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

52-003

August 30, 1995

APPLICANT: Westinghouse Electric Corporation

PROJECT: AP600

SUBJECT: SUMMARY OF MEETING TO DISCUSS EXTERNAL REACTOR VESSEL COOLING FOR THE WESTINGHOUSE AP600 DESIGN

A public meeting was held at the U.S. Nuclear Regulatory Commission (NRC) offices in Rockville, Maryland on August 17, 1995, between representatives of the NRC and Westinghouse. Attachment 1 contains a list of attendees. The purpose of the meeting was to discuss the AP600 reactor vessel insulation design. The staff is interested in the insulation design's capability to allow for external reactor vessel cooling (ERVC) during a severe accident in order to ensure in-vessel retention (IVR) of the molten debris. As noted in SECY 95-172, the IVR strategy could offer severe accident mitigation by preventing severe accident phenomena such as core-concrete interaction, high-pressure melt ejection, containment liner melt-through, and ex-vessel steam explosions.

Westinghouse presented the design philosophy, design requirements, and the conceptual insulation design. By letter dated August 17, 1995, Westinghouse submitted the conceptual design details of the vessel insulation. The non-proprietary version of the submittal is provided in Attachment 2.

The staff stated that the insulation design appeared to be a reasonable conceptual design and the level of design detail appeared appropriate for design-certification purposes. However, many details and applicability of test conditions and results from the U.S. Department of Energy (DOE) sponsored IVR tests would need to be examined. The staff identified several concerns with the ERVC approach that will need to be addressed in subsequent meetings and submittals. These concerns include:

(1) Structural capability of the insulation to withstand dynamic pressure loads during an accident, and adequacy of the ULPU oscillations/data for characterizing pressure loads

(2) Potential clogging of flow paths with debris

(3) Westinghouse submittal (on the AP600 docket) of the DOE report with results and explanation of the applicability to the AP600 design

(4) Effects of ERVC in terms of thermal shock/jet impingement

(5) Location of conceptual design details and requirements (e.g. in the SSAR)

(6) ULPU configuration and test results

(7) Reactor cavity sump design and function (followup side issue)

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Because of the uncertainty involved with IVR and the novelty of the ERVC approach, the staff stated that some amount of ex-vessel severe accident work (e.g. fuel-coolant and core-concrete interaction) would be required. Westinghouse expressed concern that the staff may not give sufficient credit to the ERVC approach to warrant investing the time and resources on this severe accident mitigation feature, if Westinghouse were asked to conduct the same level of analysis that the evolutionary ALWR designers were required to perform.

The staff stated that the level of credit given to ERVC could not be determined a priori and that the degree of ex-vessel phenomena analysis would be dictated by the reliability of ERVC. Westinghouse would have to provide adequate technical justification to establish confidence that potential hot spots and uncertainty in the heat transfer coefficient both within the molten debris pool and from the lower reactor vessel head to the surrounding water are not significant issues. The staff has placed the review on hold pending a Westinghouse submittal of the DOE report on the AP600 docket.

original signed by:
Michael X. Franovich, Project Manager
Standardization Project Directorate
Division of Reactor Program Management
Office Of Nuclear Reactor Regulation

Docket No. 52-003

Attachment:
As stated

cc w/attachment:
See next page

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NAME:	MFranovich:sp	RArchitzel
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DOCUMENT NAME: MSUM0817.MXF

cc: Mr. Nicholas J. Liparulo, Manager
Nuclear Safety and Regulatory Analysis
Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
P.O. Box 355
Pittsburgh, PA 15230

Mr. B. A. McIntyre
Advanced Plant Safety & Licensing
Westinghouse Electric Corporation
Energy Systems Business Unit
Box 355
Pittsburgh, PA 15230

Mr. John C. Butler
Advanced Plant Safety & Licensing
Westinghouse Electric Corporation
Energy Systems Business Unit
Box 355
Pittsburgh, PA 15230

Mr. M. D. Beaumont
Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
One Montrose Metro
11921 Rockville Pike
Suite 350
Rockville, MD 20852

Mr. Sterling Franks
U.S. Department of Energy
NE-42
Washington, DC 20585

Mr. S. M. Modro
EG&G Idaho Inc.
Post Office Box 1625
Idaho Falls, ID 83415

Mr. Charles Thompson, Nuclear Engineer
AP600 Certification
U.S. Department of Energy
NE-451
Washington, DC 20585

Mr. Frank A. Ross
U.S. Department of Energy, NE-42
Office of LWR Safety and Technology
19901 Germantown Road
Germantown, MD 20874

Mr. Ronald Simard, Director
Advanced Reactor Program
Nuclear Energy Institute
1776 Eye Street, N.W.
Suite 300
Washington, DC 20006-3706

STS, Inc.
Ms. Lynn Connor
Suite 610
3 Metro Center
Bethesda, MD 20814

Mr. James E. Quinn, Projects Manager
LMR and SBWR Programs
GE Nuclear Energy
175 Curtner Avenue, M/C 165
San Jose, CA 95125

Mr. John E. Leatherman, Manager
SBWR Design Certification
GE Nuclear Energy, M/C 781
San Jose, CA 95125

Barton Z. Cowan, Esq.
Eckert Seamans Cherin & Mellott
600 Grant Street 42nd Floor
Pittsburgh, PA 15219

Mr. Ed Rodwell, Manager
PWR Design Certification
Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, CA 94303

MEETING PARTICIPANTS
AP600 SEVERE ACCIDENTS MEETING ON
EXTERNAL REACTOR VESSEL COOLING
ROCKVILLE, MARYLAND
AUGUST 17, 1995

NAME	ORGANIZATION
MICHAEL X. FRANOVICH	NRC
J. KUDRICK	NRC
JOHN MONNINGER	NRC
ALAN RUBIN	NRC
ALI BEHBAHANI	NRC
BOB PALLA	NRC
CINDY HAAG	AP600 LICENSING W
JIM SCOBEL	W RISK ASSESSMENT
CHARLES THOMPSON	DOE
ROGER SCHREIBER	WESTINGHOUSE

Attachment 1

Attachment 2

AP600 Presentation Materials (non-proprietary version)
Submitted on August 17, 1995
Westinghouse Letter NTD-NRC-95-4531

WESTINGHOUSE/NRC MEETING

ON

AP600 REACTOR CAVITY AND INSULATION

Roger Schreiber

August 17, 1995

REVIEW OF REACTOR CAVITY DESIGN

Agenda/Objectives

- Review overall cavity design
- Summarize major design requirements
- Present/discuss conceptual design
- Review design against IVR requirements
- Agree on scope for Design Certification

DESIGN CONSIDERATIONS

Insulation/In-Vessel Retention

Shielding

Ventilation

Access Requirements

INSULATION/IN-VESSEL RETENTION

Insulation Needs

- Provide 4" reflective or equivalent

IVR Considerations

- Water ingress and steam egress
- Loads/movement of panels
- Symmetry
- Applicability of ULPU

VENTILATION

- Concrete/Vessel Supports
- Excore Detectors
- Shield Material

SHIELDING

Neutron Streaming Paths

- Up through cavity seal
- Loop piping penetrations
- Penetrations at bottom of cavity

ACCESS REQUIREMENTS

To Vessel Surface

- For NDE
- For post-ADS inspection/cleaning

To Excores

- Insertion & removal from bottom

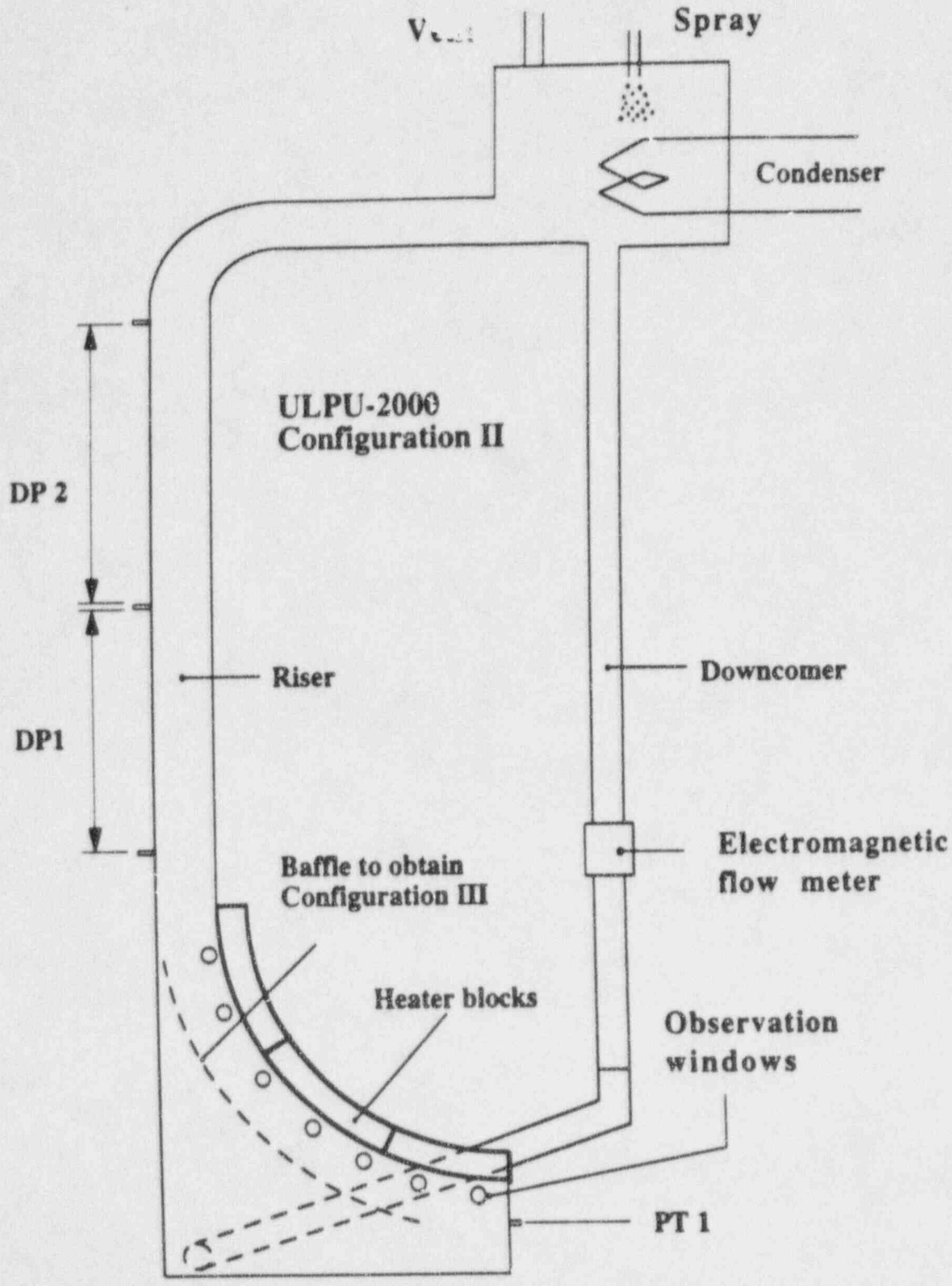
APPLICABILITY OF ULPU TEST

Phase II Testing

- Established upper limit for design flow rate
- Gave pressure loads due to boiling

Phase III Testing

- Planned for summer 1995
- AP600 specific



Vent
Spray
Condenser
ULPU-2000
Configuration II
DP 2
DP1
Riser
Downcomer
Electromagnetic
flow meter
Baffle to obtain
Configuration III
Heater blocks
Observation
windows
PT 1

ULPU PHASE II TESTING

<u>Design Flow</u>

- Scaling Factor: $\frac{\text{(AP600 circumference)}}{\text{ULPU Width}}$

- Q = 120 gpm x 83.75 = 10,050 gpm

- Represents upper iimit (no flow restriction)

IN-VESSEL RETENTION REQUIREMENTS

<u>Loads/Movement of Insulation</u>

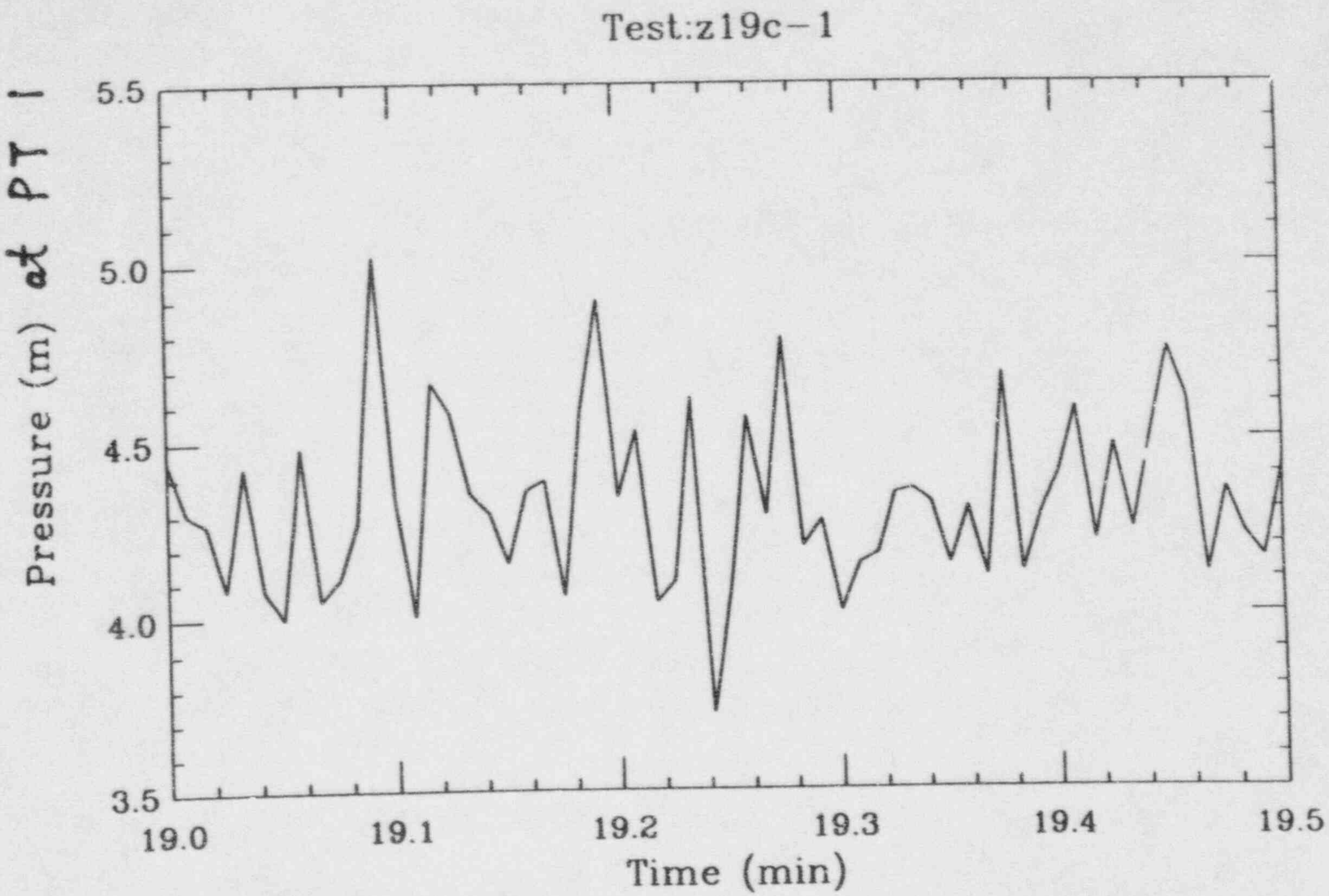
- Steady loads due to elevation head and flow losses

- Unsteady loads due to bubble formation and collapse

STEADY LOADS

<u>Conclusions</u>

- With proper sizing, inlet losses negligible
- Resulting load on insulation is outward at all times
- Magnitude $\leq$ 9 psid
- Outward deflection is benign



Test:z19c-1
Pressure (m) at PT 1
5.5
5.0
4.5
4.0
3.5
19.0
19.1
19.2
19.3
19.4
19.5
Time (min)

IN-VESSEL RETENTION REQUIREMENTS

Unsteady Loads

- Magnitude $\leq$ 2 psid peak-to-peak, based on ULPU data at 2 Hz

- Maximum inward load $\leq$ 1 psid

- Frame of 3 x 3 x 1/4 angle shapes can easily withstand

- Currently taking measurements at higher frequencies (10 Hz)

IN-VESSEL RETENTION REQUIREMENTS

ULPU Phase III Testing

- Exit flow restriction to simulate vent dampers and vessel supports

- Baffle to represent insulation at lower head

- Sealed inlet flow area and representative geometry

SUMMARY/CONCLUSIONS

Feasible Design Concept Established

IVR Concerns Incorporated

- Water ingress/steam egress
- Loads/movement of insulation
- Symmetry
- Applicability of ULPU data

Design Certification should include **at most:**

- Functional specs
- Conceptual design

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