WESTINGHOUSE CLASS 3

WCAP 13283 R1

WESTINGHOUSE PROPRIETARY CLASS 2 VERSION
EXISTS AS WCAP 13234 R1

LONG TERM COOLING TEST

Westinghouse Electric Corporation
Energy Systems Business Unit
Nuclear And Advanced Technology Division
P.O. Box 355
Pittsburgh, Pennsylvania 15230

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LONG TERM COOLING TEST

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AP600 LONG TERM COOLING TEST SPECIFICATION, REV. 1

1.0 BACKGROUND INFORMATION

This test was initially designed to demonstrate the low pressue (<50 psig) long-term cooling phenomenon of AP600 with a quartz model. Quartz material was selected because it would provide visual results and because Portland General Electric (PGE) would contribute in funding such a program.

However, some concerns associated with the quartz model were raised about the model cost, the safe operation of the test and the limitation on the system pressure. Consequently, stainless steel was selected for the following reasons:

(A) Quartz model can only be run at low pressure, about 65 psia. It was felt that at this low a system pressure Automatic Depressurization system (ADS) can not be adequately simulated. With stainless steel model the system pressure can be much higher, hence ADS actuation can be simulated accurately.

(B) Since the pressure limit on the quartz material is so low and the water temperature in the test is relatively high, the margin for the safe operation of the test is very small.

(C) The cost of the major components such as the reactor vessel, if made of quartz, would be approximately 30% of the entire test model cost. The cost of stainless steel vessel would be significantly less.

(D) With stainless steel model, the original test scope can be fulfilled, and additional scope can be added.

1.0 BACKGROUND INFORMATION (Continued)

Since the initiation of the proposed quartz model, additional test scope was incorporated to properly address the AP600 long term cooling process. Consequently, the stainless steel model was selected in favor of the quartz model.

This test shall be made of stainless steel and the original test scope with the quartz model shall be maintained, except flow visualization is eliminated. The test model shall include reactor coolant system, passive core cooling system, steam generator system, chemical and volume control system and normal residual heat removal system.

Since the NRC review of the AP600 program has begun, the scope of this test shall be expanded to help address their concerns. Finally, the entire test facility shall be a complete and scaled representation of the AP600. The test is now a low pressure integral system test of AP600 since the test model consists of the entire AP600 Reactor Coolant System and Passive Safety Systems.

2.0 PURPOSE

This test is designed to provide valid thermal hydraulic data to verify the AP600 thermal hydraulic computer codes. The data shall capture key AP600 phenomena such as gravity injection, natural convection and post-accident long term core cooling behavior at various modes of operations.

To validate the AP600 thermal hydraulic computer codes, the following features shall be incorporated in the test:

- The AP600 Reactor Coolant System including the reactor vessel and internals, two steam generators, two reactor coolant pumps, the pressurizer and the connecting hot and cold legs.
- AP600 passive safety features including the steam generator system (SGS) the passive core cooling systems (PXS) and the automatic depressurization system (ADS) shall be simulated in the test. The non-safety systems connecting to the passive safety systems also shall be simulated. These non-safety systems include normal residual heat removal system (RNS) and chemical and volume control system (CVS).

  The interaction between the passive safety features and the non-safety systems shall be investigated.
- The AP600 containment sump and floodup volume shall be simulated in the test to investigate sump recirculation behavior.
- Small break lost-of-coolant-accidents (SBLOCA) and inadvertent ADS operation shall be simulated in the test to investigate the operation process of the AP600 passive safety features. Each of these accidents shall be simulated from the onset of the accident to the final long term core cooling mode operation.

2.0 PURPOSE (Continued)

Each operation shall provide data to characterize the cooling flow paths into the simulated reactor, through the core, to and out the ADS valves, steam generators, the ADS valves on the hot legs and the break in the loop piping, and other loops in the test facility.

Since this test is a low pressure integral system test, it will provide data to validate the low pressure range of the computer code. The high pressure data will be provided by the SPES test in Italy. However, this test shall provide data at a pressure overlapping the SPES test.

3.0 TEST OBJECTIVES

The overall objective of the test program is to obtain test data at various modes of operations of a 1/4 height scale model of the AP600 Reactor Coolant System (RCS) and applicable portions of the AP600 PXS, Steam Generator System, ADS, Chemical and Volume Control System (CVS) and Normal Residual Heat Removal System (NRS). The test is designed to operate at 400 psia and 400°F.

This scaled experiment shall be made of stainless steel material. The RCS model shall include the reactor vessel (RV) and the internals, pressurizer (PZR), two (2) steam generators (SG), two (2) hot legs, four (4) cold legs and the associate valves and pipes. The lower containment structure shall be modeled to include the RV cavity and other lower containment volumes that will flood up during the transient and the lower containment recirculation operations. The portions of the PXS to be modeled shall include the ADS, two (2) accumulators, two (2) core makeup tanks (CMT's), one (1) passive RHR heat exchanger, and one (1) incontainment reactor water storage tank (IRWST) as well as all interconnecting valves and piping. One (1) makeup pump and the associated makeup piping loop of the CVS and one (1) normal residual heat removal pump and the associated pipe from the IRWST to RCS cold leg also shall be modeled.

One train of ADS shall be used in the test to represent two independent trains in AP600. This simulated ADS train shall consist of three (3) parallel lines simulating the first three (3) stages of AP600 ADS, with each line properly scaled to represent two trains in AP600. The number of 4th stage trains and locations shall be properly modeled in the test. In addition, the 4th stage ADS orientation shall be adjustable in the test.

3.0 TEST OBJECTIVES (Continued)

Water will be used as the working fluid and the reactor core will be simulated with electric heater rods scaled to match AP600 core decay heat during the long term cooling mode. Break locations on both the hot and cold leg loop piping, direct vessel injection (DVI) lines, CMT balances lines to either the pressurizer or the cold leg, will be simulated.

Specific objectives are to:

- Design and construct a scale model which will provide valid thermal hydraulic data including the long term cooling mode for the AP600,
- Measure flows, pressure drops and temperatures in all loop flow paths and the simulated reactor vessel to characterize the operation of the AP600 during the long term cooling mode to obtain a mass and energy balance on the system,
- Determine from the experiments, the effects of injection line size as well as ADS vent line sizes on the core cooling behavior and provide a rationale to scale these results to the AP600.
- Provide valid thermal/hydraulic data on the core flow behavior on a scaled basis for each of the different injection modes: accumulators, CMT, IRWST and the lower containment sump return,
- Provide data on the effect of the location of the 4th stage of the ADS on core cooling,
- Investigate a wide range of test conditions to examine the limits of core coolability for the post accident period.
- Provide data on the interfacing effect from CVS makeup pump and RNS RHR pump on long term core cooling.

3.0 TEST OBJECTIVES (Continued)

- Provide a basis to scale the test result to high pressure core cooling transients.
- Measure flows at the ADS and the breaks as well as other loop flow paths. These flow measurements shall aid in the estimation of boron buildup in AP600.
- Provide capability to simulate the injection of nitrogen gas from the PXS accumulators in order to show that non-condensible gas does not have an adverse effect on PXS injection and ADS venting capabilities.

4.0 REFERENCES

(A) AP600 Plant Description Document, December, 1990.

(B) FLECHT SEASET Program: Final Report, EPRI NP-4112, Project 959-1, September, 1986.

(C) AP600 Reactor Coolant System (RCS) SSD, NSE-92-0081

(D) AP600 Passive Core Cooling System (PXS) SSD, NSE-92-0034

(E) AP600 Steam Generator System (SGS) SSD, NSE-92-0036

(F) AP600 Normal Residual Heat Removal System (RNS) SSD, NSE-92-0031

(G) AP600 Chemical & Volume Control System (CVS) SSD, NSE-92-0082

(H) Reactor Vessel and Internals Drawings:

- MV01 V1 001, Rev. 1
- MV01 V2 001, Rev. 1
- RXS V2 001, Rev. 2
- MI01 V1 001, Rev. 2

(I) Steam Generator and Pressurizer Drawings:

- MB01 V2 101, Rev. 3
- MB01 V1 001, Rev. 2
- MB01 V2 001

(J) Primary Loop Layout Drawings:

- PL01 V2 001, Rev. 3

4.0 REFERENCES (Continued)

(K) NSSS Systems Drawings:

- RCS M6 001, Rev. 6
- SGS M6 001, Rev. 4
- PXS M6 001, Rev. 4
- CVS M6 001, Rev. 5
- RNS M6 001, Rev. 3

(L) IMP THRIVE Data, MED-RPV-3403

(M) AP600 Design Parameter List, NSE-90-0334

(N) PRHR HX Design Document, SEE-FS(91)-0179

(O) AP600 General Arrangement Drawings for reactor floodup volume:

- 1010 P2 001, Rev. 1
- 1020 P2 001, Rev. 1
- 1020 P2 002, Rev. 1
- 1030 P2 001, Rev. 1
- 1040 P2 001, Rev. 1
- 1000 P2 901, Rev. 1
- 1000 P2 902, Rev. 1
- 1000 P2 907, Rev. 1

(P) Containment Volumes and Heat Sinks Calculations,

5.0 TEST FACILITY REQUIREMENTS

The test facility for the AP600 Long Term Cooling Test shall model the AP600 RCS, PXS, ADS, portion of SGS, CVS and RNS and lower containment structures. A proposed test facility P&ID is shown in Figure 1. The test facility shall have the following capabilities:

(A) Provide adequate space for all test components and supporting systems such that the test can be constructed and operated with ease, efficiency and safety. The facility shall be constructed indoors. Large tanks, if required, may be placed outdoors if adequate protection from freezing or other environmental damage is provided. All test components shall be situated at scaled heights as determined from a scaling study based on prototypical AP600 dimensions.

(B) A controlled electrical supply system estimated to be at least [400] (b,c) kilowatts must be provided to power the electrical heater rods in the reactor core model in order to simulate the core decay heat during long term cooling operation. Controls must be such that the decay heat transient can be approximated.

(C) A cold water supply capable of providing uncontaminated cold water at adequate rates for system and equipment fill, CVS makeup, and SG feedwater supply. Pumped fill and drain capability must be installed.

(D) Adequate drainage systems must be provided to remove water from the test loop as well as any spillages or overflows such that the test facility will not be adversely affected.

5.0 TEST FACILITY REQUIREMENTS (Continued)

(E) A system to condense steam and measure the condensate or flows from selected discharge pipes must be provided.

(F) Adequate ventilation must be provided to remove steam or water vapor discharged from the test facility.

(G) A data collection system (DAS) to record up to [ ] b,c from various sources such as thermocouples, pressure sensors, flow meters, shall be provided. All data shall be permanently recorded on an acceptable electronic media (such as floppy diskettes) for transmission to Westinghouse. (See Section 8.0.)

(H) Major operating parameters such as system pressure and temperature shall be visually displayed independent to the DAS system.

(I) An instrumentation plan shall be developed and used which will permit accurate calculations of transient mass and energy balances for the systems.

(J) The facility shall be capable of performing steady-state experiments as well as transient blowdown tests.

The test vendor is to perform detail scaling analysis of the Long Term Cooling Test Facility, instrumentation design, steam generator design, PRHR HX loop design, control room design, supporting structure design and to operate the test facility. The vendor must submit all designs to Westinghouse Test Engineering for review and approval prior to procurement and fabrication. Westinghouse is to supply the test facility design and the reactor vessel and internals design. A preliminary set of

5.0 TEST FACILITY REQUIREMENTS (Continued)

drawings are attached in Appendix A for review. In addition, the vendor has the responsibility of procurement and fabrication of the entire test facility which includes instrumentation calibration. Bench testing of instrumentation is permitted if necessary subject to AP600 Test Engineering approval.

6.0 TEST ARTICLES

All test articles and interconnecting piping shall be sized and located at the proper elevations based on the scaling study using prototypical AP600 dimensions to the maximum extent possible. The following test articles are to be provided for the AP600 Long Term Cooling Test:

(A) Reactor Vessel

The RV shall be constructed of stainless steel material and include a model representation of the upper and lower reactor internals, the core barrel and downcomer, the reactor core (using electrically heated rods) and the upper head region. Connections for the hot and cold legs and PXS injection nozzles shall be provided. Heat losses from the vessel shall be minimized. Westinghouse is to provide the design of the reactor vessel and internals. The vendor is to fabricate and assemble it.

(B) Reactor Coolant Loop Piping

Both the hot and cold leg (of the RCS) pipes shall be made of stainless steel material. Heat losses from the loop piping shall be minimized.

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Westinghouse is to provide the design of the reactor coolant loop piping including pipe routing. The vendor is responsible for the actual fabrication of the loop.

6.0 TEST ARTICLES (Continued)

(C) Steam Generator

The two steam generators shall be made of stainless steel. While the SG channel head shall be sized according to the scaling study from prototypical AP600 dimensions, the upper body of the SG need not be of prototypical scale but shall approximate the AP600 to the maximum extent possible. A heat exchanger shall be provided to remove the heat from the secondary side of each steam generator or dump the steam directly to an existing steam line. Although steam generator tube rupture (SGTR) is not tested at this time, the SG design must incorporate provisions to allow testing of SGTR conditions. The vendor is to design and construct the steam generators. Westinghouse will review and approve the design prior to actual fabrication.

(D) Pressurizer (PZR)

One (1) pressurizer with pressurizer spray shall be used in the test. It shall be made of stainless steel material. A heater shall be used for level and pressure control. Vendor is to design and fabricate the PZR. Westinghouse shall review and approve the design.

(E) Automatic Depressurization System

Valves and pipes shall be provided off the top of the PZR and to the simulated sparger in IRWST to simulate the first three stages of the ADS.

The two (2) independent trains of 1-3 stage ADS in AP600 shall be modeled with one (1) train in the test. However, the total rate of each stage of AP600 ADS shall be properly scaled in the test, i.e. the line size and valve size in each stage in the test shall be properly scaled to represent 2 trains of each stage in AP600.

6.0 TEST ARTICLES (Continued)

The fourth stage of the ADS shall be represented by two valves; one located off each hot leg and discharge into the simulated lower containment compartment tank. The fourth stage lines shall be capable of connecting to both the top and bottom of each hot leg. Westinghouse is to design the ADS and the vendor is to fabricate and assemble the ADS.

(F) Core Makeup Tank

Two (2) closed vessels made of stainless steel material shall be provided to gravity drain into the RV through the safety injection nozzles. Water level and flow rates shall be measured. Control logic shall be provided to actuate ADS valves via the CMT levels. See P&ID (Figure 1) for more instrumentation. Westinghouse is to provide CMT design and piping design for fabrication by the vendor.

(G) In-Containment Refueling Water Storage Tank (IRWST)

A closed vessel shall be provided to simulate the IRWST. This vessel shall be capable of venting to atmospheric pressure or pressurized to a given pressure simulating containment pressure in AP600. This tank shall be equipped with sufficient venting capacity to prevent over-pressurization. The vent/relief valves shall be capable of maintaining a desired pressure ranging from atmospheric pressure to 40 psig (containment pressure). The discharge line from the first three stages of ADS valves located on the top of the PZR shall lead to a simulated sparger located in the IRWST. The elevation of the simulated sparger in the IRWST shall be made adjustable such that the sparger lines can be discharged at different levels below the normal IRWST water level. The vendor is to design and fabricate the IRWST, and the design must be approved by Westinghouse.

6.0 TEST ARTICLES (Continued)

(H) Lower Containment Structure

A vessel shall be provided to simulate the flooded volumes in the lower containment. This vessel shall be sized to contain all water from the RCS, ACCS, CMT's and IRWST. A return line to each DVI injection pipe shall be provided to represent the lower containment return sumps. The inlet elevation of the return line in the vessel shall be scaled prototypically. The vessel shall be able to operate at atmospheric pressure or be pressurized to simulate

containment pressure. Venting and pressure control device shall be used to prevent over-pressurization. Westinghouse shall design the lower containment structure for fabrication by the vendor.

(I) Accumulators

Two (2) water tanks representing the accumulators shall be designed and made of stainless steel material. It shall be designed to full system pressure and will be pressurized with nitrogen. Vendor is to design and fabricate the accumulators.

(J) Passive RHR Heat Exchanger (PRHR HX)

One (1) 100% capacity of AP600 PRHR HX shall be modeled in the test. The PRHR HX shall be made of stainless steel material and of C-tube type. The heat transfer shall be properly modeled. Westinghouse shall supply information for vendor to design and fabricate the PRHR HX.

(K) Normal RHR System

Part of the normal RHR System shall be modeled in this facility. Specifically, one (1) RHR pump and lines connecting from IRWST to DVI shall be modelled. Westinghouse is to provide the design for fabrication by vendor.

6.0 TEST ARTICLES (Continued)

(L) Chemical and Volume Control System (CVS)

Portion of the CVS shall be modeled. Specifically, the CVS makeup pump and the associated lines to the steam generator channel head (cold leg side) shall be modeled with stainless steel material. Westinghouse is to provide detail design and the vendor is to fabricate it.

(M) Interconnecting Piping

All interconnecting piping shall be designed to be of proper size based on the scaling analysis. Adequate pipe strength, support and flexibility shall be provided to insure the integrity of the system. All pipe lines shall be designed and routed to avoid water hammer and shall be capable of being completely drained and cleared. Injection lines and vent lines shall contain replaceable orifices for simulating the effective pipe size. Westinghouse is to provide detail design of the piping for fabrication by the vendor.

The vendor is to perform the work required to scale, fabricate and install these test articles and submit the design to Westinghouse Test Engineering for review/approval prior to their procurement.

7.0 INSTRUMENTATION AND CONTROL REQUIREMENTS

Proposed instrumentation and control locations are identified and superimposed on the test P&ID as shown in Figure 1, Instrumentation on the reactor vessel is shown in Figure 2. These instruments and their locations are shown only to provide a basis for a final instrumentation and control plan. They have been chosen to obtain data needed to perform an overall mass/energy balance of the primary loop during both transient and steady state conditions.

(A) Types of Instrumentation

It is important to define all the instrumentation that may be required to obtain a mass/energy balance in the test facility prior to construction of the loop. Allowances for installation of instrumentation, such as taps for differential pressure transducers, can then be installed during construction in the event they are required in the future. Table 1 is a preliminary list of the instrumentation. It is by no means a complete list since more may be added in the future as needed. However, it does serve the measuring purpose for those tests listed in Section 9.0. The following types of instrumentation are to be provided for the AP600 Long Term Cooling Test:

- Thermocouples (T/C's) shall be used to measure the temperature of the coolant in the primary and secondary systems as well as any supply or component cooling water. They also measure selected component wall and insulation temperature in order to complete mass/energy balance on the component.

7.0 INSTRUMENTATION AND CONTROL REQUIREMENTS (Continued)

T/C's shall also be used to measure the temperature distribution in the heater core. Locations shall be chosen within selected heater rods to obtain both the axial and radial temperature distribution within the heater core. Premium grade thermocouples shall be used and connected through controlled purity extension wire to a low level volt meter and analog to digital conversion circuit in the data acquisition system (DAS).

- Recording flowmeters shall be used to measure all single phase water mass flow rates. The range of these meters must be carefully selected to minimize error.
- Pressure transducers shall record the absolute pressures within various tanks and at selected location in the test loops.
- Differential pressure transducers shall be used to record pressure drops and liquid levels in the various tanks and vessels in the test loops as well as the liquid inventory in various pipes in the primary loop.

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- [ ]
- Turbine meters can be used to measure single phase steam flow or liquid flow. For low rate liquid flow, a magnetic flow meter or other applicable flow meters can be used.
- Instrumentation is required to measure and record the ambient air conditions including barometric pressure, temperature and humidity.

7.0 INSTRUMENTATION AND CONTROL REQUIREMENTS (Continued)

(B) Types of Controls

The test shall model the AP600 process control where ever necessary. Controls shall be utilized in the test facility to aid the smooth operation of test runs. Following is a preliminary list of process controls to be used in the test. Additional controls may be added if necessary subject to approval by AP600 Test Engineering:

- Steam Generator Level Control

  Water level in the steam generator shall be controlled. This is performed by monitoring the steam generator level which is interlocking with the feed water control valve. A Programmable Logic Controller (PLC) can be used for this purpose.

- Steam Generator Main Steam Throttle Control

  Main steam flow is controlled with throttle valve and PLC.

- ADS Actuation

  The ADS valves are interlocked to open at selected CMT water levels. Valves included in this operation are 1-3 stage ADS valves and 2 fourth stage ADS valves.

- CMT Actuation

  The CMT injection line isolation valves and the CMT to cold leg balance line isolation valves are normally closed and are interlocked to open simultaneously. They are controlled by PLC to open at simulated "S" signal or low pressurizer water level. The isolation valves at the CMT to pressurizer balance lines are normally opened and no interlocking required.

7.0 INSTRUMENTATION AND CONTROL REQUIREMENTS (Continued)

- Steam Generator Steam Isolation Valve Control

  On/off control of each steam generator steam line isolation valve. Valve is normally open and is interlocked to close.

- Reactor Vessel Heater Rod Control

  Power to heater rods is interlocked to shut off at high heater and sheath temperature, high reactor vessel pressure or low reactor vessel water level.

- PRHR Discharge Line On/Off Control

  PRHR discharge line isolation valve is interlocked to open at the actuation of the first stage ADS valve.

- Other on/off valves are CVS and RHR pump discharge isolation valves.

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SHEET 1 OF
File: Piping LAYER: PID7

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AP600 LONG TERM COOLING TEST
P & ID - PRIMARY LOOP
DWG. NO. LKL 920203 REV. 1
SHEET 2 OF

FILE: INSTRMNT LAYER: INSTRU2

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Design Eng'r		AP600 LONG TERM COOLING TEST P & ID
Approval		
Approval		DWG NO. LKL 920203 REV. 2
Approval		SHEET 3 OF

File: Piping PID5

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TABLE 1

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TABLE 1 (Continued)

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N* Not enough data available at time of revision.

Rev. 8/14/92

TABLE 1 (Continued)

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N* Not enough data available at time of revision.

Rev. 8/14/92

TABLE 1 (Continued)

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N* Not enough data available at time of revision.

TABLE 1 (Continued)

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Rev. 8/14/92

TABLE 1 (Continued)

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Rev. 8/14/92

TABLE 1 (Continued)

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N* Not enough data available at time of revision.

TABLE 1 (Continued)

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TABLE 1 (Continued)

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Rev. 8/14/92

TABLE 1 (Continued)

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Rev. 8/14/92

TABLE 1 (Continued)

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TABLE 1 (Continued)

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Rev. 8/14/92

TABLE 1 (Continued)

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Rev. 8/14/92

TABLE 1 (Continued)

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TABLE 1 (Continued)

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Note 1: The gauges on the tops of the accumulators are necessary for the operator to determine tank pressure as the tanks are charged with nitrogen.

N* Not enough data available at time of revision.

Rev. 8/14/92

TABLE 1 (Continued)

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N* Not enough data available at time of revision.

TABLE 1 (Continued)

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TABLE I (Continued)

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N* Not enough data available at time of revision.

TABLE 1 (Continued)

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N* Not enough data available at time of revision.

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8.0 DATA ACQUISITION

The data acquisition system shall include the equipment necessary to receive, transmit, process and record the voltage or current signals output from the individual sensing instruments including amplifiers, signal conditioners, transmitters, interconnecting wiring, analog to digital convertors, interfacing boards, switching panels, computers, displays and other recording devices as needed.

(A) Input Channels

The ability to receive up to [1000] (b.c.) analog signals from the various thermocouples, pressure sensors, flow meters and other instrumentation and record them digitally will be required. Shielded leads shall be used for all signal input leads to minimize noise.

(B) Sampling Rates

Total system input for the required data acquisition system shall be a minimum of [70 channels scanned per second] (b,c). Higher input rates are allowable.

(C) System Accuracy

Digitizing errors for the various channels from sensor to DAS shall meet or exceed the following requirements:

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- Thermocouples
- Flow Meters
- Pressure Transducers
- All other instrumentation

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8.0 DATA ACQUISITION (Continued)

(D) Signal Input Levels

The data acquisition system must be capable of processing the following signal levels for the various instrumentation channels:

- Thermocouples
- Flow Meters
- Pressure Transducers
- All other instrumentation

[ ]b,c

(E) On-Line Data Storage

The capacity of the data acquisition system must be capable of storing and maintaining all data retrieved and recorded during a single test. Steady state tests are expected to run for up to three hours or longer. Transient tests may run for up to 8 hours or longer.

(F) On-Line Monitoring

The data acquisition system must have the capability of validating test signals while testing is in operation. For example, dynamic strip chart displays, CRT displays, channel snapshots or other acceptable displays shall be available for verification

(G) Post Test Requirements

Permanent storage of all test data shall be on electronic media such as computer diskettes or magnetic tapes to be delivered to Westinghouse Electric Corporation following each series of tests.

9.0 TEST ~~OPERATION~~

The operation of the test facility shall be established and documented in the Test Operating Procedures. These Operating Procedures shall include, but not be limited to:

(A) Facility Shakedown

A series of pre-operational tests will be performed to assure that the model has been built to the specifications defined herein and that the facility can be operated safely and reliably. As a minimum, the following types of Pre-Operational Tests shall be performed:

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9.0 TEST OPERATION (Continued)

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Detailed Shakedown Test Operation Procedures shall be developed and approved by Westinghouse in advance of the tests.

(B) Calibration

All instrumentation and the DAS shall be calibrated to traceable national standards under controlled conditions to assure their operability and accuracy. A series of instrumentation readings under controlled conditions shall be documented.

(C) Integral System Testing

Steady state and transient integral system tests shall be performed to examine:

- the operation of the long term gravity makeup path from the in-containment refueling water storage tank (IRWST),
- the long term core cooling via gravity makeup and the natural circulation flow path from the flooded reactor vessel cavity, and

9.0 TEST OPERATION (Continued)

- the operation of the ACCs and CMTs during different types of SBLOCAs combined with,
  - Single failures of ADS valves
  - Active or inactive PRHR
  - Active or inactive Non-safety RHR or CVS systems

The tests shall provide data to characterize the cooling flow paths into the reactor, through the core, into and out of the Automatic Depressurization System (ADS) valves, steam generators (SG), the ADS valves on the hot leg and the break in the reactor coolant system piping. These tests shall be defined and delineated in a test matrix to be provided by AP600 Test Engineering. Attention shall be given to the initial conditions of the test loop prior to initiation of the test. This includes initial system inventory, power, pressure, flows, and temperatures.

Two main categories of tests shall be performed in the OSU AP600 Test facility:

- Small Break LOCA Tests
- Long Term Cooling Tests

These tests shall be grouped into series as follows:

Series 1: Cold Leg SBLOCA

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9.0 TEST OPERATION (Continued)

Series 2: CMT - Cold Leg Balance Line SBLOCA

b,c

Series 3: DVI Injection Line SBLOCA

b,c

Series 4: Inadvertent First Stage ADS Operation

b,c

Series 5: Hot Leg SBLOCA

b,c

Series 6: PZR/CMT Balance Line Break

b,c

9.0 TEST OPERATION (Continued)

Series 7: Long Term Cooling

b,c

Series 8: Other tests shall be added if necessary as determined by AP600 Test Engineering.

10.0 TEST REPORTS AND DATA REQUIREMENTS

All test data shall be the property of Westinghouse Electric Corporation. A series of reports and procedures shall be submitted as deliverables in order to properly document the test facility design, operation and data reporting.

(A) Facility Design Report

A facility design report describing the facility, test articles, instrumentation and data acquisition system used to meet the requirements of this specification shall be prepared by Westinghouse with the help of the Test Vendor.

(B) Instrumentation Bench Test Report

A summary report shall be provided by the vendor if bench testing of certain types of instrumentation is necessary. The vendor shall provide recommendation to Westinghouse Test Engineering on instrumentation selection for the test program.

(C) Test Operating Procedures

A series of Test Operating Procedures describing the operation of the facility and the test matrix shall be prepared by the test vendor in accordance with the applicable QA requirements of Section 11.0 and shall be submitted for review and approval by Westinghouse Test Engineering prior to the start of testing. Instrumentation check shall be included in the procedures prior to the start of each test.

(D) Test Data Transmittal

Following each completed set of tests, data is to be transferred to a suitable electronic media and forwarded to Westinghouse Test Engineering.

10.0 TEST REPORTS AND DATA REQUIREMENTS (Continued)

(E) Preliminary Test Reports

Following the completion of each test series defined in Section 9.0 data is to be collected, verified and transmitted to Westinghouse Test Engineering as a preliminary test report. this report is to include all test calibration data, a verified data reduction calculation and an error analysis of the instrumentation.

(F) Final Test Report

A final test report is to be provided to Test Engineering which contains a description of the test facility and construction, photos and video tapes of the test facility in various operating modes, test results, pre-test and post-test calibrations, instrumentation error/uncertainty analyses, data reduction, data verification and analyses performed. All data stored electronically and all video tapes shall be provided to Westinghouse Test Engineering with the final test report. This final test report shall be a cooperative effort between Westinghouse Test Engineering and the vendor.

Also, included in the final test report shall be a section of detail instrumentation and DAS description as well as control logics.

11.0 QUALITY ASSURANCE REQUIREMENTS

Testing quality assurance shall conform to ANSI/ASME NQA-1-1986. As this is a safety related test, the Code of Federal Regulations title 10 Part 21 (10CFR21) also applies. To incorporate the requirements of NQA-1, the following measures shall be taken in the detailed test procedure:

1. Provisions for ensuring that those performing the tests are qualified and trained in the quality assurance requirements of the test specification.
2. Provisions for ensuring that changes to the test procedure are reviewed and approved to the same extent as the originals.
3. Provisions for ensuring that the latest approved revision of the test procedure is used.
4. Provision for calibration of test equipment, traceable to recognized national standards. If no such standard exists, a description of the calibration method shall be included.
5. Provisions for verification and configuration control of computer software (if any) used to collect or reduce data.
6. Provision for reporting and reconciling deviations from the approved test procedure.
7. Provisions (such as a signed checklist) for ensuring that test prerequisites are met. Test prerequisites include calibrated instrumentation, appropriate equipment, trained personnel, condition of test equipment and item(s) to be tested, suitable environmental conditions, and provisions for data acquisition.

11.0 QUALITY ASSURANCE REQUIREMENTS (Continued)

8. Provisions for ensuring that necessary monitoring is performed and that test conditions are maintained. (A test long containing periodic signed entries that include any pertinent observations or information not captured elsewhere is recommended.)

9. Documented evaluation of test results by the test sponsor to ensure that test requirements were met.

10. Identification in the test records of items tested, date of the test, instrumentation and data recorders, type of observation, results and acceptability, action taken in connection with noted deviations, and person who evaluates the test results.

APPENDIX A - TEST FACILITY PRELIMINARY DRAWINGS

Drawing List

LKL 911100 (18 sheets)	Reactor Vessel General Assembly
LKL 911202 (14 sheets)	Upper Reactor Vessel Assembly
LKL 911201 (5 sheets)	Lower Reactor Vessel
LKL 911206 (2 sheets)	Upper Internal Assembly
LKL 911022 (9 sheets)	Lower Internal Assembly
LKL 911007 (3 sheets)	Grid Ring - Outline and Details
LKL 911004	Top Reflector Hold Down Ring
LKL 911010	Lower Core Plate - Alternate
LKL 911014	Upper Core Plate
LKL 911018	Lower Core Barrel
LKL 911028	Reflector Ring
LKL 911029	Reflector Liner
LKL 911102	Bottom Support Flange
LKL 911104	Heater Rod Details
LKL 911105	Barrel Hold Down Rings
LKL 911107	Static Tap Tube
LKL 911108	Static Tap and TC Boss
LKL 911109	DP Tool Detail
LKL 911200	Instrument Ring
LKL 911203	Alignment Pin & Boss Plate
LKL 911204	Hot Leg Nozzle
LKL 911208	Upper Guide Tube Details
LKL 911212	Upper Barrel Details
LKL 911205	Upper Vessel Details
LKL 911207	Lower Guide Tube Details
LKL 911209	Upper Support Plate
LKL 911210	Top Barrel Plate
LKL 911214	Top Flange Assembly
LKL 911219	Primary coolant Loop Layout
LKL 920200 (7 sheets)	Test Model Isometric - at 0° side
LKL 920201 (7 sheets)	Test Model Isometric - at 180° side
LKL 920203 (3 sheets)	P&ID
LKL 911218 (2 sheets)	Vessel Instrumentation/Hookup

The above drawings cover approximately 90% of the entire test facility. More drawings shall be provided when available.

PAGES 56 THRU 144 CONTAIN AP600 LONG TERM

COOLING TEST RV GENERAL ASSEMBLY

AND DETAIL DRAWINGS. THESE ARE PROPRIETARY

TO WESTINGHOUSE ELECTRIC CORPORATION.