June 16, 1994

Docket No. 52-003

APPLICANT: Westinghouse Electric Corporation

FACILITY: AP600

SUBJECT: SUMMARY OF MEETING WITH WESTINGHOUSE ON AP600 QUALITY ASSURANCE (QA) PROGRAM

On June 7 and 8, 1994, members of the Office of Nuclear Reactor Regulation staff met with representatives of Westinghouse Electric Corporation at the Westinghouse Energy Center, Monroeville, Pennsylvania, to discuss the implementation of the AP600 QA program. The meeting topics included discussions on: design control practices, QA requirements imposed on suppliers of design and test services, audit program conduct, an overview of the remaining AP600 developmental tests, test control practices, design and test record retention practices, and self-assessments. The staff noted that the applicant appeared to be adequately implementing QA program requirements, including 10 CFR Part 50, Appendix B/NQA-1 QA requirements for their suppliers of design and test services, a comprehensive internal and external audit program, and test records/data and design output documents retention by Westinghouse. The staff stated its plan to verify detailed implementation of the AP600 QA program during the conduct of a RVIB inspection tentatively planned for the Fall 1994 time frame.

The staff additionally observed a demonstration of the use of the Computer Aided Design software that is being used by Westinghouse and the design subcontractors.

Enclosure 1 is a list of meeting attendees. Enclosure 2 is a copy of the revised agenda. Enclosure 3 is a copy of non-proprietary handout materials presented by Westinghouse at the meeting.

(Original signed by)
Ralph E. Architzel, Section Chief
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal, NRR

Enclosures:
As stated

cc w/enclosures:
See next page



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| ACRS (11) w/o encl. | JMoore, 15B18 | EJordan,MNBB3701 | |
| WRussell/FMiraglia | RGramm | | |

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DF03

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

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

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

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

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

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

Mr. Steve Goldberg
Budget Examiner
725 17th Street, N.W.
Room 8002
Washington, D.C. 20503

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

Mr. Victor G. Snell, Director
Safety and Licensing
AECL Technologies
9210 Corporate Boulevard
Suite 410
Rockville, Maryland 20850

Mr. Raymond N. Ng, Manager
Technical Division
Nuclear Management and
Resources Council
1776 Eye Street, N.W.
Suite 300
Washington, D.C. 20006-3706

Ms. Lynn Connor
Suite 610
3 Metro Center
Bethesda, Maryland 20818

MEETING WITH WESTINGHOUSE TO DISCUSS QA ISSUES
AND PLANS FOR VENDOR

June 7 and 8, 1994

Meeting Attendees

| NAME | AFFILIATION |
|---|---|
| Ralph Architzel | NRC/ADAR |
| Frederick R. Allenspach | NRC/RPEB |
| Rich McIntyre | NRC/RVIB |
| Bob Gramm | NRC/DRIL |
| Eugene J. Piplica | Westinghouse/ATBA/AP600 Test Engineering |
| Kenneth A. Kloes | Westinghouse/ESBU Projects Quality Assurance |
| David N. Alsing | Westinghouse/ESBU Projects QA Manager |
| John C. Butler | Westinghouse/AP600 Licensing |
| Mark Barclay | Westinghouse/ATBA/PCCA |
| Jim Winters | Westinghouse/ATBA/Projects Eng |
| Jack Wheeler | DOE |
| Andrea Orazi | ANPA (Italy) |

Enclosure 1

**Westinghouse/NRC Meeting on AP600 QA Program**
**June 7-8, 1994**
**Monroeville, PA**

| | Item | Lead | Target Times |
|---|---|---|---|
| | June 7, 1994; Conference Room 327A | | |
| 0. | NRC Familiarization w/ Project Documents | Butler | 11:00 - 1:00 |
| | June 7, 1994; Conference Room 401B | | |
| 1. | Introductions | Winters | 1:00 - 1:15 |
| 2. | Overview of Westinghouse AP600 Project and QA Organization | Winters | 1:15 - 1:45 |
| 3. | Discussion of application of Topical Program to AP600 and program differences (if any) from Part 52 (Specific question to be answered: Does a separate QA plan exist for AP600 project?) | Alsing/Kloes | 1:45 - 2:45 |
| | **Break** | | |
| 4. | Description of AP600 Test Program Scope (including Westinghouse, U.S. and foreign test facilities) | Piplica | 3:00 - 4:00 |
| | June 8, 1994; Small Marketing Conference Room | | |
| 5. | Discussion on processes Westinghouse employs to verify technical adequacy of deliverables | Winters | 8:00 - 8:45 |
| 6. | Discussion of quality program and implementing procedures for:<br>- instructions, procedures, and drawings<br>- design control (including independent design verification<br>- test control<br>- control of measuring and test equipment<br>- audits<br>- software QA<br>- document control<br>- QA records (design record files)<br>- nonconformances<br>- corrective action | Alsing/Kloes | 8:45 - 9:45 |
| 7. | RAI issues (external sources of design services) | Butler | 9:45 - 10:15 |
| 8. | Review of Internal/External Westinghouse audit program and sample review of audit reports | Alsing/Kloes | 10:15 - 11:00 |
| 9. | Review of contractual arrangements, quality programs, and Westinghouse audits for foreign organizations providing testing and design support to AP600 project | Alsing/Piplica | 11:00 - 11:30 |
| 10. | NRC Audit Schedule/Plans | NRC | 11:30 - 11:45 |
| 11. | Summary Discussions | All | 11:45 - 12:00 |

Enclosure 2

# AP600 DESIGN CERTIFICATION PROJECT ORGANIZATION


12/22/93/4

Enclosure 3

# Quality Assurance Requirements
# for
# AP600 Program

**GOVERNMENT**

10CFR50 Appendix B

- Law
- Applicable to Safety–Related Equipment (Nuclear Basic Requirements)
- 18 Criteria on Design, Procurement, Fabrication, etc.

**INDUSTRY**

ASME NQA–1–1989
NQA–1b–1991 Addenda

- Industry Interpretation and Applications of 10CFR50 Appendix B
- General Restatement of 18 Criteria
- More Detailed Treatment of Selected Criteria in Supplements and Appendices

Regulatory Guide 1.28 Revision 3

- Endorses NQA–1

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**WESTINGHOUSE**

Westinghouse Quality Assurance Plan, WCAP–8370

- (W) Topical Report on Quality Assurance

AP600 Quality Assurance Program Plan, WCAP–12600

- Application of WCAP–8370 to AP600 Program
- Highlights Specific Commitments

NATD Quality Assurance Program WCAP–9565

- Division Program
- Applies to all NATD Activities

AP600 Program Operating Procedures WCAP–12601

- ATBA Procedures Manual for AP600 Work
- Project Quality Plan
- Matrix Shows Applicable WCAP–9565 Procedures

# Quality Assurance Requirements
# for
# AP600 Detailed Design and Design Certification Program

WESTINGHOUSE / SUPPLIERS

**AP600 Quality Assurance Program Plan/Description**

- Describes applicability of supplier's quality assurance program to AP600 work
- Includes matrix of implementing procedures

**Supplier Quality Assurance Program**

- Company QA Manual

**Supplier Implementing Procedures**

- Procedures within Engineering and Quality Assurance which implement QA Manual and satisfy NQA-1


## Summary

- The test program is extensive
- Many successful results to date confirm design features
- Test data has been/will be incorporated into analysis codes which in turn confirm plant performance
- Program includes two integral tests at high and low pressure
- Test program is highly responsive to USNRC and the Utilities

## Test Categories

- Safety Related Tests
- Non-Safety Related Equipment Tests
- Basic Research Tests

# Safety Related Tests

AP600

- Provide data for computer codes used for SSAR analysis:
  - Models
  - Correlations
  - Verification

- Generally, a thermal-hydraulic test
  - Performed to understand and explain T/H phenomena
  - Can be system or separate effects test

- Highest quality assurance pedigree
  - NQA-1 applies, 10CFR21 applies
  - Test specification required
  - Test operating procedures required
  - Test facility design documentation required
  - Quality records required

- Examples
  - Large Scale PCCS Heat Transfer tests
  - Integral Systems tests (SPES-2, OSU)
  - Separate Effect Tests (ADS, CMT)

# Non-Safety Related Equipment Tests

AP600

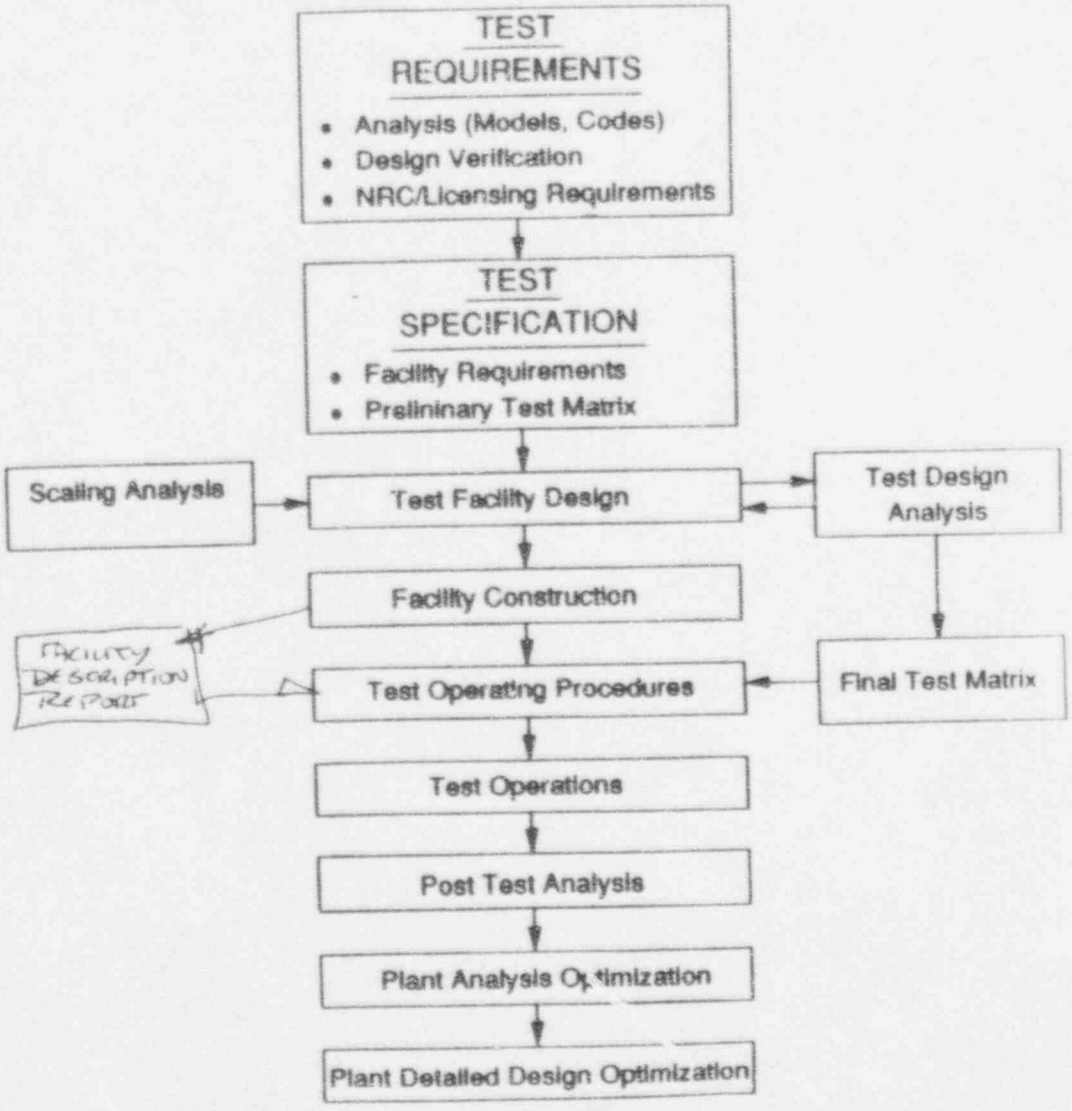
- Provide design information on specific components
  - Feasibility of design
  - Manufacturability
  - Verify component performance
- Generally mechanical tests
  - Performance data
  - Wear data
- High quality assurance standards
  - NQA-1 applies
  - Test specification optional
  - Test operating procedures required
  - Test facility design documentation required
  - Quality records required
- Examples
  - High Inertia Rotor tests
  - RCP Flow tests (air & water)
  - Check Valve tests

## Basic Research Tests

AP600

- Experimental in nature
- Generally bench tests performed at universities
  - Investigate specific phenomena in detail
  - Answer specific questions of performance or feasibility
  - Provide guidance for further testing
- Quality requirements
  - Test plan required
  - Test facility design documents required
- Examples
  - University of Wisconsin condensation tests
  - University of Tennessee Reactor Vessel Air Visualization tests
  - Bench Wind Tunnel test

# AP600 Test, Analysis & Design Process



## AP600 Testing Programs


- Design Certification Tests
  - Passive Core Cooling System Tests
  - Passive Containment Cooling System (PCCS) Tests
- Engineering Tests
  - Component Design Verification Tests


# PASSIVE CORE COOLING SYSTEM TESTS

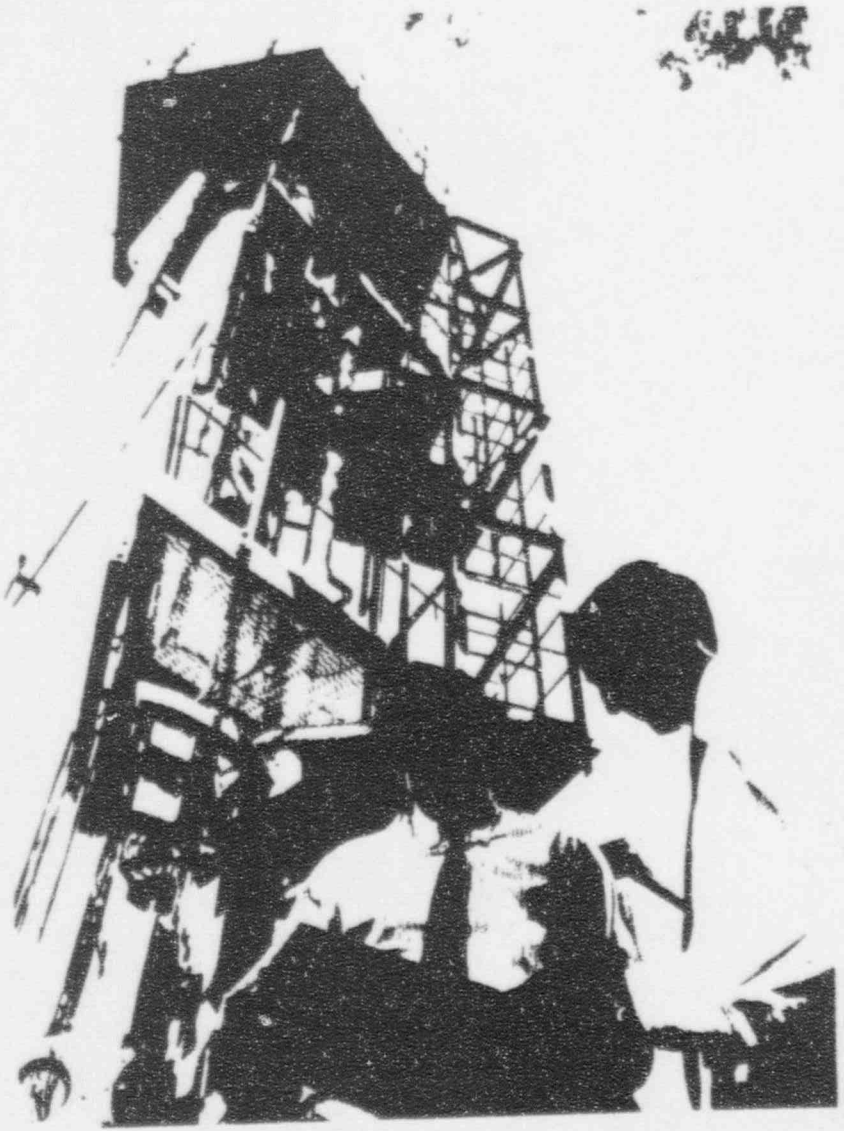
## AP600 Passive Core Cooling System Tests

- Passive Residual Heat Removal Heat Exchanger Tests
- Automatic Depressurization System Phase A Tests
- Integral Systems Tests
- Departure from Nucleate Boiling Tests
- Core Makeup Tank Tests
- Automatic Depressurization System Phase B Tests

## Completed Tests

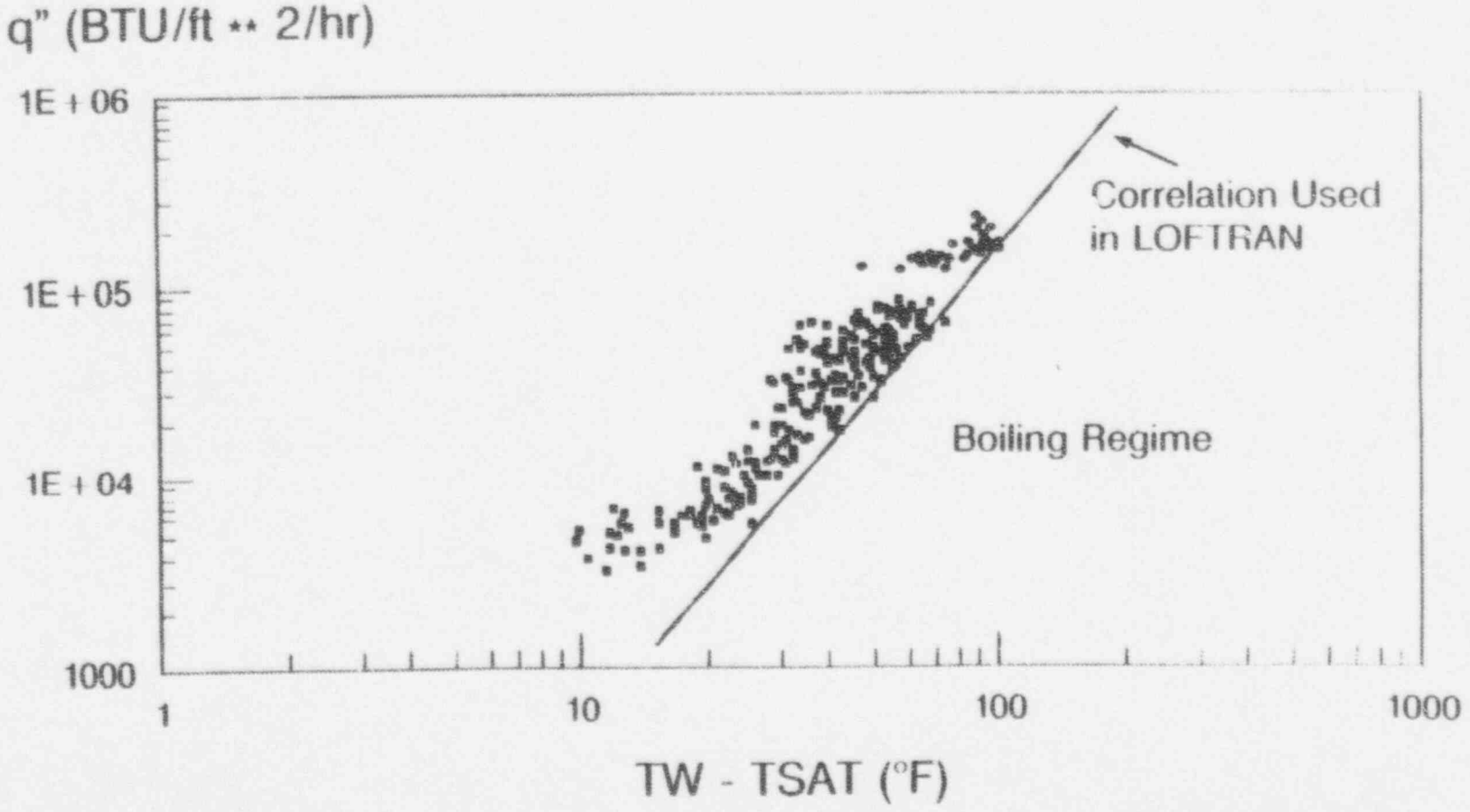
- Passive Residual Heat Removal Heat Exchanger Test
  - Confirmed heat transfer performance
- Automatic Depressurization System (ADS) Phase A Test
  - Sparger blowdown characteristics have been tested

## Passive RHR Heat Exchanger Test



AP600

## PRHR Data and Correlation Used in LOFTRAN Computer Code




## Ongoing and Planned Tests

- Two separate Integral System Tests examine the behavior of the plant and interconnected systems
  - Full-height, full-pressure test at SPES facility in Italy models two AP600 loops with CMTs, accumulators, passive heat exchanger, IRWST, and automatic depressurization system
  - A quarter-scale lower pressure (~400 psig) test at Oregon State University will model the NSSS, passive safety features, and important non-safety features
- Departure from Nucleate Boiling (DNB) Test
  - The AP600 pump design includes a high inertia rotor to control flow coastdown
  - Ample margin to DNB eliminates design impact
- Core Makeup Tank Test
- ADS Phase B Test


# Passive Containment Cooling System Tests

## AP600 Passive Containment Cooling System Tests


- Feasibility Tests
- Condensation Tests
- Heat Transfer Tests
- Water Distribution Tests
- Wind Tunnel Tests

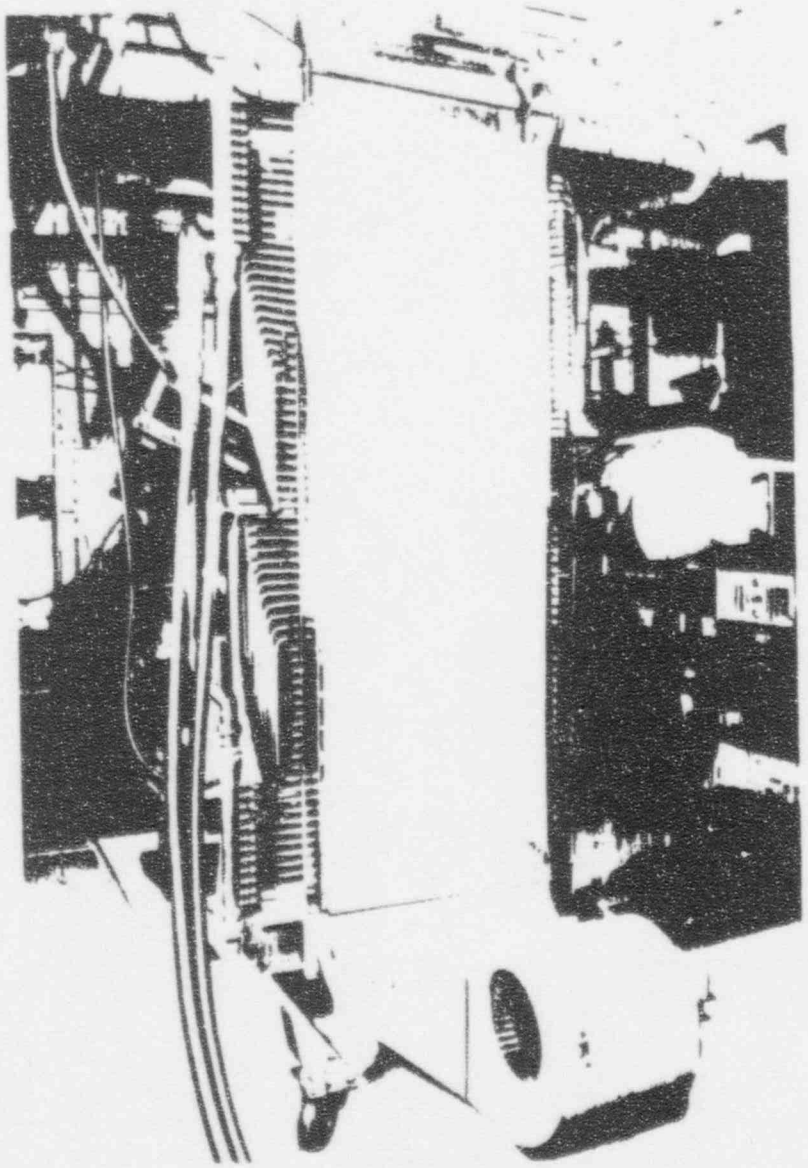
## Completed Tests

- Bench Wind Tunnel Experiment
  - Assessed effects of wind on shield building design (inlet/outlet location)
- Air Flowpath Pressure Drop Test
  - Obtained pressure drop data through the downcomer and annulus
- Water Flim Formation Test
  - Confirmed wettability of a coated steel surface

## Completed Tests (continued)

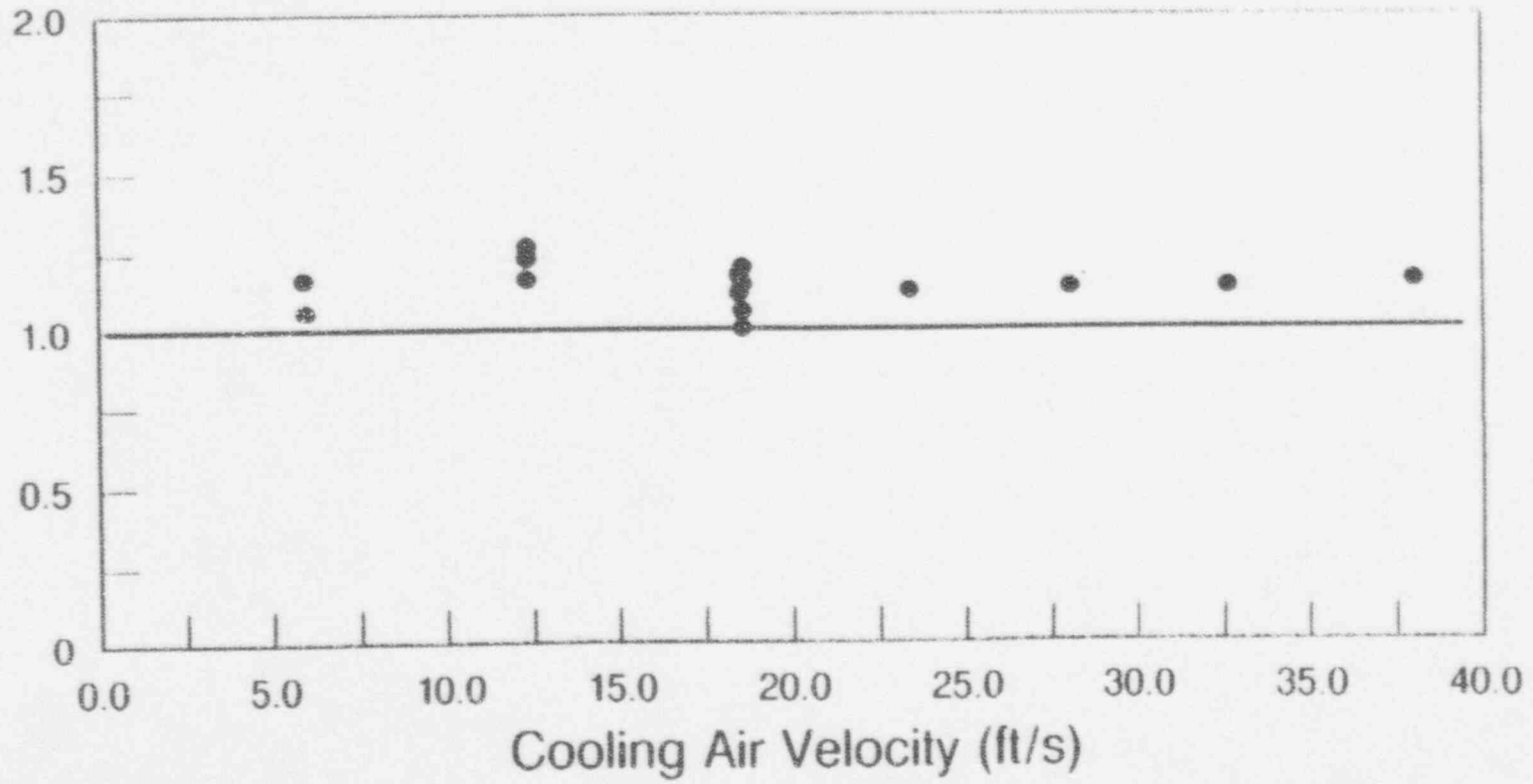
- Heated Plate and Integral PCCS Tests
  - Confirmed heat transfer capability
- Large - 1/8th scale PCCS Heat Transfer Tests
  - Detailed interior/exterior heat transfer performance characteristics
- Water Distribution Tests
  - Measured prototypical water coverage
- Wind Tunnel Test
  - Confirmed natural circulation with site wind conditions present
  - Optimized air inlet and exhaust arrangements

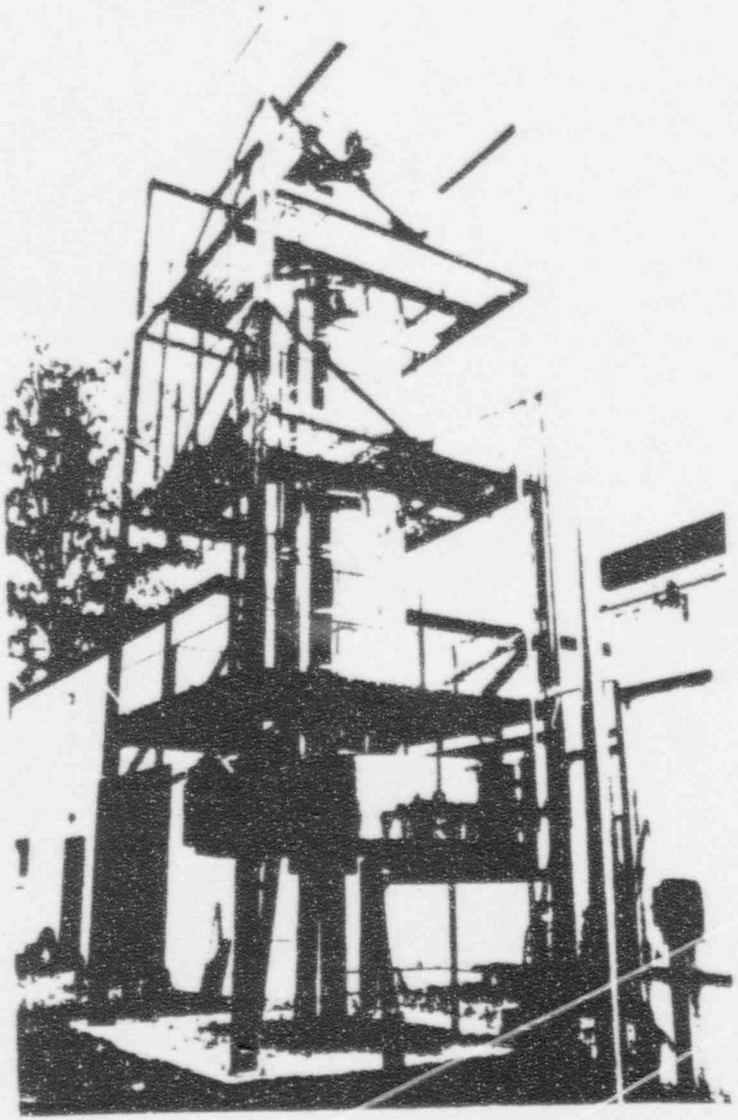
# AP600 PCCS Heated Plate Tests



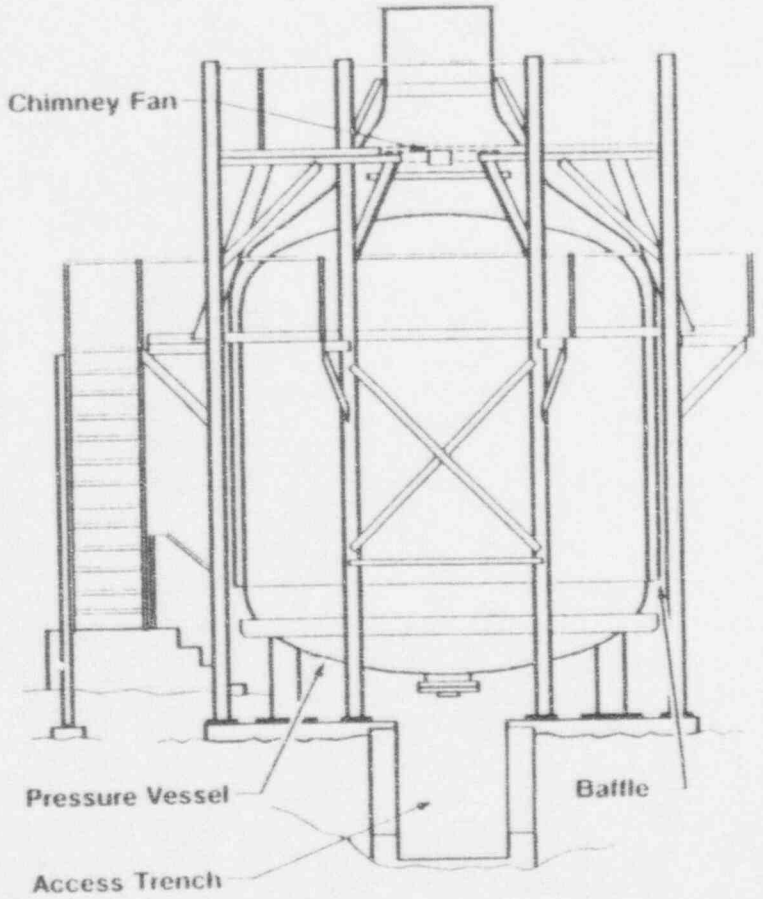
## AP600 PCCS Heated Plate Test Results

Wetted-Evaporative Cooling over Range of Water Flowrates and Plate Angle





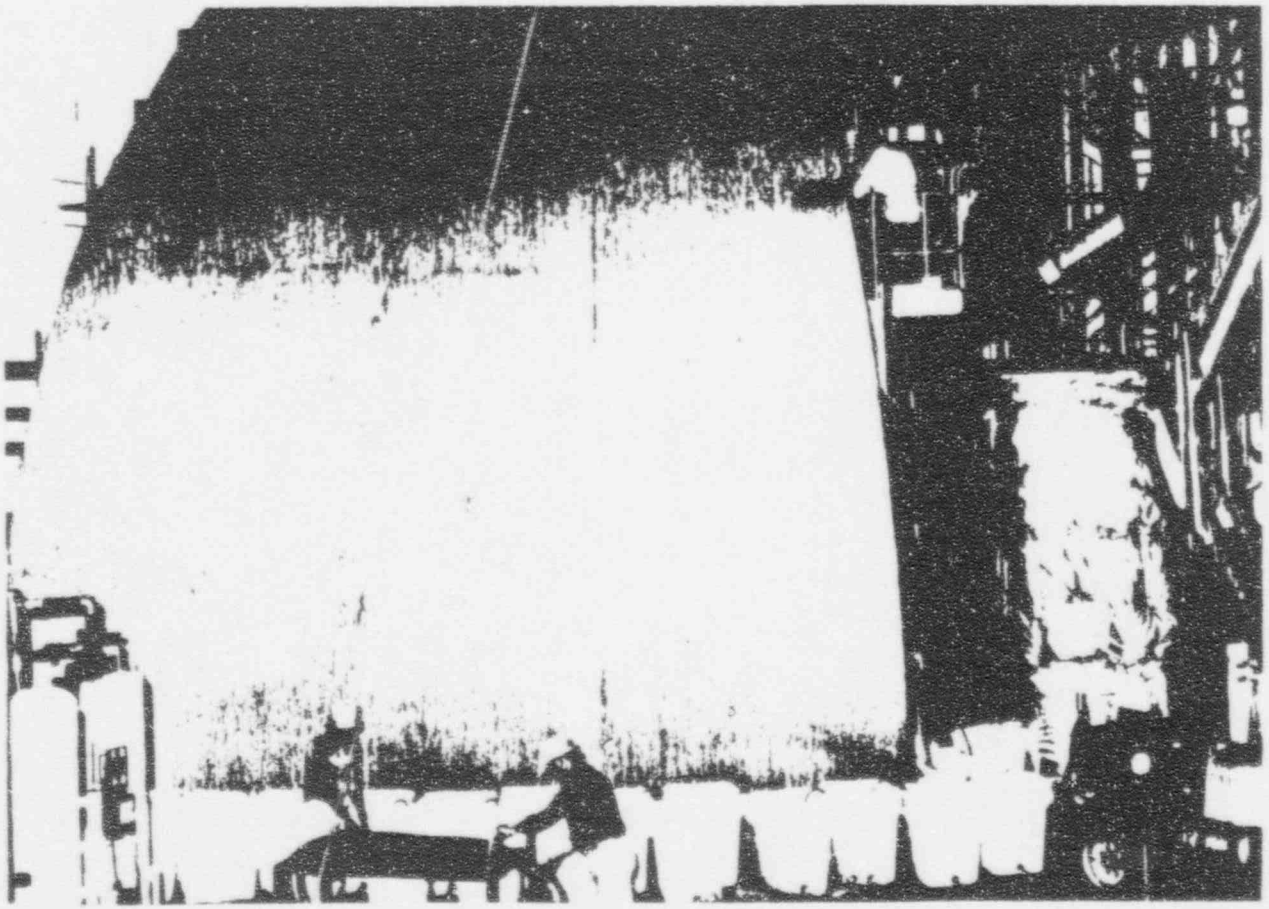
# AP600 Large Scale PCCS Heat Transfer Tests



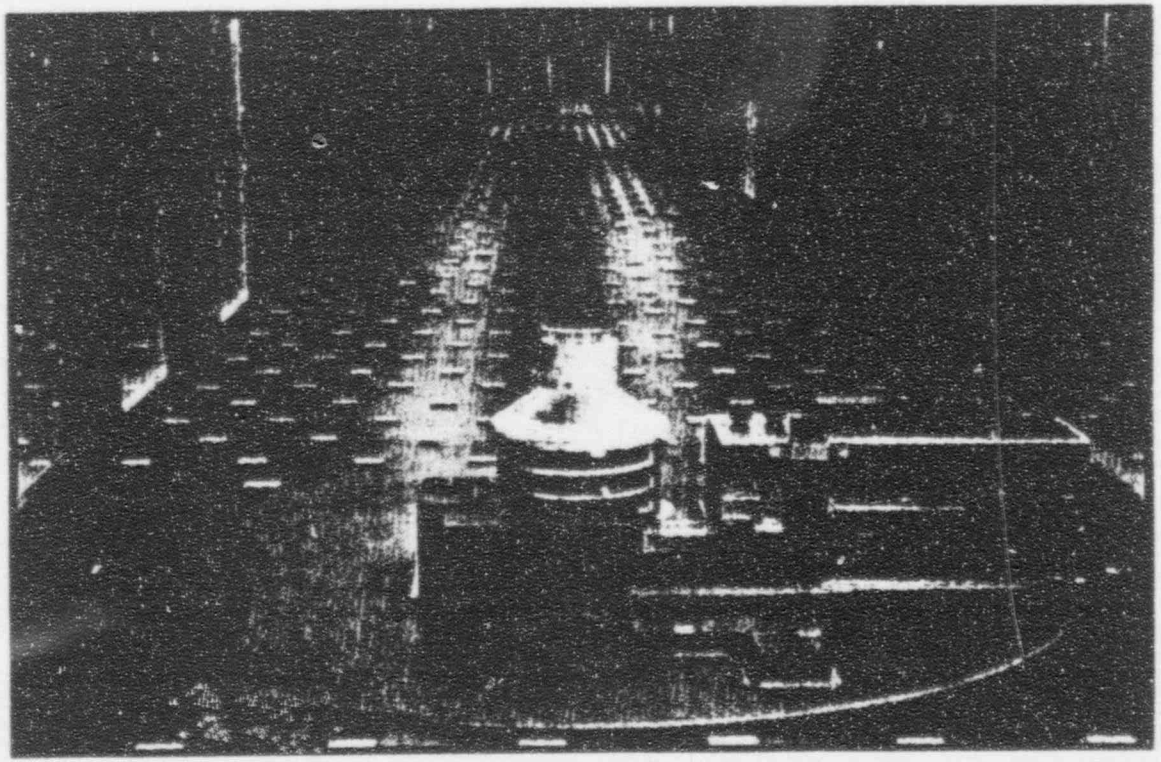
# AP600 Water Distribution Tests

AP600

Full-Scale Representation of 1/8th Segment of AP600 Containment Dome



# AP600 Wind Tunnel Test



# AP600 Passive Containment Cooling System Tests

## Ongoing and Planned Tests

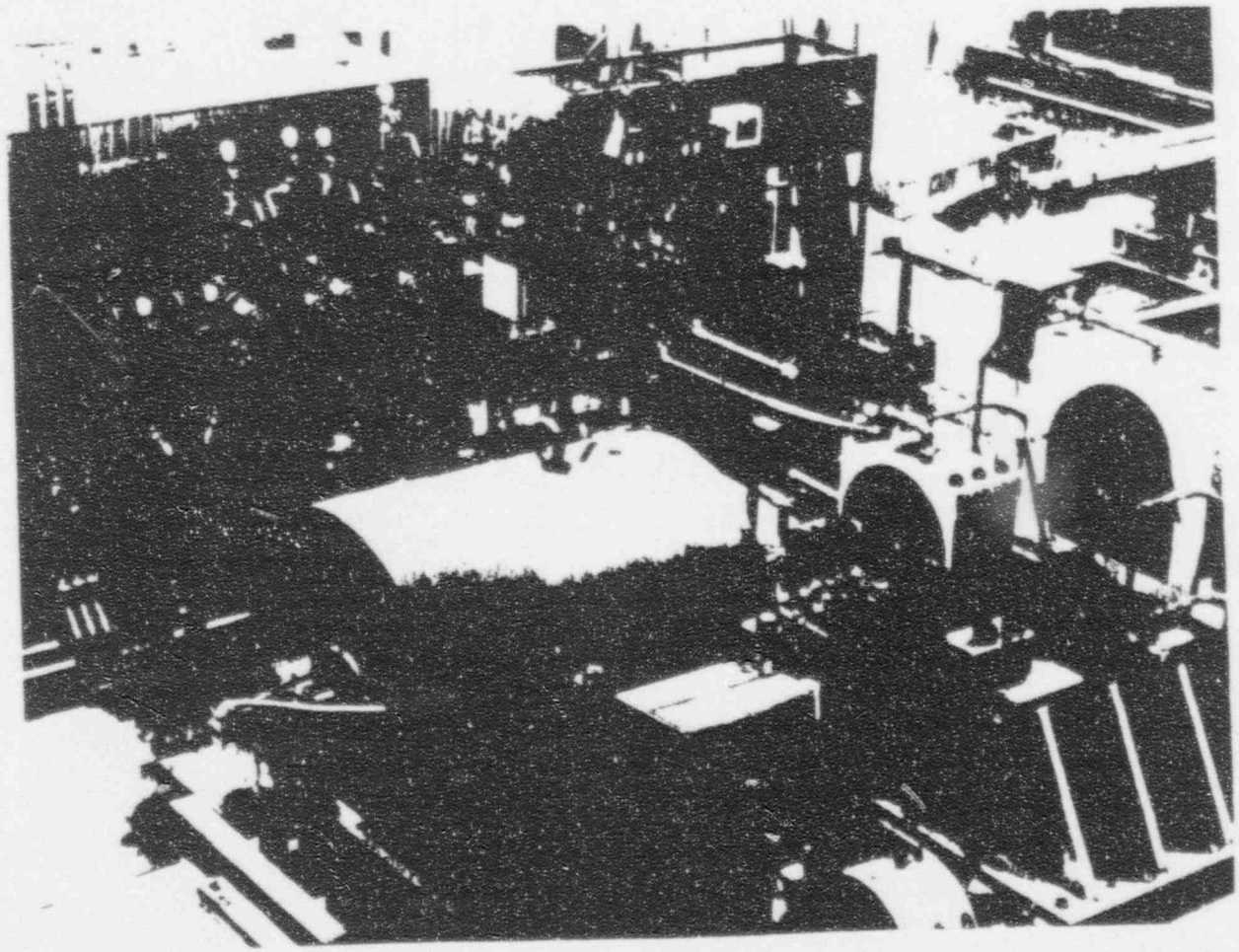
- Heat Transfer Tests
  - The 1/8th scale facility includes modeling of internal containment structures to assess steam distribution effects
  - Results from completed baseline tests and from previous tests incorporated into WGOTHIC analysis code with excellent results
- Water Distribution Tests
  - Measure water coverage using water distribution system
- Wind Tunnel Tests
  - Repeat at high Reynolds numbers
  - Site geography effects will be assessed with a smaller model which varies site features


# Component Design Verification Tests

## Completed Tests

- Reactor coolant pump/steam generator channel head air flow test
  - No flow maldistributions
- Reactor coolant pump journal bearing test
  - Determined dynamic/horsepower characteristics
- Incore Instrumentation System (IIS) Test
  - Demonstrated IIS will not be affected by Control Rod Drive Mechanism (CRDM) electromagnetic interference
- Reactor vessel flow visualization
  - No abnormal flow distribution
- Check Valve Mechanical Test
  - Demonstrated low pressure performance

# AP600 High Inertia Pump Journal and Bearing Test



## Ongoing or Planned Component Tests

- Reactor Coolant Pump Flow Test
- Incore Instrumentation Flow Induced Vibration Test
- Check Valve Tests
- Fourth Stage ADS Valve Test


## Key Tests for Design Certification

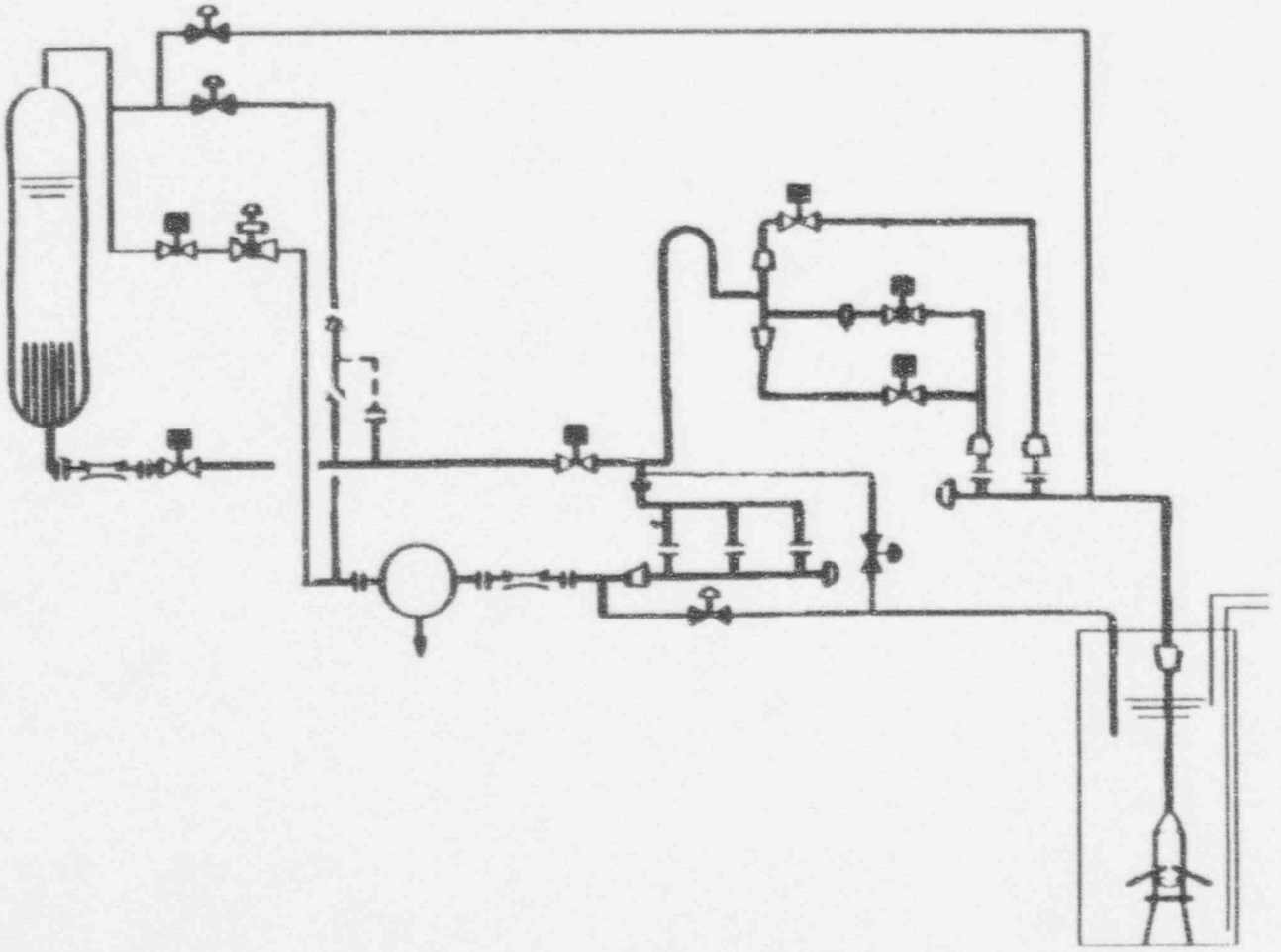
## Key Tests for Design Certification

- Separate Effects Tests
  - Automatic Depressurization Test - Phase B
  - Core Makeup Tank Tests
- Integral Tests
  - OSU 1/4 Height Scaled Pressure Test
  - SPES-2 Full-Height, Full-Pressure Test
  - PCCS Large Scale Heat Transfer Tests

## ADS Phase B Test

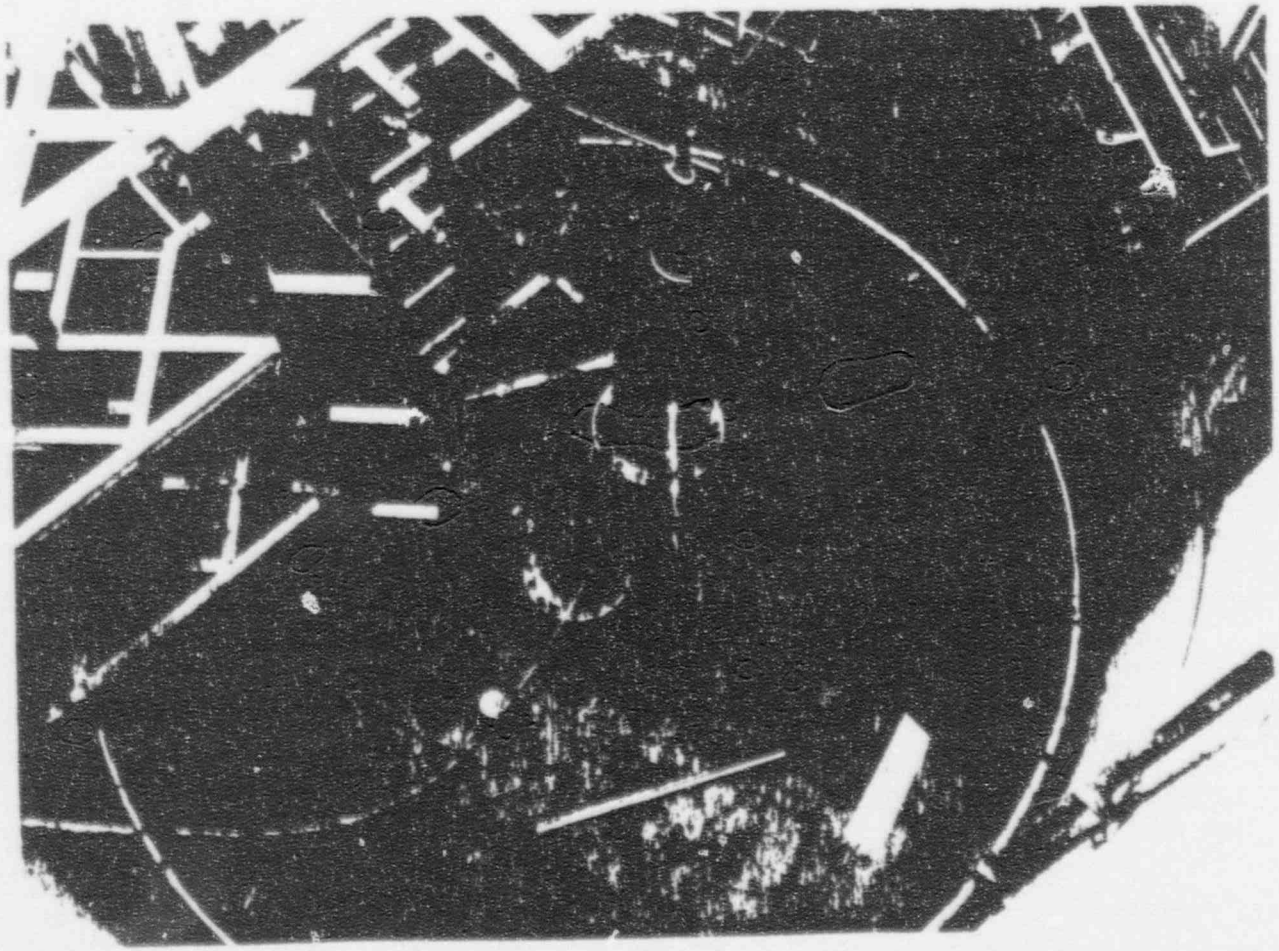
- Organization - ENEA
- Location - VAPORE Facility, Casaccia, Italy
- Key Features
  - Separate effects test
  - Full scale, prototypic hardware
- Purpose of Tests
  - Evaluate valve performance
  - Obtain piping load data
- Progress
- Schedule

# ADS Phase B Test



## ADS Phase B Test

AP600



# PCCS Large Scale Heat Transfer Tests

- Organization - Westinghouse

- Location - Science and Technology Center, Churchill, PA

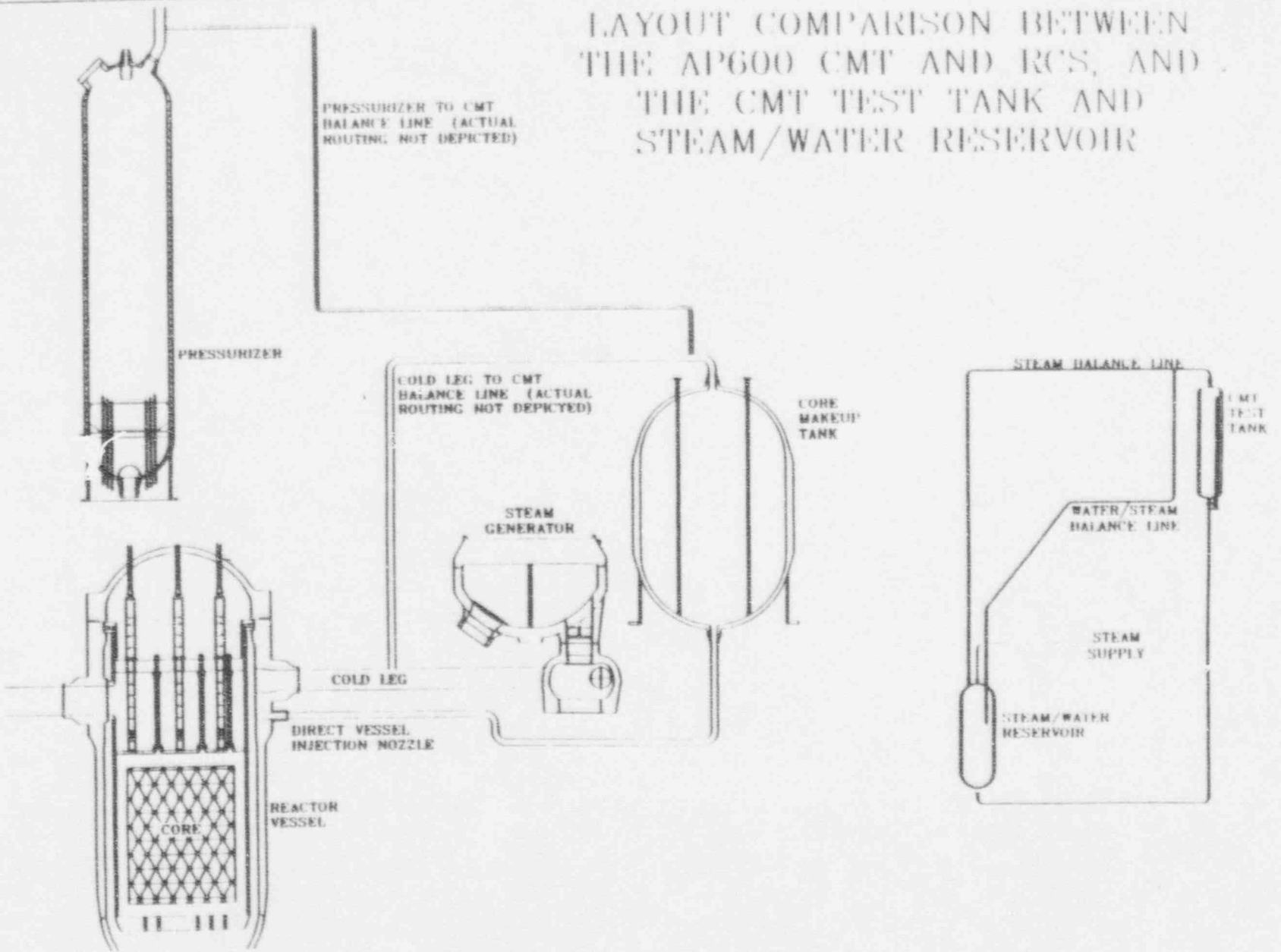
- Key Features
  - 1/8th scale containment vessel
  - 100 psig max pressure
  - 350°F max temperature
  - Interior containment model of operating deck and SG compartment
  - Variable coverage water distribution system
  - Exterior water film and air cooling
  - Three independent methods used to obtain heat balances

- Purpose
  - Obtain data to verify computer code used to predict containment performance

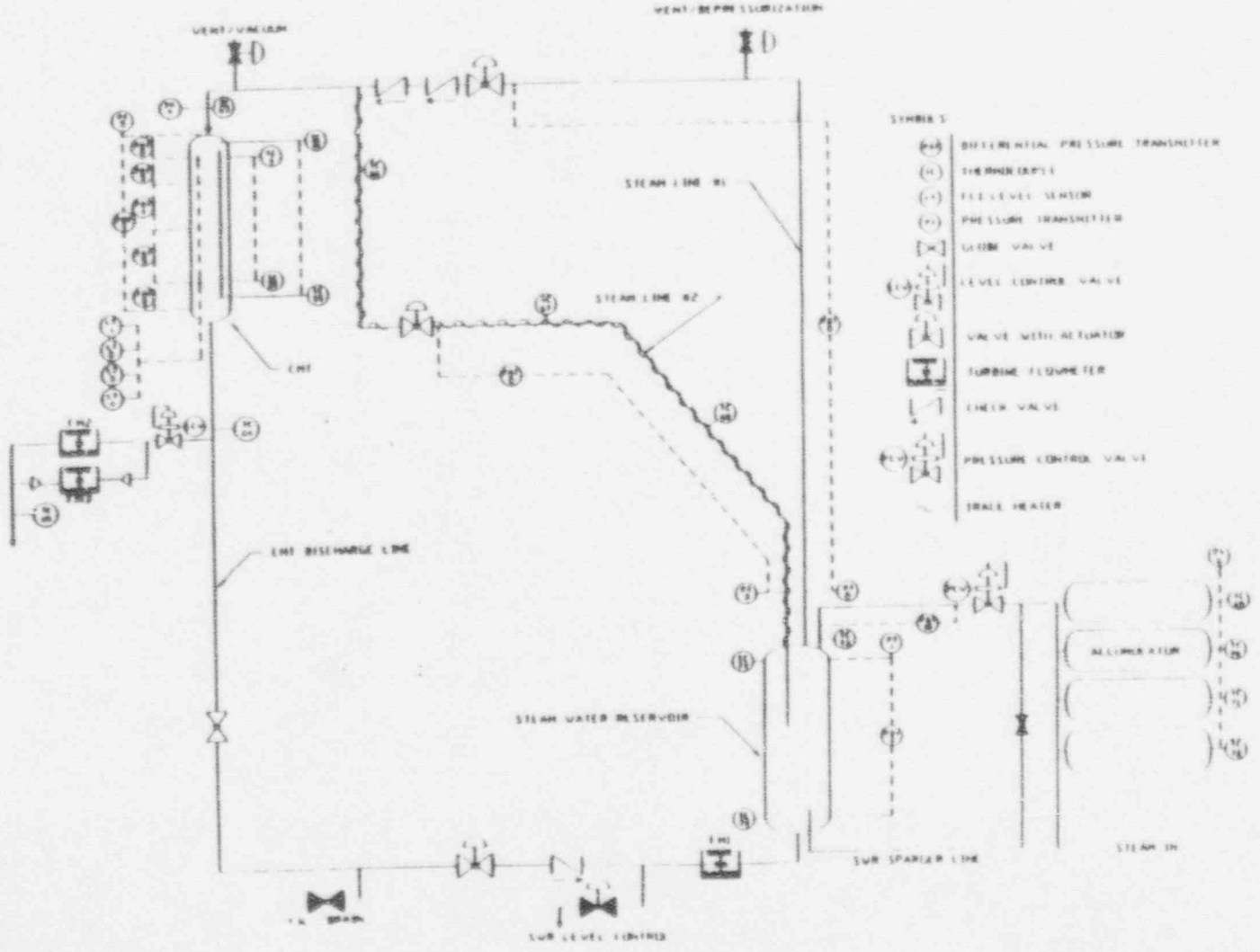
## Core Makeup Tank Test

- o Organization - Westinghouse
- o Location - Waltz Mill Site, Madison, PA
- o Key Features
  - Separate effects test at full pressure and temperature
  - Simulated CMT (10 ft high x 2 ft diameter)
  - Simulated cold leg and pressurizer balance lines
- o Purpose of Tests
  - Evaluate CMT performance
  - Evaluate CMT level instrumentation
  - Obtain T/H data for code verification
- o Progress
- o Schedule

# Core Makeup Tank Test



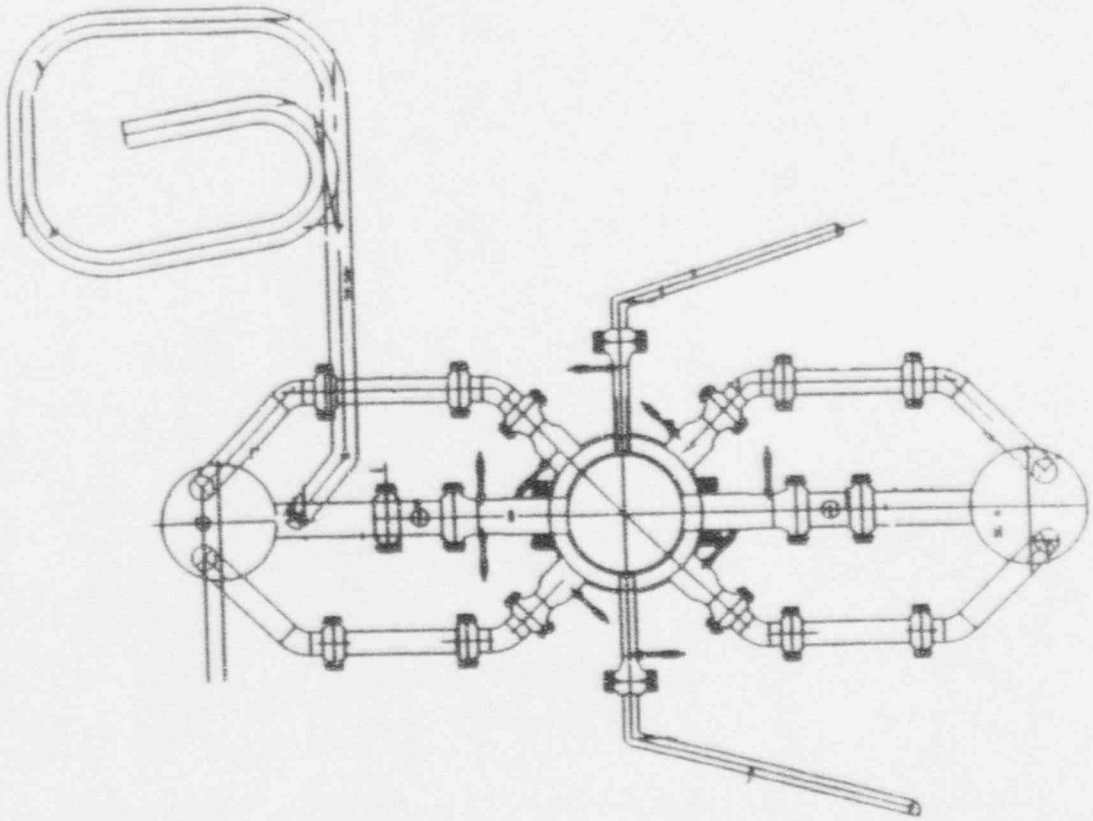
# Core Makeup Tank Test



## OSU 1/4 Height Scaled Pressure Tests

- Key Features
  - Low pressure, scaled facility
  - Complete RCS and Passive Core Cooling System model
  - 1/4 scaled height
  - 400 psig maximum pressure
  - Stainless steel components and piping
- Purpose of Tests
  - Provide T/H data for code verification at low pressure operation and during long term cooling
- Progress
- Schedule

# OSU 1/4 Height Scaled Pressure Tests



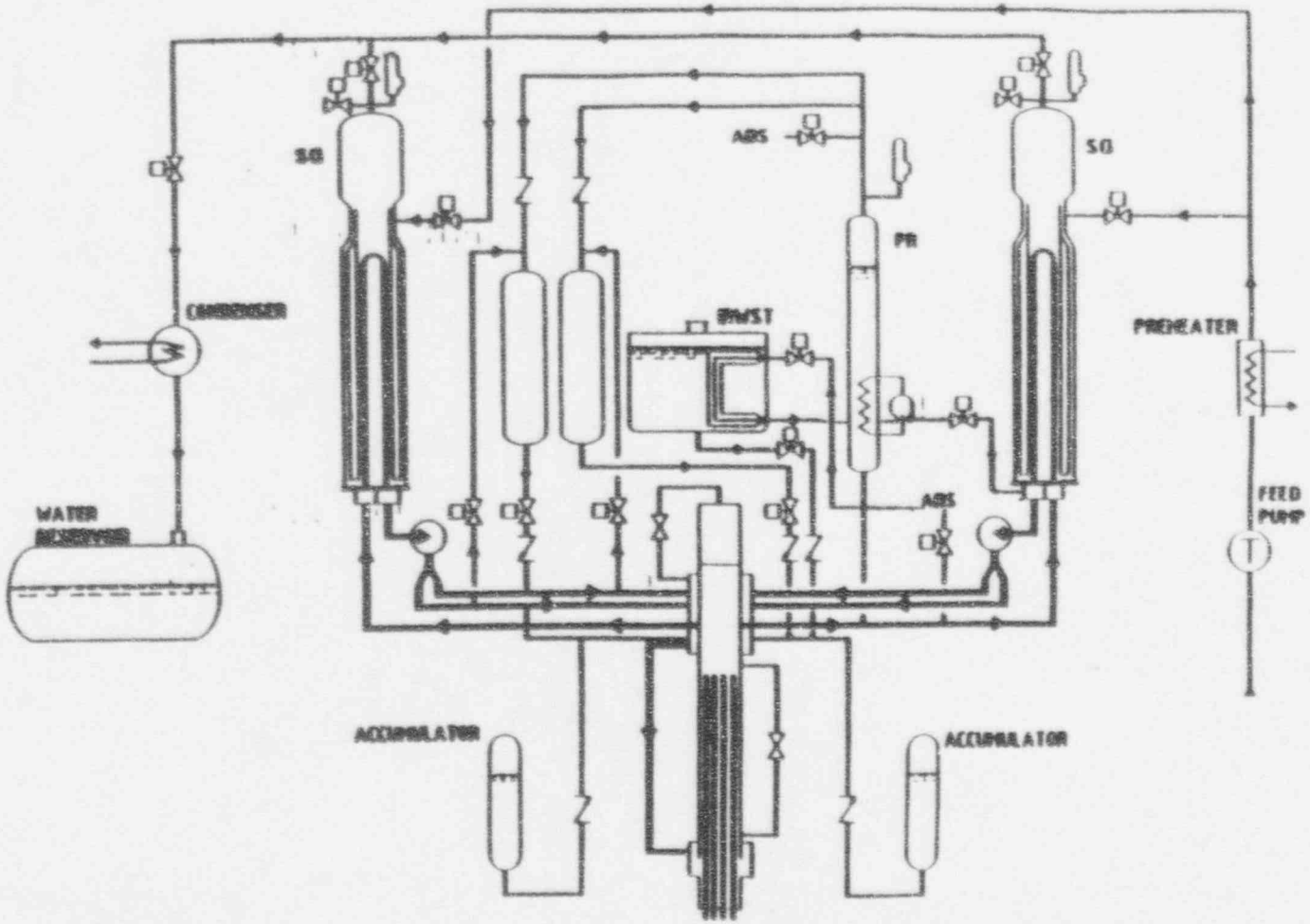
# SPES-2 Full-Height, Full Pressure Tests

- Organization - SIET supported by ENEA, ENEL, and Ansaldo
- Location - SPES Facility, Piacenza, Italy
- Key Features
  - 1/395 volume scale, full pressure, full height facility
  - 2250 psig, 600°F
  - Full simulation of AP600 features
    - Two cold legs / one hot leg per loop
    - Two CMTs, Two accumulators
    - ADS simulation
    - Two active steam generators
    - Full height heated core
    - PRHR modeled
    - IRWST modeled
    - Direct vessel injection

## SPES-2 Full-Height, Full-Pressure Tests

- Purpose of Tests
  - Obtain T/H data at high pressure for computer code verification
- The SPES-2 test matrix will address:
  - SBLOCA simulations (break size, location, interactions w/ nonsafety systems)
  - Steam line break
  - Steam generator tube rupture
    - Design basis with/without active systems to mitigate
    - Beyond design basis events
- Progress
- Schedule

# SPES-2 Full-Height, Full-Pressure Tests




# Core Makeup Tank Test

- Scaling logic will be provided to verify that the key thermal-hydraulic phenomena will be captured in the scaled CMT test

- Engineering analysis of the CMT has been proceeding using WCOBRA/TRAC to help size components, design the tests, place instrumentation as well as to test the code

- The CMT data will be analyzed to determine:
  - Mass/energy balances
  - Wall condensation heat transfer coefficients
  - Interfacial heat transfer
  - Thermal Stratification/Mixing effects
  - Void fraction with depressurization
  - Natural circulation behavior

- SSAR codes ( WCOBRA/TRAC and NOTRUMP) will be used to analyze the CMT tests


## Oregon State University (OSU) Low Pressure Integral Systems Test

- A detailed scaling analysis has been performed to design the reduced pressure, reduced height facility

- Engineering analysis is being performed with NOTRUMP to help size the components, verify the pressure scaling approach and plan the tests

- The OSU tests will be analyzed to determine:
  - Transient system behavior for different break locations, sizes, and system failures
  - Test facility transient mass/energy balance
  - Flow regime characteristics

- Tests will be analyzed using NOTRUMP and WCOBRA/TRAC


## SPES-2 Full Height, Full Pressure Integral Systems Tests

- Scaling analysis has been performed to size loop components
- Engineering analysis of the facility is being performed by Ansaldo using RELAP5/Mod 3, to verify scaling and to establish test operating procedures
- Currently setting up a NOTRUMP model for SPES-2
- SPES-2 tests will be analyzed to determine:
  - Transient system behavior for different SBLOCA break locations, sizes, system failures; Steam generator tube rupture; and Main steam line break
- Tests will be analyzed using NOTRUMP and WCOBRA/TRAC

## Large Scale Containment Tests

- Scaling logic presented in WGOTHIC topical report (WCAP-13246)
- Feasibility tests analyzed with WGOTHIC
  - University of Wisconsin condensation tests
  - Heated plate tests
- Integral (small scale) PCCS tests have been analyzed with WGOTHIC and COMPACT
- Engineering analysis of Large Scale tests was down with COMPACT to help place instrumentation, examine flow patterns
- Large scale baseline tests have been analyzed with WGOTHIC
- Currently performing pretest/engineering analysis with WGOTHIC to establish test conditions
- Large scale test data will be analyzed to obtain
  - test mass/energy balances inside and outside of containment
  - local heat flux, heat transfer coefficients
  - non-condensible distribution
- Large scale tests will be analyzed using WGOTHIC


## Conclusions

- A comprehensive AP600 test and analysis program has been developed and is in progress
- Key new features are being tested
- Tests will characterize the unique features at large scales so that computer models can be developed or verified
- State-of-the-art safety analysis methods employed
- The combined test and analysis program will meet AP600 licensing needs