

INFORMATION ON ONE HUMAN ERROR IN THE IPE

$$\text{HEP}(\text{median}) = p_2 + p_3 = 1.000\text{E}+0 + 6.0\text{E}-3 = 1.000\text{E}+0$$

- Consideration of Dependency:
There is no dependency between this HEP and other Type C HEPs.

- HEP Conversion To A Mean:

$$\begin{aligned} \text{HEP}(\text{mean}) &= \text{HEP}(\text{median}) * M \\ &\text{where } M = \text{EXP}\{[1/1.645] * \ln(\text{EF})^2/2\} \\ &M = 1.00 \text{ for an EF} = 1 \\ &= 1.000\text{E}+0 * 1.00 = 1.000\text{E}+0 \end{aligned}$$

D.6.32.2 Summary: HEP-1FRC:1-11-S1

Fault Trees: FFT00
 Gates: GFFT421 (OR) S1 medium LOCA for Y01.
 Physical Id: HEP-1FRC:1-11-S1
 Description: 1-FR-C.1 INADEQUATE
 CORE COOLING STEP11
 DEPRESSURIZE SGS ____
 Failure Rate: 1.000E+0
 Distribution: Lognormal
 Median: 1.000E+0
 Error Factor: 1
 Reference: 324MAF.N
 9-1-92

Why modified: NAPS IPE Final Quantification Value

D.6.33 HEP-1FRC:1-11-S2

D.6.33.1 Analysis: HEP-1FRC:1-11-S2

- Equivalent Surry HRA: HEP-1FRC:1-12-S2
 see Surry IPE report page D.3-83 to D.3-84.
 calculated mean = 3.067E-1
- NAPS Procedures:
 - 1-E-0 Reactor Trip or Safety Injection, Rev 9, 12-14-91.
 - 1-E-1 Loss of Reactor Or Secondary Coolant, Rev 2, 12-27-89.
 - 1-ES-1.2 Post LOCA Cooldown and Depressurization, Rev 4, 12-27-89.

1-F-0 Critical Safety Function Status Trees, Rev 0, 12-27-89.
1-FR-C.1 Response To Inadequate Core Cooling, Rev 3, 12-27-89.

- 1-E-0 verifies proper response of the Reactor Protection and Emergency Core Cooling Systems. Step 25 checks that the RCS is intact by checking the containment radiation, pressure and sump level. The RNO is to transition to 1-E-1. Step 28 initiates monitoring of the Critical Safety Function Status Trees.

- 1-E-1 Step 20 checks if RCS cooldown and depressurization is required and transitions to 1-ES-1.2.

- 1-F-0 provides a method for checking Critical Safety Functions. These status trees are monitored during all emergency procedures except during the first 25 steps of 1-E-0. Operators will immediately implement the applicable procedure whenever an orange or red path are encountered. Attachment 2 is for Core Cooling. The red paths implement 1-FR-C.1, the orange paths implement 1-FR-C.2, the yellow paths implement 1-FR-C.3 and the green path is CSF satisfactory. The red paths are core exit thermocouple greater than 1200°F; or RCS subcooling less than 30°F when no RCP are running, core exit thermocouple greater than 700°F and RVLIS full range less than 48%.

- 1-FR-C.1 provides instructions to restore Core Cooling. This procedure is entered from the red terminus of the core cooling CSF status tree. Step 11 depressurizes all intact SGs to 120 psig. Step 14 depressurizes all intact SG to atmospheric pressure by dumping steam to the Condenser at the maximum rate. Step 19 tries to locally depressurize all intact SG to atmospheric pressure. Return to 1-E-1 is instructed once the core exit thermocouple are less than 1200°F, RVLIS is less than 67% and at least two hot leg temperatures are less than 345°F.

- HEP-1FRC:1-11-S2 represents the operator action required to identify and complete a rapid depressurization of the Steam Generators during a small break LOCA. This is the Y function on the S2 event tree.

- HEP Calculation:

Input Parameters:

T_b = 0 minutes. The CRO will be able to immediately determine if 1-FR-C.1 should be implemented without any delay.

T_e = 91 minutes (5470 seconds). The system time-window is defined by MAAP analysis (325MAF.N.5) case 36A for a 2" inch break. This break sizes cause SG dryout in 91 minutes. The operator must fully

depressurize the Steam Generators before dry out occurs.

T_s = 5 minutes. Task action time to depressurize the SGs from 1000 psig to 120 psig. This is an estimated time value.

T_w = 86 minutes. Time available for cognitive response ($T_w = T_e - T_b - T_s$).

$T_{1/2}$ = 20 minutes. Operator median response time. It is estimated that the CRO in the Control Room will require approximately 15 minutes to reach 1-E-0 step 25 to transition to 1-E-1. As discussed above, the core exit temperature will not reach 1200°F for 1350 seconds (18.5 minutes). This means the operator will have time to transition to 1-E-1 where he will then immediately transition to 1-FR-C.1 as soon as 1200°F is reached, or as soon as 700°F is reached and RVLIS < 40%. Once in 1-FR-C.1 the operator will require only five minutes to reach step 11 and initiate SG depressurization. The total operator response time will be approximately 20 minutes.

σ = 0.6 for emergency procedure steps after the immediate operator action steps, and there has been training.

P_3 = $6.0E-3$, $3.0E-3$ is the estimated human error probability from NUREG/CR-1278, Table 20-7, item 2, estimated probabilities of errors of omission per item of instruction when use of written procedures is specified, when procedures with checkoff provisions are correctly used, long list >10 items. Error Factor = 3. The error rate has been doubled due to operators normally working 12 hour shifts.

Calculations:

$$\begin{aligned} P_2(\text{mean}) &= 1 - \Phi(\ln(T_w/T_{1/2}) / \sigma) \\ &= 1 - \Phi(\ln(86/20) / 0.6) \\ &= 1 - \Phi(2.43) \\ &= 7.5E-3 \end{aligned}$$

$$\begin{aligned} P_2(\text{median}) &= \text{HEP}(\text{mean}) / M \\ &\quad \text{where } M = \text{EXP}\{[(1/1.645) * \ln(EF)]^2 / 2\} \\ &\quad M = 1.25 \text{ for an } EF = 3 \\ &= 7.5E-3 / 1.25 = 6.00E-3 \end{aligned}$$

• Adjustment For Recovery:

$R = 0.1$, the recovery factor. From NUREG/CR-1278, Table 20-22, Estimated probabilities that a checker will fail to

detect errors made by others, item 1, checking routine tasks, checker using over the shoulder inspections, verifying positions etc. Error Factor = 5. Because of the long time window, > 1 hour, credit can be taken for recovery of this operator action due to the TSC manning. This recovery is applicable to only the p_3 term.

$$p_3(\text{recovered}) = p_3 * R = 6.0E-3 * 0.1 = 6.0E-4$$

$$\text{HEP}(\text{median}) = p_2 + p_3 = 6.00E-3 + 6.0E-4 = 6.60E-3$$

- Consideration of Dependency:
There is no dependency between this HEP and other Type C HEPs.

- HEP Conversion To A Mean:

$$\text{HEP}(\text{mean}) = \text{HEP}(\text{median}) * M$$

where $M = \text{EXP}\{[1/1.645) * \ln(EF)]^2/2\}$
 $M = 1.25$ for an $EF = 3$

$$= 6.6E-3 * 1.25 = 8.25E-3$$

D.6.33.2 Summary: HEP-1FRC:1-11-S2

Fault Trees: FFT00, MS100

Gates: GFFT422 (OR) S2 small LOCA for Y02.
 GFFT423 (OR) T1 LOOP for Y03.
 GFFT424 (OR) T4 Seal LOCA for Y04.
 GMS1112 (OR) Failure of operator to dump steam from 2 of 3 SG's.

Physical Id: HEP-1FRC:1-11-S2

Description: 1-FR-C.1_INADEQUATE
 CORE_COOLING_STEP11
 DEPRESSURE_SGS__S2__

Failure Rate: 8.250E-3

Distribution: Lognormal

Median: 6.600E-3

Error Factor: 3

Reference: 324MAF.N _____
 9-1-92 _____

Why modified: NAPS IPE Final Quantification Value