1.0
**
** XDJETO is the initial diameter of a corium jet when it hits the water
** surface in the vessel lower plenum. It affects jet breakup,
** particulation and quenching.
**
** Used in subroutine DBJET.
** New for MAAP4.
**
** ==========================================================================
ENT0 0.05 // Dimensionless
** Min = 0.01 Max = 0.14
**
** @@@ 4.0.3 BJS 12/4/95 - Changed the nominal values for BWR and PWR
** parameter files from 0.09. See the following discussion.
**
** ENT0 is the jet entrainment coefficient for the Ricou-Spalding correla-
** tion. It is used to calculate the particulation of a corium jet
** entering a water pool in both the RPV lower plenum and the containment.
** ENT0 is used to determine how large a fraction of the molten jet from
** the core will be entrained and become particulated as it pours through
** the water pool in the lower plenum. The state of the debris bed in the

** lower head -- mostly particulated or mostly molten (continuous bed) --
** will determine whether the debris bed is quenchable or not.
**
** Because of CRD guide tubes in the BWR lower plenum not as much
** entrainment would be expected as in a PWR. The debris would enter the
** lower plenum in the region between the guide tubes. With the limited
** area available between the guide tubes, the potential for interaction of
** the molten stream with water would be limited. Hence, the nominal
** values for ENT0 for BWRs is now set to 0.01 to reflect the reduced
** potential for entrainment.
**
** The value of 0.05 was found to give the best temperature response in the
** MAAP4.0.2 TMI-2 benchmark. Experiments give a range of 0.03 to 0.14.
** Users may want to vary ENT0 to determine the impact of this parameter
** in terms of uncertainty.
**
** Used in subroutine DBJET.
** New for MAAP4.
**
** ==========================================================================
FDDP 1.0 // Dimensionless
** Min = 1.e-3 Max = 1.0
**
** FDDP is the multiplier for the calculated diameter of particulated
** debris from jets entering water pools. The surface area calculated
** from the diameter affects quenching and oxidation.
**
** Used in subroutine DBJET.
** New for MAAP4.
**
** ==========================================================================
FOXBJ 1.0 // Dimensionless
** Min = 0.0 Max = 1.0
**
** FOXBJ is the multiplier for the particulated debris oxidation reaction
** fraction. This fraction is calculated using a correlation for the
** Baker-Just model for debris oxidation. Particulate oxidation is
** calculated for debris jets that break up in water pools in both the
** vessel and the containment. A value of FOXBJ less than one reduces the
** amount of debris that is oxidized.
**
** Used in subroutine DBJET.
** New for MAAP4.
**
** ==========================================================================
VFENT 0.25 // Dimensionless
** Min = 0.0 Max = 1.0
**
** VFENT is the void fraction of steam in the debris jet entrainment
** interaction zone. Increasing VFENT increases the net steam generation
** during quenching.
**
** Used in subroutine DBJET.
** New for MAAP4.

```
**
** ==================================================================
EPSPB         0.4          // Dimensionless
** Min = 0.26     Max = 0.53
**
** EPSPB is the assumed porosity of the particulate debris bed in the vessel
** lower head.
**
** Used in subroutines LPBED, DBBED, DBPEB and MOVECR.
** New for MAAP4.
**
** ==================================================================
** ==================================================================
** CORE SPRAY AND UPPER HEAD INJECTION
** ---------------------------------
**
** ==================================================================
** ==================================================================
FOVER         0.0          // Dimensionless
** Min = 0.0   Max = 1.0
** Typical BWR range is 0-0.6
**
** FOVER is the fraction of the core spray (BWR) or upper head injection
** (PWR) that goes into the core bypass flow area and consequently into the
** lower plenum.  The spray/injection that bypasses the core is potentially
** available for bottom-up quenching, while that sprayed/injected into the
** core does top-down quenching.  The fraction is a function of the core
** design.
**
**     If FOVER=0 then all spray/injection is to the core.
**     If FOVER=1 then all spray/injection is to the bypass region.
**
** Used in subroutine HEATUP.
** Replaces PWR event code 201 in MAAP 3B (now can have a fractional split
** for UHI).
**
** ==================================================================
** ==================================================================
** LOWER HEAD AND VESSEL FAILURE PARAMETERS
** --------------------------------------
**
** ==================================================================
** ==================================================================
FOPTLH        0.0          // Dimensionless
** Min = 0   Max = 2
**
** @@@ 4.0.2 CYP 5/15/95 - FOPTLH is new in the code and the parameter
** files.
**
** FOPTLH is the flag for the lower head debris bed model option:
**
**  = 0 - model continuous bed + metal layer + particle bed.
**
**  = 1 - model continuous bed + particle bed only (no steel layer - steel
```

```
**       is part of the continous bed).
**
**  = 2 - model one mixed pool (continuous bed only, with no metal
**       layer and no particle bed).  This is the same as the MAAP 3B
**       approach.
**
** The selected option will have a small impact on the vessel failure time.
** The parameter was added to allow users to study the uncertainties
** associated with the debris bed configuration.
**
** Used in subroutines BWRVSL (BWR) and PRISYS (PWR).
** New for MAAP4.
**
** ======================================================================
** @@@ 4.0.2 CDW 5/17/95 - Added XROF0/XROF1 to the parameter files.  They
** are used in subroutine RVFLMK, the vessel failure model, and are new for
** MAAP4.
**
XROF0          0.01  M        // Units: [M,FT]
** Min = 0.005   Max = 0.250
**
** XROF0 is the initial radius of the primary vessel failure opening.  The
** primary failure opening can be in any of the five nodes of the lower
** head.  The location, i.e., which of the five nodes, is determined by
** the code as part of the failure calculations.  Failure is usually due to
** attack of stainless steel or material creep.
**
** ----------------------------------------------------------------------
XROF1          0.1  M         // Units: [M,FT]
** Min = 0.05  max = 0.5
**
** XROF1 is the initial radius of the secondary vessel failure opening.  If
** the primary failure is not in the lowest node of the lower head, node 1,
** the code will determine if and when the lowest node does fail as it
** continues to be heated by debris that remains in the lower head.  Note:
** if the primary failure is in node 1 the time of primary and secondary
** failure in the figures-of-merit, included in the log and tabular output
** files, will be the same.
**
** ======================================================================
FDAMLH         0.4            // Dimensionless
** Min = 0   Max = 1
**
** FDAMLH is the lower head node damage fraction for failure.  If a vessel
** lower head node other than the bottom node fails due to creep, the
** damage fractions for nodes below the failed node are examined.  If the
** integrated damage fraction exceeds FDAMLH those lower nodes also fail.
** This comparison is made only at the time when the initial node fails.
** This feature was added in Rev. 4.0.1 to improve numerical performance.
**
** Used in subroutine FDAMLH.
** New for MAAP4.
**
** ======================================================================
```

NVP 1.0 // Dimensionless
** Min = 1 Max = 10
**
** NVP is the number of reactor vessel penetrations that initially fail due
** to corium attack, and hence are the number of corium jets that impact
** the containment floor. In general, specifying a value of 1.0 for this
** parameter is adequate given that continuing vessel wall ablation expands
** the initial penetration failure radius, eventually representing more
** than one penetration. However, a value of 1.0 may not be conservative
** for all accident sequences or vessel internal geometries. For sequences
** where this is a concern, the value may be adjusted via a local parameter
** change in the input file.
**
** Used in subroutine JET.
** Use in MAAP4 = use of NVP in MAAP3B PWR.
**
** ======================================================================
FCRDR 0.1 // Dimensionless
** Min = 0 Max = 1
**
** FCRDR is the fraction of the original core mass below which the remaining
** core is dumped into the lower head plenum. The core melt progression
** modeling tends to result in a small fraction of the core being held
** indefinitely in the original core boundaries, with heat being removed
** convectively and radiatively to the rest of the primary system. This is
** reasonable. However, the model's ability to correctly compute heat
** transfer and gas flow areas is limited under these conditions. Users will
** find it advantageous to dump out the remaining core at this point, if for
** no other reason than to expedite MAAP calculations.
**
** For sequences in which a part of the core material remains in the original
** core boundary long after vessel failure, it is suggested that this value
** be increased to determine the sensitivity to long term fission product
** revaporization.
**
** Used in subroutine HEATUP.
** Use in MAAP4 = use in MAAP3B (parameter called FMAXCP in BWR 3B).
**
** ======================================================================
** ======================================================================
** IN-VESSEL COOLING
** ----------------
**
** MAAP models the potential for core debris to be cooled within the
** reactor vessel lower head if the debris is submerged in water.
** Experiments and evidence from TMI-2 indicate that when molten debris
** falls into the lower head it does not adhere to the wall. Instead, a
** gap is formed. Water in the gap can serve to transfer heat from both
** the vessel wall and the debris, with the principal benefit being the
** cooling of the lower head wall. The description of subroutine DBBED in
** the MAAP4 User's Manual contains a discussion of this cooling mechanism.
**
** The model parameters that affect in-vessel cooling are XGAPLH, FHTGAP,
** FQUEN and ECREPF. These parameters were investigated as part of the

** NUPEC/FAI uncertainty study, and the results are summarized in the
** individual parameter descriptions. The model is activated when *Control
** parameter IGCHF is set to 1. All of these parameters are used in
** subroutine DBBED, and are new for MAAP4.
**
** @@@ 4.0.3 CEH 2/14/96 - XGAP0 is a new model parameter.
** Model parameter XGAP0 is similar in usage to XGAPLH. In the same manner
** that XGAPLH pertains to heat transfer between relocated core debris and
** the lower head wall, so XGAP0 pertains to heat transfer between
** relocated core debris and the inner wall of penetrations into the lower
** head, such as instrument tubes, control rod drive assemblies (BWR), and
** primary system piping (BWR drain lines). This model parameter is used
** in subroutine CRUST.
**
** ==================================================================
** ==================================================================
XGAPLH 10.e-6 M // Units: [M,FT]
** Min = 1.e-6 Max = 300.e-6
**
** @@@ 4.0.3 BJS 11/17/95 - The nominal value of XGAPLH was changed from
** 100 microns to 10 microns based on the TMI-2 benchmarking results.
**
** XGAPLH is the initial size of the gap between the debris and the lower
** head steel wall. This gap is expected to open up as the lower head
** wall is heated and limited material creep occurs. Once the gap is
** created, water can ingress and energy can be removed due to boiling in
** the gap.
**
** An initial gap size on the order of 100 microns is supported by
** experiment. Generally, this size gap is sufficient to prevent the wall
** from over-heating, and a safe stable state is reached. Initial gaps on
** the order of 10 microns or less are not sufficient. However, as the
** wall overheats it expands, increasing the gap to the point where it is
** sufficient. The size of the gap needed to provide effective cooling is
** very small compared to the vessel strain required to fail the lower
** head. The initial gap size does not significantly influence conditions
** in the vessel.
**
** ==================================================================
FHTGAP 1.0 // Dimensionless
** Min = 0.0 Max = 1.0
**
** @@@ 4.0.2 SMD 7/31/95 -- FHTGAP was added to the code and the parameter
** files.
**
** FHTGAP is the heat transfer effectiveness in the crust/lower head wall
** gap. This parameter multiplies the heat flux from the debris to the gap
** calculated with the Monde critical heat flux correlation. It is used to
** reduce the efficiency of cooling in the gap.
**
** With reduced heat transfer a somewhat larger RPV strain is calculated,
** but the wall is eventually cooled and a safe stable state develops. The
** efficiency of the cooling process does not have a significant influence
** on the overall conditions in the vessel.

```
**
** ======================================================================
FQUEN        0.2        // Dimensionless
** Min = 0  Max = 1
**
** @@@ 4.0.3 BJS 12/22/95 - Changed the value of FQUEN from 0 or 1 to a
** realistic nominal value of 0.2. This is an intermediate value between
** the experimentally-determined lower limit and values that would likely
** lead to full quenching.
**
** @@@ 4.0.3 SMD 4/3/96 -- FQUEN description was revised to reflect changes
** in subroutine DBBED which replaced the model parameter FCHF with a static
** value of 0.1. This removes the influence of FCHF on conditions in-vessel
** while still allowing the user to investigate in-vessel debris heat transfer
** uncertainties using FQUEN.
**
** FQUEN is the multiplier to the flat plate critical heat flux for
** lower head debris bed quenching by overlying water. A value of 0 means
** that the metal layer is impermeable to water. In this case, heat is only
** transferred to the water by convection or conduction at the metal
** surface. A value of 1 means that water can ingress into the metal layer
** and quench it at a rate controlled by the critical heat flux. This is in
** addition to the convection/conduction heat transfer at the surface.
** Adjusting the value of FQUEN can be used to investigate the uncertainty
** associated with the ingression of water into the debris.
**
** With values of FQUEN on the order of 0.036 (an experimentally-determined
** lower limit) the core debris (at typical decay heat levels) would not be
** fully quenched by an overlying water pool. For values on the order of
** 0.36 and higher, it would likely be fully quenched. If the debris is
** not quenched by water ingression and if gap cooling is neglected vessel
** failure will likely occur. On the other hand, gap cooling is an
** effective mechanism regardless of the amount of cooling due to water
** ingression.
**
** Used in subroutines LPDEB and DBBED.
** New for MAAP4.
**
** ======================================================================
ECREPF       0.2        // Dimensionless
** Min = 0.0    Max = 1.0
**
** ECREPF is the at strain failure for vessel ductile material. There is a
** substantial uncertainty associated with the strain. However, as
** determined by the uncertainty analysis, increasing or decreasing ECREPF
** by a factor of ten does not have a significant influence on the overall
** lower head wall cooling process. This is due to the stabilizing
** feedback between the creep rate and the wall temperature. Specifically,
** if the creep rate is not large enough to provide a cooling path the wall
** becomes hotter, which increases the growth rate until there is
** sufficient cooling if water is available in the lower plenum. If water
** is not available, the vessel will strain and fail regardless of the
** value of ECREPF.
**
```

** Lower head failure modes were also investigated in the uncertainty
** analysis. It was observed that failure due to creep rupture is more
** likely than failure of penetration welds. The value of ECREPF did not
** significantly change the conditions in the primary system or the time
** of vessel failure.
**
** ======================================================================
XGAPPB 0.001 M // Units: [M,FT]
** Min = 0.001 Max = 0.05
**
** @@@ 4.0.3 BJS 12/22/95 - Changed the value of XGAPPB from 0.0002 to
** 0.001, which is a more realistic lower limit.
**
** XGAPPB is the minimum allowable thermal gap between the particle bed and
** its surroundings: upper crust, metal layer, lower head and lower plenum
** structures. Without this constraining parameter, the calculated heat
** flux could be unrealistically high.
**
** Used in subroutine DBPED, DBBED
** New for MAAP4.
**
** ======================================================================
XGAP0 100.e-6 M // Units: [M,FT]
** Min = 1.e-6 Max = 300.e-6
**
** @@@ 4.0.3 CEH 2/14/96 - XGAP0 is a new model parameter.
**
** XGAP0 is the initial size of the gap between the debris and the inner
** surface of penetrations in the lower head. Experiments performed at FAI
** (see Reference [1] below) have shown that if water is present within the
** penetration at the time of debris relocation into the penetration, the
** noted gap will be formed by vaporization of water embedded in
** micro-scale cavities on the inner surface of the penetration wall. The
** presumption of pre-existing water is justified by the fact that water
** should reside in these penetrations (even in the case of a so-called
** "dry" lower head) unless the penetration itself is the site of a primary
** system break, which would render this issue moot.
**
** The experiments support a nominal initial gap of 100 microns with a
** nominal range of 1-300 microns. If the initial gap itself is not
** sufficient to prevent wall overheating, the wall will strain due to
** creep (at elevated pressure) as its temperature increases, thus
** increasing the gap size and mitigating the heat transfer contributing to
** the overheat. Consult subroutine CRUST and its associated description
** in the MAAP4 User's Manual for details.
**
** PWR penetrations include instrument guide tubes. Consult the *PRIMARY
** SYSTEM parameter section for parametric details regarding penetration
** specifications.
**
** References:
**
** 1. "Experiments to Address Lower Plenum Response Under Severe Accident
** Conditions", Volume 1: Technical Report, EPRI TR-103389-V1,

```
**     Project 3130-02, Final Report, April 1994.
**
** ======================================================================
FEMISD       0.80e0          // Dimensionless
** Min = 0.E0   Max = 1.E0
**
** @@@ 4.0.3 SMD 8/7/96 - FEMISD is a new model parameter.
**
** FEMISD is the emissivity for debris that is within RPV lower head
** penetrations.  It is used in models such as subroutine CRUST, which
** predicts the pentration's thermal response to the introduction of molten
** debris and its subsequent potential for creep rupture.  Specifically,
** CRUST uses FEMISD in the calculation of radiation heat flux between the
** debris crust and the penetration wall.
**
** ======================================================================
FEMISP       0.79e0          // Dimensionless
** Min = 0.E0   Max = 1.E0
**
** @@@ 4.0.3 SMD 8/7/96 - FEMISP is a new model parameter.
**
** FEMISP is the emissivity for the RPV lower head penetrations.  It is
** used in models such as subroutine CRUST, which predicts the pentration's
** thermal response to the introduction of molten debris and its subsequent
** potential for creep rupture.  Specifically, CRUST uses FEMISP in the
** calculation of radiation heat flux between the debris crust and the
** penetration wall.  FEMISP is also used in the radiation heat flux
** between the penetration wall and the surrounding containment atmosphere.
**
** Currently, CRUST uses FEMISP for all PWR penetration types.  PWR
** penetrations include instrument guide tubes.  Consult the *PRIMARY
** SYSTEM parameter section for parametric details regarding penetration
** specifications.
**
** ======================================================================
FRCOEF       0.005           // Dimensionless
** Min = 0.001   Max = 0.1
**
** FRCOEF is the corium friction coefficient used to calculate the
** convective heat transfer coefficient.  The heat transfer coefficient is
** used to calculate the ablation rate of the reactor vessel wall.  The
** heat transfer coefficient, H, is based on the Colburn-Reynolds analogy
** for a Prandtl number close to unity:
**
** H = (FRCOEF * RHOC * C * U ) / 2
**
** Where:  RHOC = corium density
**           C   = corium specific heat
**           U   = corium velocity through penetration
**
** Used in subroutine VFAIL.
** Use in MAAP4 = use in MAAP3B.
**
** ======================================================================
```

```
TDSTX          0.1  S        // Units: [S,HR]
** Min = 0.0  Max = 0.5
**
** TDSTX is the time delay after corium contacts the pedestal or cavity
** floor before a steam explosion is triggered.
**
** Used in subroutine EXVIN.
** Use in MAAP4 = use in MAAP3B.
**
** ======================================================================
** ======================================================================
** STEAM GENERATOR PARAMETERS
** ------------------------
**
** ======================================================================
** ======================================================================
FAOUT          0.3           // Dimensionless
** Min = 0.1  Max = 0.5
**
** @@@ 4.0.3 BJS 12/22/95 - Changed FAOUT from 0.2 to 0.3 to be consistent
** with other parameter files and MAAP 3B.
**
** FAOUT is the fraction of S/G tubes carrying "out" flow in the hot leg
** natural circulation model. See the description of subroutine HLNC in
** the MAAP4 User's Manual for more information about this model.
** Specifying a value of zero for FAOUT forces the flow off. This requires
** using the sensitivity analysis option for *Model parameter checking in
** the input file. The magnitude of this parameter does not affect B&W
** calculations unless it is set to zero to force the flow off.
**
** Used in subroutine HLNC.
** Use in MAAP4 = use in MAAP3B.
**
** ======================================================================
** @@@ 4.0.3 CYP 8/15/96 - See the new *Control parameters JNUTUB and
** JNBTUB which specify the tube nodes for the creep rupture calculations.
**
FERSGT         1             // Dimensionless
** Min = 0   Max = 1
**
** FERSGT is the ratio of the current steam generator hot tube thickness to
** its original thickness. The decrease would be due to erosion. This
** parameter is used for hot tube creep rupture calculations.
**
** Used in subroutine PRISYS.
** New for MAAP4.
**
** ======================================================================
FBVSGT         0.0           // Dimensionless
** Min = 0.0  Max = 100.0
**
** @@@ 4.0.3 CYP 8/15/96 - Added FERSGT for the new hot leg creep rupture
** model enhancement.
**
```

```
** FBVSGT is the bobbin voltage for the faulted tube. If this value is
** greater than 0 it is used to calculate the faulted tube thickness instead
** of parameter FERSGT. The tube thickness is correlated to the burst
** pressure and bobbin voltage as follows:
**
**   Burst pressure: PBUKSI = -1.37E0*LOG(FBVSGT)+7.85E0
**   Tube thickness: XTHT = XTSG * PBUKSI/11.E0
**      where STSG is the input parameter for the tube wall thickness
**
** See also *Control parameters JNUTUB and JNBTUB which specify the tube
** nodes for the creep rupture calculations.
**
** Used in subroutine PRISYS.
**
** ========================================================================
** ========================================================================
** FISSION PRODUCTS AND AEROSOL PROPERTIES
** -------------------------------------
**
** ========================================================================
** ========================================================================
**
FPRAT          -2.0            // Dimensionless
** Min = -6.0   Max = 6.0
**
** @@@ 4.0.3 CYP 7/1/96 - Added options 3, 4, 5, and 6. See the HEATFP
** and FPRELC subroutine descriptions for a discussion of the different
** models.
**
** FPRAT is the fission product release correlation and control parameter.
** The value is used to select the set of release correlations for fission
** products from the core:
**
**    +1 or -1: NUREG-0772 model for the volatile fission products, Kelly's
**          correlation for the non-volatiles.
**
**    +2 or -2: IDCOR/EPRI steam oxidation model (Cubiccioti model) for the
**          volatile fission products, Kelly's correlation for the
**          non-volatiles.
**
**    +3 or -3  CORSOR-M model
**
**    +4 or -4  CORSOR-O model.
**
**    +5 or -5  ORNL-BOOTH model.
**
**    +6 or -6  CORSOR-M model for noble gases and CsI and CsOH; CORSOR-O
**          model for the rest of the fission product groups.
**
** The sign is used to select the release limitations:
**
**    + sign: release rates defined by correlations.
**
**    - sign: releases further limited by saturation vapor pressure for the
```

```
**         non-volatile fission products and structural materials.
**
** In MAAP the fission products are distributed into 12 groups. See the
** *Fission Product section of this file.
**
**   The following groups are considered to be the volatile fission products.
**       1) Nobles
**       2) CsI + RbI
**       3) TeO2
**       6) CsOH + RbOH
**      11) Te2
**
**   The fission products in the remaining groups are less volatile and are
**   considered to be the non-volatiles.
**       4) SrO
**       5) MoO2
**       7) BaO
**       8) La2O3 + Pr2O3 + Nd2O3 + Sm2O3 + Y2O3
**       9) CeO2
**      10) Sb
**      12) UO2 + NpO2 + PuO2
**
** Note that Te is assumed to be released as Te2, which can then be oxidized
** to TeO2. Hence, the release rate for group 3 is zero for all the
** correlations. In addition, Te can bond with unoxidized Zr, which limits its
** release. This is accounted for in release options 1 and 3 with the *Model
** parameter FTENUR, in option 2 with the *Model parameter FTENUR and in
** options 4, 5 and 6 with the multipliers in the *Fission Product section
** (see below).
**
** MAAP does not calculate releases for the group 12 fission products.
**
** The CORSOR-M, CORSOR-O and ORNL-BOOTH correlations require additional
** input, which is contained in the *Fission Product section of this file.
**
**
** Data sources: See FPRELC subroutine description for references.
**
** Used in subroutines HEATFP, FPRELC and ROWFP.
** Use in MAAP4 = use in MAAP3B.
**
** ======================================================================
** @@@ 4.0.3 CYP 7/1/96 - Added new model parameters FPVMP and FPNVMP for
** fission product release inside of a molten pool in the core. Prior to
** 4.0.3 fission products could be released from all core nodes, including
** those that comprise a molten pool even though the pool is surrounded
** by crust nodes.
**
** FPVMP and FPNVMP are the fission product release flags for volatile and
** non-volatile fission products, respectively, that control whether the
** fission products are released inside of a molten pool in the core. A
** molten pool is defined as the set of nodes with molten material that are
** surrounded by crust nodes. The parameters are used in subroutine ROWFP.
**
```

```
**
FPVMP            1          // Dimensionless
** Min = 0  Max = 1
**
**  = 0 - no volatile fission product release in molten pool nodes
**
**  = 1 - allow volatile fission product release in molten pool nodes
**    (as was always the case in prior revisions)
**
** -----------------------------------------------------------------------
**
FPNVMP           0          // Dimensionless
** Min = 0  Max = 1
**
**  = 0 - no non-volatile fission product release in molten pool nodes
**
**  = 1 - allow non-volatile fission product release in molten pool nodes
**    (as was always the case in prior revisions)
**
** =======================================================================
FTEREL           0          // Dimensionless
** Min = 0  Max = 1
**
** FTEREL is the tellurium release flag.  Specify a value of 1 if tellurium
** is released in-vessel, or 0 if it is assumed to be totally bound up with
** Zircalloy.  0 is the best-estimate value.  FTEREL applies only to the
** releases calculated with the Cubicciotti correlation (*Model parameter
** FPRAT= +2 or -2).  Experimental evidence has shown that a significant
** amount of released Te tends to bind with unoxidized Zr.  This parameter
** should not be confused with model parameter FTENUR.
**
** Used in subroutine HEATFP.
** Use in MAAP4 = use in MAAP3B.
**
** =======================================================================
FTENUR           0.9        // Dimensionless
** Min = 0        Max = 1
**
** FTENUR is the oxidized mass fraction limit to bind Te with unoxidized
** Zr.  If the calculated oxidized Zr nodal mass fraction is less than
** this limit, the Te release rate is limited; otherwise the Te release
** rate is not, as recommended in NUREG-0956.  Experimental evidence has
** shown that a significant amount of released Te tends to bind with
** unoxidized Zr.  This parameter applies only to the releases calculated
** with the NUREG-0772 correlation (*Model parameter FPRAT= +1 or -1).
** This parameter should not be confused with model parameter FTEREL.
**
** Used in subroutine HEATFP.
** Use in MAAP4 = use in MAAP3B PWR (inverse of use in 3B BWR).
**
** =======================================================================
FFPREL           1.0        // Dimensionless
** Min = 0.01  Max = 1.0
**
```

** FFPREL is the multiplier for in-core fission product and inert aerosol
** release rates. It provides a means for testing the sensitivity of the
** results to release rates.
**
** Used in subroutines HEATFP and ROWFP.
** Use in MAAP4 = use in MAAP3B PWR (inverse of SCALFP in MAAP3B BWR).
**
** ==================================================================
FCSIVP 1.0 // Dimensionless
** Min = -100.0 Max = 100.0
**
** The absolute value of FCSIVP is a multiplier to the vapor pressures of
** CsI and CsOH for vapor/aerosol equilibrium. Absolute values less than
** 1.0 correspond to reactions that would cause a decrease in the vapor
** pressures (e.g., increased condensation into aerosols). Absolute values
** greater than 1 are not physically meaningful for CsI and CsOH. However,
** they allow users to indirectly simulate other iodine species that are
** more volatile.
**
** The sign of FCSIVP is used to select one of two CsOH vapor pressure
** correlations. If FCSIVP is positive, a correlation developed by Sandia
** is used. If FCSIVP is negative a correlation developed by ANL from the
** JANAF tables is used.
**
** Long term fission product release/retention in the primary system can
** be investigated by reducing FCSIVP to 0.1 and varying the vapor pressure
** multiplier for revaporization, FVPREV.
**
** Used in subroutine GROSSE.
** Use in MAAP4 = use in MAAP3B.
**
** ==================================================================
FVPREV 1.0 // Dimensionless
** Min = .01 Max = 2.0
**
** FVPREV is the multiplier to the vapor pressures of CsI and CsOH for
** revaporization calculations. It controls the vapor/surface equilibrium.
** A value less than 1.0 enhances condensation from the vapor state, and
** hence can be used to simulate chemical reactions between CsI and CsOH
** and structural materials. A value greater than 1.0 enhances
** revaporization. It is applicable in both the primary system and
** containment.
**
** Used in subroutine GROSSE.
** Use in MAAP4 = use in MAAP3B.
**
** ==================================================================
XRSEED 0.3e-6 M // Units: [M,FT]
** Min = 0.1e-6 Max=0.1e-5
**
** XRSEED is the initial seed radius for the hygroscopic aerosol growth
** calculation.
**
** Data Source: IDCOR Report T85.2 - "Technical Support for Issue

** Resolution," 7/85.
**
** Used in subroutines FPTRAN, HYGRO and VAPRDF.
** Use in MAAP4 = use in MAAP3B.
**
** ==========================================================================
FAERDC 8.0 // Dimensionless
** Min = 1 Max = 100
**
** @@@ 4.0.3 BJS 9/1/95 - Updated value of FAERDC from 3 to 8 to be
** consistent with FAI scoping calculations.
**
** FAERDC is the ratio of the existing airborne aerosol mass to the aerosol
** mass that would result in steady-state conditions (deposition rate =
** source rate). This ratio is used to control the selection of the decay
** or steady-state aerosol deposition correlations. The following example
** illustrates the use of FAERDC.
**
** a) From time = 0 to A: A compartment's aerosol environment is in
** steady-state, i.e., the rate at which aerosol mass enters the
** region equals the rate at which it falls out. The steady-state
** aerosol correlations are used.
**
** b) At time = A: The aerosol source strength is reduced, but not
** terminated.
**
** c) From time = A to B: The aerosol mass in the region is much
** larger than the equilibrium (steady-state) mass at the reduced
** source strength (M*). The decay aerosol correlations are then
** used.
**
** d) At time = B: The decaying aerosols begin to "feel the presence"
** of the reduced source strength. At this time, a combination of
** steady-state and decay correlations (transition) are utilized
** until the equilibrium mass is reached. This shift from the
** decay to transition correlations is determined by FAERDC, i.e.,
** when the airborne mass is smaller than the equilbrium mass (M*)
** times FAERDC, the transition correlations are used.
**
** See the MAAP4 User's Manual subroutine FPTRAN description for further
** discussions of the aerosol correlations.
**
** Used in subroutines FPTRAN, FPTRRB and GROUP.
** Use in MAAP4 = use in MAAP3B.
**
** ==========================================================================
GSHAPE 2.5 // Dimensionless
** Min = 1.0 Max = 10
**
** GSHAPE is the gamma shape factor to account for non-spherical shapes in
** the aerosol coagulation calculations.
**
** Data Source: M. Epstein, P. Ellison, R. Henry, "Correlation of Aerosol
** Sedimentation", Journal of Colloid and Interface Science, 10/86.

**
** Used in subroutines LAMIN, LAMG, ADJUST and AMDIST.
** Use in MAAP4 = use in MAAP3B.
**
** ===========================================================================

CSHAPE 1.0 // Dimensionless
** Min = 1.0 Max = 15.0
**
** CSHAPE is the chi shape factor to account for non-spherical shapes of
** the aerosols in Stokes' Law for gravitational settling.
**
** Data Source: M. Epstein, P. Ellison, R. Henry, "Correlation of Aerosol
** Sedimentation", Journal of Colloid and Interface Science, 10/86.
**
** Used in subroutines LAMIN, LAMG and LAMTH.
** Use in MAAP4 = use in MAAP3B.
**
** ===========================================================================

FE0 0.33 // Dimensionless
** Min = .33 Max = 1.0
**
** FE0 is the aerosol collision efficiency. This variable multiplies the
** gravitational coagulation term in the kinetic equation of aerosol
** coagulation and deposition. It is used in MAAP's inertial impaction and
** gravitational sedimentation aerosol removal rate functions. A value of
** .33 represents the Prupacher-Klett model, which is the currently favored
** model. At the other extreme, a value of 1 for this variable represents
** the Fuchs model, which may be preferred for certain aerosol-related
** sensitivity studies.
**
** Data Sources: 1) H.R. Prupacher & J.D. Klett, "Microphysics of Clouds
** and Precipitation," Reidel, Dordrecht, Holland (1980). 2) N.A. Fuchs,
** "The Mechanics of Aerosols," Permgamon, Oxford (1964).
**
** Used in functions LAMIN and LAMG.
** Use in MAAP4 = use in MAAP3B.
**
** ===========================================================================

FEFFDR 0.02 // Dimensionless
** Min = 0.01 Max = 0.05
**
** FEFFDR is the aerosol capture efficiency of containment sprays. This is
** the fraction of the total volume swept by the falling drops which is
** cleansed of aerosols.
**
** Used in subroutines FPTRAN, FPTRNP and FPTRRB
** Use in MAAP4 = use in MAAP3B.
**
** ===========================================================================

XRDB 0.01e-6 M // Units: [M,FT]
** Min = 0.01e-6 Max = 1.0e-6
**
** XRDB is the radius of aerosol particles released from debris beds into
** overlying water pools. Adjusting this parameter allows users some

** control over the decontamination factor (DF) that is used to determine
** how much of the aerosol material released from the debris is captured in
** the water covering the debris beds. In general, the DF decreases as the
** particle radius is increased up to about 0.1 microns. Beyond that
** value, the DF increases with increasing particle size.
**
** DF = mass entering pool/mass leaving pool
**
** Used in subroutine AERODF.
** Use in MAAP4 = use in MAAP3B.
**
** ==========================================================================
FDFDB 1.0 // Dimensionless
** Min = 1.e-4 Max = 100
**
** FDFDB is a multiplier to the calculated aerosol decontamination factors
** (DFs) for debris bed releases into water pools. It was added in Rev.
** 4.0.1 as part of the MAAP 3B 19.01 upgrades. Note that the output pool
** DFs for the ic'th debris pool are DFADB(ic) for aerosols and DFVDB(ic)
** for vapors.
**
** Used in subroutine AUXFP.
** Analagous to the DF multipliers in MAAP 3B.
**
** ==========================================================================
FDFJJ 1.0 // Dimensionless
** Min = 1.e-4 Max = 100
**
** FDFJJ is a multiplier to the calculated aerosol decontamination factors
** (DFs) for containment junction releases into water pools. It was added
** in Rev. 4.0.1 as part of the MAAP 3B 19.01 upgrades. Note that the
** output pool DFs for the j'th junction flow are DFAJ(j) for aerosols and
** DFVJ(j) for vapors.
**
** Used in subroutine AUXFP.
** Analagous to the DF multipliers in MAAP 3B.
**
** ==========================================================================
FDFBS 1.0 // Dimensionless
** Min = 1.e-4 Max = 100
**
** FDFBS is a multiplier to the calculated aerosol decontamination factor
** (DF) for steam generator tube rupture releases into the water pool
** should the break be covered. It was added in Rev. 4.0.1 as part of the
** MAAP 3B 19.01 upgrades.
**
** Used in subroutine AUXFP.
** Analagous to the DF multipliers in MAAP 3B.
**
** ==========================================================================
** ==========================================================================
** KUTATELADZE NUMBERS FOR CRITICAL VELOCITY CALCULATIONS
** -----------------------------------------------------
**

** Kutateladze numbers are coefficients used in the calculations of the
** velocities necessary for the entrainment (fluidization) of a liquid by a
** gas. These critical velocities are calculated as follows:
**
** UCRIT = K * ((G * SIGMA * (DLIQ - DGAS))/ DGAS^2)^.25
**
** where K = Applicable Kutateladze number
** G = Acceleration of gravity
** SIGMA = Surface tension of the liquid
** DLIQ = Liquid density
** DGAS = Gas density
**
** The actual velocities are compared with the critical velocities. If the
** actual velocity exceeds the critical velocity then there is entrainment.
** The values of the Kutateladze numbers are dependent on the flow regime,
** as discussed below. The higher the value, the more difficult it is to
** entrain the liquid. The calculation of the critical velocities is done
** in function UCRDR. See the description of this function in the MAAP4
** User's Manual for further information.
**
** ==========================================================================
** ==========================================================================
FCHF 0.1 // Dimensionless
** Min = 0.0036 Max = 0.3
**
** @@@ 4.0.3 BJS 12/22/95 - Changed the value of FCHF from 0.14 to the
** best-estimate value of 0.1.
**
** @@@ 4.0.3 SMD 4/3/96 -- FCHF description was revised to reflect changes
** in subroutine DBBED which replaced the model parameter FCHF with a static
** value of 0.1.
**
** FCHF is the flat plate critical heat flux (CHF) Kutateladze number.
** This number applies to the case of pool levitation of droplets from a
** heated surface in contact with an overlying water pool. The critical
** velocity marks the transition from a churn-turbulent pool to a fluidized
** bed of droplets. It is used for ex-vessel debris heat transfer only.
** Model parameter FQUEN is used to influence in-vessel debris heat transfer.
**
** The NUPEC/FAI uncertainty analysis addresses the influence of FCHF on
** ex-vessel debris coolability. Large values (on the order of 0.1)
** represent efficient water ingression, resulting in coolable debris.
** Small values (on the order of 0.036 to 0.0036) represent impermeable
** debris. The uncoolable debris transfers energy to concrete, resulting
** in concrete erosion and subsequent pressurization of the containment.
** Hence, the value of FCHF has a strong influence on containment failure.
**
** Some experiments suggest a value of 0.14 for FCHF. Benchmarking results
** of the SWISS metal-water-concrete experiment give 0.1 as the
** best-estimate value. Other experiments with more prototypic materials
** show lower heat transfer rates. To evaluate the sensitivity of reduced
** heat transfer between a debris bed and an overlying water pool, reduce
** FCHF to 0.02. This will greatly decrease the heat flux into the water
** pool, and as a result, greatly increase the heat flux into the vessel or

```
** concrete.
**
** Note that since FCHF no longer applies to debris in the vessel lower head,
** the user can reduce the value of FCHF to model non-coolable debris in the
** containment without influencing conditions in-vessel.
**
** Use in MAAP4 = use in MAAP3B.
**
** ==========================================================================
FCRHY        0.3        // Dimensionless
** Min = 0.1   Max = 1.0
**
** FCRHY is the core hydrodynamic limit Kutateladze number. This number
** applies to the case where liquid droplets would be entrained in the gas
** stream and kept from coming in contact with the core material. FCRHY
** is used in the core when the core has lost its rod-like geometry.
** (Parameter FFLOOD is used when the core geometry is intact.)
**
** Use in MAAP4 = use in MAAP3B PWR.
**
** ==========================================================================
FFLOOD       3.0        // Dimensionless
** Min = 2.0  Max = 4.0
**
** FFLOOD is the flooding Kutateladze number. This number is used to
** calculate the critical velocity for the case of flooding of liquid
** films. This flooding marks the transition from slug to annular flow,
** which is caused by the instability of waves on the surface of the
** liquid. Such a case could occur when gases passing through the cavity
** in a PWR containment are capable of pushing the molten core debris into
** the lower compartment. Note that the critical velocity is multiplied by
** parameter FENTR for corium and water entrainment from the cavity or
** pedestal.
**
** Use in MAAP4 = use in MAAP3B.
**
** ==========================================================================
FDROP        3.7        // Dimensionless
** Min = 3.0  Max = 5.0
**
** FDROP is the dispersed droplet flow Kutateladze number. It is used to
** calculate the critical velocity for the transition from annular to
** dispersed droplet flow.
**
** Use in MAAP4 = use in MAAP3B.
**
** ==========================================================================
FENTR        100.0      // Dimensionless
** Min = 0.2  Max = 100
**
** FENTR multiplies the critical velocity to represent the difficulty
** (> 1.0) or ease (< 1.0) for debris and water to be entrained out of the
** cavity or pedestal. It applies to the critical velocity calculated with
** either FFLOOD or with a hardwired value of 3.0.
```

```
**
** The gas velocity following reactor vessel failure is compared to the
** modified critical velocity to determine if the gas velocity is
** sufficient to entrain debris or water out of the cavity or pedestal. A
** large value (100.0) is used if the user wishes to prevent dispersal.
**
** The main factors that influence the actual velocity in the flow path
** through and out of the cavity or pedestal are the differential pressure
** between the reactor vessel and the cavity or pedestal and the area and
** resistance of the flow path. The differential pressure is largely a
** function of the accident scenario, while the flow area and resistance
** are primarily a function of plant-specific geometry. In general,
** entrainment is more likely for high pressure vessel failure sequences
** in plants with a small flow area and little resistance in the flow path
** than it is for low pressure vessel failure sequences in plants with a
** large flow area and considerable path resistance. Setting FENTR to 1.0
** emphasizes the dependence on accident sequence characteristics, i.e.,
** high or low vessel failure pressure, and minimizes the influence of
** plant geometry. Entrainment will then take place in virtually all high
** pressure vessel failure cases, but rarely if ever in low vessel
** pressure failure cases.
**
** Data source: IDCOR PWR IPE Source Term Assessment Methodology
** (FAI Report 85-58)
**
** Used in subroutine AUXEVT.
** Use in MAAP4 = use in MAAP3B.
**
** ========================================================================
FCHTUR        1.53          // Dimensionless
** Min = 1.0   Max = 5.0
**
** FCHTUR is the churn-turbulent critical velocity coefficient. It is used
** for calculating the critical superficial gas drift velocity for a
** churn-turbulent bubbly flow regime, UCRCT:
**
**    UCRCT = FCHTUR * (G * SIGMA * (DLIQ - DGAS))/ DLIQ^2)^.25
**
** where  G = Acceleration of gravity
**        SIGMA = Surface tension of liquid
**        DLIQ  = Liquid density
**        DGAS  = Gas density
**
** DATA SOURCE(S): Y.Y. Hsu and R.W. Graham, "Transport Processes in Boiling
** and Two-phase Systems", McGraw-Hill, New York, 1976
**
** Used in function UCRCT.
** Use in MAAP4 = use in MAAP3B.
**
** ========================================================================
** ========================================================================
** VOID FRACTIONS
** --------------
**
```

```
** ==========================================================================
** ==========================================================================
FSPAR        1.35        // Dimensionless
** Min = 0  Max = 5
**
** FSPAR is the sparged pool void fraction coefficient.  It is used in the
** drift flux model to calculate the void fraction for bottom-sparged steam
** injection into a water pool.  FSPAR is an empirical correlation factor
** for the one-dimensional flow theory which accounts for the fact that the
** void distribution and velocity profile across the pool are non-uniform.
**
**    ALPHA = LAMBDA / (1 + (FSPAR * LAMBDA))
**
** where  ALPHA  = Void fraction
**        LAMBDA = Ratio of superficial gas velocity to drift velocity
**
**
** Used in subroutine VFSPAR.
** Use in MAAP4 = use in MAAP3B.
**
** ==========================================================================
FVOL         2.0         // Dimensionless
** Min = 1.0  Max = 2.5
**
** FVOL is the volumetric steam generation void fraction coefficient.  It
** is used in the drift flux model to calculate the average void fraction
** for a water pool with a volumetric steam source:
**
**    ALPHA = LAMBDA/ (2 + (FVOL * LAMBDA))
**
** where  ALPHA  = Average void fraction
**        LAMBDA = Ratio of superficial gas velocity to drift velocity
**
**
** Used in subroutines VFVOL, AVVOID and VSLFLO (BWR only).
** Use in MAAP4 = use in MAAP3B for VFVOL (other routines are new for MAAP4).
**
** ==========================================================================
** ==========================================================================
** FLOW COEFFICIENTS
** -----------------
**
** ==========================================================================
** ==========================================================================
FCDBRK       0.75        // Dimensionless
** Min = 0.1  Max = 1.0
**
** @@@ 4.0.3 BJS 11/17/95 - The value has been changed from 0.7 to 0.75 for
** consistency with the other parameter files.
**
** FCDBRK is the discharge coefficient for flows through primary system
** breaks except steam generator tube ruptures.  It is also used for BWR
** generalized openings and BWR vessel failure.  The calculated flows
** determine the primary system depressurization rate and the rate of
```

```
** energy deposition to the containment.  The flow is determined as
** follows:
**
**    WLOCA = ABRK * G * FCDBRK
**
** where   ABRK   = LOCA break area (parameter ABB or AUB for PWRs, ALOCA
**                 for BWRs)
**         G      = Mass flux (a function of void fraction)
**         FCDBRK = ((F * L/D) + K)^-.5
**         F      = Friction factor
**         L/D    = Pipe equivalent length to diameter ratio
**         K      = Sudden expansion loss coefficient
**
**
** Note: The discharge coefficients for flow through PWR generalized
** openings and vessel failure are input parameters FCDGO(I) and FCDVF,
** respectively.  The discharge coefficient for steam generator tube
** ruptures is 1.
**
** Data Sources: Plant FSAR - LOCA analyses section
**
** Used in subroutines WFLOW and KRESIS.
** Use in MAAP4 = use in MAAP3B.
**
** ======================================================================
FCDVF          0.75            // Dimensionless
** Min = 0.1  Max = 1.0
**
** The absolute value of FCDVF is the primary system discharge coefficient
** for vessel failure.  If FCDVF is set to a negative value water is not
** allowed to come back into the primary system.
**
** Used in subroutine PRISYS.
** New for MAAP4.
**
** ======================================================================
** ======================================================================
** HEAT AND MASS TRANSFER PARAMETERS
** -------------------------------
**
** ======================================================================
** ======================================================================
HTCONC         5.e3  W/M**2-C   // Units: [W/M**2-C,BTU/FT**2-HR-F]
** Min = 0.1e-5  Max = 0.1e+7
**
** @@@ 4.0.3 BJS 8/29/95 - Added HTCONC to PWR parameter files.
**
** HTCONC is the conduction heat transfer coefficient between fuel and
** cladding for covered fuel nodes.  When the fuel expands it can come into
** contact with the cladding, and heat can be conducted across the contact
** points.  The total heat transfer coefficient between the fuel and the
** cladding is the sum of this conduction coefficient and the radiation
** coefficient.  HTCONR is the comparable conduction term for uncovered
** fuel nodes.
```

```
**
** Used in subroutine COVER.
** New for MAAP4.
**
** ------------------------------------------------------------------------
HTCONR       750.0  W/M**2-C   // Units: [W/M**2-C,BTU/FT**2-HR-F]
** Min = 0.1e-5   Max = 0.1e+7
**
** @@@ 4.0.3 BJS 8/29/95 - Added HTCONR to PWR parameter files.
**
** HTCONR is the conduction heat transfer coefficient between fuel and
** cladding for uncovered fuel nodes.  When the fuel expands it can come
** into contact with the cladding, and heat can be conducted across the
** contact points.  The total heat transfer coefficient between the fuel
** and the cladding is the sum of this conduction coefficient and the
** radiation coefficient.
**
** Used in subroutine ROW.
** New for MAAP4.
**
** ===========================================================================
HTFB         300.0  W/M**2-C   // Units: [W/M**2-C,BTU/FT**2-HR-F]
** Min = 100.0  Max = 400.0
**
** HTFB is the coefficient for film boiling heat transfer from corium to an
** overlying pool.
**
** Used in routines dealing with heat transfer from corium.
** Use in MAAP4 = use in MAAP3B.
**
** ===========================================================================
CDCMLP       2.75             // Dimensionless
** Min = 1.0   Max = 100.0
**
** @@@ 4.0.3 BJS 8/30/95  Added CDCMLP to PWR parameter files.
**
** CDCMLP is the exponent for the two-phase debris pool heat transfer
** coefficient correction factor.  It is used for debris in the lower
** plenum in the same way that *Model parameter CDU is used for debris in
** the containment.
**
** Used in subroutine DBBED.
** New for MAAP4.
**
** ===========================================================================
HTCMCR       3500.0  W/M**2-C   // Units: [W/M**2-C,BTU/FT**2-HR-F]
** Min = 500.0  Max 10000.0
**
** HTCMCR is the nominal downward heat transfer coefficient for convective
** heat transfer from molten corium to the lower crust for corium-concrete
** interaction calculations.  It is used to calculate the actual heat
** transfer coefficient, HTD, via the expression
**
**     HTD=HTCMCR*(1-FSOL)**CDU
```

**
** where FSOL is the corium solid fraction, and CDU is another *Model
** parameter.
**
** HTCMCS is the equivalent heat transfer coefficient for sideward heat
** transfer. They may or may not be the same value. Based on the BETA
** experiment the downward heat transfer coefficient should be larger
** than the sideward coefficient.
**
** Used in subroutine DECOMP.
** New for MAAP4 (HTCMCR in MAAP3B has a different definition).
**
** =====================================================================
HTCMCS 3000.0 W/M**2-C // Units: [W/M**2-C,BTU/FT**2-HR-F]
** Min = 500.0 Max = 10000.0
**
** HTCMCS is the nominal sideward heat transfer coefficient for convective
** heat transfer from molten corium to the side crust for corium-concrete
** interaction calculations. It is used to calculate the actual heat
** transfer coefficient, HTS, via the expression
**
** HTS=HTCMCS*(1-FSOL)**CDU
**
** where FSOL is the corium solid fraction, and CDU is another *Model
** parameter.
**
** HTCMCR is the equivalent heat transfer coefficient for downward heat
** transfer. See above.
**
** Used in subroutine DECOMP.
** New for MAAP4.
**
** =====================================================================
CDU 2.75 // Dimensionless
** Min = 1.0 Max = 3
**
** CDU is the exponent used to calculate the downward and sideward heat
** transfer coefficients for convective heat transfer from molten corium to
** the lower and side crusts, respectively, for corium-concrete
** interaction calculations. See the descriptions of HTCMCR and HTCMCS
** above.
**
** Used in subroutine DECOMP.
** New for MAAP4.
**
** =====================================================================
FGCRXS 1.0 // Dimensionless
** Min = 0.0 Max = 1.0
**
** @@@ 4.0.3 BJS 8/30/95 Added FGCRXS to all parameter files.
**
** FGCRXS is the fraction of off-gas from sideward corium-concrete
** interactions that enters the molten corium pool. The remainder bypasses
** the pool. Gas entering the molten pool significantly affects the

** chemical reactions. In particular, the addition of the gas increases
** the Zr oxidation and subsequently the concrete erosion. Benchmarking of
** the DECOMP model with experiments such as the BETA tests has shown
** better agreement when the off-gas is assumed to enter the pool. In
** MAAP3B, only off-gas from lower (floor) interactions is assumed to enter
** the pool. This is modeled in MAAP4 by setting FGCRXS to 0.
**
** Used in subroutine DECOMP.
** New for MAAP4.
**
** ===========================================================================
HTSTAG 850.0 W/M**2-C // Units: [W/M**2-C,BTU/FT**2-HR-F]
** Min = 10.0 Max = 5000.0
**
** HTSTAG is the natural circulation (reactor coolant pumps off) steam
** generator primary side heat transfer coefficient when single- or
** two-phase natural circulation is occurring in the coolant loops. Note
** that the coolant velocity and void fraction distribution are not
** computed under these conditions.
**
** Used in subroutines HXFRSG and QSGCV
** Use in MAAP4 = use in MAAP3B.
**
** ===========================================================================
HTBLAD 0.0 W/M**2-C // Units: [W/M**2-C,BTU/FT**2-HR-F]
** Min = 0.0 Max = 500.0
**
** @@@ 4.0.3 BJS 12/22/95 - Added HTBLAD to the PWR parameter files.
**
** HTBLAD is the heat transfer coefficient that is added to the core node
** to water heat transfer coefficient to correct for the fact that there is
** relatively greater heat transfer from the control blades to the cooler
** bypass flow. The heat transfer between the control blades and the
** bypass flow is not explicitely modeled. Instead, the core node to
** water heat transfer is increased via HTBLAD.
**
** Used in subroutines COVER and ROW.
** Use in MAAP4 changed compared to use in MAAP3B.
**
** ===========================================================================
SCALH 1.0 // Dimensionless
** Min = 0.5 Max = 10
**
** SCALH is the scale factor for heat transfer coefficients for heat
** transfer to passive heat sinks.
**
** Used in various heat transfer routines.
** Use in MAAP4 = use in MAAP3B.
**
** ===========================================================================
** FUPOOL, FDPOOL amd FSPOOL are used in subroutine HEATUP to multiply the
** convective heat transfer coefficients for heat transfer between two
** crust core nodes (IGTYP=4), between two molten pool core nodes (IGTYP=5)
** and between a crust and a molten pool node. They are for upward,

** downward and sideward heat transfer, respectively. These parameters
** allows users to evaluate the sensitivity of the results to the highly
** uncertain molten pool natural circulation phenomena. The heat transfer
** calculations are discussed in Section 3.6 of the HEATUP subroutine
** description in the MAAP4 User's Manual. These parameters are new for
** MAAP4.
**
** @@@ 4.0.3 BJS 8/30/95 - Added *POOL parameters to the PWR parameter
** files.
**
FUPOOL 1.0 // Dimensionless
** Min = 0.01 Max = 2.0
**
FDPOOL 1.0 // Dimensionless
** Min = 0.01 Max = 2.0
**
FSPOOL 1.0 // Dimensionless
** Min = 0.01 Max = 2.0
**
** ====================================================================
FNUDRP 18.0 // Dimensionless
** Min = 2 Max = 30
**
** FNUDRP is the Nusselt number to govern heat conduction into droplets,
** e.g., from containment sprays. Available data suggests that this
** variable is independent of droplet diameter. The recommended value of
** 18 is consistent with both experimental evidence and theoretical
** derivations that consider the effects of circulatory flow patterns
** within a droplet.
**
** Data Sources: 1) A. Lekic, "The Rate of Growth of Drops During Conden-
** sation," M.A.Sc. Thesis, University of Waterloo (1970). 2) R. Kronig
** & J.C. Brink, "On the Theory of Extraction from Falling Droplets,"
** Appl. Sci. Res. (1950), Vol. A2. 3) E. Kulic, "An Experimental and
** Theoretical Study of Simultaneous Heat and Mass Transfer Applied to
** Steam Dousing," Phd. Thesis, University of Waterloo (1976).
**
** Used in subroutine SPRAY
** Use in MAAP4 = use in MAAP3B.
**
** ====================================================================
FXOCD 1.0 // Dimensionless
** Min = 1 Max = 1.0e4
**
** @@@ 4.0.3 BJS 8/29/95 - Added FXOCD to WICE and WLD parameter files.
**
** FXOCD defines the water level, as a the fraction of XOJUNC, which is
** needed to cause complete condensation of steam by pools submerging
** containmentjunctions. XOJUNC(J) is specified in the topology section
** for each junction J. It is the water height above which the junction
** is considered shut for gas flow. XOJUNC is set to the height of the the
** junction for vertical junctions, i.e., junctions in walls. FXOCD
** applies to both vertical and horizontal junctions.
**

```
** Used in subroutines AUXCFL and AUXFLO.
** New for MAAP4.
**
** ======================================================================
** ======================================================================
** EMISSIVITIES
** ------------
**
** The emissivities are used in various radiation heat transfer
** calculations. Their use in MAAP4 is the same as in MAAP3B. The only
** exception is EGAS, which is a new parameter for MAAP4. It is used in
** subroutine ROW. Data sources for emissivities are heat transfer texts
** or tables.
**
** ======================================================================
** ======================================================================
EW          .9          // Dimensionless
** Min = 0.8   Max = 1.0
**
** EW is the emissivity of water.
**
** ------------------------------------------------------------------
EWL         0.85        // Dimensionless
** Min = 0.7   Max = 1.0
**
** EWL is the emissivity of walls.
**
** ------------------------------------------------------------------
EEQ         0.85        // Dimensionless
** Min = 0.7   Max = 1.0
**
** EEQ is the emissivity of equipment.
**
** ------------------------------------------------------------------
ECM         0.85        // Dimensionless
** Min = 0.7   Max = 1.0
**
** ECM is the emissivity of corium surfaces.
**
** ------------------------------------------------------------------
EG          0.6         // Dimensionless
** Min = 0.5   Max = 1.0
**
** EG is the emissivity of gas. It is essentially the emissivity of steam
** because the emissivity of the other gases are generally small.
**
** ------------------------------------------------------------------
EGAS        0.1         // Dimensionless
** Min = 0.001   Max = 1.0
**
** EGAS is the emissivity of steam.
**
** ======================================================================
** ======================================================================
```

```
** DIRECT CONTAINMENT HEATING (DCH)
** ------------------------------
**
** There are two models in the code for DCH, the MAAP3B scoping model,
** subroutine DCH, and a more mechanistic model, subroutine DCH1, which is
** new for MAAP4. To use the DCH model set the value of parameter FCMDCH
** to a positive value. To use the DCH1 model set the value of parameter
** FENTRC to a positive value. Do not set them both to positive values
** because these models are mutually exclusive. Additional *Model
** parameters used in the DCH1 model are FDENTR, FWEBER and FPDIF. All
** five of these parameters are discussed below.
**
** The DCH1 model applies to cavities where debris can be relatively easily
** dispersed into the containment, i.e., through open instrument tunnels.
** It does not apply to containments in which the entrained flow would pass
** through the vessel support skirt or tight instrument passages. For
** these configurations any DCH modeling should be done with the older
** model.
**
** Functionally, both DCH models can be used in the BWR and PWR codes.
** However, they have not been tested in the BWR code, and their use for
** BWRs is currently not recommended. Generally, the geometry of a BWR
** containment precludes substantial debris dispersal and pressurization by
** DCH. See the discussion in "Approximate Source Term Methodology for
** Boiling Water Reactors," FAI/86-1.
**
** ========================================================================
** ========================================================================
FCMDCH          0.0             // Dimensionless
** Min = 0.0  Max = 0.5
**
** @@@ 4.0.3 BJS 10/1/95 - In order to avoid conflict in the code with the
** DCH1 model, the value of FCMDCH has been set to 0.0 in all of the sample
** parameter files. A value of 0.5 is recommended when the DCH model is to
** be invoked. This value is considered by FAI to be an upper bound, as
** discussed below.
**
** FCMDCH is the fraction of the entrained corium mass which is assumed to
** be finely fragmented and to interact completely (sensible heat and
** oxidation) with the gas of the containment compartment to which it is
** entrained. A value of 0.0 would be used to model wavelike displacement
** of corium between two compartments. A value of 1.0 would represent the
** maximum possible breakup of debris and the maximum potential for high
** containment pressure. This parameter can be viewed as an efficiency
** factor that allows the effective heat transfer and hydrogen production
** to be controlled between two physical bounds. Note that hydrogen
** combustion during DCH can be caused by flying hot particles, and this
** can be simulated by a parameter change to turn on a fictitious igniter
** in the region that is receiving debris.
**
** Calculations documented in IDCOR Report 85/2 and the PWR IPE Source Term
** Assessment Methodology (FAI Report 85-58) indicate that a value for
** FCMDCH should typically be less than approximately 0.1. A value of 0.5
** is recommended as an upper bound. This value is based on a comparison
```

** of containment pressure and temperature predictions calculated by MAAP3B
** with those from the SNL/IET-5 experiment. Note that unlike the nominal
** values of the other model parameters, this value of FCMDCH is a maximum
** value because the IET-5 experiment does not take into account the
** mitigating effects of:
**
** 1. Co-dispersal of overlying RPV water with the corium. As
** demonstrated by the integral effects test (IET-2) in the Surtsey
** facility, this would be an additional heat sink that would serve to
** suppress DCH peak pressures and, in particular, the temperatures in
** the containment.
**
** 2. Steam-filled RPV used for blowdown in the experiments. In
** contrast, the actual system would have a substantial mass fraction
** of hydrogen that could limit the extent of hydrogen generation due
** to steam-metal oxidation within the entrained debris.
**
** 3. Debris surrogate with a relatively high metal content in the
** experiments. The surrogate was not prototypic of corium composition.
** It generally contained chromium and aluminum along with large amounts
** of iron, which might have yielded a non-prototypic amount of hydrogen
** from oxidation. For example, the debris found in the TMI-2 lower
** plenum is essentially all oxidic. Also, vapor phase burning of
** aluminum may have contributed to non-prototypic hydrogen generation.
**
** 4. Experiments and MAAP 3.0B both postulate worst-case RPV failure at
** the bottom of the vessel. MAAP4 allows for failures at the top of
** the lower plenum hemisphere surge line, and hot leg, etc. These
** failure locations could prevent or mitigate the DCH containment
** loading.
**
** 5. The experiment simulated 30 tonnes of debris in the lower plenum.
** MAAP can have upwards of 100 Tonnes at vessel failure. Entrainment
** rate limitations call into question the validity of direct scaling
** of FCMDCH equal to 0.5 from 30 to 100 tonnes.
**
** The above is indicative of the complex nature of this phenomenon,
** requiring the noted conservatisms within the experiment design. In view
** of this, if FCMDCH=0.5 results in unacceptable containment pressures, it
** is recommended that this value be used as the upper bound in a
** sensitivity study. This approach is especially relevant in view of
** geometry-specific containment considerations which are not addressed by
** the noted test series.
**
** The calculated entrainment rate during a DCH event is also dependent
** upon *Model parameter TTENTR, which is the entrainment time constant.
** Increasing TTENTR effectively decreases the entrainment rate by
** extending the entrainment over a longer time period. Like parameter
** FCMDCH, the uncertainty in the nominal value of TTENTR should be
** considered in a DCH sensitivity study.
**
** Used in subroutine DCH.
** Use in MAAP4 = use in MAAP3B.
**

```
** ======================================================================
TTENTR        0.5 S      // Units: [S,HR]
** Min = 0.1  Max = 10.0
**
** TTENTR is the corium debris entrainment time constant for the DCH model,
** and the water entrainment time constant for both the DCH and DCH1
** models. The time constant is the effective time that it will take to
** empty the pedestal or cavity of entrained corium and water. The models
** in MAAP assume that the discharge mass flowrate is the current total
** mass divided by TTENTR. See the discussion for FCMDCH for comments
** about TTENTR.
**
** Used in subroutines AUXREG, DEBRIS and ENTRAN
** Use in MAAP4 = use in MAAP3B.
**
** ======================================================================
FCMA          0.0        // Dimensionless
** Min = 0   Max = 1
**
** FCMA is the fraction of corium, water and gas that is displaced/
** entrained due to reactor vessel blowdown that goes to the second
** receiving compartment. The capability to simultaneously displace/
** entrain from the cavity to the upper and lower compartments was added in
** Rev. 4.0.1 as part of the MAAP3B 19.01 upgrades. Simultaneous
** entrainment only applies to the scoping DCH model, subroutine DCH. The
** junctions used for displacement/entrainment are identified by *Pointers
** parameters JENTR and JENTRA.
**
** Used in subroutine DEBRIS.
** Use in MAAP4 = use in MAAP3B.
**
** ======================================================================
** The following four parameters are used for the DCH1 model. These
** parameters had been in the *Debris section of the parameter file. They
** were moved to the *Model parameter common block for Rev. 4.0.1, and are
** now listed in the *Model parameter section.
**
** ------------------------------------------------------------------
FENTRC        0.0        // Dimensionless
** Min = 0.0  Max = 1.0
**
** FENTRC is the multiplier for the entrainment efficiency for the DCH1
** model. This parameter is provided to allow the user to control the
** amount of entrained material for DCH sensitivity analvses. If it is set
** to 0 the mechanistic DCH model is not used.
**
** ------------------------------------------------------------------
FWEBER        10.0       // Dimensionless
** Min = 0.0  Max = 100.0
**
** FWEBER is the Weber number used in the calculation of the diameter of
** the debris particles that are created during the entrainment process for
** the DCH1 model. Increasing the Weber number means that it is more
** difficult for particles to form.
```

```
**
** Reference: "Fundamentals of the Hydrodynamic Mechanism of Splitting in
** Dispersion Processes," J. O. Hinze, et. al., A.I.Ch.E. Journal, Vol. 1,
** No. 3, 1955.
**
** -------------------------------------------------------------------
FPDIF        1.e-8  M**2/S     // Units: [M**2/S]
** Min = 0.1e-11   Max = 0.1e-07
**
** FPDIF is the diffusivity of fission products migrating through the
** molten material for the DCH1 model.  It is used to calculate the fission
** product release from the particulated debris.
**
** NOTE: The units of diffusivity are not converted in the code.  Hence,
** the value for FPDIF should be in SI units (m**2/s) even for a parameter
** file that is in British units.  (1 m**2/s = 3.875e4 ft**2/hr)
**
** Reference: W. Jost, "Diffusion in Solids, Liquids. Gases," Academic
** Press, NY, 1960.
**
** -------------------------------------------------------------------
FDENTR       -1.0          // Dimensionless
** Min = -1.0   Max = 1.0
**
** FDENTR is the de-entrainment efficiency to account for entrained mass
** that would be lost due to impaction on structures for the DCH1 model.
** If a positive value is specified it is the actual de-entrainment
** efficiency.  If a value of -1 is specified the code calculates a
** de-entrainment efficiency according to the SNL Walker model.  Only the
** remaining entrained mass is used for the DCH (heat transfer and
** oxidation) calculations, while the total (original) entrained mass is
** used for the fission product release calculations.
**
** ========================================================================
** ========================================================================
** ACTIVITY COEFFICIENTS
** --------------------
**
** Activity coefficients are used in the METOXA chemical equilibrium model
** for debris pool and fission product release calculations.  They adjust
** the extent of the reactions to take into account non-ideal behavior as
** determined by experiments.  A value of 1.0 means that the ideal
** reactions are used.  The coefficients are used in subroutine CHRX in the
** same way that they are used in MAAP3B.  FAC has been added for MAAP4.
**
** ========================================================================
** ========================================================================
FASI         0.01          // Dimensionless
** Min = .0001    Max = 1.0
**
** FASI is the activity coefficient for SiO2.
**
** -------------------------------------------------------------------
FASR         0.05          // Dimensionless
```

** Min = 0.001    Max = 1.0
**
** FASR is the activity coefficient for SrO.
**
** --------------------------------------------------------------------
FABA 0.05 // Dimensionless
** Min = 0.001   Max = 1.0
**
** FABA is the activity coefficient for BaO.
**
** --------------------------------------------------------------------
FAKO 1.0e-8 // Dimensionless
** Min = 0.1e-9   Max = 0.1e-5
**
** FAKO is the activity coefficient for K2O.
**
** --------------------------------------------------------------------
FAC 100.0 // Dimensionless
** Min = 0.0001    Max = 1000.0
**
** @@@ 4.0.3 BJS 8/29/95 - Added FAC to the WICE parameter file.
**
** FAC is the activity coefficient for carbon. A value greater than one
** prevents the complete reduction of carbon, i.e., CO and not C will be
** produced.
**
** ===========================================================================
** ===========================================================================
** COMBUSTION
** ----------
** Combustion of H2 and CO is calculated in subroutine FLAMM and its
** descendant routines. The *Model parameters that control combustion are
** listed below.
**
** To completely disable combustion for sensitivity studies set TJBRN equal
** to 3000 K, TAUTO equal to 3000 K, and DXHIG equal to 1.
**
** ===========================================================================
** ===========================================================================
TJBRN 1060. K // Units: [K,F]
** Min = 900  Max = 1900
**
** TJBRN is the temperature of a H2 jet entering a non-inerted compartment
** which is sufficient to cause a local burn. If hot, hydrogen-rich and/or
** carbon monoxide-rich gases are transported into cooler, oxygen-rich
** regions, ignition is possible without an ignition source for jet
** temperatures greater than or equal to TJBURN (typically 1060 K). A
** sensitivity case with TJBRN set to 3000K will disable jet burning, and
** demonstrate containment performance for larger global burns simply
** because more H2/CO will be available for global burns.
**
** Data source: HEDL-TME 78-80.
**
** Used in subroutine CBURN.

** Use in MAAP4 = use in MAAP3B.
**
** ====================================================================
TAUTO 983. K , // Units: [K,F]
** Min = 750 Max = 1200
**
** TAUTO is the auto-ignition temperature for hydrogen and carbon monoxide
** burns. A global burn will occur in a region if the gas temperature
** exceeds TAUTO regardless of the fuel concentrations in the region. As
** with TJBRN, increasing TAUTO to 3000K will allow H2/CO to build up so
** that containment performance for larger global burns can be
** demonstrated.
**
** Used in subroutine FLAMM.
** Use in MAAP4 = use in MAAP3B.
**
** ====================================================================
XSTIA 0.75 // Dimensionless
** Min = 0.55 Max = 0.75
**
** @@@ 4.0.3 BJS 9/1/95 - Changed the value of XSTIA from 0.55 to 0.75 for
** consistency with the other parameter files.
**
** XSTIA is the steam mole fraction required to inert an H2-Air-H2O mixture
** at incipient auto-ignition. At region gas temperatures just below
** auto-ignition, this steam mole fraction will prevent a burn.
** Flammability limits for high inertant concentration and high temperature
** are sensitive to the value of XSTIA.
**
** Used in subroutine FLAMM.
** Use in MAAP4 = use in MAAP3B.
**
** ====================================================================
DXHIG 0.0 // Dimensionless
** Min = -0.04 Max = 1
**
** DXHIG is the offset H2 and CO mole fraction for ignition of a flammable
** mixture when there is no obvious source of ignition, e.g., during a
** station blackout sequence. DXHIG is added, or subtracted if negative,
** to the downward flammability limit. Ignition (global burns) will occur
** if the H2 or CO mole fraction exceeds the limit plus the offset.
** Blackout sequence results are sensitive to this variable if a
** sufficiently high H2 concentration exists and DXHIG is set to a large,
** positive value, e.g., 0.9.
**
** Used in subroutine FLAMM.
** Use in MAAP4 = use in MAAP3B.
**
** ====================================================================
FLPHI 2.0 // Dimensionless
** Min = 0 Max = 10
**
** FLHPI is the flame flux multiplier. This is the coefficient in the
** continuity equation of MAAP's combustion model that takes into account

```
** uncertainties in area, flame speed and density. The nominal value of
** 2.0 yields good agreement with experimental data. A value of 10 is
** recommended if fans, purges or sprays are working. FLHPI influences the
** burn time, and subsequently the peak compartment pressures and
** temperatures.
**
** Used in subroutine IGBURN.
** Use in MAAP4 = use in MAAP3B.
**
** ==========================================================================
** ==========================================================================
** MATERIAL PROPERTIES
** -------------------
**
** ==========================================================================
** ==========================================================================
**
** The following parameters, TOXMP through STML, were moved to the *Model
** parameter section in Rev. 4.0.1. They are user-specified material
** properties for debris, and are used in subroutine TMATRL. This
** subroutine is used when *Control parameter IUSETD is set to 0. (When
** IUSETD is set to 1, subroutine TDEBRI is used.) TMATRL gives the
** properties of a mixture of metal and oxidic debris. Iron, nickel and
** chromium and their oxides are grouped as metals. The remaining
** components of the debris are grouped as oxides. TMATRL is used for
** properties of debris in the RPV and in debris jets from the RPV to the
** containment. TDEBRI can also be used for these applications. TDEBRI is
** always used for debris in the containment; TMATRL is not applicable in
** the containment.
**
** In TDEBRI the material properties are based on a uniform composition and
** an equilibrium state in the debris. There is considerable uncertainty
** regarding the distribution and the thermal and chemical states of the
** constituent materials. TMATRL provides the means for investigating the
** impact of the uncertainties in the resulting material properties on such
** things as RPV failure time.
**
** NOTE: The nominal/default values of the TMATRL input parameters were
** determined from hand calculations. They are based on PWR compositions,
** and do not take into account BWR fuel cans and control blades.
**
** ------------------------------------------------------------------
TOXMP      2500.0  K       // Units: [K,F]
** Min = 1000.0    Max = 5000.0
**
** TOXMP is the melting point of oxidic debris.
**
** ------------------------------------------------------------------
LHOX       1.5e5  J/KG     // Units: [J/KG,BTU/LB]
** Min = 1.0e4     Max = 1.0e7
**
** LHOX is the latent heat of oxidic debris.
**
** ------------------------------------------------------------------
```

```
UOXMP       12.65e5  J/KG       // Units: [J/KG,BTU/LB]
** Min = 1.0e4       Max = 1.0e7
**
** UOXMP is the specific energy of solid oxidic debris at its melting point.
**
** ------------------------------------------------------------------
CPOX        514.0  J/KG-C     // Units: [J/KG-C,BTU/LB-F]
** Min = 100   Max = 1500
**
** CPOX is the specific heat of oxidic debris.
**
** ------------------------------------------------------------------
KOX           3.0  W/M-C      // Units: [W/M-C,BTU/FT-HR-F]
** Min = 1.0  Max = 100.0
**
** KOX is the thermal conductivity of oxidic debris.
**
** ------------------------------------------------------------------
DOX        9100.0  KG/M**3    // Units: [KG/M**3,LB/FT**3]
** Min = 5000.0  Max = 1.0e4
**
** DOX is the density of oxidic debris.
**
** ------------------------------------------------------------------
VSCOX        6.e-3  KG/M-S    // Units: [KG/M-S,LB/FT-S]
** Min = 1.e-4   Max = 1.e-2
**
** VSCOX is the viscosity of oxidic debris.  Note that the units of
** viscosity were not converted properly prior to Rev. 4.0.2.  A factor of
** 0.0283 was used to convert from British to SI units.  As of Rev. 4.0.2,
** the correct factor of 1.49 is used.
**
** ------------------------------------------------------------------
STOX          1.0  KG/SEC**2  // Units: [KG/SEC**2]
** Min = 0.1   Max = 10.0
**
** STOX is the surface tension of oxidic debris.
**
** NOTE: the units of surface tension are not converted in the code. Hence,
** the value for STOX should be in SI units (kg/sec**2) even for a
** parameter file that is in British units.  (1.0 kg/sec**2 = 0.069 lbf/ft)
**
** ------------------------------------------------------------------
TMLMP       1700.0  K         // Units: [K,F]
** Min = 1000.0  Max = 5000.0
**
** TMLMP is the melting point of the metal.
**
** ------------------------------------------------------------------
LHML        2.8e5  J/KG       // Units: [J/KG,BTU/LB]
** Min = 1.0e4  Max = 1.0e7
**
** LHML is the latent heat of the metal.
**
```

** -------------------------------------------------------------------
UMLMP        7.376e5 J/KG      // Units: [J/KG,BTU/LB]
** Min = 1.0e4  Max = 1.0e7
**
** UMLMP is the specific energy of the solid metal at the melting point.
**
** -------------------------------------------------------------------
CPML         558.0 J/KG-C      // Units: [J/KG-C,BTU/LB-F]
** Min = 100.E0  Max = 1500.E0
**
** CPML is the specific heat of the metal.
**
** -------------------------------------------------------------------
KML          35.0 W/M-C        // Units: [W/M-C,BTU/FT-HR-F]
** Min = 1  Max = 100
**
** KML is the thermal conductivity of the metal.
**
** -------------------------------------------------------------------
DML          7370.0 KG/M**3    // Units: [KG/M**3,LB/FT**3]
** Min = 5000.0  Max = 1.0e4
**
** DML is the density of the metal.
**
** -------------------------------------------------------------------
VSCML        6.e-3 KG/M-S      // Units: [KG/M-S,LB/FT-S]
**
** VSCML is the viscosity of the metal.  Note that the units of viscosity
** were not converted properly prior to Rev. 4.0.2.  A factor of 0.0283 was
** used to convert from British to SI units.  As of Rev. 4.0.2, the correct
** factor of 1.49 is used.
**
** Min = 1.e-4  Max = 1.e-2
**
** -------------------------------------------------------------------
STML         1.0 KG/SEC**2     // Units: [KG/SEC**2]
** Min = 0.1   Max = 10.0
**
** STML is the surface tension of the metal.
**
** NOTE: the units of surface tension are not converted in the code.
** Hence, the values for STOX and STML should be in SI units (kg/sec**2)
** even for a parameter file that is in British units.  (1.0 kg/sec**2 =
** 0.069 lbf/ft)
**
** ========================================================================
**
** The following solidus and liquidus parameters are used with the phase-
** diagram model for material properties.  This model is in subroutine
** TDEBRI, and is selected by setting *Control parameter IUSETD to 1.  See
** the above discussion regarding the application of the TMATRL and TDEBRI
** models.  These parameters are new for MAAP4.
**
** -------------------------------------------------------------------

```
TSOLSO       1650.0  K        // Units: [K,F]
** Min = 1400 Max = 2000
**
** TSOLSO is the steel oxide solidus.
**
** ------------------------------------------------------------------
TLIQSO       1800.0  K        // Units: [K,F]
** Min = 1500.  Max = 2100.
**
** TLIQSO is the steel oxide liquidus.
**
** ------------------------------------------------------------------
TSCS         1700.0  K        // Units: [K,F]
** Min = 1500.  Max = 1900.
**
** TSCS is the steel solidus.
**
** ------------------------------------------------------------------
TLCS         1740.0  K        // Units: [K,F]
** Min = 1550.  Max = 2000.
**
** TLCS is the steel liquidus.
**
** ========================================================================
**
** The following parameters are used in functions PMSOL and PMLIQ, which
** calculate the solidus and liquidus of iron plus a mixture of other
** metals.  The functions are used in subroutine TDEBRI, the phase-diagram
** model.  These parameters are new for MAAP4.
**
** ------------------------------------------------------------------
TFE2ML       1918.0  K        // Units: [K,F]
** Min = 1500.0  Max = 2200.0
**
** TFE2ML is the Fe2M melting point, where M represents the mixture of
** other metals.
**
** ------------------------------------------------------------------
TMMS         2100.0  K        // Units: [K,F]
**
** TMMS is the solidus of other metals.
**
** Min = 1400.0  Max = 2300.0
**
** ------------------------------------------------------------------
TMML         2200.0  K        // Units: [K,F]
**
** TMML is the liquidus of other metals.
**
** Min = 1500.0  Max = 2400.0
**
** ------------------------------------------------------------------
FNE1         0.2              // Dimensionless
** Min = 0.05   Max = 0.3
```

```
**
** FNE1 is the Fe mole fraction at the Fe-rich eutectic point.
**
** -------------------------------------------------------------------
FNE2          0.7           // Dimensionless
** Min = 0.35  Max = 0.95
**
** FNE2 is the Fe mole fraction at the Fe-lean eutectic point.
**
** -------------------------------------------------------------------
TE1         1575.0  K        // Units: [K,F]
** Min = 1000.0  Max = 1650.0
**
** TE1 is the Fe-rich eutectic temperature.
**
** -------------------------------------------------------------------
TE2         1200.0  K        // Units: [K,F]
** Min = 1000.0  Max = 1750.0
**
** TE2 is the metal-rich eutectic temperature.
**
** ===========================================================================
FGCSSR      0.666666          // Dimensionless
** Min = 0.5  Max = 0.75
**
** FGCSSR is the critical H2 mole fraction below which there is no
** Fe-steam reaction.
**
** Used in subroutines SSRACT.
** Use in MAAP4 = use in MAAP3B PWR.
**
** ===========================================================================
FFEOX          1.0          // Dimensionless
** Min = 0.75  Max = 1.333
**
** FFEOX is the parameter that adjusts the stoichiometry of iron oxide from
** FeO to Fe3O4.  Decreasing FFEOX decreases the Fe3O4/FeO ratio.
**
** Used in subroutines SSRACT and BWRVSL (BWR) and PRISYS (PWR).
** Use in MAAP4 changed from use in MAAP3B PWR.
**
** ===========================================================================
** ===========================================================================
** CHEMISTRY
** ---------
**
** The following are used to calculate the pH of containment water pools.
** The calculation, which is done in subroutine AUXFP, is new for MAAP4.
**
** -------------------------------------------------------------------
CKABA      8.73e-10  KG-MOLE/M**3  //  Units: [KG-MOLE/M**3]
** Min = 1.e-13   Max = 1.e-7
**
** CKABA is the disassociation coefficient of H3BO3 in water (in units of
```

** kg-mole/m3).
**
** ----------------------------------------------------------------------
CHNO3     7.048e-13          // Dimensionless
** Min = 1.e-16     Max = 1.e-10
**
** CHNO3 is the coefficient for HNO3 radiolytic generation.
**
** ==========================================================================
** ==========================================================================
**
** @@@ 4.0.3 BJS 8/29/95: OBSOLETE *MODEL PARAMETERS:
**
** The following *Model parameters are not used. They were obsolete as of
** MAAP4.0. They were in pre-released versions of the code, and remained
** in the sample parameter files.
**
** SCALU: scale factor for burn velocity.
**
** LHEU: latent heat of fusion of U-ZR-ZRO2 eutectic
**
** TSB4C, TLB4C, TSBCS, TLBCS: B4C and B-C-Zr-S eutectic solidus and
** liquidus
**
******************************************************************************
*Concrete
******************************************************************************
*BR
**
** This parameter section defines the inputs for defining the
** thermo-physical properties of the concrete floors and walls in
** contact with a corium debris pool.
**
** General Guidance Concerning Concrete Data Acquisition:
** ------------------------------------------------
**
** 1. Unless otherwise stated, concrete properties are for "pure" (i.e.,
**    unreinforced) concrete.
**
** 2. With rare exception, the concrete used in most nuclear plants falls
**    into three general categories from a chemical/thermal standpoint,
**    which are in turn described by their predominant geological makeup;
**    1) Basaltic, 2) Limestone/Common Sand, and 3) Limestone.
**
** 3. Determining which category applies to a particular plant is actually
**    more important to MAAP core-concrete interaction calculations than
**    the detailed concrete property data itself. If the applicable cate-
**    gory can be ascertained, differences in MAAP results between generic
**    data for the category and plant-specific concrete data are usually
**    small, and far less distinguishable than comparable differences
**    between generic data sets for the three concrete categories. Exper-
**    ience has shown that if comprehensive plant-specific concrete che-
**    mistry data cannot be readily acquired, there are at least two good
**    alternatives for determining a plant's concrete category, and subse-

```
**    quently justifying the use of generic concrete data for MAAP:
**
**    a. Geography/Geology Relationship - Amongst the concrete's three
**       basic components (cement, sand, and aggregate), the aggregate
**       has the largest influence on which concrete category applies.
**       It is common (and economical) to obtain concrete materials from
**       sources in the same general area as the plant site, and this is
**       especially true for aggregate. The plant concrete's geological
**       makeup, and therefore its chemical/thermal category, can almost
**       always be discovered by geographically pinpointing the aggre-
**       gate's source (i.e., quarry). If it is not already at hand,
**       obtaining data about the overall geology of a given geographical
**       area is relatively easy.
**
**    b. Limited Plant-Specific Data - Any plant-specific data
**       that is sufficient to at least loosely quantify one or two key
**       mass fraction variables in this group is an adequate basis for
**       identifying the concrete category. The key variables are CaO
**       mass fraction MFCN(2) and CO2 mass fraction, MFCN(2). Relatively
**       small values (below approximately 0.15 for CaO and 0.05 for CO2)
**       typify Basaltic concrete. Relatively high values (above approx.
**       0.35 for CaO and 0.30 for CO2) are typical for Limestone concrete.
**       Limestone/Common Sand values are generally within a range of 0.25
**       to 0.35 for CaO and 0.15 to 0.25 for CO2.
**
**
** Possible data sources for these parameters are:
**
**     1) Handbook of Chemistry & Physics
**
**     2) JANAF Thermochemical Tables
**
**     3) The Oxide Handbook
**
**     4) Thermodynamic properties of elements and oxides
**
**     5) Structural concrete specification data
**
**     6) CORCON Manual
**
**     7) Spectrographic analysis of plant structural concrete sample
**
**     8) Plant structural concrete and/or steel (imbedments) drawings
**
** ======================================================================
CPCN0      0.2131  BTU/LB-F   // Units: [J/KG-C,BTU/LB-F]
**
** This parameter is the average specific heat of concrete mass-averaged
** over the temperature range from 300 K to the melting point;
**
**        CPCN0 = Sum of {[CP(Tav)i * MFi]}
**
** Where:  CP(Tav)i = Specific heat of compound "i", evaluated at Tav,
**
```

```
**      i       = Compounds listed in MFCN(i), i.e., SiO2, CaO, etc.,
**
**      MFi     = Mass fraction of compound "i", MFCN(i)
**
**      Tav     = Average concrete temperature,
**              = (Tinitial + Tmelt) / 2
**
**      Where:  Tinitial = Initial concrete temperature, and,
**              Tmelt    = Concrete melting temperature, TCNMP.
**
** ========================================================================
TCNMP       2336.0  F        // Units: [K,F]
**
** This parameter is the melting temperature of concrete.  The value should
** be between the temperature where the concrete begins melting, commonly
** referred to as the "Solidus", and the temperature where it becomes
** completely liquid, referred to as the "Liquidus".  These input
** parameters were best estimated values used in the DECOMP MCCI
** benchmarks.
**
** ========================================================================
LHDEC       430.02  BTU/LB    // Units: [J/KG,BTU/LB]
**
** This parameter is the energy absorbed in endothermic chemical reactions
** during concrete decompositions.
**
** ========================================================================
LHCN        344.02  BTU/LB    // Units: [J/KG,BTU/LB]
**
** This parameter is the concrete latent heat of melting.
**
** ========================================================================
** Name: MFCN(12)              Units: [Dimensionless]
**
** Parameter MFCN(i) is the mass fraction of the i'th component of the
** concrete, where the i'th component is:
**
**    1) SiO2
**    2) CaO
**    3) Al2O3
**    4) K2O
**    5) Na2O
**    6) MgO, MnO, or TiO2
**    7) Fe2O3
**    8) Fe
**    9) Cr2O3
**   10) H2O
**   11) CO2
**   12) O2
**
** The constituent mass fractions should add up to 1.  Do not set the
** mass fraction of CO2 to zero, even if it is very small.
**
** The CaO mass fraction, MFCN(2), is one of the key variables that
```

** distinguishes the plant's overall concrete category; i.e., Basaltic,
** Limestone/Common Sand, or Limestone.
**
** For the Fe mass fraction, MFCN(8), a value of 0.0 should always be
** specified, as MAAP actually accounts for the mass of metallic iron
** through the rebar density variable, DCSRCN.
**
** The H2O mass fraction, MFCN(10), should be the sum of free and chemically
** bound H2O.
**
** The CO2 mass fraction, MFCN(11), is one of the key variables that
** distinguishes the plant's overall concrete category; i.e., Basaltic,
** Limestone/Common Sand, or Limestone. Compared to the other concrete mass
** fraction input variables, it also has a relatively strong influence on
** the gas generation rates produced by MAAP's corium-concrete interaction
** calculations.
**
** For the O2 mass fraction, MFCN(12), a value of 0.0 should always be
** specified, as this particular mass fraction is actually used only for
** internal purposes by MAAP.
**
MFCN(1) 0.54
MFCN(2) 0.17
MFCN(3) 8.69e-2
MFCN(4) 2.59e-3
MFCN(5) 1.05e-2
MFCN(6) 4.82e-2
MFCN(7) 1.18e-2
MFCN(8) 3.20e-2
MFCN(9) 0.0
MFCN(10) 8.00e-2
MFCN(11) 1.00e-7
MFCN(12) 0.0
**
** ========================================================================
DCSRCN 5.41 LB/FT**3 // Units: [KG/M**3,LB/FT**3]
**
** This parameter is the rebar density, the mass of rebar per unit volume
** of reinforced concrete. This value should be representative of the
** concrete floor and/or sidewall in contact with the corium debris pool.
**
** ========================================================================
** Specifying the Liquidus and Solidus Curves for the Core-Concrete Mixture.
**
** @@@ 4.0.3 MAM 11/20/95 The descriptions of the following new MAAP4
** parameters were clarified.
**
** The liquidus and solidus curves must be defined for the molten core-
** concrete, UZO-CN, mixture. Given that the y-axis is the temperature and
** the x-axis is the mixture concrete fraction, the data points required to
** define the curves are:
**
** Liquidus Curve Solidus Curve
** Temperature Composition Temperature Composition

```
**
**      TLUZO      0.0        TSUZO      0.0
**      TCNLI1     FCNSO1     TSOLCN     FCNSOL
**      TCNLI2     FCNSO2     TSOLCN     1.0
**      TCNLI3     FCNSO3
**      TLIQCN     1.0
**
** These parameters are inputs to subroutine UUZOSL to define the shape of
** the phase diagram.  The shape of the phase diagram should correspond to
** one of the three phase diagram shapes as shown in Figure 1 of the UUZOSL
** subroutine writeup of the MAAP4 User's Manual.  The shape of the phase
** diagram depends on the type of the concrete.  All parameters except TLUZO
** and TSUZO are described next.  Parameters TLUZO and TSUZO are calculated
** by functions PLIQ and PSOL given the fuel mixture composition.  Note that
** the last two points of the solidus curve forms a plateau.  See subroutine
** UUZOSL writeup for further details.
**
** ==========================================================================
TLIQCN     2600.0 F     // Units: [K,F]
**
** This parameter is the concrete liquidus temperature.
**
** ==========================================================================
TSOLCN     2150.0 F     // Units: [K,F]
**
** This parameter is the concrete solidus temperature.
**
** ==========================================================================
FLCNSL     0.1          // Dimensionless
**
** This parameter is the liquid fraction for pure CN+SO solid at TSOLCN,
** and it is used to model the congruent melting/freezing at TSOLCN.
**
** ==========================================================================
FLCNLQ     0.9          // Dimensionless
**
** This parameter is the liquid fraction for pure CN+SO liquid at TLIQCN,
** and it is used to model the congruent melting/freezing at TLIQCN.
**
** ==========================================================================
FCNSOL     0.1          // Dimensionless
**
** This parameter is the fraction of concrete composition point for the
** start of the UZO-CN solidus curve plateau.
**
** ==========================================================================
FLCNSO     0.1          // Dimensionless
**
** This parameter is the liquid fraction for UZO-CN solid at FCNSOL, and
** it is used to model the congruent melting/freezing at FCNSOL.
**
** ==========================================================================
TCNLI1     3716.3 F     // Units: [K,F]
**
```

** @@@ 4.0.3 MAM This parameter was missing from ICE-like and TMI B&W-like
** pwr parameter files.
**
** This parameter is the first temperature point for the UZO-CN liquidus
** curve corresponding to FCNSO1.
**
** ==========================================================================
TCNLI2 3680.3 F // Units: [K,F]
**
** @@@ 4.0.3 MAM This parameter was missing from ICE-like and TMI B&W-like
** parameter files.
**
** This parameter is the second temperature point for the UZO-CN liquidus
** curve corresponding to FCNSO2.
**
** ==========================================================================
TCNLI3 3644.3 F // Units: [K,F]
**
** @@@ 4.0.3 MAM This parameter was missing from ICE-like and TMI B&W-like
** parameter files.
**
** This parameter is the third temperature point for the UZO-CN liquidus
** curve corresponding to FCNSO3.
**
** ==========================================================================
FCNSO1 0.49 // Dimensionless
**
** This parameter is the first concrete fraction composition point for
** the UZO-CN liquidus curve corresponding to TCNLI1.
**
** ==========================================================================
FCNSO2 0.5 // Dimensionless
**
** This parameter is the second concrete fraction composition point for
** the UZO-CN liquidus curve corresponding to TCNLI2.
**
** ==========================================================================
FCNSO3 0.51 // Dimensionless
**
** This parameter is the third concrete fraction composition point for
** the UZO-CN liquidus curve corresponding to TCNLI3.
**
** ==========================================================================
NIWALD -1 // Dimensionless
**
** This parameter is the wall orientation for downward wall in contact
** with the corium pool. It is always set to -1.
**
** ==========================================================================
NIWALS 1 // Dimensionless
**
** This parameter is the wall orientation for sidewall wall in contact
** with the corium pool. It is always set to 1.
**

** ==========================================================================
** @@@ 4.0.3 BJS 9/28/95 - Expanded definitions of XWCNS and XWCND to
** indicate how the parameters are used in the code (TR 397I).
**
** XWCNS is the thickness of the sidewall and XWCND is the thickness of
** the floor in contact with a corium pool through which there will be a
** temperature gradient. The wall or floor is divided into 10 coarse nodes
** plus 10 fine nodes, where the thickness of the 10 fine nodes equals the
** thickness of 1 coarse node. The grid moves as the wall or floor ablates
** due to concrete attack. Temperature profiles are calculated using this
** nodalization. Specifying a larger thickness will produce coarser
** nodalization, and specifying a smaller thickness will produce finer
** nodalization. Specifying a value larger than 1.0 m is not recommended
** and was observed to give poor agreement in MCCI benchmarks with
** experimental data. These parameters should be set to the smaller value
** of either 1.0 m or the actual thickness of the concrete because a
** significant temperature gradient occurs only within 1.0 m. Users may
** want to reduce the values of these parameters to refine the
** calculations, e.q., produce a smoother temperature gradient, but the
** impact is expected to be small.
**
XWCNS 3.28 FT // Units: [M,FT]
**
**
XWCND 3.28 FT // Units: [M,FT]
**
** ==========================================================================
FGMCCI 1 // Dimensionless
**
** This parameter is a benchmarking flag defining the geometry type:
**
** = 1, Round
** = 2, Round, no side erosion
** = 3, Square, no side erosion
**
** It is always set to one, and is changed only for MCCI specific
** benchmarks.
**
** ==========================================================================
TGOS 80.33 F // Units: [K,F]
**
** @@@ 4.0.3 MAM 11/17/95 This parameter was missing from all parameter
** files.
**
** Parameter TGOS is for MCCI DECOMP benchmarking only. It is used only
** when the wall is a DECOMP sidewall and the parameter HTEXT is non-zero.
** When HTEXT is non-zero the DECOMP sidewall outer surface losses heat at
** the rate specified by HTEXT * (Tsurf - TGOS).
**
** @@@ 4.0.3 BJS 3/20/96 - Corrected units. Value was 300 F when it should
** have been 300 K = 80.33 F.
**
** ==========================================================================
** @@@ 4.0.3 MAM 11/17/95 All the Young's modulus and stress loads were moved

** to Containment Stress - Strain Failure parameter section where it belongs.
**
****************************************************************************
*Timing
****************************************************************************
*SI
**
** Parameter section Timing falls into two categories: 1) it defines
** several timing interval inputs, and 2) it defines several limiting rate
** of change quantities for code hardwired critical quantities.
**
** The list of Timing variables was expanded from the sample parameter
** files to include parameter variables that are normally set in the input
** file which can be changed during MAAP sequence, and to include output
** parameter variables of interest that are in common block timing. These
** are listed after all input parameters.
**
** The units label for this parameter section was corrected from british
** to metric. Variables TDFQMN, TDFQMX, and MDFPMN were affected. @@@4.0.3
**
** ========================================================================
TDMAX 20.0 S // Units: [S]
**
** This parameter is the maximum MAAP time step. TDMAX must be specified
** in seconds regardless of the units selected (SI or British).
**
** Warning: TDMAX is used at the beginning of a run to set up heat sink
** nodalization based on the Courant limit. Users can change TDMAX during a
** run, but they should not change it to a value greater than that used at
** the beginning. Changing it to a higher value will result in numerical
** problems.
**
** @@@ 4.0.3 BJS 3/8/96 Note that for a steady-state sequence it is
** recommended that TDMAX be reduced to values on the order of 1 second for
** BWRs and 10 seconds for PWRs for stability.
**
** ========================================================================
TDMIN 0.005 S // Units: [S]
**
** This parameter is the minimum MAAP time step. TDMIN must be specified
** in seconds regardless of the units selected (SI or British).
**
** ========================================================================
TDFQMN 1.0 S // Units: [S,HR]
**
** This parameter is the minimum plot interval frequency at which data
** will be written out to the plot files. The plot intervals will not
** be smaller than TDFQMN for all plot files. See AUTODT and PLTMAP
** subroutine write-ups in the MAAP4 Users Manual for additional
** information about how the plotting frequency is set.
**
** ========================================================================
TDFQMX 300.0 S // Units: [S,HR]
**

** This parameter is the maximum plot interval frequency at which data
** will be written out to the plot files. The plot intervals will not
** be larger than TFDQMX for all plot files. See AUTODT and PLTMAP
** subroutine write-ups in the MAAP4 Users Manual for additional
** information about how the plotting frequency is set.
**
** ==================================================================
TDMVIE 200. S // Units: [S,HR]
**
** This parameter is the time interval at which the MAAP4-GRAAPH movie
** playback data file is written.
**
**
** ==================================================================
** Since running time is at a premium, it is essential for MAAP to have an
** efficient mechanism for the selection of time step size. The selection
** method is implemented in two routines, INTGRT and INTGFP, which each
** select a time step size based on a set of selected state and rate
** variables. These two time steps are used to integrate all the variables
** in both the thermal-hydraulic and fission product MAAP models over to
** the current time step to the next one. Selection algorithms are explained
** in the INTGRT and INTGFP subroutine descriptions in the MAAP4 Users Manual,
** Volume 2.
**
** The set of state variables used in determining the maximum usable time
** step size are those specified by the user using the parameter file
** section *Integration, and those hardwired in MAAP, typically in routines
** INTGRT and INTGFP. The following Timing parameter variable definitions
** for the maximum allowable change fractions for time step size selection
** apply only to the hardwired set of state variables. Each change
** fraction description identifies what state process variable is used.
** After the time step sizes have been computed for all the selected state
** variables, the minimum time step size of all process is then selected.
**
** In general, significantly relaxing the typical values shown below for
** these variables is not recommended, as slow MAAP operation times are
** virtually always attributable to other causes.
**
** ==================================================================
MDFPMN 0.05 KG // Units: [KG,LB]
**
** This parameter is the minimum inter-node fission product mass change
** considered when selecting time step in fission product models. It is
** used with parameter variable MFCHFP.
**
** ==================================================================
MFCHFP 0.025 // Dimensionless
**
** This parameter is the maximum allowed fission product mass change
** fraction per MAAP timestep. It is used in selecting the timestep size
** based on the rate of fission product mass (greater than MDFPMN) transfer
** between compartments and between compartment and reactor vessel.
**
** ==================================================================

```
MFCHMX        0.025          // Dimensionless
**
** This parameter is the maximum allowed water mass change fraction per
** MAAP timestep.  It is used in selecting the timestep size based on water
** mass change in the primary system or in the broken steam generator when
** either system is about to go solid.
**
** ========================================================================
FTGCHX        0.02           // Dimensionless
**
** This parameter is the maximum allowed primary system pressure change
** fraction per MAAP timestep.  It is used in selecting the timestep size
** based on primary system pressure rate of change.
**
** ========================================================================
FPPSHL        0.01           // Dimensionless
**
** This parameter is the maximum allowed primary system pressure change
** fraction during half-loop operation per MAAP timestep.  It is used in
** selecting the largest allowed timestep size based on primary system
** pressure rate of change.  This parameter supersedes parameter FTGCHX
** during half-loop operation.
**
** ========================================================================
FMCHX         0.025          // Dimensionless
**
** This parameter is the maximum allowed mass change fraction per MAAP
** timestep.  Currently it is not used.
**
** ========================================================================
FUCHX         0.02           // Dimensionless
**
** This parameter is the maximum allowed energy change fraction per MAAP
** timestep.  It is used in selecting the timestep size based on the rate
** of energy changes of fuel, cladding, control rods, control blades, and
** water rods materials during core heatup.
**
** ========================================================================
FTCHX         0.02           // Dimensionless
**
** This parameter is the maximum allowed gas temperature change fraction
** per MAAP timestep.  It is used in selecting the timestep size based on
** all compartment's (containment and auxiliary building) gas temperature
** rate of change.
**
** @@@ 4.0.3 12/14/95 MAM  Added note about combustible gas burning
** excessively controlling the timestep.
**
** The value of this parameter may be relaxed from 2 to 10 percent
** especially for MAAP sequences where excessive combustible gas burning
** occured which in turn significantly reduced the overall MAAP run time due
** to spiking gas temperature without changing the overall MAAP results.
**
** ========================================================================
```

```
FWCHX         0.50          // Dimensionless
**
** This parameter is the maximum allowed water mass change fraction per
** MAAP timestep.  It is used in selecting the timestep size based on all
** compartment's water mass rate of change.
**
** ==========================================================================
FVCHX         0.05          // Dimensionless
**
** This parameter is the maximum allowed water volume change fraction per
** MAAP timestep. Currently it is not used.
**
** ==========================================================================
FPCHX         0.05          // Dimensionless
**
** This parameter is the maximum allowed pressure change fraction per
** MAAP timestep.  It is used in selecting the timestep size based on all
** compartment's gas pressure rate of change.
**
** ==========================================================================
** A list of timing input parameter variables normally set in the input
** file is presented next, some which may be of interest.
**
** TTPRNT        Units: [S,HR]
**
** This parameter is the tabular output and restart file print interval.
** It defines the interval at which the tabular output and restart file are
** written.  It is normally  set in the input file using PRINT INTERVAL IS
** statement.  It can be changed during a MAAP run using operater action or
** local parameter change for finer or coarser print intervals.
**
** TILAST        Units: [S,HR]
**
** This parameter is the sequence end time.  It defines the time at which
** the MAAP sequence is to end.  Normally it is set in the input file using
** the END TIME IS statement.  It can be set equal to the current problem
** time variable TIM during a MAAP run using operator action to terminate
** the sequence immediately.
**
** TTSTAT        Units: [S,HR]
**
** This parameter is the MAAPGRAAPH display interval.  It defines the
** time interval at which the MAAPGRAAPH graphical display is refreshed.
** This is normally set in the input file using the DISPLAY INTERVAL IS
** statement.  It is also set via a pulldown menu in the MAAPGRAAPH
** graphical picture.
**
** ==========================================================================
** A list of timing output parameter variables is presented next, some
** which may be of interest.
**
** TIOP          Units: [S,HR]
**
** This parameter is the operator intervention time.
```

**
** TIM Units: [S,HR]
**
** This parameter is the current MAAP accident time.
**
** TD Units: [S,HR]
**
** This parameter is the current MAAP accident timestep.
**
** NCRTEQ Units: [Dimensionless]
**
** This parameter is the index of the state variable controlling the timestep.
**
** TDOLD Units: [S,HR]
**
** This parameter is the previous MAAP accident timestep. This is the
** actual time step used in integrating MAAP state variables, before the
** current timestep.
**
** TIMRAT Units: [S,HR]
**
** This parameter is the ratio of MAAP timestep to hardware CPU timestep.
** It is used as a measure of continuous numerical performance, and it is
** platform specific.
**
** TDNEW Units: [S,HR]
**
** This parameter is the current initial guess for the MAAP timestep before
** the ICALL=3 iteration.
**
** TIUX Units: [S,HR]
**
** This parameter is the user defined event code intervention time.
**
** TDHUCL Units: [S,HR]
**
** This parameter is the largest allowed timestep size which is limited by
** the rate of energy change in the cladding.
**
** TDHUCR Units: [S,HR]
**
** This parameter is the largest allowed timestep size which is limited by
** the rate of energy change in the control/water rods.
**
** TDHUU2 Units: [S,HR]
**
** This parameter is the largest allowed timestep size which is limited by
** the rate of energy change in the fuel.
**
** TDHU Units: [S,HR]
**
** This parameter is the largest allowed timestep size for subroutine
** HEATUP as determined from the minimum of all individual component
** largest allowed time step sizes.

**
** TDAUXM Units: [S,HR]
**
** This parameter is the largest allowed time step size due to compartment
** gas mass fraction rate of change. The allowed gas mass fraction change
** fraction per MAAP timestep is hard-coded at 50 percent.
**
** TIPRNT Units: [S,HR]
**
** This parameter is the tabular and restart output time.
**
** TDINV Units: [1/S,1/HR]
**
** This parameter is the inverse of MAAP timestep TD.
**
** TISCRM Units: [S,HR]
**
** This parameter is the reactor scram time.
**
** TIVF Units: [S,HR]
**
** This parameter is the reactor vessel failure time.
**
** TDPXU Units: [S,HR]
**
** This parameter is the largest allowed time step size due to debris pool
** upper crust energy rate of change. The allowed crust energy change
** fraction per MAAP timestep is hard-coded at 2.5 percent.
**
** TDPXE Units: [S,HR]
**
** This parameter is the largest allowed time step size due to debris pool
** embedded crust energy rate of change. The allowed crust energy
** change fraction per MAAP timestep is hard-coded at 2.5 percent.
**
** TDPXL(5) Units: [S,HR]
**
** This parameter is the largest allowed time step size due to debris pool
** lower crust energy rate of change. The allowed crust energy change
** fraction per MAAP timestep is hard-coded at 2.5 percent.
**
** TDAVG(25) Units: [S,HR]
**
** This parameter is the plot file timestep size between plotting interval
** for the i'th plot file.
**
** TDPZR Units: [S,HR]
**
** This parameter is the largest allowed timestep size for pressurizer
** rates of change, determined by subroutine PZR via a call to FLOEXP.
**
** TIDENT Units: [S,HR]
**
** This parameter is the time at which DCH1 entrainment ends.

**
****************************************************************************
*Integration Control
****************************************************************************
**
** This parameter section is for user-defined integration control in
** selecting which parameters may be used to control the MAAP time step
** size. This parameter section is used in addition to the hardwired
** time step control parameters defined in the *Timing parameter section.
**
** Since running time is at a premium, it is essential for MAAP to have an
** efficient mechanism for the selection of time step size. The selection
** method is implemented in two routines, INTGRT and INTGFP, which each
** select a time step size based on a set of selected state and rate
** variables. These two time steps are used to integrate all the variables
** in both the thermal-hydraulic and fission product MAAP models over to
** the current time step to the next one. Selection algorithms are explained
** in the INTGRT and INTGFP subroutine descriptions in the MAAP4 Users Manual,
** Volume 2.
**
** The set of state variables used in determining the maximum usable time
** step size are those specified by the user using the parameter file
** section *Integration, and those hardwired in MAAP, typically in routines
** INTGRT and INTGFP. The following Timing parameter variable definitions
** for the maximum allowable change fractions for time step size selection
** apply only to the hardwired set of state variables. Each change
** fraction description identifies what state process variable is used.
** After the time step sizes have been computed for all the selected state
** variables, the minimum time step size of all process is then selected.
**
** There are three methods of controlling the MAAP time step in this
** parameter section. These are:
**
**     1. fractional change limitation,
**     2. threshold specified explicitly, and
**     3. threshold specified by reference to parameter input.
**
** Each of these methods is explained next. Note that only SI units are
** allowed.
**
** 1. Fractional change limitation:
** --------------------------------
**
** This method calculates the time step size as the absolute of:
**
**     maximum allowed fractional change * current value / current rate
**
** where the value and the rate are the state variable and corresponding
** state rate of change variable, respectively. Note that this is the same
** method used in subroutine INTGRT for the hardwired set of state and rate
** variables.
**
** The input syntax for this method is:
**

```
** INDEX  R  X-NAME F-NAME F-CHANGE  X-MIN  X-MAX  TRUE #1  FALSE #2
**
** where:  INDEX    = index of limiting variable
**         R        = a fractional change (i.e., a rate) limitation
**         X-NAME   = state or auxilary variable name
**         F-NAME   = rate of change variable name
**         F-CHANGE = maximum allowed fractional change
**         X-MIN    = minimum value of X-NAME for limitation
**         X-MAX    = maximum value of X-NAME for limitation
**         TRUE #1  = used when event #1 is true
**         FALSE #2 = used when event #2 is false
**
** The INDEX does not have to be sequential.  The "TRUE  #1" and "FALSE
** application to situations where specific MAAP event flags or codes are
** true or false.  When TRUE #1 is true the time step control is on,. When
** FALSE #2 is false the time step control is on.  Either "TRUE" or "FALSE"
** or both "TRUE" and "FALSE" conditions can be used.
**
** Example:
**
** 1  R  MSTPS  FMSTPS  0.05  1.E1  1.E10  TRUE  25
**
** The time step limiting variable #1 is MSTPS and the corresponding rate of
** change variable is FMSTPS.  The maximum allowed fractional change is 5%
** during a time step.  If MSTPS < 10 kg it is not used to limit the
** time step.  If MSTPS > 1.e10 kg it is not used to limit the time step.
** It is used only when event code 25 is true, i.e., the primary system
** is using the nonequilibrium thermodynamic model.
**
**
** 2. Threshold Value Explicitly Specified:
** ----------------------------------------
**
** This method (and the third third method calculates the time step size as
** the absolute of:
**
**      (current value - threshold value) / current rate
**
** where the value and the rate are the state variable and corresponding
** state rate of change variable, respectively.  It is provided as a means
** of controlling the rate of change about some abrupt change in conditions
** such as opeing relief valves, etc.  The calculated time step size will
** be relatively large until the current value approaches the threshold
** value.
**
** The input syntax for this method is:
**
** INDEX  T   X-NAME  F-NAME  THRESH
** INDEX  T+  X-NAME  F-NAME  THRESH
** INDEX  T-  X-NAME  F-NAME  THRESH
**
** where:  T     = a threshold limitation both ascending and descending
**         T+    = an ascending threshold limitation
**         T-    = an descending threshold limitation
```

```
**      THRESH = the threshold value
**
** Example:
**
** 2  T+ PPS FPPS 17.5E6
**
** The time step limiting variable #2 is PPS and the corresponding rate of
** change variable is FPPS.  The time step will be limited only if the FPPS
** rate term is positive, e.g., ascending and about the threshold boundary.
**
**
** 3. Threshold Variable Specified by Reference:
** ------------------------------------------
**
** This method is identical to the second method discussed above except
** that instead of a explict threshold number, a threshold parameter
** variable can be specified instead.
**
** The input syntax for this method is:
**
** INDEX  T  X-NAME  F-NAME  T-NAME
**
** where:  T-NAME = the variable name for the threshold
**
** Example:
**
** 3  T+ PPS FPPS PPZSVL
**
** The time step limiting variable #3 is PPS and the corresponding rate of
** change variable is FPPS.  The time step will be limited only if the FPPS
** rate term is positive, e.g., ascending and about the threshold boundary
** define by parameter variable PPZSVL.
**
**
** For all User Defined Event Codes see the *USEREVT parameter section
**
**
** Primary System Gas Mass **********************************************
**
1  R MSTPS    FMSTPS    0.025  1.E1   1.E10  FALSE  685
2  R MH2PS    FMH2PS    0.025  1.E1   1.E10
5  R MSTBS    FMSTBS    0.025  1.E1   1.E10  FALSE  158
6  R MSTUS    FMSTUS    0.025  1.E1   1.E10  FALSE  167
**
** Primary System Water Mass *******************************************
**
7  R MWBI     FMWBI     0.025  1.E2   1.E10  FALSE  10
8  R MWUI     FMWUI     0.025  1.E2   1.E10  FALSE  10
9  R MACUM    FMACUM    0.025  1.E2   1.E10
10 R MWCR     FMWCR     0.025  1.E2   1.E10  TRUE   686
11 R MWDC     FMWDC     0.025  1.E2   1.E10
12 R MUHI     FMUHI     0.025  1.E2   1.E10
13 R MWBS     FMWBS     0.025  1.E2   1.E10  FALSE  158
14 R MWUS     FMWUS     0.025  1.E2   1.E10  FALSE  167
```

```
**
** Primary System Gas Temperature *************************************
**
15 R TGPS    FTGPS    0.02  1.E2  1.E4  TRUE  25
**
** Reactor Pressure Vessel Failure ************************************
**
16 R XRVP    FXRVP    0.02  1.E-3 1.E10 TRUE  3
**
** Lower Plenum Debris ************************************************
**
** @@@ 4.0.3 MAM 12/8/95  Increased the low limit from 1.e4 to 2.e6
17 R UCMPS    FUCMPS    0.5   2.E6  1.E10 TRUE  3
**
** Compartment Mass and Energy ****************************************
**
18 R MSTRB(9) FMSTRB(9) 0.05  1.E0  1.E10 FALSE 132
19 R UGRB(9)  FUGRB(9)  0.05  1.E0  1.E10 FALSE 132
**
END
****************************************************************************
*Pltmap
****************************************************************************
*BR
**
** ========================================================================
**                   General Notes
** ========================================================================
**
** In addition to the following notes citing general format and structure
** of this parameter file section, it is recommended that the user consult
** the following references in the MAAP4 User's Manual:
**
**    i) the PLTMAP subroutine description in Volume 2, and
**    ii) the PLOTFIL section within the General Input Decks description
**        in Section 3 Volume 1.
**
** These references, which contain essentially the same information,
** provide detailed information that is the basis for the abridged notes
** here.  The former and latter references describe plot file definitions
** in the *PLTMAP section of the parameter file and in the PLOTFIL section
** of the input deck, respectively.
**
**
**
** 1)  This parameter file section enables user-definition of the number
**     and content of plot file outputs from the code as well as the plot
**     point frequency; that is, the time spacing between plotted data
**     points.  This section allows a maximum of 25 plot files and 99
**     variables per plot file.
**
** 2)  Plot file definitions can be made in the input deck using the same
**     format as that discussed for the *PLTMAP section.  As noted above,
**     consult the PLOTFIL section in Section 3 Volume 1 of the User's
```

```
**    Manual.
**
** 3)  Variables in nearly all MAAP common blocks can be designated within
**    a plot file.  Exceptions are variables in common blocks that contain
**    both real and integer variables and variables in some utility common
**    blocks.  To simplify the distinction between eligible and ineligible
**    common blocks, a list of eligible common blocks is available upon
**    request from the MAAP Maintenance Group.
**
**    ------------------------
** 4)  UNITS CONVERSION WARNING:
**    ------------------------
**
**    A correspondence between the MAAP naming convention and physical
**    quantity units exists.  For instance, variable names beginning with
**    "TD" are assumed to be time variables with units of seconds (SI) or
**    hours (BR).
**
**    Virtually all input parameters conform to this convention, which
**    facilitates correct units conversion for British input parameters.
**    However, since potential plotted output variable encompass a much
**    larger group, spanning all eligible common blocks, it cannot be
**    categorically assured that all output variables will conform to the
**    naming and units convention.
**
**    For example, array SIGW(x,y) is the stress in the nodes of the RPV
**    lower head.  However, it does not conform to the naming convention.
**    String "SIGW" is not affliated with any units in the convention.
**    Therefore, it is assumed dimensionless and has no British conversion
**    factor.
**
**    In a worst case scenario, a non-conforming variable may become
**    affiliated with the wrong units.  For example, the name of a
**    non-conforming flow rate may be such that it is erroneously assumed
**    to have pressure units per the convention.  In this case, the wrong
**    conversion factor would be affiliated with the variable.
**
**    Therefore, while most variables do conform to the convention, if
**    there is a doubt regarding conformity, the variable in question
**    should be plotted in SI units.  This will eliminate a potentially
**    erroneous conversion to BR units.
**
** 5)  Plot file frequency format within *PLTMAP parameter section:
**
**    The frequency of data acquistion for all plot files is defined by
**    the following line within the *PLTMAP section:
**
**    FREQ <minimum plot period> <maximum plot period>
**
**    The bounding plot frequencies are expressed in terms of a minimum
**    and maximum time period between data points.  For instance, the
**    specification:
**
**    FREQ 1.0 300.0
```

```
**
**    sets the minimum and maxium time periods at 1 and 300 seconds,
**    respectively.
**
**    Note, when using this format, the bounding time periods should
**    ALWAYS be expressed in terms of seconds, regardless of the
**    prevailing units designation within this parameter file section.
**
**    The FREQ statement can also be specified in the PLOTFIL section of
**    the input file. Consult the PLOTFIL description within Section 3
**    Volume 1 of the MAAP4 User's Manual.
**
** 6)  Plot file frequency format within *TIMING parameter section:
**
**    An equivalent method of establishing the bounding time periods for
**    plotting is the specification of parameters TDFQMN (minimum plot
**    period) and TDFQMX (maximum plot period) in the *TIMING section.
**    This method allows for units specification other than SI (seconds).
**
**    These parameters can also be defined within the input file via a
**    local parameter change or operator action.
**
** 7)  Plot file definition format:
**
**    A plot file definition begins with the PLOTFIL definition statement:
**
**    PLOTFIL <file spec> // <comment>
**
**    where <file spec> = a filename or a FORTRAN unit number
**          <comment>   = a comment string, such as a description of the
**                        plot file contents
**
**    The definition ends with either a PLOTFIL definition statement for
**    another plot file or the END statement. Also, the character strings
**    " / " or " // " (spaces included) can be used to indicate the start
**    of a descriptive comment string. (The use of " // ", instead of
**    " / ", is recommended.)
**
**    The variable names to be included in the plot file are then
**    specified between these markers. All names specified on a given
**    line should be separated by commas or a space. As many names as
**    desired can be placed on a line within a limit of 80 columns. There
**    is no limit on the number of lines containing variable names,
**    provided the total number of variables for the file does not exceed
**    99. Individual comment lines, beginning with "**", are also allowed
**    in the variable specification block within the plot file definition.
**
** 8)  In addition to the basic specification of a variable within the plot
**    file definition, some more advanced attributes can be added to the
**    variable specification by using the AVERAGE and CRITERION
**    statements. Consult the PLTMAP subroutine description in Volume 2
**    of the User's Manual for details regarding their usage.
**
**    Other advanced features discussed within this reference are the
```

```
**    TIMOFF and TIME statements.
**
** 9)  The format of numerical values in the plot file output is specified
**     by parameter IPLT1.  Consult the IPLT1 description in the *CONTROL
**     section of the parameter file for details regarding format options.
**
** 10) When designating FORTRAN unit numbers in the PLOTFIL definition
**     statement, remember to avoid conflict with unit numbers that are
**     already assigned to other MAAP input and output files, such as the
**     input deck, parameter file, log file and tabular output file(s).
**     The default (or user-selectable) unit numbers for such files are
**     documented in Section 2 Volume 1 of the MAAP4 User's Manual.
**
**     In view of the potential conflicts, the best approach is to utilize
**     a continuous series of unit numbers that resides outside the range
**     of pre-assigned numbers.  For instance, the sample plot files
**     provided in this parameter file section are conventionally assigned
**     sequential unit numbers in the range 31 - 38.
**
**     If a unit number, as opposed to a filename, is specified in the
**     PLOTFIL definition statement, the default filename for the plot file
**     uses the input deck root filename as its root filename.  The file
**     type is then a concatenation of string "D" and the unit number.  For
**     instance, if the input deck is TMLB.INP, then the filename for plot
**     file #31 will be TMLB.D31.
**
** 11) Individual plot files specified in this section can be deactivated
**     by simply commenting out ("**") the corresponding block of lines.
**
**
** ======================================================================
**                    Plot File Definitions
** ======================================================================
**
** @@@ 4.0.3 CEH 12/6/95
** Note: Maximum plotting period has been changed to be
**      consistent with parameter TDFQMX.
**
FREQ 1.0 300.0
**
*********************************************************************
PLOTFIL 31 / PRIMARY SYSTEM, PZR, STEAM GENERATOR & ESF
**
** CORE & PRIMARY PRESSURE BOUNDARY
**
MCR   / total mass of core material remaining in core
criterion MH2CR 500 KG / integrated mass of H2 generated in core
MWCR  / mass of water in core
average QWCR     / heat transfer from core to water
TWCR  / temperature of water in core
ZWV   / boiled-up water level measured from bottom of RPV
WGUPCR / natural circ flow rate between upper plenum & core
MH2CBT / integrated mass of H2 generated from CCI in containment
criterion PPS 22.e6 pa / pressure in primary system
```

TCMPS / temperature of total debris bed in lower plenum
TWUI / temperature of water in unbroken intermediate leg
criterion TGPS 1200 k / temperature of gas in primary system
ZWCPS / collapsed water level in primary system (from bottom of RPV)
WWUL / one loop pumped flow rate of water in unbroken loop
MWPS / mass of water in primary system excluding pressurizer
MH2PS1 / mass of H2 in primary system
MDWTOT / global balance of water in primary system & containment
MCMTPS / mass of total debris + metal layer in lower plenum
MLTCR / mass of total molten core material in core
ZWBC / water level in broken cold leg (from bottom of RPV)
ZWUC / water level in unbrkn cold leg (from bottom of RPV)
TWBI / temperature of water in unbroken intermediate leg
TCRHOT / maximum core temperature
WHLBL / nat circ between upper plenum & S/G in broken loop
WSGBL / nat circ between S/G inlet & outlet plena in broken loop
TSGBHP / temperature of gas in S/G inlet plenum in broken loop
WSTCMP / total steaming rate from debris bed & jet in lower plenum
average QWLP / heat transfer rate from debris to water in lower plenum
FSTQNJ / ratio of heat loss as steam to heat source in lower plenum
**
** PRESSURIZER
**
criterion TGPZ 1200 k / temperature of gas in pressurizer
TWPZ / temperature of water in pressurizer
criterion PPZ 22.e6 pa / pressure in pressurizer
ZWPZ / collapsed water level in pressurizer
MH2PZ1 / mass of H2 in pressurizer
TSR1 / temperature of surge line metal
**
ZWBH / water level in broken loop hot leg
ZWUH / water level in unbroken loop hot leg
WHLUL / countercurrent flow rate of gas in unbroken hot leg
WSGUL / countercurrent flow rate of gas in unbroken S/G tubes
TGUP / temperature of gas in upper plenum
**
** STEAM GENERATORS
**
ZWBS / collapsed water level in broken S/G downcomer
PBS / pressure in broken S/G
criterion TGBS 1200 k / temperature of gas in broken S/G
ZWUS / collapsed water level in unbroken S/G downcomer
PUS / pressure in unbroken S/G
criterion TGUS 1200 k / temperature of gas in unbroken S/G
TWBS / temperature of water in broken S/G
TWUS / temperature of water in unbroken S/G
average QSGTOT / total heat transfer from pri. sys. water to secondary
WCDHBS / flow rate of condensate on hot side of broken S/G
**
** ENGINEERED SAFEGUARDS
**
PACUM / pressure in accumulator
ZWRWST / water level in refueling water storage tank
WESFDC / flow rate of ESF water to downcomer nodes

WESFCL / flow rate of ESF water to cold leg nodes
PQT / pressure in quench tank
TWQT / temperature of water in quench tank
MH2QT1 / mass of H2 in quench tank
**
** PRIMARY SYSTEM / CONTAINMENT INTERFACE FLOWS
**
average WWBB / flow rate of water out of broken loop break
average WGBB / flow rate of gas out of broken loop break
average WWUB / flow rate of water out of unbroken loop break
average WGUB / flow rate of gas out of unbroken loop break
average WWVP / flow rate of water out of RPV failure
average WGVP / flow rate of gas out of RPV failure
average WWRV / flow rate of water out of pressurizer relief valve
average WGRV / flow rate of gas out of pressurizer relief valve
average WWBST / flow rate of water out of broken S/G relief valve
average WGBST / flow rate of gas out of broken S/G relief valve
average WSTUSB / flow rate of steam out of main steam line break
average WWRD / flow rate of water out of quench tank rupture disk
average WSTRD / flow rate of steam out of quench tank rupture disk
**
** TIME STEP CONTROL
**
TDOLD / previous time step size
TDINV / inverse of previous time step size
NCRTEQ / ID no. of MAAP global time step controlling variable
TIMRAT / accident-to-CPU time ratio
**
** CORE ENERGY BALANCE
**
UDECT / decay energy
URATT / oxidation energy
URADT / energy loss by radiation
UHTNT / energy loss by core flow
UMLNT / energy loss by melt flow
UNODT / energy gain in core nodes
UPROD / total energy produced = UDECT + URATT
ULOSS / total energy tracked = URADT + UHTNT + UMLNT + UNODT
UCMCR / energy out of core carried by melt
URADBF / radiation energy received by core shroud
MH2CR1 / integrated H2 generation from core
MH2CR2 / integrated H2-steam balance = 0, if balanced
MH2SCR / integrated H2 generation from core barrel surface
MH2SDC / integrated H2 generation from downcomer surface
MH2SUP / integrated H2 generation from UPI surface
MH2S / total H2 generation from surface = MH2SCR+MH2SDC+MH2SUP
VFPS / AVERAGE VOID FRACTION IN PRIMARY SYSTEM
**
**********************************************************************
PLOTFIL 32 / CONTAINMENT JUNCTION INFO.
**
** JUNCTIONS:
**
** 1) CAVITY THRU BYPASS - LOWER COMPT

** 2) CAVITY THRU TUNNEL - LOWER COMPT
** 3) LOWER COMPT - ANNULAR COMPT
** 4) LOWER COMPT - UPPER CYLINDER
** 5) LOWER COMPT - ICE COND COMPT
** 6) UPPER DOME - ENVIRONMENT (FAILURE JUNCTION)
** 7) UPPER CYLINDER - UPPER DOME
** 8) UPPER DOME - UPPER SPRAY
** 9) ICE COND COMPT - ICE UPPER COMPT
** 10) ICE UPPER COMPT - UPPER DOME
**
** GAS FLOW
**
WRB(1) / gas flow rate through junction 1
WRB(2) / gas flow rate through junction 2
WRB(3) / gas flow rate through junction 3
WRB(4) / gas flow rate through junction 4
WRB(5) / gas flow rate through junction 5
WRB(6) / gas flow rate through junction 6
WRB(7) / gas flow rate through junction 7
WRB(8) / gas flow rate through junction 8
WRB(9) / gas flow rate through junction 9
WRB(10) / gas flow rate through junction 10
**
** COUNTER-CURRENT GAS FLOW
**
WCCRB(1) / counter-current gas flow rate through junction 1
WCCRB(2) / counter-current gas flow rate through junction 2
WCCRB(3) / counter-current gas flow rate through junction 3
WCCRB(4) / counter-current gas flow rate through junction 4
WCCRB(5) / counter-current gas flow rate through junction 5
WCCRB(6) / counter-current gas flow rate through junction 6
WCCRB(7) / counter-current gas flow rate through junction 7
WCCRB(8) / counter-current gas flow rate through junction 8
WCCRB(9) / counter-current gas flow rate through junction 9
WCCRB(10) / counter-current gas flow rate through junction 10
**
** WATER FLOW
**
WWRB(1) / water flow rate through junction 1
WWRB(2) / water flow rate through junction 2
WWRB(3) / water flow rate through junction 3
WWRB(4) / water flow rate through junction 4
WWRB(5) / water flow rate through junction 5
WWRB(6) / water flow rate through junction 6
WWRB(7) / water flow rate through junction 7
WWRB(8) / water flow rate through junction 8
WWRB(9) / water flow rate through junction 9
WWRB(10) / water flow rate through junction 10
**
** COUNTER-CURRENT WATER FLOW
**
WWCCRB(1) / counter-current water flow rate through junction 1
WWCCRB(2) / counter-current water flow rate through junction 2
WWCCRB(3) / counter-current water flow rate through junction 3

```
WWCCRB(4)  / counter-current water flow rate through junction 4
WWCCRB(5)  / counter-current water flow rate through junction 5
WWCCRB(6)  / counter-current water flow rate through junction 6
WWCCRB(7)  / counter-current water flow rate through junction 7
WWCCRB(8)  / counter-current water flow rate through junction 8
WWCCRB(9)  / counter-current water flow rate through junction 9
WWCCRB(10) / counter-current water flow rate through junction 10
**
*******************************************************************
PLOTFIL 33 / CONTAINMENT COMPARTMENTS (1 to 4) INFO.
**
** COMPARTMENTS: 1. CAVITY COMPARTMENT
**            2. LOWER COMPARTMENT
**            3. UPPER CYLINDER COMPARTMENT
**            4. ANNULAR COMPARTMENT
**
** Note that PRB(i) is the pressure in compartment i provided that the
** compartment is not solid (filled with water). PEX0(i) is the pressure
** in the compartment if it is solid or not. PRB(i) = PEX0(i) only if
** the compartment is not solid. PEX0(i) can be plotted just like PRB(i).
** If it is anticipated that a compartment will become solid, PEX0(i)
** should be plotted instead.
**
** CAVITY
**
PRB(1)     / pressure in compt 1
TGRB(1)    / temperature of gas in compt 1
PPSTRB(1)  / partial pressure of steam in compt 1
MWRB(1)    / mass of water in compt 1
TWRB(1)    / temperature of water in compt 1
ZWRB(1)    / collapsed water level (from bottom of floor) in compt 1
MGRB(1)    / mass of gas in compt 1
MSTRB(1)   / mass of steam in compt 1
NFSTRB(1)  / mole fraction of steam in compt 1
NFH2RB(1)  / mole fraction of H2 in compt 1
NFO2RB(1)  / mole fraction of O2 in compt 1
NFN2RB(1)  / mole fraction of N2 in compt 1
NFC2RB(1)  / mole fraction of C2 in compt 1
NFCORB(1)  / mole fraction of CO in compt 1
MCMTB(1)   / mass of total corium pool in compt 1
TCMB(1)    / average temperature of corium pool in compt 1
TCMIB(1)   / temperature of corium pool surface facing gas in compt 1
TCNDI(1)   / downward corium-concrete interface temperature in compt 1
TCNSI(1)   / sideward corium-concrete interface temperature in compt 1
ZCMB(1)    / height of corium pool in compt 1
XCNDB(1)   / thickness of downward facing crust in corium in compt 1
XCNSB(1)   / thickness of sideward facing crust in corium in compt 1
TCMMPB(1)  / melting temperature of corium pool in compt 1
FXCNDB(1)  / rate of change of XCNDB(1) in compt 1
FXCNSB(1)  / rate of change of XCNSB(1) in compt 1
**
** LOWER COMPT
**
PRB(2)     / pressure in compt 2
```

TGRB(2) / temperature of gas in compt 2
PPSTRB(2) / partial pressure of steam in compt 2
MWRB(2) / mass of water in compt 2
TWRB(2) / temperature of water in compt 2
ZWRB(2) / collapsed water level (from bottom of floor) in compt 2
MGRB(2) / mass of gas in compt 2
MSTRB(2) / mass of steam in compt 2
NFSTRB(2) / mole fraction of steam in compt 2
NFH2RB(2) / mole fraction of H2 in compt 2
NFO2RB(2) / mole fraction of O2 in compt 2
NFN2RB(2) / mole fraction of N2 in compt 2
NFC2RB(2) / mole fraction of C2 in compt 2
NFCORB(2) / mole fraction of CO in compt 2
MCMTB(2) / mass of total corium pool in compt 2
TCMB(2) / average temperature of corium pool in compt 2
TCMIB(2) / temperature of corium pool surface facing gas in compt 2
TCNDI(2) / downward corium-concrete interface temperature in compt 2
TCNSI(2) / sideward corium-concrete interface temperature in compt 2
ZCMB(2) / height of corium pool in compt 2
XCNDB(2) / thickness of downward facing crust in corium in compt 2
XCNSB(2) / thickness of sideward facing crust in corium in compt 2
TCMMPB(2) / melting temperature of corium pool in compt 2
FXCNDB(2) / rate of change of XCNDB(2) in compt 2
FXCNSB(2) / rate of change of XCNSB(2) in compt 2
**
** UPPER CYLINDER
**
PRB(3) / pressure in compt 3
TGRB(3) / temperature of gas in compt 3
PPSTRB(3) / partial pressure of steam in compt 3
MWRB(3) / mass of water in compt 3
TWRB(3) / temperature of water in compt 3
ZWRB(3) / collapsed water level (from bottom of floor) in compt 3
MGRB(3) / mass of gas in compt 3
MSTRB(3) / mass of steam in compt 3
NFSTRB(3) / mole fraction of steam in compt 3
NFH2RB(3) / mole fraction of H2 in compt 3
NFO2RB(3) / mole fraction of O2 in compt 3
NFN2RB(3) / mole fraction of N2 in compt 3
NFC2RB(3) / mole fraction of C2 in compt 3
NFCORB(3) / mole fraction of CO in compt 3
**
** ANNULAR COMPT
**
PRB(4) / pressure in compt 4
TGRB(4) / temperature of gas in compt 4
PPSTRB(4) / partial pressure of steam in compt 4
MWRB(4) / mass of water in compt 4
TWRB(4) / temperature of water in compt 4
ZWRB(4) / collapsed water level (from bottom of floor) in compt 4
MGRB(4) / mass of gas in compt 4
MSTRB(4) / mass of steam in compt 4
NFSTRB(4) / mole fraction of steam in compt 4
NFH2RB(4) / mole fraction of H2 in compt 4

```
NFO2RB(4)  / mole fraction of O2 in compt 4
NFN2RB(4)  / mole fraction of N2 in compt 4
NFC2RB(4)  / mole fraction of C2 in compt 4
NFCORB(4)  / mole fraction of CO in compt 4
**
*********************************************************************
PLOTFIL 64 / CONTAINMENT COMPARTMENTS (5 to 9) INFO.
**
** COMPARTMENTS: 5. UPPER DOME COMPARTMENT
**             6. UPPER SPRAY COMPARTMENT
**             7. STEEL SHELL COMPARTMENT
**             8. ICE CONDENSER UPPER COMPARTMENT
**             9. ICE CONDENSER COMPARTMENT
**
** UPPER DOME
**
PRB(5)     / pressure in compt 5
TGRB(5)    / temperature of gas in compt 5
PPSTRB(5)  / partial pressure of steam in compt 5
MWRB(5)    / mass of water in compt 5
TWRB(5)    / temperature of water in compt 5
ZWRB(5)    / collapsed water level (from bottom of floor) in compt 5
MGRB(5)    / mass of gas in compt 5
MSTRB(5)   / mass of steam in compt 5
NFSTRB(5)  / mole fraction of steam in compt 5
NFH2RB(5)  / mole fraction of H2 in compt 5
NFO2RB(5)  / mole fraction of O2 in compt 5
NFN2RB(5)  / mole fraction of N2 in compt 5
NFC2RB(5)  / mole fraction of C2 in compt 5
NFCORB(5)  / mole fraction of CO in compt 5
**
** UPPER SPRAY
**
PRB(6)     / pressure in compt 6
TGRB(6)    / temperature of gas in compt 6
PPSTRB(6)  / partial pressure of steam in compt 6
MWRB(6)    / mass of water in compt 6
TWRB(6)    / temperature of water in compt 6
ZWRB(6)    / collapsed water level (from bottom of floor) in compt 6
MGRB(6)    / mass of gas in compt 6
MSTRB(6)   / mass of steam in compt 6
NFSTRB(6)  / mole fraction of steam in compt 6
NFH2RB(6)  / mole fraction of H2 in compt 6
NFO2RB(6)  / mole fraction of O2 in compt 6
NFN2RB(6)  / mole fraction of N2 in compt 6
NFC2RB(6)  / mole fraction of C2 in compt 6
NFCORB(6)  / mole fraction of CO in compt 6
**
** STEEL SHELL
**
PRB(7)     / pressure in compt 7
TGRB(7)    / temperature of gas in compt 7
PPSTRB(7)  / partial pressure of steam in compt 7
MWRB(7)    / mass of water in compt 7
```

TWRB(7) / temperature of water in compt 7
ZWRB(7) / collapsed water level (from bottom of floor) in compt 7
MGRB(7) / mass of gas in compt 7
MSTRB(7) / mass of steam in compt 7
NFSTRB(7) / mole fraction of steam in compt 7
NFH2RB(7) / mole fraction of H2 in compt 7
NFO2RB(7) / mole fraction of O2 in compt 7
NFN2RB(7) / mole fraction of N2 in compt 7
NFC2RB(7) / mole fraction of C2 in compt 7
NFCORB(7) / mole fraction of CO in compt 7
**
** ICE CONDENSER U COMPT
**
PRB(8) / pressure in compt 8
TGRB(8) / temperature of gas in compt 8
PPSTRB(8) / partial pressure of steam in compt 8
MWRB(8) / mass of water in compt 8
TWRB(8) / temperature of water in compt 8
ZWRB(8) / collapsed water level (from bottom of floor) in compt 8
MGRB(8) / mass of gas in compt 8
MSTRB(8) / mass of steam in compt 8
NFSTRB(8) / mole fraction of steam in compt 8
NFH2RB(8) / mole fraction of H2 in compt 8
NFO2RB(8) / mole fraction of O2 in compt 8
NFN2RB(8) / mole fraction of N2 in compt 8
NFC2RB(8) / mole fraction of C2 in compt 8
NFCORB(8) / mole fraction of CO in compt 8
**
** ICE CONDENSER COMPT
**
PRB(9) / pressure in compt 9
TGRB(9) / temperature of gas in compt 9
PPSTRB(9) / partial pressure of steam in compt 9
MWRB(9) / mass of water in compt 9
TWRB(9) / temperature of water in compt 9
ZWRB(9) / collapsed water level (from bottom of floor) in compt 9
MGRB(9) / mass of gas in compt 9
MSTRB(9) / mass of steam in compt 9
NFSTRB(9) / mole fraction of steam in compt 9
NFH2RB(9) / mole fraction of H2 in compt 9
NFO2RB(9) / mole fraction of O2 in compt 9
NFN2RB(9) / mole fraction of N2 in compt 9
NFC2RB(9) / mole fraction of C2 in compt 9
NFCORB(9) / mole fraction of CO in compt 9
**
*****************************************************************
PLOTFIL 65 / ICE CONDENSER SPECIFIC INFO.
**
MICE / mass of ice
AICE / remaining ice surface area
QGICE / energy rate from gas to ice
WMLICE / ice melting rate
WCDICE / condensation rate on ice
QWICE / water energy rate from condensate & ice melting

WCPI / sum of WG*CP inflow
QGNCI / sum of non-condensiable gas energy inflow
TWSTI / average inflow steam saturation temperature
TGI / average inflow gas temeprature
HSTI / average inflow steam enthaply
WGSIC / sum of total inflow WG to ice compt
WGIIC(1) / flow rate of steam into ice compt
WGIIC(2) / flow rate of H2 into ice compt
WGIIC(3) / flow rate of O2 into ice compt
WGIIC(4) / flow rate of N2 into ice compt
WGIIC(5) / flow rate of CO into ice compt
WGIIC(6) / flow rate of CO2 into ice compt
WGOIC(1) / flow rate of steam from ice compt
WGOIC(2) / flow rate of H2 from ice compt
WGOIC(3) / flow rate of O2 from ice compt
WGOIC(4) / flow rate of N2 from ice compt
WGOIC(5) / flow rate of CO from ice compt
WGOIC(6) / flow rate of CO2 from ice compt
WGFNA / fan flow rate
QGFN / fan gas power exchange
TOUTI / ice compt exit temperature
TEX0I / actual ice compt exit temperature
**
*******************************************************************
PLOTFIL 34 / DETAILED PRIMARY SYSTEM THERMAL HYDRAULIC INFO.
**
** GAS TEMPERATURE
**
TGCR / temperature of gas in core
TGUP / temperature of gas in upper plenum
TGBH / temperature of gas in broken hot leg
TGBHT / temperature of gas in broken hot tube
TGBCT / temperature of gas in broken cold tube
TGBIL / temperature of gas in broken intermediate leg
TGBC / temperature of gas in broken cold leg
TGDC / temperature of gas in downcomer and lower head
TGUH / temperature of gas in unbroken hot leg
TGUHT / temperature of gas in unbroken hot tube
TGUCT / temperature of gas in unbroken cold tube
TGUIL / temperature of gas in unbroken intermediate leg
TGUC / temperature of gas in unbroken cold leg
TGDM / temperature of gas in upper head and dome
**
** HEAT SINK TEMPERATURE
**
TPHSF(1) / surface temperature of core side lower core barrel
TPHSF(2) / surface temperature of UPI
TPHSF(3) / surface temperature of UP side of upper core barrel
TPHSF(4) / surface temperature of UP side of dome plate
TBH(2,1) / surface temperature of broken hot leg pipes
TPHSF(6) / surface temperature of broken hot tubes
TPHSF(7) / surface temperature of broken cold tubes
TPHSF(8) / surface temperature of broken intermediate leg pipes
TPHSF(9) / surface temperature of broken cold leg pipes

TPHSF(10) / surface temperature of RPV shell below flange
TPHSF(11) / surface temperature of DC side of lower core barrel
TPHSF(12) / surface temperature of DC side of upper core barrel
TUH(2,1) / surface temperature of unbroken hot leg pipes
TPHSF(14) / surface temperature of unbroken hot tubes
TPHSF(15) / surface temperature of unbroken cold tubes
TPHSF(16) / surface temperature of unbroken intermediate leg pipes
TPHSF(17) / surface temperature of unbroken cold leg pipes
TPHSF(18) / surface temperature of upper head side of up. plen. plate
TPHSF(19) / surface temperature of inside of RPV dome
**
** CIRCULATION FLOW
**
WVUL / volume flow rate from upper plenum to one unbroken loop
WVBL / volume flow rate from upper plenum to one broken loop
FLOSS / heat loss from PS & S/G to containment divided by decay heat
W(8) / flow rate from downcomer to core
W(1) / flow rate from core to upper plenum
W(2) / flow rate from upper plenum to broken hot leg
W(3) / flow rate from broken hot leg to hot leg tubes
W(4) / flow rate from broken hot leg tubes to cold leg tubes
W(5) / flow rate from broken cold leg tubes to intermediate leg
W(6) / flow rate from broken intermediate leg to cold leg
W(7) / flow rate from broken cold leg to downcomer
W(9) / flow rate from unbroken hot leg to hot leg tubes
W(10) / flow rate from unbroken hot leg tubes to cold leg tubes
W(11) / flow rate from unbroken cold leg tubes to intermediate leg
W(12) / flow rate from unbroken intermediate leg to cold leg
W(13) / flow rate from unbroken cold leg to downcomer
W(14) / flow rate from RPV dome to upper plenum
W(15) / flow rate from RPV failure to cavity
W(16) / flow rate from RPV failure to lower compartment
W(17) / flow rate through broken loop break
W(18) / flow rate through unbroken loop break
WGSR / flow rate of gas through PZR surge line per FLOEXP routine
WGSB / flow rate of gas through PZR surge line per SURGE routine
**
**********************************************************************
PLOTFIL 35 / FISSION PRODUCT INFO.
**
** FISSION PRODUCT RELEASE FROM CONTAINMENT
**
FREL(1) / mass fraction of inert aerosol released to environment
FREL(2) / mass fraction of CsI released to environment
FREL(3) / mass fraction of TeO2 released to environment
FREL(4) / mass fraction of SrO released to environment
FREL(5) / mass fraction of MoO2 released to environment
FREL(6) / mass fraction of CsOH released to environment
FREL(7) / mass fraction of BaO released to environment
FREL(8) / mass fraction of La2O3, etc. released to environment
FREL(9) / mass fraction of CeO2 released to environment
FREL(10) / mass fraction of Sb released to environment
FREL(11) / mass fraction of Te2 released to environment
FREL(12) / mass fraction of UO2, etc. released to environment

**
MAIRPS / airborne mass of gas (w/o noble)/aerosol in pri. sys.
MAIRC / airborne mass of gas (w/o noble)/aerosol in containment
MFCSIP / mass fraction of CsI in primary system
MFCSIC / mass fraction of CsI in containment
**
QFPHSF(1) / deposited FP heating on core side of lower core barrel
QFPHSF(2) / deposited FP heating on UPI
QFPHSF(3) / deposited FP heating on UP side of upper core barrel
QFPHSF(4) / deposited FP heating on UP side of dome plate
QFPHSF(5) / deposited FP heating on broken hot leg pipes
QFPHSF(6) / deposited FP heating on broken hot tubes
QFPHSF(7) / deposited FP heating on broken cold tubes
QFPHSF(8) / deposited FP heating on broken intermediate leg pipes
QFPHSF(9) / deposited FP heating on broken cold leg pipes
QFPHSF(10) / deposited FP heating on RPV shell below flange
QFPHSF(11) / deposited FP heating on DC side of lower core barrel
QFPHSF(12) / deposited FP heating on DC side of upper core barrel
QFPHSF(13) / deposited FP heating on unbroken hot leg pipes
QFPHSF(14) / deposited FP heating on unbroken hot tube
QFPHSF(15) / deposited FP heating on unbroken cold tubes
QFPHSF(16) / deposited FP heating on unbroken intermediate leg pipes
QFPHSF(17) / deposited FP heating on unbroken cold leg pipes
QFPHSF(18) / deposited FP heating on upper head side of up.plen. plate
QFPHSF(19) / deposited FP heating on inside of RPV dome
QGFPPS(1) / suspended FP heating in core
QGFPPS(2) / suspended FP heating in upper plenum
QGFPPS(3) / suspended FP heating in broken hot leg
QGFPPS(4) / suspended FP heating in broken hot tube
QGFPPS(5) / suspended FP heating in broken cold tube
QGFPPS(6) / suspended FP heating in broken intermediate leg
QGFPPS(7) / suspended FP heating in broken cold leg
QGFPPS(8) / suspended FP heating in downcomer and lower head
QGFPPS(9) / suspended FP heating in unbroken hot leg
QGFPPS(10) / suspended FP heating in unbroken hot tube
QGFPPS(11) / suspended FP heating in unbroken cold tube
QGFPPS(12) / suspended FP heating in unbroken intermediate leg
QGFPPS(13) / suspended FP heating in unbroken cold leg
QGFPPS(14) / suspended FP heating in upper head and dome
**
*********************************************************************
PLOTFIL 36 / LOWER PLENUM DEBRIS BED BEHAVIOR
**
MWDC / mass of water in downcomer & lower head
MCMTPS / mass of total debris bed in RPV lower plenum
MPBPS / mass of particulate bed in lower plenum
MSSPS / mass of metal layer
MCRUMT / mass of oxide central pool
MXPSU / mass of oxide upper crust
MXPSLT / mass of total oxide lower crusts
MEQPS(1) / mass of equipment in lower plenum
**
TWDC / temperature of water in downcomer & lower head
TCMPS / temperature of total debris bed in lower plenum

```
TPBPS     / temperature of particulate bed
TSSPS     / temperature of metal layer
TCRUMT    / temperature of oxide debris pool
TXPSU     / temperature of oxide upper crust
TXPSL(1)  / temperature of oxide lower crust 1
TXPSL(2)  / temperature of oxide lower crust 2
TXPSL(3)  / temperature of oxide lower crust 3
TXPSL(4)  / temperature of oxide lower crust 4
TXPSL(5)  / temperature of oxide lower crust 5
TCMMPP    / melting temperature of total debris
TPBPMP    / melting temperature of particulate debris
TSSPMP    / melting temperature of metal layer
TCMBMP    / melting temperature of oxide debris
TPSHS     / temperature of heat sink facing debris
TEQPS(1)  / temperature of equipment in lower plenum
**
ZCMLP     / elevation of total debris bed from RPV bottom
ZCRIUM    / elevation of oxide debris bed from RPV bottom
XPBPS     / thickness of particulate debris
XSSPS     / thickness of metal layer
XXPSU     / thickness of upper crust
XXPSL(1)  / thickness of lower crust 1
XXPSL(2)  / thickness of lower crust 2
XXPSL(3)  / thickness of lower crust 3
XXPSL(4)  / thickness of lower crust 4
XXPSL(5)  / thickness of lower crust 5
XDPBPS    / average diameter of particles in particulate bed
**
WSTCMP    / total steaming rate from debris bed & jet in lower plenum
WSTLP     / steaming rate from debris jet quenching in lower plenum
WH2PVA    / H2 generation rate upon debris particle oxidation
WSTPVA    / water consumption rate upon debris particle oxidation
WCMTJ     / debris jet total flow rate
WCMENT    / debris jet entrainment flow rate
WMLPB     / melting rate of particulate debris to continuum debris
**
QCMCR     / debris energy flow rate out of core
QCMDEC    / total decay power in the lower plenum debris
QCMHS     / total upward heat transfer from debris to heat sink
QCMLP     / actual heat removal from debris by water
QVSLT     / total downward heat transfer from debris to RPV wall
QQUEN     / heat transfer from debris pool by water ingression
QGCHFT    / total critical heat flux during boiling in the gap
QEXRVW    / heat trans from RPV wall to cavity water
**
**********************************************************************
PLOTFIL 37 / CORE BARREL & UPPER PLENUM INFO.
**
** UPPER PLENUM
**
TPHSF(2)  / surface temperature of UPI
MUPINT    / current mass of UPI
QCMHS2    / radiation heat transfer from debris to UPI
**
```

```
** CORE BARREL
**
** NODALIZATION OF BARREL TEMPERATURE (J,I):
**
**   J: AXIAL ; 1 = BOTTOM, 13 = TOP
**     (AXIAL NODALIZATION IS CONSISTENT W/ CORE)
**   I: RADIAL; 1 = INNER, 5 = OUTER LAMINA
**
TCBL(1,1)  / temperature of core barrel node (1,1)
TCBL(2,1)  / temperature of core barrel node (2,1)
TCBL(3,1)  / temperature of core barrel node (3,1)
TCBL(4,1)  / temperature of core barrel node (4,1)
TCBL(5,1)  / temperature of core barrel node (5,1)
TCBL(6,1)  / temperature of core barrel node (6,1)
TCBL(7,1)  / temperature of core barrel node (7,1)
TCBL(8,1)  / temperature of core barrel node (8,1)
TCBL(9,1)  / temperature of core barrel node (9,1)
TCBL(10,1) / temperature of core barrel node (10,1)
TCBL(11,1) / temperature of core barrel node (11,1)
TCBL(12,1) / temperature of core barrel node (12,1)
TCBL(13,1) / temperature of core barrel node (13,1)
**
MCBLNJ(1)  / mass of core barrel nodes (1,1) thru (1,5)
MCBLNJ(2)  / mass of core barrel nodes (2,1) thru (2,5)
MCBLNJ(3)  / mass of core barrel nodes (3,1) thru (3,5)
MCBLNJ(4)  / mass of core barrel nodes (4,1) thru (4,5)
MCBLNJ(5)  / mass of core barrel nodes (5,1) thru (5,5)
MCBLNJ(6)  / mass of core barrel nodes (6,1) thru (6,5)
MCBLNJ(7)  / mass of core barrel nodes (7,1) thru (7,5)
MCBLNJ(8)  / mass of core barrel nodes (8,1) thru (8,5)
MCBLNJ(9)  / mass of core barrel nodes (9,1) thru (9,5)
MCBLNJ(10) / mass of core barrel nodes (10,1) thru (10,5)
MCBLNJ(11) / mass of core barrel nodes (11,1) thru (11,5)
MCBLNJ(12) / mass of core barrel nodes (12,1) thru (12,5)
MCBLNJ(13) / mass of core barrel nodes (13,1) thru (13,5)
**
**************************************************************************
PLOTFIL 38 / LOWER HEAD FAILURE MECHANISMS
**
QP1DEC     / decay heat of corium plugging a penetration tube
QP1RAD     / heat removal rate from a plugged penetration tube
QP1AVL     / excess sensible heat in corium plugging penetration tube
QP1MEL     / energy needed to melt a penetration tube wall
FLDPT1(1)  / force to push out a penetration tube in lower head node 1
FLDPT1(2)  / force to push out a penetration tube in lower head node 2
FLDPT1(3)  / force to push out a penetration tube in lower head node 3
FLDPT1(4)  / force to push out a penetration tube in lower head node 4
FLDPT1(5)  / force to push out a penetration tube in lower head node 5
FWDPT1(1)  / shear load the penetration tube weld can carry in node 1
FWDPT1(2)  / shear load the penetration tube weld can carry in node 2
FWDPT1(3)  / shear load the penetration tube weld can carry in node 3
FWDPT1(4)  / shear load the penetration tube weld can carry in node 4
FWDPT1(5)  / shear load the penetration tube weld can carry in node 5
FSSPT1(1)  / shear load the bound penetration tube can carry in node 1
```

FSSPT1(2) / shear load the bound penetration tube can carry in node 2
FSSPT1(3) / shear load the bound penetration tube can carry in node 3
FSSPT1(4) / shear load the bound penetration tube can carry in node 4
FSSPT1(5) / shear load the bound.penetration tube can carry in node 5
**
FCREP(1) / damaged fraction in lower head node 1
FCREP(2) / damaged fraction in lower head node 2
FCREP(3) / damaged fraction in lower head node 3
FCREP(4) / damaged fraction in lower head node 4
FCREP(5) / damaged fraction in lower head node 5
FCRPUH / damaged fraction in unbroken hot leg
FCRPBH / damaged fraction in broken hot leg
FCRBHT / damaged fraction in broken hot tube
FCRUHT / damaged fraction in unbroken hot tube
FCRPSR / damaged fraction in pressurizer surge line
**
UJET / velocity of corium jet entering lower plenum water
XDJETO / initial diameter of corium jet
XDJET / diameter of corium jet reaching lower head
UMELT / lower head erosion velocity due to corium jet
XERODE / erosion distance of lower head
**
average QSL / heat flux from the metal layer to the vessel wall
average QTSL / total heat transfer rate from metal layer to vessel wall
PSSHP / hoop stress load on RPV lower head
PSSYLD / yield stress load on RPV lower head
**
XRVP / RPV failure opening radius
**
QCMVP / energy discharge rate of total debris
WCMVP / discharge flow of total debris thru RPV failure
WPBVP / discharge flow of particulate debris thru RPV failure
WSSVP / discharge flow of metallic debris thru RPV failure
WOXVP / discharge flow of oxidic debris thru RPV failure
**
*********************************************************************
PLOTFIL 60 / CORE MOLTEN POOL INFO.
**
ICOLAP(1) / row no. for core collapse in channel 1
ICOLAP(2) / row no. for core collapse in channel 2
ICOLAP(3) / row no. for core collapse in channel 3
ICOLAP(4) / row no. for core collapse in channel 4
ICRUST(1) / row no. for bottom crust in channel 1
ICRUST(2) / row no. for bottom crust in channel 2
ICRUST(3) / row no. for bottom crust in channel 3
ICRUST(4) / row no. for bottom crust in channel 4
ITOPCR(1) / row no. for top crust in channel 1
ITOPCR(2) / row no. for top crust in channel 2
ITOPCR(3) / row no. for top crust in channel 3
ITOPCR(4) / row no. for top crust in channel 4
ILOWMX / highest row no. for low flow region in nat. circ.
**
*********************************************************************
PLOTFIL 78 / DETAILED RPV LOWER HEAD THERMAL RESPONSE

```
**
** Notes:
**
** 1) Lower head nodalization key for indices (I,J):
**
**   I: Axial node;     1 = Bottom of RPV lower head
**                      5 = Interface between RPV head and cylinder
**                      6 = Bottom of RPV cylinder
**                      10= Top of RPV cylinder
**   J: Radial node;    1 = Inner most radial node
**                      x = Outer most radial node (where x is the
**                          max. dimension, nominally 5.)
**
** RPV lower head node temperatures
**
TRV(1,1),TRV(1,2),TRV(1,3),TRV(1,4),TRV(1,5)
TRV(2,1),TRV(2,2),TRV(2,3),TRV(2,4),TRV(2,5)
TRV(3,1),TRV(3,2),TRV(3,3),TRV(3,4),TRV(3,5)
TRV(4,1),TRV(4,2),TRV(4,3),TRV(4,4),TRV(4,5)
TRV(5,1),TRV(5,2),TRV(5,3),TRV(5,4),TRV(5,5)
**
** RPV cylinder node temperatures
**
TRV(6,1),TRV(6,2),TRV(6,3),TRV(6,4),TRV(6,5)
TRV(7,1),TRV(7,2),TRV(7,3),TRV(7,4),TRV(7,5)
TRV(8,1),TRV(8,2),TRV(8,3),TRV(8,4),TRV(8,5)
TRV(9,1),TRV(9,2),TRV(9,3),TRV(9,4),TRV(9,5)
TRV(10,1),TRV(10,2),TRV(10,3),TRV(10,4),TRV(10,5)
**
** RPV lower head wall thickness (indexed by circumference nodes)
**
XTRVH(1),XTRVH(2),XTRVH(3),XTRVH(4),XTRVH(5)
**
** RPV lower head node stresses
**
** (See note at the top of the *PLTMAP section regarding the units
**  conversion warning.)
**
SIGW(1,1),SIGW(1,2),SIGW(1,3),SIGW(1,4),SIGW(1,5)
SIGW(2,1),SIGW(2,2),SIGW(2,3),SIGW(2,4),SIGW(2,5)
SIGW(3,1),SIGW(3,2),SIGW(3,3),SIGW(3,4),SIGW(3,5)
SIGW(4,1),SIGW(4,2),SIGW(4,3),SIGW(4,4),SIGW(4,5)
SIGW(5,1),SIGW(5,2),SIGW(5,3),SIGW(5,4),SIGW(5,5)
**
**********************************************************************
PLOTFIL 85 / DETAILED STEAM GENERATOR TUBE TEMPERATURES
**
** Notes:
**
** 1) S/G tube nodalization key for indices (I,J):
**
**   I: Axial nodes ; 1 = Bottom axial node in the tube wall
**                    x = Top axial node in the tube wall
**                        (where x is the max. dimension)
```

```
**    J: Radial nodes ; 1 = Inner most radial node in the tube wall
**                   y = Outer most radial node in the tube wall
**                      (where y is the max. dimension)
**
** 2) Consult the BSTGEN/USTGEN subroutine description in Volume 2 of
**    the MAAP4 User's Manual for a detailed discussion of the refined
**    S/G tube subdivision into subregions: hot outflow, cold outflow,
**    cold backflow, and hot backflow.
**
**
** Average hot tube node temperatures in the broken and unbroken
** loops.  Note, these average temperatures stem from the old
** methodology, in which the hot and cold tube regions are NOT
** subdivided into outflow and backflow subregions.
**
TBHT(1,1),TBHT(2,1),TBHT(3,1),TBHT(4,1),TBHT(5,1)
TUHT(1,1),TUHT(2,1),TUHT(3,1),TUHT(4,1),TUHT(5,1)
**
** Hot tube node temperatures for the outflow subregion in the broken
** and unbroken loops.  Note, these temperatures and those for the
** backflow subregion stem from the new methodology, in which the
** hot and cold tube regions ARE subdivided into outflow and backflow
** subregions.
**
TBHTO(1,1),TBHTO(2,1),TBHTO(3,1),TBHTO(4,1),TBHTO(5,1)
TUHTO(1,1),TUHTO(2,1),TUHTO(3,1),TUHTO(4,1),TUHTO(5,1)
TBHTO(6,1),TBHTO(7,1),TBHTO(8,1),TBHTO(9,1),TBHTO(10,1)
TUHTO(6,1),TUHTO(7,1),TUHTO(8,1),TUHTO(9,1),TUHTO(10,1)
TBHTO(11,1),TBHTO(12,1),TBHTO(13,1),TBHTO(14,1),TBHTO(15,1)
TUHTO(11,1),TUHTO(12,1),TUHTO(13,1),TUHTO(14,1),TUHTO(15,1)
TBHTO(16,1),TBHTO(17,1),TBHTO(18,1),TBHTO(19,1),TBHTO(20,1)
TUHTO(16,1),TUHTO(17,1),TUHTO(18,1),TUHTO(19,1),TUHTO(20,1)
**
** Hot tube node temperatures for the backflow region in the broken
** and unbroken loops.
**
TBHTB(1,1),TBHTB(2,1),TBHTB(3,1),TBHTB(4,1),TBHTB(5,1)
TUHTB(1,1),TUHTB(2,1),TUHTB(3,1),TUHTB(4,1),TUHTB(5,1)
**
**
END
****************************************************************************
*Prtlis
****************************************************************************
*BR
**
** =========================================================================
**                  General Notes
** =========================================================================
**
** 1)  The PRINT LIST command offers the capability to send a list of the
**     names and current values of selected variables, along with the
**     current MAAP time, to a selected or default output file.
**
```

```
** 2)  This feature can be used to:
**
**     i)  augment existing tabular output for process variables of
**         interest for specific users or sequences,
**     ii) allow selected process data to be written to the log file or
**         special files that may be more easily edited or manipulated
**         to understand or summary a run, and
**     iii) allow specific parameters to be printed at specific event times
**         for sequence diagnosis.  For example, the corium composition
**         within the RPV at the time of vessel failure.
**
** 3)  The *PRTLIS section is the location for the PRINT LIST definitions.
**     The general format rules are:
**
**     a) PRINT LIST definition statements begin with the key word "LIST",
**        which is always the first word on a new line.  (See the format
**        for the PRINT LIST definition statement below.)
**     b) In the lines that follow the PRINT LIST definition statement, 1
**        to 99 variable names to be included in the list can be specified.
**        The variable names should be separated by one or more spaces or a
**        comma.  The allowed variables are those in common blocks,
**        including the XPLTX user utility common block.  (Exceptions are
**        those variables in common blocks containing both real and integer
**        variables.)
**     c) Up to 25 print list's can be defined.
**     d) The key word "END" must appear as the last line (not a
**        comment) in the *PRTLIS section.
**
** 4)  The format for the PRINT LIST definition statement is:
**
**     LIST <#><PL-NUMBER> TO UNIT <#><UNIT>
**
**     where <#>          = optional pound sign
**         <PL-NUMBER>  = an integer print list number between 1 and 25
**         TO UNIT      = optional keywords
**         <UNIT>       = an integer FORTRAN output unit number
**
** 5)  The PRINT LIST command can be activated by including "PRINT LIST #",
**     where # is the number of the pre-defined print list, in an action
**     block.  (Consult the USEREVT section within Section 2 Volume 1 of
**     the MAAP4 User's Manual for details regarding user-defined event
**     codes and action blocks.)
**
**     In addition to activation within action blocks, print lists can
**     also be activated by setting event code 322 true.  This will force a
**     default printing of all print lists to the their associated file
**     units.
**
** 6)  The format for the PRINT LIST command is:
**
**     PRINT LIST <#><PL-NUMBER>
**
**     where <#>          = optional pound sign
**         <PL-NUMBER>  = an integer print list number between 1 and 25
```

```
**
** 7)  Consult the PRTLIS subroutine description in Volume 2 of the MAAP4
**     User's Manual for additional information.
**
** 8)  The following caveats are notable:
**
**     a) Currently, PRINT LIST definition statements can only be made in
**        the *PRTLIS section of the parameter file.  They cannot be
**        defined via the input deck.  This is different from MAAP 3.0B,
**        where lists could be defined in both files.
**
**     b) If FORTRAN file opening is performed by the operating system
**        via JCL commands (i.e., if IFILOP=0 in the MAAP main program),
**        then a file name must be assigned to the FORTRAN unit number
**        specified in a PRINT LIST definition.  For example,
**        FOR030.DAT could be assigned to unit #30.
**
**     c) If FORTRAN file opening is performed by MAAP itself (i.e., if
**        IFILOP>0 in the MAAP main program), then a FORTRAN unit number
**        specified in a PRINT LIST definition should be one that is
**        opened by default in MAAP.
**
**        Example output files include the log file or the tabular output
**        file(s).  Section 2 Volume 1 of the MAAP4 User's Manual shows
**        that the default unit number for the log file is 6, and the
**        unit number(s) for the tabular output file(s) are set by input
**        parameter array IPSET1().  (Consult the *CONTROL section of the
**        parameter file for a discussion of the IPSET1() array.)
**
**        Assignment of a print list to a file unit number that is not
**        opened by default in MAAP could result in the loss of data for
**        the print list.
**
** 9)  The noted caveats illustrate that the REPORT TEMPLATE capability
**     within the input deck is a superior alternative to the PRINT LIST
**     command when selected variable tabular output data is desired.
**     Consult the REPORT TEMPLATE section of Section 2 Volume 1 of the
**     MAAP4 User's Manual for details regarding its use.
**
** 10) The following sample *PRTLIS entry is a print list definition for
**     the PWR code. The data for variables in LIST #1 will be sent to the
**     log file (default unit 6) when printing of the list is activated by
**     execution of the PRINT LIST command within action block #3
**     associated with user-defined event code shown for the sample input
**     deck entry.
**
**     Sample *PRTLIS entry:
**
**     LIST #1 TO UNIT 6
**     PPS,TCMPS,TWPS,MCMTPS,MWPS,MFH2PS,MH2PS,MH2CR1
**     MSTPS,MFZRPS,MFU2PS,MFZOPS,MCR
**     END
**
**     Input deck entry:
```

```
**
**   USEREVT
**     401 TIM > 3600 S
**     401 ACTION #3
**
**     ACTION #3
**       PRINT LIST #1
**     END
**   END
END
**************************************************************************
**Pltdos
**************************************************************************
*BR
**
** ======================================================================
**                  General Notes
** ======================================================================
**
** 1)  MAAP4-DOSE is a FORTRAN computer code that estimates radiation dose
**     rates inside and outside a nuclear power plant in response to a
**     severe accident.  EPRI members are automatically licensed users of
**     MAAP4-DOSE.  Non-EPRI members can obtain a MAAP4-DOSE user license
**     by contacting EPRI or FAI.
**
** 2)  MAAP4-DOSE bases its results upon fission product data
**     (time-dependent fission product masses within selected containment
**     nodes and fission product release rates to the environment) received
**     from prior execution of the MAAP4 computer code.
**
**     The noted input data for MAAP4-DOSE can be obtained from MAAP4 by
**     specifying values for parmeters in the *PLTDOS parameter section.
**     These parameters specify the content and organization of the data
**     files generated by MAAP4.  The parameters and their corresponding
**     data files are categorized into three groups below: in-plant fission
**     product data, ex-plant fission product data, and time-invariant
**     fission product data.
**
** 3)  FORTRAN file unit assignments, file opening and data acquistion
**     during MAAP4 execution are enabled only if the *PLTDOS parmeters are
**     specified explicitly.  Therefore, writing to the noted data files
**     can be disabled by commenting out the *PLTDOS parameter
**     specifications.  Since data generation for MAAP4-DOSE is not the
**     default convention for MAAP4, the sample parameter values below are
**     generally disabled.
**
** 4)  For additional information regarding the input parameters and output
**     data, consult the PLTDOS subroutine description in Volume 2 of the
**     MAAP4 User's Manual, and the MAAP4-DOSE User's Manual within Volume
**     4 of the MAAP4 User's Manual.  The MAAP4-DOSE User's Manual is
**     provided to only licensed users, as noted above.
**
** 5)  The in-plant data files all have the same group of output data
**     variables.  Similarly, ex-plant data files all have the same group
```

```
**    of output data variables that are distinct from those within the
**    in-plant data files.
**
** ======================================================================
**    In-Plant MAAP4-DOSE Output Control Parameter Specifications
** ======================================================================
**
** ===================================================================
TDIN        0.1667  HR        // Units: [S,HR]
**
** TDIN is the time interval at which in-plant fission product data is to
** be generated by MAAP4 for MAAP4-DOSE.
**
**
** ===================================================================
IMAXIN          4           // Dimensionless
**
** IMAXIN is the total number of containment compartments from which data
** for in-plant dose calculations are to be extracted. The current maximum
** value is 29.
**
**
** ===================================================================
** Name: JNIN(1:29)           Units: [Dimensionless]
**
** Element JNIN(i) within the JNIN one-dimensional array is the MAAP4 index
** for the i'th containment compartment providing data for MAAP4-DOSE.  The
** compartments are defined in the *AUXILIARY BUILDING parameter file
** section.
**
JNIN(1)       1
JNIN(2)       2
JNIN(3)       3
JNIN(4)       4
**
** ===================================================================
** Name: ILUIN(1:29)          Units: [Dimensionless]
**
** Element ILUIN(i) within the ILUIN one-dimensional array is the FORTRAN
** logical unit number for output data from the i'th compartment.
**
ILUIN(1)      71
ILUIN(2)      72
ILUIN(3)      73
ILUIN(4)      74
**
** ===================================================================
IBIN          2          // Dimensionless
**
** IBIN is the control flag for output file format.  Enter 1 for binary
** output files. Enter 2 for ASCII output files.
**
**
** ======================================================================
```

```
**      Ex-Plant MAAP4-DOSE Output Control Parameter Specifications
** ======================================================================
**
** ======================================================================
TDEX          0.1667  HR        // Units: [S,HR]
**
** TDEX is the time interval at which ex-plant fission product data is to
** be generated by MAAP4 for MAAP4-DOSE.
**
**
** ======================================================================
IMAXEX            1             // Dimensionless
**
** IMAXEX is the total number of ex-plant release points from the
** containment to the environment.  The current maximum value is 5 release
** points.  Parameters JNEX(i) and JJEX(i) then specify the MAAP4 donor
** compartment and junction, respectively, for the i-th release point.
**
**
** ======================================================================
** Name: JNEX(1:5)              Units: [Dimensionless]
**
** Element JNEX(i) within the JNEX one-dimensional array is the MAAP4 index
** for the containment compartment that is the donor for the i'th release
** point.  The compartments are defined in the *AUXILIARY BUILDING
** parameter file section.
**
JNEX(1)         3
JNEX(2)         0
**
** ======================================================================
** Name: JJEX(1:5)              Units: [Dimensionless]
**
** Element JJEX(i) within the JJEX one-dimensional array is the MAAP4 index
** for the junction that is providing the i'th release point pathway.  The
** junctions are defined in the *TOPOLOGY parameter file section.
**
JJEX(1)         6
JJEX(2)         0
**
** ======================================================================
** Name: ILUEX(1:5)             Units: [Dimensionless]
**
** Element ILUEX(i) within the ILUEX one-dimensional array is the FORTRAN
** logical unit number for output data from the i'th release point.
**
ILUEX(1)        75
ILUEX(2)         0
**
** ======================================================================
IBEX            2               // Dimensionless
**
** IBEX is the control flag for output file format.  Enter 1 for binary
** output files. Enter 2 for ASCII output files.
```

```
**
**
** ===================================================================
IMAXSG          0           // Dimensionless
**
** IMAXSG provides an option to generate data for MAAP4-DOSE during a steam
** generator tube rupture event in which fission product flow from the
** rupture bypasses the containment and enters the environment.  The steam
** generator secondary side SV/RV's serve as the release point.
**
** Possible values are 1 (enable option) and 0 (disable option).
** Effectively, this option designates the steam generator as a compartment
** for ex-plant release that is in addition to the number of compartments
** stated by IMAXEX.  Therefore, ILUEX(IMAXEX+1) is the FORTRAN unit number
** for output data from this release point.
**
** @@@ 4.0.3 CEH 12/12/95
** This is an existing parameter that was not included in the previous
** revision (4.0.2) of the sample parameter files.  Its value remains
** unchanged from its default value (in block data) in the previous
** revision (4.0.2) of the code.
**
**
** ===================================================================
** Name: ZNSGRV              Units: [M,FT]
**
** ZNSGRV is the elevation at which the steam generator secondary side
** SV/RV's discharge to the environment compartment.  The reference point
** for this elevation is the same as that used to establish elevations for
** containment compartment floors.  It is applicable only when parameter
** IMAXSG is set to 1, which means that the steam generator is being
** modeled as an additional compartment for ex-plant release.  Consult the
** IMAXSG parameter description.
**
** @@@ 4.0.3 CEH 12/12/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files.
**
**
**
** ===================================================================
**   Time-invariant MAAP4-DOSE Output Control Parameter Specifications
** ===================================================================
**
** ===================================================================
ILUTM          76          // Dimensionless
**
** ILUTM is the FORTRAN logical unit number for output of time-invariant
** data.
**
**
** ===================================================================
IBTM           2           // Dimensionless
**
```

** IBTM is the control flag for output file format. Enter 1 for binary
** output files. Enter 2 for ASCII output files.
**
**************************************************************************
*Core
**************************************************************************
*BR
**
** This parameter section defines the inputs for the reactor core.
**
** MAAP's core nodalization permits up to 175 nodes with limits of: 1) 25
** or less axial rows and 2) 7 or less radial rings (or channels). The
** number of nodes to be used is set by the values given to Heatup/Core
** parameter variables NCHAN and NAXNOD. Although no single nodalization
** scheme is "correct" for all cases, experience indicates that finer axial
** nodalization is more appropriate than finer radial nodalization. A
** minimum of 10 axial nodes is suggested, as axial gradients strongly
** influence zircalloy oxidation and melt progression. There are no strong
** radial gradients due to fluid mixing and/or radiation heat transfer, and
** therefore coarser nodalization for inner rings is acceptable. Outer
** radial rings do exhibit some gradients, due to heat losses to the core
** shroud, and in general due to low peaking factors. Overall, however,
** seven radial rings are likely to be more than sufficient for radial
** nodalization.
**
** In general, reducing the total number of core nodes yields a corresponding
** decrease in MAAP run time. Consequently, modeling the core with less than
** 175 nodes is desireable. For example, using 15 axial nodes and five
** radial rings for a total of 75 nodes (large, but still well within the
** limit of 175) puts emphasis on axial rather than radial nodalization. An
** arrangement of this sort could be a good compromise for the majority of
** core configurations.
**
** Certain MAAP applications could also warrant core nodalization sensitivity
** studies. Such an approach may be appropriate for cases in which the
** extent of debris entrainment, direct containment heating, core-concrete
** attack, ex-vessel debris coolability, and/or the timing of the onset of
** melt are important.
**
** The core may be divided into three distinct regions as 1) upper non-active
** core region defined by the number of axial rows using parameter NNFT, 2)
** active core region, and 3) lower non-active core region defined by the
** number of axial rows using parameter NNFB. The total number of axial rows
** is the sum of the three regions as defined by parameter NAXNOD. The
** distinction of active versus non-active core regions is simply due to the
** presence or absence of UO2 material. Typically, the upper non-active core
** region is used to represent the upper tie plate and core structure. The
** lower non-active core region is used to represent the lower tie plate and
** the core support plate.
**
** In all the sample parameter files, one axial row is used to represent the
** upper tie plate in the upper non-active core region and two axial rows are
** used to represent the lower tie plate (row 2) and the core support plate
** (row 1) in the lower non-active core region. The mass parameters MSSNFT,

** MSSNFB, MZRNFT, and MZRNFB are used to define the amounts of stainless
** steel and zircalloy in the non-fuel regions.
**
** The physical boundary of active and non-active core regions are defined by
** Heatup/Core parameters ZCRU, ZCRL, XDZNFT, and XDZNFB. ZCRU and ZCRL are
** the elevations of the top and bottom of active fuel with respect to the
** inside bottom of the reactore pressure vessel. XDZNFT and XDZNFB are the
** heights of the non-active upper and lower core regions.
**
** The core consists of NASS fuel assemblies with each assembly consisting
** of NPIN fuel pins plus NCROD guide tubes or water rods. The PWR core
** setup treats the whole core as one big assembly. Therefore PWR users
** must set NASS to 1, and NPIN and NCROD should be the total for the
** whole core. The core may also have NBLAD control blades.
**
** The total mass of core computed by the MAAP4 code is:
**
** MCR0 = MU20 + MZR0C + MZR0K + MBC0 + MSS0 + MAG0 + MSS0CL +
** MSSNFT + MSSNFB
**
** where MU20 = mass of UO2 in the active core region,
**
** MZR0C = mass of Zr in the cladding and water/control rods in the
** active and non-active (upper and lower) core regions,
**
** MZR0K = mass of Zr in the fuel bundle can in the active and upper
** non-active core region,
**
** MBC0 = mass of B4C in the control blades in the active core region,
**
** MSS0 = mass of stainless steel in the control blades in the
** active and non-active (upper and lower) core regions,
**
** MAG0 = sum of MSM0(1), MSM0(2), MSM0(3) the control/structural
** material in the active core region,
**
** MSS0CL = mass of stainless steel in the cladding and the water/
** control rods in the active core region only,
**
** MSSNFT = mass of stainless steel in the cladding and the water/
** control rods in the upper non-active core region. and
**
** MSSNFB = mass of stainless steel in the cladding and the water/
** control rods in the lower non-active core region.
**
** It is important to note whether the material is for the active core region
** only or for both the active and non-active core regions. See the specific
** parameter inputs for additional details.
**
** The Control parameter variable ISSCL selects the material type to be used
** for the fuel rod cladding. Setting ISSCL = 0 uses Zr material type for
** the fuel rod cladding. Setting ISSCL = 1 uses stainless steel material
** type for the fuel rod cladding. Note that the Heatup/Core parameter
** variables MSS0CL and MZR0C are mutually exclusive, that is, one or the

```
** other can only be used in accordance to the value of parameter ISSCL.
**
** The Control parameter variable IBCCR selects the material type of pwr-like
** control rods.  Setting IBCCR = 0 uses the AG-IN-CD control material type
** whose masses are defined by parameters MSM0(1), MSM0(2), and MSM0(3).
** Setting IBCCR = 1 uses the B4C-SS control material type whose masses are
** defined by parameters MSM0(1) and MSM0(2).  See *Fission parameter section
** for additional discussions about the parameter variable MSM0.
**
** Possible data sources for the majority of input parmeters can be obtained
** from:
**
**      1) Plant FSAR - Core section
**      2) Operator Training Manual - Fuel section
**      3) Core reload analysis
**      4) Fuel specification data
**      5) Fuel material certification documentation
**      6) Plant FSAR - Reactor Vessel section
**      7) Operator Training Manual - Reactor Vessel section
**      8) Reactor vessel assembly drawing
**      9) Reactor internals component drawings
**
** ======================================================================
QCR0        1.16e10  BTU/HR     // Units: [W,BTU/HR]
**
** This parameter is the initial core full power, nominal 100% rated thermal
** power.
**
** ======================================================================
MU20        204200.0  LB        // Units: [KG,LB]
**
** This parameter is the total mass of UO2 in the active core region.  If a
** documented value for this variable is not readily available, it can be
** approximated as follows;
**
**      MU20 = PI * XRPEL**2 * XLFUEL * NPIN * RHOUO2
**
** Where:  XRPEL  = Fuel pellet radius
**         XLFUEL = Active fuel length, = ZCRU - ZCRL
**         NPIN   = Number of fuel pins
**         RHOUO2 = UO2 density,
**                = .95 * UO2 Theoretical density (Typical)
**
** ======================================================================
MZR0C       45352.0  LB         // Units: [KG,LB]
**
** This parameter is the total initial mass of zircalloy (Zr) in the
** cladding including the fuel and water/control rods in both the active
** and non-active core regions.  This parameter is used when the cladding
** material type variable ISSCL is set to 0 and the MSS0CL parameter should
** be set to 0.  Note that MZR0C includes MZRNFT and MZRNFB zircalloy masses
** in the non-active core region.  Thus, the actual mass of Zr in the fuel
** rod cladding in the active core region would be MZR0C-MZRNFT-MZRNFB.
**
```

```
** If a documented value for this variable is not readily available, it can
** be approximated as  follows;
**
**      MZR0 = (PI/4) * (2*XDPIN*XTZR - XTZR**2) * RHOZR * XLFUEL * NPIN
**
** Where:  XDPIN  = Fuel pin outside diameter
**         XTZR   = Fuel cladding thickness
**         RHOZR  = Zircalloy density
**         XLFUEL = Fuel active length = ZCRU - ZCRL, or
**                = actual fuel rod length (see discussion)
**         NPIN   = Number of fuel pins
**
** Note that this equation yields only the amount of zircalloy mass in the
** fuel rod cladding in the active core region.  Additional zircalloy found
** in the active core region but not in the cladding can be added to this
** term.  Also note that the parameter MZR0C should also include all
** zircalloy masses in the non-active core region, which are actually
** represented by parameters MZRNFT and MZRNFB.  Hence, the suggestion to
** use the actual fuel rod length would result in a better approximation of
** the initial zircalloy mass.  However, the additional zircalloy found in
** the non-active core region but not in the cladding can be added to this
** term and to MZRNFT and MZRNFB terms.
**
** If the additional amount of zircalloy is considerable (relative to the
** mass of cladding) users should consider performing a sensitivity study
** with masses varying between the mass of cladding and the total zircalloy
** mass.  In addition consider varying the model parameter FAOX which
** multiplies the availiable zircalloy surface area available for oxidation.
** Corresponding PWR MAAP 3.0B parameter is MZR0.
**
** ======================================================================
MSS0CL          0.0  LB          // Units: [KG,LB]
**
** This parameter is the total inital mass of stainless steel (SS) in the
** cladding including the fuel and water/control rods in active core region
** only.  This parameter is used when the cladding material type variable
** ISSCL is set to 1 and the MZR0C parameter should be set to 0.  The mass
** of stainless steel can be approximated by the same method presented for
** the MZR0C parameter but using the active fuel length only - not the
** actual fuel length.
**
** The stainless steel masses in the non-active core regions are represented
** by parameters MSSNFT and MSSNFB independent of cladding material type and
** MSS0CL.
**
** ======================================================================
MZR0K           0.0  LB          // Units: [KG,LB]
**
** This parameter is the total initial mass of zircaloy (Zr) for all fuel
** assembly cans/channels from the bottom of the active core region to the
** top of the upper non-active core region.  Thus, the channel length
** includes the active core and the upper non-active core region.  Do not
** include the fuel can zircally mass from the non-active region below the
** active core region but instead add the mass to parameter MZRNFB.  Note
```

```
** that this parameter refers only to the cans and does not include the
** cladding on the fuel rods. Either of the following approaches may be
** used to approximate the inital zircalloy mass in the cans:
**
** Method 1:
** ---------
** MZR0K = (No. of fuel assys.) * (zircaloy mass/can)
**
** Method 2:
** ---------
** MZR0K = [W**2 - (W - 2*T)**2]*L*N*RHOZR
**
** Where:  W     = Outside width of fuel channel
**         T     = Channel wall thickness
**         L     = Length of channel
**         N     = Number of fuel assemblies
**         RHOZR = Density of Zircaloy
**
** ========================================================================
MBC0          0.0  LB        // Units: [KG,LB]
**
** This parameter is the total initial mass of B4C in all control blades in
** the active core region. The initial mass of boron carbide (B4C) in core
** may be estimated as follows:
**
**      MBC0 = NBLAD * ACRD * XLCRD * RHOB4C
**
** Where:  NBLAD  = number of control blades
**         ACRD   = cross-sectional area of one control blade
**         XLCRD  = length of one control blade
**         RHOB4C = density of B4C
**                = approximately 0.7 * Theoretical density density of B4C,
**                  typically 2500 Kg/m^3 per CRC Handbook of Chemistry &
**                  Physics, 53rd Ed., pg. B-74
**
** ========================================================================
MSS0          0.0  LB        // Units: [KG,LB]
**
** This parameter is the total initial mass of stainless steel in all
** control blades in the active and non-active core regions.
**
** ========================================================================
MTU0          0.0  LB        // Units: [KG,LB]
**
** @@@ 4.0.3 MAM 8/29/95  Parameter MTU0 was missing from all parameter
** files.
**
** This parameter is the total initial mass of tungsten in the active core
** region. This parameter is only used for CORA core heatup benchmarks and
** should be set to zero otherwise.
**
** ========================================================================
XDPIN         0.030  FT      // Units: [M,FT]
**
```

** This parameter is the fuel pin outside diameter.
**
** ========================================================================
XRPEL 0.0129 FT // Units: [M,FT]
**
** This parameter is the fuel pellet radius.
**
** ========================================================================
XTZR 0.00188 FT // Units: [M,FT]
**
** This parameter is the fuel cladding thickness. If the core includes more
** more than one rod design, resulting in more than one clad thickness in
** the core being represented, the value for this variable should be a
** weighted average thickness based on the fractions of the total number of
** fuel rods for each of the rod designs involved.
**
** ========================================================================
ZCRL 10.11 FT // Units: [M,FT]
**
** This parameter is the vertical distance between the bottom of the active
** fuel and the lowest point of the inside of the reactor vessel lower
** head. This defines the boundary between the active core region and the
** lower (bottom) non-active core region.
**
** ========================================================================
ZCRU 22.11 FT // Units: [M,FT]
**
** This parameter is the vertical distance between the top of active fuel
** and the lowest point of the inside of the reactor vessel lower head.
** This defines the boundary between the active core region and the upper
** (top) non-active core region.
**
** ========================================================================
XTCAN 0.0 FT // Units: [M,FT]
**
** This parameter is the fuel can/channel wall thickness.
**
** ========================================================================
XTBLAD 0.0 FT // Units: [M,FT]
**
** This parameter is the thickness of control blade.
**
** ========================================================================
NASS 1 // Dimensionless
**
** This parameter is the number of fuel assemblies. The PWR core is
** represented in the code as one fuel assembly. Therefore, for PWRs NASS
** must be set to 1.
**
** ========================================================================
NPIN 50952 // Dimensionless
**
** This parameter is the number of fuel pins per fuel assembly. It is used
** in the calculation of the mass of material in the core.

**
** ==========================================================================
NCROD 3028 // Dimensionless
**
** This parameter is the number of control rods per fuel assembly. It is
** used in the calculation of the mass of material in the core.
**
** ==========================================================================
NBLAD 0 // Dimensionless
**
** This parameter is the number of control blades.
**
** ==========================================================================
NROWS 15 // Dimensionless
**
** This parameter is the number of rows per fuel assembly (15x15 for PWR's
** and 8x8 for BWR's). It is used in subroutine GNODE for core node flow
** area calculations.
**
** For PWRs the number of assemblies, NASS, is set to 1 and the number of
** fuel pins and control rods, NPIN and NCROD, respectively, are the total
** number for the whole core because they are used to calculate the mass
** of core material. On the other hand, NROWS is used to calculate an area
** for natural circulation. Therefore, it should be the number of rows per
** actual fuel assembly.
**
** ==========================================================================
NCHAN 4 // Dimensionless
**
** This parameter is the number of radial rings that divide the core radially.
**
** ==========================================================================
NAXNOD 19 // Dimensionless
**
** This parameter is the number of axial rows that divide the core axially.
** Note that NAXNOD includes NNFT and NNFB. Thus, the number of rows for
** the active core region is NAXNOD-NNFT-NNFB.
**
** ==========================================================================
NNFT 1 // Dimensionless
**
** This parameter is the number of non-fuel rows above the active core
** region (maximum of 5). These rows are used to represent the upper
** non-active core region which typically includes the upper gas plenum,
** upper tie plate, and upper core structure.
**
** ==========================================================================
NNFB 2 // Dimensionless
**
** This parameter is the number of non-fuel rows below the active core
** region (maximum of 5). These rows are used to represent the lower
** non-active core region which typically includes the core support plate,
** lower tie plate, lower gas plenum, and lower core structure.
**

** ================================================================
**
** Parameter NNBT is the number of control blade rows above the active core
** region (maximum of 5). User must enter the same value used in parameter
** NNFT or optionally zero if parameter MBC0 is zero.
**
** @@@ 4.0.3 MAM 8/29/95 Starting with MAAP 4.0.2, parameter NNBT is no
** longer a user input parameter.
**
** ================================================================
**
** Parameter NNBB is the number of control blade rows below the active core
** region (maximum of 5). User must enter the same value used in parameter
** NNFB or optionally zero if parameter MBC0 is zero.
**
** @@@ 4.0.3 MAM 8/29/95 Starting with MAAP 4.0.2, parameter NNBB is no
** longer a user input parameter.
**
** ================================================================
FXOX0 1.e-4 // Dimensionless
**
** This parameter is the initial fraction of ZrO2 to Zr mass ratio. This
** parameter is used to obtain the zircaloy oxide mass in the Zr fuel/water
** rod and guide tube cladding, fuel can channels, and non-active core
** masses (MZRNFT and MZRNFB). This same ratio is also used to specify the
** stainless steel oxide mass in the stainless steel components (cladding if
** ISSCL = 1 and control blade).
**
** ================================================================
** The next three stainless steel composition parameters MFFESS, MFCRSS, and
** MFNISS define the composition of all stainless steel masses represented
** in the core including non-fuel regions above and below the active core,
** steel masses in the control blades and rods, and the fuel rod cladding if
** the stainless steel cladding option was selected. These compositions are
** also applied to lumped equipment masses in the reactor vessel lower head.
** See Primary System parameter section for additional details about lumped
** equipment mass structures in the lower head.
**
** The purpose of these composition parameters are to partition the steel
** mass into iron, chromium, and nickel masses when the steel melts. Note
** that the chromium oxidizes differently than the iron and this fact is
** taken into account by direct containment heating and core-concrete
** interactions models.
**
** Do not confuse these stainless steel composition parameters with carbon
** steel composition parameters MFFECS, MFCRCS, MFNICS, and MFCACS which
** are defined in the Primary System parameter section and are used for all
** reactor vessel wall heat sinks.
**
MFFESS 0.72 // Dimensionless
**
** This parameter is the mass fraction of iron (Fe) in the stainless steel.
**
**

```
MFCRSS        0.19          // Dimensionless
**
** This parameter is the mass fraction of chromium (Cr) in the stainless
** steel.
**
**
MFNISS        0.09          // Dimensionless
**
** This parameter is the mass fraction of nickle (Ni) in the stainless
** steel.
**
** ==========================================================================
** Fuel Cladding Ballooning Variables
**
** Parameters XTZR, VOLGPN, PFILL, FVLGP, and FVUGP are used in MAAP's fuel
** cladding ballooning calculations.
**
** ==========================================================================
VOLGPN      4.90e-4  FT**3      //  Units: [M**3,FT**3]
**
** This parameter is the gas volume per fuel pin.  The gas volume can be
** estimated as:
**
**      VOLGPN = V1 + V2 + V3 + V4
**
** Where:  V1 = Gas volume in upper plenum
**         V2 = Gas volume in lower plenum
**         V3 = Gas volume in annular gap
**         V4 = Gas volume in axial gap between pellets
**
** ==========================================================================
PFILL       464.7  PSI      //  Units: [PA,PSI]
**
** This parameter is the as-built room temperature fuel pin fill gas
** pressure.
**
** ==========================================================================
FVLGP         0.01          // Dimensionless
**
** This parameter is the fraction of the total fuel pin gas volume which is
** contained in the fuel pin lower gas plenum.  This parameter can be
** estimated as:
**
**       FVLGP = V2 / VOLGPN
**
** Where:  V2     = Lower plenum gas volume
**        VOLGPN = Gas volume per fuel pin
**
** ==========================================================================
FVUGP         0.373         // Dimensionless
**
** This parameter is the fraction of the total fuel pin gas volume which is
** contained in the fuel pin upper gas plenum.  This parameter can be
** estimated as:
```

```
**
**      FVUGP = V1 / VOLGPN
**
** Where:  V1     = Upper plenum gas volume
**        VOLGPN = Gas volume per fuel pin
**
** ========================================================================
XRBF          6.74  FT        // Units: [M,FT]
**
** This parameter is the radius of core shroud.  Note that the MAAP 3.0B
** definition is incorrect.
**
** ========================================================================
NPKNOD          0            // Dimensionless
**
** This parameter is an option flag to specify how the core power peaking
** factors will be assigned.
**
**      =0, power peaking factors are assigned using the product of
**          1-D parameters FPA() and FPR()
**
**      =1, two dimensional nodal power peaking factors are assigned
**          using 2-D parameter FPKNOD()
**
** Two examples of obtaining the needed core peaking factors are explained
** in the discussion of parameters FPKNOD(), FPR(), and FPA().  Note that
** peaking factors for axial rows in the non-active core region must have a
** value of zero.
**
** ========================================================================
** Name: FPKNOD(1:175)           Units: [Dimensionless]
**
** This parameter is the two dimensional core nodal power peaking factors
** from the bottom axial row at the inside radial ring to the top axial row
** (NAXNOD) at the outer radial ring (NCHAN).  The basic core node indexing
** formula is:
**
**      IJ = NAXNOD * (IR - 1) + IA
**
** where: IJ = the core node index,
**        IR = the ir'th radial ring index, and
**        IA = the ia'th axial row index.
**
** For example, the corresponding core node index located at the third axial
** row in the second radial ring is:
**
**      IJ = NAXNOD * (2 - 1) + 3
**
** Parameter FPKNOD() is omitted since parameters FPA() and FPR() is used
** instead.  See parameter NPKNOD.
**
** Recommended values of peaking factors for each core node can be calculated
** as follows:
**
```

```
** 1.  Obtain core peaking factor maps for beginning of life (BOL), middle
**     of cycle, and end of life (EOL).  The radial factors are typically
**     provided as a one-quarter map of the core at a number of core eleva-
**     tions while the axial factors are typically provided at a number of
**     radial locations in the core.
**
** 2.  The core peaking factors that should be selected from the above data
**'    set are the axial factors for the core centerline and the radial
**     factors for the core mid-plane elevation at the time of cycle that
**     the peaking factors exhibit the largest gradients (i.e., have their
**     "Peakiest" values).  If the radial factors are only provided for
**     elevations above and below the core mid-plane then the appropriate
**     values to be used in the parameter file should be obtained by linear
**     interpolation between the data that most closely brackets the
**     mid-plane.
**
** 3.  The peaking factor data in Item 2 must be transformed to values
**     appropriate for the MAAP core representation by performing the
**     following calculations:
**
**     A. Transformation of data from I axial nodes (in the original core
**        peaking factor maps) to the J axial nodes required for the MAAP
**        core representation.
**
**     i)  Calculate the mid-plane elevation of each axial node in the
**         original core representation [ORIG_AX_EL(I)] by:
**
**         - Dividing the length of active fuel (XZFUEL = ZCRU - ZCRL)) by
**           the original number of axial nodes (ORIG_NO_AX_NODES) from the
**           data obtained from Item 2 above,
**
**         - Then calculating the distance from the fuel element bottom to
**           the center (midplane elevation) of each node (ORIG_AX_EL(I) )...
**
**           NODE_HT_ORIG = XZFUEL / ORIG_NO_AX_NODES
**
**           ORIG_AX_EL(I) = {(.5) * NODE_HT_ORIG} + {(I-1) * NODE_HT_ORIG}
**
**
**     ii) Calculate the mid-plane elevation of each axial node in the MAAP
**         core representation [MAAP_AX_EL(J)] by:
**
**         - Dividing the length of the active fuel (XZFUEL) by the number
**           of MAAP active core axial nodes (MAAP_NO_AX_NODES = NAXNOD -
**           NNFT - NNFB),
**
**         - Then calculating the distance from the fuel element bottom to
**           the center (midplane elevation) of each node (MAAP_AX_EL(J))...
**
**           NODE_HT_MAAP = XZFUEL / MAAP_NO_AX_NODES
**
**           MAAP_AX_EL(J) = {(.5) * NODE_HT_MAAP} + {(J-1) * NODE_HT_MAAP}
**
**
```

```
**    iii) The core peaking factor used for each axial node elevation in the
**         MAAP core (AX_PK_MAAP(J)) is obtained by linearly interpolating
**         between the axial peaking factor values at elevations in the
**         original core representation above and below each MAAP node ele-
**         vation.  Let the J'th MAAP nodal elevation occur between the I
**         and I+1 original nodal elevations.  The calculation is then;
**
**         AX_PK_MAAP(J) = AX_PK_ORIG(I) + [AX_PK_ORIG(I+1) - AX_PK_ORIG(I)]
**                    * {[MAAP_AX_EL(J) - ORIG_AX_EL(I)]
**                    / [ORIG_AX_EL(I+1)-ORIG_AX_EL(I)]}
**
**    B. Transformation of data from the X*Y bundles (from the original or
**       revised (per Item 2) radial core peaking factor maps) to the N
**       radial rings of the MAAP core representation.
**
**    i)  Calculate the equivalent radius of each radial ring in the MAAP
**        core representation [EQ_RING_RAD(N)].
**
**        RING_AREA(N) = PI * XRBF**2 * FA(N)
**
**        EQ_RING_RAD(1) = (RING_AREA(1)/PI)**.5
**
**        EQ_RING_RAD(N) = {[RING_AREA(N) + PI*EQ_RING_RAD(N-1)**2]/PI}**.5
**        (FOR  N > 1)
**
**    ii)  Calculate the distance between the core centerline and the center-
**        line of each fuel assembly [DIST(X,Y)] by using the distance
**        between adjacent assemblies (DIST_BETW_ADJ_ASSY)
**
**        DIST(X,Y) = {[DIST_BETW_ADJ_ASSY * (X-.5)]**2
**                + [DIST_BETW_ADJ_ASSY * (Y-.5)]**2}**.5
**
**    iii) Obtain the core peaking factor for each radial ring in the
**        MAAP core representation [rad_pk_maap(n)] by averaging the radial
**        peaking factors for all the bundles in each ring.  For example,
**        the peaking factors that would be summed for the innermost ring
**        would be all those whose fuel assembly satisfies the condition;
**
**        DIST(X,Y) < EQ_RING_RAD(1);
**
**        The overall sum would then be divided by the number of bundles
**        satisfying the above condition to obtain RAD_PK_MAAP(1).  For
**        the Nth inner ring, the peaking factors that would be summed
**        would be all those whose fuel assembly satisfies the condition;
**
**        EQ_RING_RAD(N-1) < DIST(X,Y) < EQ_RING_RAD(N)      {for N > 1}
**
**        The resulting sum is then divided by the number of bundles in
**        the ring to obtain RAD_PK_MAAP(N).
**
**    C. Combination of the axial and radial peaking factors into MAAP
**       active core node peaking factors.  The peaking factors resulting
**       from the calculations described in Items A and B above represent
**       the axial and radial factors in terms of the desired MAAP core
```

```
**      nodalization.  To obtain a single peaking factor to describe each
**      node for parameter FPEAK(N,J), these numbers would be multiplied
**      together as follows;
**
**      FPEAK(N,J) = RAD_PK_MAAP(N) * AX_PK_MAAP(J)
**
**      Transform FPEAK(N,J) to the input parameter FPKNOD(IJ) as shown
**      in the following example for the case where the lower two axial
**      rows and one top axial rows are modeled as non-active core regions
**      with NAXNOD = 13;
**
**         FPKNOD(1)  = 0.          (non-active axial row 1, ring 1)
**         FPKNOD(2)  = 0.          (non-active axial row 2, ring 1)
**         FPKNOD(3)  = FPEAK(1,1)  (bottom active axial row, ring 1)
**         FPKNOD(4)  = FPEAK(1,2)  (second active axial row, ring 1)
**                 .
**                 .
**         FPKNOD(12) = FPEAK(1,10)  (top active axial row, ring 1)
**         FPKNOD(13) = 0.           (non-active axial row 13, ring 1)
**
**         FPKNOD(14) = 0.           (non-active axial row 1, ring 2)
**         FPKNOD(15) = 0.           (non-active axial row 2, ring 2)
**         FPKNOD(16) = FPEAK(2,1)   (bottom active axial row, ring 2)
**         FPKNOD(17) = FPEAK(2,2)   (second active axial row, ring 2)
**                 .
**                 .
**         FPKNOD(25) = FPEAK(2,10)  (top active axial row, ring 2)
**         FPKNOD(26) = 0.           (non-active axial row 13, ring 2)
**
**         FPKNOD(27) = 0.           (non-active axial row 1, ring 3)
**         FPKNOD(28) = 0.           (non-active axial row 2, ring 3)
**         FPKNOD(29) = FPEAK(3,1)   (bottom active axial row, ring 3)
**                 .
**                 .
**
** ======================================================================
** Name: FPA(1:25)             Units: [Dimensionless]
**
** Parameter FPA(i) is the peaking factor for the i'th axial row,
** from bottom axial row 1 to top axial row NAXNOD.
**
** Axial power distribution (shape) data is generally supplied as either 20
** to 30 tabular data points from the bottom to top of the active fuel length
** or as a power shape curve of normalized power factor versus distance from
** bottom to top of active fuel length.  To accomodate the tabular form the
** number of active core axial nodes (NAXNOD-NNFT-NNFB) for MAAP should be
** selected if at all possible such that these data points can be evenly
** grouped and an average value can be produced for each group.
**
** Given a power shape curve begin by splitting the curve into (NAXNOD -
** NNFT  - NNFB) equal segments (nodes).  Next, sum the corresponding power
** factors at the beginning and end of each segment and divide each by two.
** These simple averages then become the first, FPA(2), through the next to
** last, FPA(NAXNOD-2), MAAP axial peaking factors.  In this instance, users
```

** need not normalize the peaking factor data as this is done internally by
** MAAP. As it was for the tabular example, the peaking factor for the
** first and last two uppermost axial nodes must be set to 0.0.
**

| | |
|---|---|
| FPA(1) | 0.00 |
| FPA(2) | 0.00 |
| FPA(3) | 0.55 |
| FPA(4) | 0.90 |
| FPA(5) | 1.18 |
| FPA(6) | 1.25 |
| FPA(7) | 1.31 |
| FPA(8) | 1.33 |
| FPA(9) | 1.33 |
| FPA(10) | 1.30 |
| FPA(11) | 1.25 |
| FPA(12) | 1.19 |
| FPA(13) | 1.17 |
| FPA(14) | 1.03 |
| FPA(15) | 0.94 |
| FPA(16) | 0.83 |
| FPA(17) | 0.70 |
| FPA(18) | 0.54 |
| FPA(19) | 0.00 |

**
** ====================================================================
** Name: FPR(1:7)                Units: [Dimensionless]
**
** Parameter FPR(i) is the peaking factor for the i'th radial ring starting
** from the center (ring 1) and moving to the peripheral ring (NCHAN).
**
** Radial power factor data is usually supplied in the form of a 1/4 core map
** with average (bottom to top) peaking factors for each fuel assembly which
** virtually always assumes that the other 3/4s of the core replicate the
** first. To generate MAAP radial peaking factors the individual assembly
** peaking factors must first be grouped in roughly concentric layers
** starting at the core center. Although referred to as radial rings, the
** layers need not be precisely circular. They need not have equal areas.
** Area fractions, also regarded as volume fractions, are specified using
** parameter variable FA(). However, the layers should be symmetrical
** around the core center, e.g. separations between the layers should be
** at equivalent points on the X and Y axes. After establishing which
** assemblies fall into each ring the assembly peaking factors for each ring
** are summed. Each total is then divided by the number of assemblies in the
** corresponding ring to obtain the MAAP radial peaking factor values. The
** result is the average power of the assemblies in each radial node divided
** by the average power of the assemblies in the whole core with the latter
** being the total power/total number of assemblies.
**

| | |
|---|---|
| FPR(1) | 2.08 |
| FPR(2) | 1.05 |
| FPR(3) | 0.57 |
| FPR(4) | 0.30 |

**
** ====================================================================

** Name: FA(1:7) Units: [Dimensionless]
**
** FA(i) is the area or volume fraction of i'th radial ring starting from the
** center (1) and moving to the peripheral (NCHAN). Each radial area
** fraction is the number of fuel assemblies (or pins) in each radial ring
** divided by the total number of fuel assemblies (or pins) in the core.
**
FA(1) 0.25
FA(2) 0.25
FA(3) 0.25
FA(4) 0.25
**
** ==================================================================
** Name: NSPCR(1:25) Units: [Dimensionless]
**
** This parameter is the grid spacer index moving from bottom to top.
** NSPCR(i) should be set to 1 to indicate the presence of a grid spacer at
** the bottom of the i'th axial row. The presence of grid spacers will have
** an impact on downward molten core relocation.
**
NSPCR(1) 0
NSPCR(2) 1
NSPCR(3) 0
NSPCR(4) 0
NSPCR(5) 1
NSPCR(6) 0
NSPCR(7) 0
NSPCR(8) 1
NSPCR(9) 0
NSPCR(10) 0
NSPCR(11) 1
NSPCR(12) 0
NSPCR(13) 0
NSPCR(14) 1
NSPCR(15) 0
NSPCR(16) 0
NSPCR(17) 1
NSPCR(18) 0
NSPCR(19) 1
**
** ==================================================================
** The following parameters are used to define the non-active core regions
** above and below the active core region. Recall that parameters NNFT and
** NNFB are used to define how many axial rows exists in the non-active
** region above and below the active core, respectively.
**
** ==================================================================
** Name: XDZNFT(1:5) Units: [M,FT]
**
** XDZNFT(i) is the height of the i'th axial row in the upper non-active
** core region above the active core starting from the bottom (1) and moving
** to the top (NNFT). Typically, the top axial row NAXNOD represents the
** upper tie plate.
**

XDZNFT(1) 0.492 FT
XDZNFT(2) 0.0 FT
XDZNFT(3) 0.0 FT
XDZNFT(4) 0.0 FT
XDZNFT(5) 0.0 FT
**
** ========================================================================
** Name: XDZNFB(1:5) Units: [M,FT]
**
** XDZNFB(i) is the height of the i'th axial row in the lower non-active
** core region below the active core moving from the bottom (1) to the top
** (NNFB). Typically, the bottom axial row 1 represents the core plate, and
** bottom axial row 2 represents the lower tie plate.
**
XDZNFB(1) 0.492 FT
XDZNFB(2) 1.614 FT
XDZNFB(3) 0.0 FT
XDZNFB(4) 0.0 FT
XDZNFB(5) 0.0 FT
**
** ========================================================================
** Name: MSSNFT(1:5) Units: [KG,LB]
**
** MSSNFT(i) is the i'th axial row mass of stainless steel in the upper
** non-active core region above the active core moving from the bottom (1)
** to the top (NNFT). Typically, the top axial row NAXNOD represents the
** upper tie plate.
**
MSSNFT(1) 0.0 LB
MSSNFT(2) 0.0 LB
MSSNFT(3) 0.0 LB
MSSNFT(4) 0.0 LB
MSSNFT(5) 0.0 LB
**
** ========================================================================
** Name: MSSNFB(1:5) Units: [KG,LB]
**
** MSSNFB(i) is the i'th axial row mass of stainless steel in the lower
** non-active core region above the active core moving from the bottom (1)
** to the top (NNFB). Typically, the bottom axial row 1 represents the core
** plate, and bottom axial row 2 represents the lower tie plate.
** PWR MAAP 3.0B corresponding parmaeter is MCSP0.
**
MSSNFB(1) 6400.0 LB
MSSNFB(2) 13186.0 LB
MSSNFB(3) 0.0 LB
MSSNFB(4) 0.0 LB
MSSNFB(5) 0.0 LB
**
** ========================================================================
** Name: MZRNFT(1:5) Units: [KG,LB]
**
** MZRNFT(i) is the i'th axial row mass of zircalloy (Zr) in the upper
** non-active core region above the active core moving from the bottom (1)

```
** to the top (NNFT).  Note that this mass is also a part of the total
** zircalloy cladding mass in the whole core represented by parameter MZR0C.
** An approximated value of the mass can be obtained as:
**
**      MZRNFT(i) = MZR0C * XDZNFT(i) /
**          (ZCRU - ZCRL + sum of XDZNFT + sum of XDZNFB)
**
** @@@ 4.0.3 MAM 8/29/95  Do not include MZR0K mass in the calculation
** above as was suggested in previous sample parameter file descriptions.
**
MZRNFT(1)     1528.5  LB
MZRNFT(2)        0.0  LB
MZRNFT(3)        0.0  LB
MZRNFT(4)        0.0  LB
MZRNFT(5)        0.0  LB
**
** ========================================================================
** Name: MZRNFB(1:5)            Units: [KG,LB]
**
** MZRNFB(i) is the i'th axial row mass of zircalloy (Zr) in the lower
** non-active core region below the active core moving from the bottom (1)
** to the top (NNFB).  Note that this mass is also a part of the total
** zircally mass in the whole core represented by parameter MZR0C.  An
** approximated value of the mass can be obtained as:
**
**      MZRNFB(i) = MZR0C * XDZNFB(i) /
**          (ZCRU - ZCRL + sum of XDZNFT + sum of XDZNFB)
**
** @@@ 4.0.3 MAM 8/29/95  Do not include MZR0K mass in the calculation above
** as was suggested in previous sample parameter file descriptions.
**
MZRNFB(1)        0 0  LB
MZRNFB(2)     1528.5  LB
MZRNFB(3)        0.0  LB
MZRNFB(4)        0.0  LB
MZRNFB(5)        0.0  LB
**
** ========================================================================
NGASU          19          // Dimensionless
**
** This parameter is the index of the axial row having the fuel rod upper
** gas plenum.  NGASU should be set to NAXNOD+1 if no upper gas plenum is
** modeled.
**
** ========================================================================
NGASL          2           // Dimensionless
**
** This parameter is the index of the axial row having the fuel rod lower
** gas plenum.  NGASL should be set to 0 if no lower gas plenum is modeled.
**
** ========================================================================
NPLAT          1           // Dimensionless
**
** This parameter is the index of the axial row having the core support
```

** plate. NPLAT should be set to 0 if no core support plate is modeled.
** This parameter can be set the same as NGASL if modeling the lower gas
** plenum or not with the core support plate on the same axial row.
**
** ========================================================================
ABP 20.68 FT**2 // Units: [M**2,FT**2]
**
** This parameter is the bypass cross-sectional area for the region between
** the core baffle and the core barrel. Make sure that the value specified
** here is consistent with the core/core bypass area specified in Primary
** System parameter ACR.
**
** ========================================================================
AGCRFP 0.210 FT**2 // Units: [M**2,FT**2]
**
** This parameter is the effective flow area through each core former plate
** in the axial direction. The former plates are in the baffle - core
** barrel annulus. This represents flow through the holes in the horizontal
** surfaces of the core former plates in TMI-type core geometries and is
** not likely to apply to Westinghouse plants or to BWR core geometries.
** If it does not apply set the parameter to zero.
**
** AGCRFP is used in the manometric balance. If natural circulation is
** allowed and the return flow is through the baffle - core barrel annulus
** for PWRs or the outer bypass region for BWRs then AGCRFP is also used
** for the return flow for those rows that have former plates. AGBF is
** used for those rows that do not have former plates. The code determines
** which rows have former plates using the assumption that the plates are
** uniformly distributed along the core. See the description for AGBF for
** more information about the natural circulation parameters.
**
** ========================================================================
NCRFP 8 // Dimensionless
**
** This parameter is the number of core former plates in the baffle - core
** barrel annulus. It is used with parameter AGCRFP in TMI-type core
** geometries only and is not likely to apply to Westinghouse plants or to
** BWR core geometries. If it does not apply set the parameter to zero.
**
** ========================================================================
AGBF 0.0 FT**2 // Units: [M**2,FT**2]
**
** @@@ 4.0.3 MAM 12/15/95 Updated description for AGBF for all parameter
** files.
**
** Parameter AGBF is used only if the in-vessel natural circulation return
** path is in the baffle - core barrel annulus for PWR's or the outer
** bypass region for BWR's, i.e., when the *Model parameter FNCBP is set to
** one and in-vessel natural circulation is allowed, i.e.; when *Model
** parameter FFRICR is positive. For plants with such a configuration
** (likely to be B&W and BWR core geometries), this parameter must be
** non-zero.
**
** This parameter is the "effective flow area per row" and represents the

```
** approximate effective flow area available through the core baffle when
** the natural circulation flow is assumed to go down the core baffle -
** core barrel annulus. This parameter is ignored for most cases where it
** can be safely assumed that natural circulation occurs totally within the
** core itself. The users can enter the total effective flow area divided
** by the number of rows used in the core nodalization scheme:
**
**      AGBF = (NBFH * ABFH) / NAXNOD
**
** Where: NBFH   = number of holes in core baffle
**        ABFH   = effective area of one core baffle hole
**        NAXNOD = number of axial rows in core nodalization
**
** In any event, a significant degree of uncertainty applies to the flow
** pattern for cores with large effective flow areas through the core
** peripheral since no detailed solutions are known to exist.
**
** ======================================================================
ABPINC        0.0  FT**2      // Units: [M**2,FT**2]
**
** This parameter is the in-core bypass cross-sectional area for the region
** between the fuel cans and the control blades. Do not include the area
** from the outside fuel cans to the core shroud wall. This parameter is a
** subset of the parameter ABP and make sure that the value specified here
** is consistent with the core/core bypass area specified in the Primary
** System parameter AFLCOR. This parameter is set to 0 for PWR's.
**
** ======================================================================
** *
** *    An example for more comprehensive non-fuel region input set
** *
** *    2 top non-fuel rows, 9 active fuel rows, 3 bottom non-fuel rows
** *
** * NAXNOD   14      number of rows
** *
** *
** * NNFT     2       number of non-fuel nodes above active fuel, <=5
** *                  upper gas plenum (1st),
** *                  upper tie plate (2nd)
** *
** * INNFB    3       number of non-fuel nodes below active fuel, <=5
** *                  model support plate (1st),
** *                  tie plate or lower fitting (2nd),
** *                  lower gas plenum (3rd)
** *
** * FPA(1)  = 0.     axial peaking factor bottom, support plate
** * FPA(2)  = 0.     axial peaking factor, tie plate or lower end fitting
** * FPA(3)  = 0.     axial peaking factor, lower gas plenum
** * FPA(4)  = 0.695  axial peaking factor
** * FPA(5)  = 1.09   axial peaking factor
** * FPA(6)  = 1.195  axial peaking factor
** * FPA(7)  = 1.2    axial peaking factor
** * FPA(8)  = 1.185  axial peaking factor
** * FPA(9)  = 1.16   axial peaking factor
```

** * FPA(10) = 1.1 axial peaking factor
** * FPA(11) = 1.035 axial peaking factor
** * FPA(12) = 0.88 axial peaking factor
** * FPA(13) = 0. axial peaking factor, upper gas plenum
** * FPA(14) = 0. axial peaking factor top, upper tie plate
** *
** * XDZNFT(1) = 0.1780 lengths of upper non-fuel nodes, gas plenum
** * XDZNFT(2) = 0.0762 lengths of upper non-fuel nodes, tie plate
** * XDZNFT(3) = 0.0 not used
** * XDZNFT(4) = 0.0 not used
** * XDZNFT(5) = 0.0 not used
** *
** * XDZNFB(1) = 0.3560 length of bottom non-fuel nodes, support plate
** * XDZNFB(2) = 0.0762 length of bottom non-fuel nodes, tie plate
** * XDZNFB(3) = 0.1780 length of bottom non-fuel nodes, lower gas plenum
** * XDZNFB(4) = 0.0 not used
** * XDZNFB(5) = 0.0 not used
** *
** * MSSNFT(1) = 0.0 SS mass of upper non-fuel nodes, gas plenum
** * MSSNFT(2) = 907.0 SS mass of upper non-fuel nodes, tie plate
** * MSSNFT(3) = 0.0 not used
** * MSSNFT(4) = 0.0 not used
** * MSSNFT(5) = 0.0 not used
** *
** * MSSNFB(1) = 22501.0 SS mass of bottom non-fuel nodes, support plate
** * MSSNFB(2) = 1500.0 SS mass of bottom non-fuel nodes, tie plate
** * MSSNFB(3) = 0.0 SS mass of bottom non-fuel nodes, lower gas plenum
** * MSSNFB(4) = 0.0 not used
** * MSSNFB(5) = 0.0 not used
** *
** * MZRNFT(1) = 900.6 Zr mass of upper non-fuel nodes, upper gas plenum
** * MZRNFT(2) = 0.0 Zr mass of upper non-fuel nodes, tie plate
** * MZRNFT(3) = 0.0 not used
** * MZRNFT(4) = 0.0 not used
** * MZRNFT(5) = 0.0 not used
** *
** * MZRNFB(1) = 0.0 Zr mass of bottom non-fuel nodes, support plate
** * MZRNFB(2) = 0.0 Zr mass of bottom non-fuel nodes, tie plate
** * MZRNFB(3) = 900.6 Zr mass of bottom non-fuel nodes, lower gas plenum
** * MZRNFB(4) = 0.0 not used
** * MZRNFB(5) = 0.0 not used
** *
*****************************************************************************
*Fission Product
*****************************************************************************
*SI
**
** This parameter section is used for setting up the core fission product
** masses and fractional decay power and core structural material masses.
**
** ===========================================================================
** Name: MFPIN(1:25) Units: [KG,LB]
**
** Parameter MFPIN(i) defines the ith initial core fission mass as:

```
**
**     1) Mass of XE AS XE-131
**     2) Mass of KR AS KR-84
**     3) Mass of I AS I-131
**     4) Mass of RB AS RB-86
**     5) Mass of CS AS CS-133
**     6) Mass of SR AS SR-88
**     7) Mass of BA AS BA-138
**     8) Mass of Y AS Y-89
**     9) Mass of LA AS LA-139
**     10) Mass of ZR AS ZR-91
**     11) Mass of NB AS NB-109
**     12) Mass of MO AS MO-96
**     13) Mass of TC AS TC-99
**     14) Mass of RU AS RU-101
**     15) Mass of SB AS SB-122
**     16) Mass of TE AS TE-128
**     17) Mass of CE AS CE-140
**     18) Mass of PR AS PR-141
**     19) Mass of ND AS ND-144
**     20) Mass of SM AS SM-150
**     21) Mass of NP AS NP-237
**     22) Mass of PU AS PU-239
**     23) Reserved for future use
**     24) Reserved for future use
**     25) Reserved for future use
**
** Fission product masses defined in parameter array MFPIN() are treated
** separately when in the core or the debris. The masses are then lumped
** into the following MAAP fission product groups when released:
**
**     GROUP 1 VAPOR (V): Nobles (Xe + Kr)
**     GROUP 1 AEROSOL (A): All non-radioactive inert aerosols
**     GROUP 2  V & A:  CsI + RbI
**     GROUP 3  V & A:  TeO2
**     GROUP 4  V & A:  SrO
**     GROUP 5  V & A:  MoO2
**     GROUP 6  V & A:  CsOH + RbOH
**     GROUP 7  V & A:  BaO
**     GROUP 8  V & A:  La2O3 + Pr2O3 + Nd2O3 + Sm2O3 + Y2O3
**     GROUP 9  V & A:  CeO2
**     GROUP 10 V & A:  Sb
**     GROUP 11 V & A:  Te2
**     GROUP 12 V & A:  UO2 + NpO2 + PuO2
**
** The initial masses of specific fission products requested for parameters
** MFPIN(1) through MFPIN(25) are used to calculate the total number of moles
** for the particular elements involved.
**
** The initial mass of the fission products can be obtained by performing
** ORIGEN calculations for the various fuel cycles (based on burnup).
**
MFPIN(1)      320.0  KG
MFPIN(2)       16.5  KG
```

```
MFPIN(3)      14.8  KG
MFPIN(4)      18.1  KG
MFPIN(5)     161.0  KG
MFPIN(6)      59.1  KG
MFPIN(7)      75.4  KG
MFPIN(8)      28.2  KG
MFPIN(9)      76.8  KG
MFPIN(10)    220.0  KG
MFPIN(11)      3.4  KG
MFPIN(12)    191.0  KG
MFPIN(13)     45.8  KG
MFPIN(14)    128.0  KG
MFPIN(15)      1.0  KG
MFPIN(16)     30.8  KG
MFPIN(17)    162.0  KG
MFPIN(18)     62.6  KG
MFPIN(19)    210.0  KG
MFPIN(20)     41.9  KG
MFPIN(21)     32.0  KG
MFPIN(22)    578.0  KG
MFPIN(23)      0.0  KG
MFPIN(24)      0.0  KG
MFPIN(25)      0.0  KG
**
** Users may scale the supplied parameter values by the core power as:
**
**      MFPIN(i)[My plant] = QCR0[My plant] / QCR0[UG] * MFPIN(i)[UG]
**
** Where:  QCR0[My plant] = initial/nominal core power for this plant
**                  (*Core parameter QCR0)
**
**       QCR0[UG]       = MAAP Users Guide core power
**
**       MFPIN(i)[UG]   = MAAP Users Guide i'th initial fission product mass
**
** =====================================================================
** Name: MSM0(1:5)              Units: [KG,LB]
**
** Parameter MSM0(i) defines the ith initial structural material mass.  The
** types of structural material mass requested is dependent on *Control
** parameter IBCCR flag and are:
**
**        IBCCR=0     IBCCR=1
**
**      1)  CD        B4C
**      2)  IN        SS
**      3)  AG        -
**      4)  SN        SN
**      5)  MN        MN
**
MSM0(1)      303.0  KG
MSM0(2)      909.0  KG
MSM0(3)     4848.6  KG
MSM0(4)      347.0  KG
```

```
MSM0(5)        196.0 KG
**
** The mass of core structural material parameters includes both the core
** structure and the control rods. It should not include the control
** blade boron carbide mass. That mass is input in parameter section
** *Core as parameter MCB0. Note that the order of structural
** materials is different for MAAP3B and MAAP4.
**
** Two types of control rods may be modeled. The user may only select one
** type. The control rods may be modeled containing CD-IN-AG mass or
** containing B4C and SS mass. The *Control parameter IBCCR is used to
** select the control rod type. Setting parameter IBBCR to 0 selects the
** CD-IN-AG control rod type and setting parameter IBBCR to 1 selects B4C-SS
** type.
**
** The structural materials may be released from the core as aerosols and
** are lumped together with the concrete aerosols in MAAP fission product
** group 1.
**
** For CD-AG-IN control rods the initial masses of Cd, In, and Ag can be
** calculated as follows using typical mass fractions: Cd = .05, In = .15,
** and Ag = .8.
**
**     MSM0(1) = VCRT * DEQ * .05
**     MSM0(2) = VCRT * DEQ * .15
**     MSM0(3) = VCRT * DEQ * .8
**
** Where: VCRT = Total control rod volume,
**             = .25 * PI * XDCR**2 * XLCR * NCR * NASS
**
** Where: XDCR = Control rod diameter
**        XLCR = Control rod length
**        NCR  = Number of control rods per assembly
**        NASS = Number of assemblies
**
**        DEQ  = Equivalent density,
**             = (.05 * DCd) + (.15 * DIn) + (.8 * DAg)
**
** Where: DCd = Cd density
**        DIn = In density
**        DAg = Ag density
**
** and the density data can be obtained from the CRC Handbook of Chemistry
** and Physics.
**
** Similar calculations can be done if the control rods are B4C.
**
** The initial mass of Sn (tin) in core can be determined from the total
** amount of zircalloy as:
**
**     MSM0(4) = (MZR0C + MZR0K) * FWZR
**
** Where: MZR0C = Initial zircalloy mass in cladding
**              (*Core parameter MZR0)
```

```
**
**      MZR0K = Initial zircalloy mass in fuel cans
**             (*Core parameter MZR0K)
**
**      FWZR  = Weight percent of tin in Zircalloy, typically 0.0145
**              per ASTM-B-353; See following table
**
**     ----------------------------------------
**     |Alloying Elements in Zircalloy-2 and -4|
**     |    [ASTM-B-353 Nominal Values]        |
**     |---------------------------------------|
**     |                 Percent by weight |
**     |                 ----------------- |
**     | Element          Zr-2      Zr-4 |
**     |-------           ----      ---- |
**     | Tin              1.45      1.45 |
**     | Iron             0.14      0.21 |
**     | Chromium           0.10      0.10 |
**     | Nickel            0.05      Neg. |
**     | Zirconium          Balance    Bal. |
**     ----------------------------------------
**
** The initial mass of Mn is typically 2% of the amount of stainless steel
** and 5% of the Inconel. Include the mass of Mn from MSS0, MSS0CL, MSSNFT(),
** MSSNFB(), and MSM0(2) when IBCCR=1 and any core components from the bottom
** of active fuel to the top of the fuel assemblies that would be expected
** to become a part of the core melt.
**
** ==========================================================================
** Name: FQP(1:12)              Units: [Dimensionless]
**
** This parameter is the fraction of decay power in each MAAP fission
** product group.  The sum of all fission product groups, FQP(1-12), does
** not add up to one because the balance of the fraction of decay power is
** held by the non-volatiles. Note that UO2 contribution to group 12 should
** not include the nonvolatile species.  The twelve fission product groups
** used in MAAP are:
**
**       1) NOBLES
**       2) CSI + RBI
**       3) TEO2
**       4) SRO
**       5) MOO2
**       6) CSOH + RBOH
**       7) BAO
**       8) LA2O3 + PR2O3 + ND2O3 + SM2O3 + Y2O3
**       9) CEO2
**      10) SB
**      11) TE2 (USE SAME VALUE AS FQP(3))
**      12) UO2 + NPO2 + PU02
**
FQP(1)        0.03
FQP(2)        0.17
FQP(3)        0.02
```

| | |
|---|---|
| FQP(4) | 0.04 |
| FQP(5) | 0.02 |
| FQP(6) | 0.01 |
| FQP(7) | 0.02 |
| FQP(8) | 0.27 |
| FQP(9) | 0.03 |
| FQP(10) | 0.006 |
| FQP(11) | 0.02 |
| FQP(12) | 0.16 |

**

** The FQP array is defined to be the fraction of the decay power that is
** generated by the constituents of each of the twelve "fission product
** groups". The remainder of the decay power is generated by all the other
** fission products that are in the fuel.
**
** In MAAP, all fission products except those in the twelve groups are
** assumed to always remain in the fuel. Those in the twelve groups may
** be released from the fuel (as a function of the fuel temperature) and
** move independently of it. The fuel in MAAP is represented by UO2. Note
** that a portion of the UO2 itself can be released as a vapor and move
** independently of the bulk of the fuel and the remaining fission products
** (hence group 12).
**
** MAAP tracks the masses of each fission product group in the different
** regions of the primary system and containment. MAAP then assigns a
** portion of the total decay heat to the i'th fission product group in each
** location using: 1) the fractions specified in the FQP array and 2) the
** fraction of the initial mass of each group that is in that location.
** Similarly, MAAP tracks the mass of fuel in each location and calculates
** the decay heat due to the fission products that are assumed to always
** remain in the fuel by using: 1) a corresponding FQP value that is equal
** to 1 minus the sum of the FQP fractions and 2) the fraction of the
** initial fuel mass that is in each location.
**
** The FQP fractions can be determined from the results of core inventory
** and power calculations using such codes as ORIGEN2. These codes generate
** the mass and the decay power of the fission products as a function of time.
** The input to these codes includes the mass and enrichment of the uranium
** fuel, the thermal power of the reactor and its operating time. Therefore,
** the values for the FQP array are plant-specific and vary with time.
**
** Users should be aware of the following points related to the creation,
** usage and impact of the FQP array.
**
** - The components of the array that have the most impact on the
** distribution of the decay power are those that correspond to the
** fission products that are most readily released (the volatile ones).
**
** - In general, the FQP array is not a strong function of the plant type,
** power level or time of operation if the reactor has been operated for
** more than about a year.
**
** - The array is a function of the time since shut-down. The values
** correspond to approximately 5 hours after shut-down. The code was

```
** written to use only a single set of values, which is considered
** sufficient because the array would not change substantially after the
** initial shut-down period. If users want to account for the time-
** dependent nature of the array, the values can be modified during the
** sequence via local parameter changes. However, the fraction of the
** decay power associated with the remainder of the fuel is only
** calculated at the beginning of the sequence. Changes to the array
** such that the sum of the values changes will result in an "imbalance"
** in the distribution of the decay heat. Presumably this effect is
** small but FAI has not tested the code with time-dependent values.
**
** - The impact of different values of the FQP array was evaluated for the
** station blackout sample problems with MAAP 3.0B BWR Rev. 8 and PWR Rev.
** 18 of the code. The two versions were run using values corresponding to
** .5, 5 and 15 hours after shutdown, and a linear average of values over a
** considerably longer period of time. The figures-of-merit from these
** different cases were compared. The impact on the results is noticeable
** but the progression of the sequences does not substantially change.
**
** Those who are using the default values of the array for their plant-
** specific calculations should evaluate the sensitivity of their results to
** these values, particularly for cases involving substantial revaporization.
** Users who have questions regarding the calculation of plant-specific values
** may contact FAI for further information.
**
**
==========================================================================
** @@@ 4.0.3 CYP 3/16/96 - The following parameters were added for the
** CORSOR-M, CORSOR-O and ORNL-BOOTH fission product release correlations.
** The correlation option is set via *Model parameter FPRAT. See the
** description of subroutine FPRELC in the User's Manual for more information
** about the correlations and the user input.
**
FCORSM          1.e0            // Dimensionless
**
** FCORSM is the multiplier for the CORSOR-M fission product release rates for
** all fission product groups.
**
** -----------------------------------------------------------------------
**
** The CORSOR-O and ORNL-BOOTH models both require two input parameters
** for each fission product group. The first one is for the initial fuel
** (steam-rich) condition and the second one is for the reduced fuel
** (H2-rich) condition. They are used to calculate the release rate
** coefficient, which is a function of the mole fraction of hydrogen in the
** gas flow for the fuel node. The calculation uses a linear interpolation
** between the two input values. For some fission products the values of the
** two input parameters are the same.
**
** When doing sensitivity studies on fission product releases with the
** CORSOR-O and ORNL-BOOTH models both values for each fission product group
** should be adjusted.
**
** The fission product groups are
```

```
**      1) Nobles
**      2) CsI + RbI
**      3) TeO2
**      4) SrO
**      5) MoO2
**      6) CsOH + RbOH
**      7) BaO
**      8) La2O3 + Pr2O3 + Nd2O3 + Sm2O3 + Y2O3
**      9) CeO2
**     10) Sb
**     11) Te2
**     12) UO2 + NpO2 + PuO2
**
** See Table 5.1 in NUREG/CR-6261 for the CORSOR-O and ORNL-BOOTH
** correlations.
**
** ------------------------------------------------------------------------
**
** Name: FCORO1(1:12)          Units: [Dimensionless]
**
** FCORO1(I) is the CORSOR-O relative multiplier for the initial fuel
** (steam-rich) condition for fission product group I.
**
FCORO1(1)      1.0
FCORO1(2)      0.8
FCORO1(3)      0.0
FCORO1(4)      0.01
FCORO1(5)      0.25
FCORO1(6)      1.0
FCORO1(7)      0.02
FCORO1(8)      0.0002
FCORO1(9)      0.0002
FCORO1(10)     0.5
FCORO1(11)     0.8
FCORO1(12)     0.0
**
** Name: FCORO2(1:12)          Units: [Dimensionless]
**
** FCORO2(I) is the CORSOR-O relative multiplier for the reduced fuel
** (H2-rich) condition for fission product group I.
**
FCORO2(1)      1.0
FCORO2(2)      0.8
FCORO2(3)      0.0
FCORO2(4)      0.1
FCORO2(5)      0.01
FCORO2(6)      1.0
FCORO2(7)      0.2
FCORO2(8)      0.0002
FCORO2(9)      0.002
FCORO2(10)     0.02
FCORO2(11)     0.02
FCORO2(12)     0.0
**
```

```
** Note that for groups 5, 10 and 11 the ORNL recommended values for initial
** fuel and reduced fuel are the same, while those for oxidized fuel are
** much higher. The larger values are used here for FCORO1.
**
** ----------------------------------------------------------------------
**
** Name: FORNL1(1:12)          Units: [Dimensionless]
**
** FORNL1(I) is the ORNL-BOOTH relative multiplier for the initial fuel
** (steam-rich) condition for fission product group I.
**
FORNL1(1)     1.0
FORNL1(2)     0.64
FORNL1(3)     0.0
FORNL1(4)     0.0001
FORNL1(5)     0.0625
FORNL1(6)     1.0
FORNL1(7)     0.0004
FORNL1(8)     4.0e-8
FORNL1(9)     4.0e-8
FORNL1(10)    0.25
FORNL1(11)    0.64
FORNL1(12)    0.0
**
** Name: FORNL2(1:12)          Units: [Dimensionless]
**
** FORNL2(I) is the ORNL-BOOTH relative multiplier for the reduced fuel
** (H2-rich) condition for fission product group I.
**
FORNL2(1)     1.0
FORNL2(2)     0.64
FORNL2(3)     0.0
FORNL2(4)     0.01
FORNL2(5)     0.0001
FORNL2(6)     1.0
FORNL2(7)     0.04
FORNL2(8)     4.0e-8
FORNL2(9)     4.0e-6
FORNL2(10)    4.0e-4
FORNL2(11)    4.0e-4
FORNL2(12)    0.0
**
** ----------------------------------------------------------------------
**
XGRAIN       6.e-6 M       // Units: [M,FT]
**
** XGRAIN is the measured initial grain radius in the fuel. It is used in
** the ORNL-BOOTH correlation.
**
**
******************************************************************************
*Initial Conditions
******************************************************************************
*BR
```

**
** This parameter section defines the inputs for initial conditions.
** Possible data sources for the majority of the parameters can be obtained
** from:
**
**     1) Plant FSAR - Primary system, Steam generator,
**        Containment, and ECCS sections
**     2) Operator Training Manual - Primary system,
**        Pressurizer, Steam generator, and ECCS sections
**     3) Plant operating surveillance data
**     4) Containment and/or Containment HVAC sizing design calculations
**     5) Plant Tech Specs
**
** ==========================================================================
TWPSNM    590.8 F    // Units: [K,F]
**
** This parameter is the nominal full power primary system average water
** temperature.
**
** ==========================================================================
PPSNOM    2249.67 PSI    // Units: [PA,PSI]
**
** This parameter is the nominal full power primary system pressure.
**
** ==========================================================================
TWPS0    590.8 F    // Units: [K,F]
**
** This parameter is the initial primary system average water temperature
** for a given sequence.
**
** If it is not a half-loop sequence this value will be same as TWPSNM.
** For a half-loop sequence input the right temperature.
**
** ==========================================================================
PPS0    2249.67 PSI    // Units: [PA,PSI]
**
** This parameter is the initial primary system pressure for a given
** sequence.
**
** If it is not a half-loop sequence this value will be same as PPSNOM.
** For a half-loop sequence input the right containment pressure or
** primary system pressure if sealed.
**
** ==========================================================================
ZWPZ0    27.93 FT    // Units: [M,FT]
**
** This parameter is the initial pressurizer water level.
**
** ==========================================================================
MWSG0    89300.0 LB    // Units: [KG,LB]
**
** This parameter is the initial mass of water on the secondary side of
** one steam generator (S/G).
**

```
** =======================================================================
PSG0         1000.0  PSI       // Units: [PA,PSI]
**
** This parameter is the initial pressure on the secondary side of each of
** the S/Gs.
**
** =======================================================================
MBAPS0          0.0  LB        // Units: [KG,LB]
**
** @@@ 4.0.3 MAM 11/14/95 This parameter was missing from all pwr parameter
** files.
**
** This parameter is the initial total mass of boric acid in the primary
** system water. The mass of boric acid is tracked in the reactor vessel as
** MBAPS and in the containment as MFPWB(13,iv) for the iv'th comparment
** water pool.  In the containment or auxilary building compartments the
** mass of H3BO3 in the water pool is used to determine the pH value of the
** water pool and can be plotted as FPHVAL(iv) for the iv'th comparment
** water pool.  Presently the pH of the reactor vessel water is not
** computed.  See subroutine AUXFP writeup of the MAAP4 User Manual for
** additional details of how the pH value is calculated.
**
** =======================================================================
** The following parameters TSG0HL, MWSGHL, PSG0HL, ZWPSHL, and MWPSHL only
** apply for half-loop operation.
**
TSG0HL          0.0  F         // Units: [K,F]
**
** This parameter is the initial temperature of water and gas in the steam
** generator for half-loop operation.
**
**
MWSGHL          0.0  LB        // Units: [KG,LB]
**
** This parameter is the initial water mass in the S/G for half-loop
** operation.
**
**
PSG0HL          0.0  PSI       // Units: [PA,PSI]
**
** This parameter is the initial pressure in the S/G for half-loop
** operation.
**
**
ZWPSHL          0.0  FT        // Units: [M,FT]
**
** This parameter is the initial water level above the top of the core for
** half-loop operation.
**
**
MWPSHL          0.0  LB        // Units: [KG,LB]
**
** This parameter is the initial primary system water mass.  If this mass
** is larger than the mass required to cover the core then this mass will
```

```
** be used instead of the mass calculated using the above input water level
** (ZWPSHL). If MWPSHL < MWMIN, the minimum water mass required to cover
** the core, then the water level (ZWPSHL) is used to calculate the total
** primary system water mass. The minimum water mass is defined as:
**
**     MWMIN = (VHD+VLOWCR+ADC*(ZCRU-ZRVCYL)+ACR*(ZCRU-ZCRL))/VWPS
**
** ===========================================================================
TCN0        98.75  F        // Units: [K,F]
**
** This parameter is the initial temperature of the concrete floor used in
** MCCI. Containment walls and floors are initialized to the compartment
** gas temperature they face.
**
** ===========================================================================
TAMB        80.3  F         // Units: [K,F]
**
** This parameter is the environment, e.g., compartment INODRB+1, temperature.
**
** ===========================================================================
PAMB        14.7  PSI       // Units: [PA,PSI]
**
** This parameter is the environment, e.g., compartment INODRB+1, pressure.
**
******************************************************************************
*Primary System
******************************************************************************
*BR
**
** Unless otherwise noted the reference point for all elevation variables
** in this section is the lowest point of the inside of the reactor
** pressurized vessel (RPV) head. When a variable such as the volume
** of the downcomer (VDC) is called for the actual downcomer volume
** should be used even though the MAAP nodalization lumps other volumes
** with the downcomer volume (the lumping is done internally in MAAP).
** ===========================================================================
NCL         4               // Dimensionless
**
** number of cold legs
**
** ===========================================================================
XDHL        2.42  FT        // Units: [M,FT]
**
** This parameter is the inner diameter of one hot leg pipe. If the hot leg
** diameter is not uniform, then use a volume average diameter such that:
**
**   XDHL = 2 * (VHL / (PI * XLHL))**.5
**
** Where:  VHL  = Total hot leg volume
**         XLHL = Length of hot leg
**
** ===========================================================================
XTHL        0.304  FT       // Units: [M,FT]
**
```

** This parameter is the minimum thickness of the hot leg and it is
** used in the hot leg creep rupture calculation.
**
** ========================================================================
XRRV 7.21 FT // Units: [M,FT]
**
** This parameter is the inside radius of cylindrical part of the reactor
** vessel. If the radius is not uniform from top to bottom then use a
** volume averaged radius.
**
** @@@ 4.0.3 BJS 3/21/96 - Corrected the value of XRRV. It had been
** mistyped as 7.72 in the draft User's Guide.
**
** ========================================================================
VLOWCR 231.47 FT**3 // Units: [M**3,FT**3]
**
** This parameter is the fluid volume which is inside the core barrel and
** lies between the bottom of the core and the line which denotes the top
** of the reactor vessel lower head (the last is the same as the bottom
** of the reactor vessel cylindrical section). Do not include volumes
** occupied by structures like the flow distribution plate, support columns,
** instrumentation tubes, butt type columns, etc.
**
** ========================================================================
ACR 74.92 FT**2 // Units: [M**2,FT**2]
**
** This parameter is the effective flow area of the core plus core bypass
** area.
**
** ========================================================================
VCL1 80.97 FT**2 // Units: [M**2,FT**2]
**
** This parameter is the volume of horizontal run of pipe in one cold leg
** from the reactor vessel out to the main coolant pump. Do not include the
** reactor vessel and RCP nozzles' fluid volumes. VCL1 should be based on the
** cold leg pipe inner diameter. Even if the plant has two cold legs for each
** hot leg only the volume of one cold leg should be included in VCL1.
**
** ========================================================================
XRVP0 0.0625 FT // Units: [M,FT]
**
** This parameter is the radius of vessel penetration. If there is no
** vessel penetration in the lower head (e.g. some CE plants) then use the
** assumed initial radius of failure when the RPV lower head fails due to
** corium attack. Supply one (1) for the number of failed penetrations in
** the model parameter section. This radius is the outer radius and it
** should be greater than the tube thickness XTPT1. If several different
** radii exist use the radius associated with the smallest attachment weld
** thickness.
**
** ========================================================================
QCP0 1.67e7 BTU/HR // Units: [W,BTU/HR]
**
** This parameter is the energy input from one primary system main coolant

** pump (when it is running).
**
** =====================================================================
WWMU0 0.0 LB/HR // Units: [KG/S,LB/HR]
**
** This parameter is the total makeup flow rate to the primary system.
** During normal operation the makeup flow rate should equal the letdown
** flow rate. This variable is used mainly in the TMI scenario and most
** users will input zero. This water mass is not subtracted from the RWST
** inventory and continues (if power is available) until it is manually
** shut off.
**
** =====================================================================
TWMU 557.8 F // Units: [K,F]
**
** This parameter is the temperature of makeup water.
**
** =====================================================================
XDCL 2.29 FT // Units: [M,FT]
**
** This parameter is the inner diameter of a cold leg pipe. If the cold leg
** diameter is not uniform then use a weighted average diameter such that:
**
** XDCL = 2 * ((VCL - VRCP) / (PI * XLCL))**.5
**
** Where: VCL = Total cold leg volume
** VRCP = Fluid volume of one reactor (main) coolant pump
** XLCL = Length of cold leg
**
** =====================================================================
ZSR 28.57 FT // Units: [M,FT]
**
** This parameter is the center elevation of the nozzle which connects the
** surge line to the hot leg. The elevation of the surge line nozzle
** must be higher than the elevation of the bottom of the coolant nozzles.
**
** =====================================================================
FBB 3 // Dimensionless
**
** This parameter is the broken loop break location key (primary system
** node number):
** 3--broken hot leg node
** 4--broken hot leg "tube" node (B&W only)
** 6--broken intermediate leg node (between pump and cold side of S/G)
** 7--broken cold leg node (horizontal part of cold leg)
** 8--downcomer node (i.e. downcomer plus lower head)
**
** NOTE: You can only specify FBB and ZBB either in the parameter file or
** in initial local parameter change but not in subsequent local parameter
** changes.
**
** =====================================================================
ABB 0.0 FT**2 // Units: [M**2,FT**2]
**

```
** This parameter is the break area of the broken loop. Enter a value of
** zero if there is no break.
**
** ======================================================================
ZBB         26.3  FT**2     // Units: [M**2,FT**2]
**
** This parameter is the broken loop break elevation. The vertical distance
** is measured from the elevation of the center of the break to the
** elevation of the inside bottom  of the RPV lower head. NOTE: You can
** only specify FBB and ZBB either in the paramaeter file or  in initial
** local parameter change but not in subsequent local parameter  changes.
**
** ======================================================================
MSGPHD       1.14e5  LB      // Units: [KG,LB]
**
** This parameter is the mass of the S/G head and tubesheet per steam
** generator  (both upper/lower heads and tubesheets for OTSGS).  In the
** code one half of  this mass is added to MSHEL to create the total mass
** of the S/G external  heat sink.  The other half of this mass is added to
** the mass of the  intermediate leg which is calculated using MCLTOT (see
** below).
**
** ======================================================================
VBLKCL       50.55  FT**3     // Units: [M**3,FT**3]
**
** This parameter is the maximum volume of water in one cold leg which will
** still allow gas to flow past the lowest part of the cold leg.
** This concerns the lowest part of the cold leg spool piece between the RCP
** inlet and the vertical piping section downstream of S/G outlet (the entire
** piping section between the RCP and S/G is more commonly referred to as the
** intermediate leg).  VBLKCL should include the complete volume of any
** existing horizontal segment of this spool piece, as well as the portions
** of the two elbows that would be occupied by water when the horizontal
** section is water filled.
**
** ======================================================================
VCL         317.52  FT**3     // Units: [M**3,FT**3]
**
** This parameter is the total volume of one cold leg. It includes
** the volume of both the cold and intermediate legs and the volume of the
** pump that is in contact with the fluid (the pump casing).
**
** ======================================================================
VHL          93.98  FT**3     // Units: [M**3,FT**3]
**
** This parameter is the total volume of one hot leg. The entire piping fluid
** volume between the RPV outlet and the S/G inlet excluding the pressurizer
** and the pressurizer surge line fluid volumes.  It should not include the
** volume occupied by metal masses within the hot leg.  The volumes in
** the RPV nozzle (up to the core barrel) and the connection to the steam
** generator should be included.
**
** ======================================================================
VRV         4404.4  FT**3     // Units: [M**3,FT**3]
```

```
**
** This parameter is the total fluid volume of the reactor vessel (i.e. the
** net volume not including the core itself or the internal structures).
**
** ======================================================================
VDC          844.8  FT**3      // Units: [M**3,FT**3]
**
** This parameter is the total volume of the downcomer. The downcomer is
** modelled as ending at the elevation where the lower head of the RPV meets
** the cylindrical section.
** Note: the core barrel is also assumed to stop at this point. For users
** who must determine a value for VDC from vessel construction/assembly
** drawings the following approach provides a rough but adequate
** approximation:
**
** VDC = VBVA1 + VBVA2 - VHLN - VTS + VCLN
**
** Where:  VBVA1 = Annular volume between the core barrel outside
**                diameter (OD) and the RPV wall inside diameter (ID)
**                from the upper core support plate elevation down to
**                the thermal shield bottom elevation,
**
**             = (PI*((XDURV**2-XDCB**2)*XHURV+(XDLRV**2-XDCB**2)*XHLRV)/4
**
** Where:  XDURV = Upper (above the thermal shield) RPV wall ID
**         XDCB  = Core barrel OD
**         XHURV = Upper (above the thermal shield) RPV wall vertical height
**         XDLRV = Lower (top to bottom of thermal shield) RPV wall ID
**         XHLRV = Lower (top to bottom of thermal shield) RPV wall
**               vertical height
**         VBVA2 = Annular volume between the core barrel OD and the RPV wall
**               ID from the top of the RPV lower head to the core barrel
**               bottom elevation, or
**
**         VBVA2= RPV lower head volume above the core barrel bottom
**              elevation, minus the core barrel volume below the top
**              of the lower head
**
**         VHLN  = Total volume occupied by the hot leg nozzles in the RPV
**               minus core barrel annulus,
**
**             = NHL * AHL * XGAP
**
** Where:  NHL  = Number of hot legs
**         AHL  = Cross-sectional area of one hot leg nozzle
**         XGAP = Gap between the RPV wall and the core barrel
**
**         VTS   = Volume occupied by the thermal shield,
**
**             = (PI/4) * (XDTSO**2 - XDTSI**2) * XHTS
**
** Where:  XDTSO = Thermal shield OD
**         XDTSI = Thermal shield ID
**         XHTS  = Thermal shield vertical height
```

```
**
**      VCLN  = Total fluid volume within the cold leg nozzles,
**
**            = NCL * ACL * XLCLN
**
** Where:  NCL   = Number of cold legs
**         ACL   = Cross-sectional area of one cold leg nozzle
**         XLCLN = Centerline length of one cold leg nozzle from the
**                 RPV wall ID to the cold leg piping weld attachment
**
** ===========================================================================
VLOWDC       647.8  FT**3      // Units: [M**3,FT**3]
**
** This parameter is the portion of downcomer volume which is below the
** elevation of the bottom of the cold leg nozzles. For users who must
** determine a value for VLOWDC from vessel construction/assembly drawings
** the following provides a rough but adequate approximation:
**
**     VLOWDC = VDCTS + VBVA2 + VCLTS - VTS
**
** Where:  VDCTS = Annular volume between the core barrel OD and the RPV wall
**                 ID from the top to the bottom of the thermal shield,
**
**               = PI * (XRRV**2 - (.5 * XDCB)**2) * XHTS
**
** Where:  XRRV = RPV wall inside radius
**         XDCB = Core barrel OD
**         XHTS = Thermal shield vertical height
**         VBVA2 = Annular volume between the core barrel OD and the RPV wall
**                 ID from the top of the RPV lower head to the core barrel
**                 bottom elevation (same as for VDC)
**         VCLTS = Annular volume between the core barrel OD and the RPV wall
**                 ID from the top of the thermal shield to the bottom
**                 elevation of the cold leg nozzles,
**         VTS   = Volume occupied by the thermal shield (same as for VDC)
**
**
** ===========================================================================
FSR          3.0          // Dimensionless
**
** This parameter is the primary system node number where the surge line is
** connected. For U-tube S/G geometry plants enter a 3 for the
** pressirizer to be in  the broken loop, enter a 9 for the pressurizer in the
** unbroken loop. Use 4 and 10, respectively, for B&W plants.
**
** ===========================================================================
NHL          4.0          // Dimensionless
**
** This parameter is the number of hot legs
**
** ===========================================================================
VFCPMX       0.5          // Dimensionless
**
** This parameter is the void fraction limit for reactor coolant pump (RCP)
```

** trip. If MAAP calculates a RCP inlet water void fraction greater than
** the value specified here then the forced flow through the RCPs will be
** set to zero (without pump coastdown).
**
** ======================================================================
PPSL 1952.67 PSI // Units: [PA,PSI]
**
** This parameter is the low pressurizer pressure trip point.
** If a given scram set point (trip) does not exist then input a value
** which the code will never exceed.
**
** ======================================================================
PPSH 2413.67 PSI // Units: [PA,PSI]
**
** This parameter is the high pressurizer pressure trip point.
** If a given scram set point (trip) does not exist then input a value which
** the code will never exceed.
**
** ======================================================================
TDIFPS 200.0 DEG-F // Units: [DEG-K,DEG-F]
**
** This parameter is the high loop delta-T scram setpoint
** MAAP will scram the reactor if the temperature difference between the
** cold and hot leg exceeds the value specified for this variable. This
** parameter is a temperature differential.
** If a given scram set point (trip) does not exist, input a value which
** the code will never exceed.
**
** ======================================================================
ZWPZL -100.0 FT // Units: [M,FT]
**
** This parameter is the low pressurizer water level trip referenced to
** the bottom of pressurizer.
** If a given scram set point (trip) does not exist, input a value which
** the code will never exceed.
**
** ======================================================================
ZWPZH 41.58 FT // Units: [M,FT]
**
** This parameter is the high pressurizer water level trip referenced to
** the bottom of the pressurizer.
** If a given scram set point (trip) does not exist, input a value which
** the code will never exceed.
**
** ======================================================================
TDSCRM 5.56e-4 HR // Units: [S,HR]
**
** This parameter is the reactor trip delay time. TDSCRAM is the time
** differential between receipt of a scram signal and the time when all of
** the control rods are completely inserted into the core.
**
**
** ======================================================================
TDPOWR 0.0 HR // Units: [S,HR]

```
**
** @@@ 4.0.3 CEH 2/21/96:
** This parameter is new. Previously, it was used in only the BWR code.
** Now, it is generic to both codes.
**
**
** The nominal time period for the transition from full core power to decay
** power. The period starts at reactor scram initiation, which is defined
** to occur only after the scram delay time (parameter TDSCRM) has expired.
** During this period, the core power fraction is assumed to decrease
** linearly from a value of 1 to the value of the decay power fraction at
** time TDPOWR after scram initiation.
**
** It is intended to approximate the contingency of a core power ramp-down
** during control rod insertion. The normal core power transient at scram
** is sufficiently rapid that it can generally be considered an immediate
** transition between power levels, which is modeled by a default value of
** TDPOWR = 0 seconds. For a slower post-scram core power transient, use a
** non-trivial value for period TDPOWR.
**
**
** ======================================================================
ZWSGL        33.69  FT        // Units: [M,FT]
**
** This parameter is the steam generator water level set point for low-low
** level  reactor trip. If the S/G water level falls below the value
** specified for this  variable, MAAP will scram the reactor provided that
** the value is positive. The reference elevation for ZWSGL is the steam
** generator tube sheet.  A negative value prevents the low S/G level
** reactor trip. The actual plant  value for this set point is not
** appropriate for MAAP's single region S/G  model. In this model MAAP4
** assumes that the collapsed tube bundle and  downcomer water levels are
** the same. A reasonable initial value for  ZWSGL can be determined as
** follows:
**
** ZWSGL  = (.9 * VSGS) / (AFLWSG + ASGDC)
**
** Where:  VSGS   = S/G secondary side water volume (downcomer + tube bundle),
**                = MWSGS * VWSGS
**
** Where:  MWSGS = S/G secondary side water mass (downcomer + tube bundle)
**         VWSGS = S/G secondary side water specific volume
**
**         AFLWSG = S/G tube bundle cross-sectional area
**         ASGDC  = S/G downcomer cross-sectional area
**
** The coefficient, .9, is a scaling factor for estimating the S/G water
** mass when the downcomer level is at the scram set point. The water mass
** at this point is roughly 90% of the initial (normal) mass.
**
**
** ======================================================================
NWPST          5          // Dimensionless
**
```

** This parameter is the number of points in the main coolant pump coast-down
** curve (5 max)
**
** ====================================================================
** Name: WPST(1:5)              Units: [KG/S,LB/HR]
**
** This parameter is the mass flowrate per pump in the main coolant pump
** coast-down  curve.
** Note: The first flow rate entry must be the pump flow under nominal power
** conditions
**
** @@@ 4.0.3 CEH 7/1/96 - If, near the end of the main coolant pump
** coast-down, the hot-side RCS water temperature (variable TWHPS) becomes
** erroneously high with respect to the average RCS water temperature
** (variable TWPS), it is due to the relatively small flow rate given to the
** pump flow (variable WWUL (per pump) for multi-loop plants or WWBL (per
** pump) for 1-loop plants) by the coast-down curve.
**
** Generally, this difficulty can be addressed by using a non-trivial flow
** rate for the last entry in the coast-down curve.  Since the fundamental
** assumption is that power is being removed from the core by sensible heat
** transfer to the water circulating through the primary system, this flow
** rate must be consistent with the power transferred (variable QWCR).
**
WPST(1)      3.56e7  LB/HR
WPST(2)      3.16e7  LB/HR
WPST(3)      2.38e7  LB/HR
WPST(4)      1.83e7  LB/HR
WPST(5)      3.96e5  LB/HR
** ====================================================================
** Name: TIWPST(1:5)            Units: [S,HR]
**
** This parameter is the time point corresponding to each flow rate entry
** (WPST) in main coolant pump coast-down curve.
** Note: The first entry must be 0.0
**
TIWPST(1)      0.0  HR
TIWPST(2)    3.19e-4  HR
TIWPST(3)    1.43e-3  HR
TIWPST(4)    2.68e-3  HR
TIWPST(5)    1.94e-2  HR
** ====================================================================
ZSGTS         37.0  FT        // Units: [M,FT]
**
** This parameter is the elevation of the top of the S/G tubesheet measured
** from the elevation of the bottom of RPV.
**
** ====================================================================
XTRV          0.45  FT        // Units: [M,FT]
**
** This parameter is the thickness of RPV lower head.
**
** ====================================================================
ZNOZ          26.18  FT       // Units: [M,FT]

**
** This parameter is the elevation of the base of the coolant loop nozzles.
** It is the vertical distance between the bottom of nozzles and the inside
** bottom of RPV lower head.
**
** ===================================================================
ZLOWNZ      10.31 FT       // Units: [M,FT]
**
** This parameter is the vertical distance from lowest elevation of a cold
** leg to the elevation of the base of the cold leg nozzle on the RPV.
**
** ===================================================================
VHL1        76.15 FT**3      // Units: [M**3,FT**3]
**
** This parameter is the volume of the horizontal run of a hot leg pipe.
** If there is more than one horizontal piping section per hot leg VHL1
** should be the total volume for all horizontal sections. VHL1 should
** include the volume of the RPV hot leg nozzle up to the core barrel.
** Note: Parameter VHL1 should be less than or equal to VHL. VHL1 is used
** along with VHL to calculate primary system water levels, volumes, heat
** transfer areas, sedimentation areas, etc.
**
** ===================================================================
WWLET0       0.0 LB/HR     // Units: [KG/S,LB/HR]
**
** This parameter is the total letdown flow rate. See note for makeup flow,
** WWMU0, above.
**
** ===================================================================
PDCR0       1000. PSI      // Units: [PA,PSI]
**
** This parameter is the pressure drop across the RCPs during normal full
** power operation. Note: This parameter is only used to compute a friction
** coefficient that is used during two-phase natural circulation,
** especially in B&W plants. As such, limited benchmarking studies
** indicate that whereas a value of 120 psid or so would seem applicable
** from the definition, a value of about 1000 psid results in a more
** accurate friction coefficient. While not completely understood, part of
** this difference is thought to be due to the added resistance provided by
** the stopped RCP impellers. In any event, code results should be
** generally insensitive to the value entered, except in critical
** applications in B&W plants involving a long period of two-phase natural
** circulation with parameter VFPS, PS void fraction, greater than VFSEP,
** the phase separation void fraction.
**
** @@@ 4.0.3 BJS 4/8/96 - Updated WLD and ice condenser value to be
** consistent with 1000 psi value from MAAP 3B thermal-hydraulic benchmarks.
**
** ===================================================================
FUB         9          // Dimensionless
**
** This parameter is the location key for the unbroken loop break, if any
**
** 9 --unbroken hot leg node

** 10--unbroken hot leg "tube" node (B&W only)
** 12--unbroken intermediate leg node
**
** Note: An unbroken loop break in the unbroken loop's cold leg or downcomer
** node is not allowed. To specify breaks in the downcomer use the
** appropriate broken loop break key.
** Most users will use the "unbroken" loop break only for pump seal LOCAS
** in TMLB sequences. It can also be used for special purposes (e.g. LOFT FP/2
** simulation).
** Downcomer break along with the broken loop break is controlled by
** event code 209. One can turn the breaks on and off separately by using a
** local parameter change intervention or a IF condition/action block as
** shown in section 3 of Vol I of the MAAP4 user's manual.
**
** ========================================================================
AUB 0.0 FT**2 // Units: [M**2,FT**2]
**
** This parameter is the area of the unbroken leg break. Enter a value of
** zero if there is no break.
**
** ========================================================================
ZUB 26.3 FT // Units: [M,FT]
**
** This parameter is the elevation of the unbroken loop break. See notes
** pertaining to broken loop break elevation above.
**
** ========================================================================
ZDMP 30.07 FT // Units: [M,FT]
**
** This parameter is the elevation of the RPV dome plate. The "dome" refers
** to the region above the upper plenum. The "dome plate" is the perforated
** plate that divides the upper plenum from the dome. See drawings in the
** PRISYS section of the MAAP4 User's Manual.
**
** ========================================================================
ZDM 41.11 FT // Units: [M,FT]
**
** This parameter is the elevation of the inside of the top of the RPV closure
** head.
**
** ========================================================================
ZFLANG 33.57 FT // Units: [M,FT]
**
** This parameter is the elevation of the RPV flange (closure studs).
** Note: This elevation is taken to be the top of the core barrel.
**
** ========================================================================
ADMWX 353.43 FT**2 // Units: [M**2,FT**2]
**
** This parameter is the outside area of the dome exterior wall.
** It can be adequately approximated as follows:
**
** ADMWX = ASDOME + ASFH + ASFV
**

```
** Where:  ASDOME = Surface area of upper head spher section,
**             = 2 * PI * XRDOME * XHDOME
**
** Where:  XHDOME = Vertical height of the upper head spherical section
**         XRDOME = Outside radius of the upper head spherical section
**
**         ASFH   = Surface area of the horizontal portion of the upper
**                  head flange section,
**                = PI * (XRFHO**2 - XRFHI**2)
**
** Where:  XRFHO = Outside radius of the horizontal portion of the upper head
**                 flange section
**         XRFHI = Inside radius of the horizontal portion of the upper head
**                 flange section
**
**         ASFV   = Surface area of the vertical portion of the upper head
**                  flange section,
**                = 2 * PI * XRFHO * XHFV
**
** Where:   XHFV = Height of the vertical portion of the upper head
**                 flange section
**
** ========================================================================
MCBL         1.04e5  LB       // Units: [KG,LB]
**
** This parameter is the mass of the core barrel below the elevation of the
** top of the core  and is called the "lower core barrel". This mass should
** also include the baffle, thermal  shields, and former plates.  It can be
** adequately estimated as follows:
**
** MCBL = MBTC + MBAF + MTS + MCFP
**
** Where:  MBTC = Mass of core barrel below top of core,
**             = PI * (XRCBO**2 - XRCBI**2) * XHCBL * DCB
**
** Where:  XRCBO = Core barrel outer radius
**         XRCBI = Core barrel inner radius
**         XHCBL = Vertical distance from top of core to bottom of core barrel
**         DCB   = Core barrel material density
**
**         MBAF  = Mass of core baffle,
**              = XLBAF * XHBAF * XTBAF * DBAF
**
** Where:  XLBAF = Average core baffle circumferential length
**         XHBAF = Core baffle height ( same as core height)
**         XTBAF = Core baffle thickness
**         DBAF  = Core baffle material density
**
**          MTS  = Mass of thermal shield,
**              = XHTS * PI * (XRTSO**2 - XRTSI**2) * DTS
**
** Where:  XHTS  = Thermal shield height
**         XRTSO = Thermal shield outer radius
**         XRTSI = Thermal shield inner radius
```

```
**      DTS   = Thermal shield material density
**
**       MCFP = Mass of core former plates,
**            = NFP * XTFP * DFP * PI * (XRFPO**2 - ((.5 * XLBAF) / PI)**2)
**
** Where:  NFP   = Number of former plates
**      XTFP  = Thickness of one former plate
**      DFP   = Former plate material density
**      XRFPO = Former plate outer radius
**
** ======================================================================
MCBH        4.48e4  LB        // Units: [KG,LB]
**
** This parameter is the mass of the core barrel above the elevation of the
** top of the core. In MAAP this mass is referred to as the "upper core
** barrel". It can be adequately estimated as follows:
**
** MCBH = PI * (XRCBO**2 - XRCBI**2) * XHCBU * DCB
**
** Where:  XRCBO = Core barrel outer radius
**      XRCBI = Core barrel inner radius
**      XHCBU = Vertical distance from top of core to top of core barrel
**      DCB   = Core barrel material density
**
** If the plant has a ring that is concentric with the core barrel the ring
** should be included with the upper core barrel if the ring has a
** significant  temperature gradient across it.  That is, the outside of
** the ring would  see cooler gases than the inside.  However, if the ring
** would essentially be surrounded by the hot upper plenum gases then it
** should be included  with the upper plenum internals.
**
** ======================================================================
MUPI        2.13e4  LB        // Units: [KG,LB]
**
** This parameter is the mass of the upper plenum internals. If the plant
** has a ring that is concentric with the core barrel the ring  should be
** included with the upper core barrel if the ring has a significant
** temperature gradient across it.  That is the outside of the ring would
** see cooler gases than the inside.  However, if the ring would
** essentially be surrounded by the hot upper plenum gases then it should
** be included  with the upper plenum internals.
**
** ======================================================================
MDMP        7.84e4  LB        // Units: [KG,LB]
**
** This parameter is the mass of the RPV upper core support plate,
** i.e. the "dome" plate.
**
** ======================================================================
MDMW        2.58e5  LB        // Units: [KG,LB]
**
** This parameter is the mass of the wall forming the exterior of the RPV
** dome. This is the mass of the upper portion of the RPV itself.  It
** includes the  RPV closure head spherical section, the flange section of
```

** the head, and the flange mating section of the vessel. It can be
** adequately approximated as follows:
**
** MWDW = MRVUH + (DRV * VRVF)
**
** Where: MRVUH = Mass of RV upper head
** DRV = Density of RPV material
** VRVF = Volume of RPV flange section (do not deduct for flange
** closure studs and nuts),
** = PI * (XRRVFO**2 - XRRVFI**2) * XHRVF
**
** Where: XRRVFO = RPV outside radius (at RPV upper head flange)
** XRRVFI = RPV inside radius (at RPV upper head flange)
** XHRVF = Height of RPV wall flange section
**
**
** ======================================================================
MHLTOT 1.33e4 LB // Units: [KG,LB]
**
** This parameter is the total mass of one hot leg. This does not include
** the mass of the steam generator outlet portion of the lower head or the
** upper head, or the mass of any portion of the tubesheet(s). These masses
** are included in MSGPHD in the S/G section.
** this parameter can be adequately approximated as follows:
**
** MHLTOT = .25 * PI * (XDHLO**2 - XDHL**2) * XLHL * DHL
**
** Where: XDHLO = Hot leg piping outside diameter
** XDHL = Hot leg piping inside diameter
** XLHL = Hot leg piping length from RPV nozzle to SG nozzle
** DHL = Hot leg piping material density
**
** ======================================================================
MCLTOT 9.15e4 LB // Units: [KG,LB]
**
** This parameter is the total mass of one cold leg. This term includes the
** mass of the intermediate leg and that portion of the pump that is in
** contact with the fluid (the pump casing). This parameter should not
** include the mass of the outlet plenum of tubesheet which is included in
** MSGPHD in the S/G section. Note: The code calculates the total mass of
** the cold legs for each S/G by multiplying MCLTOT by the number of cold
** legs per S/G and by the ratio of the horizontal volume to total volume.
** It then calculates the total mass of the intermediate legs for each S/G
** by multiplying MCLTOT by the number of cold legs per S/G, subtracting
** the mass of the cold legs (the horizontal runs) and then adding one
** half of MSGPHD.
**
** ======================================================================
MRV 5.44e5 LB // Units: [KG,LB]
**
** This parameter is the mass of the RPV wall below the upper head flange.
** This is the mass of the lower portion of the RPV itself. The sum of MRV
** and MWDW should represent the complete RPV mass (less internals). MRV
** includes the masses of the RPV cylindrical section (below the upper head

```
** flange mating section), the inlet (cold leg) and outlet (hot leg)
** nozzles, and the lower head. Commonly used data sources provide the
** entire vessel mass including the upper head mating flange section. If
** the mass of this section has been determined (i.e., in the course of
** determining a value for MWDW) subtracting it from the overall vessel
** mass will provide a proper value for MRV. It can also be adequately
** approximated as follows:
**
**        MRV = MRVCYL + MRVLH + MCLNT + MHLNT - MNOZO
**
** Where: MRVCYL = Mass of RPV cylindrical section,
**             = PI * (XRRVO**2 - XRRV**2) * XHCYL * DRV
**
** Where: XRRVO = RPV cylinder section outer radius
**        XRRV  = RPV cylinder section inner radius
**        XHCYL = RPV cylinder section height
**        DRV   = RPV material density
**
**       MRVLH  = Mass of RPV lower head (assumes that lower head is a
**                hemisphere),
**              = (2/3) * PI * (XRLHO**3 - XRLHI**3) * DRV
**
** Where: XRLHO = RPV lower head outer radius
**        XRLHI = RPV lower head inner radius
**
**       MCLNT  = Total mass of cold leg nozzles,
**             = PI * (XLCLN * (XRCLOP**2 + (XRCLOP * XRCLOV) +
**               XRCLOV**2-XRCLIP**2-(XRCLIP*XRCLIV)-XRCLIV**2)*DRV*NCL
**
** Where: XLCLN  = Cold leg nozzle length from RPV wall outer surface to
**                 cold leg piping weld attachment
**        XRCLOP = Cold leg nozzle outer radius at piping weld attachment
**        XRCLOV = Cold leg nozzle outer radius at RPV wall outer surface
**        XRCLIP = Cold leg nozzle inner radius at piping weld attachment
**        XRCLIV = Cold leg nozzle inner radius at RPV wall outer surface
**        NCL    = Number of cold legs
**
**        MHLNT  = Total mass of hot leg nozzles,
**              = PI*(XLHLN*(XRHLOP**2+(XRHLOP*XRHLOV)+XRHLOV**2-
**                XRHLIP**2-(XRHLIP*XRHLIV)-XRHLIV**2))*DRV*NHL
**
** Where: XLHLN  = Hot leg nozzle length from RPV wall outer surface to hot
**                 leg piping weld attachment
**        XRHLOP = Hot leg nozzle outer radius at piping weld attachment
**        XRHLOV = Hot leg nozzle outer radius at RPV wall outer surface
**        XRHLIP = Hot leg nozzle inner radius at piping weld attachment
**        XRHLIV = Hot leg nozzle inner radius at RPV wall outer surface
**        NHL    = Number of hot legs
**
**        MNOZO  = Total mass of RPV cylinder section removed for hot/cold
**                 leg nozzle openings,
**               = DRV*PI*((NCL*XRCLIV**2)+(NHL*XRHLIV**2))*(XRRVO-XRRV)
**
** ==================================================================
```

```
AGUP        81.03  FT**2      // Units: [M**2,FT**2]
**
** This parameter is the flow area in the upper plenum the region above
** the core and below the dome plate.
** Note: The product of this and the difference in elevations between the top
** of the core and the dome plate defines the upper plenum volume.
** AGUP can be adequately approximated as follows:
**
** AGUP = PI * (XRUCP**2 - (NGT * XRGT**2)) - (NSC * ASC)
**
** Where:  XRUCP = Upper core plate radius
**         NGT   = Number of control rod guide tubes
**         XRGT  = Outside radius of one control rod guide tube
**         NSC   = Number of support columns
**         ASC   = Cross-sectional area of one support column
**
** ======================================================================
XDHUP       0.942  FT        // Units: [M,FT]
**
** This parameter is the hydraulic diameter in the upper plenum.
** It can be adequately approximated as follows:
**
** XDHUP = (4 * AGUP) / XWPUP
**
** Where:  AGUP  = RPV upper plenum water line flow area
**         XWPUP = Upper plenum wetted perimeter,
**               = 2 * PI * (XRRV + (NGT * XRGT) + (NSC * (ASC / PI)**.5))
**
** Where:  XRRV = RPV cylinder section inner radius
**         NGT  = Number of control rod guide tubes
**         XRGT = Outside radius of one control rod guide tube
**         NSC  = Number of support columns
**         ASC  = Cross-sectional area of one support column
**
** ======================================================================
AUPI        1693.06  FT**3     // Units: [M**3,FT**3]
**
** This parameter is the total heat transfer area of the upper plenum
** internals. It can be adequately approximated as follows:
**
** AUPI = 2 * PI * XHUP * ((NGT * XRGT) + (NSC * (ASC / PI)**.5))
**
** Where:  XHUP = Vertical distance from top of upper core plate to bottom of
**                upper support plate
**         NGT  = Number of control rod guide tubes
**         XRGT = Outside radius of one control rod guide tube
**         NSC  = Number of support columns
**         ASC  = Cross-sectional area of one support column
**
** If the plant has a ring that is concentric with the core barrel, the
** ring  should be included with the upper core barrel if the ring has a
** significant  temperature gradient across it.  That is the outside of the
** ring would  see cooler gases than the inside.  However, if the ring
** would essentially be surrounded by the hot upper plenum gases then it
```

** should be included with the upper plenum internals. The affected
** parameters are MCBH and ACBH or MUPI and AUPI.
**
** ======================================================================
QC0 8.53e6 BTU/HR // Units: [W,BTU/HR]
**
** This parameter is the convective (non-radiative) heat losses under
** nominal conditions from the steam generators, pressurizer, and rest of
** primary system to the containment.
**
** Note: Detailed calculations indicate that under normal operation, the
** primary system heat loss is due virtually entirely to uninsulated parts
** of the system and heat loss through insulation is typically negligible.
** Thus this number should be approximately the total nominal primary
** system heat loss (see IDCOR report 85-2 for discussion). This heat load
** can be estimated by determining the amount of heat removed by the
** containment cooling system under normal operating conditions. The plant
** should be able to provide data on the amount of heat extracted from the
** containment by the normal mode of containment cooling. Containment heat
** removal records can be obtained from start-up test records.
**
** ======================================================================
FINPS 12.0 // Dimensionless
**
** This parameter is the number of plates in primary system reflective
** insulation. For plants with other type of insulation enter 0 for calcium
** silicate bulk insulation or enter -1 for rock wool insulation.
** CAUTION: If the plant's primary system insulation material is different
** than three materials then consideration should be given to modify
** function THCBUL which supplies the thermal conductivity
**
** ======================================================================
XTINS 0.296 FT // Units: [M,FT]
**
** This parameter is the total thickness of the insulation. A non-zero
** value should only be used if it is bulk insulation and a zero value
** should be used if it is reflective insulation.
**
** ======================================================================
ZRVCYL 7.32 FT // Units: [M,FT]
**
** This parameter is the elevation of the base of the cylindrical
** part of the RPV above the inside bottom of the lower head.
**
** ======================================================================
VHD 399.58 FT**3 // Units: [M**3,FT**3]
**
** This parameter is the fluid volume of the lower head of the RPV. Do not
** include volumes occupied by structures within the lower head such as
** instrument tubes, etc..
**
** ======================================================================
ACBL 2692.97 FT**2 // Units: [M**2,FT**2]
**

```
** This parameter is the total heat transfer area of lower core barrel
** /thermal  shields/baffle etc. (i.e. that portion below the top of the
** core).  Include both sides of these structures as they are wetted on
** both sides.
**
** ==========================================================================
ACBH        841.28  FT**2     // Units: [M**2,FT**2]
**
** This parameter is the total heat transfer area of the upper core barrel
** If the plant has a ring that is concentric with the core barrel the ring
** should be included with the upper core barrel if the ring has a
** significant  temperature gradient across it.  That is the outside of the
** ring would  see cooler gases than the inside.  However, if the ring
** would essentially be surrounded by the hot upper plenum gases then it
** should be included  with the upper plenum internals. The affected
** parameters are MCBH and ACBH or MUPI and AUPI.
**
** ==========================================================================
XLGAP       1.13e-2  FT       // Units: [M,FT]
**
** This parameter is the clearance between fuel rods. It is the rod pitch
** minus  the outside diameter of fuel rod.
**
** ==========================================================================
HALFLP         0           // Dimensionless
**
** This parameter is a flag to run half-loop operation
**   = 0 normal operation
**   = 1 half-loop operation
** Half-loop operation is an operation mode after normal reactor shut down in
** which the primary system water level is decreased to about the hot leg
** midplane. Decay heat is removed by the RHR with suction from the hot leg
** and discharge to the cold leg. When there is a loss of RHR, it can lead to
** core uncovery and a severe accident.
**
** ==========================================================================
WRHRHI         0  LB/HR     // Units: [KG/S,LB/HR]
**
** This parameter is the RHR pump flow injection into cold leg during
** half-loop  operation. Users can also use the new (generalized) ESF model
** to arrange for  different suction and discharge locations and calculate
** the flow rates based on the RHR pump head curve in which case WRHRHI
** should be set to 0 also.
**
** ==========================================================================
WRHRHO         0  LB/HR     // Units: [KG/S,LB/HR]
**
** This parameter is the RHR pump suction flow from the hot leg during
** half-loop  operation.  For the steady state situation WRHRHI=WRHRHO is
** true. The user can also use new ESF models to arrange different suction
** and discharge  locations and calculate flow rates based on RHR pump head
** curve.
**
** ==========================================================================
```

```
TIHALF          0  HR       // Units: [S,HR]
**
** This parameter is the time clapsed from reactor scram at the beginning of
** half-loop runs.
** Note: Data for the Westinghouse large dry plant shown here is for
** demonstration only because HALFLP = 0
**
** ===========================================================================
FQINHF          0.0          // Dimensionless
**
** This parameter is the flag that indicates how the reactor power will be
** used in the code:
**   0: decay heat calculated by MAAP based on ANSI decay curve and TIHALF
**   1: fraction of decay heat from input
**
** ===========================================================================
NFQHF           0.0          // Dimensionless
**
** This parameter is the number of the entries in the decay heat table as
** a fraction of full power as a function of time. The maximum number is
** 30. Note: Data for the Westinghouse large plant shown here is for
** demonstration only because HALFLP = 0
**
** ===========================================================================
** Name: TIFQHF(1:30)            Units: [S,HR]
**
** This parameter is the time for the power versus time table (time is
** measured  from the time of reactor scram)
**
TIFQHF(1)       0.0  HR
TIFQHF(2)       0.0  HR
** ===========================================================================
** Name: FQHF(1:30)              Units: [Dimensionless]
**
** This parameter is the decay power for the power versus time table
** (fraction of full power).
**
FQHF(1)         0.0
FQHF(2)         0.0
** ===========================================================================
** @@@4.0.3 cdw 12/20/95 All generalized opening input parameters have been
** moved to the *pointer parameter section
**
** ===========================================================================
NEQPS           1.0          // Dimensionless
**
** This parameter is the number of components (lumped material) in the
** primary system lower head (maximun 5).
**
** @@@ 4.0.3 BJS 3/21/96 - Added back the lumped material in the lower
** head for the ice condenser using 4.0.2 parameter file values.
**
** ===========================================================================
** Name: MEQPS0(1:5)             Units: [KG,LB]
```

```
**
** This parameter is the mass of lumped material.
**
MEQPS0(1)    8818.0  LB
** ====================================================================
** Name: AEQPS0(1:5)           Units: [M**2,FT**2]
**
** This parameter is the surface area of lumped material.
**
AEQPS0(1)    215.0  FT**2
** ====================================================================
** Name: ZEQPS(1:5)           Units: [M,FT]
**
** This parameter is the top elevation of lumped components as measured
** from the bottom of the reactor vessel.
**
ZEQPS(1)     10.830  FT
** ====================================================================
** Name: XHEQP0(1:5)          Units: [M,FT]
**
** This parameter is the height of the lumped component in the lower head.
**
XHEQP0(1)     1.64  FT
** ====================================================================
TIRRAD       7680.0  HR       // Units: [S,HR]
**
** This parameter is the average effective time of irradiation for the
** entire  core (used in ANSI decay power calculation). The decay power
** calculated by MAAP is a function of the following eight parameters:
** TIRRAD, EXPO, FALPHA, ENRCH, FCR, and FQFISS(1:3). Information
** regarding their revised definitions are provided below.  Also, the
** sensitivity of the decay power to these parameters is discussed.
**
** 1.  The definitions of FALPHA and FCR are are consistant with the ANSI
**     standard.  However, the product of FCR * (1 + FALPHA) is what the
**     code uses and this product is essentially the same with the old and
**     new definitions as discussed below.  FALPHA is now defined as the
**     ratio of the total macroscopic capture cross-section averaged over
**     space and energy to the total macroscopic fission cross-section
**     averaged over space and energy.
**
**     New definition:  FALPHA = XCTOTAL / XFTOTAL
**
**     where:  XCTOTAL = total macroscopic capture cross-section averaged
**                 over space and energy, and
**         XFTOTAL = total macroscopic fission cross-section (sum of
**                 cross-sections for U-235, U-238, PU-239 and PU-241)
**                 averaged over space and energy.
**
**     Old definition:  FALPHA = XCFUEL / XFFUEL
**
**     where:  XCFUEL = sum of macroscopic thermal capture cross-sections
**                 for U-235, PU-239, and PU-241, and
**         XFFUEL = sum of macroscopic fission cross-sections for U-235,
```

```
**              U-239, and PU-241.
**    Note:  Limiting the capture cross-sections to the thermal range for
**         XCFUEL was not correct but the error is small because of
**         few fast neutrons.  Also, "U-239" in XFFUEL should have
**         been "PU-239."
**
**    FCR is now defined as the ratio of the macroscopic capture cross-
**    section of U-238 averaged over space and energy to the total macro-
**    scopic absorption cross-section averaged over space and energy.
**
**    New definition:  FCR = XCU238 / XATOTAL
**
**     where:  XCU238 = macroscopic capture cross-section of U-238 averaged
**                 over space and energy, and
**          XATOTAL = total macroscopic absorption cross-section averaged
**                 over space and energy.
**
**    Old definition:  FCR = XTCU238 / XAFUEL
**
**     where: XTCU238 = macroscopic thermal capture cross-section for U-238
**           XAFUEL = sum of macroscopic thermal absorption
**                  cross-sections for fissiles U-235, U-238, U-239,
**                  and PU-241 in fuel.
**    Note:  Limiting the capture cross-sections to the thermal range for
**         XTCU238 and  XAFUEL was not correct but the error is small
**         because of few fast neutrons.  Also, "U-239" in XAFUEL should
**         have been "PU-239."
**
** 2.  Changes to the definitions FALPHA and FCR have led to new nominal
**    values.  If the value for one of these parameters is changed the
**    other should be changed as well.  Users that have confidence in their
**    old values may retain them since FCR*(1+FALPHA), the value that MAAP
**    uses, is approximately the same with the old and new definitions.
**    To demonstrate this, the following uses first the old definitions then
**    the new definitions to arrive at the same result.
**
**    Using the old definitions,
**    FCR * (1+FALPHA) = XTCU238/XAFUEL * (1 + XCFUEL/XFFUEL)
**                 = XTCU238/XAFUEL * (XFFUEL + XCFUEL)/XFFUEL  (#1).
**
**    The fission cross-section plus the capture cross-section equals the
**    absorption cross-section.  That is XFFUEL + XCFUEL = XAFUEL.
**    Substituting XAFUEL into #1 yields
**
**    FCR * (1+FALPHA) = XTCU238/XAFUEL * XAFUEL/XFFUEL
**                 = XTCU238/XFFUEL                    (#2).
**
**    XTCU238 is approximately equal to XCU238, and XFFUEL is approximately
**    equal to XFTOTAL.  Therefore,
**
**    FCR * (1+FALPHA) ~ XCU238/XFTOTAL                   (#3).
**
**    Now, using the new definitions,
**    FCR * (1+FALPHA) = XCU238/XATOTAL * (1 + XCTOTAL/XFTOTAL)     (#4).
```

```
**
**    Again the fission cross-section plus the capture cross-section
**    equals the absorption cross-section, XFTOTAL + XCTOTAL = XATOTAL.
**    So, substituting XATOTAL into #4 yields
**
**    FCR * (1+FALPHA) = XCU238/XATOTAL * XATOTAL/XFTOTAL
**                   = XCU238/XFTOTAL                     (#5).
**      Q.E.D.
**
**    New values for all these parameters were compiled from a data base
**    which was obtained by running a code similar to MIT BRICC with
**    different burnups and core conditions.  (MIT BRICC is comparable
**    to LEOPARD.)
**
** REFERENCE: "Define and Quantify the Parameter Entries for ANSI
**          Decay Heat Calculation," MAAP FAI Internal Memorandum,
**          C. D. Wu, Jan. 22, 1991.
**
** 3.  For the eight parameters noted above, the decay power is most
**    sensitive to variations in TIRRAD and relatively insensitive to the
**    others.  Therefore, extensive calculations to determine the
**    values of the latter are probably not warranted.
**
** ========================================================================
EXPO        2.604e4  TON        // Units: [MWD/METRIC,TON]
**
** This parameter is the Average fuel exposure (or burnup) at time of reactor
** shutdown. This parameter is always specified in MWD/Tonne regardless of
** the units (SI or British) used elsewhere in the Parameter File.
** NOTE: This is fuel exposure in MWD per metric ton of uranium metal (U)
** not UO2.
**
** ========================================================================
FALPHA        1.3          // Dimensionless
**
** This parameter is the ratio of total capture rate to total fission rate.
** The capture (or fission) rate is calculated by integrating cross section
** times neutron flux over energy and space.  (The capture rate had been
** defined as just the capture by the fissile constituents.  It is now the
** capture rate by all constituents.)
** The choice of beginning, middle or end-of-cycle values is up to the user.
** Users should be consistent in their selection of all relevant parameters.
**
** @@@ 4.0.3 CDW 11/15/95 Changed Westinghouse large and Ice condensor
** plant's values to 1.3 from 0.3 and 0.38 respectively, to reflect the new
** definition.
**
** ========================================================================
ENRCH      0.0336        // Dimensionless
**
** This parameter is the initial enrichment of fuel in atom fraction. If
** several enrichments exist in a given core reload which is true more
** often than not, a weighted average value is adequate.
**
```

```
** ===========================================================================
FCR        0.323        // Dimensionless
**
** This parameter is the ratio of total capture rate of U-238 to total
** absorption rate. The capture (or absorption) rate is calculated by
** integrating cross section times neutron flux over energy and space.
** (The absorption rate had been defined as just the absorption by the
** fissile constituents. It is now the absorption by all constituents.)
** The choice of beginning, middle or end-of-cycle values is up to the
** user. Users should be consistent in their selection of all relevant
** parameters.
**
** @@@ 4.0.3 CDW 11/15/95 Changed Westinghouse large and Ice
** condensor plant's values to 0.323 from 0.6 and 0.32, respectively, to
** reflect the new definition.
**
** ===========================================================================
** Name: FQFISS(1:3)          Units: [Dimensionless]
**
** This parameter supplies the fission power fraction for a set of isotopes.
**
** FQFISS(1): fission power fraction of U-235 & PU-241
** FQFISS(2): fission power fraction of PU-239
** FQFISS(3): fission power fraction of U-238
**
** These fraction are used in the ANSI decay power calculation.
**
FQFISS(1)   0.5475
FQFISS(2)   0.3868
FQFISS(3)   0.0657
** ===========================================================================
ZSINOZ       1.15 FT       // Units: [M,FT]
**
** This parameter is the height of the safety injection nozzle above the
** elevation of the bottom of the cold leg nozzle at the RPV (ZNOZ).
** Set to the same value as ZOFFCL if a B&W plant, and set to XDCL/2
** if not a B&W plant (XDCL is defined above).
**
** ===========================================================================
ZOFFCL       0.0 FT        // Units: [M,FT]
**
** This parameter is the the difference in elevations of the bottom of the
** cold leg measured at the reactor coolant pump discharge and at the RPV
** nozzle.
**
**
** ===========================================================================
MFFECS       0.72          // Dimensionless
**
** This parameter is the mass fraction of Fe in RPV internal structures.
** MFFECS and the related parameters MFCRCS, MFNICS and MFCACS are used
** when the internal structures have melted to calculate the corium pool
** material mass fractions.
**
```

```
** ======================================================================
MFCRCS        0.19          // Dimensionless
**
** This parameter is the mass fraction of Cr in RPV internal structures.
**
** ======================================================================
MFNICS        0.09          // Dimensionless
**
** This parameter is the mass fraction of Ni in RPV internal structures.
**
** ======================================================================
MFCACS        0.0           // Dimensionless
**
** This parameter is the mass fraction of Ca in RPV internal structures.
**
** ======================================================================
** Material Type for Creep Rupture Analysis
**
** @@@ 4.0.3 MAM 12/21/95  Parameters ICRPHL, ICRPSR, and ICRPHT were
** missing from all PWR parameter files.
**
** The next three parameters (ICRPHL, ICRPSR, and ICRPHT) defines the wall
** material type to be used in creep analysis.  These parameters are set
** to one of the following values:
**
**      =1, 304 Stainless Steel
**      =2, Carbon Steel
**      =3, INCONEL
**      =4, Alloy 690
**
** See subroutine CREEP writeup of the MAAP4 Users Manual for futher
** details.
**
** ======================================================================
ICRPHL        2             // Dimensionless
**
** @@@ 4.0.3 CYP 8/15/96 - Added model for independently assessing creep
** rupture in the carbon steel nozzle and in the stainless steel hot
** leg. See *Model parameter FHLCRE
**
** Parameter ICRPHL is the material type index for the hot leg.  Note that
** although Westinghouse plants all have stainless steel hot legs, users
** with such plants may still find it appropriate to enter a value of 2
** (instead of 1).  The reason for this is that this parameter is only used
** to select the material properties used for creep rupture evaluations,
** and many analysts believe that the end of the hot leg/RPV nozzle, which
** is made of carbon steel, will rupture first.
**
** ======================================================================
ICRPSR        2             // Dimensionless
**
** Parameter ICRPSR is the material type index for the pressurizer surge
** line.
**
```

```
** ========================================================================
ICRPHT          3           // Dimensionless
**
** Parameter ICRPHT is the material type index for the steam generator
** tubes.
**
** ========================================================================
** Name: NPT1(1:5)            Units: [Dimensionless]
**
** Parameter NPT1(i) is the number of penetrations in i'th lower head node.
** There are 5 radial nodes through the lower head.  NPT1(i) is used to
** indicate if a certain radial node has a penetration.  The actual number
** is not used in calculation.  The variable is used for lower head failure
** determination.
**
NPT1(1)       58
NPT1(2)        0
NPT1(3)        0
NPT1(4)        0
NPT1(5)        0
** ========================================================================
XPT1WU      0.0328  FT       // Units: [M,FT]
**
** This parameter is the penetration weld height measured from inner surface
** of lower head.
**
**
** ========================================================================
XPT1WD      0.0328  FT       // Units: [M,FT]
**
** This parameter is the penetration weld depth measured from inner surface
** of lower head.
**
** ========================================================================
XPT1GP     2.62e-4  FT       // Units: [M,FT]
**
** This parameter is the gap distance between the penetration and the bore
** on the lower head.
**
**
** ========================================================================
XPT1SH       0.0  FT       // Units: [M,FT]
**
** This parameter is the depth of the penetration shoulder if there is one.
**
**
** ========================================================================
XTPT1      4.72e-2  FT      // Units: [M,FT]
**
** This parameter is the thickness of the penetration wall outside the vessel.
**
**
** ========================================================================
FIPT1          2.           // Dimensionless
```

```
**
** This parameter is the penetration wall material type:
**  =1.0, inconel
**  =2.0, stainless steel
**  =3.0, carbon steel
**
** ====================================================================
XLPT1        6.56e10  FT        // Units: [M,FT]
**
** This parameter is the length of the penetration line outside the vessel.
** If the melt travels beyond this distance, the vessel is considered breached
**
** ====================================================================
** Name: NPSPR                   Units: [Dimensionless]
**
** This parameter is a flag used in the primary system region routine
** (subroutine PRISYS) to print out the primary system geometry information
** if the value is greater than zero. This can be used as a check to ensure
** that the input data are consistent and correct. The default value in the
** code  is 6.
**
** ====================================================================
** The following parameters: VLLPPS(), ZXLPPS(), VLLPP1(), and XZLPP1()
** are used only when the *Control variable IDBLVL is set to 1.  These
** parameters are the volume vs height lookup tables for the lower plenum.
** If IDBLVL is set to 0 (default), the MAAP code will calculate the water
** level given the water volume assuming a hemispherical lower plenum
** geometry.
**
** These volume versus height tables were developed for use in the
** subroutine DBLVL to calculate the water and corium levels in the RPV
** lower head.  All current PWR parameter files for the MAAP4 do not use
** these volume vs height lookup tables.  Instead, the assumption of lower
** plenum hemispherical shape to calculate the water level or volume is
** used.
**
** It is not recommended to use these volume vs height lookup tables in the
** PWR MAAP4 parameter files because the use of the volume versus height
** table in the lower plenum in the primary system thermal hydraulics has
** not been evaluated.
**
** ====================================================================
** Name: VLLPPS(1:10)            Units: [M**3,FT**3]
**
** This parameter is the volume entry of the RPV lower head volume versus
** height table before the lower head structure fails.
**
** ====================================================================
** Name: XZLPPS(1:10)            Units: [M,FT]
**
** This parameter is the height entry of the RPV lower head volume versus
** height table before the lower head structure fails.
**
** ====================================================================
```

```
** Name: VLLPP1(1:10)          Units: [M**3,FT**3]
**
** This parameter is the volume entry of the RPV lower head volume versus
** height table after the lower head structure fails.
**
** ============================================================================
** Name: XZLPP1(1:10)          Units: [M,FT]
**
** This parameter is the height entry of the RPV lower head volume versus
** height table after the lower head structure fails.
**
** ============================================================================
****************************************************************************
*Pressurizer
****************************************************************************
*BR
**
** This parameter section defines the inputs for the pressurizer.  Possible
** data sources for the majority of the input parameters can be obtained
** from:
**
**      1) Operator Training Manual: Pressurizer, Reactor, Primary
**           system instrumentation sections,
**
**      2) Plant FSAR: Pressurizer, Reactor instrumentation, Primary
**           system sections,
**
**      3) Pressurizer construction and/or assembly drawings,
**
**      4) Pressurizer heater, spray system, spray nozzle specification data,
**
**      5) Pressurizer heater, spray system pre-op, startup, or
**           surveillance test data,
**
**      6) Safety valve, PORV manufacturer's specification data,
**
**      7) Plant overpressure protection report (ASME Boiler and Pres-
**         sure Vessel Code compliance documentation,
**
**      8) Primary system piping specification data,
**
**      9) Primary system piping layout drawings.
**
**
** Unless otherwise noted all elevations in this Pressurizer parameter
** section, including the scram set points, should be referenced to the
** bottom of the pressurizer.  Many variable values for this section may
** be obtained from existing input files for detailed primary system codes
** like RETRAN, RELAP, TRAC, MMS, etc.
**
** ============================================================================
VPZ        1800.0  FT**3      // Units: [M**3,FT**3]
**
** Parameter VPZ is the total pressurizer free volume and includes the
```

** water and steam (gas) volumes.
**
** ==========================================================================
APZ 38.14 FT**2 // Units: [M**2,FT**2]
**
** Parameter APZ is the pressurizer cross-sectional area and should be
** based on the pressurizer inner diameter.
**
** ==========================================================================
MPZ 196000.0 LB // Units: [KG,LB]
**
** Parameter MPZ is the empty mass of pressurizer shell and heaters.
**
** ==========================================================================
PPZHT0 2224.67 PSI // Units: [PA,PSI]
**
** Parameter PPZHT0 is the pressurizer heater's pressure setpoint. If
** the primary system pressure falls below the value specified for this
** variable and as long as the pressurizer water level is above the low
** water level set point specified by parameter ZPZHT, the heaters are
** actuated to increase the pressurizer steam quantity and thereby raise
** the pressure. MAAP does not presently model heater banks and as a
** result all of the heaters are actuated at one specific setpoint.
**
** ==========================================================================
ZPZHT 9.11 FT // Units: [M,FT]
**
** Parameter ZPZHT is the pressurizer heater low water level trip point,
** and is referenced to inside bottom of the pressurizer.
**
** ==========================================================================
QPZHT0 5.04e6 BTU/HR // Units: [W,BTU/HR]
**
** Parameter QPZHT0 is the pressurizer heater total energy output rate
** (power). This should include the normal operation and standby
** (emergency) heater power input to the pressurizer. MAAP does not
** presently model heater banks and consequently the entire power value
** specified for this variable is used when the heaters are actuated. The
** total power available is considered to be a good default value, however,
** should the need arise in specific accident sequence calculations, QPZHT0
** can be attenuated to the appropriate extent. Note that this variable
** may be defined as a function or as a lookup table to vary QPZHT0 as a
** function of some independent variable. See MAAP User Manual Volume I,
** Section 3 for information on how to setup functions or a lookup table.
**
** ==========================================================================
PPZSP0 2275.0 PSI // Units: [PA,PSI]
**
** Parameter PPZSP0 is the pressurizer spray pressure setpoint. If the
** primary system pressure reaches or exceeds the value specified for this
** variable, the pressurizer sprays will be actuated to decrease the
** pressurizer steam quantity (condensation) and thereby reduce the
** pressure.
**

```
** =========================================================================
WPZSP0       3.27e5  LB/HR     // Units: [KG/S,LB/HR]
**
** Parameter WPZSP0 is the pressurizer spray mass flow rate.  These sprays
** are only available when the reactor coolant pumps (RCPs) are in
** operation.
**
** @@@ 4.0.3 BJS 5/10/96 - Auxiliary pressurizer sprays that do not require
** the coolant pumps to be on were added in Rev. 4.0.3.  See parameter WVEBS.
**
** =========================================================================
ZPZSP        45.92  FT        // Units: [M,FT]
**
** Parameter ZPZSP is the elevation of the spray header above the bottom of
** pressurizer.
**
** =========================================================================
XDPZSP       0.0213  FT       // Units: [M,FT]
**
** Parameter XDPZSP is the diameter of nominal pressurizer spray droplet.
**
** =========================================================================
WVEBS        0.0  GPM         // Units: [M**3/S,GPM]
**
** @@@ 4.0.3 BJS 5/10/96 - The capability to model auxiliary pressurizer
** sprays has been included for non-Spanish plants, i.e., for parameter
** files with ISPAIN not equal to 1.
**
** Parameter WVEBS is the volumetric flow rate of water from the RWST to
** auxiliary pressurizer sprays.  The sprays are activated by setting
** WVEBS to a value greater than zero.  The calculated flow to the sprays
** is WWEBSP.
**
** WVEBS is included here as well as in the Spanish section of the parameter
** file.  Note that the last value of WVEBS in the parameter file is the one
** that the code will use.  Therefore, if it is used for non-Spanish plants
** it should not be included in the Spanish section.  (This multiple use of
** WVEBS vs. the creation of an independent parameter was done to minimize
** the effort for including this capability.)  Also, the definition of
** WVEBS is different for Spanish and non-Spanish plants: for Spanish plants
** it is the total flow from the RWST to the cold leg and to the auxiliary
** sprays, while for non-Spanish plants it is just the flow from the RWST
** to the auxiliary sprays.
**
** =========================================================================
XDSR         0.93  FT         // Units: [M,FT]
**
** Parameter XDSR is the inside diameter of the pressurizer surge (inlet)
** line.
**
** =========================================================================
XLSR         53.41  FT        // Units: [M,FT]
**
** Parameter XLSR is the pressurizer surge (inlet) line length from the hot
```

** leg nozzle to the pressurizer inlet nozzle.
**
** ======================================================================
MPZSR 9512.23 LB // Units: [KG,LB]
**
** Parameter MPZSR is the mass of the pressurizer surge (inlet) line. It
** includes the piping mass from the hot leg nozzle to the pressurizer
** inlet nozzle.
**
** ======================================================================
XTSR 0.0943 FT // Units: [M,FT]
**
** Parameter XTSR is the surge line wall thickness.
**
** ======================================================================
XWSL 12.165 FT // Units: [M,FT]
**
** @@@ 4.0.3 MAM 11/15/95 Parameter XWSL was missing from all pwr
** parameter files.
**
** @@@ 4.0.3 BJS 3/21/96 - Replaced the zero value of XWSL with 3.708 m,
** the value in block data that had been used in prior versions.
**
** Parameter XWSL is the vertical distance between the hot leg and the
** bottom of the pressurizer. This parameter is used to account for the
** water gravity head in the surge line.
**
** ======================================================================
FLSEAL 0.0 // Dimensionless
**
** Parameter FLSEAL is the pressurizer surge line loop seal designation
** flag. Enter 0 if no surge line loop seal exists. Enter 1 if the surge
** line does have a loop seal, a bend or slope in the line, such that fluid
** must go down and then up to travel from the primary system (hot leg) to
** the pressurizer. The loop seal prevents counter-current draining of
** pressurizer water through the surge line when the primary coolant loop
** side is voided. See the description in subroutine DRAIN in the MAAP
** User's Manual, Volume 2 for further information.
**
** ======================================================================
XDDPZ 0.0313 FT // Units: [M,FT]
**
** Parameter XDDPZ is the diameter of the holes in the screen at the top of
** the pressurizer surge line.
**
** ======================================================================
NDPZ 4701 // Dimensionless
**
** Parameter NDPZ is the number of holes in the screen at the top of the
** pressurizer surge line.
**
** ======================================================================
ASEDPZ 38.14 FT**2 // Units: [M**2,FT**2]
**

```
** Parameter ASEDPZ is the sedimentation area for aerosol fission product
** settling in the pressurizer. It is the total horizontal surface area on
** which aerosols can settle which can be on several planes or elevations.
**
** ==========================================================================
** @@@ 4.0.3 MAM 11/15/95 Parameters NPZCT, ZWPZCL, and ZWPZCH were
** missing from all pwr parameter files.
**
** Parameters NPZCT, ZWPZCL, and ZWPZCH are only used when the Generalized
** Engineered Safeguard model is enabled, e.g., when parameter NESF is set
** to 1.
**
NPZCT          0          // Dimensionless
**
** Parameter NPZCT is an option flag used for pressurizer water level
** control. If NPZCT is set to 1, the HPI system is used to control the
** pressurizer water level. If NPZCT is set to 2, the charging pumps are
** used to control the pressurizer water level. When the pressurizer water
** level control is enabled (e.g., NPZCT > 0) and the pressurizer water
** level is between the two controlling set points, ZWPZCL and ZWPZCH, the
** injection flow rate is calculated as:
**
**      (1.0 - (ZWPZ-ZWPZCL)/(ZWPZCH-ZWPZCL)) * Wmax
**
** where ZWPZ is the pressurizer water level and Wmax is the maximum
** injection rate based on the appropriate pump curve. The injection flow
** rate is constrained between 0 and Wmax.
**
**
ZWPZCL         0.0  FT       // Units: [M,FT]
**
** Parameter ZWPZCL is the low end setpoint. Pressurizer water level
** control is activated when the water level falls below this elevation.
**
**
ZWPZCH         0.0  FT       // Units: [M,FT]
**
** Parameter ZWPZCH is the high end setpoint. Pressurizer water level
** control is terminated when the water level reaches this elevation.
**
** ==========================================================================
** The modeling of power operated relief valves (PORV) and safety valves
** for the pressurizer in MAAP4 has changed from MAAP 3.0B.
**
** First, the user must specify the total number of valves, the type of the
** valves (PORV or safety), and how the PORVs are powered using parameters
** NPZRV, NIPORV(i), and FPPORV.
**
** Next, the user has the option, using parameter AINPUT, of either
** defining the individual valve flow areas or defining the valve's nominal
** flow rate from which the code will calculate the flow area as was done
** in MAAP 3.0B. The set of input parameters required are different
** depending on the value of AINPUT as explained later.
**
```

```
** Finally, the user must specify the valve's opening pressure and deadband
** using parameters PSETRV(i), PDRV(i), PSETSV(i) and PDSV(i). Note that
** with individual valves, independent control of each valve is available
** which, of course, can be an important factor in accident management.
**
** By default, each valve operates in automatic mode, e.g., the valve
** relief and/or safety mode opening and closing occurs according to the
** input pressure set points. The ith valve may be manually operated using
** the following flags.
**
**    ISTUCK(i) - Flag to stick open the valve as a mechanical failure.
**
**    IFAILC(i) - Flag to stick closed the valve as a mechanical failure.
**
**    ILOCK(i)  - Flag to inhibit the automatic relief mode opening. Note
**              that this does not prevent the safety mode actuation of
**              the valve and that a stuck open valve cannot be closed
**              by this flag.
**
**    IMANON(i) - Flag to manually open the valve in the relief mode.
**              Note that power is required and that a stuck closed
**              valve cannot be opened by this flag.
**
** Some useful outputs are:
**
**    IOPEN(i)  - Valve current status flag; =0 closed, =1 open.
**
**    NCYCLE(i) - Count of the number of times the valve cycled. A complete
**              cycle is valve opening and closing once, e.g., opening
**              counts as 0.5 and closing counts as 0.5.
**
**    PHIGRV    - High set point closest to current pressure.
**
**    PLOWRV    - Low set point closest to current pressure.
**
**    ARVPZ     - Total open flow area of pressurizer valves.
**
** ======================================================================
NPZRV          5          // Dimensionless
**
** Parameter NPZRV is the total number of PORVs and safety valves modeled in
** pressurizer. The maximum number allowed is 10.
**
** ======================================================================
** Name: NIPORV(10)            Units: [Dimensionless]
**
** Parameter NIPORV(i) is a flag for indicating whether the i'th valve is a
** power operated relief valve (PORV) or a safety valve:
**
**      = 0, the i'th valve is a safety valve
**      = 1, the i'th valve is a PORV
**
NIPORV(1)      1
NIPORV(2)      1
```

```
NIPORV(3)       0
NIPORV(4)       0
NIPORV(5)       0
**
** ==========================================================================
FPPORV          0           // Dimensionless
**
** Parameter FPPORV is a flag indicating how the power operated relief
** valves (PORVs) are powered:
**
**      FPPORV = 0, AC powered
**             = 1, DC powered
**             = 2, AC and/or DC powered
**
** ==========================================================================
AINPUT          100         // Dimensionless
**
** Parameter AINPUT is a flag to indicate how the PORV and safety valves
** flow areas are calculated. If AINPUT is =0, then the flow area of the
** PORV and safety valve is calculated by the code based on the reference
** nominal flow rate. In this case, the parameters PPORVL, WPORV0, PPZSVL
** and WPZSV0 are used to calculate the flow area of the PORV and safety
** valves. If AINPUT is >1, then the flow areas of the PORV and safety
** valves are user input using parameter ASRV().
**
** ==========================================================================
** The next four parameters, WPORV0, PPORVL, WPZSV0, and PPZSV0 are
** required only if AINPUT =0, otherwise they are not needed. The code
** will calculate the nominal flow area, APORV and APZSV, based on the
** input flow rates, WPORV0 and WPZSV0, for the PORV and safety valve,
** respectively, and assign it to parameter ASRV().
**
WPORV0      210000.0  LB/HR      // Units: [KG/S,LB/HR]
**
** Parameter WPORV0 is the rated (nameplate) mass flowrate for one
** pressurizer PORV at its setpoint at PPORVL. Use an average if all of
** the PORVs do not have the same flowrate. Note that the code computed
** flow area will be assigned to all PORVs defined by parameter NIPORV().
**
**
PPORVL      2349.67  PSI       // Units: [PA,PSI]
**
** Parameter PPORVL is the reference opening pressure of a pressurizer
** power operated relief valve at the flow rate WPORV0. Note that this
** definition of the parameter has been changed from MAAP 3.0B.
**
**
WPZSV0      435000.0  LB/HR      // Units: [KG/S,LB/HR]
**
** Parameter WPZSV0 is the rated (nameplate) mass flowrate for one
** pressurizer safety valve at its setpoint at PPZSVL. Use an average if
** all of the safety valves do not have the same flowrate. Note that the
** code computed flow area will be assigned to all safety valves defined
** by parameter NIPORV().
```

**
**
PPZSVL 2499.67 PSI // Units: [PA,PSI]
**
** Parameter PPZSVL is the reference opening pressure of a pressurizer
** safety valve at the flow rate WPZSV0. Note that this definition of
** the parameter has been changed from MAAP 3.0B.
**
** ======================================================================
** Individual PORVs/Safety Valve Setup Notes
**
** In MAAP4, individual PORVs and/or safety valves are modeled, not groups
** of valves as was done for MAAP 3B. Up to ten individual valves can be
** specified. Each valve can operate as a single function safety valve or
** as a single function power operated relief valve. The relief mode
** requires AC and/or DC power to operate depending on the parameter
** FPPORV, whereas the safety mode is passive and does not require power.
** In the following discussions, references to the relief valve are power
** operated relief valve, and references to safety valve are the passive
** safety valve. The physical characteristics of each valve is specified
** as following:
**
** ASRV(i) - The flow area of the ith valve.
**
** PSETRV(i) - Relief mode pressure set point for the ith valve.
**
** PDRV(i) - Relief mode dead band for the ith valve.
**
** PSETSV(i) - Safety mode pressure set point for the ith valve.
**
** PDSV(i) - Safety mode dead band for the ith valve.
**
** FCDPRV - Discharge coefficient for all PORVs.
**
** The operating mode of the valve is defined by it's value of the safety
** and relief pressure set point. Setting either safety or relief valve's
** pressure set point to an extremely large, unattainable value, typically
** ~1.e10, will disable the corresponding mode of operation. By default,
** all the pressure set points are set to extremely large value, 1.e10,
** thus users will have to specify a realistic value for the desired mode
** of operation for all valves specified. The dead band is used to
** determine the valve closing pressure as PSET - PD for either relief or
** safety mode.
**
** ======================================================================
** Name: ASRV(10) Units: [M**2,FT**2]
**
** Effective flow area for ith S/RVs. The flow area can be calculated for
** each S/RV by either of the following methods:
**
** 1) Via The ASME B&PV Code capacity rating equation, rearranged to extract
** the effective flow area, based on the S/RV nameplate capacity;
**
** In SI Units: ASRV = (781.96 * WSRV) / PSET

```
**
** In British Units:   ASRV = (1.538e-4 * WSRV) / PSET
**
** Where:
**
**      WSRV = S/RV nameplate capacity, Kg/sec or Lbm/Hr, and,
**
**      PSET = Nominal S/RV nameplate set pressure, Pa or Psia
**
** 2) Via MAAP subroutine GFLOW critical gas flow model as described in the
** GFLOW subroutine writeup in the MAAP4 Users Manual, Vol. 2 based on S/RV
** differential pressure, nameplate capacity, and typically assumed
** isentropic flow coefficient (GAMMA) of 1.3.
**
**      ASRV = WSRV / .665 / ( (PAC / Vstm)^.5 )
**
** Where:
**
**      PAC  = Upstream (RPV) pressure [Pa];
**           The proper value for this purpose is the S/RV "Accumulation"
**           pressure, which as defined by the ASME B&PV Code is 103% of
**           the "Guage" (i.e., in psig) S/RV set pressure.  For a set
**           pressure given in absolute terms, and in SI units, PAC is;
**
**         = 1.03 * (PSET - 2951.33)
**
**      WSRV = S/RV namplate capacity, Kg/sec or Lbm/Hr, and,
**
**      PSET = Nominal S/RV nameplate set pressure, Pa or Psia
**
**      Vstm  = Saturated steam specific volume at PAC.
**
** First 2 are PORVs, and the last 3 are safety valves.
**
ASRV(1)    9.865e-3  FT**2
ASRV(2)    9.865e-3  FT**2
ASRV(3)    1.809e-2  FT**2
ASRV(4)    1.809e-2  FT**2
ASRV(5)    1.809e-2  FT**2
**
** ======================================================================
** Name: PSETRV(10)            Units: [PA,PSI]
**
** Parameter PSETRV(i) is the opening set pressure for i'th S/RVs relief
** mode.  The valve will close when the RPV pressure becomes less than the
** opening pressure minus the corresponding deadband PDRV().  In general,
** it is not unusual for all of the S/RVs in a given plant to have the same
** flow area, and be in groups of anywhere from 2 - 4 S/RVs with the same
** nominal set pressure.  In such commonly encountered situations, the best
** approach is to arrange the MAAP S/RV valves in identical nominal opening
** pressure sets.
**
** The set pressures of individual valves could be varied to account for
** the degree of set pressure drift allowed by either the ASME B&PV Code
```

** requirements, the involved plant's Tech Specs, or whatever standards the
** plant uses to control and/or test S/RV set pressures. Ordinarily, the
** allowable drift range is 99-101% of the nominal set pressure (gauge
** value), however in a few isolated instances it may be as wide as 97-103%
** of nominal. Note that although these ranges are generally associated
** with the setpoints for safety valves, they are also typically
** applicable to the settings for PORVs as well.
**
** Finally, either omitting an input value, or setting the parameter to an
** extremely large value, typically 1.e10, will disable the S/RV relief
** mode function.
**
PSETRV(1)   2349.67 PSI
PSETRV(2)   2349.67 PSI
PSETRV(3)   1.e10 PSI
PSETRV(4)   1.e10 PSI
PSETRV(5)   1.e10 PSI
**
** ======================================================================
** Name: PDRV(10)   Units: [PA,PSI]
**
** Parameter PDRV(i) is the deadband associated with the relief mode set
** pressures for ith S/RVs. This deadband is commonly referred to as an
** S/RV's "Blowdown" value. This is the delta-p between the valve opening
** and reclosing pressures, i.e., the closing pressure is computed as
** PSETRV(i) - PDRV(i). For relief valves operation, coincidental nominal
** opening and reclosing pressures are not unusual. This is not acceptable
** for MAAP, as blowdown values set to zero will produce severe and
** unrealistic S/RV cycling effects, i.e., excessive "chattering" that may
** drastically impede code operation. Under such circumstances, it may be
** necessary to assume minimum default deadband values of approximately
** 2.41e5 Pa (35 psid) to overcome this sensitivity. Operating experience
** indicates that this is a reasonable value with respect to typical S/RV
** performance fluctuations.
**
** In regards to single function safety valves operation appropriate
** values should be at least 5% of the nominal valve set pressures as
** specified by the ASME B&PV Code Section III. However, because virtually
** no facilities or requirements exist for full scale/full flow blowdown
** testing, adjustment processes used by S/RV manufacturers and later in
** plant S/RV maintenance practices tend to yield blowdown values from
** 5-10% of nominal set pressures. A somewhat conservative middle ground
** would be setting PDRV() to values corresponding to 5% to 10% of each
** S/RV PSRV() set pressures. With rare exception, all the deadbands will
** fall within the 5-10% range mentioned above by using this approach.
**
PDRV(1)   20.0 PSI
PDRV(2)   20.0 PSI
**
** ======================================================================
** Name: PSETSV(10)   Units: [PA,PSI]
**
** Parameter PSETSV(i) is the opening set pressure for S/RVs safety mode.
** The valve will close when the RPV pressure becomes less than the opening

```
** pressure minus the corresponding deadband PDSV(). Either omitting an
** input value or setting the parameter to an extremely large value,
** typically 1.e10, will disable the S/RV safety mode. The discussion
** for the relief mode set pressure, parameter PSETRV(), also applies to
** PSETSV().
**
PSETSV(1)     1.e10  PSI
PSETSV(2)     1.e10  PSI
PSETSV(3)   2499.67  PSI
PSETSV(4)   2499.67  PSI
PSETSV(5)   2499.67  PSI
**
** =====================================================================
** Name: PDSV(10)              Units: [PA,PSI]
**
** Parameter PDSV(i) is the safety mode deadband for the ith valve. The
** valve closing pressure is computed as PSETSV(i) - PDSV(i). See PDRV()
** discussion which also applies to PDSV().
**
PDSV(1)       0.0  PSI
PDSV(2)       0.0  PSI
PDSV(3)     124.0  PSI
PDSV(4)     124.0  PSI
PDSV(5)     124.0  PSI
**
** =====================================================================
FCDPRV        0.75          // Dimensionless
**
** Parameter FCDPRV is the discharge loss coefficient for the PORVs and
** safety valves.
**
**
*****************************************************************************
*Steam Generator
*****************************************************************************
*BR
**
** ===================================================================
**                    General Notes
** ===================================================================
**
** 1) The following input parameters refer to the geometric and thermal
**    hydraulic initial/boundary conditions required for MAAP thermal
**    hydraulic and fission product modelling of the steam generator
**    secondary side.
**
** 2) Possible data sources for these parameters are:
**
**    a) Final Safety Analysis Report (FSAR)
**    b) Operator Training Manual
**    c) Plant or component specific Technical Specifications
**    d) Steam generator contruction and assembly drawings
**    e) Plant Emergency Operating Procedures (EOP's)
**    f) AFW Pre-Op, startup, or in-service performance test records
```

** g) AFW pump specification data (Manufacturer's performance
** test documentation)
**
** 3) Parameter values refer to a single steam generator unit.
**
** 4) Unless otherwised noted, all elevation variables in this section
** should be referenced to the top of the steam generator tubesheet.
**
** 5) A pressure loss coefficient is conventionally symbolized by "K" and
** defined as:
**
** K = (2*DP)/(RHO*V**2)
**
** where DP = pressure loss,
** RHO = fluid density, and
** V = the fluid velocity.
**
**
** 6) Two-region steam generator model notes:
**
** Consult the BSG2R/USG2R subroutine description in the User's Manual,
** which are the B-loop and U-loop regional routines, for details
** regarding implementation, usage, and methodology for this model.
**
** Control flag ISG2R controls the type of steam generator model used:
**
** ISG2R Steam generator model selected
** ----- -----------------------------
** 0 One-region model
** 1 Two-region model
**
** Either model is adequate for most sequences. However, when more
** refined secondary side thermal hydraulic performance is required,
** the two-region model should be selected.
**
** 7) Two-region steam generator model region boundary and junction
** definitions:
**
** (Consult the BSG2R/USG2R subroutine description, which are the B-
** and U-loop regional routines, for detailed figures citing the
** region boundaries.)
**
** Region 1: Defined as the portion of the secondary side steam
** generator fluid volume bounded on the outside by the the tube
** bundle shroud, risers and swirl vane separators (primary
** separators). It is bounded on the inside by the wall of each
** tube within the bundle.
**
** Region 2: Defined as the remaining secondary side steam
** generator fluid volume outside region 1.
**
** Lower (In) junction between regions: Defined as the entrance to
** the bottom of the tube bundle from the bottom of the downcomer.
**

```
**   Upper (Out) junction between regions: Defined as the exit from the
**   swirl vane separators.
**
**   Junction with the primary side: Defined as the steam generator
**   tube rupture in region 1, if implemented. (This junction is the
**   same as that in the one-region model.)
**
**   Junctions with balance-of-plant: Defined as the feedwater spray
**   headers and the MSIV's, SV's, and PORV's. (These junctions are the
**   same as those in the one-region model.)
**
**
** ==================================================================
**              Parameter Specifications
** ==================================================================
**
** ==================================================================
VSG        5869.3  FT**3      // Units: [M**3,FT**3]
**
** This parameter is the secondary side total fluid volume. This includes
** the portion of the main steam line volume between the S/G shell and the
** main steam isolation valves (MSIV's).
**
** Parameter VOLP is a subset of parameter VSG. Consult the VOLP
** parameter description for further details regarding its use.
**
** ==================================================================
ASGDC       32.292  FT**2      // Units: [M**2,FT**2]
**
** This parameter is the secondary side downcomer cross sectional flow
** area. This is the annular flow area between the outside of the tube
** bundle shroud (tube bundle wrapper) and the inside of the steam
** generator shell.
**
** ==================================================================
AFLWSG      43.056  FT**2      // Units: [M**2,FT**2]
**
** This parameter is the secondary side tube bundle cross sectional flow
** area. This includes both the flow area through the tube bundle itself
** and any bypass flow area between the perimeter of the tube bundle and
** the inside of the tube bundle shroud.
**
**
** ==================================================================
** @@@ 4.0.3 CYP 8/15/96 - Added XLHLTS, MDPSG, MSWSG and ASWSG for the
** hot leg natural circulation model enhancements for plants with U-tube
** steam generators (IBW = 0).
**
XLHLTS       3.806  FT        // Units: [M,FT]
**
** XLHLTS is the vertical height between the bottom of the tube sheet and
** the centerline of the hot leg at the steam generator plenum.
** It is used for the plume calcualation in subroutine HLNC.
**
```

```
**
MDPSG        2591. LB        // Units: [KG,LB]
**
** MDPSG is the mass of the divider plate in the steam generator plenum (per
** steam generator).
**
**
MSWSG        14994. LB       // Units: [KG,LB]
**
** MSWSG is the mass of the hot leg side of the steam generator wall below
** the tube sheet in the inlet plenum. (Do not include the cold leg side.)
**
**
ASWSG        183. FT**2      // Units: [M**2,FT**2]
**
** ASWSG is the heat transfer area of the hot leg side of the steam generator
** wall below the tube sheet in the inlet plenum. (Do not inlcude the cold
** leg side.)
**
** ====================================================================
** Name: ZAFW                    Units: [M,FT]
**
** This parmeter is applicable to only OTSG designs.
**
** It is the elevation of auxiliary feedwater (AFW) spray header relative
** to the top of the lower tubesheet. ZAFW is applicable to only OTSG
** designs, which possess an AFW spray header at the top of the tube bundle
** that sprays directly on the outer perimeter of the tube bundle.
**
** This elevation is primarily intended to determine if the spray header is
** exposed (not submerged). If it is exposed, then a sufficient amount of
** steam will condense on the spray droplets to raise the temperature of
** the incoming AFW flow to saturation. To completely disable condensation
** on OTSG AFW sprays, set ZAFW to zero.
**
** ====================================================================
ZMFW         0.0 FT         // Units: [M,FT]
**
** This parameter is the elevation of the main feedwater (MFW) spray header
** relative to the top of the tubesheet (lower tubesheet for OTSG designs).
** This spray header directly feeds the downcomer, not the tube bundle.
**
** ZMFW is primarily intended to determine if the MFW spray header is
** exposed. If it is exposed, then a sufficient amount of steam will
** condense on the spray droplets to raise the temperature of the incoming
** MFW flow to saturation. To completely disable condensation on this
** spray, set ZMFW to zero.
**
** For inverted U-tube designs, this is also the AFW spray header. This
** spray header is submerged during normal full-power operation.
** Therefore, a nontrivial, representative value for ZMFW should be less
** than the nominal full-power water level in the steam generator
** downcomer, thus preventing condensation. If a user does not intend to
** accomodate the contingency of steam condensation on either MFW or AFW
```

```
** sprays, then ZMFW should be set to zero, as noted above.
**
** Note: For inverted U-tube designs, steam condensation on feedwater is
**     currently enabled only in the two-region steam generator model,
**     not the one-region steam generator model.
**
** ======================================================================
ZWSG0       49.213  FT       // Units: [M,FT]
**
** This parameter is the initial secondary side two-phase water level in
** the tube bundle relative to the top of the tubesheet.
**
** One-region steam genertor model application:
**
**   This parameter, along with the one-phase (collapsed) water level
**   determined from the initial water mass parameter MWSG0, determines
**   the initial average void fraction within the tube bundle.  Comparison
**   of this reference void fraction against a calculated void fraction,
**   based upon the full-power steam generation rate, yields a correction
**   factor for the void fraction.  This correction factor compensates for
**   the absense of a mechanistic momentum model for two-phase flow
**   through the tube bundle.  It insures that two-phase boilup prior to
**   reactor scram remains consistent with the reference value of ZWSG0.
**
** Two-region steam genertor model application:
**
**   Unlike the one-region model, the two-region model possesses a
**   mechanistic momentum model for two-phase flow through the tube
**   bundle.  Therefore, the correction factor noted above is not
**   required.  However, ZWSG0 is still a required input parameter for
**   OTSG designs.
**
**   For U-tube designs:
**     It is not a required input parameter.  In this case, the
**     reference value for full-power boiled-up level is the elevation
**     of the primary separators, ZSEP.  Consult the ZSEP parameter
**     description for further details.
**
**     The one exceptional case in which the U-tube designs utilize ZWSG0
**     (two-phase level at full power) as an input parameter is a half-
**     loop sequence with saturated secondary side water.  It is suggested
**     that the user input ZSEP as ZWSG0 for a half-'oop sequence.
**
** ======================================================================
TFW         440.0  F         // Units: [K,F]
**
** This parameter is the main feedwater (MFW) inlet temperature to the
** steam generator.  MAAP is not equipped with a feedwater heater model.
** Consequently, the temperature of the water downstream of the feedwater
** heaters should be specified for this parameter.
**
** ======================================================================
PSGSVL      1189.67  PSI     // Units: [PA,PSI]
**
```

** This parameter is the lowest opening (or set) pressure for the secondary
** side main steam safety valves. Set pressures for these valves are
** generally spread over a nominal range where the lowest set pressure is
** approximately 4.E5 Pa - 7.E5 Pa (60 psid - 100 psid) below the highest
** set pressure. Specifying the lowest nominal set pressure is adequate
** for this parameter.
**
** The lowest nominal set pressure can also be reduced slightly to envelope
** the low end of the allowable set pressure tolerance range (typically
** 99%-101% of the nominal guage set pressure per ASME B&PV Code).
** However, the overall affect of this refinement on MAAP calculations is
** likely to be trivial.
**
** ==================================================================
PSGSVH 1244.67 PSI // Units: [PA,PSI]
**
** This parameter is the highest opening (or set) pressure for the
** secondary side main steam safety valves. Set pressures for these valves
** are generally spread over a nominal range where the lowest set pressure
** is approximately 4.E5 Pa - 7.E5 Pa (60 psid - 100 psid) below the
** highest set pressure. Specifying the highest nominal set pressure is
** adequate for this parameter.
**
** The highest nominal set pressure can also be increased slightly to
** envelope the high end of the allowable set pressure tolerance range
** (typically 99%-101% of the nominal guage set pressure per ASME B&PV
** Code). However, the overall affect of this refinement on MAAP
** calculations is likely to be trivial.
**
** ==================================================================
NSGSV 5 // Dimensionless
**
** This parameter is the number of main steam safety valves per steam
** generator.
**
** ==================================================================
WSGSV0 6.74e5 LB/HR // Units: [KG/S,LB/HR]
**
** This parameter is the rated (nameplate) mass flowrate for one main steam
** safety valve. Use an average value if all of the safety valves do not
** have the same rated flowrate.
**
** ==================================================================
PSGRV 1107.0 PSI // Units: [PA,PSI]
**
** This parameter is the opening (or set) pressure of the secondary side
** main steam power operated relief valve(s) (PORV). MAAP assumes that all
** main steam PORV's have the same set pressure. If the actual set
** pressures vary, a simple average is adequate for this parameter. This
** set pressure is generally less than the lowest set pressure for the main
** steam safety valves. However, MAAP does not require that the PORV
** settings be lower than the SV settings.
**
** In contrast to the main steam safety valves, the main steam PORV's can

```
** be manually actuated through the appropriate operator action.
**
** ======================================================================
NSGRV        1.0          // Dimensionless
**
** This parameter is the number of secondary side main steam power operated
** relief valve(s) (PORV) per steam generator. If there are no main steam
** PORV's, set this parameter to zero. A setting of zero will disable both
** actuation on set pressure and manual actuation.
**
** ======================================================================
WSGRV0       3.97e5 LB/HR     // Units: [KG/S,LB/HR]
**
** This parameter is the rated (nameplate) mass flowrate for one main steam
** power operated relief valve (PORV). Use an average value if all of the
** PORV's do not have the same rated flowrate.
**
** ======================================================================
WFWMX        5.25e6 LB/HR     // Units: [KG/S,LB/HR]
**
** This parameter is the maximum main feedwater (MFW) mass flowrate per
** steam generator. The MAAP steam generator water level controller
** ultimately determines the actual MFW mass flowrate injected into each
** steam generator.
**
** ======================================================================
VSGPHD       317.83 FT**3     // Units: [M**3,FT**3]
**
** This parameter is the total composite fluid volume for the primary side
** inlet and outlet plenums (heads) within one steam generator. This
** volume should also include the portion of the total steam generator tube
** volume that resides within the tubesheet(s).
**
** For inverted U-tube designs, the inlet and outlet plenums are contained
** within a single lower head below the tubesheet. A partition separates
** the inlet and outlet halves of the plenum.
**
** ======================================================================
TDAFW        2.78e-3 HR       // Units: [S,HR]
**
** This parameter is the time delay for auxiliary feedwater (AFW)
** actuation. MAAP assumes that MSIV closure, MFW termination, and AFW
** actuation are all initiated at reactor scram, unless their status is
** altered by operator actions stated in the input and/or parameter files.
** MAAP models the start of the AFW system as a step function. After the
** reactor scram, MAAP waits for expiration of the delay time specified by
** TDAFW, after which AFW flow is enabled.
**
** TDAFW applies to both turbine-driven and motor-driven AFW systems.
**
** ======================================================================
TDMSIV       1.39e-3 HR       // Units: [S,HR]
**
** This parameter is the time period for MSIV closure. MAAP assumes that
```

** MSIV closure, MFW termination, and AFW actuation are all initiated at
** reactor scram, unless their status is altered by operator actions stated
** in the input and/or parameter files. After MSIV closure initiation at
** scram, MAAP assumes that the flow area through the MSIV's decreases
** linearly to zero during the time period specified by TDMSIV.
**
** ====================================================================
VSGPRI 1101.83 FT**3 // Units: [M**3,FT**3]
**
** This parameter is the total primary side fluid volume within one steam
** generator. This includes the total fluid volume within the inlet and
** outlet plenums, which is specified by parameter VSGPHD, and the total
** fluid volume within all steam generator tubes.
**
** VSGPHD already includes the portion of the total tube volume that
** resides within the tubesheet(s). So, do not account for this portion of
** the tube volume when determining the total fluid volume within all
** tubes.
**
** MAAP uses the difference between volume parameters VSGPRI and VSGPHD to
** ultimately determine the total tube surface area available for heat
** transfer between the primary and secondary side fluids.
**
** ====================================================================
XTSGTS 1.64 FT // Units: [M,FT]
**
** This parameter is the thickness of the steam generator tubesheet.
**
** ====================================================================
TAFW 134.0 F // Units: [K,F]
**
**
** This parameter is the auxiliary feedwater (AFW) inlet temperature to the
** steam generator. MAAP is not equipped with a feedwater heater model.
** Consequently, the temperature of the water downstream of the feedwater
** heaters should be specified for this parameter.
**
** ====================================================================
NTSG 3388.0 // Dimensionless
**
** This parameter is the number of tubes in one steam generator.
**
** ====================================================================
XTSG 4.17e-3 FT // Units: [M,FT]
**
** This parameter is the wall thickness of a steam generator tube.
**
**
** ====================================================================
XIDSG 6.46e-2 FT // Units: [M,FT]
**
** This parameter is the inner diameter of a steam generator tube.
**
** ====================================================================

KTSG 10.63 BTU/FT-HR-F // Units: [W/M-C,BTU/FT-HR-F]
**
** This parameter is the thermal conductivity of the steam generator tube
** material.
**
** ==================================================================
WAFWXU 1.0e9 LB/HR // Units: [KG/S,LB/HR]
**
** This parameter is the throttled motor-driven auxiliary feedwater (AFW)
** mass flowrate per steam generator in the unbroken loop (U-loop). Users
** have the option of placing an upper limit on the motor-driven AFW
** flowrate calculated from the associated pump head curve. MAAP will use
** the minimum of WAFWXU or the flowrate from the pump head curve.
**
** In general, throttling of motor-driven AFW is not a default operator
** action. Therefore, throttling can be disabled by specifying an
** excessively large value for WAFWXU (typically 1.e10 in either set of
** units).
**
** ==================================================================
FARVBX 1.0 // Dimensionless
**
** This parameter is the scaling fraction used to limit the flow area for
** steam dump valves in the broken loop (B-loop). MAAP models steam dump
** valves by using the main steam PORV's. The size of the steam dump
** valves are modelled by multiplying FARVBX with the B-loop main steam
** PORV's total flow area. MAAP makes no distinction between steam dump
** valves and main steam PORV's. Their size and usage are identical.
**
** MAAP derives the PORV total flow area from the number of steam
** generators in the B-loop (1), the number of PORV's per generator
** (parameter NSGRV), their set pressure (parameter PSGRV) as the upstream
** stagnation pressure, and their nominal flowrate (parameter WSGRV0).
** FARVBX values less than one are intended to restrict the B-loop
** depressurization rate to less than the full rate available through the
** PORV's.
**
** ==================================================================
FARVUX 1.0 // Dimensionless
**
** This parameter is the scaling fraction used to limit the flow area for
** steam dump valves in the unbroken loop (U-loop). MAAP models steam dump
** valves by using the main steam PORV's. The size of the steam dump
** valves are modelled by multiplying FARVUX with the U-loop main steam
** PORV's total flow area. MAAP makes no distinction between steam dump
** valves and main steam PORV's. Their size and usage are identical.
**
** MAAP derives the PORV total flow area from the number of steam
** generators in the U-loop (parameter NHL - 1), the number of PORV's per
** generator (parameter NSGRV), their set pressure (parameter PSGRV) as the
** upstream stagnation pressure, and their nominal flowrate (parameter
** WSGRV0). FARVUX values less than one are intended to restrict the
** U-loop depressurization rate to less than the full rate available
** through the PORV's.

```
**
** ======================================================================
ZWCTLB        24.606  FT        // Units: [M,FT]
**
** This parameter is the desired collapsed water level in the steam
** generator downcomer of the broken loop (B-loop). The MAAP steam
** generator water level control model uses this parameter as the target
** level.
**
** For circumstances that require level control targeted for the
** nominal full-power level, such as a steady state sequence, simply set
** ZWCTLB to any negative value, like -1.
**
** The following information regarding associated MAAP modeling is provided
** as guidance for the selection of a parametric value. This will
** facilitate the sequence-specific feedwater system performance that is
** desired by the user.
**
** MAAP assumes that MSIV closure, MFW termination, and AFW actuation are
** all initiated at reactor scram, unless their status is altered by
** operator actions stated in the input and/or parameter files.
** (Simulation of continued MFW availability after scram, which is a
** possible contingency in a plant, would be enabled through the noted
** operator actions.) After an established delay time (see parameter
** TDAFW), relatively cold AFW injection could decrease the secondary side
** fluid pressure and temperature, which would enhance primary-to-secondary
** side heat transfer and would subsequently decrease primary system
** pressure.
**
** Therefore, to simulate hot shutdown (primary and secondary pressures
** remain relatively high) set ZWCTLB to a value that is equal to or less
** than the nominal full-power downcomer water level, which is dictated by
** several initial conditions such as the initial water mass (parameter
** MWSG0). This will lessen the AFW flow requirements for post-scram level
** maintenance.
**
** Aside from these special considerations, plant data should generally be
** used to set ZWCTLB.
**
** ======================================================================
ZWCTLU        24.606  FT        // Units: [M,FT]
**
** This parameter is the desired collapsed water level in the steam
** generator downcomer of the unbroken loop (U-loop). The MAAP steam
** generator water level control model uses this parameter as the target
** level.
**
** For circumstances that require level control targeted for the
** nominal full-power level, such as a steady state sequence, simply set
** ZWCTLU to any negative value, like -1.
**
** The following information regarding associated MAAP modeling is provided
** as guidance for the selection of a parametric value. This will
** facilitate the sequence-specific feedwater system performance that is
```

** desired by the user.
**
** MAAP assumes that MSIV closure, MFW termination, and AFW actuation are
** all initiated at reactor scram, unless their status is altered by
** operator actions stated in the input and/or parameter files.
** (Simulation of continued MFW availability after scram, which is a
** possible contingency in a plant, would be enabled through the noted
** operator actions.) After an established delay time (see parameter
** TDAFW), relatively cold AFW injection could decrease the secondary side
** fluid pressure and temperature, which would enhance primary-to-secondary
** side heat transfer and would subsequently decrease primary system
** pressure.
**
** Therefore, to simulate hot shutdown (primary and secondary pressures
** remain relatively high) set ZWCTLU to a value that is equal to or less
** than the nominal full-power downcomer water level, which is dictated by
** several initial conditions such as the initial water mass (parameter
** MWSG0). This will lessen the AFW flow requirements for post-scram level
** maintenance.
**
** Aside from these special considerations, plant data should generally be
** used to set ZWCTLU.
**
** ==================================================================
XDSGTS 9.8425 FT // Units: [M,FT]
**
**
** This parameter is the diameter of the steam generator tubesheet.
**
** ==================================================================
ZDEADB 0.0 FT // Units: [M,FT]
**
** This parameter is the deadband for the "bang-bang" mode of steam
** generator water level control in the broken loop (B-loop). A non-zero
** value for ZDEADB automatically enables this mode. It is mainly intended
** for B&W OTSG designs, particularly for MAAP simulation of the TMI-2
** accident sequence.
**
** The so-called "bang-bang" mode is a non-standard mode in which
** the feedwater flowrate is controlled as a discrete step function of
** water level. This is contrast to the standard mode in which the
** flowrate is controlled as a continuous, exponential function of water
** level.
**
** The step function in "bang-bang" mode is based upon the deadband ZDEADB
** around the target level, parmeter ZWCTLB. If the water level is below
** ZWCTLB-ZDEADB/2, then the maximum feedwater flowrate is injected
** into the B-loop. If the water level is above ZWCTLB+ZDEADB/2, then,
** the minimum feedwater flowrate is injected. Finally, if the water level
** is above ZWCTLB+ZDEADB, the feedwater flowrate is zero.
**
** For the MFW system, the maximum feedwater flowrate is based upon
** parameter WFWMX, and the minimum feedwater flow rate is hardwired to
** zero.

**
** For the AFW system, the maximum feedwater flowrate is based upon its
** parametric pump head curve (and parmeter WAFWXB if throttling of
** motor-driven AFW is enabled), and the minimum feedwater flow rate is
** based upon parameter WBATMN.
**
** ======================================================================
ZDEADU 0.0 FT // Units: [M,FT]
**
** This parameter is the deadband for the "bang-bang" mode of steam
** generator water level control in the unbroken loop (U-loop). A non-zero
** value for ZDEADU automatically enables this mode. It is mainly intended
** for B&W OTSG designs, particularly for MAAP simulation of the TMI-2
** accident sequence.
**
** The so-called "bang-bang" mode is a non-standard mode in which
** the feedwater flowrate is controlled as a discrete step function of
** water level. This is contrast to the standard mode in which the
** flowrate is controlled as a continuous, exponential function of water
** level.
**
** The step function in "bang-bang" mode is based upon the deadband ZDEADU
** around the target level, parmeter ZWCTLU. If the water level is below
** ZWCTLU-ZDEADU/2, then the maximum feedwater flowrate is injected
** into the U-loop. If the water level is above ZWCTLU+ZDEADU/2, then
** the minimum feedwater flowrate is injected. Finally, if the water level
** is above ZWCTLU+ZDEADU, the feedwater flowrate is zero.
**
** For the MFW system, the maximum feedwater flowrate is based upon
** parameter WFWMX, and the minimum feedwater flow rate is hardwired to
** zero.
**
** For the AFW system, the maximum feedwater flowrate is based upon its
** parametric pump head curve (and parmeter WAFWXU if throttling of
** motor-driven AFW is enabled), and the minimum feedwater flow rate is
** based upon parameter WBATMN.
**
** ======================================================================
WBATMN 0.0 LB/HR // Units: [KG/S,LB/HR]
**
** This parameter is the minimum auxiliary feedwater (AFW) mass flowrate
** per steam generator when the water level controller is in the
** "bang-bang" mode. See the descriptions for associated parameters ZDEADB
** and ZDEADU for details regarding the "bang-bang" mode.
**
** ======================================================================
FMSLB 0.0 // Dimensionless
**
** This parameter is the identification flag for a main steam line break
** configuration. It is used to:
**
** i) initiate a main steam line break and
** ii) specify the type of break configuration.
**

```
** The following values are permissible for FMSLB:
**
**    FMSLB     Main steam line break status and configuration
**    -----     -------------------------------------------
**      0       No break
**      1       Break in broken loop (B-loop)
**      2       Break common to both B-loop and U-loop (all S/G's)
**
** In the case of a break, all steam discharge is directed to the containment
** node specified by parameter JNMSLB. (See *POINTERS section of the
** parameter file for details.)
**
** ==================================================================
XLSHEL       59.055  FT        // Units: [M,FT]
**
** This parameter is the total vertical height between the top of the steam
** generator tubesheet and the top of the steam generator shell.
**
** XLSHEL establishes the height of the secondary side heat sink
** (two-dimensional) posed by the steam generator shell mass within the
** bounds of XLSHEL and associated internal structural heat sinks masses
** that comprise parameter MSHEL.
**
** ==================================================================
MSHEL       6.614e5  LB        // Units: [KG,LB]
**
** @@@ 4.0.3 CEH 11/27/95  The parameter value has been modified.
**
** This parameter is the total mass of steam generator shell and associated
** secondary side heat sinks specified below. Note, the mass of reflective
** insulation can be included in MSHEL, although this addition is small
** relative to the shell mass itself.
**
** For the two-region steam generator model:
**
**     (See General Notes at the top of the *STEAM GENERATOR section
**      regarding regional boundary definitions for Regions 1 and 2.)
**
**     MSHEL includes the portion of the shell bounded by the shell length
**     as stated in the description of parameter XLSHEL. It also includes
**     any internal structures within Region 2 of the model, particularly
**     the steam dryers (secondary moisture separators). However, it
**     does not include internal structures such as the tube bundle
**     shroud, risers, and swirl vane separators (primary moisture
**     separators). These are included in the tube bundle shroud mass
**     parameter MSHD.
**
**     Other structual masses that are NOT INCLUDED within MSHEL are
**     the masses of the tubes, the tubesheet(s) and the primary side
**     steam generator head(s). The masses of the tubesheet(s) and the
**     primary side head(s) are included in parameter MSGPHD. MAAP
**     combines MSHEL with half of MSGPHD when performing shell heat sink
**     calculations. The other half of MSGPHD is associated with primary
**     side heat sinks.
```

**
**
** For the one-region steam generator model:
**
**     MSHEL includes the portion of the shell bounded by the shell length
**     as stated in the description of parameter XLSHEL. However, since
**     this model uses a single control volume, it is not feasible to
**     accurately model heat transfer to any internal structures. In this
**     case, MAAP assumes that the mass of internal components is small
**     relative to the mass of the shell. Users can make an adequate
**     first approximation by adding internal component masses to MSHEL.
**     However, the refined structural heat sink modeling provided by the
**     two-region model is a superior alternative to the one-region model
**     assumption that the shroud heat sink is small relative to the
**     shell.
**
**     External structual masses that are not included within MSHEL are
**     the masses of the tubesheet(s) and the primary side steam
**     generator head(s). These are included in parameter MSGPHD. MAAP
**     combines MSHEL with half of MSGPHD when performing shell heat sink
**     calculations. The other half of MSGPHD is associated with primary
**     side heat sinks.
**
** ==================================================================
FINSG          12.0          // Dimensionless
**
** This parameter is the number of plates in the reflective insulation
** around the steam generator shell. The maximum allowable value is 16.
** MAAP also supports the calcium silicate bulk (FINSG = 0) and mineral
** wool (FINSG = -1) insulation types. No other types are currently
** supported..
**
** ==================================================================
NSB          4.0          // Dimensionless
**
** This parameter is the primary side loss of coolant accident (LOCA) break
** location key for a steam generator tube rupture (SGTR) event. One of
** the values show below must be specified, even if no SGTR is to be
** simulated. Neglecting to do this can cause a fatal error in MAAP.
**
**     NSB     Break location
**     ---     --------------
**      4      Hot tube side of the tube bundle
**      5      Cold tube side of the tube bundle
**
** For inverted U-tube designs, the hot tubes extend from the
** top of the tubesheet on hot leg side to the top of the "U". The cold
** tubes extend from the top of the "U" to the top of the tubesheet on the
** intermediate leg side.
**
** ==================================================================
ASB          0.0 FT**2     // Units: [M**2,FT**2]
**
** This parameter is the primary side loss of coolant accident (LOCA) break

** area for a steam generator tube rupture (SGTR) event. This is an
** "effective" area, which means that the discharge or loss coefficient
** associated with the break must be embedded within ASB.
**
** For example, in the case of a double-ended (double guillotine) rupture
** of a single tube, ASB should not be assigned the available flow area,
** which is twice the tube cross sectional area for this type of rupture.
** Rather, the product of a discharge coefficient, which reflects the
** two-phase frictional impedance posed by tube length on each side of
** the rupture, and the tube flow area should be assigned to ASB.
**
** SGTR initiation requires both a non-zero value for ASB and an event code
** status change citing that a break in the primary system has occurred.
**
** ==================================================================
ZSB 3.2808 FT // Units: [M,FT]
**
** This parameter is the primary side loss of coolant accident (LOCA) break
** elevation for a steam generator tube rupture (SGTR) event.
**
** The break elevation is relative to the top of the tubesheet.
**
** ==================================================================
ASEDSG 53.82 FT**2 // Units: [M**2,FT**2]
**
** This parameter is the sedimentation area for aerosol fission product
** settling on the secondary side one steam generator. This is the total
** horizontal surface area on which aerosols can settle, which can be
** planes at several elevations.
**
** The suggested minimum value is the available surface area on the top of
** the tubesheet.
**
** Sedimentation area is the total upward-facing area on which fission
** products can settle. This is should include (where appropriate) floors,
** equipment, etc. If two upward-facing areas are stacked vertically, then
** both should be included, since the upper area does not mask the lower
** area. However, it can potentially mitigate the deposition on the lower
** surface. Therefore, the appropriate interpretation is that ASEDSG
** exists within a range between the area of the upper surface alone and
** the summation of the upper and lower surface areas.
**
** ==================================================================
WAFWXB 1.0e9 LB/HR // Units: [KG/S,LB/HR]
**
** This parameter is the throttled motor-driven auxiliary feedwater (AFW)
** mass flowrate per steam generator in the broken loop (B-loop). Users
** have the option of placing an upper limit on the motor-driven AFW
** flowrate calculated from the associated pump head curve. MAAP will use
** the minimum of WAFWXB or the flowrate from the pump head curve.
**
** In general, throttling of motor-driven AFW is not a default operator
** action. Therefore, throttling can be disabled by specifying an
** excessively large value for WAFWXB (typically 1.e10 in either set of

```
** units).
**
** ==================================================================
AMSLB         0.0  FT**2      // Units: [M**2,FT**2]
**
** This parameter is the flow area for a main steam line break. MAAP uses
** a discharge loss coefficient of 1. Therefore, to include a more
** realistic coefficient, treat AMSLB as an effective area by embedding the
** loss coefficient within its value.
**
** A main steam line break is initiated by assigning non-zero values to both
** AMSLB and FMSLB, which are the main steam line break status and
** configuration flag.
**
** ==================================================================
** Name: TDIFBW                Units: [DEG-K,DEG-F]
**
** This parmeter is applicable to only OTSG designs.
**
** This parameter is the the amount of superheat for steam exiting the tube
** bundle. In OTSG designs, steam generated from the water pool in lower
** portion of tube bundle acquires superheat from the exposed
** (non-submerged) upper portion of the tube bundle.
**
** During the thermal hydraulic initialization in MAAP, TDIFBW is a
** temperature difference that is added to the initial saturation
** temperature to determine the initial freeboard gas temperature on the
** secondary side.
**
** ==================================================================
** Name: VOFZSG(1:10)            Units: [M**3,FT**3]
**
** This parameter is the cumulative secondary side fluid volume. Each
** element in the VOFZSG array corresponds to an element in the ZOFSG
** array, which is a cumulative secondary side height. These arrays form a
** volume vs. height table from which water volume or collapsed level can
** be interpolated.
**
** For the two-region steam generator model:
**
**     This table is not used to compute collapsed water levels since
**     water volume and levels are tracked locally within each region as
**     opposed to globally throughout the secondary side. Instead, to
**     account for flow area change, each region is divided into three
**     subsections, and each subsection has a constant flow area.
**
**     However, this table is used for other applications within the
**     model.
**
** For the one-region steam generator model:
**
**     This table was primarily intended for inverted U-tube designs since
**     the flow area can vary substantially with height. The table can be
**     used with OTSG designs, although this may be superfluous since flow
```

```
**    areas are essentially constant throughout the steam generator.
**
**    Consult the description of parameter NZPTS for instructions
**    regarding enabling/disabling this lookup table.
**
VOFZSG(1)      0.0  FT**3
VOFZSG(2)   2966.4  FT**3
VOFZSG(3)   5869.3  FT**3
**
** ==================================================================
** Name: ZOFSG(1:10)          Units: [M,FT]
**
**
** This parameter is the cumulative secondary side height.  Each element in
** the ZOFSG array corresponds to an element in the VOFZSG array, which is
** a cumulative secondary side fluid volume.  Together, these arrays form a
** volume vs. height table from which water volume or collapsed level can
** be interpolated.
**
** For the two-region steam generator model:
**
**    This table is not used to compute collapsed water levels, since
**    water volume and levels are tracked locally within each region as
**    opposed to globally throughout the secondary side.  Instead, to
**    account for flow area change, each region is divided into three
**    subsections, and each subsection has a constant flow area.
**
**    However, this table is used for other applications within the
**    model.
**
** For the one-region steam generator model:
**
**    This table was primarily intended for inverted U-tube designs since
**    the flow area can vary substantially with height.  The table can be
**    used with OTSG designs, although this may be superfluous since flow
**    areas are essentially constant throughout the steam generator.
**
**    Consult the description of parameter NZPTS for instructions
**    regarding enabling/disabling this lookup table.
**
ZOFSG(1)     0.000  FT
ZOFSG(2)    39.370  FT
ZOFSG(3)    59.055  FT
**
** ==================================================================
NZPTS        3.0        // Dimensionless
**
** This parameter is the number of points in the volume vs. height
** table formed by parameter arrays VOFZSG and ZOFSG.  The maximum number
** is dictated by the dimension of these arrays.  If NZPTS is less than 2,
** then the table cannot be formed and is therefore disabled.  Instead,
** constant downcomer and tube bundle flow areas, ASGDC and AFLWSG
** respectively, are assumed to apply through the steam generator height.
**
```

** The table can be used with OTSG designs. However, the general
** convention is to disable it since flow areas are essentially constant
** throughout.
**
** ==================================================================
DMSL 3.2808 FT // Units: [M,FT]
**
** This parameter is the main steam line inner diameter. This parameter is
** not used to determine a main steam line area for use in flow
** calculations. Rather, it is used in conjunction with parameter VOLP to
** determine if the secondary side water level has reached the main steam
** line elevation, enabling two-phase flow through the steam line. (A
** collapsed level is used in the one-region model. A two-phase level is
** used in the two-region model.) If two-phase flow is possible, then DMSL
** is used to determine an approximate stagnation void fraction, which is
** required to determine the respective flowrates of the gas and water
** constituents.
**
** Consult the VOLP parameter description and the BSTGEN/USTGEN subroutine
** description in the MAAP4 User's Manual for further details regarding the
** usage of VOLP and DMSL.
**
** ==================================================================
VOLP 706.29 FT**3 // Units: [M**3,FT**3]
**
** This parameter is the the approximate composite volume of:
**
** i) the main steam line from the steam generator to the location where
** it turns to penetrate the containment wall, and
** ii) the portion of the fluid volume within the steam generator that is
** located above the main steam line penetration.
**
** VOLP is a subset of VSG. It is intended to represent the compressible
** gas volume that remains in an over-filled steam generator. Essentially,
** this gas volume resides above the secondary side MSIV's, PORV's, and
** SV's. Only low-quality two-phase flow (very little gas) is expelled
** during venting, thus mitigating or even preventing the
** depletion of this gas volume.
**
** Consequently, it is difficult to obtain a so-called
** "solid" steam generator in MAAP, provided parameter VOLP is given a
** sufficient value (nominally 10% of parameter VSG). Such a nominal value
** is recommended to avoid potential difficulties associated with "solid"
** steam generator behavior, particularly for the two-region steam
** generator model. Consult the BSTGEN/USTGEN subroutine description in the
** MAAP4 User's Manual for further details regarding the usage of VOLP.
**
** For standard inverted U-tube designs, VOLP would probably include the
** portion of the main steam line noted above but no portion of the steam
** generator fluid volume. Since the main steam line exits the top of the
** generator, the entire fluid volume resides below the steam line.
**
** However, while it is generally recommended that VOLP reflect the steam
** line elevation in the standard design, the user may choose for numeric

```
** reasons to increase the elevation within VOLP the portion of the steam
** generator fluid volume residing above the steam line.
**
** ==================================================================
FVSGSL        0.99          // Dimensionless
**
** This parameter is the fraction of a fluid volume that must be occupied
** by water for the volume to be considered "solid".
**
** For the one-region steam generator model:
**
**     The noted fluid volume applies to entire secondary side fluid volume.
**
** For the two-region steam generator model:
**
**     The noted fluid volume applies to the individual fluid volumes of
**     region 1 or region 2. (See General Notes regarding the boundary
**     definitions of regions 1 and 2.) Therefore, a "solid" designation
**     could apply separately to regions 1 or 2. However, by definition,
**     if region 2 is "solid", then the entire steam generator is "solid".
**
** Solid conditions within a steam generator have the potential for
** yielding difficulties in secondary side thermal hydraulic behavior. It
** is recommended that parameter VOLP be given a sufficient value to
** inhibit the onset of solid conditions. Consult the VOLP parameter
** description for guidance.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
**
** ==================================================================
ISG2R          0            // Dimensionless
**
** This parameter is the steam generator model control parameter, which
** actuates one of the two available steam generator models. The following
** values are permissible for ISG2R:
**
**   ISG2R     Steam generator model selected
**   -----     -----------------------------
**     0       One-region
**     1       Two-region
**
** Either model is adequate for most sequences. However, when more refined
** secondary side thermal hydraulic performance is required, the two-region
** model should be selected. Consult the General Notes at the top of the
** *STEAM GENERATOR section for information regarding the two-region model.
**
** ==================================================================
ZSEP        45.932  FT      // Units: [M,FT]
**
** This parameter is required only for an inverted U-tube design when
```

** the two-region steam generator model is being implemented.
**
** It is the elevation of the swirl vane separators (primary
** moisture separators) at the top of the risers (standpipes), which are
** located at the top of the tube bundle shroud. The upper junction
** between regions 1 and 2 is located at this elevation, which is
** referenced to the top of the tubesheet.
**
** =================================================================
ZRISER 39.37 FT // Units: [M,FT]
**
** This parameter is required only for an inverted U-tube design when
** the two-region steam generator model is being implemented.
**
** It is the elevation of the bottom of the risers (standpipes), which
** contain the swirl vane separators (primary moisture separators). It is
** referenced to the top of the tubesheet.
**
** ZRISER and ZSEP define the bottom and top of the standpipe subsection
** within region 1 of the two-region model.
**
** =================================================================
ARISER 37.67 FT**2 // Units: [M**2,FT**2]
**
** This parameter is required only for an inverted U-tube design when
** the two-region steam generator model is being implemented.
**
** It is the total composite flow area through the inside of all risers
** (standpipes), which reside above the tube bundle shroud (wrapper), in
** one steam generator.
**
** =================================================================
NRISER 19.0 // Dimensionless
**
** This parameter is required only for an inverted U-tube design when
** the two-region steam generator model is being implemented.
**
** It is the number of risers (standpipes), which reside above the tube
** bundle shroud (wrapper), in one steam generator.
**
** =================================================================
AUPDC 105.5 FT**2 // Units: [M**2,FT**2]
**
** This parameter is required only for an inverted U-tube design when
** the two-region steam generator model is being implemented.
**
** It is the flow area in the upper downcomer, which constitutes the region
** 2 flow area that surrounds the outside of the risers.
**
** The lower downcomer in region 2 constitutes the annulus between the
** outside of the tube bundle shroud and the inside of the shell wall.
** Its flow area is specified by parameter ASGDC.
**
** In MAAP, parameters AUPDC and ARISER are combined to yield an

** approximate flow area in the steam dome, which resides in region 2 above
** the primary separator elevation, parameter ZSEP. The steam dome
** contains the steam dryers (secondary moisture separators).
**
** ==================================================================
MSHD 1.10e5 LB // Units: [KG,LB]
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the total composite mass of the tube bundle shroud, risers
** (standpipes), and swirl vane separators (primary moisture separators).
**
** Basically, this is any structural mass the defines the boundary between
** region 1 (tube bundle) and region 2. See the MSHEL parameter
** description for a detailed discussion of the division of secondary side
** structual heat sinks among parameters MSHEL, MSHD, and MSGPHD.
**
** ==================================================================
ZDCOPN 0.98425 FT // Units: [M,FT]
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the height of the lower junction between regions 1 and 2. It is a
** vertically-oriented junction that is located between the bottom of the
** lower downcomer in region 2 and the bottom of the tube bundle in region
** 1. The elevation of this junction relative to the tubesheet is zero.
**
** This height is used to deterine if gas transport across the lower
** junction is possible. If the water level in both regions 1 and 2 is
** less then this height, then gas transport can occur across the junction.
** Otherwise, the junction is considered water-covered.
**
** ==================================================================
FCDSEP 11.97 // Dimensionless
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the loss coefficient associated with the pressure drop across the
** upper junction between regions 1 and 2. (See General Notes at the top
** of the *STEAM GENERATOR section for the formal definition of loss
** coefficient.)
**
** FCDSEP, along with loss coefficient parameter FCDSDC and the
** derived frictional losss through the lower downcomer and tube bundle,
** comprise the total frictional pressure loss that must be overcome by the
** net density difference that is driving the natural circulation between
** regions.
**
** For inverted U-tube designs, FCDSEP corresponds to the pressure drop
** incurred as secondary side fluid is transported across the swirl vane
** separators (primary moisture) separators. This is an empirical value

```
** that is a function of the separator geometry and the two-phase flow
** quality.  The recommended value is based upon nominal full-power
** operation with an exit flow quality specified by parameter FXOUT0.
**
** ==================================================================
FCDSDC        1.5          // Dimensionless
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the loss coefficient associated with the total pressure drop at:
**
** i)  the entrance to the lower downcomer at the lower-upper downcomer
**     transition, and
** ii) the exit from the lower downcomer at lower junction between
**     regions 1 and 2.
**
** (See General Notes at the top of the *STEAM GENERATOR section for the
** formal definition of loss coefficient.)
**
** A representative value can be obtained by modeling the entrance and exit
** as a sudden contraction and a sudden expansion at the ends of an
** orifice.  The frictional pressure drop within the downcomer itself is
** modeled separately.
**
** ==================================================================
FXOUT0        0.4          // Dimensionless
**
** This parameter is required only for an inverted U-tube design when
** the two-region steam generator model is being implemented.
**
** It is the vapor quality for the two-phase flow exiting the swirl vane
** separators (primary moisture separators) during nominal, full-power
** operation.
**
** FXOUT0 establishes the magnitude of the two-phase recirculation flow
** between regions 1 and 2.  Ultimately, this determines the empirical
** value of the pressure loss coefficient across the tube bundle.
**
** ==================================================================
CO            1.2          // Dimensionless
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the the lateral void distribution parameter, which is an empirical
** value within the two-phase drift flux model, for two-phase flow in
** region 1.
**
** In MAAP the drift flux model is used to determine the local void
** fraction within a two-phase flow, given the flow regime
** (churn-turbulent) and the superficial velocities of gas and liquid
** constituents.  Consult descriptions for subroutines VFAVBT, VFTAVG, and
** VFZ in the MAAP4 User's Manual for details regarding the usage of CO
```

** within the drift flux model.
**
** For churn-turbulent flow CO has an approximate empirical range from
** 1.0 to 1.5 with 1.2 being a nominal value.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
** ================================================================
COR2 1.2 // Dimensionless
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the lateral void distribution parameter, which is an empirical
** value within the two-phase drift flux model, for two-phase flow in
** region 2. See the description for parameter CO for details.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
** ================================================================
FRTDSG 1.0 // Dimensionless
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the fractional growth of the time step used for local integration
** with the two-region model.
**
** For the purpose of numerical stability, as with the MAAP global time
** step, this local time step should be inhibited from growing too rapidly
** between consecutive time steps. A nominal value of 100% is recommended.
** This allows the local time step to double between consecutive steps.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
** ================================================================
FRACSG 0.025 // Dimensionless
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the maximum fractional change over a single integration for
** thermal hydraulic variables that are integrated as part of the steam
** generator local integration. FRACSG is applicable to non-steady state
** operation, while parameter FRACSS is applicable to steady state

** operation.
**
** ================================================================
FRACSS 0.005 // Dimensionless
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the maximum fractional change over a single integration for
** thermal hydraulic variables that are integrated as part of the steam
** generator local integration. FRACSG is applicable to non-steady state
** operation while parameter FRACSS is applicable to steady state
** operation.
**
** ================================================================
F1FRAC 3.0 // Dimensionless
**
** This parameter is required for the two-region steam generator model
** only.
**
** Parameters F1FRAC and F2FRAC are shaping factors, which dictate the
** shape of the exponential function that governs the selection of the
** maximum allowable local steam generator time step within the range
** between parameters TDMAX and TDMXSS. Consult the description of
** parameter TDMXSS for full details.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
** ================================================================
F2FRAC 0.5 // Dimensionless
**
** This parameter is required for the two-region steam generator model
** only.
**
** Parameters F1FRAC and F2FRAC are shaping factors, which dictate the
** shape of the exponential function that governs the selection of the
** maximum allowable local steam generator time step within the range
** between parameters TDMAX and TDMXSS. Consult the description of
** parameter TDMXSS for full details.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
** @@@ 4.0.3 BJS 3/21/96 - Corrected the value of F2FRAC. It was
** mistyped as 5.0 in the draft User's Guide.
**
** ================================================================
TDMXSS 2.778e-4 HR // Units: [S,HR]
**

```
** This parameter is required for the two-region steam generator model
** only.
**
** It is the upper bound for the maximum time step for steam generator
** local integration.
**
** The maximum time step is determined prior to each local integration.  It
** ranges from TDMXSS to the MAAP global time step, specified by parameter
** TDMAX, and it is a smooth exponential function of the
** primary-to-secondary side power transferred across the tubes.  At steady
** state, the maximum time step is TDMXSS, and, as power decreases after
** scram, it smoothly approaches TDMAX.
**
** TDMXSS should be assigned a value that is less than or equal to TDMAX.
** This will restrict the local time steps to be small relative to TDMAX
** when the power transfer is high.  After scram, this restriction is
** relaxed as the power transfer diminishes.
**
**
*SI
** ==================================================================
TSUBMN          2.0  K          // Units: [K,F]
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the subcooling threshold above which a water pool is considered
** saturated.  It is expressed as a temperature difference below the
** saturation temperature.  If the pool subcooling is less than the
** subcooling specified by TSUBMN, then the pool is considered saturated.
**
** This parameter works in conjunction with parameter TSUBMX to provide
** some hysteresis in the transition of a pool from "saturated" to
** "subcooled" or vise versa.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files.  Its value remains
** unchanged from the previous revision.
**
** @@@ 4.0.3 BJS 3/21/96 - The values of TSUBMN and TSUBMX were changed
** from 3.6 F and 18.0 F.  They are temperature differentials, not absolute
** temperatures, but the units conversion routine interpreted them as
** absolute temperatures, resulting in incorrect values.  The conversion
** routine has subsequently been updated to interpret these variables as
** temperature differentials.
**
** ==================================================================
TSUBMX          10.0  K          // Units: [K,F]
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the subcooling threshold below which a water pool is considered
```

** subcooled. Like TSUBMN, it is expressed as a temperature difference
** below the saturation temperature. If the pool subcooling is greater
** than the subcooling specified by TSUBMN, then the pool is considered
** subcooled.
**
** This parameter works in conjunction with parameter TSUBMN to provide
** some hysteresis in the transition of a pool from "saturated" to
** "subcooled" or vise versa.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
**
*BR
** ==============================================================
FRPDEL 0.01 // Dimensionless
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the fraction which, when multiplied by the pressure in region 1
** or region 2, yields a pressure differential that is small relative to
** the region pressure. This small pressure differential is used to
** determine approximations for thermodynamic derivatives (dP/dv for
** instance) at the region pressure.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
** ==============================================================
WSG0HL 0.0 LB/HR // Units: [KG/S,LB/HR]
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is the initial secondary side steam generation rate during a
** half-loop sequence.
**
** Generally, this rate is trivial since the reactor is in cold shutdown
** mode and residual heat removal systems may be enabled to remove
** decay power.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
** ==============================================================
FVLEQH 0.92 // Dimensionless
**

** This parameter is required for the two-region steam generator model
** only.
**
** It is a threshold fraction of the region 1 fluid volume. If more than
** this fraction of the region 1 fluid volume is occupied by water, then
** region 1 is nearly full and is approaching a "solid" conditions. This
** indicates to MAAP that a minimum gas volume must be maintained in region
** 1. This is similar to the use of parameter VOLP to maintain a minimum
** gas volume in region 2. Failure to maintain a gas volume in region 1
** and the subsequent initiation of solid conditions will result in
** performance difficulties for the two-region model.
**
** FVLEQH works in conjunction with FVLEQL to add some hysteresis to the
** criterion that decides if region 1 is nearly full.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
** ==================================================================
FVLEQL 0.88 // Dimensionless
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is a threshold fraction of the region 1 fluid volume. If less than
** this fraction of the region 1 fluid volume is occupied by water, then
** region 1 is NOT nearly full. This indicates to MAAP that the region 1
** gas volume is larger than the minimum required.
**
** FVLEQL works in conjunction with FVLEQH to add some hysteresis to the
** criterion that decides if region 1 is nearly full. See the description
** for parameter FVLEQH.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
** ==================================================================
PDELMN 0.435 PSI // Units: [PA,PSI]
**
** This parameter is required for the two-region steam generator model
** only.
**
** It is a threshold pressure differential. If the difference between the
** fluid static heads in region 1 and region 2 is less than this threshold,
** then the water flow at the lower junction between the regions is
** determined by a simple manometer calculation rather than the full
** momentum equation.
**
** Normally, natural circulation between regions is determined by the
** momentum equation for the recirculation loop. However, if the static

```
** head driving the circulation is below PDELMN, then the frictional
** pressure drop, particularly in the tube bundle, is assumed to be
** trivial, and a hydrostatic balance exist between the regional water
** pools. Therefore, the relatively minor flow at the lower junction can
** be determined from the manometer balance calculation.
**
** @@@ 4.0.3 CEH 11/27/95
** Note: This is an existing parameter that was not included in previous
** revision (4.0.2) of the sample parameter files. Its value remains
** unchanged from the previous revision.
**
** =================================================================
**              Auxiliary Feedwater (AFW) Systems
** =================================================================
**
** Notes:
**
** 1) The following set of parameters are generic to the motor-driven and
**    turbine-driven AFW systems, in contrast to the following two
**    parameter sets below, which are specific to motor-driven or
**    turbine-driven AFW.
**
** 2) These generic AFW parameters generally refer to the condensate
**    storage tank (CST), from which the AFW systems derive their suction,
**    and static water heads within CST and AFW piping, which will
**    influence the pressure differential and subsequent water flow rate
**    across the AFW pump.
**
** =================================================================
MWCST0      1.0e10  LB      // Units: [KG,LB]
**
** This parameter is the initial water mass in the condensate storage tank
** (CST). This can also be considered the total water mass available for
** the prevailing (motor- or turbine-driven) auxiliary feedwater (AFW)
** system. AFW flow ceases when this water mass is depleted.
**
** An excessively large value can be specified (typically 1.0E10 in either
** set of units) if there is no limit on the AFW supply. Note, however,
** that the resulting CST water level is used, in conjunction with
** parameters ZCSTAF and ZSGAFW, to determine the net pressure differential
** (head) across the pump. Therefore, a proportional increase in parameter
** ACST, the cross sectional area of the CST, should be made to achieve a
** reasonable CST water level.
**
** =================================================================
ACST        361.42  FT**2    // Units: [M**2,FT**2]
**
** This parameter is the area of the base of the Condensate Storage Tank
** (CST). It is used to compute the CST water level, which is used with
** parameters ZCSTAF and ZSGAFW to determine the net pressure differential
** (head) across the AFW pump.
**
** @@@ 4.0.3 CEH 12/6/95
** Note: This parameter was moved here from the *ENGINEERED
```

** SAFEGUARDS parmeter section.
**
**
** ==================================================================
ZCSTAF 38.04 FT // Units: [M,FT]
**
** This parameter is the elevation of the bottom of the condensate storage
** tank relative to the AFW pump inlet. The static water head
** corresponding to this elevation contributes to the calculation of the
** pressure differential across the AFW pump, which is required to
** determine the AFW flow rate from the pump head-flow curve. Therefore,
** negative values are acceptable.
**
** @@@ 4.0.3 CEH 12/6/95
** Note: This parameter was moved here from the *ENGINEERED
** SAFEGUARDS parmeter section.
**
** ==================================================================
ZSGAFW 83.37 FT // Units: [M,FT]
**
** This parameter is the elevation of AFW spray header within the steam
** generator, relative to the AFW pump outlet. The static water head
** corresponding to this elevation contributes to the calculation of the
** pressure differential across the AFW pump, which is required to
** determine the AFW flow rate from the pump head-flow curve. Therefore,
** negative values are acceptable.
**
** @@@ 4.0.3 CEH 12/6/95
** Note: This parameter was moved here from the *ENGINEERED
** SAFEGUARDS parmeter section.
**
** ==================================================================
** Motor-Driven Auxiliary Feedwater (AFW) System
** ==================================================================
**
** @@@ 4.0.3 CEH 12/6/95 The Motor-Driven Auxiliary Feedwater System was
** moved here from the *ENGINEERED SAFEGUARDS parameter section.
**
** Notes:
**
** 1) The following set of parameters pertain to the motor-driven AFW
** system. Note, MAAP assumes that there is one motor-driven AFW
** pump per steam generator.
**
** 2) To use the constant flow model for the pump head-flow curve, set
** parameter NAFWPT to 1, parameter WVAFW(1) to the constant volumetric
** flowrate, and parameter ZHDAFW(1) to some reasonable nominal value.
**
** 3) If the motor-driven AFW system head-flow curve information is not
** available, use the associated pump head-flow curve, but be aware
** that the pump head-flow curve will over-predict system flow since
** line friction losses are not considered.
**
**

```
** ====================================================================
NAFWPT          5          // Dimensionless
**
** This parameter is the number of points in the motor-driven auxiliary
** feedwater (AFW) pump head-flow curve (maximum of 5).
**
** ========================================================================
** Name: WVAFW(1:5)             Units: [M**3/S,GPM]
**
** WVAFW is a one dimensional array with the number of data points
** specified by NAFWPT, and it represents volumetric flowrate entries in
** the AFW pump head-flow curve.  Each flow value has a corresponding head
** value defined in the ZHDAFW(I) array.  The head-flow curve is
** conventionally configured such that flow increases, and head decreases,
** from WVAFW(1) TO WVAFW(5), but this configuration is not required.
**
WVAFW(1)     250.15  GPM
WVAFW(2)     290.30  GPM
WVAFW(3)     315.35  GPM
WVAFW(4)     338.20  GPM
WVAFW(5)     379.15  GPM
**
** ========================================================================
** Name: ZHDAFW(1:5)            Units: [M,FT]
**
** ZHDAFW is a one dimensional array with the number of data points
** specified by NAFWPT, and it represents the head (across the pump)
** entries in the AFW pump head-flow curve.  Each head value has a
** corresponding flow value defined in the WVAFW(I) array.  The head-flow
** curve is conventionally configured such that head decreases, and flow
** increases, from ZHDAFW(1) TO ZHDAFW(5), but this configuration is not
** required.
**
ZHDAFW(1)    2834.1  FT
ZHDAFW(2)    2342.2  FT
ZHDAFW(3)    1990.9  FT
ZHDAFW(4)    1639.6  FT
ZHDAFW(5)     936.9  FT
**
** ========================================================================
**        Steam Turbine-Driven Auxiliary Feedwater (AFW) System
** ========================================================================
**
** @@@ 4.0.3 CEH 12/6/95  The Turbine-Driven Auxiliary Feedwater System was
** moved here from the *GENERALIZED ENGINEERED SAFEGUARDS parameter section.
**
** Notes:
**
** 1)  The following set of parameters pertain to the turbine-driven AFW
**     system.  Note, MAAP assumes that there is one turbine-driven AFW
**     pump per steam generator.
**
** 2)  To use the constant flow model for both the pump and the steam
**     turbine head-flow curves, set parameter NIPTS to 1, parameters
```

```
**    WSTSGT(1) and WWTDFW(1) to the appropriate constant values for the
**    respective mass flow rates, and parameter PSG(1) to a reasonable
**    nominal value.
**
** 3) The turbine-driven AFW will not function if the motor-driven AFW is
**    working. Therefore, to use the turbine-driven AFW, turn off the
**    motor-driven AFW. (To perform this action, utilize the corresponding
**    event code in the *EVTMES parameter section.)
**
** 4) The turbine-driven AFW does not require power. The motor-driven AFW
**    does require power.
**
** 5) If the turbine-driven AFW system head-flow curve information is not
**    available, use the associated pump head-flow curve, but be aware
**    that the pump head-flow curve will over-predict system flow since
**    line friction losses are not considered.
**
** ======================================================================
NIPTS        0        // Dimensionless
**
** This parameter is the number of points in the turbine-driven auxiliary
** feedwater (AFW) pump head-flow curve and the AFW turbine's steam
** extraction flow curve (maximum of 5).
**
** ======================================================================
** Name: PSG(1:5)            Units: [PA,PSI]
**
** PSG is a one dimensional array with the number of data points specified
** by NIPTS. Each array element represents the steam generator secondary
** side pressure that is driving gas through the AFW turbine at the mass
** flow rate specified in the corresponding element of the WSTSGT array.
**
PSG(1)       0.0  PSI
PSG(2)       0.0  PSI
PSG(3)       0.0  PSI
PSG(4)       0.0  PSI
PSG(5)       0.0  PSI
**
** ======================================================================
** Name: WSTSGT(1:5)         Units: [KG/S,LB/HR]
**
** WSTSGT is a one dimensional array with the number of data points
** specified by NIPTS. Each array element represents the gas mass flow
** rate being driven through the AFW turbine by the steam generator secondary
** side pressure specified in the corresponding element of the PSG array.
**
WSTSGT(1)     0.0  LB/HR
WSTSGT(2)     0.0  LB/HR
WSTSGT(3)     0.0  LB/HR
WSTSGT(4)     0.0  LB/HR
WSTSGT(5)     0.0  LB/HR
**
** ======================================================================
** Name: WWTDFW(1:5)         Units: [KG/S,LB/HR]
```

**
** WWTDFW is a one dimensional array with the number of data points
** specified by NIPTS. Each array element represents the water mass flow
** rate through the turbine-driven AFW pump when the steam generator
** secdondary side pressure is at the value specified in the corresponding
** element of the PSG array.
**

| | | |
|---|---|---|
| WWTDFW(1) | 0.0 | LB/HR |
| WWTDFW(2) | 0.0 | LB/HR |
| WWTDFW(3) | 0.0 | LB/HR |
| WWTDFW(4) | 0.0 | LB/HR |
| WWTDFW(5) | 0.0 | LB/HR |

**
****************************************************************************
*Engineered Safeguards
****************************************************************************
*BR
**
** This parameter section is used for setting up the MAAP specific
** engineered safeguard systems. The user has the choice of either using
** the MAAP specific or the MAAP generalized engineered safeguard systems.
** The choice between the two is defined by the parameter NESF. When NESF
** is set to 0, the MAAP specific engineered safeguard systems will be used
** and only this parameter section is used. When NESF is set to 1, the
** MAAP generalized engineered safeguard systems will be used and this
** parameter section along with *Generalized Engineered Safeguards and
** *Pump parameter sections are used.
**
** The term generalized engineered safeguards is somewhat misleading as the
** distinction between the generalized and specific engineered safeguards
** relates only to the pump lineups, pump curves, and heat exchangers
** capabilities, not the engineered safeguard systems itself. The MAAP
** specific engineered safeguard option has very specific pump lineups and
** pump curves and may or may not have heat exchangers capabilities
** depending on the *Control parameters IRECIR and IDISCH for the
** engineered safeguard systems. The generalized engineered safeguards
** option, on the other hand, allows the users the freedom to model the
** desired pump lineup (e.g., pump suction/discharge locations), several
** distinct pump head curves for the same system, model NPSH enhancement
** flows, and optional heat exchangers for the same set of engineered
** safeguards systems.
**
** With the preceding in mind, if the generalized option is used, only the
** pump head curve and heat exchanger input parameters in this parameter
** section is superseded by equivalent pump head curve and heat exchanger
** options in the *Generalized Parameter Section. Otherwise, if the
** specific option is used, the pump head curve and heat exchanger input
** parameters in this parameter section is required. In any event, the
** input parameters that are not used when the generalized option is
** selected will be clearly identified.
**
** See subroutine writeups ENGSAF and AUXESF for further information about
** the engineered safeguards systems, both for primary system and
** containment. Also see subroutine writeup GENESF for further information

** about the generalized engineered safeguard system capabilites.
**
** Note that the MAAP code does not know if injection source is upstream or
** downstream of a pipe break. As a result, all injection sources are
** assumed to go into the vessel instead of directly out the break and when
** the vessel water level is high enough, water will flow out the break.
**
** This parameter section requires inputs for the following list of
** engineered safeguards systems:
**
** Containment Sump
**
** Refueling Water Storage Tank
**
** Cold Leg Accumulators
**
** Upper Head Injection Accumulators
**
** Charging Pumps
**
** High Pressure Injection (HPI)
**
** Low Pressure Injection (LPI)
**
** Upper (A) and Lower (B) Containment Sprays
**
** Containment Spray Heat Exchangers
**
** LPI Residual Heat Removal (RHR) Containment Spray and Heat Exchangers
**
** Containment Fan Coolers
**
** Containment Chillers
**
** Cavity Water Injection System
**
** Boron Injection for MAAP4 Specific Engineered Safeguards
**
** Flowrates specified to be volumetric should be M**3/S in SI units and
** GPM in British units. If unit labels are explictly specified, FT**3/HR
** is allowed.
**
** For better accuracy, user may elect to input "system" pump head curves
** which include the effects of friction in the inlet and outlet piping
** (which is ignored in MAAP). In doing so, be sure the assumptions on
** static head which are used in their calculation are consistent with the
** pump elevation, etc. which are input below--this is generally a factor
** only in critical applications such as feed and bleed where the charging
** pump injection flow may or may not be sufficient to match core decay
** heat.
**
** Note: In the case of injection when there is a break, the injected flow
** is assumed to go the vessel rather than directly out the break. Then,
** if the water level is high enough, water will flow out the break, i.e.

** the code does not know if the injection is up or down stream of a break.
**
** Possible data sources are:
**
** 1) ESF piping specifications and/or layout drawings
**
** 2) Plant FSAR - ESF section
**
** 3) Operator Training Manual - ESF section
**
** 4) Plant operating surveillance data
**
** 5) RWST construction drawings
**
** 6) Accumulator specification data
**
** 7) Accumulator assembly drawings
**
** 8) CHP Pre-Op, startup, or in-service performance test records
**
** 9) CHP pump specification data (Manufacturer's performance
** test documentation)
**
** 10) HPI Pre-Op, startup, or in-service performance test records
**
** 11) HPI pump specification data (Manufacturer's performance
** test documentation)
**
** 12) LPI Pre-Op, startup, or in-service performance test records
**
** 13) LPI pump specification data (Manufacturer's performance
** test documentation)
**
** 14) Plant FSAR - CVCS sections
**
** 15) Operator Training Manual - CVCS sections
**
** 16) Spray nozzle specification data
**
** 17) Spray pump Pre-Op, startup, or in-service performance test records
**
** 18) Spray pump specification data (Manufacturer's performance
** test documentation)
**
** 19) Spray heat exchanger specification data
**
** 20) LPI (RHR) or ESF heat exchanger specification data
**
** 21) Fan Cooler or Chiller specification data
**
** 22) Plant FSAR - Containment HVAC sections
**
** 23) Operator Training Manual - Containment HVAC sections
**

** 24) Containment section, elevation, and/or structural drawings
**
**
==================================================================
**
==================================================================
** Containment Sump
**
** *Pointer parameters JNCSMP and JNASMP identifies the containment
** compartments containing the lower and annular containment sumps,
** respectively, which provides the water source for pumps in recirculation
** mode taking suction from these compartments. The next two parameters,
** ACS and ZCS, are primarily used for providing geometric information in the
** MAAP4GRAAPH graphical picture.
**
** @@@ 4.0.3 MAM 12/14/94 The containment sump should be explicitly
** modeled as a part of the compartment volume vs height (VRBLK vs XRBLK)
** lookup tables in the *Auxiliary parameter section if the volume of the
** sump is to be accounted for.
**
**
==================================================================
ACS 162.5 FT**2 // Units: [M**2,FT**2]
**
** This parameter is the area of the base of the containment sump. It is
** used to compute water level in the sump.
**
** ==================================================================
ZCS 0.0833 FT // Units: [M,FT]
**
** This parameter is the depth of the base of the containment sump. It is
** used to compute water level in the sump.
**
** ==================================================================
** ==================================================================
** Refueling Water Storage Tank
**
** The RWST is the water source for the charging, HPI, LPI, and containment
** spray systems during the injection phase.
**
** ==================================================================
TRWST 85.0 F // Units: [K,F]
**
** This parameter is the refueling water storage tank (RWST) liquid
** temperature. Specifying a typical or conservatively high outside air
** temperature value is recommended.
**
** ==================================================================
MRWST0 3.28e6 LB // Units: [KG,LB]
**
** This parameter is the refueling water storage tank (RWST) initial water
** mass.
**
** ==================================================================

```
ARWST        1254.02  FT**2      // Units: [M**2,FT**2]
**
** This parameter is the area of the base of refueling water storage tank
** (RWST).  It is used to compute RWST water level.
**
** ========================================================================
WRWSTX          0.0  LB/HR      // Units: [KG/S,LB/HR]
**
** This parameter is the mass flow rate of external RWST replacement water,
** if any.  This variable is used for any water transfer system available
** for makeup to the RWST, and may include such facilities as the fire
** water system or a fire truck.  The external RWST makeup flow must be
** activated manually via MAAP Event Code #237.
**
** ========================================================================
** ========================================================================
** Cold Leg Accumulators
** ========================================================================
NACUM            4            // Dimensionless
**
** This parameter is the number of operational cold leg accumulators
**
** ========================================================================
PACUM0       646.19  PSI      // Units: [PA,PSI]
**
** Parameter PACUM0 is the initial pressure of the cold leg accumulators.
**
** ========================================================================
TACUM        110.0  F        // Units: [K,F]
**
** This parameter is the cold leg accumulator water temperature. Specifying
** a typical or conservatively high containment air temperature value is
** recommended in the absence of a documented value for this variable.
**
** ========================================================================
MACUM0       6.52e4  LB       // Units: [KG,LB]
**
** This parameter is the initial water mass in each cold leg accumulator.
**
** ========================================================================
VACUM        1350.0  FT**3     // Units: [M**3,FT**3]
**
** This parameter is the total fluid (water and gas) volume of one cold leg
** accumulator.
**
** ========================================================================
XLACUM         70.0  FT       // Units: [M,FT]
**
** This parameter is the equivalent length of one cold leg accumulator pipe
** from the accumulator the to injection nozzle.  The equivalent length
** should have the friction losses accounted for.
**
** ========================================================================
XDACUM         0.73  FT       // Units: [M,FT]
```

```
**
** This parameter is the cold leg accumulator inside pipe diameter.
**
** ====================================================================
** ====================================================================
** Upper Head Injection (UHI) Accumulators
**
** MAAP only models one Upper Head Injection (UHI) tank.  If there is more
** than one UHI accumulator tank, then scale the UHI parameters accordingly
** to get the correct flow rate for the UHI system.
**
**
=======================================================================
VUHI          0.0  FT**3      // Units: [M**3,FT**3]
**
** Parameter VUHI is the total UHI accumulators volume (water and gas).  If
** this system is not to be modeled, enter a value of zero.
**
** ====================================================================
MUHI0         0.0  LB         // Units: [KG,LB]
**
** Parameter MUHI is the initial water mass in the upper head injection
** (UHI) water accumulator.  If there is more than one UHI accumulator,
** specify the total amount of mass in all accumulators in parameter muhi0
**
** ====================================================================
XLUHI         0.0  FT         // Units: [M,FT]
**
** Parameter XLUHI is the length of the UHI pipe from the accumulator to
** the reactor vessel head.
**
**
=======================================================================
XDUHI         0.0  FT         // Units: [M,FT]
**
** Parameter XDUHI is the inside diameter of the UHI pipe.
**
**
=======================================================================
PUHI0         0.0  PSI        // Units: [PA,PSI]
**
** Parameter PUHI0 is the initial pressure of the UHI accumulator.
**
** ====================================================================
PDUHI         0.0  PSI        // Units: [PA,PSI]
**
** Parameter PDUHI is the failure differential pressure of the UHI pipe
** rupture disk.
**
** ====================================================================
** ====================================================================
** ====================================================================
ZWPZMU        70.00  FT       // Units: [M,FT]
**
```

** Parameter ZWPZMU is the pressurizer level setpoint for makeup control
** system. See related *Primary System parameters WWMU0, TWMU, and WWLET0.
** It is referenced to the bottom of the pressurizer. Users can specify a
** large value, typically 1.0e10 in either set of units, to avoid
** controlling the makeup and/or charging pump flow on pressurizer level.
** MAAP's makeup controller model does not affect HPI or LPI flow rates.
**
** ======================================================================
** The next three parameters: ZESPRW, ZESPCS, and ZESPSI are only used for
** the MAAP specific engineered safeguard systems.
**
** ======================================================================
ZESPRW 48.21 FT // Units: [M,FT]
**
** This parameter is the height of bottom of RWST above the ESF pumps.
** MAAP assumes that all pumps are at the same elevation for head
** calculations. If the actual pump elevations vary, the conservative
** approach is to specify the smallest of the vertical distances involved
** for this variable. It is not used if NESF = 1.
**
** ======================================================================
ZESPCS 24.98 FT // Units: [M,FT]
**
** This parameter is the height of bottom of containment sump above the ESF
** pumps. MAAP assumes that all pumps are at the same elevation for head
** calculations. If the actual pump elevations vary, the conservative
** approach is to specify the smallest of the vertical distances involved
** for this variable. Negative values are permissible. It is not used if
** NESF = 1.
**
** ======================================================================
ZESPSI 0.0 FT // Units: [M,FT]
**
** Parameter ZESPSI is the height of the reactor vessel injection nozzles
** above the SI pumps (LPI, HPI, and CHP). MAAP assumes that all pumps are
** at the same elevation for head calculations. If the actual pump
** elevations vary, the conservative approach is to specify the largest of
** the vertical distances involved for this variable. It is not used if
** NESF = 1.
**
**
=========================================================================
**
=========================================================================
** Charging Pumps
**
=========================================================================
PCHP0 1859.69 PSI // Units: [PA,PSI]
**
** This parameter is the charging pump (CHP) pressure setpoint. The
** charging pumps are activated when primary system pressure falls below
** the value specified for this variable.
**
** ======================================================================

TDCHP 0.0075 HR // Units: [S,HR]
**
** This parameter is the time delay for CHP start once an initiation signal
** has been received. MAAP models the start of the CHP system as a step
** function. After the initiation signal is received for CHP, MAAP waits
** an amount of time specified by TDCHP after which it starts CHP at the
** flow calculated from the CHP head-flow curve using variables ZHDCHP(1)
** and WVCHP(). Prior to this time the CHP flow remains at zero.
**
** ======================================================================
WCHPX 1.e9 LB/HR // Units: [KG/S,LB/HR]
**
** Parameter WCHPX is the total (for all pumps) limiting mass flow rate for
** the CHP system. It is used to throttle the CHP system flow rates at
** values lower than those called for by their head-flow curves. MAAP will
** use the minimum of the throttled flow and that calculated from the
** head-flow curves and the number of pumps in operation. To avoid
** throttling the mass flow, specify a large value, typically 1.0e10 in
** either set of units. Note that the amount of throttling can be changed
** by using MAAP input file local parameter changes, functions, or lookup
** tables.
**
** ======================================================================
** The rest of the input parameters for the charging pumps: NCHP, NCHPPT,
** ZHDCHP(1:5), WVCHP(1:5), and ZHDRCH(1:5) are only used for the MAAP
** specific engineered safeguard systems, e.g., when NESF = 0.
**
** ======================================================================
NCHP 2 // Dimensionless
**
** This parameter is the number of operational charging pumps.
**
** ======================================================================
NCHPPT 5 // Dimensionless
**
** This parameter is the number of points used in charging pump head-flow.
** Up to a maximum of 5 is allowed.
**
** ======================================================================
** Name: ZHDCHP(1:5) Units: [M,FT]
**
** This parameter is the highest head (m) in CHP pump head-flow curve. It
** is the shut-off head measured across the pump. ZHDCHP(I) is a one
** dimensional array with the number of data points specified by NCHPPT,
** and represents the pressure portion of the CHP head-flow curve for the
** system. Each head value has a corresponding volumetric flow rate
** defined in the one dimensional WVCHP(I) array below. If the system flow
** curve information is not available, use the pump flow curve, but be
** aware that the pump flow curve will over-predict system flow since line
** friction losses are not considered. MAAP initiates injection when the
** primary system pressure falls below the pump shut-off head.
**
ZHDCHP(1) 5930.24 FT
ZHDCHP(2) 4308.88 FT

ZHDCHP(3) 2919.14 FT
ZHDCHP(4) 1529.41 FT
ZHDCHP(5) 0.00 FT
**
**
=====================================================================
** Name: WVCHP(1:5) Units: [M**3/S,GPM]
**
** This parameter is the volumetric flowrate in CHP pump head-flow curve.
** It corresponds to the shut-off head, and must be 0.0 unless NCHPPT is
** set to 1 for a single-point (constant flow) representation. To use the
** constant flow model, a large head value should be specified for
** ZHDCHP(1).
**
WVCHP(1) 0.0 GPM
WVCHP(2) 177.5 GPM
WVCHP(3) 265.4 GPM
WVCHP(4) 317.3 GPM
WVCHP(5) 364.0 GPM
**
**
=====================================================================
** Name: ZHDRCH(1:5) Units: [M,FT]
**
** This parameter is the i'th Net Positive Suction Head (NPSH) (m) required
** for CHP. The elements of this array correspond to those of ZHDCHP() and
** WVCHP().
**
** For required NPSH data, the flow rate values specified for the head-flow
** curves are assumed to correspond to the NPSH head variables that follow.
** NPSH values are unimportant unless the inlet lines, etc. are configured
** in such a way that cavitation can occur. Should this take place, MAAP
** will continue to operate the pump(s) involved, however there will be no
** discharge flow until the NPSH requirements are satisfied.
**
ZHDRCH(1) 10.0 FT
ZHDRCH(2) 11.0 FT
ZHDRCH(3) 13.0 FT
ZHDRCH(4) 14.0 FT
ZHDRCH(5) 15.0 FT
**
** ===================================================================
** ===================================================================
** High Pressure Injection (HPI)
** ===================================================================
PHPI0 1859.69 PSI // Units: [PA,PSI]
**
** This parameter is the pressure setpoint for high pressure vessel
** injection (HPI). HPI is activated when primary system pressure falls
** below the value specified here. Assign a small number if the plant does
** not have a HPI system.
**
** ===================================================================
TDHPI 7.5e-3 HR // Units: [S,HR]

```
**
** This parameter is the time delay for HPI start once an initiation signal
** has been received. MAAP models the start of the HPI system as a step
** function. After the initiation signal is received for HPI, MAAP waits
** an amount of time specified by TDHPI after which it starts HPI at the
** flow calculated from the HPI head-flow curve using variables ZHDHPI()
** and WVHPI(). Prior to this time the HPI flow remains at zero.
**
** ======================================================================
WHPIX        1.e9  LB/HR     // Units: [KG/S,LB/HR]
**
** Parameter WHPIX is the total (for all pumps) limiting mass flow rate for
** the HPI system. It is used to throttle the HPI system flow rates at
** values lower than those called for by their head-flow curves. MAAP will
** use the minimum of the throttled flow and that calculated from the
** head-flow curves and the number of pumps in operation. To avoid
** throttling the mass flow, specify a large value, typically 1.0e10 in
** either set of units. Note that the amount of throttling can be changed
** by using MAAP input file local parameter changes, functions, or lookup
** tables.
**
** ======================================================================
** The rest of the input parameters for the high pressure injection system:
** NHPI, NHPIPT, ZHDHPI(1:5), WVHPI(1:5), and ZHDRHP(1:5) are only used for
** the MAAP specific engineered safeguard systems, e.g., when NESF = 0.
**
** ======================================================================
NHPI          2          // Dimensionless
**
** This parameter is the number of operational HPI pumps.
**
** ======================================================================
NHPIPT        5          // Dimensionless
**
** This parameter is the number of points used in HPI pump head-flow curve.
** Up to a maximum of 5 is allowed.
**
** ======================================================================
** Name: ZHDHPI(1:5)          Units: [M,FT]
**
** This parameter is the highest head (m) in HPI pump head-flow curve. It
** is the shut-off head measured across the pump. ZHDHPI(I) is a one
** dimensional array with the number of data points specified by NHPIPT,
** and represents the pressure portion of the HPI head-flow curve for the
** system. Each head value has a corresponding volumetric flow rate
** defined in the one dimensional WVHPI(I) array below. If the system flow
** curve information is not available, use the pump flow curve, but be
** aware that the pump flow curve will over-predict system flow since line
** friction losses are not considered. MAAP initiates injection when the
** primary system pressure falls below the pump shut-off head.
**
ZHDHPI(1)   3587.84  FT
ZHDHPI(2)   2892.97  FT
ZHDHPI(3)   1966.48  FT
```

ZHDHPI(4) 1039.99 FT
ZHDHPI(5) 0.0 FT
**
**
=========================================================================
** Name: WVHPI(1:5) Units: [M**3/S,GPM]
**
** This parameter is the volumetric flowrate in HPI pump head-flow curve.
** It corresponds to the shut-off head, and must be 0.0 unless NHPIPT is
** set to 1 for a single-point (constant flow) representation. To use the
** constant flow model, a large head value should be specified for
** ZHDHPI(1).
**
WVHPI(1) 0.0 GPM
WVHPI(2) 154.7 GPM
WVHPI(3) 249.1 GPM
WVHPI(4) 314.9 GPM
WVHPI(5) 373.0 GPM
**
**
=========================================================================
** Name: ZHDRHP(1:5) Units: [M,FT]
**
** This parameter is the Net Positive Suction Head (NPSH) (m) required for
** HPI. The elements of this array correspond to those of ZHDHPI() and
** WVHPI().
**
ZHDRHP(1) 8.0 FT
ZHDRHP(2) 8.0 FT
ZHDRHP(3) 8.0 FT
ZHDRHP(4) 11.0 FT
ZHDRHP(5) 13.0 FT
**
** =======================================================================
** =======================================================================
** Low Pressure Injection (LPI)
** =======================================================================
PLPI0 1859.69 PSI // Units: [PA,PSI]
**
** This parameter is the pressure setpoint for low pressure vessel
** injection (LPI). LPI is activated when primary system pressure falls
** below the value specified by parameter PLPI0.
**
** =======================================================================
TDLPI 7.5e-3 HR // Units: [S,HR]
**
** This parameter is the time delay for LPI start once an initiation signal
** has been received. MAAP models the start of the LPI system as a step
** function. After the initiation signal is received for LPI, MAAP waits
** an amount of time specified by TDLPI after which it starts LPI at the
** flow calculated from the LPI head-flow curve using variables ZHDLPI()
** and WVLPI(). Prior to this time the LPI flow remains at zero.
**
** =======================================================================

WLPIX 1.e9 LB/HR // Units: [KG/S,LB/HR]
**
** Parameter WLPIX is the total (for all pumps) limiting mass flow rate for
** the LPI system. It is used to throttle the LPI system flow rates at
** values lower than those called for by their head-flow curves. MAAP will
** use the minimum of the throttled flow and that calculated from the
** head-flow curves and the number of pumps in operation. To avoid
** throttling the mass flow, specify a large value, typically 1.0e10 in
** either set of units. Note that the amount of throttling can be changed
** by using MAAP input file local parameter changes, functions, or lookup
** tables.
**
** ==========================================================================
** The rest of the input parameters for the low pressure injection system:
** NLPI, NLPIPT, ZHDLPI(1:5), WVLPI(1:5), and ZHDRLP(1:5) are only used for
** the MAAP specific engineered safeguard systems, e.g., when NESF = 0.
**
** ==========================================================================
NLPI 2 // Dimensionless
**
** This parameter is the number of operational LPI pumps.
**
**
==========================================================================
NLPIPT 5 // Dimensionless
**
** This parameter is the number of points used in LPI pump head-flow curve.
** Up to a maximum of 5 is allowed.
**
** ==========================================================================
** Name: ZHDLPI(1:5) Units: [M,FT]
**
** This parameter is the highest head (m) in LPI pump head-flow curve. It
** is the Shut-off head measured across the pump. ZHDLPI(I) is a one
** dimensional array with the number of data points specified by NLPIPT,
** and represents the pressure portion of the LPI head-flow curve for the
** system. Each head value has a corresponding volumetric flow rate
** defined in the one dimensional WVLPI(I) array below. If the system flow
** curve information is not available, use the pump flow curve, but be
** aware that the pump flow curve will over-predict system flow since line
** friction losses are not considered. MAAP initiates injection when the
** primary system pressure falls below the pump shut-off head.
**
ZHDLPI(1) 330.29 FT
ZHDLPI(2) 260.81 FT
ZHDLPI(3) 145.00 FT
ZHDLPI(4) 87.09 FT
ZHDLPI(5) 0.00 FT
**
**
==========================================================================
** Name: WVLPI(1:5) Units: [M**3/S,GPM]
**
** This parameter is the volumetric flowrate in LPI pump head-flow curve.

```
** It corresponds to the shut-off head, and must be 0.0 unless NLPIPT is
** set to 1 for a single-point (constant flow) representation. To use the
** constant flow model, a large head value should be specified for
** ZHDLPI(1).
**
WVLPI(1)      0.00  GPM
WVLPI(2)   1463.30  GPM
WVLPI(3)   2433.10  GPM
WVLPI(4)   2834.65  GPM
WVLPI(5)   3342.98  GPM
**
**
===========================================================================
** Name: ZHDRLP(1:5)          Units: [M,FT]
**
** This parameter is the Net Positive Suction Head (NPSH) (m) required
** for LPI. The elements of this array correspond to those of ZHDLPI() and
** WVLPI().
**
ZHDRLP(1)    10.0  FT
ZHDRLP(2)    10.0  FT
ZHDRLP(3)    10.0  FT
ZHDRLP(4)    11.0  FT
ZHDRLP(5)    14.0  FT
**
** ========================================================================
** ========================================================================
** Containment Sprays (Upper - A and Lower - B)
** ========================================================================
PSP0        17.69  PSI      // Units: [PA,PSI]
**
** This parameter is the pressure setpoint for the containment sprays. The
** sprays are initiated when the containment pressure exceeds the value
** assigned to this variable.
**
** @@@ 4.0.1 BJS 2/8/95  PSP0 is for upper compt, lower compt and RHR
** sprays (not for constant flow (fire) sprays).
**
** ========================================================================
TDSPA       0.0125  HR      // Units: [S,HR]
**
** This parameter is the time delay for containment upper compartment (A)
** sprays. MAAP models the start of the containment spray system as a step
** function. After the initiation signal is received for the upper
** compartment sprays, MAAP waits an amount of time specified by TDSPA
** after which it starts the sprays at the flow calculated from the spray
** pump head-flow curve using variables ZHDSP() and WVSP(). Prior to this
** time the spray flow remains at zero. Note that the value specified for
** this variable should include the time required to fill the header.
**
** @@@ 4.0.1 BJS 2/8/95  TDSPA and TDSPB are for generalized and "hardwired"
** upper and lower compt. spray models (not for constant flow (fire) sprays).
**
** ========================================================================
```

TDSPB 0.0 HR // Units: [S,HR]
**
** This parameter is the time delay for containment lower compartment (B)
** sprays. MAAP models the start of the containment spray system as a step
** function. After the initiation signal is received for the lower
** compartment sprays, MAAP waits an amount of time specified by TDSPB
** after which it starts the sprays at the flow calculated from the spray
** pump head-flow curve using variables ZHDSP() and WVSP(). Prior to this
** time the spray flow remains at zero. Note that the value specified for
** this variable should include the time required to fill the header.
**
** ==========================================================================
XDSP 2.3e-3 FT // Units: [M,FT]
**
** This parameter is the nominal diameter of containment spray droplets
** exiting the spray header nozzles. An averaged value for this variable
** should be based on droplet volume rather than strictly on the numbers of
** droplets of different sizes.
**
** @@@ 4.0.1 BJS 2/8/95 XDSP is for upper compt, upper compt and RHR
** sprays (not for constant flow (fire) sprays).
**
** ==========================================================================
WSPNZ0 1.78e6 LB/HR // Units: [KG/S,LB/HR]
**
** This parameter is the mass flow rate through one containment spray pump
** at the differential pressure specified for parameter PSPNZ0.
**
** @@@ 4.0.1 BJS 2/8/95 WSPNZ0 are for upper compt, lower compt and RHR
** sprays (not for constant flow (fire) sprays).
**
** ==========================================================================
PSPNZ0 40.0 PSI // Units: [PA,PSI]
**
** This parameter is the differential pressure across the containment spray
** nozzles.
**
** @@@ 4.0.1 BJS 2/8/95 PSPNZ0 is for upper compt, lower compt and RHR
** sprays (not for constant flow (fire) sprays).
**
** ==========================================================================
WSPAX 1.e9 LB/HR // Units: [KG/S,LB/HR]
**
** Parameter WSPAX is the total (for all pumps) limiting mass flow rate for
** the upper compartment (A) spray system. It is used to throttle the
** upper compartment (A) spray system flow rates at values lower than those
** called for by their head-flow curves. MAAP will use the minimum of the
** throttled flow and that calculated from the head-flow curves and the
** number of pumps in operation. To avoid throttling the mass flow,
** specify a large value, typically 1.0e10 in either set of units. Note
** that the amount of throttling can be changed by using MAAP input file
** local parameter changes, functions, or lookup tables.
**
** ==========================================================================

WSPBX 1.e9 LB/HR // Units: [KG/S,LB/HR]
**
** Parameter WSPBX is the total (for all pumps) limiting mass flow rate for
** the lower compartment (B) spray system. It is used to throttle the
** lower compartment (B) spray system flow rates at values lower than those
** called for by their head-flow curves. MAAP will use the minimum of the
** throttled flow and that calculated from the head-flow curves and the
** number of pumps in operation. To avoid throttling the mass flow,
** specify a large value, typically 1.0e10 in either set of units. Note
** that the amount of throttling can be changed by using MAAP input file
** local parameter changes, functions, or lookup tables.
** This parameter is the combined (total) throttled mass flow rate for all
** pumps in lower compartment (B) sprays.
**
** ======================================================================
** The rest of the input parameters for the upper (B) and lower (B)
** containment spray systems: NSPA, NSPB, NSPPT, ZHDSP(1:5), WVSP(1:5), and
** ZHDRSP(1:5) are only used for the MAAP specific engineered safeguard
** systems, e.g., when NESF = 0.
**
**
======================================================================
NSPA 2 // Dimensionless
**
** Parameter NSPA is the number of operating spray pumps for the upper
** compartment sprays.
**
** ======================================================================
NSPB 0 // Dimensionless
**
** Parameter NSPB is the number of operating spray pumps for the lower
** compartment sprays.
**
** ======================================================================
NSPPT 1 // Dimensionless
**
** This parameter is the number of points used in spray pump head-flow
** curve. Up to a maximum of 5 is allowed.
**
** ======================================================================
** Name: ZHDSP(1:5) Units: [M,FT]
**
** This parameter is the highest head (m) in spray pump head-flow curve.
** It is the shut-off head measured across the pump. ZHDSP(I) is a one
** dimensional array with the number of data points specified by NSPPT, and
** represents the pressure portion of the SP head-flow curve for the
** system. Each head value has a corresponding volumetric flow rate
** defined in the one dimensional WVSP(I) array below. If the system flow
** curve information is not available, use the pump flow curve, but be
** aware that the pump flow curve will over-predict system flow since line
** friction losses are not considered. MAAP initiates injection when the
** primary system pressure falls below the pump shut-off head.
**
** @@@ 4.0.3 BJS 3/13/96 Corrected the indices in the table. They were all

** 1, so the values overrode each other.
**
ZHDSP(1)      350.0  FT
ZHDSP(2)        0.0  FT
ZHDSP(3)        0.0  FT
ZHDSP(4)        0.0  FT
ZHDSP(5)        0.0  FT
**
** ===================================================================
** Name: WVSP(1:5)          Units: [M**3/S,GPM]
**
** This parameter is the volumetric flowrate in spray pump head-flow curve.
** It corresponds to the shut-off head, and must be 0.0 unless NSPPT is set
** to 1 for a single-point (constant flow) representation.  To use the
** constant flow model, a large head value should be specified for
** ZHDSP(1).
**
** @@@ 4.0.3 BJS 3/13/96  Corrected the indices in the table.  They were all
** 1, so the values overrode each other.
**
WVSP(1)      3400.0  GPM
WVSP(2)         0.0  GPM
WVSP(3)         0.0  GPM
WVSP(4)         0.0  GPM
WVSP(5)         0.0  GPM
**
**
=====================================================================
** Name: ZHDRSP(1:5)          Units: [M,FT]
**
** This parameter is the Net Positive Suction Head (NPSH) (m) required for
** the spray pump.  The elements of this array correspond to those of ZHDSP()
** and WVSP().
**
ZHDRSP(1)      16.0  FT
ZHDRSP(2)      16.0  FT
ZHDRSP(3)      16.0  FT
ZHDRSP(4)      16.0  FT
ZHDRSP(5)      16.0  FT
**
** ===================================================================
** ===================================================================
** Containment Spray Heat Exchangers
**
** The input parameters for the containment spray heat exchangers, if
** selected, are only used for the MAAP specific engineered safeguard
** systems, e.g., when NESF = 0.
**
** ===================================================================
FHXSP          2          // Dimensionless
**
** Parameter FHXSP is the containment spray heat exchanger selection flag:
**
**      = -1; No heat exchanger. The water temperature is set to the

```
**              RWST source temperature,
**     = 0; No heat exchanger. The water temperature is set to the
**              containment sump source temperature,
**     = 1; Straight tube heat exchanger, and
**     = 2; U-tube heat exchanger
**
** Note that the heat exchanger type can be changed with a local parameter
** change at time zero only.
**
** ========================================================================
WCWSP       2.5e6  LB/HR      // Units: [KG/S,LB/HR]
**
** Parameter WCWSP is the inlet cooling water mass flow rate to the spray
** heat exchanger.  The inlet cooling water temperature parameter is TCWHX.
**
** ========================================================================
** MAAP experience acquired to date indicates that the most consistently
** accurate representation of heat removal performance over the range of
** conditions frequently input to MAAP's heat exchanger model (HTEXCH)
** is obtained by specifying the detailed heat exchanger design data.  If
** this data can be supplied, a value of zero should be assigned to the
** heat exchanger NTU parameter.  If for whatever reason the detailed data
** cannot be provided, a somewhat less accurate but generally reasonable
** approximation of heat exchanger performance can be obtained by providing
** heat exchanger NTU parameter, and setting the detailed heat exchanger
** parameters to zero.
**
** Users have the choice of either specifying heat exchanger NTU or
** provided detailed heat exchanger geometry inputs.  The detailed heat
** exchanger model is used only when the value of NTUSP is zero.
**
** Parameters NTSP, NBSP, XIDTSP, XTTSP, XTCSP, XSSP, KTSP, XBCSP, XIDSSP,
** and XSTSP are used for the detailed heat exchanger model when NTUSP is
** zero for the spray heat exchanger.  Note that the spray heat exchanger
** uses the RGFLHX fouling factor parameter.
**
** For further technical advice regarding MAAP's heat exchanger model,
** consult the HTEXCH subroutine description in the MAAP User's Manual,
** Volume 2, and in particular, Figure 1 in the subroutine HTEXCH writeup
** for geometric information.
**
** ========================================================================
NTUSP       0.81         // Dimensionless
**
** Parameter NTUSP is the NTU for the spray heat exchanger.  NTUSP should
** be set to 0.0 if the detailed heat exchanger model is used.
**
** ========================================================================
NTSP        0.0          // Dimensionless
**
** Parameter HTSP is the number of tubes in the containment spray heat
** exchangers.  Specify the actual number of tubes.  MAAP will multiply
** this number by two if a U-tube heat exchanger is involved (see parameter
** FHXSP).
```

```
**
** ===========================================================================
NBSP          0.0           // Dimensionless
**
** Parameter NBSP is the number of shell side baffles in the spray heat
** exchanger.
**
** ===========================================================================
XIDTSP          0.0  FT        // Units: [M,FT]
**
** Parameter XIDTSP is the spray heat exchanger tube inside diameter.
**
** ===========================================================================
XTTSP          0.0  FT        // Units: [M,FT]
**
** Parameter XTTSP is the spray heat exchanger tube wall thickness.
**
** ===========================================================================
XTCSP          0.0  FT        // Units: [M,FT]
**
** Parameter XTCSP is the spray heat exchanger tube center to center spacing.
**
** ===========================================================================
XSSP          0.0  FT        // Units: [M.FT]
**
** Parameter XSSP is the spray heat exchanger shell length.
**
** ===========================================================================
KTSP          0.0  BTU/FT-HR-F  // Units: [W/M-C,BTU/FT-HR-F]
**
** Parameter KTSP is the thermal conductivity of the spray heat exchanger
** tube wall.
**
** ===========================================================================
XBCSP          0.0  FT        // Units: [M.FT]
**
** Parameter XBCSP is the baffle cut length for the spray heat exchanger.
**
** ===========================================================================
XIDSSP          0.0  FT        // Units: [M,FT]
**
** Parameter XIDSSP is the shell inside diameter of the spray recirculation
** heat exchanger.
**
** ===========================================================================
XSTSP          0.0  FT        // Units: [M.FT]
**
** Parameter XSTSP is the tube bundle to shell gap length for the spray heat
** exchanger.
**
** ===========================================================================
** ===========================================================================
** LPI Residual Heat Removal (RHR) Containment Spray and Heat Exchangers
**
```

** The input parameters for the low pressure injection (LPI) lineup with
** containment spray and residual heat removal (RHR) heat exchangers are
** only used for the MAAP specific engineered safeguard systems, e.g., when
** NESF = 0.
**
** ================================================================================
WLPSPX 1.e9 LB/HR // Units: [KG/S,LB/HR]
**
** Parameter WLPSPX is the total (for all pumps) limiting mass flow rate for
** the LPI RHR spray system. It is used to throttle the LPI RHR spray
** system flow rates at values lower than those called for by their
** head-flow curves. MAAP will use the minimum of the throttled flow and
** that calculated from the head-flow curves and the number of pumps in
** operation. To avoid throttling the mass flow, specify a large value,
** typically 1.0e10 in either set of units. Note that the amount of
** throttling can be changed by using MAAP input file local parameter
** changes, functions, or lookup tables.
**
** ================================================================================
NLPSP0 0 // Dimensionless
**
** This parameter is the number of LPI pumps used for RHR sprays when
** system valving is aligned for sprays. If the LPI pumps are operating in
** recirculation mode, this parameter determines the number of the pumps
** that discharge to the containment sprays instead of the primary coolant
** system.
**
** ================================================================================
FHXRH 2 // Dimensionless
**
** Parameter FHXRH is the LPI (RHR) heat exchanger selection flag:
**
** = -1; No heat exchanger. The water temperature is set to the
** RWST source temperature,
** = 0; No heat exchanger. The water temperature is set to the
** containment sump source temperature,
** = 1; Straight tube heat exchanger, and
** = 2; U-tube heat exchanger
**
** Note that the heat exchanger type can be changed with a local parameter
** change at time zero only.
**
** ================================================================================
WCWRH 2.48e6 LB/HR // Units: [KG/S,LB/HR]
**
** Parameter WCWRH is the INLET cooling water mass flow rate to the LPI
** (RHR) heat exchanger. The inlet cooling water temperature parameter is
** TCWHX.
**
** ================================================================================
** MAAP experience acquired to date indicates that the most consistently
** accurate representation of heat removal performance over the range of
** conditions frequently input to MAAP's heat exchanger model (HTEXCH)
** is obtained by specifying the detailed heat exchanger design data. If

** this data can be supplied, a value of zero should be assigned to the
** heat exchanger NTU parameter. If for whatever reason the detailed data
** cannot be provided, a somewhat less accurate but generally reasonable
** approximation of heat exchanger performance can be obtained by providing
** heat exchanger NTU parameter, and setting the detailed heat exchanger
** parameters to zero.
**
** Users have the choice of either specifying heat exchanger NTU or
** provided detailed heat exchanger geometry inputs. The detailed heat
** exchanger model is used only when the value of NTURH is zero.
**
** Parameters NTRH, NBRH, XIDTRH, XTTRH, XTCRH, XSRH, KTRH, XBCRH, XIDSRH,
** and XSTRH are used for the detailed heat exchanger model when NTUSP is
** zero for the LPI (RHR) heat exchanger. Note that the LPI (RHR) heat
** exchanger uses the RGFLHX fouling factor parameter.
**
** For further technical advice regarding MAAP's heat exchanger model,
** consult the HTEXCH subroutine description in the MAAP User's Manual,
** Volume 2, and in particular, Figure 1 in the subroutine HTEXCH writeup
** for geometric information.
**
** ======================================================================
NTURH 1.29 // Dimensionless
**
** Parameter NTURH is the NTU for the LPI (RHR) heat exchanger. NTURH
** should be set to 0.0 if the detailed heat exchanger model is used.
**
** ======================================================================
NTRH 0.0 // Dimensionless
**
** This parameter is the number of tubes in LPI (RHR) heat exchangers.
**
** ======================================================================
NBRH 0.0 // Dimensionless
**
** Parameter NBRH is the number of shell side baffles in the LPI (RHR) heat
** exchanger.
**
** ======================================================================
XIDTRH 0.0 FT // Units: [M,FT]
**
** Parameter XIDTRH is the LPI (RHR) heat exchanger tube inside diameter.
**
** ======================================================================
XTTRH 0.0 FT // Units: [M,FT]
**
** Parameter XTTRH is the LPI (RHR) heat exchanger tube wall thickness.
**
** ======================================================================
XTCRH 0.0 FT // Units: [M,FT]
**
** Parameter XTCRH is the LPI (RHR) heat exchanger tube center to center
** spacing.
**

```
** ======================================================================
XSRH         0.0  FT        // Units: [M,FT]
**
** Parameter XSRH is the LPI (RHR) heat exchanger shell length.
**
** ======================================================================
KTRH         0.0  BTU/FT-HR-F // Units: [W/M-C,BTU/FT-HR-F]
**
** Parameter KTRH is the thermal conductivity of the LPI (RHR) heat
** exchanger tube wall.
**
** ======================================================================
XBCRH        0.0  FT        // Units: [M,FT]
**
** Parameter XBCRH is the baffle cut length for the LPI (RHR) heat
** exchanger.
**
** ======================================================================
XIDSRH       0.0  FT        // Units: [M,FT]
**
** Parameter XIDSRH is the shell inside diameter of the LPI (RHR)
** recirculation heat exchanger.
**
** ======================================================================
XSTRH        0.0  FT        // Units: [M,FT]
**
** Parameter XSTRH is the tube bundle to shell gap length for the LPI (RHR)
** heat exchanger.
**
** ======================================================================
** ======================================================================
** Containment Fan Coolers
**
** The fan cooler model is a containment engineered safeguard function
** which takes suction from the compartment identified by JNFCS and
** discharges to the compartment identified by JNFCD.  The fan coolers may
** be operated without heat exchangers, thus reducing it's function to just
** a fan. The fan coolers are available when the number of fan coolers
** (NFN) is greater than zero, and the compartment identified by JNFCS is
** also greater the zero.  The operation of fan coolers depends on the
** following conditions:
**
**      1. AC or DC power is available (IEVNT(205)=1)
**      2. Fan cooler is not forced off (IEVNT(221)=0),
**      3. Fan cooler is either manually activated (IEVNT(218)=1), or
**           pressure reaches the set point (PRB(JNFCS) > PFAN0), and
**      4. the delay-time (TDFAN) has clapses since the initiation.
**
** Event code 77 indicates the status of the fan coolers system, eg., on
** or off, and event code 79 indicates whether the initiation signal has
** been received.  To operate the fan coolers in fan mode only, eg.,
** without heat exchangers, set event code 203 true.  Note that this will
** also force the chillers (described later) to operate in fan mode also.
** Set parameter ATFC to zero to force only the fan coolers to operate in
```

```
** fan mode only.
**
** Useful outputs of the fan cooler model are:
**
**      WGFNA = cooler gas flow rate
**      QGFN  = energy flow rate associated with gas flow & heat exchange
**      WCDFC = condensate flow rate
**      QCDFC = energy flow rate associated with condensate flow rate
**
** For further technical advice regarding MAAP's fan cooler with heat
** exchanger model, consult the FANCLR subroutine description in the MAAP
** User's Manual, Volume 2, and for fan cooler without heat exchangers,
** consult the FAN subroutine description.  Also, see subroutine AUXESF-PWR
** writeup of the MAAP4 Users Manual for further information about this
** fan cooler system.
**
** ===========================================================================
NFN          2          // Dimensionless
**
** Parameter NFN is the number of operating fans or fan coolers.
**
** ===========================================================================
PFAN0       17.69  PSI      // Units: [PA,PSI]
**
** Parameter PFAN0 is the pressure setpoint for containment fans coolers.
** The containment fans are activated when the pressure in the containment
** exceeds the value assigned to this variable.
**
** ===========================================================================
TDFAN        0.17  HR       // Units: [S,HR]
**
** Parameter TDFAN is the time delay for fan coolers to turn on once the
** activation signal is recieved.
**
** ===========================================================================
WVFN0     299000.0  GPM      // Units: [M**3/S,GPM]
**
** Parameter WVFN0 is the gas volumetric flowrate through one fan cooler.
**
** ===========================================================================
NTFC         0          // Dimensionless
**
** Parameter NTFC is the total number of tubes in one fan cooler.
**
** ===========================================================================
ATFC         0.0  FT**2    // Units: [M**2,FT**2]
**
** Parameter ATFC is the outside area of all tubes in one fan cooler.  It
** is calculated using the outer diameter of the tubes neglecting the
** attached fins.
**
** ===========================================================================
AFINFC       0.0  FT**2    // Units: [M**2,FT**2]
**
```

** Parameter AFINC is the total surface area of all fins in one fan cooler.
**
** ==========================================================================
FFINFC 0.0 // Dimensionless
**
** Parameter FFINFC is the fan cooler fin efficiency.
**
** ==========================================================================
RGFLHX 0.0 FT**2-HR-F/BTU // Units: [M**2-C/W,FT**2-HR-F/BTU]
**
** Parameter RGFLHX is the fan cooler inside fouling factor. CAUTION: Note
** that this is also the fouling factor for all ESF heat exchangers used by
** the MAAP specific (not generalized) engineered safeguards system. The
** containment chillers, however, has its own fouling factor parameter.
**
** ==========================================================================
XDFNFC 0.0 FT // Units: [M,FT]
**
** Parameter XDFNFC is the fan cooler fin vertical length. This is the
** length between the equivalent radius of the fin and the tube outer
** radius.
**
** ==========================================================================
XTTFC 0.0 FT // Units: [M,FT]
**
** Parameter XTTC is the fan cooler tube wall thickness.
**
** ==========================================================================
KTFC 0.0 BTU/FT-HR-F // Units: [W/M-C,BTU/FT-HR-F]
**
** Parameter KTFC is the fan cooler tube wall thermal conductivity.
**
** ==========================================================================
AFLMNF 0.0 FT**2 // Units: [M**2,FT**2]
**
** Parameter AFLMNF is the minimum effective gas flow area through one fan
** cooler.
**
** ==========================================================================
XIDTFC 0.0 FT // Units: [M,FT]
**
** Parameter XIDTFC is the fan cooler tube inside diameter.
**
** ==========================================================================
NREGFC 0 // Dimensionless
**
** Parameter NREGFC is the number of nodes (maximum 5) used to model fan
** cooler. The MAAP model assumes co-current flow in the fan cooler, while
** in reality the gas flow is perpendicular to the cooling water flow.
** This assumption is made to avoid an iterative solution for the heat
** transfer process. Therefore, even though the number of nodes (sections)
** is only for calculational purposes, it should correspond to the number
** of passes that the tubes make perpendicular to the flow. Quasi-steady
** heat transfer is assumed in each node.

**
** =====================================================================
TCWHX 105.0 F // Units: [K,F]
**
** Parameter TCWHX is the inlet cooling water (i.e. service water)
** temperature for the fan coolers heat exchangers. CAUTION: Note that
** this is also the inlet cooling water temperature for all ESF heat
** exchangers used by both the MAAP specific and generalized engineered
** safeguards system. The containment chillers, however, has it's own
** inlet cooling water temperature parameter.
**
** =====================================================================
WCWFC 0.0 LB/HR // Units: [KG/S,LB/HR]
**
** Parameter WCWFC is the inlet cooling water flow rate to one fan cooler.
**
** =====================================================================
** =====================================================================
** Containment Chillers
**
** The containment chiller model is a containment engineered safeguard
** function which takes suction from the compartment identified by JNCHS
** and discharges to the compartment identified by JNCHD. The containment
** chillers function just like fan coolers. The containment chillers may
** be operated without heat exchangers, thus reducing it's function to just
** a fan. The containment chillers are available when the number of
** chillers (NCHILL) is greater than zero, and the compartment identified
** by JNCHS is also greater the zero. The operation of containment
** chillers depends on the following conditions:
**
** 1. AC or DC power is available (IEVNT(205)=1),
** 2. Containment chiller is not forced off (IEVNT(225)=0),
** 3. Chillers is either manually activated (IEVNT(210)=1), or
** pressure reaches the set point (PRB(JNCHS) > PCHR0), and
** 4. the delay-time (TDCHR) has clapses since the initiation.
**
** Event code 76 indicates the status of the containment chiller system,
** eg., on or off, and event code 78 indicates whether the initiation
** signal has been received. To operate the containment chillers in fan
** mode only, eg., without heat exchangers, set event code 203 true. Note
** that this will also force the fan coolers to operate in fan mode also.
** Set parameter ATCH to zero to force only the containment chillers to
** operate in fan mode only.
**
** Useful outputs of the containment chillers model are:
**
** WGCHR = cooler gas flow rate
** WCDCH = energy flow rate associated with gas flow & heat exchange
** QCDCH = condensate flow rate
** QGCHR = energy flow rate associated with condensate flow rate
**
** For further technical advice regarding MAAP's fan cooler with heat
** exchanger model, consult the FANCLR subroutine description in the MAAP
** User's Manual, Volume 2, and for fan cooler without heat exchangers,

```
** consult the FAN subroutine description.  Also, see subroutine AUXESF-PWR
** writeup of the MAAP4  Users Manual for further information about this
** containment chiller system.
**
*SI
** @@@ 4.0.3 BJS 3/21/96 - Corrected the values for the chiller input for
** the ice condenser parameter file.  The draft User's Guide had SI values
** that were interpreted as Br values.
**
** ========================================================================
NCHILL          0            // Dimensionless
**
** Parameter NCHILL is the number of operating containment chillers.
**
** ========================================================================
PCHR0      0.1520e6  PA        // Units: [PA,PSI]
**
** Parameter PCHR0 is the pressure setpoint for containment chillers.  The
** containment chillers are activated when the pressure in the containment
** exceeds the value assigned to this variable.
**
** ========================================================================
TDCHR          5.0  S         // Units: [S,HR]
**
** Parameter TDCHR is the time delay for chillers to turn on once the
** activation signal is recieved.
**
** ========================================================================
WVCH0         20.0  M**3/S    // Units: [M**3/S,GPM]
**
** Parameter WVCH0 is the gas volumetric flow rate through one chiller.
**
** ========================================================================
NTCH          1200           // Dimensionless
**
** Parameter NTCH is the total number of tubes in one chiller.
**
** ========================================================================
ATCH          180.0  M**2     // Units: [M**2,FT**2]
**
** Parameter ATCH is the outside area of all tubes in one chiller.  It
** is calculated using the outer diameter of the tubes neglecting the
** attached fins.
**
** ========================================================================
AFINCH        1500.0  M**2     // Units: [M**2,FT**2]
**
** Parameter AFINCH is the total surface area of all fins in one chiller.
**
** ========================================================================
FFINCH        0.50           // Dimensionless
**
** Parameter FFINCH is the chiller fin efficiency.
**
```

```
** ===========================================================================
RGFLCH       0.001  M**2-C/W   // Units: [M**2-C/W,FT**2-HR-F/BTU]
**
** Parameter RGFLCH is the chiller inside fouling factor.
**
** ===========================================================================
XDFNCH       0.05  M        // Units: [M,FT]
**
** Parameter XDFNCH is the fan cooler fin vertical length.  This is the
** length between the equivalent radius of the fin and the tube outer
** radius.
**
** ===========================================================================
XTTCH        0.001  M       // Units: [M,FT]
**
** Parameter XTTCH is the chiller tube wall thickness.
**
** ===========================================================================
KTCH         240.0  W/M-C     // Units: [W/M-C,BTU/FT-HR-F]
**
** Parameter KTCH is the chiller tube wall thermal conductivity.
**
** ===========================================================================
AFMNCH       10.0  M**2     // Units: [M**2,FT**2]
**
** Parameter AFMNCH is the minimum effective gas flow area through one
** chiller.
**
** ===========================================================================
XIDTCH       0.013  M       // Units: [M,FT]
**
** Parameter XIDTCH is the chiller tube inside diameter.
**
** ===========================================================================
NREGCH         5          // Dimensionless
**
** Parameter NREGCH is the number of nodes (maximum 5) used to model
** chiller.  The MAAP model assumes co-current flow in the chiller,
** while in reality the gas flow is perpendicular to the cooling water
** flow.  This assumption is made to avoid an iterative solution for the
** heat transfer process.  Therefore, even though the number of nodes
** (sections) is only for calculational purposes, it should correspond to
** the number of passes that the tubes make  perpendicular to the flow.
** Quasi-steady heat transfer is assumed in each node.
**
** ===========================================================================
TCWCH        310.  K       // Units: [K,F]
**
** Parameter TCWCH is the inlet cooling water (i.e. service water)
** temperature for the chillers heat exchangers.
**
** @@@ 4.0.2 BJS 9/28/95 - CORRECTED NOTE ABOUT TCWCH - IT IS ONLY USED
**                FOR CHILLERS, NOT OTHER HEAT EXCHANGERS.
**
```

** ========================================================================
WCWCH 110.0 KG/S // Units: [KG/S,LB/HR]
**
** Parameter WCWCH is the inlet cooling water flow to one chiller.
**
*BR
**
==========================================================================
**
==========================================================================
** Cavity Water Injection System
**
** The cavity water injection system is used in MAAP to simulate a proposed
** dedicated ESF which merely dumps water into the cavity. This system must
** be manually activated by using MAAP Event Code #241.
**
**
==========================================================================
MWCIT0 0.0 LB // Units: [KG,LB]
**
** Parameter MWCIT0 is the total mass in the cavity injection system tank.
**
** ========================================================================
WWCI0 0.0 LB/HR // Units: [KG/S,LB/HR]
**
** Parameter WWCI0 is the Mass flow rate of the cavity injection system.
**
** ========================================================================
** ========================================================================
** Boric Acid (H3BO3) Injection for MAAP4 Engineered Safeguards
**
** Two possible sources of boron (H3BO3) injection into the reactor vessel
** is either from the accumulator tanks and the refueling water storage
** tanks (RWST) or both. The next two parameters, FBAACU and FBARWS, ask
** for the mass fraction of the boric acid (H3BO3) being injected from each
** source. The total mass rate of boric acid (H3BO3) introduced into the
** reactor system is WBAPS and total integrated value of boric acid (H3BO3)
** injected is MBATOT. The mass of boric acid (H3BO3) is tracked in the
** reactor vessel as MBAPS and in the containment as MFPWB(13,iv) for the
** iv'th compartment water pool. In the containment or auxilary building
** compartments, the mass of H3BO3 in the water pool is used to determine
** the pH value of the water pool, and can be plotted as FPHVAL(iv) for the
** iv'th compartment water pool. Presently, the pH of the reactor vessel
** water is not computed. See subroutine AUXFP writeup of the MAAP4 User
** Manual for additional details of how the pH value is calculated.
**
** Note that the next two parameters are only used when the MAAP4 specific
** engineered safeguard system is selected, e.g., when NESF is set to 0.
**
** ========================================================================
FBAACU 0.0 // Dimensionless
**
** Parameter FBAACU is the mass fraction of the boric acid (H3BO3) in the
** accumulator tanks.

**
** ==========================================================================
FBARWS 0.0 // Dimensionless
**
** Parameter FBARWS is the mass fraction of the boric acid (H3BO3) in the
** refueling water storage tanks (RWST).
**
** ==========================================================================
** ==========================================================================
MWBAG0 0.0 LB // Units: [KG,LB]
**
** Parameter MWBAG0 is the mass of water in neutron sheild bags in the
** upper compartment. The neutron bags rupture when the primary system
** break (e.g., LOCA), fails (e.g., creep rupture), or when the quench tank
** rupture disk fails.
**
** ==========================================================================
** ==========================================================================
**
** @@@ 4.0.3 MAM 12/7/95 The generalized ESF only input parameters: TDLP2,
** TDSPC, WSPCX, WLP2X, ZSPA, ZSPA2, ZSPB, and BYPASS were moved to the
** *Generalized Engineered Safeguards parameter section.
**
** @@@ 4.0.3 MAM 12/7/95 The Steam Generator related parameters: NAFWPT,
** ZHDAFW(5), WVAFW(5), ZCSTAF, ZSGAFW, and ACST were move to the *Steam
** Generator parameter section.
**
****************************************************************************
*Generalized Engineered Safeguards
****************************************************************************
*SI
**
** This parameter section is used for setting up the generalized engineered
** safeguard systems. The user has the choice of either using the MAAP
** specific or the MAAP generalized engineered safeguard systems. The choice
** between the two is defined by the parameter NESF. When NESF is set to 0,
** the MAAP specific engineered safeguard systems will be used. When NESF
** is set to 1, the MAAP generalized engineered safeguard systems will be
** used.
**
** The generalized engineered safeguard system model allows increased
** flexibility over that available with the specific engineered safeguard
** system models in specifying the pump operation and alignment. The model
** features user control of seven completely independent pump systems:
**
** 1) containment spray system train A (SPA),
** 2) containment spray system train B (SPB),
** 3) low pressure injection train #1 (LPI-1),
** 4) low pressure injection train #2 (LPI-2),
** 5) high pressure injection (HPI),
** 6) charging pumps (CHP), and
** 7) containment spray system train C (SPC)
**
** Much of the following discussions were extracted from the subroutine

** GENESF writeup of the MAAP4 User Manual.
**
** Each pump system can have its own water source and discharge location(s),
** thus allowing users to model the exact pump lineups at their plants. In
** addition, heat exchangers can be placed downstream of any pump and
** several options exist to model Net Positive Suction Head (NPSH)
** enhancement flows for any pump. Finally, several sets of pump
** characteristics can be defined for each pump system to simulate pump
** performance under normal, recirculation, and degraded conditions as well
** as variations in pump performance due to pump lineup changes.
**
** This section includes such parameters as the pump source and discharge
** locations under normal and recirculation lineups and the number of
** operable pumps represented by the pump system. Another option which is
** featured in the generalized ESF model is the ability to specify a delay
** time to pump failure once sufficient NPSH to the pump is lost. Rather
** than failing immediately, a pump will switch to a "degraded" operating
** mode. If sufficient NPSH is re-established before the end of the delay
** time period, then the pump will revert to its normal operating mode.
** Thus, inputs to control the delay time and define the pump characteristics
** set to be used under the various operating modes are also specified in the
** Generalized Engineered Safeguards parameter section.
**
** Unique sets of MAAP event codes are defined for each pump to allow
** independent control of the seven pump systems. These event codes allow
** the user to manually turn on the pump and manually lock it off as well as
** inform the user of the pump status (normal/degraded/inoperable/on/off).
** Actual event codes for each pump system and other event codes used for
** generalized ESF are shown in Table 6 while the MAAP default event code
** messages for generalized ESF are presented in Table 7 of the GENESF
** subroutine writeup of the MAAP4 Users Manual.
**
** The event codes indicating normal or degraded pump status are set true
** (i.e., degraded) when insufficient NPSH is supplied to the pump. The
** pump status changes to inoperable if sufficient NPSH is not restored
** prior to the expiration of the pump failure delay time. Once a pump
** becomes inoperable, it remains inoperable for the duration of the
** accident sequence. If sufficient NPSH is restored to the pump prior to
** the end of the delay time period, then the pump status changes from
** degraded back to normal and the failure delay clock is reset. Finally, a
** pump's status will change to "on" whenever the pump is turned manually on
** or if an automatic initiation signal is received.
**
** Certain limitations exist in the generalized ESF pump model control logic
** which restrict the operation of the seven pump systems. For instance,
** logic in MAAP pertaining to the automatic initiation signals is not
** generalized. Thus, pumps 1, 2, and 7 (SPA, SPB, and SPC) will always
** initiate on high containment pressure and should be used to represent
** containment spray pumps. Likewise, pumps 3 and 4 (LPI-1 and LPI-2) will
** start up when the primary system pressure drops below the LPI initiation
** pressure. Thus these pumps should be used to represent the LPI and RHR
** pump trains. Pumps 5 and 6 (HPI and CHP) start up when primary system
** pressure drops below the high pressure injection and charging pump
** initiation pressure, respectively. Also, the HPI and charging pumps are

** used for the pressurizer level control model. Therefore, pump 5 should
** be used to represent the high pressure injection pumps only and pump 6
** should be used to represent the charging pumps only. With these
** limitations in mind, the seven independent pump systems actually
** represent three independent containment spray trains, two independent low
** pressure injection trains, one independent high pressure injection train,
** and one independent charging pump train.
**
** Because the pumps are predefined to represent specific systems the only
** "piggybacking" configurations that are allowed are the upper compartment
** spray and LPI system pumps (pumps 1, 3 and 4) which can discharge to the
** HPI and charging pumps (pumps 5 and 6). Thus, the lower and train C
** containment spray pumps (pumps 2 and 7) do not have the capability to be
** lined up in series with any other pump systems. To avoid unexpected
** pump behavior, users should adhere to these limitations when specifying
** pump lineups in either the MAAP parameter file or input deck.
**
** For each pump system, the following input parameters are requested:
**
** 1. number of operational pumps,
**
** 2. pump characteristic set ID selection for normal pump lineup,
**
** 3. water suction source for normal pump lineup,
**
** 4. discharge location for normal pump lineup,
**
** 5. pump characteristic set ID selection for recirculation pump
** lineup,
**
** 6. water suction source for recirculation pump lineup,
**
** 7. discharge location for recirculation pump lineup,
**
** 8. NPSH enhancement flow source selection,
**
** 9. NPSH enhancement flow rate,
**
** 10. elapsed time to pump failure once insufficient NPSH occurred,
**
** 11. pump characteristic set ID selection for degraded pump lineup,
**
** 12. height of bottom of RWST above pumps,
**
** 13. height of bottom of containment sump above pumps,
**
** 14. height of reactor vessel injection nozzles above pumps.
**
** If an external NPSH enhancement water storage tank is used, the initial
** water temperature and mass are specified.
**
** Finally, the boron injection source can be specified.
**
** Flowrates specified to be volumetric should be M**3/S in SI units and

```
** GPM in British units.  If unit labels are explictly specified, FT**3/HR
** is allowed.
**
** For better accuracy, user may elect to input "system" pump head curves
** which include the effects of friction in the inlet and outlet piping
** (which is ignored in MAAP). In doing so, be sure the assumptions on
** static head which are used in their calculation are consistent with the
** pump elevation, etc. which are input below--this is generally a factor
** only in critical applications such as feed and bleed where the charging
** pump injection flow may or may not be sufficient to match core decay
** heat.
**
** Note: In the case of injection when there is a break, the injected flow
** is assumed to go the vessel rather than directly out the break.  Then,
** if the water level is high enough, water will flow out the break, i.e.
** the code does not know if the injection is up or down stream of a break.
**
** Typical data sources are:
**
**      1) Plant FSAR - ESF section.
**
**      2) Operator Training Manual - ESF section.
**
**      3) ESF piping and Instrumentation diagrams (P&IDs)
**
**      4) Pump Pre-Op. startup, or in-service performance test records
**
**      5) Containment spray system process flow diagram
**
**      6) Containment section, elevation, and/or equipment location
**           drawings.
**
**      7) Plant FSAR - ESF or Containment HVAC sections
**
**      8) Operator Training Manual - ESF or Containment HVAC section
**
** ==========================================================================
NESF            0           // Dimensionless
**
** Parameter NESF is used for selecting the engineered safeguard model.
** The options are:
**
**      = 0 for MAAP specific engineered safeguard systems
**      = 1 for MAAP generalized engineered safeguard systems
**
** ==========================================================================
** @@@ 4.0.3 MAM 12/7/95  The following generalized ESF only input
** parameters: TDLP2, TDSPC, WSPCX, WLP2X, ZSPA, ZSPA2, ZSPB, and BYPASS
** were moved here from the *Engineered Safeguards parameter section.
**
*BR
** @@@ 4.0.3 BJS 3/21/96 - Corrected the values/units of TDLP2 through ZSPB.
** The values were interpreted as being in SI units in the draft User's
** Guide when they are actually in Br units.
```

```
**
**
=============================================================================
TDLP2        7.50e-3  HR        // Units: [S,HR]
**
** Parameter TDLP2 is the time delay for actuation of LPI pump train 2.
**
** ==========================================================================
TDSPC          0.0  HR        // Units: [S,HR]
**
** Parameter TDSPC is the time delay for actuation of containment spray
** pumps train C.
**
** @@@ 4.0.1 BJS 2/8/95  TDSPC is for generalized ESF spray train C (not for
**                  the "hardwired" ESF model).
**
** ==========================================================================
WSPCX         1.e10  LB/HR      // Units: [KG/S,LB/HR]
**
** Parameter WSPCX is the total (for all pumps) limiting mass flow rate for
** the containment spray train C system.  It is used to throttle the
** containment spray train C system flow rates at values lower than those
** called for by their head-flow curves.  MAAP will use the minimum of the
** throttled flow and that calculated from the head-flow curves and the
** number of pumps in operation.  To avoid throttling the mass flow,
** specify a large value, typically 1.0e10 in either set of units.  Note
** that the amount of throttling can be changed by using MAAP input file
** local parameter changes, functions, or lookup tables.
**
** ==========================================================================
WLP2X         1.e10  LB/HR      // Units: [KG/S,LB/HR]
**
** Parameter WLP2X is the total (for all pumps) limiting mass flow rate for
** the LPI-2 system.  It is used to throttle the LPI-2 system flow rates at
** values lower than those called for by their head-flow curves.  MAAP will
** use the minimum of the throttled flow and that calculated from the
** head-flow curves and the number of pumps in operation.  To avoid
** throttling the mass flow, specify a large value, typically 1.0e10 in
** either set of units.  Note that the amount of throttling can be changed
** by using MAAP input file local parameter changes, functions, or lookup
** tables.
**
** ==========================================================================
** The next three parameters: ZSPA, ZSPA2, and ZSPB are used for spray fall
** height and for water head from pump discharge to spray header.
**
** ==========================================================================
ZSPA          5.22  FT        // Units: [M,FT]
**
** This parameter is the height of the upper containment spray header above
** the floor of the JNUCS compartment.
**
** ==========================================================================
ZSPA2         0.0  FT        // Units: [M,FT]
```

**
** This parameter is the height of the upper containment spray header train
** 2 above the floor of the JNUCS compartment.
**
** ===================================================================
ZSPB 51.33 FT // Units: [M,FT]
**
** This parameter is the height of the lower containment spray header
** above the floor of the JNLCS compartment.
**
** ===================================================================
BYPASS 0.0 // Dimensionless
**
** @@@ 4.0.3 MAM Parameter BYPASS was missing from all PWR parameter
** files.
**
** Parameter BYPASS is an option flag for excess flow from LPI during
** piggybacking:
**
** 0 = no bypass flow accounted for
** 1 = bypass flow to hot leg
** 2 = bypass flow to cold leg
**
*SI
**
** ===================================================================
** ===================================================================
** Upper Compartment Containment Spray System
** ===================================================================
** ===================================================================
NSPAG 1 // Dimensionless
**
** Parameter NSPAG is the number of operational upper compartment spray
** (SPA) pumps.
**
** ===================================================================
NORSPA 1 // Dimensionless
**
** Parameter NORSPA is the pump characteristic set ID for normal pump
** lineup for the upper compartment containment spray. The pump
** characteristic parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5),
** FHXP#, NTPM#, NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#,
** XSTR#, NWCW#, TICW#(5), WCWP#(5), and NTU# where # is the value of
** NORSPA, and these parameters are defined in the Pump parameter section.
**
** ===================================================================
NSSPA 3 // Dimensionless
**
** Parameter NSSPA is the water source selection flag for normal pump
** lineup for the upper compartment spray pumps.
**
** = 0: No source (i.e., system not functional)
** = 1: Hot leg
** = 2: Cold leg

```
**      = 3: RWST
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**
** ==========================================================================
NDSPA           4           // Dimensionless
**
** Parameter NDSPA is the pump discharge location selection flag for normal
** pump lineup for the upper compartment spray.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 6: Inlet of HPI pump
**      = 7: Inlet of charging pump
**      = 8: Discharge to both HPI and charging pump inlets
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**      =10: HPI inlet and upper compartment spray header #1
**      =11: HPI inlet and cold leg
**      =12: CHP inlet and upper compartment spray header #1
**      =13: CHP inlet and cold leg
**
** @@@ 4.0.3 MAM 11/28/95 Options 6-8 and 10-13 were missing from the
** parameter file.
**
** ==========================================================================
RECSPA          1           // Dimensionless
**
** Parameter RECSPA is the pump characteristic set ID for recirculation
** pump lineup for the upper compartment containment spray.  The pump
** characteristic parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5),
** FHXP#, NTPM#, NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#,
** XSTR#, NWCW#, TICW#(5), WCWP#(5), and NTU# where # is the value of
** RECSPA, and these parameters are defined in the Pump parameter section.
**
** ==========================================================================
RSSPA           0           // Dimensionless
**
** Parameter RSSPA is the water source selection flag for recirculation
** pump lineup for the upper compartment spray pumps.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Rwst
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**
** ==========================================================================
RDSPA           4           // Dimensionless
**
** Parameter RDSPA is the pump discharge location selection flag for
```

** recirculation pump lineup for the upper compartment spray.
**
** = 1: Hot leg
** = 2: Cold leg
** = 3: Downcomer
** = 4: Upper compartment spray header #1 (Compt. JNUCS)
** = 5: Lower compartment spray header (Compt. JNLCS)
** = 6: Inlet of HPI pump
** = 7: Inlet of charging pump
** = 8: Discharge to both HPI and charging pump inlet
** = 9: Upper compartment spray header #2 (Compt. JNUCS)
** =10: HPI inlet and upper compartment spray header #1
** =11: HPI inlet and cold leg
** =12: CHP inlet and upper compartment spray header #1
** =13: CHP inlet and cold leg
**
** @@@ 4.0.3 MAM 11/28/95 Options 10-13 were missing from the parameter file.
**
** ======================================================================
SNPSPA 0 // Dimensionless
**
** Parameter SNPSPA is the Net Positive Suction Head (NPSH) enhancement
** flow source selection flag for the upper compartment spray.
**
** = 0: No enhancement flow
** = 1: NPSH enhancement recirculation flow is drawn from discharge
** side pump downstream of heat exchanger outlet if it exists,
** and recirculated to inlet side of pump
** = 2: NPSH enhancement flow from SPA outlet
** = 3: NPSH enhancement flow from external water storage tank
**
** ======================================================================
WESPA 0.0 KG/S // Units: [KG/S,LB/HR]
**
** Parameter WESPA is the NPSH enhancement flow rate. Set WESPA to 0 if no
** NPSH enhancement is to be modeled for the upper compartment spray pump
** lineup.
**
** ======================================================================
TDNSPA 0.0 S // Units: [S,HR]
**
** Parameter TDNSPA is the time to upper compartment spray pump failure
** after the time when insufficient pump NPSH occurred. The pumps will
** continue to operate with degraded performance (see parameter DEGSPA)
** until the time elapsed since the time when insufficient pump NPSH occurred
** exceeds TDNSPA. If the elapsed time exceeded parameter TDNSPA before the
** pumps re-acquired sufficient pump NPSH, then the pumps will be lost for
** the duration of the run. If the pumps re-acquire sufficient NPSH, then
** the time counter will be reset.
**
** ======================================================================
DEGSPA 1 // Dimensionless
**
** Parameter DEGSPA is the pump characteristic set ID for degraded pump

** lineup for the upper compartment containment spray. The pump
** characteristic parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5),
** FHXP#, NTPM#, NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#,
** XSTR#, NWCW#, TICW#(5), WCWP#(5), and NTU# where # is the value of
** DEGSPA, and these parameters are defined in the Pump parameter section.
** This set of pump characteristics is automatically selected when the
** pumps have insufficient NPSH. This pump characteristic set can be the
** same as that specified for normal lineup (see parameter NSSPA) if no
** degraded pump performance is to be considered. The user can specify an
** "alternative" pump performance set instead of the "degraded" pump
** performance set.
**
** ==========================================================================
ZSPARW 15.0 M // Units: [M,FT]
**
** Parameter ZSPARW is the distance of bottom of RWST above the upper
** compartment spray pumps. This parameter is only relevant only if the
** pump water source is from the RWST, otherwise it can be safely ignored.
**
** ==========================================================================
ZSPACS 7.5 M // Units: [M,FT]
**
** Parameter ZSPACS is the distance of bottom of containment sump above the
** upper compartment spray pumps. This parameter is only relevant only if
** the pump water source is from the lower or annular compartment,
** otherwise it can be safely ignored.
**
** ==========================================================================
ZSPASI 9.8 M // Units: [M,FT]
**
** Parameter ZSPASI is the distance of the reactor vessel injection nozzles
** above the upper compartment spray pumps. This parameter is relevant
** only if the pump water source is from the primary system or are used for
** injection to the vessel. otherwise it can be safely ignored.
**
** ==========================================================================
** ==========================================================================
** Lower Compartment Containment Spray System
** ==========================================================================
** ==========================================================================
NSPBG 0 // Dimensionless
**
** Parameter NSPBG is the number of operational lower compartment spray
** (SPB) pumps.
**
** ==========================================================================
NORSPB 7 // Dimensionless
**
** Parameter NORSPB is the pump characteristic set ID for normal pump
** lineup for the lower compartment containment spray. The pump
** characteristic parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5),
** FHXP#, NTPM#, NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#,
** XSTR#, NWCW#, TICW#(5), WCWP#(5), and NTU# where # is the value of
** NORSPB, and these parameters are defined in the Pump parameter section.

```
**
** ==========================================================================
NSSPB          3          // Dimensionless
**
** Parameter NSSPB is the water source selection flag for normal pump
** lineup for the lower compartment spray pumps.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Rwst
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**
** ==========================================================================
NDSPB          5          // Dimensionless
**
** Parameter NDSPB is the pump discharge location selection flag for normal
** pump lineup for the lower compartment spray.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**
** ==========================================================================
RECSPB         7          // Dimensionless
**
** Parameter RECSPB is the pump characteristic set ID for recirculation
** pump lineup for the lower compartment containment spray. The pump
** characteristic parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5),
** FHXP#, NTPM#, NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#,
** XSTR#, NWCW#, TICW#(5), WCWP#(5), and NTU# where # is the value of
** RECSPB, and these parameters are defined in the Pump parameter section.
**
** ==========================================================================
RSSPB          5          // Dimensionless
**
** Parameter RSSPB is the water source selection flag for recirculation
** pump lineup for the lower compartment spray pumps.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: RWST
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**
** ==========================================================================
RDSPB          5          // Dimensionless
**
** Parameter RDSPB is the pump discharge location selection flag for
```

```
** recirculation pump lineup for the lower compartment spray.
**
**     = 1: Hot leg
**     = 2: Cold leg
**     = 3: Downcomer
**     = 4: Upper compartment spray header #1  (Compt. JNUCS)
**     = 5: Lower compartment spray header     (Compt. JNLCS)
**     = 9: Upper compartment spray header #2  (Compt. JNUCS)
**
** ==========================================================================
SNPSPB          0          // Dimensionless
**
** Parameter SNPSPB is the Net Positive Suction Head (NPSH) enhancement
** flow source selection flag for the lower compartment spray.
**
**     = 0: No enhancement flow
**     = 1: NPSH enhancement recirculation flow is drawn from discharge
**          side pump downstream of heat exchanger outlet if it exists,
**          and recirculated to inlet side of pump
**     = 2: NPSH enhancement flow from SPA outlet
**     = 3: NPSH enhancement flow from external water storage tank
**
** ==========================================================================
WESPB          10.0  KG/S     //  Units: [KG/S,LB/HR]
**
** Parameter WESPB is the NPSH enhancement flow rate.  Set WESPB to 0 if no
** NPSH enhancement is to be modeled for the lower compartment spray pump
** lineup.
**
** ==========================================================================
TDNSPB          0.0  S        //  Units: [S,HR]
**
** Parameter TDNSPB is the time to lower compartment spray pump failure
** after the time when insufficient pump NPSH occurred.  The pumps will
** continue to operate with degraded performance (see parameter DEGSPB)
** until the time elapsed since the time when insufficient pump NPSH occurred
** exceeds TDNSPB.  If the elapsed time exceeded parameter TDNSPB before the
** pumps re-acquired sufficient pump NPSH, then the pumps will be lost for
** the duration of the run.  If the pumps re-acquire sufficient NPSH, then
** the time counter will be reset.
**
** ==========================================================================
DEGSPB          7          // Dimensionless
**
** Parameter DEGSPB is the pump characteristic set ID for degraded pump
** lineup for the lower compartment containment spray.  The pump
** characteristic parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5),
** FHXP#, NTPM#, NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#,
** XSTR#, NWCW#, TICW#(5), WCWP#(5), and NTU# where # is the value of
** DEGSPB, and these parameters are defined in the Pump parameter section.
** This set of pump characteristics is automatically selected when the
** pumps have insufficient NPSH.  This pump characteristic set can be the
** same as that specified for normal lineup (see parameter NSSPB) if no
** degraded pump performance is to be considered.  The user can specify an
```

** "alternative" pump performance set instead of the "degraded" pump
** performance set.
**
** ==========================================================================
ZSPBRW 15.0 M // Units: [M,FT]
**
** Parameter ZSPBRW is the distance of bottom of RWST above the lower
** compartment spray pumps. This parameter is only relevant only if the
** pump water source is from the RWST, otherwise it can be safely ignored.
**
** ==========================================================================
ZSPBCS 7.5 M // Units: [M,FT]
**
** Parameter ZSPBCS is the distance of bottom of containment sump above the
** lower compartment spray pumps. This parameter is only relevant only if
** the pump water source is from the lower or annular compartment,
** otherwise it can be safely ignored.
**
** ==========================================================================
ZSPBSI 9.8 M // Units: [M,FT]
**
** Parameter ZSPBSI is the distance of the reactor vessel injection nozzles
** above the lower compartment spray pumps. This parameter is relevant
** only if the pump water source is from the primary system or are used for
** injection to the vessel, otherwise it can be safely ignored.
**
** ==========================================================================
** ==========================================================================
** Low Pressure Injection (Train 1) System
** ==========================================================================
** ==========================================================================
NLP1G 1 // Dimensionless
**
** Parameter NLP1G is the number of operational low pressure injection #1
** (LPI1) pumps.
**
** ==========================================================================
NORLP1 2 // Dimensionless
**
** Parameter NORLP1 is the pump characteristic set ID for normal pump
** lineup for the low pressure injection #1. The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of NORLP1, and these
** parameters are defined in the Pump parameter section.
**
** ==========================================================================
NSLP1 3 // Dimensionless
**
** Parameter NSLP1 is the water source selection flag for normal pump
** lineup for the low pressure injection #1 pumps.
**
** = 0: No source (i.e., system not functional)
** = 1: Hot leg

```
**      = 2: Cold leg
**      = 3: RWST
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**
** ============================================================================
NDLP1           2           // Dimensionless
**
** Parameter NDLP1 is the pump discharge location selection flag for normal
** pump lineup for the low pressure injection #1 pumps.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 6: Inlet of HPI pump
**      = 7: Inlet of charging pump (CHP)
**      = 8: Discharge to both HPI and Charging pump inlet
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**      =10: HPI inlet and upper compartment spray header #1
**      =11: HPI inlet and cold leg
**      =12: CHP inlet and upper compartment spray header #1
**      =13: CHP inlet and cold leg
**
** @@@ 4.0.3 MAM 11/28/95 Options 10-13 were missing from the parameter file.
**
** ============================================================================
RECLP1          2           // Dimensionless
**
** Parameter RECLP1 is the pump characteristic set ID for recirculation
** pump lineup for the low pressure injection #1. The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of RECLP1, and these
** parameters are defined in the Pump parameter section.
**
** ============================================================================
RSLP1           4           // Dimensionless
**
** Parameter RSLP1 is the water source selection flag for recirculation
** pump lineup for the low pressure injection #1 pumps.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: RWST
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**
** ============================================================================
RDLP1           8           // Dimensionless
**
** Parameter RDLP1 is the pump discharge location selection flag for
```

```
** recirculation pump lineup for the low pressure injection #1.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 6: Inlet of HPI pump
**      = 7: Inlet of charging pump
**      = 8: Discharge to both HPI and charging pump inlet
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**      =10: HPI inlet and upper compartment spray header #1
**      =11: HPI inlet and cold leg
**      =12: CHP inlet and upper compartment spray header #1
**      =13: CHP inlet and cold leg
**
** @@@ 4.0.3 MAM 11/28/95 Options 10-13 were missing from the parameter file.
**
** ========================================================================
SNPLP1          0           // Dimensionless
**
** Parameter SNPLP1 is the Net Positive Suction Head (NPSH) enhancement
** flow source selection flag for the low pressure injection #1.
**
**      = 0: No enhancement flow
**      = 1: NPSH enhancement recirculation flow is drawn from discharge
**           side pump downstream of heat exchanger outlet if it exists,
**           and recirculated to inlet side of pump
**      = 2: NPSH enhancement flow from SPA outlet
**      = 3: NPSH enhancement flow from external water storage tank
**
** ========================================================================
WELP1          0.0  KG/S       //  Units: [KG/S,LB/HR]
**
** Parameter WELP1 is the NPSH enhancement flow rate.  Set WESPB to 0 if no
** NPSH enhancement is to be modeled for the low pressure injection #1 pump
** lineup.
**
** ========================================================================
TDNLP1          0.0  S         //  Units: [S,HR]
**
** Parameter TDNLP1 is the time to low pressure injection #1 pump failure
** after the time when insufficient pump NPSH occurred.  The pumps will
** continue to operate with degraded performance (see parameter DEGLP1)
** until the time elapsed since the time when insufficient pump NPSH occurred
** exceeds TDNLP1.  If the clapsed time exceeded parameter TDNLP1 before the
** pumps re-acquired sufficient pump NPSH, then the pumps will be lost for
** the duration of the run.  If the pumps re-acquire sufficient NPSH, then
** the time counter will be reset.
**
** ========================================================================
DEGLP1          6           // Dimensionless
**
** Parameter DEGLP1 is the pump characteristic set ID for degraded pump
```

** lineup for the low pressure injection #1. The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of DEGLP1, and these
** parameters are defined in the Pump parameter section. This set of pump
** characteristics is automatically selected when the pumps have
** insufficient NPSH. This pump characteristic set can be the same as that
** specified for normal lineup (see parameter NSLP1) if no degraded pump
** performance is to be considered. The user can specify an "alternative"
** pump performance set instead of the "degraded" pump performance set.
**
** ==========================================================================
ZLP1RW 15.0 M // Units: [M,FT]
**
** Parameter ZLP1RW is the distance of bottom of RWST above the low
** pressure injection #1 pumps. This parameter is only relevant only if
** the pump water source is from the RWST, otherwise it can be safely
** ignored.
**
** ==========================================================================
ZLP1CS 7.5 M // Units: [M,FT]
**
** Parameter ZLP1CS is the distance of bottom of containment sump above the
** low pressure injection #1 pumps. This parameter is only relevant only
** if the pump water source is from the lower or annular compartment,
** otherwise it can be safely ignored.
**
** ==========================================================================
ZLP1SI 9.8 M // Units: [M,FT]
**
** Parameter ZLP1SI is the distance of the reactor vessel injection nozzles
** above the low pressure injection #1 pumps. This parameter is relevant
** only if the pump water source is from the primary system or are used for
** injection to the vessel, otherwise it can be safely ignored.
**
** ==========================================================================
** ==========================================================================
** Low Pressure Injection (Train 2) System
** ==========================================================================
** ==========================================================================
NLP2G 0 // Dimensionless
**
** Parameter NLP2G is the number of operational low pressure injection #2
** (LPI2) pumps.
**
** ==========================================================================
NORLP2 2 // Dimensionless
**
** Parameter NORLP2 is the pump characteristic set ID for normal pump
** lineup for the low pressure injection #2. The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of NORLP2, and these
** parameters are defined in the Pump parameter section.

```
**
** ========================================================================
NSLP2          3          // Dimensionless
**
** Parameter NSLP2 is the water source selection flag for normal pump
** lineup for the low pressure injection #2 pumps.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Rwst
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**
** ========================================================================
NDLP2          2          // Dimensionless
**
** Parameter NDLP2 is the pump discharge location selection flag for normal
** pump lineup for the low pressure injection #2 pumps.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 6: Inlet of HPI pump
**      = 7: Inlet of charging pump
**      = 8: Discharge to both HPI and charging pump inlet
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**      =10: HPI inlet and upper compartment spray header #1
**      =11: HPI inlet and cold leg
**      =12: CHP inlet and upper compartment spray header #1
**      =13: CHP inlet and cold leg
**
** @@@ 4.0.3 MAM 11/28/95 Options 10-13 were missing from the parameter file.
**
** ========================================================================
RECLP2         2          // Dimensionless
**
** Parameter RECLP2 is the pump characteristic set ID for recirculation
** pump lineup for the low pressure injection #2.  The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of RECLP2, and these
** parameters are defined in the Pump parameter section.
**
** ========================================================================
RSLP2          4          // Dimensionless
**
** Parameter RSLP2 is the water source selection flag for recirculation
** pump lineup for the low pressure injection #2 pumps.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
```

```
**      = 2: Cold leg
**      = 3: Rwst
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**
** ==========================================================================
RDLP2          4          // Dimensionless
**
** Parameter RDLP2 is the pump discharge location selection flag for
** recirculation pump lineup for the low pressure injection #2.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 6: Inlet of HPI pump
**      = 7: Inlet of charging pump
**      = 8: Discharge to both HPI and charging pump inlet
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**      =10: HPI inlet and upper compartment spray header #1
**      =11: HPI inlet and cold leg
**      =12: CHP inlet and upper compartment spray header #1
**      =13: CHP inlet and cold leg
**
** @@@ 4.0.3 MAM 11/28/95 Options 10-13 were missing from the parameter file.
**
** ==========================================================================
SNPLP2         0          // Dimensionless
**
** Parameter SNPLP2 is the Net Positive Suction Head (NPSH) enhancement
** flow source selection flag for the low pressure injection #2.
**
**     = 0: No enhancement flow
**     = 1: NPSH enhancement recirculation flow is drawn from discharge
**          side pump downstream of heat exchanger outlet if it exists,
**          and recirculated to inlet side of pump
**     = 2: NPSH enhancement flow from SPA outlet
**     = 3: NPSH enhancement flow from external water storage tank
**
** ==========================================================================
WELP2          0.0  KG/S     // Units: [KG/S,LB/HR]
**
** Parameter WELP2 is the NPSH enhancement flow rate.  Set WESPB to 0 if no
** NPSH enhancement is to be modeled for the low pressure injection #2 pump
** lineup.
**
** ==========================================================================
TDNLP2         0.0  S        // Units: [S,HR]
**
** Parameter TDNLP2 is the time to low pressure injection #2 pump failure
** after the time when insufficient pump NPSH occurred.  The pumps will
** continue to operate with degraded performance (see parameter DEGLP2)
** until the time elapsed since the time when insufficient pump NPSH occurred
```

** exceeds TDNLP2. If the elapsed time exceeded parameter TDNLP2 before the
** pumps re-acquired sufficient pump NPSH, then the pumps will be lost for
** the duration of the run. If the pumps re-acquire sufficient NPSH, then
** the time counter will be reset.
**
** ==================================================================
DEGLP2 2 // Dimensionless
**
** Parameter DEGLP2 is the pump characteristic set ID for degraded pump
** lineup for the low pressure injection #2. The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of DEGLP2, and these
** parameters are defined in the Pump parameter section. This set of pump
** characteristics is automatically selected when the pumps have
** insufficient NPSH. This pump characteristic set can be the same as that
** specified for normal lineup (see parameter NSLP2) if no degraded pump
** performance is to be considered. The user can specify an "alternative"
** pump performance set instead of the "degraded" pump performance set.
**
** ==================================================================
ZLP2RW 15.0 M // Units: [M,FT]
**
** Parameter ZLP2RW is the distance of bottom of RWST above the low
** pressure injection #2 pumps. This parameter is only relevant only if
** the pump water source is from the RWST, otherwise it can be safely
** ignored.
**
** ==================================================================
ZLP2CS 7.5 M // Units: [M,FT]
**
** Parameter ZLP2CS is the distance of bottom of containment sump above the
** low pressure injection #2 pumps. This parameter is only relevant only if
** the pump water source is from the lower or annular compartment,
** otherwise it can be safely ignored.
**
** ==================================================================
ZLP2SI 9.8 M // Units: [M,FT]
**
** Parameter ZLP2SI is the distance of the reactor vessel injection nozzles
** above the low pressure injection #2 pumps. This parameter is relevant
** only if the pump water source is from the primary system or are used for
** injection to the vessel, otherwise it can be safely ignored.
**
** ==================================================================
** ==================================================================
** High Pressure Injection System
**
** The generalized engineered safeguards system uses subroutine PZWLC to
** provide the limiting HPI throttled pump flow rate if the pressurizer
** water level control is enabled using *Pressuizer parameters NPZCT,
** ZWPZCL, and ZWPZCH.
**
** ==================================================================

```
** ======================================================================
NHPIG          1          // Dimensionless
**
** Parameter NHPIG is the number of operational high pressure injection
** (HPI) pumps.
**
** ======================================================================
NORHPI         3          // Dimensionless
**
** Parameter NORHPI is the pump characteristic set ID for normal pump
** lineup for the high pressure injection.  The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of NORHPI, and these
** parameters are defined in the Pump parameter section.
**
** ======================================================================
NSHPI          3          // Dimensionless
**
** Parameter NSHPI is the water source selection flag for normal pump
** lineup for the high pressure injection pumps.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: RWST
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**      = 6: LPI 1
**      = 7: LPI 2
**      = 8: SPA discharge
**
** @@@ 4.0.3 MAM 11/28/95 Option 8 was missing from the parameter file.
**
** ======================================================================
NDHPI          2          // Dimensionless
**
** Parameter NDHPI is the pump discharge location selection flag for normal
** pump lineup for the high low pressure injection pumps.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**
** ======================================================================
RECHPI         3          // Dimensionless
**
** Parameter RECHPI is the pump characteristic set ID for recirculation
** pump lineup for the high pressure injection.  The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
```

```
** TICW#(5), WCWP#(5), and NTU# where # is the value of RECHPI, and these
** parameters are defined in the Pump parameter section.
**
** ==========================================================================
RSHPI          6          // Dimensionless
**
** Parameter RSHPI is the water source selection flag for recirculation
** pump lineup for the high pressure injection pumps.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: RWST
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**      = 6: LPI 1
**      = 7: LPI 2
**      = 8: SPA discharge
**
** @@@ 4.0.3 MAM 11/28/95 Option 8 was missing from the parameter file.
**
** ==========================================================================
RDHPI          2          // Dimensionless
**
** Parameter RDHPI is the pump discharge location selection flag for
** recirculation pump lineup for the high pressure injection.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**
** ==========================================================================
SNPHPI         0          // Dimensionless
**
** Parameter SNPHPI is the Net Positive Suction Head (NPSH) enhancement
** flow source selection flag for the high pressure injection.
**
**      = 0: No enhancement flow
**      = 1: NPSH enhancement recirculation flow is drawn from discharge
**           side pump downstream of heat exchanger outlet if it exists,
**           and recirculated to inlet side of pump
**      = 2: NPSH enhancement flow from SPA outlet
**      = 3: NPSH enhancement flow from external water storage tank
**
** ==========================================================================
WEHPI          0.0  KG/S      // Units: [KG/S,LB/HR]
**
** Parameter WEHPI is the NPSH enhancement flow rate.  Set WESPB to 0 if no
** NPSH enhancement is to be modeled for the high pressure injection pump
** lineup.
**
```

** ==========================================================================
TDNHPI 0.0 S // Units: [S,HR]
**
** Parameter TDNHPI is the time to low pressure injection #2 pump failure
** after the time when insufficient pump NPSH occurred. The pumps will
** continue to operate with degraded performance (see parameter DEGHPI)
** until the time elapsed since the time when insufficient pump NPSH occurred
** exceeds TDNHPI. If the elapsed time exceeded parameter TDNHPI before the
** pumps re-acquired sufficient pump NPSH, then the pumps will be lost for
** the duration of the run. If the pumps re-acquire sufficient NPSH, then
** the time counter will be reset.
**
** ==========================================================================
DEGHPI 3 // Dimensionless
**
** Parameter DEGHPI is the pump characteristic set ID for degraded pump
** lineup for the low pressure injection #2. The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of DEGHPI, and these
** parameters are defined in the Pump parameter section. This set of pump
** characteristics is automatically selected when the pumps have
** insufficient NPSH. This pump characteristic set can be the same as that
** specified for normal lineup (see parameter NSHPI) if no degraded pump
** performance is to be considered. The user can specify an "alternative"
** pump performance set instead of the "degraded" pump performance set.
**
** ==========================================================================
ZHPIRW 15.0 M // Units: [M,FT]
**
** Parameter ZHPIRW is the distance of the bottom of the RWST above the
** high pressure injection pumps. This parameter is only relevant only if
** the pump water source is from the RWST, otherwise it can be safely
** ignored.
**
** ==========================================================================
ZHPICS 7.5 M // Units: [M,FT]
**
** Parameter ZHPICS is the distance of the bottom of the containment sump
** above the high pressure injection pumps. This parameter is only
** relevant only if the pump water source is from the lower or annular
** compartment, otherwise it can be safely ignored.
**
** ==========================================================================
ZHPISI 9.8 M // Units: [M,FT]
**
** Parameter ZHPISI is the distance of the reactor vessel injection nozzles
** above the high pressure injection pumps. This parameter is relevant
** only if the pump water source is from the primary system or are used for
** injection to the vessel, otherwise it can be safely ignored.
**
** ==========================================================================
** ==========================================================================
** Charging Pump System

```
**
** The generalized engineered safeguards system uses subroutine PZWLC to
** provide the limiting CHP throttled pump flow rate if the pressurizer
** water level control is enabled using *Pressurizer parameters NPZCT,
** ZWPZCL, and ZWPZCH.
**
** ========================================================================
** ========================================================================
NCHPG          1          // Dimensionless
**
** Parameter NCHPG is the number of operational charging pump injection
** (CHP) pumps.
**
** ========================================================================
NORCHP         4          // Dimensionless
**
** Parameter NORCHP is the pump characteristic set ID for normal pump
** lineup for the charging pump injection.  The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of NORCHP, and these
** parameters are defined in the Pump parameter section.
**
** ========================================================================
NSCHP          3          // Dimensionless
**
** Parameter NSCHP is the water source selection flag for normal pump
** lineup for the charging pump injection.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: RWST
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**      = 6: LPI 1
**      = 7: LPI 2
**      = 8: SPA discharge
**
** @@@ 4.0.3 MAM 11/28/95 Option 8 was missing from the parameter file.
**
** ========================================================================
NDCHP          2          // Dimensionless
**
** Parameter NDCHP is the pump discharge location selection flag for normal
** pump lineup for the charging pump injection.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**
```

```
** ==========================================================================
RECCHP          4          // Dimensionless
**
** Parameter RECCHP is the pump characteristic set ID for recirculation
** pump lineup for the high pressure injection. The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of RECCHP, and these
** parameters are defined in the Pump parameter section.
**
** ==========================================================================
RSCHP           6          // Dimensionless
**
** Parameter RSCHP is the water source selection flag for recirculation
** pump lineup for the charging pumps.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: RWST
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**      = 6: LPI 1
**      = 7: LPI 2
**      = 8: SPA discharge
**
** @@@ 4.0.3 MAM 11/28/95 Option 8 was missing from the parameter file.
**
** ==========================================================================
RDCHP           2          // Dimensionless
**
** Parameter RDCHP is the pump discharge location selection flag for
** recirculation pump lineup for the charging pump injection.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**
** ==========================================================================
SNPCHP          0          // Dimensionless
**
** Parameter SNPCHP is the Net Positive Suction Head (NPSH) enhancement
** flow source selection flag for the charging pump injection.
**
**      = 0: No enhancement flow
**      = 1: NPSH enhancement recirculation flow is drawn from discharge
**           side pump downstream of heat exchanger outlet if it exists,
**           and recirculated to inlet side of pump
**      = 2: NPSH enhancement flow from SPA outlet
**      = 3: NPSH enhancement flow from external water storage tank
**
```

** ==========================================================================
WECHP 0.0 KG/S // Units: [KG/S,LB/HR]
**
** Parameter WECHP is the NPSH enhancement flow rate. Set WESPB to 0 if no
** NPSH enhancement is to be modeled for the charging pumps lineup.
**
** ==========================================================================
TDNCHP 0.0 S // Units: [S,HR]
**
** Parameter TDNCHP is the time to charging pump failure after the time when
** insufficient pump NPSH occurred. The pumps will continue to operate with
** degraded performance (see parameter DEGCHP) until the time elapsed since
** the time when insufficient pump NPSH occurred exceeds TDNCHP. If the
** elapsed time exceeded parameter TDNCHP before the pumps re-acquired
** sufficient pump NPSH, then the pumps will be lost for the duration of the
** run. If the pumps re-acquire sufficient NPSH, then the time counter will
** be reset.
**
** ==========================================================================
DEGCHP 4 // Dimensionless
**
** Parameter DEGCHP is the pump characteristic set ID for degraded pump
** lineup for the charging pump injection. The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of DEGCHP, and these
** parameters are defined in the Pump parameter section. This set of pump
** characteristics is automatically selected when the pumps have
** insufficient NPSH. This pump characteristic set can be the same as that
** specified for normal lineup (see parameter NSCHP) if no degraded pump
** performance is to be considered. The user can specify an "alternative"
** pump performance set instead of the "degraded" pump performance set.
**
** ==========================================================================
ZCHPRW 15.0 M // Units: [M,FT]
**
** Parameter ZCHPRW is the distance of bottom of RWST above the charging
** pumps. This parameter is only relevant only if the pump water source is
** from the RWST, otherwise it can be safely ignored.
**
** ==========================================================================
ZCHPCS 7.5 M // Units: [M,FT]
**
** Parameter ZCHPCS is the distance of bottom of containment sump above the
** charging pumps. This parameter is only relevant only if the pump water
** source is from the lower or annular compartment, otherwise it can be
** safely ignored.
**
** ==========================================================================
ZCHPSI 9.8 M // Units: [M,FT]
**
** Parameter ZCHPSI is the distance of the reactor vessel injection nozzles
** above the charging pumps. This parameter is relevant only if the pump
** water source is from the primary system or are used for injection to the

```
** vessel, otherwise it can be safely ignored.
**
** ======================================================================
** ======================================================================
** Containment Spray System Train C
** ======================================================================
** ======================================================================
NSPCG          0          // Dimensionless
**
** Parameter NSPCG is the number of operational train C containment spray
** (SPC) pumps.
**
** ======================================================================
NORSPC         1          // Dimensionless
**
** Parameter NORSPC is the pump characteristic set ID for normal pump
** lineup for the train C containment spray. The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of NORSPC, and these
** parameters are defined in the Pump parameter section.
**
** ======================================================================
NSSPC          3          // Dimensionless
**
** Parameter NSSPC is the water source selection flag for normal pump
** lineup for the train C containment spray pumps.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: RWST
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**
** ======================================================================
NDSPC          4          // Dimensionless
**
** Parameter NDSPC is the pump discharge location selection flag for normal
** pump lineup for the train C containment spray.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**
** ======================================================================
RECSPC         1          // Dimensionless
**
** Parameter RECSPC is the pump characteristic set ID for recirculation
** pump lineup for the train C containment spray. The pump characteristic
** parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5), FHXP#, NTPM#,
```

```
** NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#, XSTR#, NWCW#,
** TICW#(5), WCWP#(5), and NTU# where # is the value of RECSPC, and these
** parameters are defined in the Pump parameter section.
**
** ========================================================================
RSSPC          0         // Dimensionless
**
** Parameter RSSPC is the water source selection flag for recirculation
** pump lineup for the train C containment spray pumps.
**
**      = 0: No source (i.e., system not functional)
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: RWST
**      = 4: Lower compartment sump  (Compt. JNCSMP)
**      = 5: Annular compartment sump  (Compt. JNASMP)
**
** ========================================================================
RDSPC          4         // Dimensionless
**
** Parameter RDSPC is the pump discharge location selection flag for
** recirculation pump lineup for the train C containment spray.
**
**      = 1: Hot leg
**      = 2: Cold leg
**      = 3: Downcomer
**      = 4: Upper compartment spray header #1  (Compt. JNUCS)
**      = 5: Lower compartment spray header     (Compt. JNLCS)
**      = 9: Upper compartment spray header #2  (Compt. JNUCS)
**
** ========================================================================
SNPSPC         0         // Dimensionless
**
** Parameter SNPSPC is the Net Positive Suction Head (NPSH) enhancement
** flow source selection flag for the train C containment spray.
**
**      = 0: No enhancement flow
**      = 1: NPSH enhancement recirculation flow is drawn from discharge
**           side pump downstream of heat exchanger outlet if it exists,
**           and recirculated to inlet side of pump
**      = 2: NPSH enhancement flow from SPA outlet
**      = 3: NPSH enhancement flow from external water storage tank
**
** ========================================================================
WESPC          0.0  KG/S     // Units: [KG/S,LB/HR]
**
** Parameter WESPC is the NPSH enhancement flow rate.  Set WESPC to 0 if no
** NPSH enhancement is to be modeled for the lower compartment spray pump
** lineup.
**
** ========================================================================
TDNSPC         0.0  S       // Units: [S,HR]
**
** Parameter TDNSPC is the time to train C containment spray pump failure
```

** after the time when insufficient pump NPSH occurred. The pumps will
** continue to operate with degraded performance (see parameter DEGSPC)
** until the time elapsed since the time when insufficient pump NPSH occurred
** exceeds TDNSPC. If the elapsed time exceeded parameter TDNSPC before the
** pumps re-acquired sufficient pump NPSH, then the pumps will be lost for
** the duration of the run. If the pumps re-acquire sufficient NPSH, then
** the time counter will be reset.
**
** ==========================================================================
DEGSPC 1 // Dimensionless
**
** Parameter DEGSPC is the pump characteristic set ID for degraded pump
** lineup for the lower compartment containment spray. The pump
** characteristic parameters used are NPOI#, ZHDP#(5), WVPM#(5), ZHDR#(5),
** FHXP#, NTPM#, NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#, XIDS#,
** XSTR#, NWCW#, TICW#(5), WCWP#(5), and NTU# where # is the value of
** DEGSPC, and these parameters are defined in the Pump parameter section.
** This set of pump characteristics is automatically selected when the
** pumps have insufficient NPSH. This pump characteristic set can be the
** same as that specified for normal lineup (see parameter NSSPC) if no
** degraded pump performance is to be considered. The user can specify an
** "alternative" pump performance set instead of the "degraded" pump
** performance set.
**
** ==========================================================================
ZSPCRW 15.0 M // Units: [M,FT]
**
** Parameter ZSPCRW is the distance of the bottom of the RWST above the
** train C containment spray pumps. This parameter is only relevant only
** if the pump water source is from the RWST, otherwise it can be safely
** ignored.
**
** ==========================================================================
ZSPCCS 7.5 M // Units: [M,FT]
**
** Parameter ZSPCCS is the distance of the bottom of the containment sump
** above the train C containment spray pumps. This parameter is only
** relevant only if the pump water source is from the lower or annular
** compartment, otherwise it can be safely ignored.
**
** ==========================================================================
ZSPCSI 9.8 M // Units: [M,FT]
**
** Parameter ZSPCSI is the distance of the reactor vessel injection nozzles
** above the train C containment spray pumps. This parameter is relevant
** only if the pump water source is from the primary system or are used for
** injection to the vessel, otherwise it can be safely ignored.
**
** ==========================================================================
** The next two parameters are required if the NPSH enhancement flow from
** the external water storage tank is modeled for any of the pump systems.
**
TWEXT 0.0 K // Units: [K,F]
**

```
** Parameter TWEXT is the water temperature in external storage tank.
**
MWEXT0          0.0  KG        // Units: [KG,LB]
**
** Parameter MWEXT0 is the initial water mass in external storage tank.
**
** ======================================================================
** ======================================================================
** Boric Acid (H3BO3) Injection for MAAP4 Generalized Engineered Safeguards
**
** Three possible sources of boric acid (H3BO3) injection into the reactor
** vessel is either from the injection flow to the downcomer, cold leg,
** and/or hot leg. The next three parameters, FBADC0, FBACL0, and FBAHL0,
** asks for the mass fraction of the boric acid (H3BO3) being injected from
** each source. The total mass rate of boric acid (H3BO3) introduced into
** the reactor system is WBAPS and the total integrated value of the boric
** acid (H3BO3) injected is MBATOT. The mass of boric acid (H3BO3) is
** tracked in the reactor vessel as MBAPS and in the containment as
** MFPWB(13,iv) for the iv'th comparment water pool. In the containment or
** auxilary building compartments, the mass of H3BO3 in the water pool is
** used to determine the pH value of the water pool, and can be plotted as
** FPHVAL(iv) for the iv'th comparment water pool. Presently, the pH of
** the reactor vessel water is not computed. See subroutine AUXFP writeup
** of the MAAP4 User Manual for additional details of how the pH value is
** calculated.
**
** Note that the next three parameters are only used when the MAAP4
** generalized engineered safeguard system is selected, e.g., when NESF
** is set to 1.
**
** Also note that when the engineered safeguard suction source is from the
** containment sump, the corresponding boric acid mass fraction is not
** removed from the containment sump water pool. This limitiation only
** applies when the generalized engineered safeguard systems are used.
** The MAAP specific engineered safeguard systems correctly accounts for
** the boric acid removal when the suction source is the containment sump.
**
** ======================================================================
** Name: FBADC0                Units: [Dimensionless]
**
** @@@ 4.0.3 MAM 12/6/95  Parameter FBADC0 was missing from all PWR
** parameter files.
**
** Parameter FBADC0 is the mass fraction of the boric acid (H3BO3) in the
** injection flow to the downcomer.
**
** ======================================================================
** Name: FBACL0                Units: [Dimensionless]
**
** @@@ 4.0.3 MAM 12/6/95  Parameter FBACL0 was missing from all PWR
** parameter files.
**
** Parameter FBACL0 is the mass fraction of the boric acid (H3BO3) in the
** injection flow to the cold leg.
```

**
** ==============================================================================
** Name: FBAHL0 Units: [Dimensionless]
**
** @@@ 4.0.3 MAM 12/6/95 Parameter FBAHL0 was missing from all PWR
** parameter files.
**
** Parameter FBAHL0 is the mass fraction of the boric acid (H3BO3) in the
** injection flow to the hot leg.
**
** ==============================================================================
** ==============================================================================
**
** @@@ 4.0.2 CDW 6/29/95 Parameters ACSD and ZCSD are no longer used.
**
** @@@ 4.0.3 MAM 12/6/95 Containment chiller input parameters were moved
** to the *Engineered Safeguards parameter section.
**
** @@@ 4.0.3 MAM 12/6/95 Steam Driven Auxiliary Feedwater System were
** moved to the *Steam Generator parameter section.
**
*************************************************************************
*Pump Characteristics
*************************************************************************
*SI
**
** This parameter section only applies if MAAP generalized engineered
** safeguard models are used, eg., when parameter NESF is set to 1. This
** parameter section is to be used with the *Generalized Engineered
** Safeguards parameter section. This parameter section defines the
** characteristics of a pump system and up to 21 distinct pump
** characteristic sets may be defined. The input setup consists of
** defining the three main characteristics:
**
** 1) The pumping capacity of a pump (flow vs head) for a normal,
** alternate, or degraded line-up. Such information are
** typically obtained from system curves.
**
** 2) Net Positive Suction Head (NPSH) requirements.
**
** 3) Heat exchanger attributes if a heat exchanger exits
** downstream of the pump.
**
** In Generalized Engineered Safeguards parameter section, the specific
** engineered safeguard systems assigns the pump characteristic set (id)
** number which correspond to one of the pump characteristic sets defined
** here. A unique set of pump characteristics must be used for each pump
** system used or assigned. So for pump systems that have the same
** characteristics, simply duplicate the set and assign an independent set
** number in the Generalized Engineered Safeguards parameter section
** whenever a pump characteristic set id is requested.
**
** A group of twenty parameters representing forty data inputs are needed
** to define the #'th pump system or characteristics. These are:

```
**
**    1. NPOI#          [Dimensionless]
**    2. ZHDP#(5)        [M,FT]
**    3. WVPM#(5)         [M**3/S,GPM]
**    4. ZHDR#(5)        [M,FT]
**    5. FHXP#           [Dimensionless]
**    6. NTPM#           [Dimensionless]
**    7. NBPM#           [Dimensionless]
**    8. XIDT#         [M,FT]
**    9. XTT#          [M,FT]
**   10. XTC#          [M,FT]
**   11. XS#          [M,FT]
**   12. RGFL#         [M**2-C/W,FT**2-HR-F/BTU]
**   13. KT#          [W/M-C,BTU/FT-HR-F]
**   14. XBC#          [M,FT]
**   15. XIDS#         [M,FT]
**   16. XSTR#         [M,FT]
**   17. NWCW#           [Dimensionless]
**   18. TICW#(5)        [S,HR]
**   19. WCWP#(5)         [KG/S,LB/HR]
**   20. NTU#          [Dimensionless]
**
** In MAAP 3.0B, the forty data points for each pump system characteristics
** were entered as COMPMP(1:40) for 1'th pump system, COMPMP(41:80) for
** 2'nd pump system, COMPMP(81:120) for 3'rd pump system, etc. In MAAP4,
** because of the conformance to variable naming rules in order to ensure
** proper units identification based on the variable's name, the variables
** listed above were added to the code for the 21 distinct pump systems,
** where the symbol # represents a number ranging from 1 to 21. Hence,
** these names can be used in place of the COMPMP() name. Each of the 20
** parameter variables are explained next.
**
** ======================================================================
** Pump Head Flow Curve, ZHDP#() vs WVPM#()
**
** ZHDP#(i) is a one dimensional array with up to 5 data points representing
** the pressure head of the pump head flow curve for the #'th pump system.
** The actual number of data points to use is defined by the parameter NPOI#.
** Each pressure head value has a corresponding volumetric flow rate defined
** in the one dimensional WVPM#(i) array. MAAP calculates a delta-head and
** performs a comparison to determine which two of the five ZHDP#(i) values
** bound it. MAAP then performs a linear interpolation using the
** corresponding WVPM#(i) flow rates to obtain the system flow rate. Note
** that a single data point can be used to model constant flow, if so then
** set NPOI# to 1, set ZHDPM#() to a large number, and WVPM#() to the
** desired constant flow rate.
**
** If the system flow curve information is not available use the pump flow
** curve, but be aware that the pump flow curve will over-predict system
** flow since line friction losses are not considered.
**
** Name: NPOI#              Units: [Dimensionless]
**
** This parameter is the number of data points in the #'th pump head curve.
```

```
**
** Name: ZHDP#(5)              Units: [M,FT]
**
** This parameter is the array of pump head for the #'th pump head flow
** curve.
**
** Name: WVPM#(5)              Units: [M**3/S,GPM]
**
** This parameter is the array of volumetric flow rate for the #'th pump
** head flow curve.
**
** ======================================================================
** Name: ZHDR#(5)              Units: [M,FT]
**
** This parameter is the Net Positive Suction Head (NPSH) required for the
** pump corresponding to the pump head flow curve variables ZHDP#() and
** WVPM#(). Note that the NPSH curve data points must have a one to one
** correspondence to the pump head flow curve data points. The pump will
** trip if the available NPSH is less than the pump NPSH required, defined
** by ZHDR#() array for the flow rate obtained from the head flow curve.
** Set these values to zero to not to trip the pump off due to insufficient
** NPSH.
**
** ======================================================================
** Heat Exchanger for the #'th Pump System/Characteristics
**
** MAAP experience acquired to date indicates that the most consistent
** accurate representation of heat removal performance over the range of
** conditions frequently inputted to MAAP's heat exchanger model (HTEXCH)
** is obtained by specifying the detailed heat exchanger design data. If
** this data can be supplied, a value of zero should be assigned to the
** heat exchanger NTU parameter. If for whatever reason the detailed data
** cannot be provided, a somewhat less accurate but generally reasonable
** approximation of heat exchanger performance can be obtained by providing
** heat exchanger NTU parameter, and setting the detailed heat exchanger
** parameters to zero.
**
** Users have the choice of either specifying the heat exchanger NTU or
** providing detailed heat exchanger geometry inputs. The detailed heat
** exchanger model is used only when the value of NTU# is zero for the
** specified if a heat exchanger is to be modeled for the #'th pump
** system/characteristics.
**
** Parameters NTPM#, NBPM#, XIDT#, XTT#, XTC#, XS#, RGFL#, KT#, XBC#,
** XIDS#, XSTR#, NWCW#, TICW#(), and WCWP() are used for the detailed
** heat exchanger model when NTU# is zero for the #'th heat exchanger.
**
** For further technical advice regarding MAAP's heat exchanger model,
** consult the HTEXCH subroutine description in the MAAP User's Manual,
** Volume 2, and in particular, Figure 1 in the subroutine HTEXCH writeup
** for geometric information.
**
** ======================================================================
** Name: FHXP#                 Units: [Dimensionless]
```

```
**
** Parameter FHXP# is a flag for the type of the #'th heat exchanger:
**
**      -1 =  set the outlet temperature of the heat exchanger to the
**            RWST temperature.
**       0 =  no heat exchanger is modeled, set the outlet temp to the
**            suction source temperature.
**       1 =  straight tube heat exchanger
**       2 =  u-tube heat exchanger
**
** Note that the heat exchanger type must be specified at the start of a
** MAAP run.  It is not resetable during a MAAP run using local parmaeter
** change.
**
** ======================================================================
** Name: NTU#                  Units: [Dimensionless]
**
** Parameter NTU# is the NTU for the #'th heat exchanger.  NTU# should be
** set to 0.0 if the detailed heat exchanger model is used.
**
** ======================================================================
** Name: NTPM#                 Units: [Dimensionless]
**
** Parameter NTPM# is the number of tubes in the #'th heat the exchanger.
** Specify the actual number of tubes.  MAAP will multiply this number by
** two if a U-tube heat exchanger is involved (see parameter FHXP#).
**
** ======================================================================
** Name: NBPM#                 Units: [Dimensionless]
**
** Parameter NBPM# is the number of shell side baffles in the #'th heat
** exchanger.
**
** ======================================================================
** Name: XIDT#                 Units: [M,FT]
**
** Prameter XIDT# is the #'th heat exchanger tube inside diameter.
**
** ======================================================================
** Name: XTT#                  Units: [M,FT]
**
** Parameter XTT# is the #'th heat exchanger tube wall thickness.
**
** ======================================================================
** Name: XTC#                  Units: [M,FT]
**
** Parameter XTC# is the #'th heat exchanger tube center to center spacing.
**
** ======================================================================
** Name: XS#                   Units: [M,FT]
**
** Parameter XS# is the #'th heat exchanger shell length.
**
** ======================================================================
```

```
** Name: RGFL#             Units: [M**2-C/W,FT**2-HR-F/BTU]
**
** Parameter RGFL# is the #'th heat exchanger fouling factor.  This is the
** total heat resistance due to fouling on both the shell and tube sides.
**
** ==========================================================================
** Name: KT#               Units: [W/M-C,BTU/FT-HR-F]
**
** Parameter KT# is the thermal conductivity for the #'th heat exchanger
** tube wall.
**
** ==========================================================================
** Name: XBC#              Units: [M,FT]
**
** Parameter XBC# is the baffle cut length for the #'th heat exchanger.
**
** ==========================================================================
** Name: XIDS#             Units: [M,FT]
**
** Parameter XIDS# is the shell inner diameter for the #'th heat exchanger.
**
** ==========================================================================
** Name: XSTR#             Units: [M,FT]
**
** Parameter XSTR# is the tube bundle to shell gap length for the #'th heat
** exchanger.
**
** ==========================================================================
** Name: NWCW#             Units: [Dimensionless]
**
** Parameter NWCW# is the number of data points in the #'th pump system
** heat exchanger service water cooling curve represented by parameter
** arrays TICW#() and WCWP#().  Note that the cooling water flow through
** the heat exchanger is independent of the number of pumps.
**
** ==========================================================================
** Name: TICW#(5)          Units: [S,HR]
**
** Parameter TICW#() is the array of times corresponding to the service
** water mass flow rate array WCWP#().
**
** ==========================================================================
** Name: WCWP#(5)          Units: [KG/S,LB/HR]
**
** Parameter WCWP#() is the array of service water mass flow rates for the
** temperature is specified by the *Engineered Safeguard fan cooler
** parameter TCWHX.
**
** ==========================================================================
** The current scheme has seven sets of pump characteristics defined as:
**
**    Pump characteristic #1, normal upper compartment spray flow (SPA)
**    Pump characteristic #2, normal LPI1 flow
**    Pump characteristic #3, normal HPI flow
```

```
**   Pump characteristic #4, normal CHP flow
**   Pump characteristic #5, normal recirculation system spray flow
**   Pump characteristic #6, degraded LPI1 flow
**   Pump characteristic #7, normal lower compartment spray flow (SPB)
**
************************   PUMP 1   ************************
*********************   NORMAL SPA FLOW   *********************

NPOI1      1       // one point, constant flow

ZHDP1(1)   1000    // pump head
ZHDP1(2)   0
ZHDP1(3)   0
ZHDP1(4)   0
ZHDP1(5)   0

WVPM1(1)   1.65e-1   // volumetric flow
WVPM1(2)   0.0
WVPM1(3)   0.0
WVPM1(4)   0.0
WVPM1(5)   0.0

ZHDR1(1)   3.05    // NPSH
ZHDR1(2)   3.05
ZHDR1(3)   3.05
ZHDR1(4)   3.05
ZHDR1(5)   3.05

FHXP1      1       // straight tube heat exchanger type
NTU1       0.989   // heat exchanger NTU

NTPM1      0.0     // number of tubes
NBPM1      0.0     // number of baffles
XIDT1      0.0     // tube ID
XTT1       0.0     // tube thickness
XTC1       0.0     // center to center
XS1        0.0     // shell length
RGFL1      0.0     // fouling factor
KT1        0.0     // tube thermal conductivity
XBC1       0.0     // baffle length
XIDS1.     0.0     // shell ID
XSTR1      0.0     // bundle to shell length

NWCW1      1       // one point, constant flow

TICW1(1)   0.0     // time
TICW1(2)   0.0
TICW1(3)   0.0
TICW1(4)   0.0
TICW1(5)   0.0

WCWP1(1)   311.9   // mass flowrate
WCWP1(2)   0.0
WCWP1(3)   0.0
```

```
WCWP1(4)  0.0
WCWP1(5)  0.0

*********************     PUMP 2      *********************
*********************   NORMAL LPI1 FLOW  *********************

NPOI2     5      // number of points

ZHDP2(1)  120.0   // pump head
ZHDP2(2)  110.0
ZHDP2(3)  100.0
ZHDP2(4)  60.0
ZHDP2(5)  0.0

WVPM2(1)  0.0     // volumetric flow
WVPM2(2)  6.90e-2
WVPM2(3)  1.15e-1
WVPM2(4)  2.10e-1
WVPM2(5)  2.75e-1

ZHDR2(1)  3.05    // NPSH
ZHDR2(2)  3.05
ZHDR2(3)  3.05
ZHDR2(4)  3.05
ZHDR2(5)  3.05

FHXP2     1       // straight tube heat exchanger type
NTU2      0.989   // heat exchanger NTU

NTPM2     0.0     // number of tubes
NBPM2     0.0     // number of baffles
XIDT2     0.0     // tube ID
XTT2      0.0     // tube thickness
XTC2      0.0     // center to center
XS2       0.0     // shell length
RGFL2     0.0     // fouling factor
KT2       0.0     // tube thermal conductivity
XBC2      0.0     // baffle length
XIDS2     0.0     // shell ID
XSTR2     0.0     // bundle to shell length

NWCW2     1       // one point, constant flow
TICW2(1)  0.0     // time
WCWP2(1)  311.9   // mass flowrate

*********************     PUMP 3      *********************
*********************   NORMAL HPI FLOW   *********************

NPOI3     5      // number of points

ZHDP3(1)  1044.5  // pump head
ZHDP3(2)  925.0
ZHDP3(3)  835.0
ZHDP3(4)  615.0
```

```
ZHDP3(5)   0.0

WVPM3(1)   0.0      // volumetric flow
WVPM3(2)   3.40e-3
WVPM3(3)   1.40e-2
WVPM3(4)   2.20e-2
WVPM3(5)   3.80e-2

ZHDR3(1)   3.05     // NPSH
ZHDR3(2)   3.05
ZHDR3(3)   3.05
ZHDR3(4)   3.05
ZHDR3(5)   3.05

FHXP3      0        // no heat exchanger
NTU3       0.0      // heat exchanger NTU

NTPM3      0.0      // number of tubes
NBPM3      0.0      // number of baffles
XIDT3      0.0      // tube ID
XTT3       0.0      // tube thickness
XTC3       0.0      // center to center
XS3        0.0      // shell length
RGFL3      0.0      // fouling factor
KT3        0.0      // tube thermal conductivity
XBC3       0.0      // baffle length
XIDS3      0.0      // shell ID
XSTR3      0.0      // bundle to shell length

NWCW3      1        // one point, constant flow
TICW3(1)   0.0      // time
WCWP3(1)   311.9    // mass flowrate

*********************      PUMP 4       *********************
*********************   NORMAL CHP FLOW   *********************

NPOI4      5        // number of points

ZHDP4(1)   1620.0   // pump head
ZHDP4(2)   1550.0
ZHDP4(3)   1300.0
ZHDP4(4)   880.0
ZHDP4(5)   0.0

WVPM4(1)   0.0      // volumetric flow
WVPM4(2)   4.60e-3
WVPM4(3)   9.15e-3
WVPM4(4)   1.60e-2
WVPM4(5)   2.60e-2

ZHDR4(1)   3.05     // NPSH
ZHDR4(2)   3.05
ZHDR4(3)   3.05
ZHDR4(4)   3.05
```

```
ZHDR3(5)   3.05

FHXP4      0       // no heat exchanger
NTU4       0.0     // heat exchanger NTU

NTPM4      0.0     // number of tubes
NBPM4      0.0     // number of baffles
XIDT4      0.0     // tube ID
XTT4       0.0     // tube thickness
XTC4       0.0     // center to center
XS4        0.0     // shell length
RGFL4      0.0     // fouling factor
KT4        0.0     // tube thermal conductivity
XBC4       0.0     // baffle length
XIDS4      0.0     // shell ID
XSTR4      0.0     // bundle to shell length

NWCW4      1       // one point, constant flow
TICW4(1)   0.0     // time
WCWP4(1)   311.9   // mass flowrate

*********************        PUMP 5        ********************
********************  SPRAY RECIRC SYSTEM  ********************

NPOI5      1       // one point, constant flow

ZHDP5(1)   1000.0  // pump head
ZHDP5(2)   0.0
ZHDP5(3)   0.0
ZHDP5(4)   0.0
ZHDP5(5)   0.0

WVPM5(1)   1.65e-1  // volumetric flow
WVPM5(2)   0.0
WVPM5(3)   0.0
WVPM5(4)   0.0
WVPM5(5)   0.0

ZHDR5(1)   3.05    // NPSH
ZHDR5(2)   3.05
ZHDR5(3)   3.05
ZHDR5(4)   3.05
ZHDR5(5)   3.05

FHXP5      1       // straight tube heat exchanger type
NTU5       0.989   // heat exchanger NTU

NTPM5      0.0     // number of tubes
NBPM5      0.0     // number of baffles
XIDT5      0.0     // tube ID
XTT5       0.0     // tube thickness
XTC5       0.0     // center to center
XS5        0.0     // shell length
RGFL5      0.0     // fouling factor
```

```
KT5        0.0     // tube thermal conductivity
XBC5       0.0     // baffle length
XIDS5      0.0     // shell ID
XSTR5      0.0     // bundle to shell length

NWCW5      1       // one point, constant flow
TICW5(1)   0.0     // time
WCWP5(1)   311.9   // mass flowrate

*********************     PUMP 6     *********************
*********************  DEGRADED LPI1 FLOW  *********************

NPOI6      5       // number of points

ZHDP6(1)   120.00  // pump head
ZHDP6(2)   110.0
ZHDP6(3)   100.0
ZHDP6(4)   60.0
ZHDP6(5)   0.0

WVPM6(1)   0.0     // volumetric flow
WVPM6(2)   3.450e-2
WVPM6(3)   0.575e-1
WVPM6(4)   1.050e-1
WVPM6(5)   1.375e-1

ZHDR6(1)   3.05    // NPSH
ZHDR6(2)   3.05
ZHDR6(3)   3.05
ZHDR6(4)   3.05
ZHDR6(5)   3.05

FHXP6      1       // straight tube heat exchanger type
NTU6       0.989   // heat exchanger NTU

NTPM6      0.0     // number of tubes
NBPM6      0.0     // number of baffles
XIDT6      0.0     // tube ID
XTT6       0.0     // tube thickness
XTC6       0.0     // center to center
XS6        0.0     // shell length
RGFL6      0.0     // fouling factor
KT6        0.0     // tube thermal conductivity
XBC6       0.0     // baffle length
XIDS6      0.0     // shell ID
XSTR6      0.0     // bundle to shell length

NWCW6      1       // one point, constant flow
TICW6(1)   0.0     // time
WCWP6(1)   311.9   // mass flowrate

*********************     PUMP 7     *********************
*********************  NORMAL SPB FLOW  *********************
```

```
NPOI7      5        // number of points

ZHDP7(1)   1000     // pump head
ZHDP7(2)   800
ZHDP7(3)   600
ZHDP7(4)   400
ZHDP7(5)   200

WVPM7(1)   0.E0     // volumetric flow
WVPM7(2)   4.13e-2
WVPM7(3)   6.86e-2
WVPM7(4)   1.24e-1
WVPM7(5)   1.65e-1

ZHDR7(1)   3.05     // NPSH
ZHDR7(2)   3.05
ZHDR7(3)   3.05
ZHDR7(4)   3.05
ZHDR7(5)   3.05

FHXP7      1        // straight tube heat exchanger type
NTU7       0.989    // heat exchanger NTU

NTPM7      0.0      // number of tubes
NBPM7      0.0      // number of baffles
XIDT7      0.0      // tube ID
XTT7       0.0      // tube thickness
XTC7       0.0      // center to center
XS7        0.0      // shell length
RGFL7      0.0      // fouling factor
KT7        0.0      // tube thermal conductivity
XBC7       0.0      // baffle length
XIDS7      0.0      // shell ID
XSTR7      0.0      // bundle to shell length

NWCW7      1        // one point, constant flow
TICW7(1)   0.0      // time
WCWP7(1)   311.9    // mass flowrate

** Pump characteristic sets 8 through 21 are not used here, but are
** available to define characteristics for additional pumps sets.
*************************************************************************
*Pointers
*************************************************************************
*BR
**
** Pointer parameters identify such items as the containment compartments
** (also referred to as nodes) that are in contact with the primary system
** external heat sinks, specialized compartments, compartments that can
** contain corium, specialized junctions, and junctions through which
** corium can flow. The containment compartments are defined in the
** *Auxiliary Building section of the parameter file, and the containment
** junctions are defined in the *Topology section of the parameter file.
**
```

```
** @@@ 4.0.3 BJS 12/10/95 - The parameters that define the generalized
** openings are now grouped in the *Pointers section.
**
** ==========================================================================
** Name: JNPS(1:14)              Units: [Dimensionless]
**
** JNPS(i) is the identification number of the containment compartment that
** interfaces with the i'th primary system node's external heat sink(s).
** This is the compartment that the outside surface of the heat sink is in.
** The containment should be nodalized such that the external heat sinks
** from one primary system node do not interface with more than one
** compartment, i.e, a heat sink should not straddle two compartments.
**
** The index i is the index of the primary system node.  The PWR primary
** system nodes are as follows:
**
**        Node 1 - core
**        Node 2 - upper plenum
**        Node 3 - broken steam generator hot leg
**        Node 4 - broken steam generator hot leg tubes (U-tube S/G)
**               - broken steam generator candy cane (once-through S/G)
**        Node 5 - broken steam generator cold leg tubes (U-tube S/G)
**               - broken steam generator tubes (once-through S/G)
**        Node 6 - broken steam generator intermediate leg
**        Node 7 - broken steam generator cold leg
**        Node 8 - downcomer
**        Node 9 - unbroken steam generator hot leg
**        Node 10 - unbroken steam generator hot leg tubes (U-tube S/G)
**                - unbroken steam generator candy cane (once-through S/G)
**        Node 11 - unbroken steam generator cold leg tubes (U-tube S/G)
**                - unbroken steam generator tubes (once-through S/G)
**        Node 12 - unbroken steam generator intermediate leg
**        Node 13 - unbroken steam generator cold leg
**        Node 14 - reactor dome
**
** Because the heat sinks in the core (node 1), the upper plenum (node 2),
** and the steam generator tubes (nodes 4, 5, 10 and 11 for U-tube steam
** generators and nodes 5 and 11 for once-through steam generators) do not
** interface directly with the containment, JNPS for these indices are not
** used.  They are included in the above list just for completeness.  See
** the  figures in the PRISYS and PSHS-P subroutine descriptions in the
** MAAP4 User's Manual for more information.
**
JNPS(1)       2
JNPS(2)       2
JNPS(3)       2
JNPS(4)       2
JNPS(6)       2
JNPS(7)       2
JNPS(8)       1
JNPS(9)       2
JNPS(10)      2
JNPS(12)      2
JNPS(13)      2
```

```
JNPS(14)        2
**
** ======================================================================
** ======================================================================
** SPECIALIZED CONTAINMENT COMPARTMENTS
** ----------------------------------
**
** The following parameters are the identification numbers of specialized
** containment compartments.
**
** ======================================================================
** ======================================================================
JNPZ            2           // Dimensionless
**
** JNPZ is the identification number of the compartment containing the
** pressurizer.
**
** ======================================================================
JNSR            2           // Dimensionless
**
** JNSR is the identification number of the compartment containing the
** surge line.  If a value of 0 is specified then JNSR is set equal to JNPZ
** in the code.
**
** ======================================================================
JNBSG           2           // Dimensionless
**
** JNBSG is the identification number of the compartment containing the
** broken steam generator.
**
** ======================================================================
JNUSG           2           // Dimensionless
**
** JNUSG is the identification number of the compartment containing the
** unbroken steam generator(s).
**
** ======================================================================
JNVP            1           // Dimensionless
**
** JNVP is the identification number of the compartment receiving the
** effluent (liquid, gas and debris) from the vessel lower head failure.
**
** ======================================================================
JNRV            2           // Dimensionless
**
** JNRV is the identification number of either the compartment receiving
** the SRV effluent if there is no quench tank, or the compartment
** containing the quench tank.  Setting the *Pointer parameter IQT to 0
** indicates that there is no quench tank.  Setting IQT to 1 indicates that
** there is a quench tank.  In the latter case, the SRV effluent goes to
** the quench tank.
**
** ======================================================================
JNMSLB          10          // Dimensionless
```

```
**
** JNMSLB is the identification number of the compartment receiving the
** effluent from a main steam line break. Note that the effluent from
** steam generator safety and relief valves always goes to the environment.
**
** ===========================================================================
JNBB          2          // Dimensionless
**
** JNBB is the identification number of the compartment receiving the
** broken loop break effluent. Associated break parameters are ZBB, ABB
** and FBB in the *Primary System section and ZNBB in the *Interfaces
** section.
**
**
** ===========================================================================
JNUB          2          // Dimensionless
**
** JNUB is the identification number of the compartment receiving the
** unbroken loop break effluent. Associated break parameters are ZUB, AUB
** and FUB in the *Primary System section and ZNUB in the *Interfaces
** section.
**
** ===========================================================================
JNICE         9          // Dimensionless
**
** JNICE is the identification number of the compartment containing the ice
** condenser. Enter a value of 0 if an ice condenser is not to be modeled.
**
** ===========================================================================
JNCSMP        2          // Dimensionless
**
** JNCSMP is the identification number of the compartment containing the
** containment sump. It is used as the water source when in the
** recirculation mode.
**
** ===========================================================================
JNASMP        4          // Dimensionless
**
** JNASMP is the identification number of the compartment containing the
** annular compartment sump. It is used as the water source when in the
** recirculation mode if selected in the generalized ESF model.
**
** ===========================================================================
JNUCS         6          // Dimensionless
**
** JNUCS is the identification number of the compartment containing the
** upper compartment and the RHR sprays. This parameter is used with both
** the hardwired and the generalized ESF models.
**
** ===========================================================================
JNLCS         2          // Dimensionless
**
** JNLCS is the identification number of the compartment containing the
** lower compartment sprays. This parameter is used with both the
```

** hardwired and the generalized ESF models.
**
** ========================================================================
JNFCS 3 // Dimensionless
**
** JNFCS is the identification number of the compartment from which the fan
** coolers take suction.
**
** ========================================================================
JNFCD 2 // Dimensionless
**
** JNFCD is the identification number of the compartment that the fan
** coolers disharge to. This includes condensation flows.
**
** ========================================================================
JNCHS 3 // Dimensionless
**
** JNCHS is the identification number of the compartment from which the
** chillers take suction.
**
** ========================================================================
JNCHD 2 // Dimensionless
**
** JNCHD is the identification number of the compartment that the chillers
** disharge to. This includes condensation flows.
**
** ========================================================================
JNCIN 3 // Dimensionless
**
** JNCIN is the identification number of the compartment containing
** containment instruments. The pressure in this compartment is used to
** determine the high pressure and low pressure injection cooling criteria
** signals, which are specific to Spanish type plants. JNCIN is only used
** when the *Control parameter ISPAIN is set 1.
**
** ========================================================================
JNSFP 0 // Dimensionless
**
** JNSFP is the identification number of the compartment containing the
** spent fuel pool.
**
** ========================================================================
JNPRHR 0 // Dimensionless
**
** JNPRHR is the identification number of the compartment containing the
** AP600 passive RHR system.
**
** ========================================================================
** ========================================================================
** CORIUM POOLS
** -----------
**
** ========================================================================
** ========================================================================

** Name: JNCM(1:10)          Units: [Dimensionless]
**
** @@@ 4.0.3 BJS 7/8/96 - Clarified definition of JNCM
**
** JNCM(IC) is the identification number of the containment compartment
** that can contain corium debris pool IC. For example, if JNCM(2)=3 then
** corium pool 2 is in compartment 3. Note that the first zero entry
** terminates the count of possible corium pools.
**
JNCM(1)     1
JNCM(2)     2
JNCM(3)     0
JNCM(4)     0
JNCM(5)     0
JNCM(6)     0
JNCM(7)     0
JNCM(8)     0
JNCM(9)     0
JNCM(10)    0
**
** ========================================================================
** ========================================================================
** SPECIALIZED CONTAINMENT JUNCTIONS
** ------------------------------
**
** The following parameters are the identification numbers of specialized
** containment junctions.
**
** ========================================================================
** ========================================================================
JENTR       2       // Dimensionless
**
** JENTR is the identification number of the junction through which corium
** and water can be displaced/entrained by the gases released during the
** reactor vessel blowdown. This is the junction through which DCH may
** occur.
**
** ========================================================================
JENTRA      0       // Dimensionless
**
** JENTRA is the second junction through which corium and water can be
** displaced/entrained. The fraction of displaced/entrained corium and
** water that goes through this junction is specified by *Model parameter
** FCMA. The displacement/entrainment through the second junction occurs
** at the same time as through the first junction, JENTR. The two
** junctions should be in series. That is, the downstream compartment for
** the first junction should be either the upstream or downstream
** compartment for the second junction.
**
** ========================================================================
** Name: JDCF(1:4)          Units: [Dimensionless]
**
** JDCFs are the identification numbers of the junctions that are used in
** the detailed containment failure model. This model is used to

```
** calculate the failure of cylindrical containment outer walls due to
** stress/strain as a result of containment pressurization. The input
** parameters for this model are described in the *Containment Stess -
** Strain section of the parameter file. The junctions are defined in
** the *Topology section, and they must be failure type junctions. Note
** that the overpressure criteria specified in their junction definitions
** will still apply.
**
** The detailed containment failure model has not been fully tested in
** MAAP4. Hence, users should carefully review their output if they use
** this model.
**
JDCF(1)        0
JDCF(2)        0
JDCF(3)        0
JDCF(4)        0
** ====================================================================
** ====================================================================
** CORIUM JUNCTIONS
** ---------------
**
** ====================================================================
** ====================================================================
** Name: JCMW(1:20)          Units: [Dimensionless]
**
** JCMW(J) is the identification number of the Jth containment junction
** through which corium debris can flow to other containment volumes.
** Once the code reads a value of 0 for JCMW(j) in the list it ignores the
** rest, i.e., JCMW(j+1). etc. are ignored. Hence the junctions should be
** listed consecutively.
**
JCMW(1)        1
JCMW(2)        2
JCMW(3)        0
JCMW(4)        0
JCMW(5)        0
JCMW(6)        0
JCMW(7)        0
JCMW(8)        0
JCMW(9)        0
JCMW(10)       0
JCMW(11)       0
JCMW(12)       0
JCMW(13)       0
JCMW(14)       0
JCMW(15)       0
JCMW(16)       0
JCMW(17)       0
JCMW(19)       0
JCMW(18)       0
JCMW(20)       0
**
** ====================================================================
** ====================================================================
```

** MISCELLANEOUS
** ------------
**
** ======================================================================
** ======================================================================
IQT 1 // Dimensionless
**
** IQT indicates if there is a quench tank. A value of 1 is used to model
** a quench tank using the QNCHTK region routine. A value of 0 is used if
** there is no quench tank or if the quench tank is modeled as a
** containment node instead of the specialized QNCHTK model. See the
** related *Pointers parameter JNRV for additional information.
**
** ======================================================================
ICMAX 9 // Dimensionless
**
** ICMAX is the largest identification number for compartments that are in
** the containment. Compartments with identification numbers greater than
** ICMAX and less than or equal to INODRB are assumed to be in the
** auxiliary/reactor building. The total number of compartments in both
** the containment and the auxiliary/reactor building is defined by
** *Control parameter INODRB. Note that if a junction crossing this
** containment boundary opens, the containment failure flag is set.
**
**
=========================================================================
** Name: JNERT(1:40) Units: [Dimensionless]
**
** JNERT(I) specifies the initial gas composition in containment
** compartment I.
**
** = 0: air (80% nitrogen, 20% oxygen)
** = 1: nitrogen inerted
** = 2: steam
**
** If a value is not specified for any compartment the default value in the
** code will be used. For the PWR code the default for all compartments is
** air (JNERT=0).
**
JNERT(1) 0
JNERT(2) 0
JNERT(3) 0
JNERT(4) 0
JNERT(5) 0
JNERT(6) 0
JNERT(7) 0
JNERT(8) 0
JNERT(9) 0
**
** ======================================================================
** ======================================================================
** GENERALIZED OPENINGS
** ------------------
**

** ================================================================
** ================================================================
**
** Up to three generalized openings between the primary system and the
** containment compartment may be defined. The following parameters are
** required to define each generalized opening. The generalized opening
** is open for flow as long the flow area is non-zero. A typical way to
** control when a generalized opening is open for flow is to change the
** value of the flow area via an operator intervention block in the input
** file. An example of this is the rupture of the hot legs in the PWR TMLB
** sample input file. The output water and gas flow variables, WWGO(J) and
** WGGO(J), can be plotted or printed to examine the flow rates through
** opening J. Positive flow is defined as being from the primary system to
** the containment.
**
** @@@ 4.0.3 BJS 12/6/95 - All of the parameters used to define the
** generalized openings have been grouped here. Some of these were
** originally in other sections of the parameter file.
**
** ================================================================
** Name: INGO(1:3) Units: [Dimensionless]
**
** INGO(j) specifies the primary system node to which the j'th opening is
** connected. See the parameter array JNPS(i) for a list of the primary
** system node identification numbers.
**
INGO(1) 6
INGO(2) 6
INGO(3) 6
**
** ================================================================
** Name: JNGO(1:3) Units: [Dimensionless]
**
** JNGO(j) specifies the containment compartment node to which the j'th
** opening is connected.
**
JNGO(1) 2
JNGO(2) 2
JNGO(3) 2
**
** ================================================================
** Name: ZGO(1:3) Units: [M,FT]
**
** ZGO(j) is the height of the centerline of the j'th generalized opening
** above the bottom (inside) of the vessel lower head.
**
ZGO(1) 28.71 FT
ZGO(2) 28.71 FT
ZGO(3) 28.71 FT
**
** ================================================================
** Name: ZNGO(1:3) Units: [M,FT]
**
** ZNGO(j) is the height of the centerline of the j'th generalized opening

```
** above the floor of the receiving compartment identified by pointer
** JNGO(j).
**
ZNGO(1)      32.81  FT
ZNGO(2)      32.81  FT
ZNGO(3)      32.81  FT
**
**
==========================================================================
** Name: AGO(1:3)             Units: [M**2,FT**2]
**
** AGO(j) is the flow area of the j'th generalized opening.  The discharge
** coefficients FCDGO(j) are used for the flow calculations in the PWR code.
**
AGO(1)       0.0  FT**2
AGO(2)       0.0  FT**2
AGO(3)       0.0  FT**2
**
**
==========================================================================
** Name: FCDGO(1:3)           Units: [Dimensionless]
**
** FCDGO(j) is the discharge coefficient for the j'th generalized opening.
**
FCDGO(1)     0.75
FCDGO(2)     0.75
FCDGO(3)     0.75
**
**
==========================================================================
** Name: CBGO(1:3)            Units: [Dimensionless]
**
** CBGO(j) is a multiplier to calculate the effective radius for the j'th
** generalized opening.  It is used to represent the vertical orientation
** of the break with a value ranging from 2.0 indicating a vertical
** oriented break to a value of 0.1 indicating a break which is oriented
** almost horizontally.  See the description of subroutine VFBRK in the
** MAAP4 User's Manual for a discussion of the use  of the break flow
** parameter.
**
CBGO(1)      2.0
CBGO(2)      2.0
CBGO(3)      2.0
**
**
==========================================================================
** Name: IDIRGO(1:3)          Units: [Dimensionless]
**
** @@@ 4.0.3 BJS 12/11/95 - Added missing parameter IDIRGO to the parameter
** files.
**
** IDIRGO(j) indicates the allowed flow direction for the j'th generalized
** opening.  It is essentially used to model check valves.
**
```

```
**  = 0: Flow can go both ways between the primary system and the
**      containment.
**  = 1: Flow can only go from the primary system to the containment.
**  = 2: Flow can only go from the containment to the primary system.
**
IDIRGO(1)       0
IDIRGO(2)       0
IDIRGO(3)       0
**
** ======================================================================
** ======================================================================
** Plume Chain Junctions
** --------------------
**
** Plume chain junctions are a series of containment junctions through
** which the gaseous effluent from the primary system can rise.  The
** junctions are used in the subnodal physics plume model, which calculates
** mass and energy exchange between containment compartments due to the
** rising of bouyant gas.  See the description of subroutine PLUME in the
** MAAP4 User's Manual.  Note that this model is independent of the
** stratification subnodal physics model that is enabled using *Control
** parameter ISBNOD.  Both of these models were added to the code to
** support the HDR benchmarking effort.
**
** The junctions in each plume chain should be successively higher
** junctions.  The junctions can be both horizontally-oriented, i.e., in a
** ceiling, and vertically-oriented, i.e., in a wall.  A zero entry
** indicates the end of the plume chain.
**
** @@@ 4.0.3 BJS 12/8/95 - Added the missing plume chain pointers to the
** parameter files.
**
** ======================================================================
** Name: JJRV(1:10)          Units: [Dimensionless]
**
** JJRV(j) is an array of junction identification numbers that constitute
** the plume chain for effluent from the relief values.
**
JJRV(1)       0
**
** ======================================================================
** Name: JJVP(10)            Units: [Dimensionless]
**
** JJVP(j) is an array of junction identification numbers that constitute
** the plume chain for effluent from the vessel failure.
**
JJVP(1)       0
**
** ======================================================================
** Name: JJGO(1:10,1:3)      Units: [Dimensionless]
**
** JJGO(i,j) is an array of junction identification numbers that constitute
** the plume chain for the effluent from the j'th generalized opening.
**
```

```
JJGO(1,1)      0
**
JJGO(1,2)      0
**
JJGO(1,3)      0
**
** ========================================================================
** Name: JJBB(1:10)          Units: [Dimensionless]
**
** JJBB(i) is an array of junction identification numbers that constitute
** the plume chain for effluent from the broken loop break.
**
JJBB(1)        0
**
** ========================================================================
** Name: JJUB(1:10)          Units: [Dimensionless]
**
** JJUB(i) is an array of junction identification numbers that constitute
** the plume chain for effluent from the unbroken loop break.
**
JJUB(1)        0
**
** ========================================================================
** Name: JJMSLB(1:10)          Units: [Dimensionless]
**
** JJMSLB(i) is an array of junction identification numbers that constitute
** the plume chain for effluent from the main steam line break.
**
JJMSLB(1)      0
**
** ========================================================================
**
** @@@ 4.0.3 BJS 12/8/95 - The parameter JSGTS(i) has been moved to the
** *Topology section of the parameter file.
**
***************************************************************************
*Interfaces
***************************************************************************
*BR
**
** The interfacing flowpaths between the primary system and the containment
** and auxiliary/reactor building include the relief valves, safety valves,
** primary system breaks, vessel failure openings and generalized openings.
** The heights of these interfacing flowpaths relative to the receiving
** containment compartments are specified by the user in this section.
** They are used by subroutine INTERF to calculate mass and energy flows
** between the primary system and the containment. The receiving
** compartments' identification numbers are specified in the *Pointers
** parameter section.
**
** The dimensions of all interfacing flowpath heights are length. The
** heights are relative to the respective receiving compartment floors.
**
** ========================================================================
```

ZNRV 32.81 FT // Units: [M,FT]
**
** ZNRV is the average height of the SRV pipe exit above the floor of the
** quench tank if *Pointers parameter IQT is set to 1, or above the floor
** of the compartment receiving the SRV effluent identified by pointer JNRV
** if IQT is set to 0.
**
** ==========================================================================
ZNVP 15.44 FT // Units: [M,FT]
**
** ZNVP is the height of the bottom of lower head above the floor of the
** receiving compartment identified by pointer JNVP. This height is used
** in conjunction with the height of the failure location measured from the
** bottom of the vessel, ZROF, to.determine the total height of the failure
** above the floor of the receiving compartment. ZROF is calculated in
** subroutine RVFLMK.
**
** ==========================================================================
ZNBB 32.81 FT // Units: [M,FT]
**
** The height of the centerline of the broken loop break above the floor of
** the receiving compartment identified by pointer JNBB.
**
** ==========================================================================
ZNUB 32.81 FT // Units: [M,FT]
**
** The height of the centerline of the unbroken loop break above the floor
** of the receiving compartment identified by pointer JNUB.
**
** ==========================================================================
ZNMSLB 32.81 FT // Units: [M,FT]
**
** The height of the centerline of the main steam line break above the
** floor of the receiving compartment identified by pointer JNMSLB.
**
** ==========================================================================
**
** @@@ 4.0.3 BJS 12/6/95 - The generalized opening parameter ZNGO was moved
** to the *Pointers section of the parameter file.
**
****************************************************************************
*Auxiliary Building
****************************************************************************
*BR
**
** This parameter section defines the containment and/or auxiliary building
** compartment's geometry and other inputs. This parameter section is used
** with parameter section *Topology which defines the flowpaths between the
** compartments. The number of compartments, sometimes called nodes, is
** defined by the Control parameter INODRB, and note that the environment
** compartment is always INODRB+1. Whenever possible, corresponding or
** equivalent MAAP 3.0B parameters were noted.
**
** Possible data sources for the majority of parameters can be obtained

** from:
**
** 1) Plant or containment elevation, section, structural, and/or
** equipment location drawings,
**
** 2) Plant FSAR - Containment section, or
**
** 3) Operator Training Manual - Containment section.
**
** For the PWR MAAP4 code, up to 40 compartments can be specified.
** The ice condenser-like containment compartments are currently set up as:
**
** 1) Cavity compartment
** 2) Lower compartment
** 3) Upper Cylinder compartment
** 4) Annular compartment
** 5) Upper Dome Compartment
** 6) Upper Spray Compartment
** 7) Steel Shell Compartment
** 8) Ice Condenser Upper Compartment
** 9) Ice Condenser Compartment
** 10) Environment
**
**
** Some Guidelines:
**
** To prevent phantom flows in a containment configuration, ensure that
** the floor elevation of two containment compartments connected by
** horizontal junctions in vertical walls have the same elevation. See
** note in *Topology parameter section about phantom flows.
**
** Try to be as represenative as possible with respect to the actual
** containment configuration.
**
** Although a MAAP4 containment configuration can be constructed to mimic
** the MAAP 3.0B hardwired containment configuration, this should only be
** done for comparision purposes since more often than not, many plants
** have specific geometric features that should be physically represented
** in the MAAP4 containment configuration.
**
** ==================================================================
** Name: VOLRB(40) Units: [M**3,FT**3]
**
** Parameter VOLRB(iv) is the total free volume of the iv'th compartment.
** It does not include the volume occupied by any walls, structures or
** equipment.
**
VOLRB(1) 16776.0 FT**3
VOLRB(2) 262372.0 FT**3
VOLRB(3) 272666.0 FT**3
VOLRB(4) 65849.0 FT**3
VOLRB(5) 342127.0 FT**3
VOLRB(6) 55207.0 FT**3
VOLRB(7) 40445.0 FT**3

VOLRB(8)   47000.0 FT**3
VOLRB(9)   200255.0 FT**3
**
** MAAP 3.0B to MAAP4 conversion notes: MAAP 3.0B parameters VC0, VB0, VA,
** and VD can be used as the volume of the cavity, lower, annular, and
** upper compartments. For ice condenser containment, MAAP 3.0B parameters
** VI and VU can be used as the volume of the ice condenser, and upper ice
** plenum, respectively.
**
** ==========================================================================
** Name: ZFRB(40)   Units: [M,FT]
**
** Parameter ZFRB(iv) is the elevation of the iv'th compartment floor
** relative to ground level, the floor elevation of the environment
** compartment (INODRB+1). Note that the environment floor elevation may
** be set, which otherwise defaults to zero.
**
ZFRB(1)   -28.08 FT
ZFRB(2)   0.0 FT
ZFRB(3)   51.33 FT
ZFRB(4)   0.0 FT
ZFRB(5)   111.75 FT
ZFRB(6)   150.78 FT
ZFRB(7)   0.0 FT
ZFRB(8)   101.76 FT
ZFRB(9)   39.21 FT
**
** ==========================================================================
** Name: AGKEY(40)   Units: [M**2,FT**2]
**
** Parameter AGKEY(iv) is the largest characteristic total cross-sectional
** area in the iv'th compartment through which the gas flows. The
** AGKEY(iv) parameter is used with parameter XDGKEY(iv) for convective
** heat transfer from containment heat sinks, both lumped and distributed,
** due to gas flows. In MAAP 3.0B, AGKEY(iv) and XDGKEY(iv) were
** hard-coded at 1 and 0, respectively.
**
AGKEY(1)   524.8 FT**2
AGKEY(2)   4492.0 FT**2
AGKEY(3)   5411.0 FT**2
AGKEY(4)   4151.0 FT**2
AGKEY(5)   10372.0 FT**2
AGKEY(6)   5606.0 FT**2
AGKEY(7)   2295.0 FT**2
AGKEY(8)   4151.0 FT**2
AGKEY(9)   4211.0 FT**2
**
** ==========================================================================
** Name: XDGKEY(40)   Units: [M,FT]
**
** Parameter XDGKEY(iv) is the iv'th compartment hydraulic diameter
** associated with parameter AGKEY(iv). If XDGKEY(iv) is zero, XDGKEY(iv)
** is then computed assuming circular compartment cross-section as:
**

```
**     XDGKEY(iv) = SQRT (4.0 * AGKEY(iv) / PI )
**
XDGKEY(1)      0.0  FT
XDGKEY(2)      0.0  FT
XDGKEY(3)      0.0  FT
XDGKEY(4)      0.0  FT
XDGKEY(5)      0.0  FT
XDGKEY(6)      0.0  FT
XDGKEY(7)      0.0  FT
XDGKEY(8)      0.0  FT
XDGKEY(9)      0.0  FT
**
**
** ==========================================================================
** Within a containment compartment, several competing fission product
** aerosol removal processes in the gas space are considered. These include:
** sedimentation, impaction, and thermophoresis. Within the containment
** compartment the ten largest heat sink (see *Distributed parameter
** section) surface areas are considered available for the sedimentation
** and thermophoresis processes. The sedimented aerosols are deposited on
** the top surface of the horizontal heat sinks, the aerosols removed by
** thermophoresis are deposited on the walls, and the aerosols removed by
** impaction are distributed to the available uncovered heat sinks'
** horizontal and vertical surfaces. If there are no horizontal heat
** sinks, then the sedimented aerosols are deposited on the largest
** veritical heat sink. There is no provision in the MAAP code to allow
** the aerosols to continue settling from one compartment to the next lower
** compartment when there is no floor separating them. If a compartment
** has no heat sinks specified, the fission product aerosols removed by the
** sedimentation, impaction, and thermophoresis processes "disappears" from
** the calculations and a warning message is printed.
**
** ==========================================================================
** Name: ASEDRB(40)            Units: [M**2,FT**2]
**
** Parameter ASEDRB(iv) is the iv'th compartment aerosol sedimentation
** area. The sedimentation area should be the total upward-facing
** horizontal area in the compartment on which aerosols can settle. This
** should include (where appropriate), floors, cable trays, equipment etc.
** If two upward-facing areas are stacked one above the other, both should
** be counted, i.e. the upper does not "mask" the lower. An often-used
** approximation is 2 times the floor area. This parameter is only used to
** calculate the aerosol deposition rate and is independent of the actual
** horizontal heat sink areas used for the sedimented aerosol.
**
ASEDRB(1)    1044.59  FT**2
ASEDRB(2)    9178.91  FT**2
ASEDRB(3)   15558.66  FT**2
ASEDRB(4)    9612.54  FT**2
ASEDRB(5)       0.0  FT**2
ASEDRB(6)       0.0  FT**2
ASEDRB(7)    2295.0  FT**2
ASEDRB(8)    4151.0  FT**2
ASEDRB(9)    4211.0  FT**2
```

**
** ==========================================================================
** The next three parameters: AIMPRB(iv), XDIMRB(iv), and AGRARB(iv) are
** used collectively for the aerosol impaction removal process.
**
** ==========================================================================
** Name: AIMPRB(40)            Units: [M**2,FT**2]
**
** Parameter AIMPRB(iv) is the iv'th compartment aerosol impaction area. In
** order for impaction to be effective, the target must be of a relatively
** small width, typically < .01 m. A typical example of such a target would
** be grating within the compartment, and is used to model the impaction on
** grating. For example, a section of grating 1 m**2 in area could be made
** up of .003 m wide strips of steel spaced .1 m apart. The total impaction
** area would therfore be = .003 m * 1 m * 10 strips = .03 m**2. The grate
** diameter (or width) is .003 m and the gas flow area through the grate is
** = 1 m**2 - .03 m**2 = .97 m**2. If more than one level of grates exists,
** supply the total impaction area of all the grates, and the maximum flow
** area at any of the grate elevations.
**
AIMPRB(1)      0.0  FT**2
AIMPRB(2)      0.0  FT**2
AIMPRB(3)      0.0  FT**2
AIMPRB(4)   1237.25  FT**2
AIMPRB(5)      0.0  FT**2
AIMPRB(6)      0.0  FT**2
AIMPRB(7)      0.0  FT**2
AIMPRB(8)      0.0  FT**2
AIMPRB(9)   1237.25  FT**2
**
** ==========================================================================
** Name: XDIMRB(40)            Units: [M,FT]
**
** Parameter XDIMRB(iv) is the iv'th compartment impaction diameter.
**
XDIMRB(1)    0.0104  FT
XDIMRB(2)    0.0104  FT
XDIMRB(3)    0.0104  FT
XDIMRB(4)    0.0104  FT
XDIMRB(5)    0.0104  FT
XDIMRB(6)    0.0104  FT
XDIMRB(7)    0.0104  FT
XDIMRB(8)    0.0104  FT
XDIMRB(9)    0.0104  FT
**
** ==========================================================================
** Name: AGRARB(40)            Units: [M**2,FT**2]
**
** Parameter AGRARB(iv) is the iv'th compartment total flow area at the
** elevation of the grating.
**
AGRARB(1)      0.0  FT**2
AGRARB(2)      0.0  FT**2
AGRARB(3)      0.0  FT**2

AGRARB(4)  3306.55 FT**2
AGRARB(5)  0.0 FT**2
AGRARB(6)  0.0 FT**2
AGRARB(7)  0.0 FT**2
AGRARB(8)  0.0 FT**2
AGRARB(9)  3306.55 FT**2
**
** ==================================================================
** Name: FIDRRB(40)  Units: [Dimensionless]
**
** If parameter FIDRRB(iv) is zero, then the iv'th compartment water pool
** will drain normally through junctions to other compartments. If
** FIDRRB(iv) is a positive number, then MAAP will instantly drain all
** water from the current, iv'th compartment to the compartment index
** specified by FIDRRB(iv).
**
FIDRRB(1)  0
FIDRRB(2)  0
FIDRRB(3)  0
FIDRRB(4)  0
FIDRRB(5)  0
FIDRRB(6)  0
FIDRRB(7)  0
FIDRRB(8)  0
FIDRRB(9)  0
**
** ==================================================================
** Name: TGRB0(40)  Units: [K,F]
**
** Parameter TGRB0(iv) is the initial gas temperature in the iv'th
** compartment.
**
TGRB0(1)  110.0 F
TGRB0(2)  110.0 F
TGRB0(3)  87.5 F
TGRB0(4)  110.0 F
TGRB0(5)  87.5 F
TGRB0(6)  87.5 F
TGRB0(7)  87.5 F
TGRB0(8)  15.0 F
TGRB0(9)  15.0 F
**
** ==================================================================
** Name: PRB0(40)  Units: [PA,PSI]
**
** Parameter PRB0(iv) is the initial pressure in the iv'th compartment.
**
PRB0(1)  14.79 PSI
PRB0(2)  14.79 PSI
PRB0(3)  14.79 PSI
PRB0(4)  14.79 PSI
PRB0(5)  14.79 PSI
PRB0(6)  14.79 PSI
PRB0(7)  14.79 PSI

```
PRB0(8)     14.79  PSI
PRB0(9)     14.79  PSI
**
** ============================================================================
** Name: FRHB0(40)              Units: [Dimensionless]
**
** Parameter FRHB0(iv) is the initial relative humidity in the iv'th
** compartment.
**
FRHB0(1)      0.22
FRHB0(2)      0.22
FRHB0(3)      0.22
FRHB0(4)      0.22
FRHB0(5)      0.22
FRHB0(6)      0.22
FRHB0(7)      0.22
FRHB0(8)      0.22
FRHB0(9)      0.22
**
** ============================================================================
** Name: NIGRB(40)              Units: [Dimensionless]
**
** Parameter NIGRB(iv) is the number of igniters in the iv'th compartment.
**
NIGRB(1)       0
NIGRB(2)      32
NIGRB(3)       4
NIGRB(4)      14
NIGRB(5)       0
NIGRB(6)       8
NIGRB(7)       0
NIGRB(8)      14
NIGRB(9)       0
**
** ============================================================================
** Name: XIGRB(40)              Units: [M,FT]
**
** Parameter XIGRB(iv) is the average elevation of igniters from the floor
** in the iv'th compartment.
**
XIGRB(1)       0.0  FT
XIGRB(2)      55.88 FT
XIGRB(3)      47.17 FT
XIGRB(4)      22.00 FT
XIGRB(5)       0.0  FT
XIGRB(6)      11.22 FT
XIGRB(7)       0.0  FT
XIGRB(8)      12.24 FT
XIGRB(9)       0.0  FT
**
** ============================================================================
** Name: XRBRRB(40)             Units: [M,FT]
**
** Parameter XRBRRB(iv) is the characteristic burn radius for the iv'th
```

** compartment for combustible gas burns. Even if a compartment does not
** have igniters, inputs to XRBRRB and XHBRRB are still required since
** global burns may occur and the burn model needs these parameters.
** Otherwise, a fatal run-time error will occur. If no igniters exist, the
** effective radius of the compartment, i.e., the square root of the
** average cross-sectional area divided by pi, can be used.
**
XRBRRB(1) 14.37 FT
XRBRRB(2) 40.34 FT
XRBRRB(3) 42.99 FT
XRBRRB(4) 33.45 FT
XRBRRB(5) 42.99 FT
XRBRRB(6) 28.00 FT
XRBRRB(7) 2.5 FT
XRBRRB(8) 31.33 FT
XRBRRB(9) 31.33 FT
**
** ========================================================================
** Name: XHBRRB(40) Units: [M,FT]
**
** Parameter XHBRRB(iv) is the characteristic height of the iv'th
** compartment for combustible gas burns. This is the floor to ceiling
** height, not the vertical distance between the igniter and the ceiling.
** Even if a compartment does not have igniters, inputs to XRBRRB and
** XHBRRB are still required since global burns may occur and the burn
** model needs these parameters. Otherwise, a fatal run-time error will
** occur.
**
**
XHBRRB(1) 25.85 FT
XHBRRB(2) 101.76 FT
XHBRRB(3) 57.92 FT
XHBRRB(4) 39.21 FT
XHBRRB(5) 39.03 FT
XHBRRB(6) 18.51 FT
XHBRRB(7) 28.57 FT
XHBRRB(8) 15.24 FT
XHBRRB(9) 62.55 FT
**
** ========================================================================
** Name: XWRB0(40) Units: [M,FT]
**
** Parameter XWRB0(iv) is the initial height of water in the iv'th
** compartment. The volume will be obtained from the volume vs height
** lookup tables.
**
XWRB0(1) 0.0 FT
XWRB0(2) 0.0 FT
XWRB0(3) 0.0 FT
XWRB0(4) 0.0 FT
XWRB0(5) 0.0 FT
XWRB0(6) 0.0 FT
XWRB0(7) 0.0 FT
XWRB0(8) 0.0 FT

```
XWRB0(9)       0.0  FT
**
** ========================================================================
** Name: TWRB0(40)              Units: [K,F]
**
** Parameter TWRB0(iv) is the initial water temperature in the iv'th
** compartment.
**
TWRB0(1)       0.0  F
TWRB0(2)       0.0  F
TWRB0(3)       0.0  F
TWRB0(4)       0.0  F
TWRB0(5)       0.0  F
TWRB0(6)       0.0  F
TWRB0(7)       0.0  F
TWRB0(8)       0.0  F
TWRB0(9)       0.0  F
**
** ========================================================================
** Volume vs Height Lookup Tables
**
** Name: XRBLK(10,40)           Units: [M,FT]
** Name: VRBLK(10,40)           Units: [M**3,FT**3]
**
** Volume vs Height lookup tables consists of two arrays, one for the
** height and one for the volume where:
**
**     XRBLK(i,iv)= i'th height lookup entry for iv'th compartment, and
**
**     VRBLK(i,iv)= i'th volume lookup entry for iv'th compartment.
**
** Up to 10 points may be defined for each containment and/or auxiliary
** building compartment.  If only two entries are specified, it is
** equivalent to assume a constant cross-sectional area as a function of
** height.  This is the same assumption used in the MAAP 3.0B fixed
** containment model.  The volume vs height lookup tables allow the user to
** represent the geometry of the compartments in more detail.
**
** If VRBLK(1,iv)= -1, then the torus geometry is used and the next two
**              entries are expected:
**
**   VRBLK(2,iv)= XRTOR; minor radius of torus
**   XRBLK(2,iv)= XLTOR; circumference of torus
**
** ========================================================================
**
** Cavity,Compartment
**
XRBLK(1,1)     0.0  FT
VRBLK(1,1)     0.0  FT**3
XRBLK(2,1)    48.0  FT
VRBLK(2,1)   16776.  FT**3
XRBLK(3,1)     0.0  FT
VRBLK(3,1)     0.0  FT**3
```

```
**
** Lower Compartment
**
XRBLK(1,2)      0.0  FT
VRBLK(1,2)      0.0  FT**3
XRBLK(2,2)    51.33  FT
VRBLK(2,2)  262372.  FT**3
XRBLK(3,2)      0.0  FT
VRBLK(3,2)      0.0  FT**3
**
** Upper Cylinder Compartment
**
XRBLK(1,3)      0.0  FT
VRBLK(1,3)      0.0  FT**3
XRBLK(2,3)    60.42  FT
VRBLK(2,3)  272666.  FT**3
XRBLK(3,3)      0.0  FT
VRBLK(3,3)      0.0  FT**3
**
** Annular Compartment
**
XRBLK(1,4)      0.0  FT
VRBLK(1,4)      0.0  FT**3
XRBLK(2,4)    39.21  FT
VRBLK(2,4)   65849.  FT**3
XRBLK(3,4)      0.0  FT
VRBLK(3,4)      0.0  FT**3
**
** Upper Dome Compartment
**
XRBLK(1,5)      0.0  FT
VRBLK(1,5)      0.0  FT**3
XRBLK(2,5)    39.03  FT
VRBLK(2,5)  342127.  FT**3
XRBLK(3,5)      0.0  FT
VRBLK(3,5)      0.0  FT**3
**
** Upper Spray Compartment
**
XRBLK(1,6)      0.0  FT
VRBLK(1,6)      0.0  FT**3
XRBLK(2,6)    18.51  FT
VRBLK(2,6)   55207.  FT**3
XRBLK(3,6)      0.0  FT
VRBLK(3,6)      0.0  FT**3
**
** Steel Shell Compartment
**
XRBLK(1,7)      0.0  FT
VRBLK(1,7)      0.0  FT**3
XRBLK(2,7)   169.29  FT
VRBLK(2,7)   40445.  FT**3
XRBLK(3,7)      0.0  FT
VRBLK(3,7)      0.0  FT**3
```

```
**
** Ice Upper Compartment
**
XRBLK(1,8)      0.0  FT
VRBLK(1,8)      0.0  FT**3
XRBLK(2,8)     15.24  FT
VRBLK(2,8)   47000.  FT**3
XRBLK(3,8)      0.0  FT
VRBLK(3,8)      0.0  FT**3
**
** Ice Condenser Compartment
**
XRBLK(1,9)      0.0  FT
VRBLK(1,9)      0.0  FT**3
XRBLK(2,9)     62.55  FT
VRBLK(2,9)  200255.  FT**3
XRBLK(3,9)      0.0  FT
VRBLK(3,9)      0.0  FT**3
**
** ========================================================================
** Auxiliary Building CO2 Fire Suppression System
**
** The auxiliary building CO2 fire suppression system is available only for
** compartment indices greater than the Pointer parameter ICMAX.  The CO2
** system consists of three parameters: MC2RB0, TC2RB, and WC2RB(iv), as
** explained next.  The CO2 injection flow is initiated into the compartment
** when it's gas temperature exceeds TC2RB, or when when parameter IRBC2(iv)
** is set equal to 1 in the input file.  1000-level event codes flag when
** the system has been turned on for the respective compartment.  Event code
** 178 flags when the CO2 supply is depleted.
**
** ========================================================================
MC2RB0       1102.0  LB        // Units: [KG.LB]
**
** Parameter MC2RB0 is the initial mass of CO2 supply in a CO2 fire
** suppression system.
**
** ========================================================================
TC2RB        980.0  F         // Units: [K,F]
**
** Parameter TC2RB is the CO2 injection activation temperature.
**
** ========================================================================
** Name: WC2RB(40)               Units: [KG/S,LB/HR]
**
** Parameter WC2RB(iv) is the CO2 injection flow rate for the iv'th
** compartment.  The default values are zero.
**
** @@@ 4.0.1 BJS 2/10/95  The WC2RB variables for containment were removed
** since the system is available only for auxiliary building., ie.,
** compartments greater than ICMAX.
**
WC2RB(6)       0.0  LB/HR
WC2RB(7)       0.0  LB/HR
```

```
WC2RB(8)      0.0 LB/HR
WC2RB(9)      0.0 LB/HR
**
** =========================================================================
** Constant Flow Fire Sprays
**
** @@@ 4.0.1 BJS 2/8/95   Added description.
**
** WSPRB is the water flow rate for constant flow (fire) sprays.  They are
** applicable for any containment and/or auxiliary building compartment.
** TWSPRB is the spray water temperature, XDSPRB is the spray droplet
** diameter, MSPRB0 is the initial spray water mass, and XHSPRB is the
** spray fall height. These sprays are intiated by setting IRBSP(iv)=1 in
** the input file.  These sprays in the auxilary building, i.e., those in
** compartments with indices greater than ICMAX, are initiated if the gas
** temperature in the compartment exceeds TSPRB or if event code 240 is set
** true.  If the sprays are turned on with event code 240, they can be
** turned off by setting event code false.  If they are turned on with
** IRBSP(i), then they can be turned off with IRBSP(i).  If they are turned
** on because the gas temperature exceeded TSPRB, then it is necessary to
** set IRBSP(I)=0 to turn them off provided the gas temperature falls below
** the set point.  1000-level event codes flag when the sprays turn on and
** off.  Event code 177 flags when the source for the sprays is empty.  The
** flow to the constant flow sprays can easily be made variable by using
** lookup tables or functions in the input file.
**
** @@@ 4.0.1 BJS 2/8/95  Clarified MSPRB0,TWSPRB, XDSPRB and TSPRB
** definitions - they are for the constant flow (fire) sprays
**
** =========================================================================
MSPRB0       2.2e10  LB        // Units: [KG,LB]
**
** Parameter MSPRB0 is the initial mass of water available for constant
** flow (fire) sprays.
**
** =========================================================================
TWSPRB        89.3  F        // Units: [K,F]
**
** Parameter TWSPRB is the constant flow (fire) spray water temperature.
**
** =========================================================================
XDSPRB      0.00328  FT        // Units: [M,FT]
**
** Parameter XDSPRB is the constant flow (fire) spray'drop diameter.
**
** =========================================================================
TSPRB         980.0  F        // Units: [K,F]
**
** Parameter TSPRB is the constant flow (fire) spray activation
** temperature.  Note that the initiation temperature only applies to
** compartments with indices greater than ICMAX.
**
** =========================================================================
** Name: WSPRB(40)            Units: [KG/S,LB/HR]
```

```
**
** Parameter WSPRB(iv) is the spray flow rate for the fire sprays in the
** iv'th compartment.
**
WSPRB(1)     0.0  LB/HR
WSPRB(2)     0.0  LB/HR
WSPRB(3)     0.0  LB/HR
WSPRB(4)     0.0  LB/HR
WSPRB(5)     0.0  LB/HR
WSPRB(6)     0.0  LB/HR
WSPRB(7)     0.0  LB/HR
WSPRB(8)     0.0  LB/HR
WSPRB(9)     0.0  LB/HR
**
** ========================================================================
** Name: XHSPRB(40)          Units: [M,FT]
**
** Parameter XHSPRB(iv) is the spray fall height from the spray header to
** the iv'th compartment floor.
**
XHSPRB(1)     0.0  FT
XHSPRB(2)    51.33  FT
XHSPRB(3)    60.42  FT
XHSPRB(4)     0.0  FT
XHSPRB(5)    39.03  FT
XHSPRB(6)     5.22  FT
XHSPRB(7)     0.0  FT
XHSPRB(8)    15.24  FT
XHSPRB(9)    62.55  FT
**
** ========================================================================
** Compartment to Compartment Spray Flow
**
** @@@ 4.0.1 MAM 12/8/94 Added description of compt to compt spray flow
** variables - applies to both constant flow (fire) sprays and esf sprays
** (upper compt., lower compt., and rhr sprays).
**
** By default, any spray flow within a compartment will fall to that
** compartment's floor and subsequently overflow to the other compartments
** through junction openings whether or not a physical floor actually
** exists. The next three inputs: FSPR(ix), NSPS(ix), and NSPR(ix)
** provides a mechanism by which the spray flow is allowed to continue
** falling to the next compartment below. This mechanism is crucial in
** situations where, for example, the upper compartment is sub-divided into
** two or more compartments stacked on top of each other, and since there
** is no "physical" floors between them, the spray flow would be expected
** to fall through these compartments on it's way to the lower
** compartment.
**
** The fraction of spray flow within a containment compartment that flows
** to the next compartment can be specified, i.e., from upper compartment
** to lower compartment. The remaining fraction, if any, falls to the
** source compartment floor. The three variables are:
**
```

```
**     NSPS(ix) = the spray flow source compartment,
**
**     NSPR(ix) = the spray flow receiver compartment, and
**
**     FSPR(ix) = the fraction of the spray flow in the source compartment
**              that may fall (flow) to the receiver compartment.
**
** A maximum of 30 for BWR and 40 for PWR such fractions can be defined.
** Note that the index is deliberatly defined as "ix" because it is not a
** compartment index.  A compartment spray flow may fall to more than one
** compartment, say N compartments.  Just define N fractions or
** connections for that compartment.  Be sure to check that the total
** fraction leaving the source compartment does not exceed one.
**
** As an example, let's say there are upper compartment (U1) sprays
** operating and there are two lower comparments (L1 and L2).  Let 30% of
** the spray fall into each lower compartment (L1 and L2) and let the
** remaining 40% fraction fall on the upper compartment floor.  Then, the
** inputs would be:
**
**     NSPS(1) = U1 INDEX
**     NSPR(1) = L1 INDEX
**     FSPR(1) = .3
**
**     NSPS(2) = U1 INDEX
**     NSPR(2) = L2 INDEX
**     FSPR(2) = .3
**
** @@@ 4.0.3 MAM 12/14/95  Added note about XHSPRB(iv).
**
** Be sure to supply a non-zero spray fall height value, XHSPRB(iv), for
** all compartments expected to have a spray flow source.  This includes
** compartments with spray headers and compartments expected to receive
** compartment to compartment spray flows.  If the value is zero, then the
** spray flow will be simply added to the compartment floor without the
** effects of spray falling through the compartment's amosphere.
**
** ======================================================================
** Name: NSPS(40)              Units: [Dimensionless]
**
** Parameter NSPS(ix) is the spray flow source compartment for the ix'th
** connection.
**
NSPS(1)         0
**
** @@@ 4.0.3 MAM 11/7/95 Added NSPS(ix) description to all parameter files.
**
** ======================================================================
** Name: NSPR(40)              Units: [Dimensionless]
**
** Parameter NSPR(ix) is the spray flow reciever compartment for the ix'th
** connection.
**
NSPR(1)         0
```

```
**
** @@@ 4.0.3 MAM 11/7/95 Added NSPR(ix) description to all parameter files.
**
** ======================================================================
** Name: FSPR(40)              Units: [Dimensionless]
**
** Parameter FSPR(ix) is the fraction of the spray flow in the source
** compartment that may fall (flow) to the receiver compartment for the
** ix'th connection.
**
FSPR(1)        0.0
**
** @@@ 4.0.3 MAM 11/7/95 Added FSPR(ix) description to all parameter files.
**
** ======================================================================
** Name: WNAOH(40)             Units: [KG/S,LB/HR]
**
** WNAOH(iv) is the NaOH injection mass flow rate to the iv'th compartment.
**
WNAOH(1)       0.0  LB/HR
WNAOH(2)       0.0  LB/HR
WNAOH(3)       0.0  LB/HR
WNAOH(4)       0.0  LB/HR
**
** ======================================================================
** Name: WACID(40)             Units: [KG/S,LB/HR]
**
** WACID(iv) is the HNO3 injection mass flow rate to the iv'th compartment.
** The equivalent HNO3 of any strong acid mass flow into the iv'th
** compartment can be simulated.  For example, to inject 0.1 kg/sec of HCl
** into the iv'th  compartment, input WACID(iv) as 0.1 * MHNO3 / MHCl where
** MHNO3 and MHCl is the molecular weight of MHNO3 and MHCl, respectively.
** Be sure to preserve the hydrogen ratio, e.g., to inject 0.1 kg/sec of
** H2SO4 into the iv'th  compartment, input WACID(iv) as 0.1 / 2 * MHNO3 /
** MH2SO4 where MHNO3 and MH2SO4 are the molecular weights of MHNO3 and
** MH2SO4, respectively.
**
WACID(1)       0.0  LB/HR
WACID(2)       0.0  LB/HR
WACID(3)       0.0  LB/HR
WACID(4)       0.0  LB/HR
**
** ======================================================================
** Name: XRBLRB(40)            Units: [M,FT]
**
** @@@ 4.0.1 MAM 12/8/94  Added new variable XRBLRB for HTGPL
**
** XRBLRB(iv) is the mean radiation beam length for the iv'th compartment
** water pool.  The XRBLRB(iv) parameter is used by subroutine HTGPL for
** the interfacing water pool surface and gas space heat and mass transfer
** calculations.  The XRBLRB(iv) parameter is geometry dependent.  If
** XRBLRB(iv) is set to zero, the MAAP4 code will calculate the mean
** radiation beam length assuming a 1.18 * VOLRB(iv) / AWATRB(iv)
** geometric relationship which is an approximation for a rectangular
```

** parallelepiped (1:2:6) radiating to 2x6 face. For most compartment
** geometries, this approximation is sufficient. This approximation fails
** for narrow or tight geometries such as the downcomer pipes in the MARK
** I, II plants, or the annulus gas space between the free standing
** containment steel shell and the outer containment concrete wall. For
** these situations, 1.5 to 2 times the narrowest length should be a good
** approximation.
**
******************************************************************************
*Topology
******************************************************************************
*BR
**
** This *Topology parameter section defines the junctions, i.e., the
** flowpaths between the containment and/or auxiliary building
** compartments.
**
** There are two input lines required for entering data for each junction
** and the last line after defining all the junctions must be
** "END". After the END line, there are several miscellaneous junction
** specific input parameters related to junction fans, discharge
** coefficient, and aerosol filtering functions.
**
** The first of the two input lines defining a junction defines one of the
** four possible junction types:
**
** 1. Normally open flowpath. This is defined by the word
**
**         JUNCTION
**
**     on the first line, and the code sets the internal flag IFRB(j)=1
**     for the j'th junction.
**
** 2. Normally closed flowpath designed to fail on a pressure differential.
**     This is defined by the word
**
**         FAILURE
**
**     on the first line, and the code sets the internal flag IFRB(j)=0
**     for the j'th junction.
**
** 3. A valve type flowpath that functions like a vacuum breaker or a
**     check valve. This is defined by the word
**
**         VACUUM or
**         CHECK
**
**     on the first line, and the code sets the internal flag IFRB(j)=-2
**     for the j'th junction.
**
** 4. A loop seal type flowpath. This is defined by the word
**
**         LOOP
**

```
**     on the first line, and the code sets the internal flag IFRB(j)=-3
**     for the j'th junction.
**
** The internal code flag IFRB(j) indicates the type of junction and
** whether it is open or not. The j'th junction is open when IFRB(j) is
** greater than zero, otherwise the junction is closed. There is an
** external variable, JFRB(j) that provides the user with manual control
** of the junction, as shown next:
**
**     JFRB(j) =  1, manually force the junction open.
**
**     JFRB(j) =  0, manually force the junction closed.
**
**     JFRB(j) = -1, restore to its initial, auto state.
**
** The parameter JFRB() does not override the junction type and is
** typically used in the input file to provide operator manual control
** of the junctions.
**
** The MAAP4 code counts the junctions in the order they are read-in in
** the *Topology parameter section. Thus, the 3'rd junction is the third
** read-in junction. The total count of junctions is IMAXJ.
**
** @@@ 4.0.3 SMD 3/5/96 - Note:
** The junctions in MAAP4 must always be in consecutive order. When
** removing a junction, all subsequent junctions and any parameters which
** reference those junctions need to be re-numbered (i.e. if junction
** 3 is removed, junction 4 now becomes junction 3, junction 5 becomes
** junction 4, etc.). The following parameters may need to be modified
** if a junction is removed: JJEX(I), JDCF(I), MAERFF(I), FDFFIL(I),
** JSGTS(I) where I represents a junction number.
**
** The second line defines the characteristics of the junction:
**
**   A. The compartment index on the upstream side of the junction. The
**      corresponding MAAP variable is IVOL(j,1);
**
**   B. The compartment index on the downstream side of the junction. The
**      corresponding MAAP variable is IVOL(j,2);
**
**   C. Use 1 if the junction is in the floor or ceiling, e.g., the flow
**      is vertical, or use 0 if the junction is in the wall, e.g., the
**      flow is horizontal. The corresponding MAAP variable is IHRB(j);
**
**   D. The height of the upstream opening of the junction above the floor
**      of the upstream compartment. The corresponding MAAP variable is
**      ZJUNC(j,1);
** @@@ 4.0.3 BJS 4/18/96 - The word "bottom was replaced with "upstream
** opening" to make the definition more generic.
**   For horizontal (floor or ceiling) junctions:
**    - If the upstream compartment is below the downstream compartment,
**      i.e., positive flowrates indicate that the flow is up, then
**      the upstream opening is physically the bottom of the junction.
**    - If the upstream compartment is above the downstream compartment,
```

```
**      i.e., positive flowrates indicate that the flow is down, the
**      upstream opening is physically the top of the junction.
**   The height of the upstream opening above the floor of the upstream
**   compartment should always be positive.
**
** For example:
**
**                  Upstream Compartment
** 1.)                                    This junction is in a floor
**      _________ _ _ _ ________ floor of compt.  with the upstream compt.
**          |     |                      above the downstream compt.
**          |Junction|                       The upstream opening is
**          |     |                      level with the floor of the
**      _______|_ _ _ _|___ ceiling of compt.   upper compart. so the
**                                       height of the opening is 0.
**               Downstream Compartment
**
**
**                 Upstream Compartment
** 2.)          _ _ _ _                    This junction is like the
**      _______|     |______ floor of compt.  one above, but it has a
**          |     |                      curb.  The opening of the
**          |Junction|                       junction above the floor
**          |     |                      is the height of the curb.
**      _______|_ _ _ _|___ ceiling of compt.
**
**               Downstream Compartment
**
**
**
**   E. Facing the opening, the width of the junction.  The corresponding
**      MAAP variable is XWJUNC(j);
**
**   F. Facing the opening, the height of the junction.  The corresponding
**      MAAP variable is XHJUNC(j);
**
**   G. The length of the junction.  The corresponding MAAP variable is
**      XLJUNC(j);
**
**   H. The area of the junction.  The corresponding MAAP variable is
**      AJUNC0(j);
**
**   I. The water depth above which the junction is considered shut for
**      gas flow.  This applies to both ends of the junction.  It is
**      measured with respect to ZJUNC(j,1) for the upstream side (input)
**      and ZJUNC(j,2) for the downstream side (calculated).  The
**      corresponding MAAP variable is XOJUNC(j).  See below for further
**      information about this parameter.
**
** If the junction is a failure junction type, add the next two items
** at the end of the second line.
**
**   J. The differential pressure required to fail or open the junction
**      if the upstream compartment has the higher pressure.  The
```

```
**     corresponding MAAP variable is PFFJ(j);
**
**   K. The differential pressure required to fail or open the junction
**     if the downstream compartment has the higher pressure.  The
**     corresponding MAAP variable is PFBJ(j).
**
** Note that this is guage, not absolute pressure.
**
** If the junction is a vacuum breaker or check valve junction type, add
** the next two items at the end of the second line.
**
**   J. The differential pressure required to open the vacuum breakers
**     junction if the upstream compartment has the higher pressure.
**     The corresponding MAAP variable is PFFJ(j);
**
**   K. The differential pressure required to close the vacuum breakers
**     once opened.  The corresponding MAAP variable is PFBJ(j).
**
** Note that the vacuum or check valve flows are one directional from
** upstream compartment to downstream compartment only.
**
** If the junction is a loop seal junction type, add the next two items at
** the end of the second line.
**
**   J. The differential pressure required to clear or open the junction
**     if the upstream compartment has the highest pressure.  The
**     corresponding MAAP variable is PFFJ(j);
**
**   K. The differential pressure required to clear or open the junction
**     if the downstream compartment has the highest pressure.   The
**     corresponding MAAP variable is PFBJ(j).
**
** Note that the junction vertical length is included to check if only
** water, not gas flow is allowed.
**
** ==================================================================
** Phantom Flow - Artifical Circulation Flow
**
** @@@ 4.0.3 MAM 12/14/95  Added note about phantom flows.
**
** If two nodes in a circulation flow path are staggered, an artificial
** circulation flow can arise.  This 'phantom flow' is inherent in the
** lumped parameter model where the gas density is assumed to be uniform
** within each compartment.  Currently, the known remedy for this problem
** is to avoid staggered nodes by adjusting the floor elevations (if the
** stagger is minor), or by breaking up a node into two (if the stagger is
** pronounced) to avoid staggered nodes.  That is, all nodes in the same
** floor should be the same floor elevation.
**
** Likewise, junctions of non-zero length through floors and ceilings can
** give rise to artificial flow because half the junction is assumed to be
** occupied by donor node gas and the other half the receiver node gas.
** Therefore, it is suggested to use zero length junctions unless finite
** length junctions are needed to provide curbs to prevent water flows.
```

```
**
** The users should run a null transient to test the containment
** nodalization and eliminate 'phantom' flows. To run a null transient,
** the user can run the code in containment benchmark mode and change the
** BENCH subroutine to bypass HDR calculations. A control flag will be
** introduced in MAAP 4.0.4 to provided the user a way to run the null
** transient without changing the BENCH subroutine.
**
**
** @@@ 4.0.3 CYP 4/17/96 - Further information about phantom flows.
**
** Modifications were made to Rev. 4.0.3 of the code to include the
** dependence of density/pressure on elevation to reduce phantom
** flows. It was necessary to introduce the following restriction
** for defining junctions so that the code will interpret the junction
** input without ambiguity:
**
**   When a compartment is fully enclosed within another compartment
**   and there is a junction from the top of the inside compartment
**   into the surrounding compartment, the surrounding compartment
**   must be the upstream compartment, and the enclosed compartment
**   must be the downstream compartment. That is, positive flow will
**   be from the surrounding compartment down into the enclosed
**   compartment. (If the enclosed compartment is defined to be the
**   upstream compartment then the code will treat the junction as
**   if it is in the bottom of the compartment, not in the top.)
**
**
** ==================================================================
** General Notes
**
** Junctions of non-zero length through floors and ceilings can contribute
** to artificial flow because half the junction is assumed to be occupied
** by donor node gas and the other half the receiver node gas. Therefore,
** it is suggested to use zero length junctions unless finite length
** junctions are needed to provide curbs to prevent water flows.
**
** If the junction is a vertical wall, the opening height is re-set to
** the value of the junction height.
**
** @@@ 4.0.3 MAM 12/14/95 Expanded parameter XOJUNC(j) discussion.
**
** The water height above which the junction is considered shut for gas
** flow (XOJUNC) only applies to junctions in floors/ceilings or junction
** as vertical pipe. The water height is the height above the junction
** opening that the compartment water level has to meet or exceed in order
** to shut the junction off for gas flow. The reason for this term is that
** gas can bubble through or be entrained in water flowing through a
** horizontal junction where the water level is above the opening of the
** junction. The code does not contain a mechanistic model for this gas
** flow. Hence, it is user controlled via XOJUNC. For junctions with a
** small cross-sectional area relatively little water would close it to gas
** flow. But for larger junctions, a relatively high head of water would
** be needed. Using a value of 0 for XOJUNC will result in a divide by
```

```
** zero error.  A small but non-zero value of XOJUNC should be used in
** place of 0 if bubbling or entrainment is not expected.  Using larger
** values of XOJUNC may be useful for code stability: if XOJUNC is small
** then the flow area can vary substantially with small changes in water
** level, if XOJUNC is larger it gives the code a chance to find a water
** level at which the pressure drop across the junction just matches
** hydrostatic head imbalances.  A higher value of XOJUNC is unlikely to
** significantly affect the accuracy of the calculations, and it may reduce
** AXWFLO and AUXFLO convergence failures.  A typical example might be a 5
** meter opening in the floor.  Then the water level on the floor should at
** least exceed 1 or more meters before disallowing further gas flow for
** that opening.  Note that the junction opening height applies to both
** ends, top and bottom, of the junction.  Also note that the junction is
** fractionally open if the water height is between the junction opening
** and XOJUNC(j) for the j'th junction.  In the case of downcomer pipes, an
** opening height of 1/2 to 1 pipe diameter is sufficient.
**
** If the junction's width equals the height, the junction opening is
** assumed to be circular.  Otherwise, the junction is assumed to be
** rectangular.  To model a square opening, set the junction width slightly
** larger than the height.
**
** If the junction is rectangular, the area can be different than the
** product of length and width if the junction represents the sum of
** several holes that are at similiar elevations.
**
** Note that the containment failure area supplied for the failure junction
** is a subjective number that is expected to vary from plant to plant,
** even for similar plants.
**
** @@@ 4.0.2 BJS 9/29/95 - A solid containment compartment is one that is
** filled with water.  The code cannot handle a situation in which a solid
** compartment is only connected to another solid compartment.  This should
** be kept in mind when defining the junctions between the compartments.
** One work-around to this limitation is to open an alternative junction
** from the first compartment to go solid to another non-solid compartment
** just before the second compartment goes solid.
**
**
** The junction specifications can be changed in the input file using local
** parameter changes.  The following two junction input lines in the
** parameter file:
**
**    Failure #6
**    3 5 0 8 0.025 1.68 0.1 0.025 0.9286e6 1.e8
**
** are equivalent to the following local parameter changes in the input
** file:
**
**    IMAXJ = MAX(6,IMAXJ)
**    IFRB(6)   = 0       // Failure junction type
**    IVOL(6,1) = 3       // Compartment 3 is upstream
**    IVOL(6,2) = 5       // Compartment 5 is downstream
**    IHRB(6)   = 0       // Vertical junction, hortizontal flow
```

```
**   ZJUNC(6,1) = 8.0      // Bottom of junction height with respect to
**                         // upstream floor
**   XWJUNC(6)  = 8        // Width
**   XHJUNC(6)  = 0.025    // Height
**   XLJUNC(6)  = 1.68     // Length
**   AJUNC0(6)  = 0.1      // Area
**   XOJUNC(6)  = 0.025    // Water height to shut off gas flow
**   PFFJ(6)    = 0.9286e6 // Upstream to downstream failure pressure
**   PFBJ(6)    = 1.e8     // Downstream to upstream failure pressure
**
** and also equivalent to the following local parameter changes in the
** input file:
**
**   Define Failure 6
**   3 5 0 8 0.025 1.68 0.1 0.025 0.9286e6 1.e8
**
** In the last example, the junction number must be present as the last
** element on the "Define ..." input line.  See subroutine LOCPAR
** subroutine writeup of the MAAP4 Users Manual.
**
** @@@ 4.0.3 BJS 4/12/96 - Note:  When changing/adding junction information
** in the input file using the first method set the value of XOJUNC equal
** to the height of the junction, XHJUNC, for vertical junctions.  The code
** will do this automatically if the junction information is specified
** in the parameter file or in the input file using the second method.
**
**
** ======================================================================
**
**  Junctions currently defined for the Ice Condenser containment are:
**
**     1) CAVITY THRU BYPASS - LOWER COMPARTMENT
**     2) CAVITY THRU TUNNEL - LOWER COMPARTMENT
**     3) LOWER COMPARTMENT - ANNULAR COMPARTMENT
**     4) LOWER COMPARTMENT - UPPER CYLINDER
**     5) LOWER COMPARTMENT - ICE COND COMPARTMENT
**     6) UPPER DOME - ENVIRONMENT (FAILURE JUNCTION)
**     7) UPPER CYLINDER - UPPER DOME
**     8) UPPER DOME - UPPER SPRAY
**     9) ICE COND COMPARTMENT - ICE UPPER COMPARTMENT
**    10) ICE UPPER COMPARTMENT - UPPER DOME
**
** ======================================================================

JUNCTION #1 CONNECTING COMPTS 1-2; CAVITY THRU BYPASS - LOWER COMPT
1 2 0   41.08   6.37   6.57   8.0    41.84   6.57

JUNCTION #2 CONNECTING COMPTS 1-2; CAVITY THRU TUNNEL - LOWER COMPT
1 2 1   41.08   6.5    10.0   4.0    0.0     4.0
** block junction #2 for now since there is a seal table
** 1 2 1   41.08   6.5    10.0   4.0    65.0    4.0

JUNCTION #3 CONNECTING COMPTS 2-4; LOWER COMPT - ANNULAR COMPT
2 4 0   25.66   45.1   45.29  3.0    2042.66  45.29
```

JUNCTION #4 CONNECTING COMPTS 2-3; LOWER COMPT - UPPER CYLINDER
2 3 1   51.33   2.04   2.25   2.5   4.6   2.5

** Personal communication from the plant for opening/closing pressures:
** Opening pressure vs junction area should be defined as lookup table
** in input decks rather than in here

VACUUM #5 CONNECTING COMPTS 2-9; LOWER COMPT - ICE COND COMPT
2 9 0   39.21   160.08 7.33   3.0   1173.39   3.0   0.0   0.0

FAILURE #6 CONNECTING COMPTS 5-10; UPPER DOME - ENVIRONMENT
5 10 0   31.25   0.94   1.15   3.0   1.08   1.15 85.0   1.E8

JUNCTION #7 CONNECTING COMPTS 3-5; UPPER CYLINDER - UPPER DOME
3 5 1   60.42   76.1   76.3   0.03   5806.1   0.03

JUNCTION #8 CONNECTING COMPTS 5-6; UPPER DOME - UPPER SPRAY
5 6 1   39.03   74.77   74.97   0.03   5605.3   0.03

JUNCTION #9 CONNECTING COMPTS 9-8; ICE COND COMPT - ICE UPPER COMPT
9 8 1   62.55   64.79   64.99   3.28   4211.   3.28

JUNCTION #10 CONNECTING COMPTS 8-5; ICE UPPER COMPT - UPPER DOME
8 5 1   15.24   44.35   44.54   1.0   1975.43   1.0

END   // end of junction definitions
**
** ==================================================================
** ==================================================================
** Name: PFAN(1:120)   Units: [PA.PSI]
**
** Parameter PFAN(j) is the fan volumetric flow rate imposed on the j'th
** junction. By definition, the flow direction is from upstream to
** downstream as defined in the junction definition card. Junction fans
** are always assumed to be on as long as power is available. If there is
** no AC or DC power available, then fans will cease to operate. This is
** the only input parameter related to fan in the junction.
**
** CAUTION: Supply explicit unit labels, e.g., M**3/S, GPM, FT**3/HR, e.g.,
**
**   PFAN(1) = 100 M**3/S
**
** because the MAAP code expects the input value of PFAN to be in units of
** volumetric flow rate. After the input value of PFAN is read in, MAAP
** converts the value of PFAN into an equivalent pressure head internally
** for the rest of the calculations. As a result, the internal units for
** PFAN are PA or PSI. Because explicit unit labels take precedence over
** internally defined units, the explicit unit label will ensure that the
** volumetric flow rate unit conversion is done correctly. The default
** values of PFAN(j) for all junctions j is zero.
**
** ==================================================================
** Name: FCDJ(1:120)   Units: [Dimensionless]

```
**
** Parameter FCDJ(j) is the discharge loss coefficient for the j'th
** junction.  The default values of FCDJ(j) for all junctions j is 0.75.
**
** ======================================================================
** Name: INJDF(120)            Units: [Dimensionless]
**
** @@@ 4.0.1 MAM 12/8/94  Added new variable INJDF for AUXFP.
**
** Parameter INJDF(j) is an option flag for defining the injection mode to
** be used in subroutine POOLDF to select the appropriate DF data set for
** the j'th junction.  It is only used for junctions that are submerged in
** water pools.  By default, the code sets the injection mode for junctions
** in walls as side venting into the water pool and for junctions in floors
** as downcomer injection into water pool.  The options are:
**
**       = 0, for junctions in walls, INJDF is set to 2 and for
**            junctions in floors/ceiling, INJDF is set to 3.
**
**       = 1, sparger gas injection into water pool,
**       = 2, side vent gas injection into water pool,
**       = 3, downcomer gas injection into water pool, and
**       = 4, corium debris gas flow into overlying water pool.
**
** The default values of INJDF(j) for all junctions j is zero and see
** POOLDF subroutine writeup of the MAAP4 User Manual for further
** information.
**
** ======================================================================
** The next three parameters: MAERFF(), FDFFIL(), and JNGTS() are used to
** model the junction aerosol filters, e.g., charcoal filters.  The Standby
** Gas Treatment System "SGTS" charcoal filtering model in MAAP 3.0B was
** generalized for use on the junction flowpaths.  The model allows the
** user to specify the junction's decontamination factor (DF = aerosol mass
** in / aerosol mass out) and the accumulated aerosol mass limit that would
** terminate the DF effect, i.e., fail the filters.
**
** @@@ 4.0.3 BJS 3/6/96 - Added back values for MAERFF(6), FDFFIL(6),
** and JSGTS(6) for the ice condenser.
** ======================================================================
** Name: FDFFIL(1:120)         Units: [Dimensionless]
**
FDFFIL(6)       1.2
**
** Parameter FDFILL(j) is the decontamination factor (DF) to be used for
** the j'th junction aerosol filters when it is intact.  The default values
** of FDFFIL(j) for all junctions j is one.
**
** ======================================================================
** Name: MAERFF(1:120)         Units: [KG,LB]
**
MAERFF(6)       1.e27  LB
**
** Parameter MAERFF(j) is the total aerosol mass limit above which the
```

** aerosol filters for the j'th junction fails. The default values of
** MAERFF(j) for all junctions j is zero.
**
** ===========================================================================
** Name: JSGTS(1:120)          Units: [Dimensionless]
**
JSGTS(6)          0
**
** Parameter JSGTS(j) is an control flag for aerosol filter control:
**
**      = 0, operative,
**      = 1, failed or inoperative
**
** By default, the parameter JSGTS(j) for all junctions j is initially set
** to 1. Set it to 0 to turn on or enable the aerosol filter. Note that
** parameter JSGTS(j) is set to 1 when the total aersol mass collected,
** MAERF(j), is greater than the accumulated aerosol mass limit, MAERFF(j)
** for the j'th junction. The output parameter MSGTS(i) is the total
** i'th fission product group aerosol mass collected on all junction
** aerosol filters.
**
*****************************************************************************
*Debris
*****************************************************************************
*BR
**
** Debris quantities typically end with the letter "B". Debris quantities
** are on a per corium pool basis, ie., ic'th corium pool index, not iv'th
** compartment index. The correlation of the ic'th corium pool and the
** iv'th compartment is defined by parameter variable JNCM() in the
** pointers parameter section. For example, if JNCM(2)=3 then compartment
** in compartment #3 is TCMB(2).
**
** ===========================================================================
** Name: ACMPLB(10)          Units: [M**2,FT**2]
**
** This parameter is the floor surface area which the ic'th corium debris
** pool may occupy. This floor area may be less than the total compartment
** floor area. For example, in MARK I plant, it would be expected that
** only 1/4 to 1/3 of the drywell floor area may recieve corium flow from
** the pedestal through the doorway. This floor area may also vary depending
** on the type of the sequence being modeled. For example, it would be
** expected that the floor area would be larger for high pressure vessel
** failure seqeunce which would forcefully spread the corium over an larger
** area, compared to a low pressure vessel failure sequence in which corium
** flows as a function of gravity and viscosity.
**
ACMPLB(1)    648.99 FT**2
ACMPLB(2)    814.87 FT**2
ACMPLB(3)    0.0 FT**2
ACMPLB(4)    0.0 FT**2
ACMPLB(5)    0.0 FT**2
ACMPLB(6)    0.0 FT**2
ACMPLB(7)    0.0 FT**2

```
ACMPLB(8)       0.0  FT**2
ACMPLB(9)       0.0  FT**2
ACMPLB(10)      0.0  FT**2
**
** ==========================================================================
AKEY1        306.00  FT**2      // Units: [M**2,FT**2]
**
** This parameter is the effective gas flow area used in computing the
** critical gas velocity for debris displacement or flooding due to failed
** vessel.  Corium displacement or flooding is simply the movement of
** corium mass from one compartment to the next by the pushing force of
** gas flow.
**
** The effective gas flow area, AKEY1, should be roughly the size of the
** largest characteristic cross-sectional area that corium must traverse
** on its way to the opening, where it may be flooded to upper or lower
** compartments.  Note that this flooding/displacement model only applies
** to junction JENTR for flows out of compartment JNVP.  Both JENTR and
** JNVP parameters are defined in the Pointers parameter section.
**
** This model is the same model used in MAAP 3B code, the displacement or
** flooding of the corium debris from the cavity to the lower compartment
** due to high gas velocity discharged at vessel failure.  The flashing of
** water flow from failed vessel, hygrogen gas flow from failed vessel, and
** steam production from steam explosion, if any, is summed and multiplied
** with the gas specific volume to obtain the volumetric gas flowrate.  The
** volumetric gas flowrate is then divided by AKEY1 to obtain the gas
** velocity, viz:
**
**         gas velocity = wg * vg / akey1
**
**                      = volumetric flow / akey1
**
** The calculated gas critical velocity is then compared with the flooding
** velocity threshold as obtained from using function UCRDR with a value
** of 3 for the Kutateladze number to determine if debris displacement
** should occur.  The criteria for flooding is met when the calculated gas
** velocity exceeds the flooding velocity.  Since the Kutateladze number
** is hardwired at 3 in the code, the model parameter FENTR which is a
** multiplier to the flooding velocity, can be varied to make the flooding
** velocity larger or smaller.
**
** Increasing parameter AKEY1 will decrease the critical velocity making it
** more difficult to meet the criteria for debris displacement due to high
** velocity gas flow.  The reverse situation is true when parameter AKEY1 is
** decreased.
**
** Note that in PWR MAAP 3B, AKEY1 was computed as:
**
**     AKEY1 =  ATNCX / (ATN0/(ATN0+ATNBP))
**
** where
**
**     ATN0  = Tunnel cross-sectional area
```

```
**      ATNBP = Bypass area other than tunnel coupling to lower/upper
**      ATNCX = Largest cross-sectional area that water/corium must
**              traverse to the opening where it may be entrained.
**
** For Zion-like plant, ATN0=5.92, ATNBP=0.5, ATNCX=12.0, hence AKEY1 ~ 13.
**
** ========================================================================
** When the mechanistic Direct Containment Heating (subroutine DCH1) model
** is selected by setting model parameter FENTRC > 0, input data are
** required for the following parameters: APLC, ATN0, XLP, XLC, XSLTBL,
** XLKEY1, and ZHLC0, as decribed next.  Related input parameters also
** required for the mechanistic DCH model are model parameters FWEBER,
** FENTRC, FPDIF and FDENTR.  Additional details of the mechanistic DCH
** model are described in the DCH1 subroutine writeup in the MAAP4 User's
** Manual.  Figure 2 of the DCH1 subroutine writeup shows the geometry of
** the parameters explained next.
**
** ========================================================================
APLC        648.99  FT**2     // Units: [M**2,FT**2]
**
** Horizontal floor surface area of cavity/instrument tunnel.
**
**
** ========================================================================
ATN0         65.00  FT**2     // Units: [M**2,FT**2]
**
** Cross-sectional area of minimum cavity flow area.
**
**
** ========================================================================
XLP          39.27  FT        // Units: [M,FT]
**
** Total length of debris flow path to the opening.
**
**
** ========================================================================
XLC          68.60  FT        // Units: [M,FT]
**
** Effective length of debris on the floor which is displaced to the
** opening.
**
**
** ========================================================================
XSLTBL       19.69  FT        // Units: [M,FT]
**
** Vertical height of opening from cavity to seal table lip.
**
**
** ========================================================================
XLKEY1        9.84  FT        // Units: [M,FT]
**
** Cross-sectional width of the cavity keyway/tunnel flow area.
**
**
```

```
** ==========================================================================
ZHLC0         51.33  FT       // Units: [M,FT]
**
** Height from floor to ceiling in lower compartment.
**
**
** ==========================================================================
** @@@ 4.0.3 BJS 9/21/95  -  Note: The model parameters for the mechanistic
** DCH model, FWEBER, FENTRC, FPDIF and FDENTR, have been moved to the
** model parameter section.
**
*******************************************************************************
*Material Type
*******************************************************************************
*BR
**
** This parameter section sets up the material type pointer for use with
** Distributed and Lumped Heat Sink parameter sections.  The material
** properties are to be defined for each material type pointer used.
** Distributed heat sinks are typically two sided wall/floor with
** 1-dimensional temperature profile through the wall/floor.  Lumped
** heat sinks are typically equipment masses lumped into a single mass.
**
** For distributed heat sinks, material properties such as density, specific
** heat, and thermal conductivity must be defined.  For lumped heat sinks,
** only the specific heat must be defined.  Values can be obtained from
** structural materials specifications, material procurement documentation,
** or from Mark's Mechanical Engineering handbook.
**
** ==========================================================================
** Material properties are defined for concrete, brick, and steel for
** distributed material type pointers 1 through 3, respectively.
**
** ==========================================================================
** Name: DHSM(1:5)              Units: [KG/M**3,LB/FT**3]
**
** Density of ith material type used for distributed heat sinks.
**
DHSM(1)      143.02  LB/FT**3
DHSM(2)       85.75  LB/FT**3
DHSM(3)      489.44  LB/FT**3
DHSM(4)        0.0  LB/FT**3
DHSM(5)        0.0  LB/FT**3
**
** Corresponding values may be consolidated from PWR MAAP 3B parameters
** DHSRB() and DIWRB() for auxiliary building walls or floors and from
** parameters DOWD, DOWC, DOWB, DIW, DFB, DOWA, DDCK for containment
** walls or floors.
**
** ==========================================================================
** Name: KHSM(1:5)              Units: [W/M-C,BTU/FT-HR-F]
**
** Thermal conductivity of ith material type for distributed heat sinks.
**
```

KHSM(1) 0.797 BTU/FT-HR-F
KHSM(2) 0.347 BTU/FT-HR-F
KHSM(3) 28.89 BTU/FT-HR-F
KHSM(4) 0.0 BTU/FT-HR-F
KHSM(5) 0.0 BTU/FT-HR-F
**
** Corresponding values may be consolidated from PWR MAAP 3B parameters
** KHSRB() and KIWRB() for auxiliary building walls or floors and from
** parameters KOWD, KOWC, KOWB, KIW, KFB, KOWA, KDCK for containment
** walls or floors.
**
** ==========================================================================
** Name: CPHSM(1:5) Units: [J/KG-C,BTU/LB-F]
**
** Specific heat of ith material type for distributed heat sinks.
**
**
CPHSM(1) 0.2099 BTU/LB-F
CPHSM(2) 0.2006 BTU/LB-F
CPHSM(3) 0.1194 BTU/LB-F
CPHSM(4) 0.0 BTU/LB-F
CPHSM(5) 0.0 BTU/LB-F
**
** Corresponding values may be consolidated from PWR MAAP 3B parameters
** CPHSRB() and CPIWRB() for auxiliary building walls or floors and from
** parameters CPOWD. CPOWC. CPOWB, CPIW, CPFB, CPOWA, CPDCK for containment
** walls or floors.
**
** ==========================================================================
** Material properties are defined for steel. aluminum, copper, lead. and
** steel lumped material type pointers 1 through 5. respectively.
**
** ==========================================================================
** Name: CPEQM(1:5) Units: [J/KG-C,BTU/LB-F]
**
** Specific heat of ith material type for lumped heat sinks.
**
CPEQM(1) 0.1100 BTU/LB-F
CPEQM(2) 0.2140 BTU/LB-F
CPEQM(3) 0.0915 BTU/LB-F
CPEQM(4) 0.0311 BTU/LB-F
CPEQM(5) 0.1194 BTU/LB-F
**
** In PWR/BWR MAAP 3B, properties of the lumped equipment masses in the
** containment were assumed to be of carbon steel type.
*****************************************************************************
*Distributed Heat Sinks
*****************************************************************************
*BR
**
** Up to 200 distributed heat sinks are allowed in the containment and/or
** auxiliary building. Distributed heat sinks are 1-dimensional heat sinks,
** nodalized through the wall. The heat sinks can be a wall or a floor
** between two compartments, or an internal wall within a compartment. The

```
** compartment may have any number of distributed heat sinks.  Subroutine
** HSNKRB manages the overall logic of distributed heat sinks by connecting
** them with the appropriate compartment.  Subroutine HTWALL does the actual
** physics of calculating the temperature profile as well as the surface
** heat transfer to the surrounding gas space or water pools.
**
** The user should try to have the heat sink surface area be consistent
** between compartments. For example, suppose there is a wall where
** compartment 1 covers the entire surface of side 1, and compartment 2 and
** 3 covers 1/2 of the total wall  area.  Then define two distributed heat
** sink walls: one facing compartment  1 and 2, and the other facing
** compartment 1 and 3.  Using a single heat sink would not be consistent
** because for side 2, either compartment 2 or compartment 3 would have to
** be applied to the total surface area.
**
** In the following discussions about the heat sinks, the terms "surfaces",
** "side", and "face" are used interchangeably.
**
** The distributed heat sink setup for a Westinghouse Ice-like containment is:
**
**   1) Concrete Cavity Wall
**   2) Concrete Lower Compartment Interior Wall
**   3) Concrete Lower Compartment Floor
**   4) Concrete Wall between Lower and Annular Compartments
**   5) Concrete Lower Outer Wall
**   6) Concrete Upper Outer Wall
**   7) Concrete Deck between Upper Cylinder and Lower Compartments
**   8) Steel Shell Wall between Annular and Air Gap Compartments
**   9) Steel Shell Wall between Condensor and Air Gap Compartments
**  10) Steel Shell Wall between Ice Upper and Air Gap Compartments
**  11) Steel Shell Wall between Upper Dome and Air Gap Compartments
**  12) Steel Shell Wall between Upper Spray and Air Gap Compartments
**
** ====================================================================
** Name: HSTYP(1:200)          Units: [Dimensionless]
**
** Parameter HSTYP(ih) is a material type index for the ih'th heat sink,
** and corresponds to the index defined in the parameter section *Material.
** The material type index is used to define the thermal properties of the
** heat sink.  A negative value indicates that the heat sink has isothermal
** surfaces.
**
HSTYP(1)        1
HSTYP(2)        1
HSTYP(3)        1
HSTYP(4)        1
HSTYP(5)        1
HSTYP(6)        1
HSTYP(7)        1
HSTYP(8)        3
HSTYP(9)        3
HSTYP(10)       3
HSTYP(11)       3
HSTYP(12)       3
```

```
**
** ======================================================================
** Name: NIWALL(1:200)          Units: [Dimensionless]
**
** Parameter NIWALL(ih) is the ih'th heat sink orientation flag defined as:
**
**      =  1, Vertical one sided heat sink
**      = -1, Hortizontal one sided heat sink
**
**      =  2, Vertical two sided heat sink
**      = -2, Hortizontal two sided heat sink
**
**      =  0, Connecting vertical two sided heat sink
**
** Defining a heat sink with NIWALL = 0 simply indicates that condensate
** water film flow is contiguous to the next heat sink.  Otherwise, the water
** flow is added to the compartment water pool when the film flow reaches
** bottom of the heat sink.  When making connecting or contiguous heat sinks,
** the order of the heat sinks should be arranged according to the direction
** of film flow. For example, to connect three heat sinks (eg., top wall,
** middle wall, and bottom wall) define the top wall as heat sink #12, the
** middle wall as heat sink #13, and bottom wall as heat sink #14 and
** NIWALL(ih) = 0 for heat sinks #12 through #13.
**
** For hortizontal heat sinks (NIWALL is negative), heat sink side for one
** sided heat sinks and face 1 for two sided heat sinks always faces up.
**
** For vertical one sided heat sinks (NIWALL = 1), side 2 is assumed to
** lose heat at a rate defined by the heat transfer coefficient parameter
** HTEXT.  See parameter HTEXT for additional descriptions.  For hortizontal
** one sided heat sinks (NIWALL = -1), HTEXT is set to zero in the code.
**
** Internal or interior walls are walls totally contained in a compartment.
** If (as occasionally encountered) walls of several thicknesses must be
** lumped together, lump only relatively thick walls (e.g., greater than
** approximately 1 foot or .3 meter in thickness) and enter the thickness
** of the thinnest wall credited.
**
** In MAAP3B, containment floors and outer walls are defined as one sided
** heat sinks.  Containment floors have hardwired values of HTEXT=0, and
** containment outer walls use the user input parameter HTEXT.  In MAAP4,
** it is recommended that the containment outer walls are defined as two
** sided heat sinks, with side 2 as the environment node.
**
NIWALL(1)       1
NIWALL(2)       2
NIWALL(3)      -1
NIWALL(4)       2
NIWALL(5)       1
NIWALL(6)       1
NIWALL(7)      -2
NIWALL(8)       2
NIWALL(9)       2
NIWALL(10)      2
```

```
NIWALL(11)      2
NIWALL(12)      2
**
** ========================================================================
** Name: AHSRB(1:200)          Units: [M**2,FT**2]
**
** Parameter AHSRB(ih) is the ih'th total one sided heat sink wall surface
** area.  The count of distributed heat sinks stops at the first zero
** surface area.  Thus it is good practice and it is recommended to have
** the last entry set to zero, especially in the case where the user count
** of heat sinks is less than the default count of heat sinks.
**
AHSRB(1)     2510.32  FT**2
AHSRB(2)     6878.61  FT**2
AHSRB(3)     3259.48  FT**2
AHSRB(4)    11373.80  FT**2
AHSRB(5)     6977.46  FT**2
AHSRB(6)    24959.34  FT**2
AHSRB(7)     2483.20  FT**2
AHSRB(8)    19571.00  FT**2
AHSRB(9)    17167.00  FT**2
AHSRB(10)    5502.00  FT**2
AHSRB(11)   12196.00  FT**2
AHSRB(12)    6683.00  FT**2
AHSRB(13)       0.00  FT**2
**
** Corresponding values may be obtained from PWR MAAP 3B parameters
** AOWC, AIWB, AFB, AOWB, AOWD, AOWA, AIWA, and ADCK for containment
** walls or floors.
**
** ========================================================================
** Name: XTHSRB(1:200)         Units: [M,FT]
**
** Parameter XTHSRB(ih) is the average wall thickness of the ih'th heat sink.
**
XTHSRB(1)       8.0  FT
XTHSRB(2)       2.0  FT
XTHSRB(3)       8.0  FT
XTHSRB(4)       3.0  FT
XTHSRB(5)       3.0  FT
XTHSRB(6)       3.06  FT
XTHSRB(7)       2.5  FT
XTHSRB(8)       0.271  FT
XTHSRB(9)       0.271  FT
XTHSRB(10)      0.271  FT
XTHSRB(11)      0.271  FT
XTHSRB(12)      0.271  FT
**
** Corresponding values may be obtained from PWR MAAP 3B parameters
** XOWC0, XIWB0, XFB, XOWB, XOWD, XOWA, and XDCK for containment walls
** or floors.
**
** ========================================================================
** Name: THS10(1:200)          Units: [K,F]
```

**
** Parameter THS10(ih) is the initial surface temperature for side 1 of the
** ih'th heat sink. MAAP will set the heat sink surface temperature to the
** gas temperature of the compartment it faces if this parameter is
** missing or less than/equal to zero.
**
** ==========================================================================
** Name: THS20(1:200)            Units: [K,F]
**
** Parameter THS20(ih) is the initial surface temperature for side 2 of the
** ih'th heat sink. MAAP will set the heat sink surface temperature to the
** gas temperature of the compartment it faces if this parameter is
** missing or less than/equal to zero.
**
** ==========================================================================
** Name: XHSRB(1:200)            Units: [M,FT]
**
** Parameter XHSRB(ih) is the average height of the ih'th heat sink. For
** a hortizontal heat sink enter a value of zero.
**
XHSRB(1)      28.08 FT
XHSRB(2)      51.33 FT
XHSRB(3)       0.0 FT
XHSRB(4)      51.33 FT
XHSRB(5)      51.33 FT
XHSRB(6)     125.17 FT
XHSRB(7)       0.0 FT
XHSRB(8)      39.21 FT
XHSRB(9)      62.55 FT
XHSRB(10)     15.24 FT
XHSRB(11)     33.78 FT
XHSRB(12)     18.51 FT
**
** ==========================================================================
** Name: ZHSRB(1:200)            Units: [M,FT]
**
** Parameter ZHSRB(ih) is the average bottom elevation of the ih'th heat
** sink with respect to ground level. This is the same reference point the
** compartment floor elevation parameter, ZFRB(), uses. For walls that are
** flushed with the iv'th compartment floor this parameter is simply equal
** to the compartment floor elevation parameter ZFRB(iv). For walls that
** are X height above the iv'th compartment floor this parameter is X plus
** ZFRB(iv).
**
** If parameter NIWALL is positive, eg., the heat sink is vertical (wall),
** then input the elevation of the bottom of the heat sink.
**
** If parameter NIWALL is negative, eg., the heat sink is hortizontal (floor),
** then input the elevation of the top surface of heat sink.
**
ZHSRB(1)     -28.08 FT
ZHSRB(2)       0.0 FT
ZHSRB(3)       0.0 FT
ZHSRB(4)       0.0 FT

ZHSRB(5) 0.0 FT
ZHSRB(6) 51.33 FT
ZHSRB(7) 51.33 FT
ZHSRB(8) 0.0 FT
ZHSRB(9) 39.21 FT
ZHSRB(10) 101.76 FT
ZHSRB(11) 117.00 FT
ZHSRB(12) 150.78 FT
**
** ======================================================================
** Name: N1HSRB(1:200) Units: [Dimensionless]
**
** Parameter N1HSRB(ih) defines the index of the compartment that faces
** ih'th heat sink side 1.
**
N1HSRB(1) 1
N1HSRB(2) 2
N1HSRB(3) 2
N1HSRB(4) 2
N1HSRB(5) 7
N1HSRB(6) 7
N1HSRB(7) 3
N1HSRB(8) 4
N1HSRB(9) 9
N1HSRB(10) 8
N1HSRB(11) 5
N1HSRB(12) 6
**
** ======================================================================
** Name: N2HSRB(1:200) Units: [Dimensionless]
**
** Parameter N2HSRB(ih) defines the index of the compartment that faces
** ih'th heat sink side 2. When parameter NIWALL is 1 or -1, this parameter
** should be set to a non-zero value preferably the environment compartment
** index to prevent run-time error. This caveat was removed starting with
** MAAP 4.0.1 and N2HSRB may be set to zero when NIWALL is 1 or -1.
**
N2HSRB(1) 10
N2HSRB(2) 2
N2HSRB(3) 10
N2HSRB(4) 4
N2HSRB(5) 10
N2HSRB(6) 10
N2HSRB(7) 2
N2HSRB(8) 7
N2HSRB(9) 7
N2HSRB(10) 7
N2HSRB(11) 7
N2HSRB(12) 7
**
** ======================================================================
** Name: XLN1(1:200) Units: [M,FT]
**
** Parameter XLN1(ih) defines the liner thickness, if present, for the

```
** ih'th heat sink face 1.
**
XLN1(1)      0.0  FT
XLN1(2)      0.0  FT
XLN1(3)    0.0313  FT
XLN1(4)      0.0  FT
XLN1(5)    0.0313  FT
XLN1(6)    0.0361  FT
XLN1(7)      0.0  FT
XLN1(8)      0.0  FT
XLN1(9)      0.0  FT
XLN1(10)     0.0  FT
XLN1(11)     0.0  FT
XLN1(12)     0.0  FT
**
** ===========================================================================
** Name: XLN2(1:200)          Units: [M,FT]
**
** Parameter XLN2(ih) defines the liner thickness, if present, for the
** ih'th heat sink face 2.
**
XLN2(1)      0.0  FT
XLN2(2)      0.0  FT
XLN2(3)      0.0  FT
XLN2(4)      0.0  FT
XLN2(5)      0.0  FT
XLN2(6)      0.0  FT
XLN2(7)      0.0  FT
XLN2(8)      0.0  FT
XLN2(9)      0.0  FT
XLN2(10)     0.0  FT
XLN2(11)     0.0  FT
XLN2(12)     0.0  FT
**
** ===========================================================================
** Name: RG1(1:200)          Units: [M**2-C/W,FT**2-HR-F/BTU]
**
** Parameter RG1(ih) defines the surface to liner gap resistance for the
** ih'th heat sink face 1 if a liner is present.  Gap resistances can be
** approximated as follows, assuming the material in the gap is air:
**
**       RGAP  = XGAP / KAIR
**
** Where:  XGAP  = Gap width, M
**
**       KAIR  = Thermal conductivity of air between the liner and wall
**             = 2.986D-4 * TAIR ** 0.78, W/M-C
**
**       TAIR  = Air temperature in the gap, K
**
** Note that although the units M**2-C/W and M**2-K/W are equivalent, the
** MAAP4 code expects M**2-C/W as the proper unit label.
**
RG1(1)       0.0  FT**2-HR-F/BTU
```

RG1(2)   0.0 FT**2-HR-F/BTU
RG1(3)   0.0501 FT**2-HR-F/BTU
RG1(4)   0.0 FT**2-HR-F/BTU
RG1(5)   0.0501 FT**2-HR-F/BTU
RG1(6)   0.0501 FT**2-HR-F/BTU
RG1(7)   0.0 FT**2-HR-F/BTU
RG1(8)   0.0 FT**2-HR-F/BTU
RG1(9)   0.0 FT**2-HR-F/BTU
RG1(10)   0.0 FT**2-HR-F/BTU
RG1(11)   0.0 FT**2-HR-F/BTU
RG1(12)   0.0 FT**2-HR-F/BTU
**
** ======================================================================
** Name: RG2(1:200)   Units: [M**2-C/W,FT**2-HR-F/BTU]
**
** Parameter RG2(ih) defines the surface to liner gap resistance for the
** ih'th heat sink face 2 if a liner is present. Gap resistances can be
** approximated as follows, assuming the material in the gap is air:
**
**   RGAP = XGAP / KAIR
**
** Where: XGAP = Gap width, M
**
**   KAIR = Thermal conductivity of air between the liner and wall
**     = 2.986D-4 * TAIR ** 0.78, W/M-C
**
**   TAIR = Air temperature in the gap, K
**
** Note that although the units M**2-C/W and M**2-K/W are equivalent, the
** MAAP4 code expects M**2-C/W as the proper unit label.
**
RG2(1)   0.0 FT**2-HR-F/BTU
RG2(2)   0.0 FT**2-HR-F/BTU
RG2(3)   0.0 FT**2-HR-F/BTU
RG2(4)   0.0 FT**2-HR-F/BTU
RG2(5)   0.0 FT**2-HR-F/BTU
RG2(6)   0.0 FT**2-HR-F/BTU
RG2(7)   0.0 FT**2-HR-F/BTU
RG2(8)   0.0 FT**2-HR-F/BTU
RG2(9)   0.0 FT**2-HR-F/BTU
RG2(10)   0.0 FT**2-HR-F/BTU
RG2(11)   0.0 FT**2-HR-F/BTU
RG2(12)   0.0 FT**2-HR-F/BTU
**
** ======================================================================
** Spray Flow Directed onto Distributed Heat Sink Surface
**
** In MAAP, heat sink surfaces are in contact with water only when submerged
** in a water pool or by condensation resulting in a water film. Parameters
** WWSP1(ih), WWSP2(ih), TWSP1(ih) and TWSP2(ih) are provided to direct a
** source of water onto the heat sink surface. Typical application would be
** spray flows directed on free standing steel containment shell (Passive
** Containment Cooling) or on heat sinks that are not expected to be
** submerged in a water pool but may cooled by containment sprays. As usual,

** the activation and control of these parameters may be set up in the input
** file as an function of time or conditions.
**
** The water film flow rate and the energy carried by the water film that
** leaves heat sink ih are stored in WWF1(ih) and QWF1(ih) for heat sink
** face #1, and WWF2(ih) and QWF2(ih) for heat sink face #2.
**
** ================================================================
** Name: WWSP1(1:200)            Units: [KG/S,LB/HR]
**
** Parameter WWSP1(ih) defines the spray flow rate to the ih'th heat sink
** face 1.
**
WWSP1(1)      0.0  LB/HR
WWSP1(2)      0.0  LB/HR
WWSP1(3)      0.0  LB/HR
WWSP1(4)      0.0  LB/HR
WWSP1(5)      0.0  LB/HR
WWSP1(6)      0.0  LB/HR
WWSP1(7)      0.0  LB/HR
WWSP1(8)      0.0  LB/HR
WWSP1(9)      0.0  LB/HR
WWSP1(10)      0.0  LB/HR
WWSP1(11)      0.0  LB/HR
WWSP1(12)      0.0  LB/HR
**
** ================================================================
** Name: TWSP1(1:200)            Units: [K,F]
**
** Parameter TWSP1(ih) defines the temperature of the spray flow to the
** ih'th heat sink face 1.
**
TWSP1(1)      62.32  F
TWSP1(2)      62.32  F
TWSP1(3)      62.32  F
TWSP1(4)      62.32  F
TWSP1(5)      62.32  F
TWSP1(6)      62.32  F
TWSP1(7)      62.32  F
TWSP1(8)      62.32  F
TWSP1(9)      62.32  F
TWSP1(10)      62.32  F
TWSP1(11)      62.32  F
TWSP1(12)      62.32  F
**
** ================================================================
** Name: WWSP2(1:200)            Units: [KG/S,LB/HR]
**
** Parameter WWSP2(ih) defines the spray flow rate to the ih'th heat sink
** face 2.
**
WWSP2(1)      0.0  LB/HR
WWSP2(2)      0.0  LB/HR
WWSP2(3)      0.0  LB/HR

```
WWSP2(4)      0.0  LB/HR
WWSP2(5)      0.0  LB/HR
WWSP2(6)      0.0  LB/HR
WWSP2(7)      0.0  LB/HR
WWSP2(8)      0.0  LB/HR
WWSP2(9)      0.0  LB/HR
WWSP2(10)     0.0  LB/HR
WWSP2(11)     0.0  LB/HR
WWSP2(12)     0.0  LB/HR
**
** ====================================================================
** Name: TWSP2(1:200)          Units: [K,F]
**
** Parameter TWSP2(ih) defines the temperature of the spray flow to the
** ih'th heat sink face 2.
**
TWSP2(1)     62.32  F
TWSP2(2)     62.32  F
TWSP2(3)     62.32  F
TWSP2(4)     62.32  F
TWSP2(5)     62.32  F
TWSP2(6)     62.32  F
TWSP2(7)     62.32  F
TWSP2(8)     62.32  F
TWSP2(9)     62.32  F
TWSP2(10)    62.32  F
TWSP2(11)    62.32  F
TWSP2(12)    62.32  F
**
** ====================================================================
** Name: XPERHS(1:200)         Units: [M.FT]
**
** Parameter XPERHS(ih) is the perimeter of the ih'th heat sink.  It is
** used in the calculation of the water film flow across the surface.
** This parameter only applies when the heat sink orientation parameter
** NIWALL(ih) is 0 and must be set to non-zero value.
**
XPERHS(1)     328.1  FT
XPERHS(2)     328.1  FT
XPERHS(3)     328.1  FT
XPERHS(4)     328.1  FT
XPERHS(5)     328.1  FT
XPERHS(6)     328.1  FT
XPERHS(7)     328.1  FT
XPERHS(8)     328.1  FT
XPERHS(9)     328.1  FT
XPERHS(10)    328.1  FT
XPERHS(11)    328.1  FT
XPERHS(12)    328.1  FT
**
** ====================================================================
** Name: THETHS(1:200)         Units: [RADIANS]
**
** Parameter THETHS(ih) is the angle of inclination of the ih'th heat
```

** sink's surface. For a vertical wall it is equal to PI/2 and for a
** horizontal wall it is equal to 0. The theta to the inside surface of
** the heat sink is always from 0 to PI/2 irrespective of the heat sink
** side index. This parameter only applies when the heat sink orientation
** parameter NIWALL(ih) is 0. Parameter THETHS was introduced in MAAP
** 4.0.1 as a part of the spanish modifications and was generalized for
** heat sinks defined with NIWALL(ih) = 0.
**
THETHS(1) 0.0 RADIANS
THETHS(2) 0.0 RADIANS
THETHS(3) 0.0 RADIANS
THETHS(4) 0.0 RADIANS
THETHS(5) 0.0 RADIANS
THETHS(6) 0.0 RADIANS
THETHS(7) 0.0 RADIANS
THETHS(8) 0.0 RADIANS
THETHS(9) 0.0 RADIANS
THETHS(10) 0.0 RADIANS
**
** ======================================================================
HTEXT 8.806 BTU/FT**2-HR-F // Units: [W/M**2-C.BTU/FT**2-HR-F]
**
** Parameter HTEXT defines the heat transfer coefficient to be used for
** heat transfer on heat sink side #2 only when the heat sink orientation
** parameter NIWALL = 1, eg., one-sided vertical wall. For hortizontal one
** sided heat sinks, HTEXT is set to zero in the code.
**
** In MAAP3B the containment outer walls and floors are defined as one sided
** heat sinks. Containment outer walls use user input parameter HTEXT, and
** containment floors have hardwired values of HTEXT=0. In MAAP4, it is
** recommended that containment outer walls be defined as two sided heat
** sinks with side 2 as the environment node. Recall that the environment
** compartment conditions are defined by parameters TAMB and PAMB.
**
** MAAP3B to MAAP4 conversion notes: The corresponding parameter name in
** MAAP3B is HTOUTW for BWR and HTOW for PWR.
**
**
** ======================================================================
** Defining Radiation Link Between Two Heat Sinks
**
** The need to define radiation heat transfer links between heat sinks is
** generally found to be important in cases where there is a containment
** steel shell inside a concrete structure separated by an air gap. For
** accident sequences where containment gases are hot it is expected that
** the radiation heat loss from the steel shell would be greater than
** convection loss, especially when the air gap is sealed. Up to 100
** radiation heat transfer links may be defined. Four input variables,
** IRAHS1(ir), IRAHS2(ir), IRASD1(ir), and IRASD2(ir), are used to define
** each radiation heat transfer link. These variables simply identify what
** heat sinks (index) and which side of each heat sink is connected. Output
** variables are QRAHS1(ih) and QRAHS2(ih) which define the net raditation
** heat flux for the identified heat sink surface. As an example, suppose
** we want to link surface #1 of heat sink #12 with surface #2 of heat sink

```
**
**     irahs1(1) = 12
**     irasd1(1) = 1
**     irahs2(1) = 11
**     irasd2(1) = 2
**
** Note that the indice for these input variables are radiation link
** indice, ir, not the heat sink indice, ih, nor the compartment indice, iv.
**
** ==========================================================================
** Name: IRAHS1(1:100)          Units: [Dimensionless]
**
** Parameter IRAHS1(ir) is the index of the first distributed heat sink for
** the ir'th link.
**
** ==========================================================================
** Name: IRAHS2(1:100)          Units: [Dimensionless]
**
** Parameter IRAHS2(ir) is the index of the second distributed heat sink for
** the ir'th link.
**
** ==========================================================================
** Name: IRASD1(1:100)          Units: [Dimensionless]
**
** Parameter IRASD1(ir) is the surface side index (either 1 or 2) of the
** first distributed heat sink for the ir'th link.
**
** ==========================================================================
** Name: IRASD2(1:100)          Units: [Dimensionless]
**
** Parameter IRASD2(ir) is the surface side index (either 1 or 2) of the
** second distributed heat sink for the ir'th link.
**
*****************************************************************************
*Lumped Heat Sinks
*****************************************************************************
*BR
**
** Up to a maximum of 200 lumped heat sinks are allowed. Lumped heat sinks
** should represent any signigicant masses of equipment, piping, piping
** supports, valves such as MSIVs, pumps, and ironwork structures such as
** grates, stairwell, platforms, etc., within the compartment. Ignoring
** smaller components such as piping and valves of less than 0.1 m {4"}
** nominal diameter is conservative and may be adviseable if the effort
** necessary to acquire accurate values is excessive. Do not include
** primary system piping already accounted for in the Primary System
** parameter sections such as recirculation piping for BWRs and reactor
** coolant piping for PWRs, and secondary system piping for PWRs in Steam
** Generator parameter section.
**
** The compartment may have any number of lumped heat sinks. Subroutines
** HSNKRB manages the overall logic of lumped heat sinks by connecting
** them with the appropriate compartment. Subroutine HTEQPT does the
** actual physics of the temperature calculation as well as surface heat
```

** transfer to the surrounding gas space or water pools.
**
** Note that the count of lumped heat sinks stops at the first zero area
** entry for AEQRB and ensures that no additional lumped heat sinks are
** considered.
**
** @@@ 4.0.3 MAM 12/14/95 Lumped heat sinks should be used to model
** primarily metallic structures, i.e., materials with high thermal
** conductivity. If structures with low thermal conductivity is to be
** modeled as a lumped heat sink, then you must make sure that the Biot
** number is less than 0.1 for the model to yeild reasonable estimates.
** The Biot number is defined as:
**
** Bi = h * (v / sa) / k
**
** where: h = convection heat transfer coefficient
** v = total volume of lumped heat sink
** sa = total surface area of lumped heat sink
** k = lumped heat sink thermal conductivity
**
** Ref: Heat Transfer, J.P. Holman, 5th ed.
** ========================================================================
** Name: NEQRB(1:200) Units: [Dimensionless]
**
** Compartment index containing the ith lumped heat sink.
**
NEQRB(1) 2
NEQRB(2) 3
**
**
========================================================================
** Name: EQTYP(1:200) Units: [Dimensionless]
**
** Material type of the ith lumped heat sink as defined in Material Type
** parameter section. CAUTION: Use the correct material index defined
** for the CPEQM array. Do not confuse or use the index used for
** distributed heat sink material properties.
**
EQTYP(1) 1
EQTYP(2) 1
**
** ========================================================================
** Name: MEQRB(1:200) Units: [KG,LB]
**
** Total mass of the ith lumped heat sink.
**
MEQRB(1) 3344000.0 LB
MEQRB(2) 927300.0 LB
**
** Corresponding values can be obtained from PWR MAAP 3B parameters MEQB
** and MEQA.
**
** ========================================================================
** Name: AEQRB(1:200) Units: [M**2,FT**2]

**
** Total surface area of ith lumped heat sink exposed to the compartment
** gas space assuming no water pool is present. Do not include surface
** area in contact with a floor or wall. The count of lumped heat sinks
** stops at the first zero entry, and adding a zero entry for the last
** entry is a good practice and is recommended.
**
AEQRB(1) 159000.0 FT**2
AEQRB(2) 67600.0 FT**2
AEQRB(3) 0.0 FT**2
**
** Corresponding values can be obtained from PWR MAAP 3B parameters AEQB
** and AEQA.
**
** ==========================================================================
** Name: ZEQRB(1:200) Units: [M,FT]
**
** Average elevation of the bottom surface of ith lumped heat sink with
** respect to the compartment floor.
**
ZEQRB(1) 0.0 FT
ZEQRB(2) 0.0 FT
**
** In MAAP 3.0B, equipment masses were either completely dry or wet without
** regard for actual water levels. This parameter and the next (ZEQRB and
** XHEQRB) were provided to represent the actual sumbergence of heat sinks.
** In PWR MAAP 3.0B, all lumped equipment masses were always dry.
**
** ==========================================================================
** Name: XHEQRB(1:200) Units: [M,FT]
**
** Average vertical height of the ith lumped heat sink.
**
XHEQRB(1) 9.84 FT
XHEQRB(2) 9.84 FT
**
** Note that the area of the submerged portion of the lumped heat sink is a
** linear function of the height ranging from 0 at the bottom of the lumped
** heat sink to 100% at the top of the heat sink. CAUTION: Care must be
** taken in constructing an lumped heat sink mass with a large height since
** steel is an efficient conductor of heat. A compartment having a water
** pool, a partially submerged lumped heat sink, and hot gas will evaporate
** the water pool much sooner than an equivalent compartment without a
** partially submerged heat sink. The average height of the lumped heat
** sink is also used in calculating the natural circulation heat transfer
** coefficient.
**
** Corresponding values can be obtained from PWR MAAP 3B parameters ZEQB
** and ZEQA.
****************************************************************************
*Containment Stress - Strain Failure Model
****************************************************************************
*BR
**

** This parameter section is for setting up the containment strain model.
**
** The user has the choice of using the containment strain model and/or
** using the simple containment overpressure model for containment failure.
** The containment strain model allows the user to represent both steel
** shells and pre-stressed and post tensioned concrete containments and
** determines the containment wall strains due to internal pressure. The
** simple containment overpressure model uses FAILURE junction definitions
** in the Topology parameter section which specifies the delta-pressure
** required to fail a junction between the containment compartment
** (compartment ID's less than or equal to ICMAX) and the auxiliary or
** environment compartment. See subroutine writeup STRAIN of the MAAP4
** User's Manual for further information about the containment strain
** model.
**
** The containment outer cylindrical wall forms the pressure boundary and
** may be segmented up to 4 cylindrical walls. The failure junction
** pointers for the containment strain model is defined in the Pointers
** parameter section using parameters JDCF(), which is used to identify
** what compartment pressures to use. This model is the same model used in
** MAAP 3.0B and needs to be tested for MAAP4.
**
** In PWR MAAP 3.0B, two outside walls, annular and upper compartment outer
** walls made up the complete containment shell.
**
** @@@ 4.0.3 BJS 3/21/96 - Corrected the values/units of NDCF through
** NTYDCF. The values were interpreted as being in SI units in the first
** User's Guide when they are actually in Br units.
**
** ======================================================================
NDCF 0 // Dimensionless
**
** This parameter is the number of containment outer walls modeled for
** detailed containment strain failure. Up to 4 containment outer walls
** are allowed. Enter 0 to bypass the containment strain calculations.
**
**
** ======================================================================
XRCONT 57.46 FT // Units: [M,FT]
**
** This parameter is the containment radius for stress calculations.
**
** Corresponding PWR and BWR MAAP 3.0B parameter is XRCONT.
**
** ======================================================================
XTGAP 6.04 FT // Units: [M,FT]
**
** For cases where the outer boundary of the containment is a steel shell
** separated from a concrete shield wall, enter the distance between the
** two, enter 0 otherwise.
**
** The corresponding PWR MAAP 3.0B parameter is XTGAP, and BWR MAAP 3.0B
** parameters are XTGAP5, XTGAP6, and XTGAP4.
**

** ==============================================================================
** Name: NHOOP(4)  Units: [Dimensionless]
**
** Parameter NHOOP(i) is the number of tendons in the hoop (radial)
** direction for the i'th containment outer wall.
**
** Corresponding PWR MAAP 3.0B parameters are NHOOPA and NHOOPD.
**

| | |
|---|---|
| NHOOP(1) | 0 |
| NHOOP(2) | 0 |
| NHOOP(3) | 0 |
| NHOOP(4) | 0 |

**
** ==============================================================================
** Name: XDHOP(4)  Units: [M,FT]
**
** Parameter XDHOP(i) is the diameter of hoop tendons for the i'th
** containment outer wall.
**
** Corresponding PWR MAAP 3.0B parameters are XDHOPA and XDHOPD.
**

| | |
|---|---|
| XDHOP(1) | 0.0 FT |
| XDHOP(2) | 0.0 FT |
| XDHOP(3) | 0.0 FT |
| XDHOP(4) | 0.0 FT |

**
** ==============================================================================
** Name: XTREH(4)  Units: [M,FT]
**
** Parameter XTREH(i) is the volume of rebar per unit area of the i'th
** containment outer wall (equivalent thickness) running in the hoop
** direction.
**
** Corresponding PWR MAAP 3.0B parameters are XTREHA and XTREHD.
**

| | |
|---|---|
| XTREH(1) | 0.0 FT |
| XTREH(2) | 0.0 FT |
| XTREH(3) | 0.0 FT |
| XTREH(4) | 0.0 FT |

**
** ==============================================================================
** Name: XDRF(4)  Units: [M,FT]
**
** Parameter XDRF(i) is the displacement in the radial direction which is
** sufficient to tear the i'th containment wall, e.g., at a penetration.
**
** Corresponding PWR MAAP 3.0B parameters are XDRFA and XDRFD.
**

| | |
|---|---|
| XDRF(1) | 0.0 FT |
| XDRF(2) | 0.0 FT |
| XDRF(3) | 0.0 FT |
| XDRF(4) | 0.0 FT |

**
** ==============================================================================

** Name: NTENZ(4) Units: [Dimensionless]
**
** Parameter NTENZ(i) is the number of tendons in the axial (vertical)
** direction for the i'th containment outer wall.
**
** Corresponding PWR MAAP 3.0B parameter is NTENZ.
**
NTENZ(1) 0
NTENZ(2) 0
NTENZ(3) 0
NTENZ(4) 0
**
** ======================================================================
** Name: XDTENZ(4) Units: [M,FT]
**
** Parameter XDTENZ(i) is the diameter of axial tendons for the i'th
** containment outer wall.
**
** Corresponding PWR MAAP 3.0B parameter is XDTENZ.
**
XDTENZ(1) 0.0 FT
XDTENZ(2) 0.0 FT
XDTENZ(3) 0.0 FT
XDTENZ(4) 0.0 FT
**
** ======================================================================
** Name: XTREZ(4) Units: [M,FT]
**
** Parameter XTREZ(i) is the volume of rebar per unit area of the i'th
** containment outer wall (equivalent thickness) running in the axial
** direction.
**
** Corresponding PWR MAAP 3.0B parameters are XTREZA and XTREZD.
**
XTREZ(1) 0.0 FT
XTREZ(2) 0.0 FT
XTREZ(3) 0.0 FT
XTREZ(4) 0.0 FT
**
** ======================================================================
** Name: XDZF(4) Units: [M,FT]
**
** Parameter XDZF(i) is the displacement in axial direction which is
** sufficient to tear the i'th containment wall, e.g., at a penetration.
**
** Corresponding PWR MAAP 3.0B parameters are XDZFA and XDZFD.
**
XDZF(1) 0.0 FT
XDZF(2) 0.0 FT
XDZF(3) 0.0 FT
XDZF(4) 0.0 FT
**
** ======================================================================
** Name: XCYL(4) Units: [M,FT]

```
**
** Parameter XCYL(i) is the height of the cylindrical part of the i'th
** containment wall.
**
** Corresponding PWR MAAP 3.0B parameters are ZACYL and ZDCYL as
** AOWD/(2.D0*PI*XRCONT).
**
XCYL(1)      57.92  FT
XCYL(2)      19.33  FT
XCYL(3)       0.0  FT
XCYL(4)       0.0  FT
**
** ======================================================================
** Name: XLOW(4)                Units: [M,FT]
**
** Parameter XLOW(i) is the liner thickness on the inside of outer wall.
**
** Corresponding PWR MAAP 3.0B parameters are XLOWA and XLOWD
**
XLOW(1)     0.0573  FT
XLOW(2)      0.063  FT
XLOW(3)       0.0  FT
XLOW(4)       0.0  FT
**
** ======================================================================
NTYDCF            1          // Dimensionless
**
** Parameter NTYDCF is a flag identifying the containment outer wall type:
**
**      = 0, Steel and concrete containment
**      = 1, Steel containment
**
** @@@ 4.0.1 CYP 10/7/94  Missing parameter NTYDCF was added.
**
** @@@ 4.0.3 BJS 3/21/96 - The containment outer wall is steel, so NTYDCF
** had been corrected to be 1 instead of 0 in the draft User's Guide.
**
** ======================================================================
** @@@ 4.0.3 MAM 11/17/95 All the Young's modulus and stress loads were
** moved to this parameter section where it actually belongs from the
** Concrete parameter section and set to appropriate default values for all
** parameter files.
*SI
**
** Note:  For free-standing steel containers, e.g., when parameter NTYDCF
** is set to 1, supply only steel "liner" properties.
**
** Properties for tendons, rebar, etc. are provided for the ice condenser
** containment even though NTYDCF is 1 to provide example values.  These
** values are the same as those provided with the other sample containments.
**
** ======================================================================
PETEN        3.e11  PA        // Units: [PA,PSI]
**
```

```
** This parameter is the elastic Young's modulus for tendons.
**
** ==========================================================================
PEREB       1.99e11  PA       // Units: [PA,PSI]
**
** This parameter is the elastic Young's modulus for rebar.
**
** ==========================================================================
PEPTEN      3.97e9  PA        // Units: [PA,PSI]
**
** This parameter is the plastic Young's modulus for tendons.
**
** ==========================================================================
PEPREB      1.4e9  PA         // Units: [PA,PSI]
**
** This parameter is the plastic Young's modulus for rebar.
**
** ==========================================================================
PSSPH       9.7e8  PA         // Units: [PA,PSI]
**
** This parameter is the pre-stress load on hoop tendons.
**
** ==========================================================================
PSSPZ       1.01e9  PA        // Units: [PA,PSI]
**
** This parameter is the pre-stress load on axial tendons.
**
** ==========================================================================
**
PSSYHT      1.53e9  PA        // Units: [PA,PSI]
**
** This parameter is the tendon yield stress.
**
** ==========================================================================
PSSYHR      4.137e8  PA       // Units: [PA,PSI]
**
** This parameter is the rebar yield stress.
**
** ==========================================================================
PSSFHT      1.65e9  PA        // Units: [PA,PSI]
**
** This parameter is the tendon ultimate stress.
**
** ==========================================================================
PSSFHR      6.2e8  PA         // Units: [PA,PSI]
**
** This parameter is the rebar ultimate stress.
**
** ==========================================================================
PEL         1.99e11  PA       // Units: [PA,PSI]
**
** This parameter is the elastic Young's modulus for liner.
**
** ==========================================================================
```

```
PEPL        1.4e9  PA       // Units: [PA,PSI]
**
** This parameter is the plastic Young's modulus for liner.
**
** ===========================================================================
PSSYHL      4.137e8  PA     // Units: [PA,PSI]
**
** This parameter is the liner yield stress.
**
** ===========================================================================
PSSFHL      6.2e8  PA       // Units: [PA,PSI]
**
** This parameter is the liner failure stress.
**
**
*************************************************************************
*Quench Tank
*************************************************************************
*BR
** ====================================================================
**                 General Notes
** ====================================================================
**
** 1)  The following input parameters refer to the geometric and thermal-
**     hydraulic initial and boundary conditions required for MAAP thermal-
**     hydraulic and fission product modeling of the quench tank that
**     receives effluent from the pressurizer via the SV's and PORV's.
**
**     The quench tank is also termed the pressurizer relief tank (PRT).
**
** 2)  Parameter IQT, in the *POINTERS section of the parameter file,
**     controls the application of the quench tank model.
**
**       IQT   Description
**       ---   -----------
**        0    Quench tank is not modelled.  The containment
**             compartment associated with pointer JNRV directly
**             receives effluent from pressurizer SV's and PORV's.
**        1    Quench tank is modelled in the containment compartment
**             associated with pointer JNRV.  Effluent from the
**             pressurizer SV's and PORV's discharges into the quench
**             tank.  If the quench tank rupture disk has failed,
**             effluent can then discharge from the quench tank into
**             containment.
**
** 3)  Possible data sources for these parameters are:
**
**     a) Plant Final Safety Analysis Report (FSAR) - pressurizer or
**        primary system sections
**     b) Operator Training Manual - pressurizer or
**        primary system sections
**     c) Plant operating surveillance data
**     d) Quench tank (PRT) construction and/or assembly drawings
**     e) Quench tank (PRT) technical specification data
```

```
**    f) Containment section, elevation, or equipment location drawings
**
**
** =================================================================
**                  Parameter Specifications
** =================================================================
**
** =================================================================
VQT          1800.  FT**3      // Units: [M**3,FT**3]
**
** This parameter is the total fluid volume within the quench tank.
**
**
** =================================================================
MWQT0        83514.  LB        // Units: [KG,LB]
**
** This parameter is the initial water mass in the quench tank.
**
** This can be determined from the nominal PRT water volume and
** temperature maintained during normal operating conditions.
**
**
** =================================================================
PQTRD        100.  PSI        // Units: [PA,PSI]
**
** This parameter is the differential pressure required to fail the quench
** tank (PRT) rupture disk.
**
**
** =================================================================
ZQTRD        11.42  FT        // Units: [M,FT]
**
** This parameter is the height of the quench tank (PRT) rupture disk
** relative to the floor of the containment compartment that contains the
** quench tank.  The noted compartment is designated by parameter JNRV,
** which is a pointer listed in the *POINTERS parameter file section.
**
**
** =================================================================
ASEDQT       208.8  FT**2      // Units: [M**2,FT**2]
**
** This parameter is the sedimentation area for aerosol fission product
** settling in the quench tank (PRT).  This is the horizontal surface area
** within the PRT that is exposed and can serve as an active site for
** aerosol settling.
**
** It should include the upper surface areas of any platforms, structual
** components, etc.  If the two upward-facing areas are stacked vertically,
** both areas should be counted.  In this regard, ASEDQT possesses an
** inherent sensitivity.  While the upper surface does not completely
** "mask" the lower surface, it can potentially mitigate the deposition on
** the lower surface.  Therefore, the appropriate interpretation is that
** ASEDQT exists within a range between the area of the upper surface alone
** and the summation of the upper and lower surface areas.
```

```
**
** To disable fission product settling in the quench tank, set ASEDQT to
** zero.  Note, if the rupture disk fails, settling in the PRT gas space is
** ignored, regardless of the value of ASEDQT.
**
****************************************************************************
*Ice
****************************************************************************
*BR
**
** Unless otherwise stated, these parameters apply only to ice condenser
**
** General Guidance Concerning Ice Data Acquisition:
** ----------------------------------------------
** Most of the parameters for *Ice are available from the FSAR or the
** Technical Specifications.  Most users will choose FHTICE=2 because the
** ice condenser exit temperature is readily available from full-scale
** section tests. The variables AICE0 and HTICE0 can be found from
** analytical work, autoclave tests, and full-scale section tests to verify
** the design performance of the ice condenser. Ice condenser maintenance
** records for total weight of ice, flow area, heat transfer area, etc.,
** are also useful sources for MICE0 and AICE0.
**
** ************************************************************************
MICE0       2.81e6  LB       // Units: [KG,LB]
**
** MICEO is the initial ice mass.  Technical Specifications give a limit
** for the minimum initial ice mass.
**
** ========================================================================
TWICE       15.0  F       // Units: [K,F]
**
** TWICE is the initial temperature of the ice.  The ice condenser
** temperature usually varies between -12 and -7 C (or 10 and 20 F).
**
** ========================================================================
VWICE      1.74e-2  FT**3/LB  // Units: [M**3/KG,FT**3/LB]
**
** @@@ 4.0.3 BJS 3/21/96 - The value of VWICE had been corrected in the
** draft User's Guide.  The value of 2.99e-2 in previous versions of the
** parameter file was incorrect.
**
** VWICE is the specific volume of the ice.  Knowing the initial ice
** temperature, VWICE is found from the thermodynamic properties of water.
**
** ========================================================================
AICE0     8.795e5  FT**2      // Units: [M**2,FT**2]
**
** AICE0 is the initial ice surface area.  This parameter is not usually
** known with any precision.  Initial guesses are available from other code
** calculations.
**
** ========================================================================
FHTICE        2          // Dimensionless
```

```
**
** FHTICE specifies the type of heat transfer calculation to be
** perfomed for the ice condenser:
**
**              = 0, mechanistic heat transfer calculation
**              = 1, input nominal heat transfer coefficient
**              = 2, input nominal exit temperature for ice
**                 chest (MAAP 3.0B method)
**
** ========================================================================
HTICE0      5036.0  BTU/FT**2-HR-F  //  Units: [W/M**2-C,BTU/FT**2-HR-F]
**
** HTICE0 is the nominal ice heat transfer coefficient.  A reasonable value
** can be obtained from Westinghouse anlytical work to establish ice
** condenser design performance.
**
** ========================================================================
**
***************************************************************************
*Ap600 Inputs
***************************************************************************
*SI
**
** @@@ 4.0.3 MAM 11/29/95  This parameter section was either partially
** documented or missing from the parameter files.  Although these inputs
** may not concern most users, the documentation of the input parameters
** was brought up to date and completed.
**
** This parameter section is for setting up the ALWR AP600 inputs for the
** core makeup tank(s) and passive residual heat removal (PRHR) system.
**
** ========================================================================
** Core MakeUp Tanks
**
** Up to two core makeup tanks can be modeled.  The Control parameter
** ICMTK(i) flag defines whether or not core makeup tanks are modeled.
** When ICMTK(i) is set to one, the i'th core makeup tank is present and
** when ICMTK(i) is set to zero, the i'th core makeup tank is not present.
** Note that the parameter ICMTK(i) must be specified at the start of a
** MAAP run.  It is not resetable during a MAAP run using local parmacter
** change.
**
** The top of the core makeup tank is connected to the pressurizer and to
** the cold leg.  The Control parameter ICMT(i) specifies what primary
** system cold leg node is connected to the core makeup tank.  See the PWR
** primary system nodalization for Westinghouse 4-loop design figure of the
** subroutine PRISYS of the MAAP4 User Manual for the actual nodal number.
** The bottom of the core makeup tank is connected to the primary system
** downcomer.
**
** The following event codes controls the valves on the pipings from the
** core makeup tank to the primary system:
**
**   275 = 1; Opens the valve on the line connecting the bottom of the
```

** core makeup tank #1 to the primary system downcomer.
**
** 275 = 0; Closes the valve on the line connecting the bottom of the
** core makeup tank #1 to the primary system downcomer.
**
** 276 = 1; Opens the valve on the line connecting the top of the
** core makeup tank #1 to cold leg node designated by ICMT(1).
**
** 276 = 0; Closes the valve on the line connecting the top of the
** core makeup tank #1 to cold leg node designated by ICMT(1).
**
** 277 = 1; Opens the valve on the line connecting the bottom of the
** core makeup tank #2 to the primary system downcomer.
**
** 277 = 0; Closes the valve on the line connecting the bottom of the
** core makeup tank #2 to the primary system downcomer.
**
** 278 = 1; Opens the valve on the line connecting the top of the
** core makeup tank #2 to cold leg node designated by ICMT(2).
**
** 278 = 0; Closes the valve on the line connecting the top of the
** core makeup tank #2 to cold leg node designated by ICMT(2).
**
** See subroutine CRMKTK write-up of the MAAP4 User Manual for futher
** details of the core makeup tank model.
**
** ======================================================================
** Name: VCMT(2) Units: [M**3,FT**3]
**
** This parameter is the total volume (water + gas) of the core makeup tank.
**
VCMT(1) 0.0 M**3
VCMT(2) 0.0 M**3
** ======================================================================
** Name: ACMT(2) Units: [M**2,FT**2]
**
** This parameter is the cross-sectional area of the core makeup tank.
**
ACMT(1) 0.0 M**2
ACMT(2) 0.0 M**2
** ======================================================================
** Name: MWMT0(2) Units: [KG,LB]
**
** This parameter is the initial mass of water in the core makeup tank.
**
MWMT0(1) 0.0 KG
MWMT0(2) 0.0 KG
** ======================================================================
** Name: TWMT0(2) Units: [K,F]
**
** This parameter is the initial temperature of the water in the core
** makeup tank.
**
TWMT0(1) 0.0 K

```
TWMT0(2)        0.0  K
** ===================================================================
** Name: ZBCMT(2)              Units: [M,FT]
**
** This parameter is the elevation of the bottom of the core makeup tank
** relative to the bottom of the reactor vessel.
**
ZBCMT(1)        0.0  M
ZBCMT(2)        0.0  M
** ===================================================================
** Name: ZCMTDC(2)             Units: [M,FT]
**
** This parameter is the elevation of the core makeup tank injection into
** the primary system downcomer relative to the reactor vessel bottom.
**
ZCMTDC(1)       0.0  M
ZCMTDC(2)       0.0  M
** ===================================================================
** Name: ZTCLMT(2)             Units: [M,FT]
**
** This parameter is the elevation of the top of the cold leg balance line
** relative to the reactor vessel bottom.
**
ZTCLMT(1)       0.0  M
ZTCLMT(2)       0.0  M
** ===================================================================
** Name: AMTDC(2)              Units: [M**2,FT**2]
**
** This parameter is the cross-sectional area of the piping from the core
** makeup tank to the primary system downcomer.
**
AMTDC(1)        0.0  M**2
AMTDC(2)        0.0  M**2
** ===================================================================
** Name: AMTCL(2)              Units: [M**2,FT**2]
**
** This parameter is the cross-sectional area of the piping from the core
** makeup tank top to the primary system cold leg.
**
AMTCL(1)        0.0  M**2
AMTCL(2)        0.0  M**2
** ===================================================================
** Name: AMTPZ(2)              Units: [M**2,FT**2]
**
** This parameter is the cross-sectional area of the piping from the core
** makeup tank to the pressurizer.
**
AMTPZ(1)        0.0  M**2
AMTPZ(2)        0.0  M**2
** ===================================================================
** Name: LDCMT(2)              Units: [Dimensionless]
**
** This parameter is the equivalent L/D ratio for the piping from the core
** makeup tank to the primary system downcomer.
```

**
LDCMT(1) 0.0
LDCMT(2) 0.0
** ================================================================
** Name: LDCLMT(2) Units: [Dimensionless]
**
** This parameter is the equivalent L/D ratio for the piping from the core
** makeup tank top to the primary system cold leg.
**
LDCLMT(1) 0.0
LDCLMT(2) 0.0
** ================================================================
** Name: LDTDVI(2) Units: [Dimensionless]
**
** This parameter is the equivalent L/D ratio for the piping from the
** Direct Vessel Injection (DVI) tee to the primary system downcomer.
**
LDTDVI(1) 0.0
LDTDVI(2) 0.0
** ================================================================
** Passive Residual Heat Removal (PRHR)
**
** The passive residual heat removal (PRHR) system model is enabled when the
** Control parameter IPRHR is set to one and the valve to the PRHR is
** opened by setting the event code 274 to true. The model calculates the
** heat transfer between the primary system coolant inside the PRHR tubes
** and the containment water pool outside the PRHR tubes. The containment
** compartment IRWST is identified by the Pointer parameter JNPRHR. See
** MAAP4 User Manual subroutine PRISYS writeup for futher details of the
** PRHR model and subroutine HXFRSG writeup which does the heat transfer
** calculations.
**
** ================================================================
NTPRHR 0.0 // Dimensionless
**
** This parameter is the number of tubes in the PRHR.
**
** ================================================================
XIDPRH 0.0 M // Units: [M,FT]
**
** This parameter is the inside diameter of tube in PRHR.
**
** ================================================================
XTPRHR 0.0 M // Units: [M,FT]
**
** This parameter is the thickness of tube in PRHR HX.
**
** ================================================================
KTPRHR 0.0 W/M-C // Units: [W/M-C,BTU/FT-HR-F]
**
** This parameter is the thermal conductivity of tube.
**
** ================================================================
HTPRHR 0.0 W/M**2-C // Units: [W/M**2-C,BTU/FT**2-HR-F]

```
**
** This parameter is the heat transfer coefficient for the primary side
** when there is two or single phase natural convection.
**
** ============================================================================
FWPRHR        0.0          // Dimensionless
**
** This parameter is the fraction of the pump flow going into the PRHR when
** the pumps are on.
**
** ============================================================================
VLPRHR        0.0  M**3    // Units: [M**3,FT**3]
**
** This parameter is the volume of the PRHR HX.
**
** ============================================================================
ZBHXRB        0.0  M       // Units: [M,FT]
**
** This parameter is the bottom of the HX relative to the bottom of the
** IRWST compartment, identified by the Pointer parameter JNPRHR.
**
** ============================================================================
ZBHXPS        0.0  M       // Units: [M,FT]
**
** This parameter is the bottom of the HX relative to the bottom of the
** reactor vessel.
**
** ============================================================================
XLVRHR        0.0  M       // Units: [M,FT]
**
** This parameter is the vertical length of the HX tube.
**
** ============================================================================
XLHRHR        0.0  M       // Units: [M,FT]
**
** This parameter is the horizontal length of the HX tube.
**
** ============================================================================
FQPRHR        1.0          // Dimensionless
**
** This parameter is the multiplier or correction factor for the total heat
** transfer through the PRHR when single or two phase natural circulation
** occurs.  MAAP4 does not calculate the flow rate and may overpredict the
** heat transfer.
**
*****************************************************************************
*Spain
*****************************************************************************
*SI
**
** @@@ 4.0.3 MAM 11/29/95  This parameter section was either partially
** documented or missing from the parameter files.  Although these inputs
** may not concern most users, the documentation of the input parameters
** was brought up to date and completed.
```

**
** This parameter section is primarly for Spanish-type plant, eg., when the
** Control parameter ISPAIN is set to 1 with the exception of parameters
** QDSFP and ZWFPUC which can be used for any pwr-type plant. The Spanish
** specific models allows for the diversion of injection flows from the hot
** or cold leg to the core upper head region and for the diversion of
** injection flows from the hot leg to the cold leg. The Spanish specific
** models also includes models for hot leg accumulators, extra borating
** system, and emergency feedwater system. See the MAAP4 User Manual
** subroutine SPNINJ and ECCRIT write-ups for further details about the
** Spanish specific safety systems.
**
** ========================================================================
QDSFP 0.0 W // Units: [W,BTU/HR]
**
** This parameter is the total decay heat power in spent fuel stored within
** the spent fuel pool. The Pointer parameter JNSFP defines the containment
** compartment in which the spent fuel pool is located. This parameter is
** independent of parameter ISPAIN.
**
** ========================================================================
ZWFPUC 0.0 M // Units: [M,FT]
**
** This parameter is the height above the compartment JNSFP floor at which
** spent fuel uncovers. The uncovered fraction of the spent fuel decay
** power is added to the compartment's gas space with the remainding spent
** fuel decay power added to the compartment's water pool. This parameter
** is independent of parameter ISPAIN.
**
** ========================================================================
FDIVUH 0.0 // Dimensionless
**
** This parameter is the fraction of injection flow diverted to upper head
** from cold or hot leg.
**
** ========================================================================
** The next three parameters PDHPCC, PDLPCC, and TDACUM are for the TRILLO
** injection signal logic. A non-zero value for PDHPCC activates the signal
** logic. See MAAP4 User Manual subroutine ECCRIT write-up for further
** details.
**
** ========================================================================
PDHPCC 0.0 PA // Units: [PA,PSI]
**
** This parameter is the pressure differential in containment for HPCC
** signal. The pressure differential is the pressure in compartment
** identified by *Pointer variable JNCIN (PRB(JNCIN) minus the environment
** pressure defined by *Initial variable PAMB.
**
** ========================================================================
PDLPCC 0.0 PA // Units: [PA,PSI]
**
** This parameter is the pressure differential in containment for LPCC
** signal. The pressure differential is the pressure in compartment

```
** identified by *Pointer variable JNCIN (PRB(JNCIN) minus the environment
** pressure defined by *Initial variable PAMB.
**
** ========================================================================
TDACUM        0.0  S        // Units: [S,HR]
**
** This parameter is the time delay from the HPCC signal to cold leg
** accumulator isolation.
**
** ========================================================================
NHLAC         0.0           // Dimensionless
**
** This parameter is the number of hot leg accumulators.
**
** ========================================================================
MLOHLA        0.0  KG       // Units: [KG,LB]
**
** This parameter is the low hot leg accumulator water mass to isolate the
** hot leg accumulator after the time when the HPCC signal occured plus the
** TDACUM elapsed time.
**
** ========================================================================
FDIVCL        0.0           // Dimensionless
**
** This parameter is the fraction of the injection flow diverted to the
** cold leg from the hot leg.
**
** ========================================================================
WVEBS         0.0  M**3/S   // Units: [M**3/S,GPM]
**
** This parameter is the volumetric flow rate from the extra borating
** system. User should increase the RWST water mass by the amount of the
** extra borating system tank to take credit of the available water
** inventory. The water flows to the cold leg unless parameter FEBSAS is
** greater then zero.
**
** @@@ 4.0.3 BJS 5/10/96 - The capability to model auxiliary pressurizer
** sprays has been included for non-Spanish plants, i.e., for parameter
** files with ISPAIN not equal to 1. Therefore, WVEBS is also included in
** the pressurizer section of the parameter file, and it has a slightly
** different definition: it is the volumetric flow rate to the spray, not
** to the cold leg and the spray (FEBSAS is not used). Note that the last
** value of WVEBS in the parameter file is the one that the code will use.
**
** ========================================================================
FEBSAS        0.0           // Dimensionless
**
** This parameter is the fraction of extra borating system flow that goes
** to pressurizer auxiliary sprays.
**
** ========================================================================
** Emergency Feedwater System
**
** When event codes 251 and/or 252 are set to 1, the unbroken loop or
```

** broken loop emergency feedwater system, respectively, are turned on as
** long as main feedwater system is off and water is available in the
** emergency feedwater tank. The S/G level control logic is same as those
** defined in *Steam Generator parameter section. This system utilizes the
** pump curve defined for the extra turbine driven auxiliary feedwater
** system in the *Generalized Safeguards parameter section - therefore,
** remember to use zero steam flow for parameter WSTSGT in those variables
** for diesel driven systems such as in the TRILLO plant. This system can
** be turned on while the ordinary auxiliary feedwater system is still on,
** and flow from both systems will be proportioned based on total possible
** flow from each with respect to actual flow required to maintain
** specified level.
**
** ==========================================================================
AEFT 0.0 M**2 // Units: [M**2,FT**2]
**
** This parameter is the cross-sectional area of the base of the emergency
** feedwater tank. Note that a single tank is represented in MAAP.
**
** ==========================================================================
MWEFW0 0.0 KG // Units: [KG,LB]
**
** This parameter is the total or available emergency feedwater water mass.
**
** ==========================================================================
TEFW 300.0 K // Units: [K,F]
**
** This parameter is the temperature of the emergency feedwater water.
**
** ==========================================================================
WEFWXB 0.0 KG/S // Units: [KG/S,LB/HR]
**
** This parameter is the throttled flow rate for emergency feedwater to the
** broken loop.
**
** ==========================================================================
WEFWXU 0.0 KG/S // Units: [KG/S,LB/HR]
**
** This parameter is the throttled flow rate for emergency feedwater to the
** unbroken loop.
**
** ==========================================================================
VLPZSR 0.0 M**3 // Units: [M**3,FT**3]
**
** This parameter is the volume in pressurizer below surge line entry
** point.
**
*****************************************************************************
*Evtmes
*****************************************************************************
**
** This parameter file section is the input data source for a MAAP4
** feature that allows users to customize some or all of the event flag and
** event code messages written to the log, tabular output, and event summary

```
** files MAAP generates.
**
** IN GENERIC FORM, AN INPUT CARD FOR *EVTMES IS ARRANGED AS FOLLOWS:
**
**
** <NUMBER> <FLAG> <MESSAGE>
**
** Where: <NUMBER> = The event flag or code number
**        <FLAG>   = The event on/off state token. Permissible tokens for
**                   the "On" state are; "1", "T", or "TRUE", and permis-
**                   sible tokens for the "Off" state are; "0", "F", or
**                   "FALSE".
**        <MESSAGE> = The character string of the event message to be dis-
**                   played for the specified flag/code and on/off state.
**                   Each message string is limited to a maximum length of
**                   48 characters (strings longer than this value will be
**                   truncated).
**
** Be sure to end this section with the keyword "END".
** Note that ** commenting is allowed.
**
** @@@ 4.0.3 SMD 12/20/95
** The event messages presented in this section are the correct ones. The
** default maap messages, as present in maap block data, are not consistent
** with these messages. Hence, this section is required in order to have
** the proper event messages.
**
** Note that the character "!" is treated as a end of line delimitor.
** and everything after "!" is ignored.
**
** THE RANGE OF EVENT CODES IS NOW:
**
**   1 THRU 199 INTERNAL EVENT CODES SET BY MAAP - NOT SETTABLE BY THE USER
** 200 THRU 399 EXTERNAL EVENT CODES DEFINED BY MAAP FOR A SPECIFIC
**          OPERATION, IE., MANUALLY TURN A PUMP ON, ETC.
** 400 THRU 699 EXTERNAL EVENT CODES NOT DEFINED BY MAAP, AVAILABLE
**          AS USER DEFINED EVENT CODES.
** @@@ 4.0.1 BJS 2/8/95
** 1000+ CONTAINMENT COMPARTMENT CONDITION EVENT CODES: SEE APPENDIX 3P OF
**      VOLUME I OF THE USERS MANUAL FOR A LIST OF THESE CONDITIONS AND
**      THE ALGORITHM USED IN THE CODE TO SET THE EVENTS.
**
**      Examples of containment compartment condition events are:
**
**        #th compartment water pool present.
**
**        #th compartment burning is in progress,
**
**        etc.
**
**
** Therfore, event codes 200 thru 699 are user definable. For example
** we could model a sequence in which the loss of ac and dc power occurs
** 30 minutes into the sequence, and re-gain the power at 1.5 hours.
```

```
** this can be modeled as
**
**     205 TIM > .5 HR AND TIM < 1.5 HR
**
** Note that 205 is MAAP defined event code for loss of ac and dc power,
** and here, we merely had defined a 205 event code condition to control
** the MAAP's event code 205 state. When the condition is true, ie.,
** time is greater than .5 hr but is less than 1.5 hr
**
** Also, you may need to renumber some of your previous user-defined
** codes to avoid collisions with new external codes.
**
** The summary output file contains a list of event codes, their status,
** and their messages. These are written to the file when the status of
** the event code changes from true to false or false to true. The time
** of the change is also included in the file. The event codes that could
** be written to the file, if their status changes, is a subset of all the
** event codes. The reason that not all of them could be written is that
** the status of a number of them change very frequently. If these were
** written to the file, it would be too long to be useful. Others are not
** written because they are for code development or debugging purposes
** only.
**
** Summary control on/off is a useful feature to select/de-select event
** codes which can be written to the summary file. If summary control is
** activated, then the third token is the summary control option - there
** are three options:
**
**      Insert "SUMMARY CONTROL ON" before the first input
**      line to be controlled. Insert "SUMMARY CONTROL OFF"
**      after the last input line to be controlled. The
**      format of the input being controlled is:
**
**        <NUMBER>  <FLAG>  <ILIST OPT>  <MESSAGE>
**
**      where <NUMBER>, <FLAG>, and <MESSAGE> are the same
**      as above, and <ILIST OPT> is
**
**        = 0: do not include event code in summary,
**        = 1: include event code in summary,
**        = 2: use pruning option on event code,
**        = blank: use default value from block data
**
** The pruning option limits the number of times an event code is written
** to the summary file. It is useful for those event codes whose status
** changes frequently. When the pruning option is invoked, the event
** message will be written every time the event code's status changes for
** the first ten times. After that, it will only be written every tenth
** time that its status changes and the number of times the status changed
** will be written next to the message. Similarly, after its status
** changes 100 times, it will be written every 50th time and after its
** status changes 500 times, it will be written every 1000th time. The
** counter that keeps track of the number of times the status changes is
** reset to zero whenever the status hasn't changed within 1000 seconds of
```

** problem time.
**
**@@@ 4.0.3 SMD 12/1/95 Summary control has been turned on for all events
** by removing all but the first summary control on/off statements.
SUMMARY CONTROL ON
**
**==========================================================================
=====
1 T BKN LOOP BK UNCOVERED
1 F BKN LOOP BK COVERED
**
** This event is used to signal if a break in the broken loop is
** uncovered (TRUE) or covered (FALSE).
** This event is set TRUE if a break of a user-specified area ABB has taken
** place (IEVNT(209) = 1) and a user-specified elevation ZBB of the break is
** higher than the collapsed water level in the primary system by at least the
** equivalent diameter of the break. It is also set if either of the
** following two conditions are met:
**
** 1) A user-specified break FBB occurs in the horizontal portion of the
** broken-loop hot leg and the boiled-up warer level in the reactor
** vessel is below a user-specified elevation ZNOZ of the nozzles by
** at least 1 cm., or
**
** 2) The user-specified break FBB occurs in the cold portion of the
** broken-loop steam generator tubes or in the intermediate portion
** of the broken-loop cold leg and the boiled-up water level in the
** broken-loop cold leg is below the user-specified elevation ZBB of
** the break by at least the equivalent diameter of the break.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 DESCRIPTION FOR EVENT 2 WAS REVISED
2 T RELOCATION OF CORE MATERIALS TO LOWER HEAD STARTED
**
** This event is used to signal relocation of the core material to lower head.
** This event is set TRUE as soon as the mass of relocated debris in the lower
** head exceeds 5 kg.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
3 T RV FAILED
3 F RV INTACT
**
** This event is used to signal if the reactor vessel has failed (TRUE) or
** is intact (FALSE).
** This event code becomes true if any of the following become true:
** 1) Vessel fails due to penetration tube ejection...IEVNT(39)
** 2) Vessel fails due to pent. tube heatup...IEVNT(58)
** 3) Vessel fails due to lower head global rupture...IEVNT(80)
** 4) Vessel fails due to jet ablation of vessel wall.IEVNT(41)

** 5) Vessel fails due to overlying steel attacking the wall...IEVNT(43)
**
** Refer to the RVFLMK section of the User's Manual, Volume 2, Part 3.
**
**=========================================================================
=====
4 T MAIN COOLANT PUMPS OFF
4 F MCP ON
**
** This event is used to signal if the main coolant pumps are off (TRUE) or
** on (FALSE).
** This event is set TRUE if the void fraction in the primary system exceeds a
** user-specified value VFCPMX, or the AC power is unavailable (IEVNT(205)=1),
** or the operator has switched off the main coolant pumps (IENVT(215)=1).
** The time at which the main coolant pumps are tripped is recorded for use
** in the pump coastdown flow calculation.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
5 T HPI ON
5 F HPI OFF
**
** This event is used to signal if the high pressure injection is on (TRUE) or
** off (FALSE).
** This event is set TRUE if the operator has switched on the HPI pumps
** (IEVNT(212)=1 and IEVNT(216)=0) while the AC power is available
** (IEVNT(205)=0). It is also set TRUE if there is at least one HPI pump, as
** indicated by the user-specified parameters NESF, NHPI and NHPIG, and if the
** pump switch is in "automatiic" (IEVNT(216)=0) while the AC power is available
** (IEVNT(205)=0), and the pressure in the primary system drops below a user-
** specified set point PHPI0 or the water level in the pressurizer drops below
** a hardwired set point ZWPZCL. Once the event is set, it will remain set,
** thereby signaling continuous actuation of the HPI pumps, until the operator
** switches off the pumps (IEVNT(216)=1) or the AC power becomes unavailable
** (IEVNT(205)=1). It is also reset if the pump switch is in "automatic"
** (IEVNT(212)=0) and the water level in the pressurizer rises above a hard-
** wired set point ZWPZCH. A timer is set with a user-specified delay TDHPI
** and turned on when the event becomes TRUE. The timer is turned off whenever
** the event is FALSE. The high pressure injection pumps are considered to be
** running only after the timer has gone off. For injection to occur when the
** pumps are running, a sufficient NPSH must also be established (see the
** discussions for IEVNT(148) and IEVNT(185)).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
6 T LPI ON
6 F LPI OFF
**
** This event is used to signal if the low pressure injection is on (TRUE) or
** off (FALSE).
** This event is set TRUE if the operator has switched on the LPI pumps
** (IEVNT(213)=1 and IEVNT(217)=0) while the AC power is available

```
** (IEVNT(205)=0). It is also set TRUE if there is at least one LPI pump, as
** indicated by the user-specified parameters NESF, NLPI and NLPIG, and if the
** pump switch is in "automatiic" (IEVNT(217)=0) while the AC power is available
** (IEVNT(205)=0), and the pressure in the primary system drops below a user-
** specified set point PLPI0. Once the event is set, it will remain set,
** thereby signaling continuous actuation of the LPI pumps, until the operator
** switches off the pumps (IEVNT(217)=1) or the AC power becomes unavailable
** (IEVNT(205)=1). A timer is set with a user-specified delay TDLPI
** and turned on when the event becomes TRUE. The timer is turned off whenever
** the event is FALSE. The low pressure injection pumps and the low pressure
** injection spray pumps are considered to be running only after the timer has
** gone off. For injection to occur when the pumps are running, a sufficient
** NPSH must also be established (see the discussions for IEVNT(146) and
** IEVNT(184).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
  7 T  ACCUM NOT FUNCTIONAL
  7 F  ACCUM FUNCTIONAL
**
** This event is used to signal if the accumulators are disabled (TRUE) or
** if the accumulators are functional (FALSE).
** This event is set TRUE if the operator has shut off the accumulator block
** valves (IEVNT(214)=1) or the water in the accumulators is depleted
** (IEVNT(188)=1).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
  8 T  ALL CM DISCH IN INITIAL BLWDWN
**
** This event is used to signal if all molten debris in primary system has
** dicharged.
** This event becomes TRUE if the vessel has already failed (IEVNT(3)=1) at
** the preceding time step and the mass of molten debris in the primary
** system is less than the exit flow rate of molten debris times the
** time step.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
**@@@ 4.0.1 CYP 12/12/94     DEFINE EVENT #9 PROPERLY
  9 T  GAS BLOWDOWN THROUGH VESSEL FAILURE CAN OCCUR
**
** This event is used to signal if gas blowdown through vessel failure can
** occur.
** This event is set TRUE if the vessel has already failed (IEVNT(3)=1) at the
** preceding time step and the mass of water in the downcomer node is less than
** a hardwired small quantity MWMIN, whose nominal value is 100 kg, and there is
** either no corium in the lower head or above the bottom of the failure
** opening or when ther gas flow is greater than zero.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
```

**=========================================================================
=====
10 T COUPLE GAS ONLY TO CORE WATER
**
** This event is used to signal if only the core water mass is in thermodynamic
** equilibrium with the primary system gas.
** This event is set TRUE if the primary system as a whole is in thermo-
** dynamic equilibrium (IEVNT(25)=0) while all loops in the primary system
** are stagnant (IEVNT(155)=1) and IEVNT(164)=1). Note that if, and only if,
** all loops in the primary system are stagnant, can either one of the event
** codes 10 and 25 be TRUE. Only one of those two event flags can be true at
** any time (see IEVNT(25)).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
11 T CHARGING PUMPS ON
11 F CHARGING PUMPS OFF
**
** This event is used to signal if the charging pumps are on (TRUE) or
** off (FALSE).
** This event is set TRUE if the operator has switched on the charging pumps
** (IEVNT(231)=1 and IEVNT(232=0)) while AC power is available (IEVNT(205)=0).
** It is also set if there is at least one charging pump, as is indicated by
** the user-specified parameters NESF, NCHP, and NCHPG, and if the pump switch
** is in "automatic" (IEVNT(231)=0) while AC power is available (IEVNT(205=0)),
** and the pressure in the primary system drops below a user-specified set point
** PCHP0 or the water level in the pressurizer drops below the hardwired set
** point ZWPZCL. Once the event is set, it will remain set, thereby signaling
** continuous actuation of the charging pumps, until the operator switches off
** the pumps (IEVNT(232)=1) or the AC power becomes unavailable (IEVNT(205)=1).
** It also resets if the pump switch is in "automatic" (IEVNT(231)=0) and the
** water level in the pressurizer rises above the hardwired set point ZWPZCH.
** A timer is set with a user-specified delay TDCHP and turned on when the event
** is TRUE. The timer is turned off whenever the event is FALSE. The charging
** pumps are considered to be running only after the timer has gone off. For
** flow to occur when the pumps are running, a sufficient NPSH must also be
** established (see discussion for event codes 149 and 183).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
12 T CM OR CORE CAN STEAM
12 F CORE POOL SUBCOOLED
**
** This event is used to signal if the water in the core is saturated (TRUE) or
** subcooled (FALSE).
** This event is set TRUE if any one of the following conditions are met:
**
** 1) The primary system is saturated (IEVNT(20)=1) and the water
** temperature in the core is within 5 degrees C of saturation or
** the primary system is in thermodynamic equilibrium (IEVNT(25)=0),
**
** 2) The primary system is in half-loop operation mode, as is indicated

** by a user-specified parameter HALFLP, and the water temperature in
** the core is within 3 degrees C of saturation, or
**
** 3) The primary system as a whole is in thermodynamic equilibrium while
** all loops in the priomary system are stagnant (IEVNT(10)=1).
**
** Once the event is set, it will remain set until the water temperature in the
** core becomes more than 10 degrees C subcooled or the primary system becomes
** subcooled (IEVNT(20)=0).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====

13 T REACTOR SCRAM
13 F REACTOR AT FULL POWER
**
** This event is used to signal if the reator scrammed (TRUE) or the reactor
** is not scrammed (FALSE).
** This event becomes TRUE if any of the following conditions are met:
**
** 1) The pressure in the primary system is lower than a user-specified
** low pressurizer-pressure trip point PPSL or higher than a user-
** specified high pressurizer-pressure trip point PPSH,
**
** 2) The temperature difference between the cold and the hot legs
** exceeds the users-specified loop differential-temperature scram
** setpoint TDIFPS.
**
** 3) The collapsed water level in the pressurizer is lower than a
** user-specified low pressurizer-water-level trip point ZWPZL or
** higher than a user-specified high pressurizer-water-level trip point
** ZWPZH.
**
** 4) The AC power is unavailable (IEVNT(205)=1),
**
** 5) The operator has forced the reactor to scram (IEVNT(227)=1),
**
** 6) The main coolant pumps are shut off (IEVNT(4)=1),
**
** 7) The charging pumps are on (IEVNT(11)=1 and IEVNT(257)=0),
**
** 8) The collapsed water level in the broken-loop or the unbroken-loop
** steam generators is lower than a user-specified steam generator
** water level trip point ZWSGL.
**
** The conditions listed above are tested in subroutine SCRAM. A timer is set
** with a user-specified delay TDSCRM and turned on when the event code becomes
** TRUE. The scram occurs only after the timer has gone off.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====

14 T FP MODELS ON
14 F FP MODELS OFF

```
**
** This event is used to signal if the fission product models are on (TRUE)
** or off (FALSE).
** This event code is set TRUE if the boiled-up water level in the reactor
** vessel is below a user-specified elevation ZCRV of the top of the core or
** the total mass of suspended water droplets in the containment exceeds 1 kg.
** The latter condition is tested in subroutine AUXEVT.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
 15  T  UNBKN LOOP HOMOGENEOUS
 15  F  UNBKN LOOP PHASES SEPARATED
**
** This event is used to signal if the two-phase mixture in the unbroken-loop
** is homogeneous (TRUE) or separated (FALSE).
** This event code is set TRUE if the priamry system is saturated (IEVNT(20)=1)
** and the flow rate of water in the unbroken loops are non-zero.  If the flow
** rate of water in the unbroken loops becomes zero and all of the following
** conditions are met:
**
** 1)  The primary system is saturated (IEVNT(20)=1) and the void fraction
**     in it is less than 0.98,
**
** 2)  The pressure in the primatry system is greater than the pressure in
**     the compartment indexed by JNBB,
**
** 3)  The core debris has not relocated to the lower head.
**
** 4)  The mass of water in the core is greater than the hardwired small
**     quantity MWMIN, and
**
** 5)  A break has occurred (IEVNT(209)=1) and the user-specified area
**     ABB, AUB, or AGO, of the break is non-zero.
**
** Then the steaming velocity due to flashing in the core and the downcomer
** and the flooding velocity are computed.  The event is set if the steaming
** velocity is greater than 1.5 times the flooding velocity and the boiled-up
** water level in the reactor vessel exceeds the user-specified elevation (ZCRV)
** of the top of the core.  Once the event is set, it will remain set until the
** steaming velocity becomes less than the flooding velocity.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
 16  T  RX VENT LINE UNCOVERED
 16  F  RX VENT LINE COVERED
**
** This event is used to signal if the reactor vessel vent line is uncovered
** (TRUE) or covered (FALSE).
** This event code is set if the water level in the broken-loop hot leg is
** below a user-specified elevation ZDM of the top of the reactor vesssel and
** all loops are stagnant (IEVNT(155)=1 and IEVNT(164)=1).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
```

```
**
**=========================================================================
=====
 17  T  CM IN LOWER HEAD POOL
 17  F  NO CM IN LOWER HD POOL
**
** This event is used to signal if the lower head pool has molten debris (TRUE)
** or has no molten debris (FALSE).
** This event code is set if either of the following conditions are met:
**
** 1)  The total mass of molten debris in the primary system exceeds 1 kg
**     and the boiled-up water level in the reactor vessel is above a
**     user-specified elevation ZCRL of the bottom of the core, or
**
** 2)  The core debris has relocated to the lower head (IEVNT(2)=1) and
**         the mass of water in the downcomer node exceeds the hardwired
**         small quantity MWMIN.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODE 18 IS OBSOLETE
** 18  T  H2 PROD IN RV POOL OVER
**
**=========================================================================
=====
 19  T  CM QUENCHED IN VESSEL
 19  F  RV CM NOT QNCHED
**
** This event is used to signal if the molten debris in the primary system is
** quenched (TRUE) or is not quenched (FALSE).
** This event is set TRUE if the total mass of molten debris in the primary
** system exceeds 1 kg and the temperature of the molten debris in the primary
** system is less than the saturation temperature of water in the primary
** system.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
 20  T  PS SAT ENERGY AVAIL
 20  F  PS AS A WHOLE SUBCOOLED
**
** This event is used to signal if the primary system as a whole is saturated
** (TRUE) or is subcooled (FALSE).
** This event code is set if the average internal energy of the steam and the
** water mixture in the primary system is greater than the saturated enthalpy
** of water or the negative excess volume of water in the primary system is
** greater than 5% of the volume of the primary system.  Once the event code
** is set, it will remain set until the excess volume of water in the primary
** system becomes greater than 1 m^3 or the total excess volume of water in the
** primary system and the pressurizer becomes greater than 0.1 m^3.  It is also
** reset if the average internal energy of the steam and water mixture in the
** primary system is less than the saturation enthalpy of water and the negative
```

** excess volume of water in the primary system is less than 5% of the volume of
** the primary system. A deadband is provided by using a 1% difference in
** pressure in computing the saturation enthapies of water in setting or
** resetting the event code.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
21 T PS PRESSURE CALCULATED
21 F PS PRESSURE DETERMINED BY PZR
**
** This event is used to signal if the primary system has void (TRUE)
** or has no void (FALSE).
** This event code is set TRUE if any of the following conditions are met:
**
** 1) The primary system is saturated (IEVNT(20)=1),
**
** 2) All loops in the primary system are stagnant (IEVNT(10)=1 or
** IEVNT(25)=1), or
**
** 3) The volume of non-condensable gases is greater than 5 m^3 and the
** excess volume of water in the primary system is negative.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
22 T PS SURGE LINE NOZ UNCOVERED
22 F PS SURGE LINE NOZ COVERED
**
** This event is used to signal if the primary system surge line nozzle is
** uncovered (TRUE) or is covered (FALSE).
** This event code is set if the collapsed water level in the hot leg is below
** the elevation of the surge line nozzle, as is indicated by the user-specified
** parameters IBW, ZSR, ZNOZ, XDSR, and XDHL, and the pertinent loop is
** stagnant (IEVNT(155)=1 and/or IEVNT(164)=1).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
23 T DWNCMR NODE HAS NO WATER
23 F DWNCMR NODE HAS WATER
**
** This event is used to signal if the lower head has no water (TRUE) or has
** water (FALSE).
** This event code is set if the mass of water in the downcomer node is less
** than the hardwired small quantity MWMIN.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
24 T MAKEUP FLOW OFF
24 F MAKEUP FLOW ON
**

** This event is used to signal if the makeup flow is off (TRUE) or is on
** (FALSE).
** This event is set if the operator has shut off the makeup flow (IEVNT(242)=1)
** or the AC power is unavailable (IEVNT(205) = 1).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
25 T PS NONEQ THERMO
25 F PS EQUIL THERMO
**
** This event is used to signal if the primary system is not in thermodynamic
** equilibrium (TRUE) or is in thermodynamic equilibrium (FALSE).
** This event is set unless at least one loop in the primary system is
** circulating (IEVNT(155)=0 or IEVNT(164)=0) or all of the following conditions
** are met:
**
** 1) The boiled-up water level in the reactor vessel is above the top of
** the core.
**
** 2) At least one of the following subconditions is satisfied:
** a. the primary system was already in thermodynamic equilibrium
** (IEVNT(25) = 0) at the preceding time step;
** b. the temperature difference between the water pool in the
** core and the gas in the primary system is within 5 degrees
** C; or
** c. the void fraction in the primary system is less than 0.1.
**
** 3) At least one of the following subconditions is satisfied:
** a. the pools in the primary system are well-mixed (IEVNT(26) = 0)
** and the sum of the deviations of the pool temperatures from
** the average primary system temperature is less than 5 degrees
** C;
** b. the pools in the primary system are well-mixed (IEVNT(26) = 0),
** the primary system was already in thermodynamic equilibrium
** c. (IEVNT(25)=0) at the preceding time step, and the sum of the
** deviations of the pool temperatures from the average primary
** system temperature is less than 15 degrees C;
** d. all loops in the primary system are circulating (IEVNT(155) = 0
** and IEVNT(164) = 0); or
** e. the void fraction in the primary system is less than 0.1, and
**
** 4) The primary system is not in half-loop operation mode, as is
** indicated by the user-specified parameter HALFLP.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
26 T PRIMARY POOLS ISOLATED
26 F PRIMARY POOLS WELL-MIXED
**
** This event is used to signal if the pools in the primary system are isolated
** (TRUE) or well-mixed (FALSE).

** This event is set if the collapsed water level in the cold legs is below the
** centerline of the reactor vessel nozzles, as is indicated by the user-
** specified parameters ZNOZ and XDCL, or the volume of water in the cold legs is
** less than 90% of the total volume of the cold legs and all loops in the
** primary system phases are stagnant (IEVNT(155) = 1 and IEVNT(164) = 1). In
** case the primary system pools were already isolated from each other (IEVNT(26)
** = 1) at the preceding time step, the event is set if the collapsed water level
** in the cold legs is not above the base of the reactor vessel nozzles by 66% of
** the inside diameter of the nozzles or the volume of water in the cold legs is
** less than the total volume of the cold legs and all loops in the primary
** system are stagnant (IEVNT(155) = 1 and IEVNT(164) = 1).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
27 T UNBKN LOOPS NOT BLOCKED AT PUMP BOWLS
27 F UNBKN LOOPS BLOCKED
**
** This event is used to signal if the gas transport in the unbroken loops are
** not blocked (TRUE) or blocked (FALSE).
** This event is set if the volume of water in the intermediate portion of the
** cold leg in the unbroken loop is less than that required to fill the pipes
** to the top of their bend, as is indicated by a user-specified parameter
** VBLKCL (bypassed for a one-loop configuration).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
28 T DWNCMR NOT BLCKD FOR GAS XPORT
28 F DWNCMR BLCKD FOR GAS XPORT
**
** This event is used to signal if the gas transport in the lower head is
** not blocked (TRUE) or blocked (FALSE).
** This event is set if the volume of water in the core and the downcomer node
** is less than a user-specified volume VHD of the lower head.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
29 T RX VENT OPEN
29 F RX VENT CLOSED
**
** This event is used to signal if the reactor vessel vent open (TRUE) or
** closed (FALSE).
** This event is set if the operator has switched on the reactor vessel vent
** (IEVNT(229) = 1) while AC power is available (IEVNT(205) = 0).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
30 T PZR HEATERS ON
30 F PZR HEATERS OFF
**
** This event is used to signal if the pressurizer heaters are on (TRUE) or

** off (FALSE).
** This event is set if the pressure in the primary system is below a user-
** specified pressurizer-heater pressure set point PPZHT0, the collapsed water
** level in the pressurizer is above a user-specified pressurizer-heater low
** water level trip point ZPZHT, the AC power is available (IEVNT(205) = 0), and
** the operator has not switched off the pressurizer heaters (IEVNT(226) = 0).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
31 T PZR SPRAYS ON
31 F PZR SPRAYS OFF
**
** This event is used to signal if the pressurizer sprays are on (TRUE) or
** off (FALSE).
** This event is set if all of the following conditions are met:
**
** 1) The flow rate of water in the unbroken loops (in the broken loop for
** a one-loop configuration) is non-zero,
**
** 2) The collapsed water level in the pressurizer is below a user-
** specified elevation ZPZSP of the pressurizer spray head.
**
** 3) The pressurizer is saturated (IEVNT(38) = 0), and
**
** 4), The operator has switched on the pressurizer sprays (IEVNT(246) = 1
** and IEVNT(223) = 0) while the AC power is available (IEVNT(205) = 0),
** or the spray switch is in "automatic" (IEVNT(223) = 0) while the AC
** power is available (IEVNT(205) = 0) and the pressure in the primary
** system is above a user-specified pressurizer-spray pressure set point
** PPZSP0.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
32 T PZR EMPTY
32 F PZR NOT EMPTY
**
** This event is used to signal if the pressurizer is empty (TRUE) or not empty
** (FALSE).
** This event is set if the mass of water in the pressurizer is less than 75 kg.
** Once the event is set, it will remain set until the mass of water in the
** pressurizer exceeds 125 kg.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
33 T 1 UNBROKEN HOT LEG RUPTURE
33 F 1 UNBROKEN HOT LEG NOT RUPTURE
**
** This event indicates that the unbroken hot leg has failed due to creep
** rupture.
** Refer to the RVFLMK section of the User's Manual.

```
**
**======================================================================
=====
 34  T  1 BROKEN HOT LEG RUPTURE
 34  F  1 BROKEN HOT LEG NOT RUPTURE
**
** This event indicates that the broken hot leg has failed due to creep
** rupture.
** Refer to the RVFLMK section of the User's Manual.
**
**======================================================================
=====
**@@@ 4.0.1 CYP DEFINE EVENT #35 PROPERLY
 35  T  VOID FRACTION IN PZR < 0.1
 35  F  VOID FRACTION IN PZR >= 0.1
**
** This event is used to signal if the void fraction in the pressurizer is
** < 0.1 (TRUE) or is >= 0.1 (FALSE).
** This event is set if the void fraction in the pressurizer is less than 0.1.
** The value of this event determines how the void fraction and the excess volume
** of water in the pressurizer will be calculated in subroutine PZR.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODE 36 IS OBSOLETE
** 36  T  PZR POOL SATURATED
** 36  F  PZR POOL SUBCOOLED
**
**======================================================================
=====
 37  T  1 UNBROKEN SG TUBE RUPTURE
 37  F  1 UNBROKEN SG TUBE NOT RUPTURE
**
** This event indicates that an unbroken loop steam generator U-tube has failed
** due to creep rupture.
** Refer to the RVFLMK section of the User's Manual.
**
**======================================================================
=====
 38  T  PZR INSUFF ENERGY FOR SAT
 38  F  PZR SYSTEM SAT ENERGY AVAIL
**
** This event is used to signal if the pressurizer is subcooled (TRUE) or is
** saturated (FALSE).
** This event is set if any one of the following conditions is met:
**
** 1)  The total excess volume of water in the primary system and the
**     pressurizer is greater than .1 m^3,
** 2)  The specific internal energy of the steam and water mixture in the
**     pressurizer is less than the saturation enthalpy of water and the
**     negative excess volume of water in the pressurizer is less than 10%
**     of a user-specified volume VPZ of the pressurizer, or
** 3)  The excess volume of water in the pressurizer exceeds 2% of the user-
```

** specified volume VPZ of the pressurizer.
**
** Once the event is set, it will remain set until the specific internal energy
** of the steam and water mixture in the pressurizer exceeds the saturation
** enthalpy of water or the negative excess volume of water in the pressurizer
** exceeds 10% of the user-specified volume VPZ of the pressurizer. A deadband
** is provided by using a 1% difference in pressure in computing the saturation
** enthalpies of water in setting or resetting the event.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
39 T 2 VESSEL FAILED BY EJECTION OF INSTRUMENT PENETRATION TUBES
**
** Event code also identified as IEVNT(IPTEJ)
** This event occurs due to a differential pressure being applied to the tube
** between the vessel and the containment. In addition, the wall of the vessel
** heats up weakening the weld holding the penetration. The result is an
** ejection of the tube due to the differential pressure acting on the
** weakened weld.
** For further information on this event code refer to description of
** subroutine PNTRAT.
**
**=====================================================================
=====
40 T PZR SOLID
40 F PZR HAS STEAM
**
** This event is used to signal if the pressurizer has no void (TRUE) or has
** void (FALSE).
** This event is set if the water in the pressurizer is subcooled (IEVNT(38) = 1)
** and the total mass of hydrogen and steam in the pressurizer is less than 1 kg.
** Refer to the EVENTS section of the User's Manual. Volume 2, Part 2.
**
**=====================================================================
=====
41 T 2 VESSEL FAILED BY MOLTEN CORIUM JET EROSION OF LOWER HEAD
**
** This event indicates that the RPV has failed due to molten corium jet
** erosion of the RPV lower head.
** Refer to the RVFLMK section of the User's Manual.
**
**=====================================================================
=====
42 T PZR SAFETY VALVE(S) OPEN
42 F PZR SAFETY VALVES CLOSED
**
** This event code indicates the status of the pressurizer safety valves
** regardless of whether the valve was opened/closed manually or automatically.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
43 T 2 VESSEL FAILED BY OVERLYING METAL LAYER ATTACKING THE WALL

```
**
** This event indicates that the RPV has failed due to overlying metal layer
** attacking the RPV wall.
** Refer to the RVFLMK section of the User's Manual.
**
**======================================================================
=====
 44  T  PZR RELIEF VALVE(S) OPEN
 44  F  PZR RELIEF VALVES CLOSED
**
** This event code indicates the status of the pressurizer relief valves
** regaurdless of whether the valve was opened/closed manually or automatically.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
 45  T  BKN LOOP NOT BLOCKD AT PMP BOWL
 45  F  BKN LOOP BLOCKED
**
** This event is used to signal if the gas transport in the broken loop is not
** blocked (TRUE) or blocked (FALSE).
** The manner in which this event is set is analogous to that described for event
** no. 27.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
 46  T  LETDOWN FLOW OFF
 46  F  LETDOWN FLOW ON
**
** This event is used to signal if the letdown flow is off (TRUE) or on (FALSE).
** This event is set if the AC power is unavailable (IEVNT(205) = 1) or the
** operator has shut off the letdown flow (IEVNT(243) = 1).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
 47  T  UHI RUPTURE DISK BKN
 47  F  UHI RUPTURE DISK INTACT
**
** This event is used to signal if the UHI rupture disk has rupture (TRUE) or
** intact (FALSE).
** The event becomes TRUE if the pressure in the UHI accumulator exceeds the
** pressure in the primary system by the UHI rupture disk failure pressure and
** the operator has not shut off the UHI accumulator block valve (IEVNT(230)=0).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
 48  T  UHI ACCUM NOT FUNCTIONAL
 48  F  UHI ACCUM FUNCTIONAL
**
** This event is used to signal if the UHI accumulator is disabled (TRUE) or
** functional (FALSE).
```

** This event is TRUE if the operator has shut off the UHI accumulator block
** valve (IEVNT(230) = 1), or the water in the UHI accumulator is depleted
** (IEVNT(190) = 1), or the UHI rupture disk has not yet ruptured (IEVNT(47)=0).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
49 T CORE HAS UNCOV
49 F CORE NEVER UNCOV
**
** This event is used to signal if the core is uncovered (TRUE) or the core
** has never uncovered (FALSE).
** This event becomes TRUE if the boiled-up water level in the reactor vessel
** drops below the user-specified elevation ZCRU of the top of active fuel.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
50 T 1 SURGE LINE RUPTURE
50 F 1 SURGE LINE NOT RUPTURE
**
** This event indicates that the Pressurizer Surge Line has failed due to creep
** rupture.
** Refer to the RVFLMK section of the User's Manual.
**
**==========================================================================
=====
51 T 2 GENERALIZED OPENING #1 UNCOVERED
51 F 2 GENERALIZED OPENING #1 COVERED
**
** This event is used to signal if generalized opening #1 is uncovered (TRUE)
** or covered (FALSE).
** This event is similar to event flag no. 1. It is set if a break of a user-
** specified area AGO(1) has taken place (IEVNT(209) = 1) and a user-specified
** elevation ZGO(1) of the break is higher than the collapsed water level in the
** primary system by at least the equivalent diameter of the break. It is also
** set if either of the following two conditions is met:
**
** 1) A user-specified break INGO(1) occurs in the horizontal portion of the
** hot legs and the boiled-up water level in the reactor vessel is below
** the user-specified elevation ZNOZ of the nozzles by at least 1 cm, or
**
** 2) The user-specified break INGO(1) occurs in the cold portion of the steam
** generator tubes or in the intermediate portion of the cold legs and the
** boiled-up water level in the cold legs is below the user-specified
** elevation ZGO(1) of the break by at least the equivalent diameter of the
** break.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
52 T 2 GENERALIZED OPENING #2 UNCOVERED
52 F 2 GENERALIZED OPENING #2 COVERED

```
**
** This event is used to signal if generalized opening #2 is uncovered (TRUE)
** or covered (FALSE).
** The manner in which this event is set is analogous to that described for
** event no. 51.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
 53  T  2 GENERALIZED OPENING #3 UNCOVERED
 53  F  2 GENERALIZED OPENING #3 COVERED
**
** This event is used to signal if generalized opening #3 is uncovered (TRUE)
** or covered (FALSE).
** The manner in which this event is set is analogous to that described for
** event no. 51.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODE 54 IS OBSOLETE
** THIS EVENT CODE HAS BEEN REPLACED BY THE CONTAINMENT COMPARTMENT
** CONDITION EVENT CODES (1000+).  SEE APPENDIX 3P OF VOLUME 1 OF THE USER'S
** MANUAL.
**  54  T  H2 PRODUCTION COMPLETED IN CAVITY POOL
**
**=====================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODE 55 IS OBSOLETE
** THIS EVENT CODE HAS BEEN REPLACED BY THE CONTAINMENT COMPARTMENT
** CONDITION EVENT CODES (1000+).  SEE APPENDIX 3P OF VOLUME 1 OF THE USER'S
** MANUAL.
**  55  T  BURN IN PROGRESS IN CAVITY
**
**=====================================================================
=====
 56  T  2  REACTOR VESSEL CYLINDRICAL PART FAILED DUE TO CREEP
**
** This event indicates that the RPV has failed due to creep of the cylindrical
** part of the reactor vessel.
** Refer to the RVFLMK section of the User's Manual.
**
**=====================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 DESCRIPTION FOR EVENT 58 WAS REVISED
 58  T  CORIUM ENTRAINED IN CAVITY
 58  F  CORIUM NO LONGER ENTRAINED IN CAVITY
**
** This event code is set to true if debris is entrained in the JNVP compartment.
** Debris is entrained if the gas velocity is greater than the gas velocity
** required to entrain the debris as defined in the AUXEVT section of the
** User's Manual, Volume 2, Part 2.
**
```

```
**=========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 DESCRIPTION FOR EVENT 59 WAS ADDED
 59  T  WATER ENTRAINED IN CAVITY
 59  F  WATER NO LONGER ENTRAINED IN CAVITY
**
** This event code is set to true if water is entrained in the JNVP compartment.
** Water is entrained if the gas velocity is greater than the gas velocity
** required to entrain the debris as defined in the AUXEVT section of the
** User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
 61  T  1  RPV SECONDARY FAILURE UPON REMAINING DEBRIS HEATUP
 61  F  1  NO RPV SECONDARY FAILURE
**
** This event indicates that a secondary failure of the RPV lower head has
** occurred due to creep.
** Refer to the RVFLMK section of the User's Manual.
**
**=========================================================================
=====
 63  T  1 BROKEN SG TUBE RUPTURE
 63  F  1 BROKEN SG TUBE NOT RUPTURE
**
** This event indicates that an broken loop steam generator U-tube has failed
** due to creep rupture.
** Refer to the RVFLMK section of the User's Manual.
**
**=========================================================================
=====
 66  T  STEAMING IN CAV LIMITED BY FLOODING
 66  F  STEAMING IN CAV NOT FLOODING-LIMITED
**
** This event indicates if the steaming in containment is limited by flooding
** and is set true when the flooding flow rate is less than the maximum
** steaming rate (WSTFL < WSTMX).
** Refer to the AUXEVT section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
 69  T  STEAM EXPLOSION HAS OCCURRED IN CAVITY
 69  F  NO STEAM EXPLOSION HAS YET OCCURRED IN CAVITY
**
** This event indicates if a steam explosion has occurred in the cavity
** and is set true if a significant amount of steam is produced when the core
** debris comes in contact with water in the cavity.  This can only occur from
** the time vessel failure occurs (Event 3 is TRUE) to the time the debris comes
** in contact with the cavity floor (Event 70 is TRUE).  This event is non-
** resettable, once it becomes true.
** Refer to the AUXEVT and EXVIN sections of the User's Manual, Volume 2,
** Part 2.
**
```

**=========================================================================
=====
70 T CORIUM IN CONTACT WITH CAVITY FLOOR
70 F CORIUM NOT YET IN CONTACT WITH CAVITY FLOOR
**
** This event code indicates that core debris is in contact with the pedestal
** floor. This event code is set true when the time since vessel failure
** exceeds the time required for the debris to fall to the pedestal floor plus
** the time delay for corium water interaction to begin (TDSTX).
** Refer to the AUXEVT and EXVIN sections of the User's Manual, Volume 2,
** Part 2.
**
**=========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODE 74 IS OBSOLETE
** THIS EVENT CODE HAS BEEN REPLACED BY THE CONTAINMENT COMPARTMENT
** CONDITION EVENT CODES (1000+). SEE APPENDIX 3P OF VOLUME 1 OF THE USER'S
** MANUAL.
** 74 T POOL H2 PRODUCTION COMPLETED IN LOWER CMPT
**
**=========================================================================
=====
76 T CHILLERS ON
76 F CHILLERS OFF
**
** The containment chillers come on after a time delay (TDCHR) after
** receiving the initiation signal (Event 78 is TRUE).
**
**=========================================================================
=====
77 T FANS/COOLERS ON
77 F FANS/COOLERS OFF
**
** The fan coolers come on after a time delay (TDFAN) after receiving
** the initiation signal (Event 79 is TRUE).
**
**=========================================================================
=====
78 T CHILLERS INITIATION SIGNAL RECEIVED
78 F CHILLERS INITIATION SIGNAL NOT RECEIVED
**
** This event is used to signal if containment chillers on (TRUE) or off (FALSE).
** This event is set if the operator has switch on the containment chillers
** (IEVNT(210) = 1 and IEVNT(225) = 0) while the AC power is available
** (IEVNT(205) = 0). It is also set if the containment chiller switch is in an
** "automatic" (IEVNT(225) = 0) while the AC power is available (IEVNT(205) = 0),
** and the pressure in the compartment indexed by JNCHS exceeds a user-specified
** set point PCHRO. Once the flag is set, it will remain set, thereby signaling
** continuous actuation of the containment chillers, until the operator switches
** off the containment chillers (IEVNT(225) = 1) or the AC power becomes
** unavailable (IEVNT(205) = 1). A timer is set with a user-specified delay
** TDCHR and turned on when the flag becomes true. The timer is turned off
** whenever the flag is false. Flow due to the containment chillers starts after
** the timer has gone off.

```
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
 79  T  FANS/COOLERS INITIATION SIGNAL RECEIVED
 79  F  FANS/COOLERS INITIATION SIGNAL NOT RECEIVED
**
** This event is used to signal if fans or fan coolers are on (TRUE) or off
** (FALSE).
** This event is set if the operator has switched on the fans/fan coolers
** (IEVNT(218) = 1 and IEVNT(221) = 0) while the AC power is available
** (IEVNT(205) = 0).  It is also set if the fan/fan cooler switch is in
** "automatic" (IEVNT(221) = 0) while the AC power is available (IEVNT(205) = 0),
** and the pressure in the compartment indexed by JNFCS exceeds a user-
** specified set point PFAN0.  Once the event is set, it will remain set, thereby
** signaling continuous actuation of the fans or the fan coolers, until the
** operator switches off the fans or fan coolers (IEVNT(221) = 1) or the AC power
** becomes unavailable (IEVNT(205) = 1).  A timer is set with a user-specified
** delay TDFAN and turned on when the event becomes true.  The timer is turned
** off whenever the event is false.  Flow due to the fans or the fan coolers
** starts after the timer has gone off.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
 80  T  REACTOR VESSEL FAILS DUE TO CREEP RUPTURE
**
** This event indicates that the RPV has failed due to lower head creep
** rupture.
** Refer to the RVFLMK section of the User's Manual.
**
**==========================================================================
=====
**@@@4.0.2 CYP 8/25/95
 81  T  REACTOR VESSEL FAILED AND 1000 SECONDS PASSED
**
** This event is used to signal if reactor vessel failed and 1000 seconds
** passed (TRUE) or intact (FALSE).
** This event is used in subroutine FLOW to include the rate of temperature
** change term in the rate of pressure change calculation.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
**@@@ 4.0.1 BJS 2/8/95  EVENT 86 APPLIES TO GENERALIZED AND "HARDWIRED" LOWER
**              COMPT. SPRAYS (NOT TO CONSTANT FLOW (FIRE) SPRAYS)
 86  T  LOWER COMPT. SPRAYS ON
 86  F  LOWER COMPT. SPRAYS OFF
**
** This event is used to signal if low spray pumps are on (TRUE) or off (FALSE).
** This event is set if the operator has switched on the lower spray pumps
** (IEVNT(219) = 1 and IEVNT(222) = 0) while the AC power is available
** (IEVNT(205) = 0).  It is also set if there is at least one lower spray pump,
** as is indicated by the user-specified parameters NESF, NSPB, and NSPBG, and
```

** if the pump switch is in "automatic" (IEVNT(222) = 0) while the AC power is
** available (IEVNT(205) = 0), and the pressure in the compartment indexed by
** JNLCS rises above a user-specified set point PSP0. Once the flag is set, it
** will remain set, thereby signaling continuous actuation of the lower spray
** pumps, until the operator switches off the pumps (IEVNT(222) = 1) or the AC
** power becomes unavailable (IEVNT(205) = 1). A timer is set with a user-
** specified delay TDSPB and turned on when the event becomes true. The timer
** is turned off whenever the event is false. The lower spray pumps are
** considered to be running only after the timer has gone off. For spray to
** occur when the pumps are running, a sufficient NPSH must also be established
** (see the discussions for event nos. 145 and 189).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
92 T Q/T RUPTURE DISK FAILED
92 F Q/T RUPTURE DISK INTACT
**
** This event is used to signal if the quench tank rupture disk has ruptured
** (TRUE) or is intact (FALSE).
** The event becomes true when the pressure in the quench tank exceeds the
** pressure in the compartment indexed by JNBB by a user-specified rupture disk
** failure pressure PQTRD. The masses of hydrogen, steam, and nitrogen and the
** total gas internal energy in the compartment indexed by JNRV are incremented
** by the respective quantities in the quench tank and the temperature and
** specific volume of water in the quench tank are updated as soon as the event
** becomes true.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
93 T QUENCH TANK RD COVERED
93 F QUENCH TANK RD NOT COV
**
** This event is used to signal if the quench tank rupture disk is covered
** (TRUE) or is uncovered (FALSE).
** This event is set if the water level in the compartment indexed by JNRV is
** above a user-specified elevation ZQTRD of the quench tank rupture disk.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
94 T Q/T RD OVERFLOWING
94 F Q/T RD NOT OVERFLOWING
**
** This event is used to signal if the quench tank is overflowing (TRUE) or
** is not overflowing (FALSE).
** This event is set if the volume of water in the quench tank exceeds a user-
** specified volume VQT of the quench tank. Note that in case the quench tank
** rupture disk has just ruptured, the water volume in the quench tank used for
** testing whether this flag is set or not is based on the specific volume of
** water in the quench tank before it is updated (see the discussion for event
** code no. 92).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.

**
**==========================================================================
=====
95 T Q/T CONTAINS WATER
95 F Q/T EMPTY
**
** This event is used to signal if the quench tank is not empty (TRUE) or empty
** (FALSE).
** This event is set if the mass of water in the quench tank exceeds the
** hardwired small quantity MWMIN.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
96 T Q/T WATER CAN STEAM
96 F Q/T WATER SUBCOOLED
**
** This event is used to signal if the quench tank is saturated (TRUE) or
** subcooled (FALSE).
** This event is set if the water temperature in the quench tank is within 10
** degrees C of the saturation temperature at the lower compartment pressure.
** Note that in case the quench tank rupture disk has just ruptured, the water
** temperature in the quench tank used for testing whether this event is set or
** not is the one before update (see the discussion for event code no. 92).
** Refer to the EVENTS section of the User's Manual. Volume 2. Part 2.
**
**==========================================================================
=====
**@@@ 4.0.1 BJS 2/8/95 EVENT 103 APPLIES TO GENERALIZED AND "HARDWIRED" UPPER
** COMPT. SPRAYS (NOT TO CONSTANT FLOW (FIRE) SPRAYS)
103 T UPPER COMPT. SPRAYS ON
103 F UPPER COMPT. SPRAYS OFF
**
** This event is used to signal if the upper spray pumps are on (TRUE) or off
** (FALSE).
** This event is set if the operator has switched on the upper spray pumps
** (IEVNT(219) = 1 and IEVNT(222) = 0) while the AC power is available
** (IEVNT(205) = 0). It is also set if the pump switch is in "automatic"
** (IEVNT(222) = 0) while the AC power is available (IEVNT(205) = 0), and the
** pressure in the compartment indexed by JNUCS rises above the user-specified
** set point PSP0. Once the flag is set, it will remain set, thereby signaling
** continuous actuation of the upper spray pumps, until the operator switches
** off the pumps (IEVNT(222) = 1) or the AC power becomes unavailable
** (IEVNT(205) = 1). A timer is set with a user-specified delay TDSPA and turned
** on when the event becomes true. The timer is turned off whenever the event is
** false. The upper spray pumps are considered to be running only after the
** timer has gone off. For spray to occur when the pumps are running, a
** sufficient NPSH must also be established (see the discussions for event
** nos. 144 and 182).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
104 T CONTMT FAILED

104 F CONTMT INTACT
**
** This event code is set true if the containment fails due to strain (Event
** 120 is TRUE), due to stress (Event 119 is TRUE), or due to overpressure
** of a failure junction.
** Refer to the AUXEVT section of the User's Manual.
**
**==========================================================================
=====
106 T NEUTRON SHIELD BAGS RUPTURED
106 F NEUTRON SHIELD BAGS INTACT
**
** This event is used to signal if the neutron shield bags have ruptured (TRUE)
** or are intact (FALSE).
** The event becomes TRUE if there are neutron shield bags, as indicated by a
** user-specified parameter MWBAG0, and if a break in the primary system has
** occurred (IEVNT(209) = 1), or the reactor vessel has failed (IEVNT(3) = 1),
** or the quench tank rupture disk has ruptured (IEVNT(92) = 1). The mass and
** total energy of water in the compartment indexed by JNUCS is incremented by
** the mass and total energy, respectively, of water in the neutron shield bags
** as soon as the event becomes true.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 DESCRIPTION FOR EVENT 119 WAS REVISED
119 T CONTMT FAILED ON PRESS - STRESS
**
** This event code indicates when the contaiment has failed due to overpressure
** of the containment wall.
** Refer to the AUXEVT, AUXREG, and STRAIN sections of the User's Manual.
**
**==========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 DESCRIPTION FOR EVENT 120 WAS REVISED
120 T CONTMT FAILED ON STRAIN
**
** This event code indicates when the contaiment has failed due to strain of
** the containment wall.
** Refer to the AUXEVT and STRAIN sections of the User's Manual.
**
**==========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODES 129-130 ARE OBSOLETE
** 129 T CONTMT FAILED IN D ON PRESS
** 130 T CONTMT FAILED IN D ON STRAIN
**
**==========================================================================
=====
132 T ICE DEPLETED
132 F ICE AVAILABLE
**
** This event is used to signal if the ice in the ice condensor has depleted
** (TRUE) or is available (FALSE).

** This event is set if there is an ice condenser, as is indicated by a user-
** specified parameter JNICE, and the mass of ice in the ice condenser becomes
** zero.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
134 T UNBKN LOOP TURBINE AFW ON
134 F UNBKN LOOP TURBINE AFW OFF
**
** This event is used to signal if the unbroken-loop turbine-driven auxiliary
** feedwater is on (TRUE) or off (FALSE).
** This event is set if water is available from the condensate storage tank
** (IEVNT(191) = 0), both the main and the auxiliary feedwater pumps are off
** (IEVNT(154) = 1 and IEVNT(157) = 1), and the operator has forced the turbine
** to drive auxiliary feedwater into the unbroken-loop steam generators
** (IEVNT(251) = 1).
** Refer to the EVENTS section of the User's Manual. Volume 2. Part 2.
**
**==========================================================================
=====
135 T BKN LOOP TURBINE AFW ON
135 F BKN LOOP TURBINE AFW OFF
**
** This flag is similar to event flag no. 134. It is set if water is available
** from the condensate storage tank (IEVNT(191) = 0), both the main and the
** auxiliary feedwater pumps are off (IEVNT(154) = 1 and IEVNT(157) = 1), and
** the operator has forced the turbine to drive auxiliary feedwater into the
** broken-loop steam generator (IEVNT(252) = 1).
** Refer to the EVENTS section of the User's Manual. Volume 2. Part 2.
**
**==========================================================================
=====
**@@@ 4.0.1 BJS 2/8/95 EVENT 139 APPLIES TO GENERALIZED C SPRAY TRAIN
** (NOT TO HARDWIRED OR CONSTANT FLOW (FIRE) SPRAYS)
139 T CONTMT SPRAYS TRAIN C ON
139 F CONTMT SPRAYS TRAIN C OFF
**
** This flag is similar to event flag no. 86. It is set if the operator has
** switched on the train C spray pumps (IEVNT(255) = 1 and IEVNT(256) = 0) while
** the AC power is available (IEVNT(205) = 0). It is also set if there is at
** least one train C spray pump, as is indicated by the user-specified
** parameters NESF and NSPCG, and if the pump switch is in "automatic"
** (IEVNT(256) = 0) while the AC power is available (IEVNT(205) = 0), and the
** pressure in the compartment indexed by JNUCS rises above the user-specified
** set point PSP0. Once the flag is set, it will remain set, thereby signaling
** continuous actuation of the train C spray pumps, until the operator switches
** off the pumps (IEVNT(256) = 1) or the AC power becomes unavailable (IEVNT(205)
** = 1). A timer is set with a user-specified delay TDSPC and turned on when the
** flag becomes true. The timer is turned off whenever the flag is false. The
** train C spray pumps are considered to be running only after the timer has gone
** off. For spray to occur when the pumps are running, a sufficient NPSH must
** also be established (see the discussions for flag nos. 150 and 140).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.

```
**
**======================================================================
=====
140  T  TRAIN C SPRAY PUMPS INSUFF NPSH
140  F  TRAIN C SPRAY PUMPS NPSH OK
**
** This flag is set if the user selects to use the generalized engineered-
** safeguards model, as is indicated by the user-specified parameter NESF, and
** the available NPSH is not greater than the required NPSH.  A timer is set
** with a user-specified delay TDNSPC and turned on when the flag becomes true.
** The timer is turned off if it did not go off at the preceding time step and
** sufficient NPSH is (re)established (see the discussion for event flag no.
** 150).  For spray to occur, the pumps must be running (see the discussion for
** event flag no. 139) and the timer must not have gone off.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODE 141 IS OBSOLETE
** 141  T  BURN IN PROGRESS IN I/C UPPER PLENUM
** 141  F  NO BURN IN I/C UPPER PLENUM
**
**======================================================================
=====
142  T  LPI TRAIN 2 ON
142  F  LPI TRAIN 2 OFF
**
** This flag is similar to event flag no. 6.  It is set if the operator has
** switched on the train 2 LPI pumps (IEVNT(253) = 1 and IEVNT(254) = 0) while
** the AC power is available (IEVNT(205) = 0).  It is also set if there is at
** least one train 2 LPI pump, as is indicated by the user-specified parameters
** NESF and NLP2G, and if the pump switch is in "automatic" (IEVNT(254) = 0)
** while the AC power is available (IEVNT(205) = 0), and the pressure in the
** primary system drops below the user-specified set point PLPI0.  Once the flag
** is set, it will remain set, thereby signaling continuous actuation of the
** train 2 LPI pumps, until the operator switches off the pumps (IEVNT(254) = 1)
** or the AC power becomes unavailable (IEVNT(205) = 1).  A timer is set with a
** user-specified delay TDLP2 and turned on when the flag becomes true.  The
** timer is turned off whenever the flag is false.  The train 2 low pressure
** injection pumps are considered to be running only after the timer has gone
** off.  For injection to occur when the pumps are running, a sufficient NPSH
** must also be established (see the discussions for flag nos. 147 and 143).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
143  T  LPI PUMPS TRAIN 2 INSUFF NPSH
143  F  LPI PUMPS TRAIN 2 NPSH OK
**
** This flag is similar to event flag no. 182.  It is set if the available NPSH
** is not greater than the required NPSH.  A timer is set with a user-specified
** delay TDNLP2 and turned on when the flag becomes true.  The timer is turned
** off if it did not go off at the preceding time step and sufficient NPSH is
** (re)established (see the discussion for event flag no. 147).  Note that if
```

** the user selects not to use the generalized engineered-safeguards model, as
** is indicated by the user-specified parameter NESF, the effective delay time
** for the timer is zero whatever value the user specifies for TDNLP2. For
** injection to occur, the pumps must be running (see the discussion for event
** flag no. 142) and the timer must not have gone off.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
**@@@ 4.0.1 BJS 2/8/95 EVENTS 144 AND 145 APPLY TO GENERALIZED ESF UPPER AND
** LOWER COMPT. SPRAYS (TRAINS A AND B)
144 T TRAIN A CONTMT SPRAY PUMPS DISABLED
144 F TRAIN A CONTMT SPRAY PUMPS OK
**
** This flag is set when the available NPSH becomes insufficient (IEVNT(182) =
** 1).
** Refer to the GENESF section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
145 T TRAIN B CONTMT SPRAY PUMPS DISABLED
145 F TRAIN B CONTMT SPRAY PUMPS OK
**
** This flag is similar to event flag no. 144. This flag is set when the
** available NPSH becomes insufficient (IEVNT(189) = 1).
** Refer to the GENESF section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
146 T LPI PUMPS TRAIN 1 DISABLED
146 F LPI PUMPS TRAIN 1 OK
**
** This flag is similar to event flag no. 144. This flag is set when the
** available NPSH becomes insufficient (IEVNT(184) = 1).
** Refer to the GENESF section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
147 T LPI PUMPS TRAIN 2 DISABLED
147 F LPI PUMPS TRAIN 2 OK
**
** This flag is similar to event flag no. 144. This flag is set when the
** available NPSH becomes insufficient (IEVNT(143) = 1).
** Refer to the GENESF section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
148 T HPI PUMPS DISABLED
148 F HPI PUMPS OK
**
** This flag is similar to event flag no. 144. This flag is set when the
** available NPSH becomes insufficient (IEVNT(185) = 1).
** Refer to the GENESF section of the User's Manual, Volume 2, Part 2.
**

**=======================================================================
=====
149 T CH PUMPS DISABLED
149 F CH PUMPS OK
**
** This flag is similar to event flag no. 144. This flag is set when the
** available NPSH becomes insufficient (IEVNT(183) = 1).
** Refer to the GENESF section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
**@@@ 4.0.1 BJS 2/8/95 EVENT 150 APPLIES TO GENERALIZED ESF SPRAY TRAIN C
150 T TRAIN C CONTMT SPRAY PUMPS DISABLED
150 F TRAIN C CONTMT SPRAY PUMPS OK
**
** This flag is similar to event flag no. 144. This flag is set when the
** available NPSH becomes insufficient (IEVNT(140) = 1).
** Refer to the GENESF section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
151 T BROKEN S/G DRY
151 F BROKEN S/G NOT DRY
**
** This flag is set if the mass of water in the broken-loop steam generator
** drops below the hardwired small quantity MWMIN. When the two-region steam
** generator model is enabled, this flag is controlled by a corresponding flag
** whose status is controlled locally by the steam generator events routine,
** SGEVT. Consult the SGEVT description for details.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
152 T SEC RV OPEN BROKEN S/G
152 F SEC RV NOT OPEN BROKEN S/G
**
** This flag is set if there is at least one steam-generator relief valve, as
** is indicated by a user-specified parameter NSGRV, and if the pressure in the
** broken-loop steam generator exceeds a user-specified relief valve setpoint
** PSGRV while the AC power is available (IEVNT(205) = 0), or the operator has
** forced open the relief valve on the broken-loop steam generator (IEVNT(233)
** = 1). When the two-region steam generator model is enabled, this flag is
** controlled by a corresponding flag whose status is controlled locally by the
** steam generator events routine, SGEVT. Consult the SGEVT description for
** details.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
153 T SEC SV(S) OPEN BROKEN S/G
153 F SEC SV(S) NOT OPEN BROKEN S/G
**
** This flag is set if the pressure in the broken-loop steam generator exceeds
** a user-specified safety valve setpoint PSGSVL or the operator has opened the

** safety valves (IEVNT (239) = 1). When the two-region steam generator model
** is enabled, this flag is controlled by a corresponding flag whose status is
** controlled locally by the steam generator events routine, SGEVT. Consult the
** SGEVT description for details.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
**@@@ 4.0.2 CEH 5/31/95 CHANGE MESSAGES TO INDICATE THAT EVENT
** CODE 154 ONLY APPLIES TO MOTOR-DRIVEN AUX FEED
154 T MOTOR-DRIVEN AUX FEEDWATER ON
154 F MOTOR-DRIVEN AUX FEEDWATER OFF
**
** This flag is set if water is available from the condensate storage tank
** (IEVNT(191) = 0), the main feedwater pumps are off (IEVNT(157) = 1), and the
** operator has not switched off the auxiliary feedwater pumps (IEVNT(224) = 0)
** while the AC power is available (IEVNT(205) = 0). A timer is set with a
** user-specified delay TDAFW and turned on when the flag becomes true. The
** timer is turned off whenever the flag is false. Auxiliary feedwater starts
** to flow after the timer has gone off.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
155 T BRKN LOOP STAGNANT
155 F BRKN LOOP CIRCULATING
**
** This flag is set true if all the following exist:
** 1) The void fraction in the primary system exceeds a user-specified value
** (VFSEP),
**
** 2) The broken-loop phases are separated (IEVNT(171) = 0),
**
** 3) The water in the core was not saturated (IEVNT(12) = 0) at the
** preceding time step, or the void fraction in the primary system is
** greater than VFLOW, and the void fraction in the primary system is
** greater than a user-specified value VFCIRC.
**
** Once the flag is set, it will remain set until any one of the following
** conditions is met:
**
** 1) The water in the core is saturated (IEVNT(12) = 1) at the preceding
** time step, the void fraction in the primary system is less than the
** user-specified value VFCIRC, and the subcooling in the primary system
** is less than 10 degrees C,
**
** 2) The void fraction in the primary system is less than a hardwired small
** quantity VFLOW whose nominal value is 0.05.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
156 T MSIV CLOSED

156 F MSIV OPEN
**
** This flag is set if the reactor has scrammed (IEVNT(13) = 1) while the MSIV
** switch is in "automatic" (IEVNT(236) = 0) or if the operator has switched off
** the MSIV's (IEVNT(235) = 1). A timer is set with a user-specified delay
** TDMSIV and turned on when the flag becomes true. The timer is turned off
** whenever the flag is false. The MSIV's starts to linearly "ramp"-close after
** the timer has gone off.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
157 T MAIN FW OFF
157 F MAIN FW ON
**
** This flag is set if the reactor has scrammed (IEVNT(13) = 1) while the main
** feedwater pump switch is in "automatic" (IEVNT(245) = 0), or the AC power is
** unavailable (IEVNT(205) = 1), or if the operator has switched off the main
** feedwater pumps (IEVNT(228) = 1).
** Refer to the EVENTS section of the User's Manual, Volume 2. Part 2.
**
**=========================================================================
=====
158 T BKN S/G EQUIL THERMO
158 F BKN S/G NONEQ THERMO
**
** This flag is set if the broken-loop steam generator was not yet in
** thermodynamic equilibrium (IEVNT(158) = 0) at the preceding time step but
** either of the following two conditions is met:
**
** 1) The reactor is at full power (IEVNT(13) = 0) and the water level in the
** broken-loop steam generator is above 92% of the average height of the
** tubes in the steam generator, or
**
** 2) The reactor has scrammed (IEVNT(13) = 1) and the volume of water in the
** broken-loop steam generator exceeds 92% of a user-specified free volume
** VSG of the steam generator.
**
** It is also set if the broken-loop steam generator was already in
** thermodynamic equilibrium (IEVNT(158) = 1) at the preceding time step and
** either of the following two conditions is met:
**
** 1) The reactor is at full power (IEVNT(13) = 0) and the water level in
** the broken-loop steam generator is above 88% of the average height of
** the tubes in the steam generator, or
**
** 2) The reactor has scrammed (IEVNT(13) = 1) and the volume of water in
** the broken-loop steam generator exceeds 88% of the user-specified free
** volume VSG of the steam generator.
**
** When the two-region steam generator model is enabled, this flag is controlled
** by a corresponding flag whose status is controlled locally by the steam
** generator events routine, SGEVT. Consult the SGEVT description for details.
**

** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
159 T BKN LOOP S/G SOLID
159 F BKN LOOP S/G VOIDED
**
** This flag is set if either of the following two conditions is met:
**
** 1) The broken-loop steam generator was not yet solid (IEVNT(159) = 0) at
** the preceding time step but the volume of water in the broken-loop steam
** generator exceeds 99% of the user-specified free volume VSG of the steam
** generator, or
**
** 2) The broken-loop steam generator was already solid (IEVNT(159) = 1) at
** the preceding time step and the volume of water in the broken-loop steam
** generator exceeds 96% of the user-specified free volume VSG of the steam
** generator.
**
** When the two-region steam generator model is enabled, this flag is controlled
** by a corresponding flag whose status is controlled locally by the steam
** generator events routine, SGEVT. Consult the SGEVT description for details.
**
** Refer to the EVENTS section of the User's Manual. Volume 2. Part 2.
**
**==========================================================================
=====
160 T S/G BK UNCOV PRI SIDE
160 F S/G BK COV
**
** This flag is set if all of the following conditions are met:
**
** 1) A break of a user-specified area ASB has occurred (IEVNT(209) = 1),
**
** 2) The broken loop is stagnant (IEVNT(155) = 1).
**
** 3) The collapsed water level in the broken loop is below the elevation of
** the steam-generator-tube rupture, as is indicated by the user-specified
** parameters ZSB and ZSGTS, and.
**
** 4) The volume of gas in the primary system exceeds 1 m3.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
161 T UNBKN S/G DRY
161 F UNBKN S/G NOT DRY
**
** This flag is similar to event flag no. 151. It is set if the mass of water
** in the unbroken-loop steam generators drops below the number of unbroken-loop
** steam generators times the hardwired small quantity MWMIN.
** When the two-region steam generator model is enabled, this flag is controlled
** by a corresponding flag whose status is controlled locally by the steam

** generator events routine, SGEVT. Consult the SGEVT description for details.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
162 T SEC RV OPEN UNBROKEN S/G'S
162 F SEC RV NOT OPEN UNBROKEN S/G'S
**
** This flag is similar to event flag no. 152. It is set if there is at least
** one steam-generator relief valve, as is indicated by the user-specified
** parameter NSGRV, and if the pressure in the unbroken-loop steam generators
** exceeds the user-specified relief valve setpoint PSGRV while the AC power is
** available (IEVNT(205) = 0), or the operator has forced open the relief valves
** on the unbroken-loop steam generators (IEVNT(249) = 1).
** When the two-region steam generator model is enabled, this flag is controlled
** by a corresponding flag whose status is controlled locally by the steam
** generator events routine, SGEVT. Consult the SGEVT description for details.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
163 T SEC SV(S) OPEN UNBROKEN S/G'S
163 F SEC SV(S) NOT OPEN UNBROKEN S/G'S
**
** This flag is set if the pressure in the unbroken-loop steam generators
** exceed the user-specified safety valve set point PSGSVL.
** When the two-region steam generator model is enabled, this flag is controlled
** by a corresponding flag whose status is controlled locally by the steam
** generator events routine, SGEVT. Consult the SGEVT description for details.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
164 T UNBKN LOOP STAGNANT
164 F UNBKN LOOP CIRCULATING
**
** This flag is set true if all the following exist:
** 1) The void fraction in the primary system exceeds a user-specified value
** (VFSEP),
**
** 2) The unbroken-loop phases are separated (IEVNT(15) = 0),
**
** 3) The water in the core was not saturated (IEVNT(12) = 0) at the
** preceding time step, or the void fraction in the primary system is
** greater than VFLOW, and the void fraction in the primary system is
** greater than a user-specified value VFCIRC.
**
** Once the flag is set, it will remain set until any one of the following
** conditions is met:
**
** 1) The water in the core is saturated (IEVNT(12) = 1) at the preceding
** time step, the void fraction in the primary system is less than the
** user-specified value VFCIRC, and the subcooling in the primary system
** is less than 10 degrees C,

**
** 2) The void fraction in the primary system is less than a hardwired small
** quantity VFLOW whose nominal value is 0.05.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
165 T BUMP UNBKN LOOPS
**
** This flag is set if any one of the following conditions is met:
**
** 1) The reactor vessel has failed (IEVNT(3) = 1) at high pressure
** (IEVNT(199) = 0) and the operator has not defeated this action
** (IEVNT(204) = 0),
**
** 2) The unbroken-loop main coolant pumps have been coasting down after
** having been tripped, i.e., current time is after the time when the pump
** trip occurred but the flow rate of water in the unbroken loops is still
** non-zero, or
**
** 3) The operator has bumped the unbroken-loop main coolant pumps
** (IEVNT(208) = 1).
**
** The assumption underlying the first condition is that the pressure difference
** across the pump bowl during depressurization following vessel failure can be
** large enough to bump the loops. Setting this flag causes the inventory in
** the cold legs to be rapidly discharged into the downcomer. This flag is
** reset if the gas volume in the primary system is not large enough to
** accommodate the volume of water to be thrown into the downcomer.
** Refer to the EVENTS section of the User's Manual. Volume 2, Part 2.
**
**==========================================================================
=====
166 T BUMP BKN LOOPS
**
** This flag is set if any one of the following conditions is met:
**
** 1) The reactor vessel has failed (IEVNT(3) = 1) at high pressure
** (IEVNT(199) = 0) and the operator has not defeated this action
** (IEVNT(204) = 0),
**
** 2) The broken-loop main coolant pumps have been coasting down after
** having been tripped, i.e., current time is after the time when the pump
** trip occurred but the flow rate of water in the broken loops is still
** non-zero, or
**
** 3) The operator has bumped the broken-loop main coolant pumps
** (IEVNT(258) = 1).
**
** In addition, the flag is set if the main coolant pumps have been tripped but
** the operator has switched the pumps on (IEVNT(247) = 1) while the AC power
** is available (IEVNT(205) = 0). This extra condition for bumping the broken
** loop is included so as to allow simulation of the 2B pump start during the

** TMI-2 accident.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
167 T UNBKN S/G EQUIL THERMO
167 F UNBKN S/G NONEQ THERMO
**
** This flag is similar to event flag no. 158. It is set if the unbroken-loop
** steam generators were not yet in thermodynamic equilibrium (IEVNT(167) = 0)
** at the preceding time step but either of the following two conditions is met:
**
** 1) The reactor is at full power (IEVNT(13) = 0) and the water level in the
** unbroken-loop steam generators is above 92% of the average height of the
** tubes in the steam generators, or
**
** 2) The reactor has scrammed (IEVNT(13) = 1) and the volume of water in the
** unbroken-loop steam generators exceeds 92% of the total volume of the
** unbroken-loop steam generators.
**
** It is also set if the unbroken-loop steam generators were already in
** thermodynamic equilibrium (IEVNT(167) = 1) at the preceding time step and
** either of the following two conditions is met:
**
** 1) The reactor is at full power (IEVNT(13) = 0) and the water level in the
** unbroken-loop steam generators is above 88% of the average height of
** the tubes in the steam generators, or
**
** 2) The reactor has scrammed (IEVNT(13) = 1) and the volume of water in the
** unbroken-loop steam generators exceeds 88% of the total volume of the
** unbroken-loop steam generators.
**
** When the two-region steam generator model is enabled, this flag is controlled
** by a corresponding flag whose status is controlled locally by the steam
** generator events routine, SGEVT. Consult the SGEVT description for details.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODE 168 IS OBSOLETE
** 168 T UNBKN LOOP S/G SOLID
** 168 F UNBKN LOOP S/G VOIDED
**
**=====================================================================
=====
169 T S/G BK UNCOV SEC SIDE
169 F S/G BK COV SEC SIDE
**
** This flag is set if the water level in the broken-loop steam generator is
** below the user-specified elevation ZSB of steam-generator-tube rupture or the
** broken-loop steam generator is dry (IEVNT(151) = 1). When the two-region
** steam generator model is enabled, this flag is controlled by a corresponding

** flag whose status is controlled locally by the steam generator events
** routine, SGEVT. Consult the SGEVT description for details.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
170 T IGNITERS POWER ON
170 F IGNITERS POWER OFF
**
** This flag is set if the operator has forced the igniters (IEVNT(207) = 1) on
** or the AC power is available (IEVNT(205) = 0).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
171 T BROKEN LOOP HOMOGENEOUS
171 F BROKEN LOOP PHASES SEPARATED
**
** The manner in which this flag is set or reset is analogous to that described
** for event flag no. 15.
** Refer to the EVENTS section of the User's Manual, Volume 2. Part 2.
**
**=========================================================================
=====
172 T BKN S/G POOL SAT
172 F BKN S/G POOL SUBCOOL
**
** This flag is set if the water temperature in the broken-loop steam generator
** is within 5 degrees C of saturation or if the broken-loop steam generator is
** in thermodynamic equilibrium (IEVNT(158) = 1) and saturated (IEVNT(173) = 0).
** When the two-region steam generator model is enabled, this flag is
** controlled by a corresponding flag whose status is controlled locally by the
** steam generator events routine, SGEVT. Consult the SGEVT description for
** details.
** Refer to the EVENTS section of the User's Manual. Volume 2. Part 2.
**
**=========================================================================
=====
173 T BROKEN-LOOP SG SUBCOOLED
173 F BROKEN-LOOP SG SATURATED
**
** This flag is set if any one of the following conditions is met:
**
** 1) The excess volume of water in the broken-loop steam generator is greater
** than .1 m3,
**
** 2) The specific internal energy of the steam and water mixture in the
** broken-loop steam generator is less than the saturation enthalpy of
** water and the negative excess volume of water in the broken-loop steam
** generator is less than 10% of the user-specified free volume VSG of the
** steam generator, or
**
** 3) The excess volume of water in the broken-loop steam generator exceeds 2%
** of the user-specified free volume VSG of the steam generator.

**
** Once the flag is set, it will remain set until the specific internal energy
** of the steam and water mixture in the broken-loop steam generator exceeds the
** saturation enthalpy of water or the negative excess volume of water in the
** broken-loop steam generator exceeds 10% of the user-specified free volume VSG
** of the steam generator. A deadband is provided by using a 1% difference in
** pressure in computing the saturation enthalpies of water in setting or
** resetting the flag.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODE 176 IS OBSOLETE
** THIS EVENT CODE HAS BEEN REPLACED BY THE CONTAINMENT COMPARTMENT
** CONDITION EVENT CODES (1000+). SEE APPENDIX 3P OF VOLUME 1 OF THE USER'S
** MANUAL.
** 176 T BURN IN AUX BLDG
** 176 F NO BURN IN AUX BLDG
**
**==========================================================================
=====
**@@@ 4.0.1 BJS 2/8/95 EVENT 177 IS FOR CONSTANT FLOW (FIRE) SPRAY
177 T CONSTANT FLOW (FIRE) SPRAY WATER GONE
**
** The Aux spray water depleted message is true when the mass of water
** available for the constant flow (fire) sprays (MSPRB) is less than TINY.
** This event is non-resettable, once it becomes TRUE.
**
**==========================================================================
=====
178 T AUX CO2 SUPPLY DEPLETED
**
** The Aux CO2 supply depleted message is true when the mass of CO2 available
** for fire suppression system (MC2FS) is less than TINY.
** This event is non-resettable, once it becomes TRUE.
**
**==========================================================================
=====
180 T AUTODT PLOT SCALING ON
180 F EQUALLY SPACED PLOT SCALING ON
**
** This flag is set if a user-specified parameter IPTSPK is non-zero.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
181 T RECIRC SYSTEM IN OPERATION
181 F ENGSAFE PUMPS USING RWST
**
** This flag is set if the operator has switched on the recirculation system
** (IEVNT(220) = 1) while the AC power is available (IEVNT(205) = 0).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**

```
**=======================================================================
=====
**@@@ 4.0.1 BJS 2/8/95 EVENTS 182 AND 189 APPLY TO GENERALIZED ESF UPPER AND
**              LOWER COMPT. SPRAYS (TRAINS A AND B)
182 T A SPRAY PUMPS INSUFF NPSH
182 F A SPRAY PUMPS NPSH OK
**
** This flag is set if the available NPSH is not greater than the required NPSH.
** A timer is set with a user-specified delay TDNSPA and turned on when the flag
** becomes true. The timer is turned off if it did not go off at the preceding
** time step and sufficient NPSH is (re)established (see the discussion for
** event flag no. 144). Note that if the user selects not to use the
** generalized engineered-safeguards model, as is indicated by the user-
** specified parameter NESF, the effective delay time for the timer is zero
** whatever value the user specifies for TDNSPA. For spray to occur, the pumps
** must be running (see the discussion for event flag no. 103) and the timer
** must not have gone off.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
183 T CH PUMPS INSUFF NPSH
183 F CH PUMPS NPSH OK
**
** This flag is set if the available NPSH is not greater than the required NPSH.
** It is also set if the plant uses a type 3 recirculation lineup (see the
** description of subroutine ENGSAF) and the recirculation system is in
** operation (IEVNT(181) = 1). A timer is set with a user-specified delay
** TDNCHP and turned on when the flag becomes true. The timer is turned off if
** it did not go off at the preceding time step and sufficient NPSH is
** (re)established (see the discussion for event flag no. 149). Note that if
** the user selects not to use the generalized engineered-safeguards model, as
** is indicated by the user-specified parameter NESF, the effective delay time
** for the timer is zero whatever value the user specifies for TDNCHP. For flow
** to occur, the pumps must be running (see the discussion for event flag no.
** 11) and the timer must not have gone off.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
184 T LPI PUMPS INSUFF NPSH
184 F LPI PUMPS NPSH OK
**
** This flag is similar to event flag no. 182. It is set if the available NPSH
** is not greater than the required NPSH. A timer is set with a user-specified
** delay TDNLP1 and turned on when the flag becomes true. The timer is turned
** off if it did not go off at the preceding time step and sufficient NPSH is
** (re)established (see the discussion for event flag no. 146). Note that if
** the user selects not to use the generalized engineered-safeguards model, as
** is indicated by the user-specified parameter NESF, the effective delay time
** for the timer is zero whatever value the user specifies for TDNLP1. For
** injection to occur, the pumps must be running (see the discussion for event
** flag no. 6) and the timer must not have gone off.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
```

```
**
**=======================================================================
=====
185 T HPI PUMPS INSUFF NPSH
185 F HPI PUMPS NPSH OK
**
** This flag is similar to event flag no. 182. It is set if the available NPSH
** is not greater than the required NPSH. A timer is set with a user-specified
** delay TDNHP1 and turned on when the flag becomes true. The timer is turned
** off if it did not go off at the preceding time step and sufficient NPSH is
** (re)established (see the discussion for event flag no. 148). Note that if
** the user selects not to use the generalized engineered-safeguards model, as
** is indicated by the user-specified parameter NESF, the effective delay time
** for the timer is zero whatever value the user specifies for TDNHP1. For
** injection to occur, the pumps must be running (see the discussion for event
** flag no. 5) and the timer must not have gone off.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODE 186 IS OBSOLETE
** THIS EVENT CODE HAS BEEN REPLACED BY THE CONTAINMENT COMPARTMENT
** CONDITION EVENT CODES (1000+). SEE APPENDIX 3P OF VOLUME 1 OF THE USER'S
** MANUAL.
** 186 T CONT SUMP WATER AVAIL
** 186 F CONT SUMP EMPTY
**
**=======================================================================
=====
187 T RWST WATER DEPLETED
187 F RWST WATER AVAILABLE
**
** This flag is set if the mass of water in the refueling water storage tank
** becomes less than the hardwired small quantity MWMIN.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
188 T ACCUMULATOR WATER DEPLETED
188 F ACCUMULATOR WATER AVAILABLE
**
** This flag is set if the mass of water in the low pressure accumulators
** becomes zero.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=======================================================================
=====
189 T B SPRAY PUMPS INSUFF NPSH
189 F B SPRAY PUMPS NPSH OK
**
** This flag is similar to event flag no. 182. It is set if the available NPSH
** is not greater than the required NPSH. A timer is set with a user-specified
** delay TDNSPB and turned on when the flag becomes true. The timer is turned
** off if it did not go off at the preceding time step and sufficient NPSH is
```

** (re)established (see the discussion for event flag no. 145). Note that if
** the user selects not to use the generalized engineered-safeguards model, as
** is indicated by the user-specified parameter NESF, the effective delay time
** for the timer is zero whatever value the user specifies for TDNSPB. For
** spray to occur, the pumps must be running (see the discussion for event flag
** no. 86) and the timer must not have gone off.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
190 T UHI ACCUM EMPTY
190 F UHI ACCUM NOT EMP
**
** This flag is set if the mass of water in the upper head injection accumulator
** becomes zero or if there is no UHI system, as is indicated by a user-
** specified parameter VUHI.
** Refer to the EVENTS section of the User's Manual. Volume 2, Part 2.
**
**=========================================================================
=====
191 T CST WATER DEPLETED
191 F CST WATER AVAILABLE
**
** This flag is set if the mass of water in the condensate storage tank becomes
** zero.
** Refer to the EVENTS section of the User's Manual. Volume 2. Part 2.
**
**=========================================================================
=====
192 T CAV INJ TANK DEPLETED
192 F CAV INJ WATER AVAILABLE
**
** This flag is set if the mass of water in the cavity injection tank becomes
** zero.
** Refer to the EVENTS section of the User's Manual. Volume 2, Part 2.
**
**=========================================================================
=====
193 T LPI SPRAYS INSUFF NPSH
193 F LPI SPRAYS NPSH OK
**
** This flag is set if the user selects not to use the generalized engineered-
** safeguards model and the available NPSH is not greater than the required
** NPSH. For spray to occur, the pumps must be running (see the discussion for
** event flag no. 6) and sufficient NPSH must be (re)established.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
196 T FAST STM PROPS IN PRI SYS USED
196 F FULLBLOWN STM PROPS IN PRI SYS
**
** This flag is set if the pressure in the primary system is less than 5 MPa or
** the primary system is in thermodynamic equilibrium (IEVNT(25) = 0), or if the

** primary system is depressurized (IEVNT(199) = 1) and all water in the lower
** head has been discharged (IEVNT(9) = 1). Once the flag is set, it will
** remain set until the pressure in the primary system rises above 6 MPa.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
197 T UNBKN LOOP BK UNCOV
197 F UNBKN LOOP BK COV
**
** This flag is similar to event flag no. 1. It is set if a break of the user-
** specified area AUB has taken place (IEVNT(209) = 1) and a user-specified
** elevation ZUB of the break is higher than the collapsed water level in the
** primary system by at least the equivalent diameter of the break. It is also
** set if either of the following two conditions is met:
**
** 1) A user-specified break FUB occurs in the horizontal portion of the
** unbroken-loop hot leg and the boiled-up water level in the reactor
** vessel is below the user-specified elevation ZNOZ of the nozzles by
** at least 1 cm, or
**
** 2) The user-specified break FUB occurs in the cold portion of the
** unbroken-loop steam generator tubes or in the intermediate portion
** OF the unbroken-loop cold leg and the boiled-up water level in the
** unbroken-loop cold leg is below the user-specified elevation ZUB of
** the break by at least the equivalent diameter of the break.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
198 T CORE COLLAPSED
198 F CORE GEOM NORMAL
**
** This flag becomes true if all of the following conditions are met:
**
** 1) The fraction of clad oxidized exceeds a user-specified value FEMBRT,
**
** 2) The boiled-up water level in the reactor vessel exceeds the elevation
** of the mid-level of the core, as is indicated by the user-specified
** parameters ZCRU and ZCRL, and
**
** 3) Heat transfer from the core to the water in the core exceeds the upper
** limit imposed by hydrodynamics.
**
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**==========================================================================
=====
199 T PRI SYS DEPRESS
199 F PRI SYS AT PRESS
**
** This flag is set if the pressure in the primary system does not exceed the
** pressure in the compartment indexed by JNBB by 20%, or 30% in the case that

```
** the primary system was already depressurized (IEVNT(199) = 1) at the
** preceding time step.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODE 200 IS OBSOLETE
** 200  T  DC CD H2 BLOCK OFF
** 200  F  DC H2 BLOCK NORMAL
**
**===========================================================================
=====
**M4
** REPLACED BY VARIABLE FOVER, FRACTION DIVERTED TO BYPASS/CORE POOL
** IE., FOVER=1 ALL SPRAY GOES INTO CORE - TOP DOWN QUENCH
**      FOVER=0 ALL SPRAY GOES TO BYPASS - BOTTOM UP QUENCH
**201  T  UHI DIVERTED TO CORE POOL
**201  F  UHI MODEL NORMAL
**
**===========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODE 202 IS OBSOLETE
** 202  T  CORE SUBMERGED BLOCK MODEL OFF
** 202  F  BLOCKAGE MODEL NORMAL
**
**===========================================================================
=====
203  T  HX COOLING WTR OFF
203  F  COOLING WATER AVAILABLE
**
** This event code, when set true by the user, will manually force off the
** the availability of fan cooler and RHR heat exchanger cooling water.
**
**===========================================================================
=====
204  T  PUMP BOWLS CANNOT CLR DRNG BLWDWN
204  F  PBLS CAN CLEAR DRNG BLWDWN
**
** This event code, when set true by the user, will disable the bump loops
** actions (Events 165 and 166). This prevents the inventory in the cold legs
** from being rapidly discharged into the downcomer.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
205  T  LOSS OF AC POWER
205  F  AC POWER AVAILABLE
**
** This event code, when set true by the user, will result in the loss of all
** AC power. Power can be recovered by setting this event back to FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
```

206 T LOSS OF DC POWER
206 F DC POWER AVAILABLE
**
** This event code, when set true by the user, will result in the loss of all
** DC power. Power can be recovered by setting this event back to FALSE.
** Setting this event code true will result in the loss of DC powered relief
** valves.
**
**=====================================================================
=====
207 T IGNITERS FORCED ON
207 F IGNITERS NORMAL
**
** This event code, when set true by the user, will force the igniters on
** even if power is not available (Event 205 is TRUE).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
208 T CLEAR UNBROKEN LOOP PUMP BOWLS
208 F UNBROKEN LOOP PUMP BOWL MODELS NORML
**
** This event code, when set true by the user, will force the unbroken loop pump
** bowls to be cleared (Event 165 set TRUE). This causes the inventory in the
** cold legs om being rapidly discharged into the downcomer.
** Refer to the EVENTS section of the User's Manual. Volume 2. Part 2.
**
**=====================================================================
=====
209 T PS BREAK(S) FAILED
209 F PS INTACT
**
** This accident initiator, when set true by the user, indicates that a LOCA
** is occurring. The LOCA area (ABB/AUB), elevation (ZBB/ZUB), location
** (FBB/FUB) and the height of LOCA break above the floor of receiving node
** (ZNBB/ZNUB) should also be specified by the user when initiating a LOCA.
**
**=====================================================================
=====
210 T CHILLERS SWITCH: MAN ON
210 F CHILLERS SWITCH: AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually initiate the
** containment chillers.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
212 T HPI SWITCH: MAN ON
212 F HPI SWITCH: AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually trigger the
** HPI system. This will provide the trigger signal to turn HPI on.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.

**
**========================================================================
=====
213 T LPI SWITCH: MAN ON
213 F LPI SWITCH: AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually trigger the
** LPI system. This will provide the trigger signal to turn LPI on.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
214 T ACCUM BLOCK VALVE: CLOSE
214 F ACCUM AUTOMATIC
**
** This event code, when set true by the user, will manually disable the
** the accumulators.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
215 T MCP SWITCH OFF OR HI-VIBR TRIP
215 F MCP SWITCH: ON/NO TRIP
**
** This event code, when set true by the user, will manually switch off the
** main coolant pumps.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
216 T HPI FORCED OFF
216 F HPI SWITCH NO FORCED OFF
**
** This event code, when set true by the user, will manually lock off the
** HPI system. This will prevent HPI from operating under all conditions
** until this event code is set back to FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
217 T LPI FORCED OFF
217 F LPI SWITCH NO FORCED OFF
**
** This event code, when set true by the user, will manually lock off the
** LPI system. This will prevent LPI from operating under all conditions
** until this event code is set back to FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
218 T FANS/COOLER SWITCH: MAN ON
218 F FANS/COOLER SWITCH: AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually initiate the

** fan coolers.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
**
**@@@ 4.0.1 BJS 2/8/95 EVENTS 219 AND 222 APPLY TO GENERALIZED AND "HARDWIRED"
** UPPER AND LOWER COMPT. SPRAYS (NOT TO CONSTANT FLOW
** (FIRE) SPRAYS)
219 T ESF UPPER/LOWER COMPT. SPRAY SWITCH: MAN ON
219 F ESF UPPER/LOWER COMPT. SPRAY SWITCH: AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually initiate the
** upper and lower compartment sprays, if they are not locked off (Event 222 is
** FALSE) and power is available (Event 205 is FALSE).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
220 T RECIRC SWITCH: MAN ON
220 F RECIRC SWITCH: OFF
**
** This event code, when set true by the user, will manually switch to
** recirculation mode. When this is done, the safety injection systems and
** containment sprays can take suction from the containment sump rather than
** the RWST and the RHR heat exchanger can be used to cool the injected water.
** Which systems take suction from the containment sump depends on the pump
** allignment for each plant.
** Refer to the ENGSAF, EVENTS, and GENESF sections of the User's Manual,
** Volume 2, Part 2.
**
**=========================================================================
=====
221 T FANS/COOLERS FORCED OFF
221 F FANS/COOLERS SWITCH: AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually force off the
** containment fan coolers. This will prevent fan coolers from operating
** under all conditions until this event code is set back to FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
222 T ESF UPPER/LOWER COMPT. SPRAYS FORCED OFF
222 F ESF UPPER/LOWER COMPT. SPRAYS SWITCH: AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually force off the
** upper and lower compartment sprays. This will prevent containment sprays
** from operating under all conditions until this event code is set back to
** FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====

```
223  T  PZR SPRAYS FORCED OFF
223  F  PZR SPRAYS AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually force off the
** pressurizer sprays.  This will prevent the pressurizer sprays
** from operating under all conditions until this event code is set back to
** FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
**@@@ 4.0.2 CEH 5/31/95  CHANGE MESSAGES TO INDICATE THAT EVENT CODE 224
** ONLY APPLIES TO MOTOR-DRIVEN AUX FEED
224  T  MOTOR-DRIVEN AUX FEED WATER FORCED OFF
224  F  MOTOR-DRIVEN AUX FEED WATER SWITCH: AUTO
**
** This event code, when set true by the user, will manually force off the
** motor-driven auxiliary feedwater pumps.  This will prevent the motor-driven
** aux feedwater from operating under all conditions until this event code is
** set back to FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
225  T  CHILLERS FORCED OFF
225  F  CHILLERS SWITCH : AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually force off the
** containment chillers.  This will prevent chillers from operating
** under all conditions until this event code is set back to FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
226  T  PZR HTRS FORCED OFF
226  F  PZR HTRS SWITCH: AUTO
**
** This event code, when set true by the user, will manually force off the
** pressurizer heaters.  This will prevent the pressurizer heaters
** from operating under all conditions until this event code is set back to
** FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**======================================================================
=====
227  T  MANUAL SCRAM
227  F  SCRAM SYSTEM AUTO
**
** The event code, when set true by the user, manually scrams the reactor (Sets
** event 13 TRUE).
**
**======================================================================
=====
228  T  MAIN FW SHUT OFF
```

228 F MAIN FW SW: AUTO
**
** This event code, when set true by the user, will manually force off the
** main feedwater pumps. This will prevent the main feedwater from operating
** under all conditions until this event code is set back to FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
229 T RX VENT SWITCH: MAN OPEN
229 F RX VENTS CLOSED
**
** This event code, when set true by the user, will manually switch on the
** reactor vessel vent. The vent will open provided power is available (Event
** 205 is FALSE).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
230 T UHI ACCUM BLOCKED
230 F UHI ACCUM AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will shut off the UHI accumulator
** block valve. This will prevent the UHI accumulator from operating under all
** conditions until this event code is set back to FALSE.
** Refer to the EVENTS section of the User's Manual. Volume 2. Part 2.
**
**===========================================================================
=====
231 T CHARGING PUMP SWITCH: MAN ON
231 F CHARGING PUMP SWITCH: AUTO
**
** This event code, when set true by the user, will manually trigger the
** Charging Pumps. This will provide the trigger signal to turn Charging
** Pumps on.
** Refer to the EVENTS section of the User's Manual. Volume 2. Part 2.
**
**===========================================================================
=====
232 T CHARGING PUMPS FORCED OFF
232 F CHARGING PUMPS SWITCH: AUTO
**
** This event code, when set true by the user, will manually lock off the
** Charging Pumps. This will prevent Charging Pumps from operating under all
** conditions until this event code is set back to FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**===========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 DESCRIPTION FOR EVENT 233 WAS REVISED TO STATE THAT IT
** APPLIES TO THE BROKEN S/G RELIEF VALVE.
233 T BROKEN S/G RELIEF VALVE OPENED MANUALLY
233 F BROKEN S/G RELIEF VALVE AUTO
**

** This event code, when set true by the user, will manually open the broken
** steam generator relief valve.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
234 T RHR SPRAY VALVE MAN OPEN
234 F RHR SPRAY VALVE MAN CLOSED
**
** This event code, when set true by the user, will manually turn on the RHR
** heat exchanger for RHR sprays. LPI also needs to be operating (Event 6 is
** TRUE) for RHR spray operation. Manually opening the RHR spray valve will
** also reduce the number of LPI pumps available for safety injection by NLPSP0
** since that number of pumps are alligned to RHR sprays.
** Refer to the EVENTS and ENGSAF sections of the User's Manual, Volume 2,
** Part 2.
**
**=========================================================================
=====
235 T S/G MSIV: FORCED CLOSED
235 F MSIV SWITCH: AUTO
**
** This event code, when set true by the user, will manually close the
** steam generator MSIV. This will prevent the S/G MSIV from opening under all
** conditions until this event code is set back to FALSE.
** Refer to the EVENTS section of the User's Manual. Volume 2. Part 2.
**
**=========================================================================
=====
236 T S/G MSIV: FORCED OPEN
236 F S/G MSIV: AUTO
**
** This event code, when set true by the user, will manually force open the
** S/G MSIV provided they are not forced closed.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
237 T EXTERNAL RWST SOURCE ON
237 F NO EXT RWST SOURCE
**
** This event code, when set true by the user, will initiate refill of the RWST
** water at the mass flowrate of external RWST replacement water flowrate
** (WRWSTX) specified in the *ENGINEERED SAFEGAURDS section of the parameter
** file.
**
**=========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT 238 IS OBSOLETE
** 238 T V SEQUENCE
** 238 F BREAK FLOW TO BCOMPT
** To initiate a LOCA outside of containment, set Event 209 TRUE and JNBB or
** JNUB equal the node number of the receiving compartment. This
** receiving compartment node will be a node outside of containment for a

** LOCA outside of containment. The LOCA area (ABB/AUB), elevation
** (ZBB/ZUB), location (FBB/FUB) and the height of LOCA break above
** the floor of receiving node (ZNBB/ZNUB) should also be specified by the
** user when initiating a LOCA outside of containment.
**
**=====================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 DESCRIPTION FOR EVENT 239 WAS REVISED TO STATE THAT IT
** APPLIES TO THE BROKEN S/G SAFETY VALVE.
239 T BROKEN S/G SAFETY VALVE OPENED MANUALLY
239 F BROKEN S/G SAFETY VALVE AUTO
**
** This event code, when set true by the user, will manually open the broken
** steam generator relief valve.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
**
**@@@ 4.0.1 BJS 2/8/95 EVENT 240 MANUALLY CONTROLS THE CONSTANT FLOW (FIRE)
** SPRAYS IN THE AUX. BLDG. IF 240 IS USED TO TURN THEM
** ON IT CAN BE USED TO TURN THEM OFF (VS. IF THEY ARE
** INITIATED VIA THE TEMPERATURE SET POINT TSPRB).
** (1000-LEVEL EVENTS INDICATE WHETHER THE SPRAYS ARE ON
** IN EACH COMPARTMENT IN BOTH THE AUX. BLDG. AND
** CONTAINMENT.)
240 T AUX. BLDG. CONSTANT FLOW (FIRE) SPRAYS ON
240 F AUX. BLDG. CONSTANT FLOW (FIRE) SPRAYS OFF
**
** This event code, when set true by the user, will manually trigger the
** Aux Building fire spray system.
**
**=====================================================================
=====
241 T CAV INJ PUMP ON
241 F CAV INJ OFF
**
** This event code, when set true by the user, will manually initiate the
** external cavity injection system.
**
**=====================================================================
=====
242 T PS MAKEUP OFF
242 F PS MAKEUP ON
**
** This event code, when set true by the user, will manually shut off the
** primary system makeup flow.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=====================================================================
=====
243 T LETDOWN SWITCH OFF
243 F LETDOWN SWITCH ON
**

** This event code, when set true by the user, will manually shut off the
** letdown flow.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
244  T  BROKEN LOOP IDLED
244  F  BROKEN LOOP NORML
**
**@@@ 4.0.3 CEH 7/1/96 -  Updated the logic description.
**
** This event code, when set true by the user, will bump the broken loop main
** coolant pumps in conjunction with:
**
**      Manual bump of the broken loop main coolant pumps (Event 247 is TRUE)
**      and AC power is available (Event 205 is TRUE),
**
**========================================================================
=====
245  T  KEEP MAIN FEED ON AT SCRAM
245  F  MAIN FEED OFF AT SCRAM
**
** This event code, when set true by the user, will prevent the main feedwater
** from tripping off due to reactor scram.  The main feedwater will still,
** however, trip off due to loss of power (Event 205 is TRUE) or main feedwater
** manually shut off (Event 228 is TRUE).
**
**========================================================================
=====
246  T  PZR SPR MAN ON
246  F  PZR SPR AUTO
**
** This event code, when set true by the user, will manually initiate the
** pressurizer sprays, if they are not locked off (Event 223 is FALSE) and
** power is available (Event 205 is FALSE).
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
247  T  BUMP BKN LOOP MCPS(TMI)
247  F  BKN LOOP MCP NORML
**
** This event code, when set true by the user, will manually bump the broken
** loop main coolant pumps.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
248  T  FORCE EXECUTION STOP
**
** This event code, when set true by the user in an operator action, will cause
** the code execution to stop at current time.
**

```
**========================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 DESCRIPTION FOR EVENT 233 WAS REVISED TO STATE THAT IT
**  APPLIES TO THE BROKEN S/G RELIEF VALVE.
249  T  UNBKN S/G RELIEF VALVE OPENED MANUALLY
249  F  UNBKN S/G RELIEF VALVE AUTO
**
** This event code, when set true by the user, will manually open the broken
** steam generator relief valve.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
250  T  ZERO OUT FRACTIONAL CHANGES IN INTGRT
**
** This event code, when set true by the user, resets the cumulative figures
** of merit.  This event is also set true automatically if the sort out new
** figures of merit option is on (ISORT=1) and the RPV fails.
**
**========================================================================
=====
**
**@@@ 4.0.1 BJS 2/10/95  EVENT MESSAGES 251 AND 252 ADDED
**        NOTE - TURBINE-DRIVEN AUX FEED WILL NOT FUNCTION IF MOTOR-DRIVEN
**        AUX FEED IS WORKING (EVENT CODE 154).  THEREFORE. TO USE
**        TURBINE-DRIVEN AUX FEED. SET EVENT CODE 224 TO 1 TO FORCE OFF
**        MOTOR-DRIVEN AUX FEED.  ALSO, TURBINE-DRIVEN AUX FEED DOES NOT
**        REQUIRE POWER (EVENT CODE 205), WHILE MOTOR-DRIVEN DOES.
**
**          FOR SPANISH PLANTS 251 AND 252 CONTROL THE EMERGENCY
**                FEEDWATER SYSTEM.
**
**
**========================================================================
=====
251  T  UNBKN LOOP TURBINE DRIVEN AFW: MAN ON
251  F  UNBKN LOOP TURBINE DRIVEN AFW: NOT MAN ON
**
** This event code, when set true by the user, will manually trigger the
** unbroken loop turbine driven auxilliary feedwater system.  This will provide
** the trigger signal to turn turbine driven AFW on.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**========================================================================
=====
252  T  BKN LOOP TURBINE DRIVEN AFW: MAN ON
252  F  BKN LOOP TURBINE DRIVEN AFW: NOT MAN ON
**
** This event code, when set true by the user, will manually trigger the
** broken loop turbine driven auxilliary feedwater system.  This will provide
** the trigger signal to turn turbine driven AFW on.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
```

**=========================================================================
=====
253 T LPI SWITCH TRAIN 2: MAN ON
253 F LPI SWITCH TRAIN 2: AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually trigger LPI
** Train 2. This will provide the trigger signal to turn LPI Train 2 on.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
254 T LPI TRAIN 2 FORCED OFF
254 F LPI SWITCH TRAIN 2 NO FORCED OFF
**
** This event code, when set true by the user, will manually lock off LPI
** Train 2. This will prevent LPI Train 2 from operating under all conditions
** until this event code is set back to FALSE.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**=========================================================================
=====
**@@@ 4.0.1 BJS 2/8/95 EVENTS 255 AND 256 APPLY TO GENERALIZED ESF SPRAY
** TRAIN C
255 T GENERALIZED ESF CONTMT SPRAY TRAIN C SWITCH: MAN ON
255 F GENERALIZED ESF CONTMT SPRAY TRAIN C SWITCH: AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually initiate the
** generalized esf containment sprays train C, if they are not locked off
** (Event 256 is FALSE) and power is available (Event 205 is FALSE).
** Refer to the EVENTS and GENESF sections of the User's Manual, Volume 2,
** Part 2.
**
**=========================================================================
=====
256 T GENERALIZED ESF CONTMT SPRAY TRAIN C FORCED OFF
256 F GENERALIZED ESF CONTMT SPRAY TRAIN C: AUTOMATIC ON/OFF
**
** This event code, when set true by the user, will manually force off the
** generalized esf containmnet sprays train c. This will prevent the
** containment sprays from operating under all conditions until this event
** code is set back to FALSE.
** Refer to the EVENTS and GENESF sections of the User's Manual, Volume 2,
** Part 2.
**
**=========================================================================
=====
257 T DONT SCRAM WHEN CHARGING PUMP ON
257 F SCRAM WHEN CHARGING PUMP ON
**
** This event code, when set true by the user, will disable the condition to
** automatically scram when charging pumps are on (Event 11 is TRUE).
**
**=========================================================================
=====

258 T CLEAR BROKEN LOOP PUMP BOWLS
258 F BROKEN LOOP PUMP BOWL MODELS NORML
**
** This event code, when set true by the user, will force the broken loop pump
** bowls to be cleared (Event 166 set TRUE). This causes the inventory in the
** cold legs to being rapidly discharged into the downcomer.
** Refer to the EVENTS section of the User's Manual, Volume 2, Part 2.
**
**====================================================================
=====
274 T PRHR VALVE IS OPEN
274 F PRHR VALVE IS CLOSED
**
** This event code, used for AP600 plant designs, is used to open the passive
** RHR valve.
**
**====================================================================
=====
**@@@ 4.0.3 SMD 12/1/95 EVENT CODES 275-278 ARE OBSOLETE
** 275 T VALVE CONNECTING THE BOTTOM OF CMT #1 TO THE PS DOWNCOMER IS OPEN
** 275 F VALVE CONNECTING THE BOTTOM OF CMT #1 TO THE PS DOWNCOMER IS
CLOSED
** 276 T VALVE CONNECTING THE PS BROKEN LOOP CL TO THE TOP OF CMT #1 OPEN
** 276 F VALVE CONNECTING THE PS BROKEN LOOP CL TO THE TOP OF CMT #1 CLOSED
** 277 T VALVE CONNECTING THE BOTTOM OF CMT #2 TO THE PS DOWNCOMER IS OPEN
** 277 F VALVE CONNECTING THE BOTTOM OF CMT #2 TO THE PS DOWNCOMER IS
CLOSED
** 278 T VALVE CONNECTING THE PS UNBROKEN LOOP CL TO THE TOP OF CMT #2 OPEN
** 278 F VALVE CONNECTING THE PS UNBROKEN LOOP CL TO THE TOP OF CMT #2
CLOSED
**
**====================================================================
=====
**@@@ 4.0.3 CYP 7/1/96 - Added event code 280 for TMI-2 benchmark (IDISCH=3).
** This event controls whether pump seal flow can go the intermediate leg
** instead of the downcomer.
280 T ESF INJECTION GOES TO INTERMEDIATE LEG FOR IDISCH EQUAL TO 3
280 F ESF INJECTION GOES TO THE DOWNCOMER AS USUAL FOR IDISCH EQUAL TO 3
**
**====================================================================
=====
320 T PRINT AND RESTART THIS TIMESTEP
**
** This event code, when set true by an operator action, forces a restart
** and log file printout at the current time.
**
**====================================================================
=====
321 T FORCE DIRECTED PRINTOUT THIS TIMESTEP
**
** This event code, when set true by an operator action, forces a directed
** printout at the current time to the specified file. For example the action
** block:
**

```
** ACTION 3
**   IEVNT(321) = 1
**   IPSET1(12) = 10
** END
**
** will activate a special printout of block 12 to unit 10 when action 3
** is activated.
**
**=======================================================================
=====
322  T  FORCE PRINT LIST PRINTOUT THIS TIMESTEP
**
** This event code, when set true by an operator action, forces a print list
** printout at the current time.
**
**=======================================================================
=====
323  T  FORCE PLOT FILE OUTPUT THIS TIMESTEP
**
** This event code, when set true by an operator action, forces plot file
** output to be written at the current time.
**
**=======================================================================
=====
END
*************************************************************************
*Userevt
*************************************************************************
**
** ==================================================================
**                    General Notes
** ==================================================================
**
** In addition to the following notes citing general format and structure
** of this parameter file section, it is recommended that the user consult
** the following references in the MAAP4 User's Manual:
**
**     i)  the USEREVT section within the General Input Decks description
**         in Section 3 Volume 1 and
**     ii) the UXEVNT subroutine description as well as descriptions for
**         related subroutines UXINP, UXPRES, UXTRAN, and UXEVAL and UXXACT
**         in Volume 2.
**
** These references provide the detailed information that is the basis for
** the abridged notes here.  The USEREVT description is the primary
** reference since it provides the most thorough discussion of format and
** application of user-defined events and action blocks.
**
**
**
** 1)  *USEREVT is the parameter file section specifying user-defined event
**     codes and action blocks.  These specifications can also be made in
**     the USEREVT section of the input deck.
**
```

** 2) This parameter section is designated by the "*USEREVT" section label
** at the beginning and the "END" statement at the end. User-defined
** event code and action block specifications in this section can be
** disabled by simply commenting out the relevant statement lines with
** string "** ".
**
** 3) Event code classifications:
**
** The following are the standard classifications citing the important
** distinctions between MAAP event codes. The UXEVNT subroutine
** description in Volume 2 of the MAAP4 User's Manual provides a more
** detailed description of event code classifications and supporting
** examples of external and user-defined event codes. (The numerical
** listing is the default range for the event code class.)
**
** Internal event codes (1-199):
**
** These event codes are reserved internally by MAAP as status flags
** for key conditions. Thus, they are not user-controllable.
**
** External event codes (200-399):
**
** These event codes are reserved internally by MAAP as so-called
** "operator action" event codes, since the majority are already
** pre-defined with a specific operator action, such as locking out
** an injection system. However, their status can be controlled
** externally by the user. Therefore, they are listed as external
** instead of purely internal or user-defined.
**
** Since external event codes are tied to coding logic within MAAP,
** users should proceed with caution when defining the criteria that
** control the status of external event codes.
**
** User-defined event codes (399-600):
**
** . These event codes are not reserved internally by MAAP, and they
** are not tied to any specific coding logic, as is the case for
** external event codes. The user can apply them as intervention
** conditions for initiating action blocks or as a condition within a
** boolean expression in another user-defined event code statement.
**
** Of course, like external event codes, the status of user-defined
** event codes can be manually controlled in the input deck. As
** such, user-defined event codes can be configured to emulate
** operator actions, such as those in the external event codes.
** However, in the strict interpretation they are not operator
** actions since they are not directly tied to internal MAAP code
** logic.
**
** 4) User-defined event code processing order:
**
** As stated at the beginning of Section 3 Volume 1 (General Input
** Decks) of the MAAP4 User's Manual, a hierarchy exists for the
** processing order of statements within the input deck, part of which

```
**   pertains to event codes.
**
**   User-defined event codes, including external event codes, are
**   processed before internal event codes. This order is required so
**   that status changes in external event codes can update the status of
**   associated internal event codes.
**
**   In regard to the processing order of individual user-defined event
**   codes, control flag IUXOLD in the *CONTROL parameter section governs
**   the process order as follows:
**
**    IUXOLD      Processing Order
**    ------      ----------------
**      0         Evaluate user-defined event codes in the order in
**   (default)      which they are read. Note, when user-defined events
**                are specified in both the *USEREVT parameter file
**                section and in the USEREVT section of the input deck,
**                the order in which they are read in is contingent upon
**                whether the parameter file is specified in the input
**                deck (via the PARAMETER FILE statment) before or
**                after the USEREVT section of the input deck.
**
**      1         Evaluate user-defined event codes in numerical
**                order, as done in MAAP 3.OB.
**
** 5) User-defined event code units convention:
**
**   When using user-defined events, SI units are assumed if there is no
**   unit label specified after a numerical value. So, for SI units the
**   user can optionally include SI units for clarity, but for BR units
**   the user must explicitly state the value and label in BR units.
**
**   Note, the *USEREVT parameter section does not comply with the *BR or
**   *SI units declaration statements that are used elsewhere in the
**   parameter file. Similarly, the USEREVT input deck section does not
**   comply with the units declaration statement (SI/BR) in the input
**   deck. Therefore, it is recommended that units be stated explicitly
**   with numberical values in user-defined event codes.
**
** 6) User-defined event code and action block input format:
**
**   There are five types of statements used to specify user-defined event
**   codes:
**
**     * Comment Statement
**     * Event Specification Statement
**     * Action Statement
**     * Event Message Statment
**     * Timer Control Statement
**
**   There are two types of statements used to specify action blocks:
**
**     * Action Block Definition Statement
**     * Action Block End Statement
```

```
**
**   The following simple example illustrates the usage and format of the
**   noted statements. The comment statement format is used here to
**   identify each statement type.
**
**   400 TGRB(3) > 922 K                !Event Specification Statement
**   400 ACTION #1                      !Action Statement
**   400 SET TIMER #1                   !Timer Control Statement
**   400 TRUE High gas temp - sprays on !Event Message Statement
**
**   ACTION #1                          !Action Block Definition
**    219 TRUE                          !Action: Turn sprays on
**   END                                !Action Block End Statement
**
**   In the example, the Event Specification Statement specifies that
**   when the upper compartment (compartment 3) gas temperature
**   exceeds 922 K, user-defined event code 400 status is set to TRUE.
**   This prompts execution of the ACTION #1, the Action Statement that
**   performs the actions defined in the Action Block Definition. In
**   this case, the action entails turning on containment sprays. (If
**   desired, action blocks can also execute local parameter changes in
**   addition to event code status changes.) The corresponding event
**   message in the Event Message Statement is then printed to the log
**   file and/or summary file to indicate the TRUE status of event code
**   400.
**
**   This example shows the basic function and capability of user-defined
**   event codes and action blocks. For detailed information, consult
**   the USEREVT section within Section 3 Volume 1 of the MAAP4 User's
**   Manual. It includes discussions of the general format and the
**   advanced applications for each user-define event and action block
**   statement type noted above as well as some additional features
**   that were excluded here.
**
** 7) Equivalent applications of user-defined event codes:
**
**   The following example uses the previous example to demonstrate that
**   there are multiple equivalent configurations for performing event
**   code status changes via user-defined events codes.
**
**   219 TGRB(3) > 922 K      !Configuration 1:
**                            !External event code 219 set via
**                            !its own Event Specification Statement
**
**   400 TGRB(3) > 922 K      !Configuration 2:
**   219 EVENT 400 TRUE       !External event code 219 set via
**                            !its own Event Specification Statement
**                            !that is contingent upon a User-defined
**                            !Event Specificatiopn Statement
**                            !(With IUXOLD equal to 0)
**
**   400 TGRB(3) > 922 K      !Configuration 3:
**   400 ACTION #1            !External event code 219 set via a
**   ACTION #1                !User-defined Event Specification
```

```
**    219 TRUE              !Statement, Action Statement
**    END                   !and Action Block Definition
**
**    Three sample configurations are shown for accomplishing the
**    actuation of the containment sprays (external event code 219) in
**    response to a high gas temperature.
**
**    Configuration 1 is the most concise, utilizing only the Event
**    Specification Statement for event 219.
**
**    Configuration 2 adds an Event Specification Statement for
**    user-defined event code 400. The gas temperature criterion resides
**    in this statement, and the Event Specification Statement for event
**    219 is contingent upon the status of the user-defined event. This
**    configuration offers the added capability of specifying a custom
**    message for user-defined event 400.
**
**    Configuration 3 maintains the Event Specification Statement for
**    user-defined event code 400, but instead accomplishes the status
**    change to event 219 via an Action Statement with an Action Block
**    Definition. This configuration is the most verbose, but it is also
**    the most versatile since the action block enables multiple event
**    code status changes and local parameter changes. These capabilities
**    are not available in the previous two configurations.
**
** 8) The IF block statement is an additional input deck statement that
**    performs all of the functions of user-defined event codes and action
**    blocks. Users may find it to be a more convenient, or even
**    superior, alternative. Consult the IF section within Section 3
**    Volume 1 of the MAAP4 User's Manual for details regarding usage and
**    general format.
**
** ==================================================================
**     User-Defined Event Code and Action Block Specifications
** ==================================================================
**
** This set of event codes pertain to the user-defined integration
** control pertaining to MAAP variable MSTPS in the *INTEGRATION
** CONTROL parameter section.

680 WCDHBS = 0. AND WCDCBS = 0.

681 WCDHUS = 0. AND WCDCUS = 0.

682 EVENT 680 TRUE AND EVENT 681 TRUE
682 TRUE  No condensation inside S/G tubes of both RCS loops

683 IEVNT(155) = 0 AND IEVNT(164) = 0
683 TRUE  Both RCS loops are circulating

684 EVENT 682 TRUE OR EVENT 683 TRUE

685 EVENT 25 FALSE AND EVENT 684 TRUE
```

** This set of event codes pertain to the user-defined integration
** control pertaining to MAAP variable MWCR in the *INTEGRATION
** CONTROL parameter section.

686 ZWV GE 3.22

** This set of event codes pertain to the user-defined integration
** control pertaining to MAAP variable MSTPZ in the *INTEGRATION
** CONTROL parameter section.

687 PPS LT 1.E7 AND PPZ LT 1.D7

688 EVENT 687 TRUE OR WGRV LE 1.D-3

689 EVENT 39 TRUE AND EVENT 688 TRUE

** This user-defined event code intervenes when any core node temp.
** reaches 2499 K to force a writing to the restart file.

690 TCRHOT > 2499 K LOCK
690 ACTION #500
690 TRUE Maximum Core Temperature has Exceeded 2499 K

** This user-defined event code intervenes at core uncovery to
** force a writing to the restart file.

691 EVENT 49 TRUE LOCK ! CORE HAS UNCOVERED
691 ACTION #500
691 TRUE Core has Uncovered

** This user-defined event code intervenes when core material comes in
** contact with the lower head to force a writing to the restart file.

692 EVENT 2 TRUE ! RELOCATION OF DEBRIS TO LOWER HEAD
692 ACTION #500
692 TRUE Relocation of Core Materials to Lower Head

** This user-defined event code intervenes at primary vessel
** failure to force a writing to the restart file.

693 EVENT 3 TRUE ! REACTOR VESSEL INITIALLY FAILED
693 ACTION #500
693 TRUE Reactor Vessel has Initially Failed

** This user-defined event code intervenes at secondary vessel
** failure to force a writing to the restart file.

696 EVENT 61 TRUE ! REACTOR VESSEL SUBSEQUENTLY FAILED
696 ACTION #500
696 TRUE Reactor Vessel has Subsequently Failed

** This user-defined event code intervenes at containment failure
** to force a writing to the restart file.

```
694 EVENT 104 TRUE      ! CONTAINMENT FAILED
694 ACTION #500
694 TRUE Containment has Failed

** This user-defined event code intervenes at RWST depletion
** to force a writing to the restart file.

695 EVENT 187 TRUE      ! RWST DEPLETED
695 ACTION #500
695 TRUE RWST Depleted

** This action forces a writing to the restart and tabular output files.

ACTION 500
 EVENT 320 TRUE  !  PRINT TABULAR OUTPUT AND WRITE RESTART FILES
END

** The following list is explicit specification of user-defined event
** codes whose event messages are to be included, or excluded, in the
** log file.

LOG ON 690,691,692,693,694,695,696

END
*BR
```