52-003

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 3, 1997

APPLICANT: Westinghouse Electric Corporation

PROJECT: AP600

SUBJECT: SUMMARY OF MEETING TO DISCUSS AP600 APPLICATION OF WCOBRA/TRAC FOR LONG TERM COOLING ANALYSES

The subject meeting was held on November 22, 1996, in the Nuclear Regulatory Commission (NRC) Rockville, Maryland, offices between representatives of Westinghouse and the NRC staff. A consultant to the Advisory Committee on Reactor Safeguards (Novak Zuber) was also present at the meeting. The purpose of the meeting was to discuss how the recently issued WCOBRA/TRAC Oregon State University (OSU) Long Term Cooling Final Validation Report (WCAP-14776) addresses previous NRC staff concerns regarding the unique aspects of the WCOBRA/TRAC computer code application for AP600 long term cooling analyses. Long term cooling calculations with WCOBRA/TRAC are unique in that Westinghouse uses a "Window Mode" approach which represents the quasi-steady state behavior of the AP600 at the most limiting, but discrete, times during long term cooling transients.

Highlights of the discussions include the following items:

- Westinghouse reiterated that WCOBRA/TRAC was chosen for long term cooling (LTC) analyses because it was the most accurate, NRC approved, low pressure code available.

- Westinghouse stated that while a continuous long term cooling analysis was possible with WCOBRA/TRAC, it is not practical. The small time step increments required by the code result in days of computer time even for the relatively short 1000-second periods used for the window time periods.

- Conservative boundary conditions such as core power, sump liquid level, and containment pressure are imposed on each window calculation. Other initial window conditions that existed at the end of the design basis LOCA analyses (such as vessel water levels) are obtained from previous calculations using NOTRUMP or WCOBRA/TRAC-LBLOCA. Westinghouse notes that WCOBRA/TRAC - LTC calculations will converge to the same steady-state conditions from any reasonable values assumed for initial conditions. The WCOBRA/TRAC - OSU Long Term Cooling Final Validation Report provides a sensitivity study showing that the long term cooling analysis is essentially independent from initial conditions and that the results are basically driven by the boundary conditions.

- Westinghouse cannot predict the oscillations observed at OSU with WCOBRA/TRAC and did not perform any window calculations during the oscillation periods. Westinghouse believes that it understands the physics of the OSU oscillations and that the reasons the oscillations

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are not a concern for the AP600. Westinghouse stated that discussions of these oscillations are provided in the OSU Test Analysis Report and the AP600 Scaling and PIRT Closure Report.

- Westinghouse stated that the single most important challenge to long term cooling is the ability to achieve and maintain adequate steam venting.

The meeting was productive and helped alleviate some concerns the staff had regarding the window approach. However, the staff still expressed some uncertainty about various aspects of the long term cooling analyses which are not clearly explained in the documentation. These items are summarized below.

- How the GOTHIC code is relied upon to establish containment conditions for the long term cooling boundary conditions, such as containment pressure and sump levels, and exactly how the thermal-hydraulics of the reactor coolant system have been decoupled from the containment analysis. In addition, it was unclear if the in-containment refueling water storage tank drain-down and switchover to the sump (recirculation) cooling mode was performed with NOTRUMP, WCOBRA/TRAC, or GOTHIC.

- Is the calculation of the best estimate containment pressure by GOTHIC conservative high or low? That is, were the calculational assumptions used in GOTHIC chosen to result in a higher than expected, containment pressure or lower than expected, containment pressure?

- What assumptions were made for flooding of the normally non-flooded volumes in containment for determining the long term containment floodup level?

- The staff felt that the key assumptions and their bases for the long term cooling analyses of the AP600 were not well documented. Westinghouse stated that the revision to Chapter 15 of the standard safety analysis report should cover these concerns. The staff requested some kind of "executive summary" of how the long term cooling methodology and assumptions are utilized and justified for analyses of the AP600. Westinghouse stated it would consider putting together a summary report but did not explicitly commit to submit such a report to the staff.

Westinghouse also addressed some of the SDSER open items. The staff stated that its review of the WCOBRA/TRAC - OSU Long Term Cooling Final Validation Report had not reached a point where discussions or closeout of the SDSER issues would be possible.

Attachment 1 is the list of meeting attendees. Attachment 2 is a copy of the presentation handouts with the proprietary material removed. Westinghouse stated that the proprietary material presented during the meeting is from the WCOBRA/TRAC - OSU LTC Final Validation Report and that the proprietary affidavit for that report is applicable.

original signed by:

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Docket No. 52-003

Attachments: As stated

cc w/attachments:
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WESTINGHOUSE - NRC MEETING
ON APPLICATION OF WCOBRA/TRAC TO THE AP600
LONG TERM COOLING ANALYSES
NOVEMBER 22, 1996
MEETING ATTENDEES

NAME	ORGANIZATION
John Butler	Westinghouse
Larry Hochreiter	Westinghouse
Dan Garner	Westinghouse
Lambros Lois	NRC
Alan Levin	NRC
Farouk Eltawila	NRC (Part Time)
Norm Lauben	NRC
Bill Huffman	NRC
Novak Zuber	NRC Consultant

Attachment 1

AP600 Plant Long Term

Cooling Calculations

L. E. Hochreiter

Nuclear Safety Analysis

Westinghouse Electric Company

November 22, 1996

Attachment 2

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Westinghouse/NRC Meeting on

AP600 Long Term Cooling

November 22, 1966

AGENDA

1.	Introduction	Westinghouse
2.	WCOBRA/TRAC OSU LTC Validation Report	Westinghouse
3.	NRC Comments on Validation	NRC
4.	W SAR Analysis Method	Westinghouse
5.	Conclusion/Actions	All

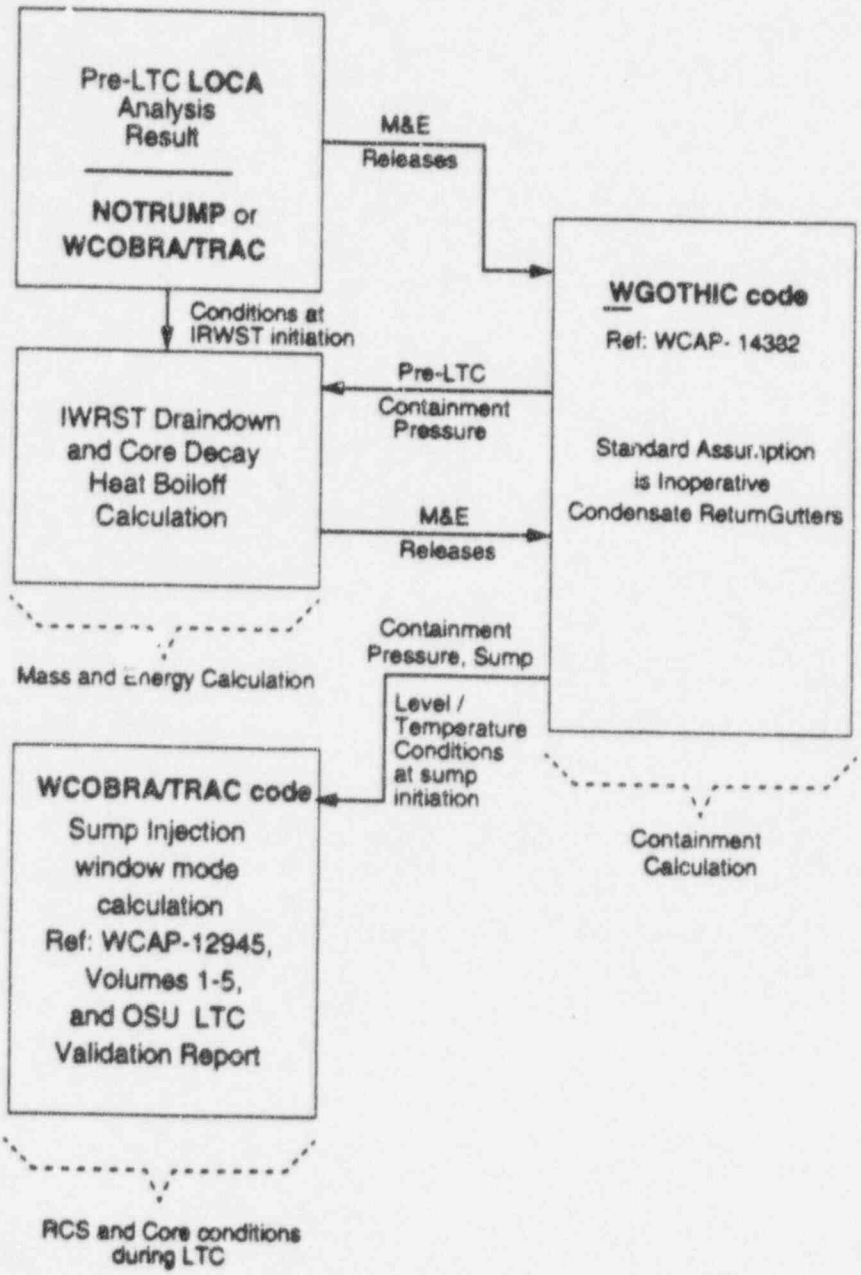

Figure 440.554-1 Long Term Cooling Calculation Code Stream

AP600 LONG TERM COOLING SSAR CALCULATIONS WITH WCOBRA/TRAC

- LONG TERM COOLING OF AP600 IS UNIQUE
  - PASSIVE SAFETY-RELATED SYSTEMS PERFORM THE FUNCTION OF ACTIVE SYSTEMS,
  - QUASI-STEADY-STATE CONDITIONS EXIST IN THE RCS AND CONTAINMENT

- A SIMPLIFIED WCOBRA/TRAC MODEL IS USED
  - WCOBRA/TRAC HAS AMPLE LOW PRESSURE, GRAVITY REFLOOD VALIDATION (CCTF, SCTE, FLECHT, FLECHT-SEASET, LOFT)
  - VESSEL CHANNELS USED FOR HOT LEGS, COLD LEGS TO BETTER CALCULATE THE FLOW REGIMES, AND PRESSURE DROPS
  - OSU LONG TERM TEST RESULTS USED FOR VALIDATION

- CALCULATE AP600 PERFORMANCE AT MOST LIMITING, DISCRETE TIMES; USING WINDOW MODE APPROACH TO VERIFY CORE COOLING

METHODOLOGY TO PERFORM A WINDOW MODE ANALYSIS

1. DETERMINE THE LIMITING PORTION OF THE LTC PHASE:

   - THAT IS MOST DEMANDING ON THE SAFETY SYSTEMS

2. SELECT INITIAL CONDITIONS FOR CALCULATION FROM PREVIOUS CALCULATIONS.

3. USE 1971 ANS + 20% DECAY HEAT TO MAXIMIZE STEAM GENERATION.

   - MAXIMIZES "STEAM BINDING" EFFECT
   - CHALLENGES RCS VENTING CAPABILITY
   - MINIMIZES IRWST/SUMP FLOW

4. PERFORM WINDOW MODE CALCULATION FOR ~ 1000 SECONDS UNTIL SYSTEM IS STEADY.

   - VERIFY THAT THE CORE REMAINS COOLABLE
   - VERIFY SYSTEM MASS BALANCE; IE, WHERE DOES THE SYSTEM FLOW GO.

INITIAL CONDITIONS FOR WINDOW CALCULATION

- INITIAL CONDITIONS WHICH CAN BE ESTIMATED AND DO NOT DETERMINE THE QUASI-STEADY STATE OBTAINED
    - PRIMARY CIRCUIT LIQUID LEVELS AND TEMPERATURE
    - STEAM GENERATOR SECONDARY SIDE LIQUID LEVELS AND TEMPERATURE
    - STRUCTURE TEMPERATURES
- WINDOW APPROACH ASSUMES THAT AN EQUIVALENT QUASI-STEADY STATE WILL BE REACHED FROM ANY REASONABLE VALUES FOR THESE INITIAL CONDITIONS
- AP600 CASES ARE ANALYZED USING INITIAL CONDITIONS FROM EARLIER NOTRUMP OR WCOBRA/TRAC CALCULATIONS

BOUNDARY CONDITIONS FOR WINDOW CALCULATION

- BOUNDARY CONDITIONS WHICH DETERMINE THE QUASI-STEADY STATE
  - CORE POWER
  - IRWST LIQUID LEVEL AND TEMPERATURE
  - CMT LIQUID LEVEL AND TEMPERATURE
  - SUMP LIQUID LEVEL AND TEMPERATURE
  - CONTAINMENT PRESSURE

- THE IMPOSED BOUNDARY CONDITIONS WILL "FLUSH-OUT" THE SELECTED INITIAL CONDITIONS AND THE SOLUTION WILL REACH A QUASI-STEADY STATE

CRITERIA FOR ACHIEVING A QUASI-STEADY STATE

- KEY VARIABLES EFFECTIVELY ACHIEVE A STEADY STATE
  - CORE LIQUID LEVEL
  - DOWNCOMER LIQUID LEVEL
  - UPPER PLENUM LIQUID LEVEL
  - UPPER PLENUM PRESSURE
  - DVI INJECTION RATE
  - BREAK FLOW
  - ADS STAGE 4 FLOW
- QUASI-STEADY CONDITIONS HAVE BEEN SUCCESSFULLY DEMONSTRATED IN THE OSU WINDOW MODE VALIDATION

AP600 LONG-TERM COOLING CASES FOR SSAR REVISION 8

- ANALYSIS BASES
  - NO CREDIT FOR CONTAINMENT GUTTERS
  - SINGLE FAILURE OF ONE FOURTH STAGE ADS VENT PATH
  - APPENDIX K MODELING, INCLUDING DECAY HEAT
  - MAXIMUM SUMP LINE DESIGN RESISTANCES
  - ANALYSIS SELECTS TIME PERIODS AND CONDITIONS THAT MINIMIZES SAFETY INJECTION AND MAXIMIZES STEAM BINDING POSSIBILITIES TO CHALLENGE THE AP600

LIMITING CASES WILL BE PERFORMED - SUMP INJECTION

- DVI AND SMALL COLD LEG BREAK LOCA WINDOW MODEL CASES
- MODELING PER THE WC/T OSU FINAL VALIDATION REPORT
- CONTAINMENT CONDITIONS AS CALCULATED BY WGOTHIC
- CASES TO SHOW ADEQUATE CORE COOLING IN THE LONG TERM

AP600 SSAR LONG-TERM COOLING WINDOW MODE CASES

CASE I - DESIGN BASIS DOUBLE -ENDED DVI PIPE BREAK

- WINDOW INCLUDES THE LATE IRWST INJECTION PHASE AND THE SWITCHOVER INTO STABLE SUMP INJECTION

- REPRESENTS EARLIEST SWITCHOVER TO SUMP INJECTION AND, THEREFORE, THE HIGHEST DECAY POWER FOR SUMP INJECTION

CASE II - DOUBLE-ENDED DVI PIPE BREAK, RNS OPERATION INITIALLY

- RNS FAILURE ASSUMED AT THE TIME OF SUMP SWITCHOVER, AFTER IRWST HAS BEEN DISCHARGED RAPIDLY BY PUMPS

- IN THIS WINDOW, SUMP INJECTION BEGINS EVEN EARLIER THAN IT DOES IN CASE I

AP600 SSAR LONG-TERM COOLING WINDOW MODE CASES (CONT'D)

CASE III - TWO-INCH COLD LEG BREAK AT SUMP INJECTION INITIATION

- WINDOW INCLUDES THE LATE IRWST INJECTION PHASE AND THE SWITCHOVER INTO STABLE SUMP INJECTION

- REPRESENTATIVE OF SMALL BREAK LOCA SWITCHOVER TO INJECT FROM A NEAR-SATURATED SUMP

CASE IV - TWO-INCH COLD LEG BREAK BEYOND 24 HOURS

- LONG-TERM PASSIVE LEAKAGE INTO FORMERLY DRY COMPARTMENTS DIMINISHES SUMP LEVEL BELOW THE INITIAL FLOODUP VALUE

CONCLUSION

- WINDOW MODE APPROACH HAS BEEN VERIFIED BY THE OSU/WCOBRA/TRAC VALIDATION EFFECT
- AP600 PLANT CALCULATIONS ARE SPECIFICALLY SELECTED:
  - USING CONSERVATIVE ASSUMPTIONS
  - CHOOSING THE TIME PERIODS WHICH WILL CHALLENGE THE AP600 PASSIVE SAFETY SYSTEMS
- RESULTS CONTINUE TO SHOW AMPLE CORE COOLING, WITH MARGIN, AS SEEN IN OSU TESTS