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PANDA Steady-State Tests

PCC Performance Test Plan and Procedures

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ABSTRACT

Part I of this document presents the Test Plan for the PANDA Steady-State PCC Performance Tests.

This Test Plan contains a general description of the PANDA test facility including the instrumentation and data acquisition system. In addition, this Test Plan specifically covers the test program objectives, the experimental facility configuration, the test facility control and safety, the test instrumentation, the data acquisition system, the data analysis, the test conditions and the test reports for the Steady-State PCC (i.e. separate effects) Test Program.

Part II of this document presents the Test Procedures for the PANDA Steady-State PCC Performance Tests.

Rev. 0 → Rev. 1 changes mark-up

Revisions to Part I, sections 1 thru 13 are marked with bars, however due to the extensive changes to the procedure Part II, no revision bars are provided as it is a general revision.

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PART I: TEST PLAN

1. INTRODUCTION

This Test Plan contains a general description of the PANDA test facility including the instrumentation and data acquisition system. In addition, this Test Plan specifically covers the test program objectives, the experimental facility configuration, the test facility control and safety, the test instrumentation, the data acquisition system, the data analysis, the test conditions and the test reports for the Steady-State PCC (i.e. separate effects) Test Program.

2. TEST PROGRAM OBJECTIVES

The objectives of the PANDA steady-state PCC tests are to provide additional data to: (a) support the adequacy of TRACG to predict the quasi-steady heat rejection rate of a PCC heat exchanger, and (b) identify the effects of scale on PCC performance.

The approach to achieve these objectives is:

a) measure the steady-state heat removal capability with various inlet air mass fractions for steam flows approaching the PCC design rating.

b) perform counterpart PCC condenser tests to those run at PANTHERS and GIRAFFE.

3. PANDA TEST FACILITY DESCRIPTION

3.1 Introduction

The tests specified in this document will be performed in the PANDA facility, a large scale, integral system test facility which models the SBWR compartments and systems which are important to the long-term containment cooling following a LOCA.

The PANDA facility was designed for transient integral systems tests. Section 3.2 gives a general description of the transient test configuration, and Section 3.3 describes the main components of the facility in greater detail.

The steady-state tests, to which this test plan is applicable, utilize only a portion of the complete facility. Section 3.4 describes the configuration for the steady-state tests.

3.2 General Description

The facility has been designed to exhibit thermal-hydraulic behavior similar to SBWR under LOCA conditions beginning approximately one hour after scram. The global volume scaling of the facility is approximately 1:25 with a nominal height scaling of 1:1. The SBWR components which are modeled in the facility are: the Passive Containment Cooling System (PCCS), the Isolation Condenser (IC) System, the Gravity Driven Cooling System (GDCS), the Reactor Pressure Vessel (RPV), the Drywell (DW), the Wetwell (WW) and the connecting piping and valves. Electric heaters provide a variable power source to simulate the core decay heat and the stored energy in the reactor structures. Rigorous geometric similarity between SBWR containment volumes and test facility vessels is not necessary to capture the fundamental features of the containment response and has not been attempted.

The PANDA vessels are connected with scaled piping components to represent the connecting lines in the SBWR. The test facility vessels and piping connections are shown schematically in Figure 3-1. The arrangement, elevations and volumes of the major vessels are shown in Figure 3-2.

The SBWR RPV is simulated by a vessel containing electric heaters. The top of the heaters is at a relative elevation which represents the top of the active fuel (TAF). With the RPV simulator partially filled with water the heaters will generate steam which is discharged to vessels representing the SBWR drywell. The drywell is represented by two vessels connected by a large diameter pipe. The wetwell is also represented by two vessels. The bottom of the wetwell vessels are filled with water to the same relative elevation above TAF as the SBWR suppression pool. The wetwell vessels are connected by two large diameter pipes, one in the gas space and one just below the water surface. The purpose of using two connected wetwell/drywell vessels is to permit a simulation of multi-dimensional or asymmetric conditions (temperature, gas fraction).

The elevation scaling of 1:1 has been applied to the parts of the system which are above the top of the SBWR core. The PANDA scaling is evaluated in Appendix B.5 of NEDO-32391 [1].

The PANDA facility includes three scaled PCC condensers and one scaled IC unit (representing the scaled capacity of two SBWR IC units). These are mounted above the drywell vessels at the same elevation above the TAF as in SBWR. Two of the PCC units are connected to one of the drywell/wetwell vessels and the third PCC is connected to the other drywell/wetwell. The IC unit is connected to the simulated RPV. All four condensers are submerged in water in tanks representing the PCC/IC pools. Figure 3-3 shows the IC/PCC condenser test units.

The SBWR GDCS pools are represented in PANDA by a single GDCS vessel. The elevation of the GDCS vessel is representative of SBWR, but the volume of the GDCS vessel is not scaled the same as other PANDA vessels. It is not necessary to scale the volume of GDCS water in order to model the part of a SBWR LOCA transient to be tested, because the GDCS tanks primary function during the time period to be tested is to act as a collection tank for the PCC condensate drain flow.

The tests will be conducted at temperatures and pressures representative of SBWR postulated LOCA conditions after initiation of the GDCS. To assure these conditions can be tested in PANDA, the facility has been designed to 10 bar (145 psia) and 180° C (356° F). These conditions exceed SBWR LOCA conditions after initiation of the GDCS.

3.3 Component Description

3.3.1 RPV

The PANDA vessel used to simulate the RPV is cylindrical with a nominal outside diameter of 1.25 m and a nominal volume of 22.8 m^3. The vessel is scaled to the SBWR RPV volume above the bottom of the reactor core. The simulated decay heat power to the test facility is provided by electrical heaters placed near the bottom of the RPV. The top of the heaters is at the same relative elevation as the top of the active fuel (TAF) in the SBWR. A cylindrical sleeve inside the RPV is used to represent the SBWR core shroud and chimney. The steam separators and dryers are not simulated because they have no significant effect on the long term release of steam to the containment. The PANDA heaters have an installed maximum capacity of 1.5 MW. The scaled decay heat of the SBWR at one hour after scram is approximately 1.0 MW. The remaining 0.5 MW can be used to simulate the RPV internal energy. A controller has been provided for the heaters to accurately follow any given energy release transient within the limitations of the installed capacity.

3.3.2 Drywell

The SBWR drywell is represented in the PANDA facility by two cylindrical vessels connected by a large diameter pipe or duct. The vessels are designated as "DW1" and "DW2". Each of the two vessels has an outside diameter of 4.0 m and nominal volume of 90 m^3. The connecting pipe between the drywell vessels has a volume of 3.5 m^3 and a diameter of 92.8 cm. The total volume of the PANDA drywell has been scaled to the SBWR upper and annular drywells, i.e. it does not include the lower drywell region. Access to the inside of both drywell vessels has been provided.

3.3.3 Wetwell

The PANDA facility has two connected vessels to represent the SBWR wetwell. The wetwell vessels are designated as "WW1" and "WW2". The two vessels are cylindrical with an outside diameter of 4.0 m each with a volume of 117 m^3. Each vessel is partially filled with water to represent the SBWR wetwell pool. There are two large horizontal pipes connecting the wetwell vessels; one in the gas space above the water level (diameter of 92.8 cm and volume of 2.7 m^3) and one just below the normal water level (diameter of 142 cm and volume of 6.3 m^3). Wetwell vessel WW1 is directly below and provides support to drywell vessel DW1. Vessels WW2 and DW2 are similarly arranged. (See Figure 3-2) Access to the inside of the wetwell vessels has been provided similar to the drywell access.

The wetwell vapor space was scaled to preserve the pressure response of the trapped non-condensable gas in combination with steam. The total wetwell pool surface area was scaled to correctly represent the evaporation/condensation processes at the pool surface.

The pool water depth extends sufficiently below the PCC vent line terminus to provide a representative volume of water with which the uncondensed steam vented into the suppression pool can mix. The suppression pool depth is large enough to cover the topmost LOCA (horizontal) vent and the wetwell-to-RPV equalization line. However, the total depth of the pool is reduced from the depth of the SBWR suppression pool by elimination of the region at the bottom of the SBWR pool which does not participate in the long term mixing.

3.3.4 PCC Condenser Pool/IC Pool

The PANDA facility represents the PCC/IC pools with four rectangular tanks mounted above the drywell vessels at an elevation above the top of the RPV heaters the same as the bottom of the SBWR IC/PCC pools are above the core TAF. The tanks for the four condensers can be interconnected below the bottom of the pool to allow free passage of water and maintain the same water level in each compartment. The auxiliary system provides demineralized water to the pool prior to a test and also drains the pool when needed for maintenance, modifications or repairs.

Steam generated in the pool during testing is vented to the surroundings and maintains the pool surface at atmospheric pressure. The pool tank was sized to provide sufficient water to keep the condenser tubes covered for approximately 24 hours. A water supply is available to refill the pool during the course of an experiment. The pool walls are insulated to limit the heat loss to that associated with net vapor generation.

3.3.5 GDCS Pools

The three SBWR GDCS pools are represented by a single tank in the PANDA facility. Since PANDA was designed to model SBWR long-term cooling performance following the initiation of GDCS injection (i.e. scram + 1 hour), the GDCS tank is not scaled to the full GDCS volume of SBWR.

The PANDA GDCS tank is a cylindrical vessel with an outside diameter of 2.0 m and a volume of 17.6 m^3. The bottom of the PANDA GDCS tank is at the same elevation as the bottom of the PANDA drywell and is the same elevation above the TAF as the SBWR. During a test, the tank collects the condensate from the PCC units and returns it to the RPV.

3.3.6 PCC Condensers

The three SBWR PCC condenser units are represented in PANDA by three condenser units scaled 1:25 for the number of tubes and header volumes and scaled 1:1 in tube height, pitch and diameter. This provides a heat transfer surface area of 1:25 of each SBWR unit. Each of the PANDA PCC units has 20 tubes welded at the top and bottom to headers having the same diameter as the SBWR units. Each of the three units has the appearance of a slice of one module of a two-module SBWR unit. This scaling is expected to ensure that secondary side behavior of the PANDA condenser unit is representative of the SBWR units. Since the PANDA condensers are only small segments of the SBWR condensers, side plates have been added to guide the flow through the tube bundle in a manner similar to that expected in a complete condenser. The PANDA PCC units are shown in Figure 3-3.

One of the PCC units (PCC1) receives steam/air mixture from DW1, vents to WW1 and drains the condensate to the GDCS tank. The other two units (PCC2 and PCC3) receive inlet flow from DW2, vent to WW2 and drain the condensate to the GDCS tank. One PCC unit, PCC3 has been constructed so that it can also receive steam directly from the RPV in order to test the steady-state performance of the condenser (See Figure 3-4).

3.3.7 Isolation Condensers

The SBWR isolation condensers are represented in PANDA by a single condenser unit, similar in design to the PANDA PCC units. The PANDA IC is scaled 1:25 to the capacity of two of the three SBWR units. It has 20 tubes of full height and diameter with prototypical spacing. Side plates guide the secondary flow outside the tubes to make it similar to the secondary side behavior of the SBWR units.

The PANDA IC unit receives steam or steam/air mixture from the simulated RPV and returns condensate to the same vessel. Small vent lines can discharge non-condensable gas from the upper and lower headers of the IC to WW1.

3.3.8 Top LOCA vents

The SBWR LOCA vents are represented in PANDA by two 100 mm diameter pipes, one from each drywell to the suppression pool of the corresponding wetwell tank. The drywell end of the vent is connected at the wall of the drywell vessel, near the bottom. The pipe enters the side of the wetwell tank, near the top of the gas space, and then turns 90-degrees downward and ends below the surface of the suppression pool. The flow resistance in the LOCA vents is not scaled for pressure drop as was done for other system piping. The pipe diameter is smaller than the "scaled" diameter (greater flow resistance) but is not a concern because there should be little or no flow through the SBWR LOCA vents at 1 hour after a scram. The suppression pool end of this pipe is submerged to a depth equivalent to the top of the uppermost LOCA vent.

3.3.9 Vacuum Breaker

The three SBWR drywell-wetwell vacuum breakers are mounted in the diaphragm floor which separates the upper drywell from the wetwell gas space. This flow path is simulated in the PANDA facility by a pipe from near the bottom of the each drywell to near the top of the corresponding wetwell. The vacuum breaker valve itself is simulated by control valves in each of these pipes. The valve controllers are programmable so that the differential pressure required for opening and closing can be controlled.

A simulated wetwell/drywell leakage path is provided by a bypass line with a valve around each of the two simulated vacuum breaker valves. Effective bypass leakage areas can be varied by changing the size of an orifice in the bypass line and the bypass flow measurement system.

3.3.10 Other System Piping

The PANDA piping which simulates the significant SBWR piping has been scaled to provide prototypical pressure losses for the scaled PANDA flow rates. The scaling has been generally based on the SBWR design as it was in December 1992. The following piping has been scaled:

PCC Condenser Piping. Each of the three PCC Condenser units has an inlet line, a condensate drain line, and a vent line.

Isolation Condenser Piping. The Isolation Condenser unit has a steam inlet line, a condensate return line, and a line for venting non-condensable gas from both the upper and lower headers.

GDCS Lines to RPV. A pipe is provided to drain water from the GDCS Pool tank to the simulated RPV.

Main Steam Line. Piping is provided to carry steam from the RPV to the drywell, representing six SBWR depressurization valves (DPV) or one broken SBWR main steam line and five DPVs.

Equalizer Line. Piping representing the SBWR equalizing line has been provided between the bottom of the wetwells and the simulated RPV.

Auxiliary Lines. The primary purpose for these lines is to supply temperature-controlled steam, water, and air to vessels and tanks in order to achieve the proper initial conditions. Under certain circumstances, specified in the test procedures, these lines may be incorporated into the actual tests.

3.4 Steady State Test Configuration

The steady state PCC tests will be run with a different hardware configuration than that to be used for the transient tests. As shown in Figure 3-4 and Figure 5-5, a pipe will be installed to deliver steam directly from the RPV to PCC3. Air can be injected into this line downstream of the steam flow measurement location. The drywell tanks play no part in these tests, so they are isolated. The pressure in the GDCS tank and the wetwell tanks are equalized through an auxiliary steam line. The PCC3 drain line will be open to the GDCS tank and the GDCS tank drain line will be open to the RPV. The check valve in the GDCS tank drain line is removed. The PCC3 vent line to the wetwell (WW2) is not submerged in water in order to better control the pressure at the PCC3 upper header.

For all tests (S1 through S9) the PCC3 steam supply line is insulated as shown in Figure 3-4.

For the tests S7 through S9 the upper and the lower drum of the PCC3 unit will partially be insulated. The insulation covers 70% of the cylindrical part of the drum circumference. The region where the condenser tubes are welded to the drum is not insulated. Figure 3-5 shows the details for the insulation of the upper drum. The lower drum is insulated in the same manner.

For the tests S7 through S9 the section of the condenser vent line which is submerged in the PCC pool will be insulated by two 1mm thick layers of Polytetrafluorethylen, wrapped around the pipe.

In Table 3.1 the tolerances on the key facility characteristics for the PANDA Steady-State PCC Performance Tests are listed.

Table 3.1: PANDA Steady-State PCC Performance Tests
Key Facility Characteristics

PARAMETER	TOLERANCE ON NOMINAL DESIGN DIMENSIONS	TOLERANCE ON AS-BUILT DIMENSIONS
PCC3 Heat Exchanger Tubing		
- Length	± 5%	± 5 mm
- Outside Diameter	± 5%	± 0.3 mm
- Thickness	± 15%	± 0.2 mm
PCC3 Heat Exchanger Headers		
- Outside diameter	± 5%	± 5 mm
- Length	± 5%	± 5 mm
- Thickness (variable)	± 5%	± 0.3 mm
- Distance between headers (drums)	± 5%	± 5 mm

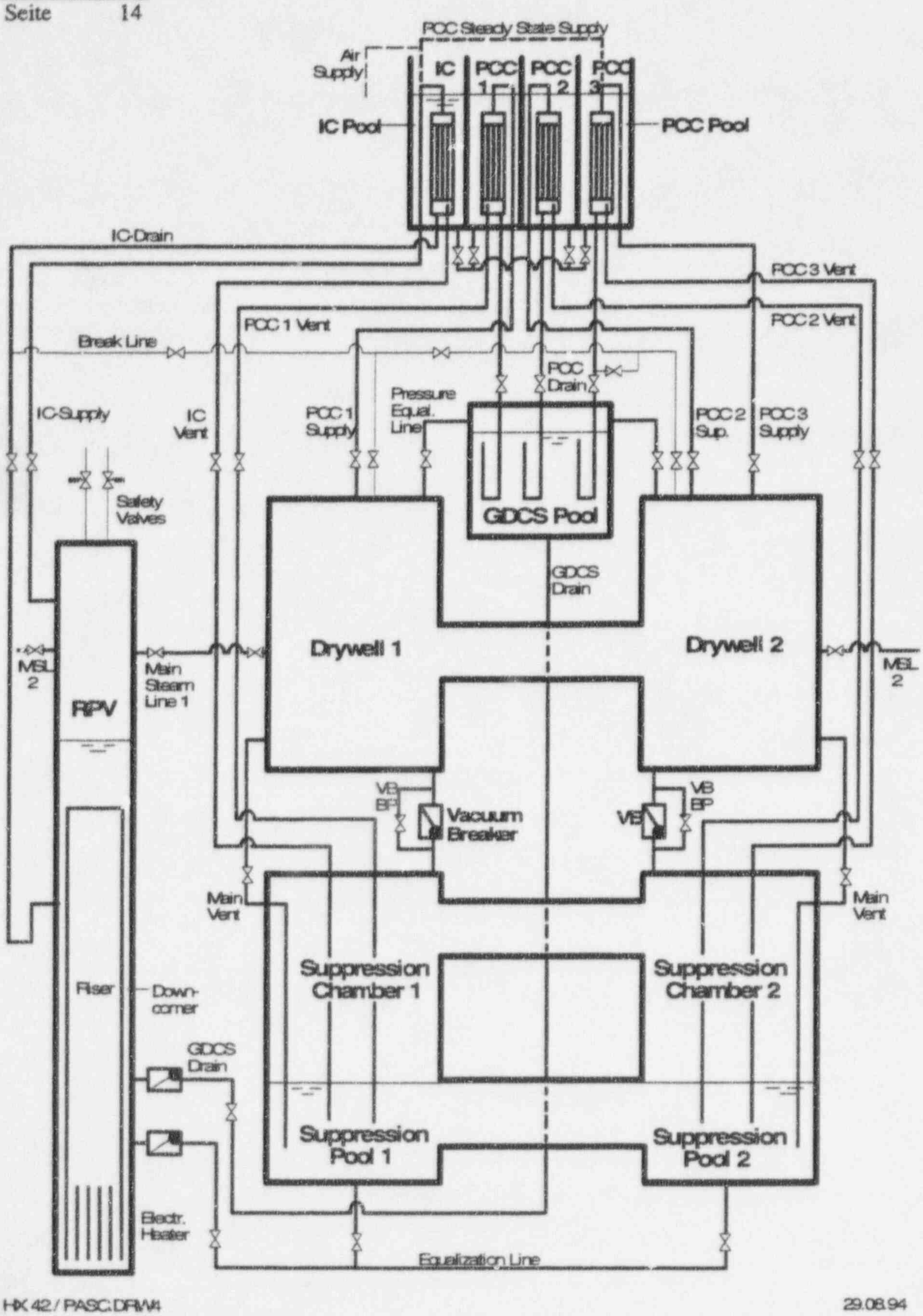

Fig. 3.1: PANDA Experimental Facility Schematic.

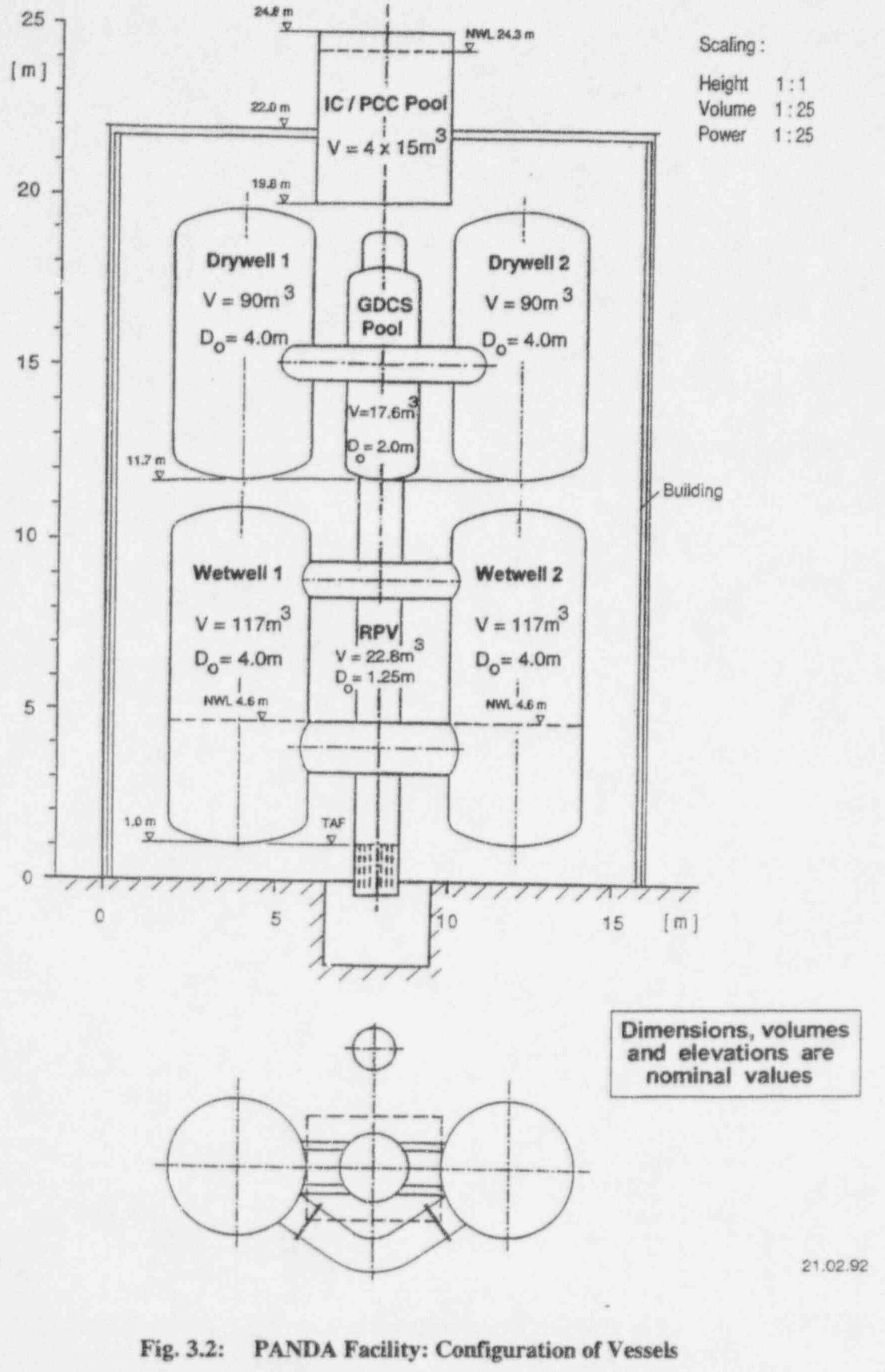

Fig. 3.2: PANDA Facility: Configuration of Vessels

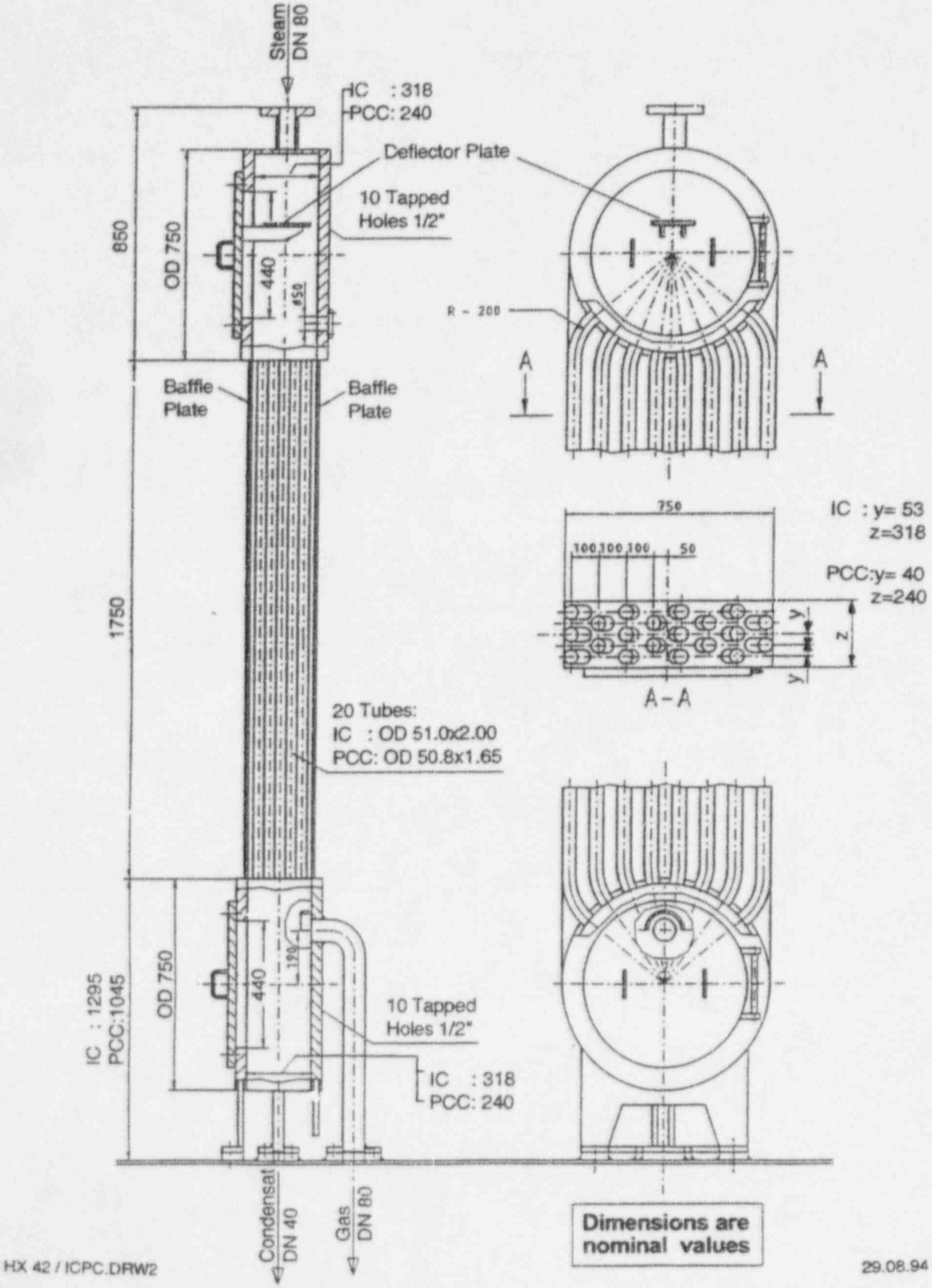

Fig. 3.3: PANDA Facility: IC/PCC Test Units

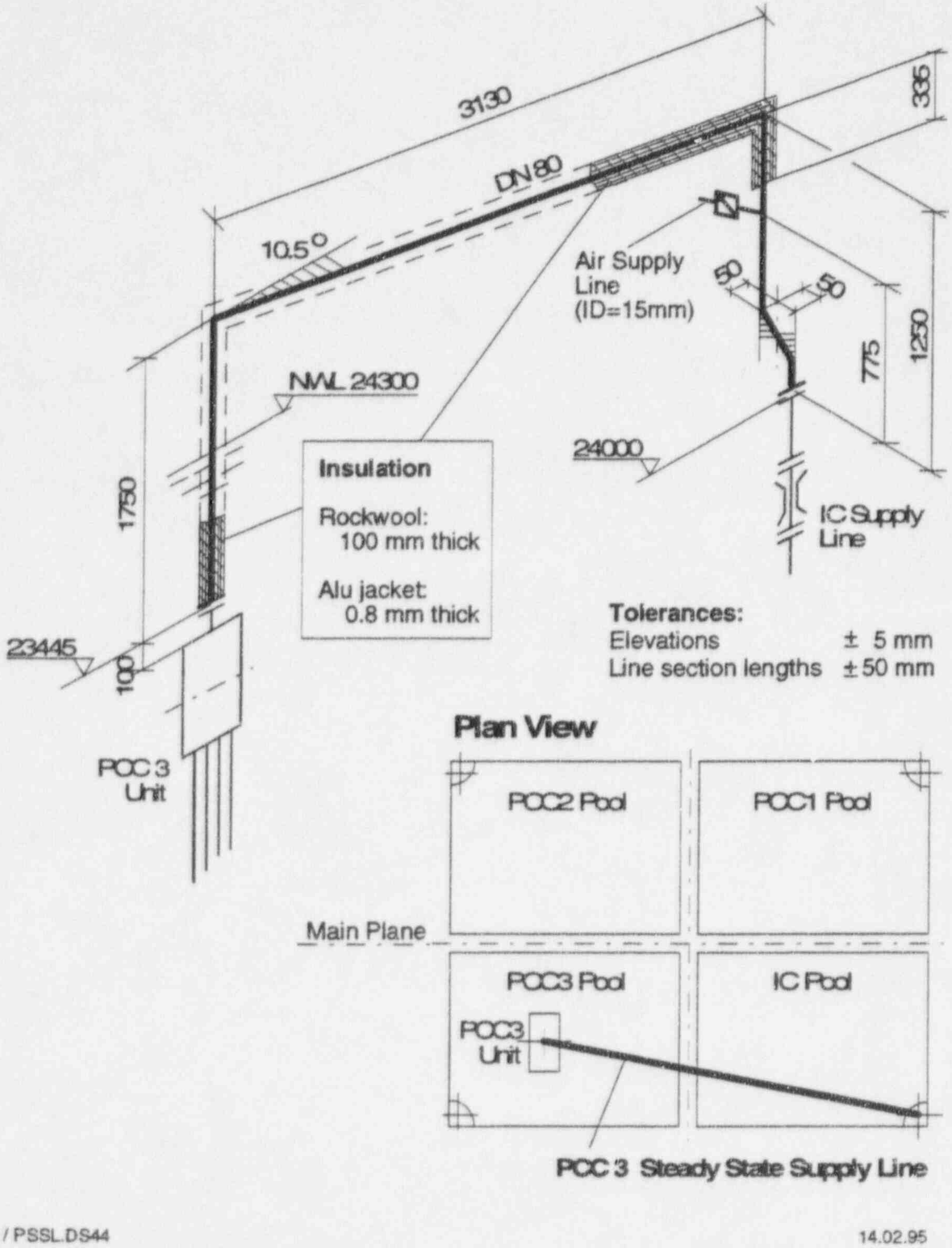

Fig. 3.4: **PANDA Facility: PCC3 Steady State Supply Line.**

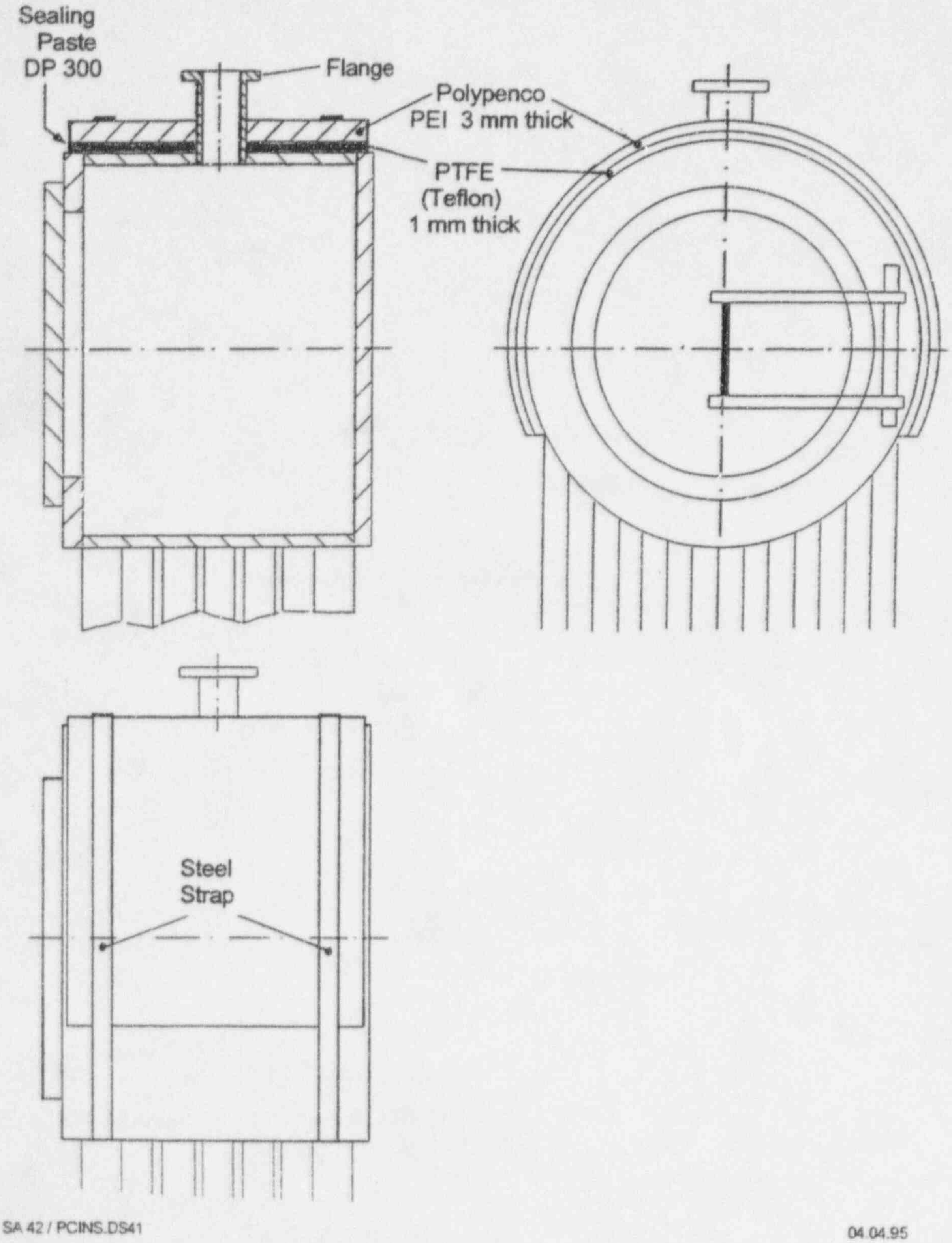

Fig. 3.5: PANDA Facility: IC/PCC Upper Drum Insulation

4. TEST FACILITY CONTROL AND SAFETY CONSIDERATIONS

4.1 Control System Description

In order to perform the steady state PCCS condenser performance tests, several control loops are to be used. These control loops will be used to manage and regulate the key test parameters. A main control system which includes the electronic controllers will be used to perform the operations.

4.1.1 Steam Flowrate Control

The control of the steam mass flow-rate to the PCC3 condenser is performed by the operator by varying the electrical power to the heaters in the RPV. The operator will adjust the power as needed to achieve the desired mass flow rate based on the measured mass flow rate determined from a vortex volumetric flow meter together with the temperature and pressure in the steam line near the vortex flow meter.

4.1.2 Air Flowrate Control

The control of the air flow-rate to the PCC3 condenser is performed using a digital electronic controller to which are connected the air mass flow measurement (hot-film flow meter) as the process variable and a pneumatic valve, inserted in the air supply line, as the actuator.

4.1.3 Pressure Control

The pressure at the inlet to the PCC3 condenser is indirectly established by controlling the wetwell (WW2) pressure using the vent system. If the PCC3 inlet pressure is low, it is possible to add air to the wetwell for those tests with pure steam flow. For these tests the auxiliary air supply system is available, because it is not being used to supply air flow to PCC3. With the wetwell temperatures at approximately saturation temperature, however, it is expected that air addition to the wetwell will not be necessary to maintain pressure.

4.1.4 PCC Pool Level Control

The PCC pool level will be monitored based on a differential pressure measurement of the head of water in the PCC pool. The test operator will maintain the collapsed pool level within the range specified for each test by adding or draining water from the PCC pool using the auxiliary water supply system.

4.1.5 RPV Water Level Control

The RPV water level will be monitored based on differential pressure measurements along the vertical length of the RPV. Once the water level in the RPV is established prior to the test, the level should remain within the range specified for each test without any draining or adding of water to the RPV during the test, because the test duration is short and the condensate drain flow to the RPV from PCC3 via the GDCS tank will make up for some of the steam flow rate from the RPV to PCC3.

4.2 Safety Considerations

To assure the structural integrity of the PANDA components and piping, the following safety valves are installed on the PANDA vessels with the noted pressure setpoints.

SAFETY VALVE	VESSEL	PRESSURE SETPOINT
CS.RS1 and CS.RS2	RPV (V.RP)	10 bar (gage)
CS.P0	Compressed air Primary tank	10 bar (gage)
CS.PG	Compressed air control tank	10 bar (gage)

(Valve and Vessel ID's are defined in Section 5.2 and Tables 5.1 and 5.2)

In addition, to assure the structural integrity of the IC and PCC condensing pools, the top of the pool will be uncovered or open directly to the atmosphere so the pressure at the pool surface will be equal to the atmospheric pressure during all shakedown tests and matrix tests.

5. INSTRUMENTATION

5.1. General Requirements

The test facility shall have sufficient instrumentation to measure all parameters needed to achieve the test objectives defined in Section 2. All test instrumentation shall be provided by PSI and shall be calibrated as necessary against traceable standards, i.e. the U.S. National Institute of Standards and Technology or equivalent.

The following Sections 5.2, 5.3, 5.4 and 5.5 cover all the currently planned instrumentation which will be used at PANDA (i.e. for steady-state and for transient tests). Section 5.6 describes the specific instrumentation requirements for the steady-state tests.

5.2 Instrumentation Identification System

The identification system for the PANDA instrumentation employs the PANDA identification code. This is composed of three strings, which are separated by a point.

<type> . <designation> . <extension>

<type> addresses the function of an identified item, <designation> refers to its location, which is expressed in terms of vessel or pipework designations (cf. Table 5.2), and <extension> is typically a counter, which allows items with otherwise identical type and designation to be distinguished. The syntax is:

CAA . CAA . AA

where 'C' stands for a character , 'A' for an alphanumeric symbol; underlined positions are mandatory. Hence, an identification code has a minimum length of four symbols and a maximum length of ten.

Based on this identification code, PANDA measuring instruments are identified by a <type> with 'M' or 'I' in the first (mandatory character) position. 'M' is used for instruments with electronically recordable output and 'I' is used for instruments with only local visual indication of measurement.

For measured data from one instrument or data which is calculated primarily from one instrument, the same identification is used as for the corresponding instrument. For measured data, which is calculated (derived) from more than one direct measurements, an additional <type> with 'D' in the first position is used if no single instrument is the primary measurement.

For a measurement identification the second symbol in the <type> string is also mandatory and specifies the measured quantity, e.g. 'T' stands for temperature, 'P' for pressure, etc. However, this information symbol moves to third position when the symbol 'S' is put in the second position, specifying that the measured quantity (typically flow) is being integrated over time. Elsewhere the third position is used to further specify the measured quantity, e.g. partial pressures or different types of temperature measurements.

5.3 Instrumentation Description

The PANDA test facility has the capability to measure the following physical parameters: temperatures, mass flow rates, pressures, differential pressures, liquid levels, gas concentrations, and electrical power. PSI document [2] defines the ranges expected for the various parameters to be measured. Table 5.3 provides a list of all the instrumentation available on the PANDA facility together with the key characteristics of each instrument including, in addition to the system instrumentation, the instrumentation of the auxilary systems. Figures 5.1 through 5.4 together with Table 5.3, show the general locations of all the instrumentation. Table 5.4 gives a summary listing of the total number of sensors of each type. The following provides an overview of the measurement capability in the facility.

5.3.1 Temperature

Most temperature measurements in the PANDA facility will be made with Inconel-sheathed Type K (Chromel-Alumel) thermocouples. The reference junction temperatures will be measured with thermistors.

There will be capability to measure the following fluid temperatures with Type K thermocouples:

- in the gas and liquid regions of vessels, i.e.
  - RPV
  - drywells and connecting line between drywells
  - wetwells and two connecting lines between wetwells
  - GDCS pool
- in the liquid regions of IC/PCC pool
- liquid surfaces temperature in DW's, WW's and GDCS pool
- in the system lines, i.e.
  - lines from the RPV to the drywell and the IC
  - lines from the drywell to the PCCs
  - LOCA vent lines
  - PCC vent lines
  - IC, PCC and GDCS drain lines
  - vacuum breaker lines between the drywells and wetwells
  - wetwell/RPV equalization lines
  - in the upper and lower headers of the IC and the PCC units
  - inside some of the tubes in all four condensers.

In addition metal temperature measurements will be taken with Type K thermocouples:

- along the length of some of the IC and PCC condenser tube walls
- on the walls of key vessels and system lines.

Platinum resistance (Pt100) temperature measuring devices with Contrans T TEU 421 amplifiers manufactured by Hartmann & Braun will be used to measure the fluid temperature at all flow rate measurement locations.

5.3.2 Flowrate

Flow rates in PANDA will be measured with four different types of flow measuring devices.

Three ultrasonic flow meters (System 990 Uniflow model manufactured by CONTROLOTRON) can be used to measure the volumetric flow rate at any three of the following locations:

- the PCC drain lines to the GDCS
- the GDCS drain line to the RPV
- the IC drain line to the RPV
- the equalization line between the RPV and suppression pool.

Ten vortex flow meters (Vortex PhD-90S model manufactured by EMCO) are set up in PANDA to measure the volumetric flow rate at the following locations:

- the main steam lines
- the IC and PCC supply lines
- the PCC vent lines
- the water supply line to the RPV or to the water auxiliary system

A small vortex flow meter (Swingwirl II model manufactured by Endress & Hauser) will be used to measure the flow in one vacuum breaker bypass leakage line.

A hot-film flow measuring device (Sensyflow VT2 model manufactured by SENSYCON) will be used to measure the air mass flow supplied to the PANDA facility by the auxiliary air system.

5.3.3 Pressure

Pressures throughout the PANDA facility will be measured with Rosemount model 3051CA, 2088A, and 1144A pressure transducers.

The facility has the capability to measure pressure at the following locations:

- in the RPV
- in the drywell vessels
- in the wetwell vessels (gas space)
- in the IC and PCC upper headers (at the inlet flow measurement location)
- in the GDCS tank
- the atmospheric pressure
- at all steam/gas flow measurement locations.

5.3.4 Differential pressure

Differential pressures throughout the PANDA facility will be measured with Rosemount model 3051CD and 1151DP transducers. Capability exists to measure the pressure differences:

- between the gas spaces of the major vessels, i.e.
  - RPV to DW1 along MS1
  - RPV to DW2 along MS2
  - DW1 to WW1
  - DW2 to WW2

- along the length of key lines, i.e.
  - PCC inlet, vent and drain lines
  - IC inlet and drain lines
  - GDCS drain line
  - WW1 and WW2 to RPV equalization line

- between upper and lower headers of the IC and PCC condenser units.

5.3.5 Water Level

Water levels will be determined at several location in the facility by differential pressure measurements with Rosemount model 3051CD and 1151DP pressure transducers. The capability exists to measure the actual water levels in these vessels:

- both drywell vessels
- both wetwell vessels
- the GDCS tank.

The equivalent "collapsed" liquid levels can be measured in locations which may have gas (steam or air) below the water surface. These are:

- in the RPV (total and 5 subsections)
- in each of the four compartments of the IC/PCC pool tank.

Capability also exists to measure the liquid level in the following lines:

- the LOCA vent lines
- the vent lines for the PCC condenser units.

5.3.6 Fluid Phase Indicator

Eight conductivity probes will be used to determine whether the fluid phase is liquid or gas at the probe location. The probes are located:

- near the bottom (exit) of the LOCA vent lines from the DW to the WW
- at the inlet and outlet of the vent lines for each of the three PCC condensers.

5.3.7 Gas concentration/humidity

Two oxygen analyzers which have the capability to determine the oxygen partial pressure can be mounted at three locations in each drywell and at two locations in each wetwell. The oxygen analyzer can be used to determine the concentration (mass-fraction) of non-condensable gas at saturated and superheated conditions.

5.3.8 Miscellaneous

Wattmeters will be used to measure the electrical power to the RPV heaters.

5.4 Instrument Calibration

5.4.1 Temperature Measurements

Inconel-sheathed Type K (Chromel-Alumel) thermocouples will be used for nearly all temperature measurements in the PANDA test facility. Approximately one-third of these thermocouples will be calibrated individually prior to installation in the facility using the thermocouple calibration procedure and hardware described in PSI report [3]. Platinum resistance temperature measuring devices (RTDs) are used for the reference calibration temperature. These platinum RTDs are calibrated in Bern at Eidgenössisches Amt für Messwesen (Swiss Federal Office of Metrology).

Table 5.6 shows that all the thermocouples to be used in PANDA will be made from a few rolls or batches of bulk thermocouple cable purchased mainly from Philips (a commercial supplier). PSI checks each batch of thermocouple wire, upon receipt from the manufacturer, to confirm the wire meets the manufacturers specification. This check is done by calibrating thermocouples made from each end of the batch or roll, over a temperature range of 50°C to 600°C.

In addition to the check of the thermocouple material when received from the manufacturer, as stated above, approximately one-third of the thermocouples to be used in PANDA will be calibrated individually using the [3] procedure. Table 5.6 shows the number of thermocouples to be calibrated and the total number of thermocouples to be used from each batch. The individual calibration will be based on approximately 30 calibration points spread uniformly over the temperature range from 50°C to 200°C. The results of these individual thermocouple calibrations will be combined for the thermocouples from each batch and statistically analyzed. The large sample individually calibrated from a batch provides confidence that the roll calibration is applicable to those thermocouples which have not been individually calibrated. From the analysis a look-up table or a constant or first order (linear) correction to the standard calibration for this thermocouple material will be determined for each batch. The look-up table or correction to the standard for each batch will be used to determine the temperatures for all thermocouples in each of the batches. The results of the analysis of the individual calibration data compared with the roll calibration will be used to show that the thermocouple accuracy requirement of ±1.5°C for the temperature measurements is fulfilled.

No recalibration of the thermocouples is planned, because most of the thermocouples would be destroyed when removed from the facility. On the other hand the temperature ranges for the thermocouples are sufficiently low to not influence the thermocouple characteristics and the sheathed K Type thermocouples have a very good long term stability. It should also be noted that there is substantial redundancy in the temperature measurements, so it will be apparent if a thermocouple reading is significantly in error.

A sample of six (approximately one-third) of the Pt100 resistance temperature measuring devices to be used to measure fluid temperatures at flow measurement locations will be calibrated by a Swiss Calibration Service Laboratory (Calibration Laboratory accredited by the Swiss Confederation represented by the Eidgenössisches Amt für Messwesen at Bern). A sample calibration of these Pt100 sensors is sufficient due to the following reasons:

a) the combined most probable error for the sensor, the amplifier, and DAS of 0.4°C [10] is small compared to the required accuracy (1.5°C),

b) the six calibration results show that the standard error is less than that given by the manufacturer,

c) in the PANDA facility there is much redundancy for temperature measurements, therefore the noncalibrated Pt100 temperature measurements can be compared with other temperature measurements during homogenous temperature conditions to confirm the manufacturer's calibration of these temperature sensors.

5.4.2 Flow Rate Measurements

Each ultrasonic and vortex volumetric flow rate meter will be individually calibrated in Bern at the Eidgenoessisches Amt fuer Messwesen prior to installation in the PANDA test facility. A linear fit to the calibration data for each volumetric flow meter will be determined and used for reduction of the flow meter data. For one flow meter of each size and type, ten to thirteen calibration points will be obtained covering the full range of expected flow rates with emphasis on low flow conditions. If these calibration data show the flow meter calibration is linear over the flow range calibrated, then the calibration of other flow meters of this size and type will be done with fewer calibration points (at least six).

The hot-film flow meter to be used for measurement of mass flow rates for air added to the facility with the auxiliary air system will be calibrated by the manufacturer, a German Calibration Service Laboratory (an accredited calibration laboratory).

The flow rate meters will be recalibrated after two years, i.e. in early 96, or earlier if there is an apparent error in a flow rate measurement or the test flow rates are exceeding the calibration range. Any significant change in calibration* for a flow meter will be identified as a non-conformance per PQAP-NC and considered in reporting and reduction of the flow rate data for that flow meter.

5.4.3 Pressure and Differential Pressure Measurements

All pressure and differential pressure sensors to be used in PANDA are manufactured by Rosemount Inc. All these sensors will be calibrated by PSI prior to installation in the facility according to the procedure defined in [4], except for the Model 2088 and SMART Rosemount pressure sensors. For the Model 2088 and SMART sensors the calibration data obtained at the Rosemount factory will be used.

The device used to generate and measure the reference pressure for the PSI calibration of all other pressure sensors is a Baratron System 170 manufactured by MKS Instruments, Inc. The reference is calibrated in Bern at Eidgenoessisches Amt fuer Messwesen.

* A significant change in calibration is defined as a change which would result in the sensor not meeting the accuracy requirement specified in Table 5.3.

The pressure and differential pressure sensors will be recalibrated after two years, i.e. in early 96. Any significant changes in calibration* will be identified as a non-conformance per PQAP-NC and considered in the reduction and reporting of data for the specific sensor with the change in calibration.

Approximately 10 calibration points will be recorded for each sensor covering the range of pressures or differential pressures expected from [2]. A linear fit to the calibration points for each sensor will be determined using the least squares method. The residual for the calibration points relative to the linear fit will be determined for each sensor. The residual will be used to establish whether or not each sensor meets its accuracy requirement.

5.4.4 Oxygen Partial Pressure Measurements

The oxygen partial pressure will be measured at some locations in the PANDA facility in order to infer the air partial pressure and humidity. The voltage output of the sensor to be used to measure the oxygen partial pressure is a function of the sensor temperature and the differential oxygen pressure across the element. [5] describes an evaluation of the feasibility of using this sensor to determine the air partial pressure and humidity in the PANDA tests. It is not necessary to calibrate this instrument based on the evaluation in [5].

5.4.5 Conductivity Probe

Conductivity probes will be used to establish whether the fluid phase at the probe location is liquid or gas. Prior to a series of tests in which the conductivity probe measurements are required, the water level near the probe will be varied so that the probe is exposed to only gas and then to only water. The output of the probe will be monitored and recorded at the Data Acquisition System (DAS) while the fluid phase the probe is exposed to is changed. This will be done to confirm that the probe can detect whether it is exposed to gas or water.

5.4.6 Power Measurement

The 115 electrical heater rods of the RPV, with a maximum capacity of 1.5 MW, are divided in 6 groups. Four groups with 23 heater rods in each group are on/off controlled and two groups with 4 and 19 heater rods, respectively, have a continuous power control. Four Sineax PQ502 Wattmeters are used for measuring the heater power of the four on/off groups. The power of the two controlled groups is measured by Sineax 6P1 Wattmeters. All six Wattmeters will be calibrated by an accredited Swiss Calibration Service Laboratory (cf. Section 5.4.1). In addition, the total power of the RPV heaters is generated using an electrical summing of the six measured group powers.

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* A significant change in calibration is defined as a change which would result in the sensor not meeting the accuracy requirement specified in Table 5.3.

5. 5 Error Evaluation

The most probable error for directly measured quantities (thermocouples, resistance temperature detectors, and core power) are calculated using the following:

$$\sigma^2 = \sigma_i^2 + \sigma_{ad}^2 + \sigma_{rj}^2 \tag{5.1}$$

where σ_i is the instrument accuracy, σ_{ad} is the error associated with the analog to digital converter, and, in the case of thermocouples, σ_{rj} is the error associated with the reference junction temperature measurement. The upper bound error is then calculated in a similar fashion:

$$\sigma_{max} = |\sigma_i| + |\sigma_{ad}| + |\sigma_{rj}| \tag{5.2}$$

The instrument accuracy for the thermocouple wire is based upon manufacturer specifications and calibrations performed at PSI. Accuracies of the other instruments are based upon manufacturer specifications or calibrations performed at the Swiss equivalent of the National Bureau of Standards.

The upper bound and most probable errors in the flow rates, absolute and differential pressures, water levels, air partial pressures, and condenser efficiencies are calculated from the relations detailed in Section 7 along with an error propagation formula. The most probable error in the quantity **u** is calculated from the following:

$$\sigma^2 = \sum_{i=1}^{N} \left(\frac{\partial u}{\partial x_i} \right)^2 \sigma_{x_i}^2 \tag{5.3}$$

where the $\mathbf{x}_i$ represent the measured quantities comprising **u**. The upper bound error takes a similar form:

$$\sigma_{max} = \sum_{i=1}^{N} \left| \frac{\partial u}{\partial x_i} \right| |\sigma_{x_i}| \tag{5.4}$$

The "accuracy" values for most of the instruments listed in Table 5.3 are based on calculations of the most probable errors using Equation 5.1 or 5.3. The detailed error analysis is summarized in [10].

5.6 Required Measurements For Tests S1 through S9

The steady state test configuration and the required instrumentation is summarized in Figure 5.5. Table 5.5 gives the measurements required to meet the objectives for Tests S1 through S9. Temperature measurements in PCC3 are desirable, but not all of these temperature measurements are required for the performance of these tests. No PANDA instrumentation other than that in Table 5.5 is necessary for the performance of Tests S1 through S9. All the sensors listed in Table 5.5 must be operable when these tests are run, except for the PCC3 temperature measurements. For the PCC3 temperature measurements, all that are required are the PCC3 inlet and outlet temperatures and a representative sample of the other temperatures as determined by the test engineer at the time of the test.

It is desirable, but not required, that at least two tests with the lower air flow rates, i.e. less than 0.01 kg/s, have enough PCC3 temperature readings to allow detailed evaluation of the heat transfer.

Table 5.1: <type> list of PANDA instrumentation identification code

C . .			Control
CC			Control valve
M .			electronically recordable measurement
	MD		pressure difference
	ME		electrical conductivity (<==> water quality)
	MH		humidity
	MI		phase indicator
	ML		water level
	MM		mass flow
	MP		absolute pressure
	MPG		air partial pressure
	MT		temperature measurement
		MTF	fluid temperature
		MTG	gas temperature
		MTI	inside wall temperature of vessels
		MTL	liquid temperature
		MTO	outside wall temperature of vessels
		MTR	thermocouple reference temperature
		MTS	water surface temperature
		MTT	wall temperature of condenser tubes
		MTV	wall temperature of lines
	MV		volume flow
	MW		electrical power

Table 5.2: <designation> list of PANDA components identification code

Main System

B0B	condensate drain Break system: main Bus
B1B	condensate drain Break system: D1 connection
B2B	condensate drain Break system: D2 connection
D1	Drywell 1
D2	Drywell 2
EN	Environment
EQ0	Equalization line: common branch
EQ1	Equalization line: S1 branch
EQ2	Equalization line: S2 branch
GD	Gravity Driven cooling system
GP1	GD Pressure equalization line 1
GP2	GD Pressure equalization line 2
GRT	GD Return line
I1	Isolation condenser
I1B	condensate drain Break system: I1 connection
I1C	I1 Condensate line
I1F	I1 Feed line
I1V	I1 Vent line
IP3	P3 feed line - segment from I1 (for steady state test only)
MS1	Main Steam line 1
MS2	Main Steam line 2
MSX	exchangable measurement section for Main Steam line
MV1	Main Vent line 1
MV2	Main Vent line 2
P1	Passive containement cooler 1
P1C	P1 Condensate line
P1F	P1 Feed line
P1V	P1 Vent line
P2	Passive containement cooler 2
P2C	P2 Condensate line
P2F	P2 Feed line

P2V	P2 Vent line
P3	Passive containement cooler 3
P3B	condensate drain Break system: P3 connection
P3C	P3 Condensate line
P3F	P3 Feed line
P3V	P3 Vent line
RP	Reactor Pressure vessel
S1	Suppression chamber 1
S2	Suppression chamber 2
TD0	D1-D2 connection
TSU	S1-S2 upper connection
TSL	S1-S2 lower connection
U0	I1 pool
U1	P1 pool
U2	P2 pool
U3	P3 pool
VB1	Vacuum Breaker line 1
VB2	Vacuum Breaker line 2
VL1	Vacuum breaker Leakage line 1
VL2	Vacuum breaker Leakage line 2

Auxilary water system

B0A	Recirculation pump circuit	
B0D	Demineralized water main bus	
B1L	Low bus branch	D1/S1
B1U	Upper bus branch	D1/S1
B2L	Low bus branch	D2/S2
B2U	Upper bus branch	D2/s2
BCA	Cooler bypass	
BHA	Heater bypass	
CRW	Cooling water cooler	
D1L	Low bus D1 connection	
D1U	Upper bus D1 connection	
D2L	Low bus D2 connection	
D2U	Upper bus D2 connection	

GDU	Upper bus GD connection
HRH	Heating water return heater
S1L	Low bus S1 connection
S1U	Upper bus S1 connection
S2L	Low bus S2 connection
S2U	Upper bus S2 connection
TD	Demineralized water tank PANDA
TP	Demineralized water tank PSI
U0L	Low bus IC pool connection
U0U	Upper bus IC pool connection
U1L	Low bus P1 pool connection
U1U	Upper bus P1 pool connection
U2L	Low bus P2 pool connection
U2U	Upper bus P2 pool connection
U3L	Low bus P3 pool connection
U3U	Upper bus P3 pool connection

Auxilary gas system

B0G	Main gas/air line
RPG	RP connection

Auxilary steam system

D1S	D1 connection
D2S	D2 connection
GDS	GD connection
S1S	S1 connection
S2S	S2 connection

Auxilary vent system

D1V	D1 connection
D2V	D2 connection
GDV	GD connection
RPV	RP connection
S1V	S1 connection
S2V	S2 connection

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
220	CC.B0G.1	G 25	0 - 100 %	-	control valve AGS:Compressor Bus
223	CC.B0G.2	G 25	0 - 100 %	-	control valve AGS:Compressor Bus
28	CC.BCA	G 100	0 - 100 %	-	control valve AWS:Cooler Bypass
29	CC.BHA	G 100	0 - 100 %	-	control valve AWS:Heater Exchanger Bypass
551	CC.BUV	K 100	0 - 100 %	-	control valve AVS:Upper Vent Bus
30	CC.CRW	G 100	0 - 100 %	-	control valve AWS:Cooler->ENV. reg.water
350	CC.MS1	K 150	0 - 100 %	-	control valve Main Steam line RPV->DW1
351	CC.MS2	K 150	0 - 100 %	-	control valve Main Steam line RPV->DW2
552	CC.RPV	B 50 R	0 - 100 %	-	control valve AVS:RPV pressure relief bypass
348	CC.S1V	K 100	0 - 100 %	-	control valve AVS:SC1 pressure relief
349	CC.S2V	K 100	0 - 100 %	-	control valve AVS:SC2 pressure relief
27	CC.UXY	B 50 RC	0 - 100 %	-	control valve AWS:Upper Bus->ENvironment
5	MD.EQ1	RM 1151 DP5	-31.- 155. kPa	1.62 kPa	pressure diff. meas. EQualization line SC1 branch
6	MD.EQ2	RM 1151 DP5	-31.- 155. kPa	1.62 kPa	pressure diff. meas. EQualization line SC2 branch
105	MD.GRT	RM 1151 DP5	-36.- 150. kPa	1.68 kPa	pressure diff. meas. Condensate Return GDCS->RPV
536	MD.I1	RM 3051 CD2	15.- 25. kPa	0.21 kPa	pressure diff. meas. IC Condenser
104	MD.I1C	RM 1151 DP5	0.- 150. kPa	1.91 kPa	pressure diff. meas. IC Condensate IC->RPV
532	MD.I1F	RM 3051 CD3	10.- 40. kPa	0.58 kPa	pressure diff. meas. IC Feed RPV->IC
543	MD.I1V.1	RM 1151 DP4	-5.- 32. kPa	0.34 kPa	pressure diff. meas. IC Vent IC->SC1
530	MD.MS1	RM 3051 CD2	0.- 10. kPa	0.17 kPa	pressure diff. meas. Main Steam line RPV->DW1
531	MD.MS2	RM 3051 CD2	0.- 10. kPa	0.17 kPa	pressure diff. meas. Main Steam line RPV->DW2
98	MD.MV1	RM 1151 DP4	0.- 37. kPa	0.40 kPa	pressure diff. meas. Main Vent line DW1->SC1
99	MD.MV2	RM 1151 DP4	0.- 37. kPa	0.40 kPa	pressure diff. meas. Main Vent line DW2->SC2
537	MD.P1	RM 3051 CD2	15.- 25. kPa	0.21 kPa	pressure diff. meas. PCC1 Condenser
540	MD.P1C	RM 3051 CD2	0.- 30. kPa	0.25 kPa	pressure diff. meas. PCC1 Condensate PCC1->GDCS
533	MD.P1F	RM 3051 CD2	0.- 30. kPa	0.26 kPa	pressure diff. meas. PCC1 Feed DW1->PCC1
544	MD.P1V.1	RM 1151 DP4	-15.- 22. kPa	0.34 kPa	pressure diff. meas. PCC1 Vent PCC1->SC1
101	MD.P1V.2	RM 1151 DP4	0.- 37. kPa	0.37 kPa	pressure diff. meas. PCC1 Vent PCC1->SC1

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
538	MD.P2	RM 3051 CD2	15.- 25. kPa	0.21 kPa	pressure diff. meas. PCC2 Condenser
541	MD.P2C	RM 3051 CD2	0.- 30. kPa	0.25 kPa	pressure diff. meas. PCC2 Condensate PCC2->GDCS
534	MD.P2F	RM 3051 CD2	0.- 30. kPa	0.26 kPa	pressure diff. meas. PCC2 Feed DW2->PCC2
545	MD.P2V.1	RM 1151 DP4	-15.- 22. kPa	0.34 kPa	pressure diff. meas. PCC2 Vent PCC2->SC2
102	MD.P2V.2	RM 1151 DP4	0.- 37. kPa	0.37 kPa	pressure diff. meas. PCC2 Vent PCC2->SC2
539	MD.P3	RM 3051 CD2	15.- 25. kPa	0.21 kPa	pressure diff. meas. PCC3 Condenser
542	MD.P3C	RM 3051 CD2	0.- 30. kPa	0.25 kPa	pressure diff. meas. PCC3 Condensate PCC3->GDCS
535	MD.P3F	RM 3051 CD2	0.- 30. kPa	0.26 kPa	pressure diff. meas. PCC3 Feed DW2->PCC3
546	MD.P3V.1	RM 1151 DP4	-15.- 22. kPa	0.34 kPa	pressure diff. meas. PCC3 Vent PCC3->SC2
103	MD.P3V.2	RM 1151 DP4	0.- 37. kPa	0.37 kPa	pressure diff. meas. PCC3 Vent PCC3->SC2
224	MD.VB1	RM 3051 CD2	20.- 46. kPa	0.19 kPa	pressure diff. meas. Vacuum Breaker SC1-DW1
225	MD.VB2	RM 3051 CD2	20.- 46. kPa	0.19 kPa	pressure diff. meas. Vacuum Breaker SC2-DW2
34	ME.B0A	EH MYCOM	0 - 200 uS/cm	0.50%	water quality meas. AWS:Pump Circuit
35	ME.B0D	EH MYCOM	0 - 200 uS/cm	0.50%	water quality meas. AWS:Main Demine. Water Bus
36	ME.RP	EH MYCOM	0 - 200 uS/cm	0.50%	water quality meas. Reactor Pressure Vessel / RPV
578	MI.I1V.2	PSI/GA COND	0 or 1	-	phase indicator IC Vent IC->SC1
70	MI.MV1	PSI/GA COND	0 or 1	-	phase indicator Main Vent line DW1->SC1
71	MI.MV2	PSI/GA COND	0 or 1	-	phase indicator Main Vent line DW2->SC2
67	MI.P1V.1	PSI/GA COND	0 or 1	-	phase indicator PCC1 Vent PCC1->SC1
579	MI.P1V.2	PSI/GA COND	0 or 1	-	phase indicator PCC1 Vent PCC1->SC1
68	MI.P2V.1	PSI/GA COND	0 or 1	-	phase indicator PCC2 Vent PCC2->SC2
580	MI.P2V.2	PSI/GA COND	0 or 1	-	phase indicator PCC2 Vent PCC2->SC2
69	MI.P3V.1	PSI/GA COND	0 or 1	-	phase indicator PCC3 Vent PCC3->SC2
581	MI.P3V.2	PSI/GA COND	0 or 1	-	phase indicator PCC3 Vent PCC3->SC2
227	ML.D1	RM 3051 CD2	0-1.8 m	0.021 m	level meas. Drywell 1 / DW1
228	ML.D2	RM 3051 CD2	0-1.8 m	0.021 m	level meas. Drywell 2 / DW2
229	ML.GD	RM 3051 CD3	0-6.3 m	0.073 m	level meas. GDCS tank / GDCS
113	ML.MS1	RM 1151 DP4	0-1.0 m	0.033 m	level meas. Main Steam line RPV->DW1

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
114	ML.MS2	RM 1151 DP4	0-1.0 m	0.033 m	level meas. Main Steam line RPV->DW2
8	ML.RP.1	RM 3051 CD3	0-21.5m	0.166 m	level meas. Reactor Pressure Vessel / RPV
9	ML.RP.2	RM 1151 DP5	0-4.1 m	0.157 m	level meas. Reactor Pressure Vessel / RPV
107	ML.RP.3	RM 1151 DP4	0-3.8 m	0.042 m	level meas. Reactor Pressure Vessel / RPV
108	ML.RP.4	RM 1151 DP4	0-3.8 m	0.042 m	level meas. Reactor Pressure Vessel / RPV
226	ML.RP.5	RM 1151 DP5	0-7.7 m	0.166 m	level meas. Reactor Pressure Vessel / RPV
360	ML.RP.6	RM 1151 DP5	0-4.6 m	0.158 m	level meas. Reactor Pressure Vessel / RPV
110	ML.S1	RM 3051 CD2	0-4.6 m	0.039 m	level meas. Suppression Chamber 1 / SC1
111	ML.S2	RM 3051 CD2	0-4.5 m	0.039 m	level meas. Suppression Chamber 2 / SC2
40	ML.TD	EH FMC671 Z		-	level meas. AWS:PANDA Demineral. water Tank
41	ML.TP	EH FMC671 Z		-	level meas. AWS:PSI Demineral. water Tank
547	ML.U0	RM 1151 DP5	0-5.6 m	0.156 m	level meas. IC pool
548	ML.U1	RM 1151 DP5	0-5.6 m	0.156 m	level meas. PCC1 pool
549	ML.U2	RM 1151 DP5	0-5.6 m	0.156 m	level meas. PCC2 pool
550	ML.U3	RM 1151 DP5	0-5.6 m	0.156 m	level meas. PCC3 pool
239	MM.B0G	HB SENSYFL	0.0-27.8 g/s	2.00%	mass flow meas. AGS:Compressor Bus
57	MP.B0A	RM 2088 A3	0.0-13.0 bar	0.293 bar	absol. pressure meas. AWS:Pump Circuit
345	MP.B0G.1	RM 2088 A3	0.0-13.0 bar	0.293 bar	absol. pressure meas. AGS:Compressor Bus
347	MP.B0G.2	RM 3051 CA2	0.0-10.3 bar	0.023 bar	absol. pressure meas. AGS:Compressor Bus
555	MP.D1	RM 3051 CA2	0.0- 6.0 bar	0.022 bar	absol. pressure meas. Drywell 1 / DW1
556	MP.D2	RM 1144 A	0.0- 6.0 bar	0.172 bar	absol. pressure meas. Drywell 2 / DW2
2	MP.EN	RM 3051 CA2	0.0- 1.5 bar	0.021 bar	absol. pressure meas. ENvironment
338	MP.GD	RM 1144 A	0.0- 6.0 bar	0.169 bar	absol. pressure meas. GDCS tank / GDCS
346	MP.I1F	RM 3051 CA2	0.0-10.3 bar	0.024 bar	absol. pressure meas. IC Feed RPV->IC
218	MP.MS1	RM 3051 CA2	0.0-10.3 bar	0.023 bar	absol. pressure meas. Main Steam line RPV->DW1
219	MP.MS2	RM 3051 CA2	0.0-10.3 bar	0.023 bar	absol. pressure meas. Main Steam line RPV->DW2
344	MP.P1F	RM 3051 CA2	0.0- 6.0 bar	0.022 bar	absol. pressure meas. PCC1 Feed DW1->PCC1
341	MP.P1V	RM 3051 CA2	0.0- 6.0 bar	0.022 bar	absol. pressure meas. PCC1 Vent PCC1->SC1

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
557	MP.P2F	RM 3051 CA2	0.0- 6.0 bar	0.022 bar	absol. pressure meas. PCC2 Feed DW2->PCC2
342	MP.P2V	RM 3051 CA2	0.0- 6.0 bar	0.022 bar	absol. pressure meas. PCC2 Vent PCC2->SC2
558	MP.P3F	RM 3051 CA2	0.0- 6.0 bar	0.022 bar	absol. pressure meas. PCC3 Feed DW2->PCC3
343	MP.P3V	RM 3051 CA2	0.0- 6.0 bar	0.022 bar	absol. pressure meas. PCC3 Vent PCC3->SC2
554	MP.RP.1	RM 3051 CA2	0.0-10.3 bar	0.023 bar	absol. pressure meas. Reactor Pressure Vessel / RPV
58	MP.RP.2	RM 2088 A3	0.0-13.0 bar	0.293 bar	absol. pressure meas. Reactor Pressure Vessel / RPV
221	MP.S1	RM 3051 CA2	0.0- 6.0 bar	0.022 bar	absol. pressure meas. Suppression Chamber 1 / SC1
222	MP.S2	RM 1144 A	0.0- 6.0 bar	0.169 bar	absol. pressure meas. Suppression Chamber 2 / SC2
339	MP.VL1	RM 3051 CA2	0.0- 6.0 bar	0.022 bar	absol. pressure meas. VB1 Leakage
143	MPG.D1	LI 1231 O2	.002-600 bar	5.00%	air partial pres. meas. Drywell 1 / DW1
245	MPG.D2	LI 1231 O2	.002-600 bar	5.00%	air partial pres. meas. Drywell 2 / DW2
482	MTF.GD.1	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. GDCS tank / GDCS
480	MTF.GD.2	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. GDCS tank / GDCS
479	MTF.GD.3	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. GDCS tank / GDCS
478	MTF.GD.4	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. GDCS tank / GDCS
477	MTF.GD.5	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. GDCS tank / GDCS
476	MTF.GD.6	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. GDCS tank / GDCS
475	MTF.GD.7	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. GDCS tank / GDCS
336	MTF.RP.1	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. Reactor Pressure Vessel / RPV
335	MTF.RP.2	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. Reactor Pressure Vessel / RPV
334	MTF.RP.3	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. Reactor Pressure Vessel / RPV
96	MTF.RP.4	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. Reactor Pressure Vessel / RPV
95	MTF.RP.5	PSI TC	1.0-196.58 C	0.8 C	fluid temp. meas. Reactor Pressure Vessel / RPV
474	MTG.D1.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 1 / DW1
473	MTG.D1.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 1 / DW1
472	MTG.D1.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 1 / DW1
471	MTG.D1.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 1 / DW1
470	MTG.D1.5	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 1 / DW1

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
469	MTG.D1.6	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 1 / DW1
468	MTG.D1S	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. ASS:DW1 connection
720	MTG.D1V	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. AVS:DW1 Vent connection
467	MTG.D2.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 2 / DW2
466	MTG.D2.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 2 / DW2
465	MTG.D2.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 2 / DW2
464	MTG.D2.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 2 / DW2
463	MTG.D2.5	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 2 / DW2
462	MTG.D2.6	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Drywell 2 / DW2
461	MTG.D2S	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. ASS:DW2 connection
719	MTG.D2V	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. AVS:DW2 Vent connection
460	MTG.GDS	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. ASS:GDCS connection
718	MTG.GDV	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. AVS:GDCS Vent connection
717	MTG.GP1.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. GDCS Pressure equal. GDCS-DW1
716	MTG.GP1.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. GDCS Pressure equal. GDCS-DW1
715	MTG.GP2.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. GDCS Pressure equal. GDCS-DW2
714	MTG.GP2.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. GDCS Pressure equal. GDCS-DW2
713	MTG.I1.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. IC Condenser
712	MTG.I1.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. IC Condenser
711	MTG.I1.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. IC Condenser
710	MTG.I1.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. IC Condenser
709	MTG.I1.5	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. IC Condenser
708	MTG.I1.6	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. IC Condenser
707	MTG.I1.7	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. IC Condenser
706	MTG.I1.8	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. IC Condenser
705	MTG.I1.9	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. IC Condenser
571	MTG.I1F.1	HB Pt100	0.0-200.00 C	0.2 C	gas temp. meas. IC Feed RPV->IC
459	MTG.I1F.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. IC Feed RPV->IC

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
704	MTG.I1F.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. IC Feed RPV->IC
237	MTG.MS1.1	HB Pt100	0.0-200.00 C	0.2 C	gas temp. meas. Main Steam line RPV->DW1
458	MTG.MS1.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Steam line RPV->DW1
456	MTG.MS1.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Steam line RPV->DW1
238	MTG.MS2.1	HB Pt100	0.0-200.00 C	0.2 C	gas temp. meas. Main Steam line RPV->DW2
455	MTG.MS2.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Steam line RPV->DW2
454	MTG.MS2.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Steam line RPV->DW2
287	MTG.MV1.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Vent line DW1->SC1
333	MTG.MV1.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Vent line DW1->SC1
216	MTG.MV1.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Vent line DW1->SC1
215	MTG.MV1.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Vent line DW1->SC1
286	MTG.MV2.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Vent line DW2->SC2
332	MTG.MV2.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Vent line DW2->SC2
214	MTG.MV2.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Vent line DW2->SC2
213	MTG.MV2.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Main Vent line DW2->SC2
703	MTG.P1.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Condenser
702	MTG.P1.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Condenser
701	MTG.P1.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Condenser
700	MTG.P1.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Condenser
699	MTG.P1.5	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Condenser
698	MTG.P1.6	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Condenser
696	MTG.P1.7	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Condenser
695	MTG.P1.8	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Condenser
694	MTG.P1.9	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Condenser
572	MTG.P1F.1	HB Pt100	0.0-200.00 C	0.2 C	gas temp. meas. PCC1 Feed DW1->PCC1
693	MTG.P1F.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Feed DW1->PCC1
365	MTG.P1V.1	HB Pt100	0.0-200.00 C	0.4 C	gas temp. meas. PCC1 Vent PCC1->SC1
692	MTG.P1V.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Vent PCC1->SC1

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
331	MTG.P1V.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Vent PCC1->SC1
212	MTG.P1V.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Vent PCC1->SC1
211	MTG.P1V.5	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC1 Vent PCC1->SC1
691	MTG.P2.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Condenser
690	MTG.P2.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Condenser
689	MTG.P2.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Condenser
688	MTG.P2.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Condenser
687	MTG.P2.5	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Condenser
686	MTG.P2.6	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Condenser
685	MTG.P2.7	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Condenser
684	MTG.P2.8	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Condenser
683	MTG.P2.9	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Condenser
573	MTG.P2F.1	HB Pt100	0.0-200.00 C	0.2 C	gas temp. meas. PCC2 Feed DW2->PCC2
682	MTG.P2F.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Feed DW2->PCC2
366	MTG.P2V.1	HB Pt100	0.0-200.00 C	0.4 C	gas temp. meas. PCC2 Vent PCC2->SC2
681	MTG.P2V.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Vent PCC2->SC2
330	MTG.P2V.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Vent PCC2->SC2
210	MTG.P2V.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Vent PCC2->SC2
209	MTG.P2V.5	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC2 Vent PCC2->SC2
528	MTG.P3.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Condenser
527	MTG.P3.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Condenser
526	MTG.P3.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Condenser
525	MTG.P3.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Condenser
524	MTG.P3.5	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Condenser
523	MTG.P3.6	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Condenser
522	MTG.P3.7	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Condenser
521	MTG.P3.8	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Condenser
520	MTG.P3.9	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Condenser

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
574	MTG.P3F.1	HB Pt100	0.0-200.00 C	0.2 C	gas temp. meas. PCC3 Feed DW2->PCC3
680	MTG.P3F.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Feed DW2->PCC3
367	MTG.P3V.1	HB Pt100	0.0-200.00 C	0.4 C	gas temp. meas. PCC3 Vent PCC3->SC2
679	MTG.P3V.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Vent PCC3->SC2
329	MTG.P3V.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Vent PCC3->SC2
208	MTG.P3V.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Vent PCC3->SC2
207	MTG.P3V.5	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. PCC3 Vent PCC3->SC2
678	MTG.RPG	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. AGS:RPV connection
677	MTG.RPV	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. AVS:RPV pressure relief bypass
206	MTG.S1.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 1 / SC1
205	MTG.S1.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 1 / SC1
204	MTG.S1.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 1 / SC1
203	MTG.S1.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 1 / SC1
202	MTG.S1.5	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 1 / SC1
201	MTG.S1.6	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 1 / SC1
200	MTG.S1S	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. ASS:SC1 connection
290	MTG.S1V	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. AVS:SC1 pressure relief
199	MTG.S2.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 2 / SC2
198	MTG.S2.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 2 / SC2
197	MTG.S2.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 2 / SC2
196	MTG.S2.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 2 / SC2
195	MTG.S2.5	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 2 / SC2
194	MTG.S2.6	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Suppression Chamber 2 / SC2
192	MTG.S2S	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. ASS:SC2 connection
288	MTG.S2V	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. AVS:SC2 pressure relief
449	MTG.TD0.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. DW1-DW2 connection
448	MTG.TD0.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. DW1-DW2 connection
447	MTG.TD0.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. DW1-DW2 connection

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
328	MTG.TSU.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. SC1-SC2 Upper connection
327	MTG.TSU.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. SC1-SC2 Upper connection
326	MTG.TSU.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. SC1-SC2 Upper connection
325	MTG.VB1.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Vacuum Breaker SC1-DW1
324	MTG.VB1.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Vacuum Breaker SC1-DW1
446	MTG.VB1.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Vacuum Breaker SC1-DW1
445	MTG.VB1.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Vacuum Breaker SC1-DW1
323	MTG.VB2.1	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Vacuum Breaker SC2-DW2
322	MTG.VB2.2	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Vacuum Breaker SC2-DW2
444	MTG.VB2.3	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Vacuum Breaker SC2-DW2
443	MTG.VB2.4	PSI TC	1.0-196.58 C	0.8 C	gas temp. meas. Vacuum Breaker SC2-DW2
362	MTG.VL1	HB Pt100	0.0-200.00 C	0.4 C	gas temp. meas. VB1 Leakage
283	MTI.D1.1	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 1 / DW1
282	MTI.D1.2	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 1 / DW1
281	MTI.D1.3	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 1 / DW1
280	MTI.D1.4	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 1 / DW1
279	MTI.D1.5	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 1 / DW1
278	MTI.D1.6	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 1 / DW1
277	MTI.D1.7	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 1 / DW1
276	MTI.D1.8	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 1 / DW1
275	MTI.D1.9	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 1 / DW1
274	MTI.D2.1	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 2 / DW2
273	MTI.D2.2	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 2 / DW2
272	MTI.D2.3	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 2 / DW2
271	MTI.D2.4	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 2 / DW2
270	MTI.D2.5	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 2 / DW2
269	MTI.D2.6	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 2 / DW2
268	MTI.D2.7	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 2 / DW2

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
267	MTI.D2.8	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 2 / DW2
266	MTI.D2.9	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Drywell 2 / DW2
263	MTI.GD.1	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. GDCS tank / GDCS
262	MTI.GD.2	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. GDCS tank / GDCS
261	MTI.GD.3	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. GDCS tank / GDCS
260	MTI.GD.4	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. GDCS tank / GDCS
259	MTI.GD.5	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. GDCS tank / GDCS
258	MTI.GD.6	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. GDCS tank / GDCS
233	MTI.RP.1	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Reactor Pressure Vessel / RPV
232	MTI.RP.2	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Reactor Pressure Vessel / RPV
231	MTI.RP.3	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Reactor Pressure Vessel / RPV
191	MTI.S1.1	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 1 / SC1
190	MTI.S1.2	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 1 / SC1
189	MTI.S1.3	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 1 / SC1
188	MTI.S1.4	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 1 / SC1
187	MTI.S1.5	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 1 / SC1
186	MTI.S1.6	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 1 / SC1
185	MTI.S1.7	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 1 / SC1
184	MTI.S1.8	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 1 / SC1
183	MTI.S1.9	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 1 / SC1
182	MTI.S2.1	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 2 / SC2
181	MTI.S2.2	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 2 / SC2
180	MTI.S2.3	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 2 / SC2
179	MTI.S2.4	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 2 / SC2
178	MTI.S2.5	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 2 / SC2
177	MTI.S2.6	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 2 / SC2
176	MTI.S2.7	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 2 / SC2
175	MTI.S2.8	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 2 / SC2

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
174	MTI.S2.9	PSI TC	1.0-196.58 C	0.8 C	inside wall temp. meas. Suppression Chamber 2 / SC2
87	MTL.B0A.1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Pump Circuit
37	MTL.B0A.2	EH Pt100	0.0-200.00 C	0.75 C	liquid temp. meas. AWS:Pump Circuit
52	MTL.B0D.1	HB Pt100	0.0-200.00 C	0.4 C	liquid temp. meas. AWS:Main Demine. Water Bus
38	MTL.B0D.2	EH Pt100	0.0-200.00 C	0.75 C	liquid temp. meas. AWS:Main Demine. Water Bus
93	MTL.B1L.1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Low Bus branch DW1/SC1
676	MTL.B1L.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Low Bus branch DW1/SC1
92	MTL.B1U	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus branch DW1/SC1
91	MTL.B2L	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Low Bus branch DW2/SC2
90	MTL.B2U.1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus branch DW2/SC2
675	MTL.B2U.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus branch DW2/SC2
18	MTL.BCA	HB Pt100	0.0-200.00 C	0.4 C	liquid temp. meas. AWS:Cooler Bypass
17	MTL.BHA	HB Pt100	0.0-200.00 C	0.4 C	liquid temp. meas. AWS:Heater Exchanger Bypass
19	MTL.CRW	HB Pt100	0.0-200.00 C	0.4 C	liquid temp. meas. AWS:Cooler->ENV. reg.water
321	MTL.D1L	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Low Bus DW1 connection
320	MTL.D1U	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus DW1 connection
319	MTL.D2L	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Low Bus DW2 connection
318	MTL.D2U	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus DW2 connection
14	MTL.EQ0	HB Pt100	0.0-200.00 C	0.4 C	liquid temp. meas. EQualization line common branch
316	MTL.GDU	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus GDCS connection
15	MTL.GRT.1	HB Pt100	0.0-200.00 C	0.4 C	liquid temp. meas. Condensate Return GDCS->RPV
88	MTL.GRT.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Condensate Return GDCS->RPV
317	MTL.GRT.3	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Condensate Return GDCS->RPV
89	MTL.HRH	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Heater Exchanger->RPV
674	MTL.I1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. IC Condenser
16	MTL.I1C.1	HB Pt100	0.0-200.00 C	0.4 C	liquid temp. meas. IC Condensate IC->RPV
672	MTL.I1C.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. IC Condensate IC->RPV
173	MTL.I1C.3	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. IC Condensate IC->RPV

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
671	MTL.P1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC1 Condenser
234	MTL.P1C.1	HB Pt100	0.0-200.00 C	0.4 C	liquid temp. meas. PCC1 Condensate PCC1->GDCS
670	MTL.P1C.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC1 Condensate PCC1->GDCS
669	MTL.P2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC2 Condenser
235	MTL.P2C.1	HB Pt100	0.0-200.00 C	0.4 C	liquid temp. meas. PCC2 Condensate PCC2->GDCS
668	MTL.P2C.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC2 Condensate PCC2->GDCS
519	MTL.P3	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 Condenser
236	MTL.P3C.1	HB Pt100	0.0-200.00 C	0.4 C	liquid temp. meas. PCC3 Condensate PCC3->GDCS
667	MTL.P3C.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 Condensate PCC3->GDCS
86	MTL.RP.1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Reactor Pressure Vessel / RPV
85	MTL.RP.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Reactor Pressure Vessel / RPV
39	MTL.RP.3	EH Pt100	0.0-200.00 C	0.75 C	liquid temp. meas. Reactor Pressure Vessel / RPV
172	MTL.S1.1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 1 / SC1
171	MTL.S1.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 1 / SC1
170	MTL.S1.3	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 1 / SC1
168	MTL.S1.4	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 1 / SC1
167	MTL.S1.5	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 1 / SC1
166	MTL.S1.6	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 1 / SC1
84	MTL.S1L	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Low Bus SC1 connection
83	MTL.S1U	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus SC1 connection
165	MTL.S2.1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 2 / SC2
164	MTL.S2.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 2 / SC2
163	MTL.S2.3	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 2 / SC2
162	MTL.S2.4	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 2 / SC2
161	MTL.S2.5	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 2 / SC2
160	MTL.S2.6	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. Suppression Chamber 2 / SC2
82	MTL.S2L	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Low Bus SC2 connection
81	MTL.S2U	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus SC2 connection

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
159	MTL.TSL.1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. SC1-SC2 Lower connection
158	MTL.TSL.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. SC1-SC2 Lower connection
157	MTL.TSL.3	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. SC1-SC2 Lower connection
432	MTL.U0.1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. IC pool
431	MTL.U0.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. IC pool
430	MTL.U0.3	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. IC pool
429	MTL.U0.4	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. IC pool
428	MTL.U0.5	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. IC pool
427	MTL.U0.6	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. IC pool
426	MTL.U0.7	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. IC pool
659	MTL.U0L	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Low Bus IC connection
658	MTL.U0U	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus IC connection
657	MTL.U1.1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC1 pool
656	MTL.U1.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC1 pool
655	MTL.U1.3	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC1 pool
654	MTL.U1.4	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC1 pool
653	MTL.U1.5	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC1 pool
652	MTL.U1.6	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC1 pool
651	MTL.U1.7	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC1 pool
650	MTL.U1L	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Low Bus PCC1 connection
648	MTL.U1U	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus PCC1 connection
647	MTL.U2.1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC2 pool
646	MTL.U2.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC2 pool
645	MTL.U2.3	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC2 pool
644	MTL.U2.4	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC2 pool
643	MTL.U2.5	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC2 pool
642	MTL.U2.6	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC2 pool
641	MTL.U2.7	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC2 pool

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
640	MTL.U2L	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Low Bus PCC2 connection
639	MTL.U2U	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus PCC2 connection
518	MTL.U3.1	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
517	MTL.U3.2	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
516	MTL.U3.3	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
515	MTL.U3.4	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
514	MTL.U3.5	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
513	MTL.U3.6	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
512	MTL.U3.7	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
511	MTL.U3.8	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
510	MTL.U3.9	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
509	MTL.U3.10	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
508	MTL.U3.11	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
507	MTL.U3.12	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
506	MTL.U3.13	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
504	MTL.U3.14	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
503	MTL.U3.15	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
502	MTL.U3.16	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
501	MTL.U3.17	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
500	MTL.U3.18	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
499	MTL.U3.19	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. PCC3 pool
638	MTL.U3L	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Low Bus PCC3 connection
637	MTL.U3U	PSI TC	1.0-196.58 C	0.8 C	liquid temp. meas. AWS:Upper Bus PCC3 connection
636	MTO.D1.1	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 1 / DW1
635	MTO.D1.2	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 1 / DW1
634	MTO.D1.3	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 1 / DW1
254	MTO.D1.4	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 1 / DW1
253	MTO.D1.5	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 1 / DW1

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
252	MTO.D1.6	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 1 / DW1
315	MTO.D1.7	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 1 / DW1
314	MTO.D1.8	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 1 / DW1
312	MTO.D1.9	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 1 / DW1
633	MTO.D2.1	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 2 / DW2
632	MTO.D2.2	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 2 / DW2
631	MTO.D2.3	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 2 / DW2
257	MTO.D2.4	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 2 / DW2
256	MTO.D2.5	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 2 / DW2
255	MTO.D2.6	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 2 / DW2
311	MTO.D2.7	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 2 / DW2
310	MTO.D2.8	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 2 / DW2
309	MTO.D2.9	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Drywell 2 / DW2
251	MTO.GD.1	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. GDCS tank / GDCS
250	MTO.GD.2	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. GDCS tank / GDCS
249	MTO.GD.3	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. GDCS tank / GDCS
248	MTO.GD.4	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. GDCS tank / GDCS
247	MTO.GD.5	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. GDCS tank / GDCS
246	MTO.GD.6	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. GDCS tank / GDCS
308	MTO.S1.1	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 1 / SC1
307	MTO.S1.2	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 1 / SC1
306	MTO.S1.3	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 1 / SC1
156	MTO.S1.4	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 1 / SC1
155	MTO.S1.5	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 1 / SC1
154	MTO.S1.6	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 1 / SC1
80	MTO.S1.7	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 1 / SC1
79	MTO.S1.8	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 1 / SC1
78	MTO.S1.9	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 1 / SC1

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
305	MTO.S2.1	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 2 / SC2
304	MTO.S2.2	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 2 / SC2
303	MTO.S2.3	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 2 / SC2
153	MTO.S2.4	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 2 / SC2
152	MTO.S2.5	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 2 / SC2
151	MTO.S2.6	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 2 / SC2
77	MTO.S2.7	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 2 / SC2
76	MTO.S2.8	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 2 / SC2
75	MTO.S2.9	PSI TC	1.0-196.58 C	0.8 C	outside wall temp. meas. Suppression Chamber 2 / SC2
142	MTP.D1	LI TC	0.0-1000.0 C	0.75%	Temp. for oxygen Probe Drywell 1 / DW1
244	MTP.D2	LI TC	0.0-1000.0 C	0.75%	Temp. for oxygen Probe Drywell 2 / DW2
1	MTR.02	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:0 - slot:2
25	MTR.03	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:0 - slot:3
49	MTR.04	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:0 - slot:4
73	MTR.05	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:0 - slot:5
97	MTR.13	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:1 - slot:3
121	MTR.14	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:1 - slot:4
145	MTR.15	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:1 - slot:5
169	MTR.16	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:1 - slot:6
193	MTR.17	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:1 - slot:7
217	MTR.23	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:2 - slot:3
241	MTR.24	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:2 - slot:4
265	MTR.25	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:2 - slot:5
289	MTR.26	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:2 - slot:6
313	MTR.27	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:2 - slot:7
337	MTR.30	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:3 - slot:0
361	MTR.31	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:3 - slot:1
385	MTR.32	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:3 - slot:2

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
409	MTR.33	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:3 - slot:3
433	MTR.34	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:3 - slot:4
457	MTR.35	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:3 - slot:5
481	MTR.36	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:3 - slot:6
505	MTR.37	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:3 - slot:7
529	MTR.40	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:4 - slot:0
553	MTR.41	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:4 - slot:1
577	MTR.42	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:4 - slot:2
601	MTR.43	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:4 - slot:3
625	MTR.44	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:4 - slot:4
649	MTR.45	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:4 - slot:5
673	MTR.46	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:4 - slot:6
697	MTR.47	HP NTC	20.0-50.0 C	0.2 C	TC. reference temperature DA: extender:4 - slot:7
408	MTS.D1.1	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Drywell 1 / DW1
407	MTS.D1.2	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Drywell 1 / DW1
406	MTS.D1.3	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Drywell 1 / DW1
405	MTS.D2.1	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Drywell 2 / DW2
404	MTS.D2.2	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Drywell 2 / DW2
403	MTS.D2.3	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Drywell 2 / DW2
402	MTS.GD.1	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. GDCS tank / GDCS
401	MTS.GD.2	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. GDCS tank / GDCS
400	MTS.GD.3	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. GDCS tank / GDCS
150	MTS.S1.1	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Suppression Chamber 1 / SC1
149	MTS.S1.2	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Suppression Chamber 1 / SC1
148	MTS.S1.3	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Suppression Chamber 1 / SC1
147	MTS.S2.1	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Suppression Chamber 2 / SC2
146	MTS.S2.2	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Suppression Chamber 2 / SC2
144	MTS.S2.3	PSI TC	1.0-196.58 C	0.6 C	pool surface temp. meas. Suppression Chamber 2 / SC2

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
425	MTT.I1.1	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
424	MTT.I1.2	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
423	MTT.I1.3	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
422	MTT.I1.4	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
421	MTT.I1.5	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
420	MTT.I1.6	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
419	MTT.I1.7	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
418	MTT.I1.8	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
417	MTT.I1.9	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
416	MTT.I1.10	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
415	MTT.I1.11	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
414	MTT.I1.12	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
413	MTT.I1.13	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
412	MTT.I1.14	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
411	MTT.I1.15	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
410	MTT.I1.16	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. IC Condenser
613	MTT.P1.1	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
612	MTT.P1.2	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
611	MTT.P1.3	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
610	MTT.P1.4	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
609	MTT.P1.5	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
608	MTT.P1.6	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
607	MTT.P1.7	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
606	MTT.P1.8	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
605	MTT.P1.9	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
604	MTT.P1.10	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
603	MTT.P1.11	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
602	MTT.P1.12	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
600	MTT.P1.13	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
599	MTT.P1.14	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
598	MTT.P1.15	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
597	MTT.P1.16	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC1 Condenser
630	MTT.P2.1	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
629	MTT.P2.2	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
628	MTT.P2.3	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
627	MTT.P2.4	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
626	MTT.P2.5	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
624	MTT.P2.6	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
623	MTT.P2.7	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
622	MTT.P2.8	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
621	MTT.P2.9	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
620	MTT.P2.10	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
619	MTT.P2.11	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
618	MTT.P2.12	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
617	MTT.P2.13	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
616	MTT.P2.14	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
615	MTT.P2.15	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
614	MTT.P2.16	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC2 Condenser
498	MTT.P3.1	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
497	MTT.P3.2	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
496	MTT.P3.3	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
495	MTT.P3.4	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
494	MTT.P3.5	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
493	MTT.P3.6	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
492	MTT.P3.7	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
491	MTT.P3.8	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
490	MTT.P3.9	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
489	MTT.P3.10	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
488	MTT.P3.11	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
487	MTT.P3.12	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
486	MTT.P3.13	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
485	MTT.P3.14	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
484	MTT.P3.15	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
483	MTT.P3.16	PSI TC	1.0-196.58 C	0.8 C	tube wall temp. meas. PCC3 Condenser
569	MTV.GP1.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. GDCS Pressure equal. GDCS-DW1
568	MTV.GP1.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. GDCS Pressure equal. GDCS-DW1
567	MTV.GP2.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. GDCS Pressure equal. GDCS-DW2
566	MTV.GP2.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. GDCS Pressure equal. GDCS-DW2
302	MTV.GRT	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Condensate Return GDCS->RPV
596	MTV.I1C	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. IC Condensate IC->RPV
594	MTV.I1F.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. IC Feed RPV->IC
399	MTV.I1F.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. IC Feed RPV->IC
595	MTV.I1F.3	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. IC Feed RPV->IC
397	MTV.MS1.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Steam line RPV->DW1
398	MTV.MS1.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Steam line RPV->DW1
396	MTV.MS1.3	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Steam line RPV->DW1
394	MTV.MS2.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Steam line RPV->DW2
395	MTV.MS2.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Steam line RPV->DW2
393	MTV.MS2.3	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Steam line RPV->DW2
292	MTV.MV1.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Vent line DW1->SC1
301	MTV.MV1.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Vent line DW1->SC1
140	MTV.MV1.3	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Vent line DW1->SC1
291	MTV.MV2.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Vent line DW2->SC2
300	MTV.MV2.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Vent line DW2->SC2

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
141	MTV.MV2.3	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Main Vent line DW2->SC2
593	MTV.P1C	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC1 Condensate PCC1->GDCS
592	MTV.P1F.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC1 Feed DW1->PCC1
591	MTV.P1F.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC1 Feed DW1->PCC1
390	MTV.P1V.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC1 Vent PCC1->SC1
590	MTV.P1V.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC1 Vent PCC1->SC1
299	MTV.P1V.3	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC1 Vent PCC1->SC1
137	MTV.P1V.4	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC1 Vent PCC1->SC1
589	MTV.P2C	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC2 Condensate PCC2->GDCS
588	MTV.P2F.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC2 Feed DW2->PCC2
587	MTV.P2F.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC2 Feed DW2->PCC2
389	MTV.P2V.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC2 Vent PCC2->SC2
586	MTV.P2V.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC2 Vent PCC2->SC2
298	MTV.P2V.3	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC2 Vent PCC2->SC2
138	MTV.P2V.4	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC2 Vent PCC2->SC2
585	MTV.P3C	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC3 Condensate PCC3->GDCS
584	MTV.P3F.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC3 Feed DW2->PCC3
583	MTV.P3F.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC3 Feed DW2->PCC3
388	MTV.P3V.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC3 Vent PCC3->SC2
582	MTV.P3V.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC3 Vent PCC3->SC2
297	MTV.P3V.3	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC3 Vent PCC3->SC2
139	MTV.P3V.4	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. PCC3 Vent PCC3->SC2
296	MTV.VB1.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Vacuum Breaker SC1-DW1
294	MTV.VB1.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Vacuum Breaker SC1-DW1
382	MTV.VB1.3	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Vacuum Breaker SC1-DW1
384	MTV.VB1.4	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Vacuum Breaker SC1-DW1
295	MTV.VB2.1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Vacuum Breaker SC2-DW2
293	MTV.VB2.2	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Vacuum Breaker SC2-DW2

Table 5.3: PANDA INSTRUMENTATION LIST

Dachannel	Processid	Type	Range	Basic Acc	Location
379	MTV.VB2.3	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Vacuum Breaker SC2-DW2
381	MTV.VB2.4	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. Vacuum Breaker SC2-DW2
387	MTV.VL1	PSI TC	1.0-196.58 C	0.8 C	wall temp. meas. VB1 Leakage
54	MV.B0A	I VORTEX 80	2.1-18.8kg/s	1.00%	volume flow meas. AWS:Pump Circuit
56	MV.B0D	I VORTEX 25	0.2-1.96kg/s	1.00%	volume flow meas. AWS:Main Demine. Water Bus
117	MV.EQ0	I USON 994	77-1135 g/s	2.00%	volume flow meas. EQualization line common branch
118	MV.GRT	I USON 994	449-2722 g/s	2.00%	volume flow meas. Condensate Return GDCS->RPV
119	MV.I1C	I USON 994	49- 379 g/s	2.00%	volume flow meas. IC Condensate IC->RPV
561	MV.I1F	I VORTEX 80	66- 337 g/s	1.50%	volume flow meas. IC Feed RPV->IC
358	MV.MS1	I VORTEX100	135- 595 g/s	1.50%	volume flow meas. Main Steam line RPV->DW1
359	MV.MS2	I VORTEX100	134- 592 g/s	1.50%	volume flow meas. Main Steam line RPV->DW2
562	MV.P1F	I VORTEX 80	72- 311 g/s	1.50%	volume flow meas. PCC1 Feed DW1->PCC1
352	MV.P1V	I VORTEX 80	68- 262 g/s	2.00%	volume flow meas. PCC1 Vent PCC1->SC1
563	MV.P2F	I VORTEX 80	73- 327 g/s	1.50%	volume flow meas. PCC2 Feed DW2->PCC2
353	MV.P2V	I VORTEX 80	62- 259 g/s	2.00%	volume flow meas. PCC2 Vent PCC2->SC2
116	MV.P3C	I USON 994	53- 387 g/s	2.00%	volume flow meas. PCC3 Condensate PCC3->GDCS
564	MV.P3F	I VORTEX 80	71- 342 g/s	1.50%	volume flow meas. PCC3 Feed DW2->PCC3
354	MV.P3V	I VORTEX 80	63- 263 g/s	2.00%	volume flow meas. PCC3 Vent PCC3->SC2
356	MV.VL1	EH VORTEX15	1.6-11.6 g/s	1.00%	volume flow meas. VB1 Leakage
42	MW.RP.1	CB SYNEAX	0 - 50 kW	2,1 %	electrical power meas Reactor Pressure Vessel / RPV
43	MW.RP.2	CB SYNEAX	0 - 300 kW	1,0 %	electrical power meas Reactor Pressure Vessel / RPV
44	MW.RP.3	CB SYNEAX	0 - 300 kW	0,6 %	electrical power meas Reactor Pressure Vessel / RPV
45	MW.RP.4	CB SYNEAX	0 - 300 kW	0,6 %	electrical power meas Reactor Pressure Vessel / RPV
46	MW.RP.5	CB SYNEAX	0 - 300 kW	0,6 %	electrical power meas Reactor Pressure Vessel / RPV
47	MW.RP.6	CB SYNEAX	0 - 300 kW	0,6 %	electrical power meas Reactor Pressure Vessel / RPV
48	MW.RP.7	HB TZA4 TOT	0 - 1500 kW	0.6-2.1 %	electrical power meas Reactor Pressure Vessel / RPV

Table 5.4: PANDA INSTRUMENTATION SUMMARY

(Including auxiliary systems instrumentation)

Temperature	Chromel-alumel thermocouples	442	
	Pt100-Resistance thermometers	21	
	Thermistors (TC ref. temp.)	30	493
Pressure	Rosemount model 3051CA transducer	15	
	Rosemount model 2088A transducer	3	
	Rosemount model 1144A transducer	3	21
Pressure difference	Rosemount model 3051CD transducer	14	
	Rosemount model 1151DP transducer	13	27
Level	Rosemount model 3051CD transducer	7	
	Rosemount model 1151DP transducer	11	18
Flow rate	Vortex flow meter	11	
	Ultrasonic flow meter	3	
	Hot-film flow meter	1	15
Gas concentration	Oxygen partial pressure probe	2	
Fluid phase dedector	Conductivity probe	9	
Electrical power	Wattmeter	6	
	Electronic totalizer	1	7
Total		**592**	

Table 5.5: INSTRUMENTATION REQUIRED FOR TEST S1 TO S9

IdentificationCode	Description	Accuracy Required
MV.I1F	Steam flow to PCC3	± 2%
MM.BØG	Air flow to PCC3	± 3%
MV.P3C	PCC3 condensate flow (PCC3 to GDCS)	± 3%
MV.GRT	PCC3 condensate flow (GDCS to RPV)	± 3%
MV.P3V	PCC3 Vent flow to WW2	± 3%
ML.U3	PCC3 pool level	± 200 mm
ML.RP.1	RPV level	± 250 mm
MP.I1F	PCC3 upper header pressure	± 3 kPa
MP.RP.1	RPV pressure	± 3 kPa
MP.P3V	PCC3 vent line pressure	± 3 kPa
MTG.P2F.1	Air/steam temperture in steady state supply line	± 1.5°C
MTG.P3F.1	Steam temperature in steady state supply line	± 1.5°C
MTL.P3C.1	PCC3 condensate temperature at GDCS inlet	± 1.5°C
MTL.GRT.1	PCC3 condensate temperature in GDCS drain line	± 1.5°C
MTG.P3V.1	Gas temperature in PCC3 vent line	± 1.5°C
MTL.P3C.2	PCC3 condensate temperature at PCC3 outlet	± 1.5°C
MTL.GRT.2	PCC3 condensate temperature at RPV inlet	± 1.5°C
MTG.P3V.2	Gas temperature in PCC3 vent line outlet at PCC3	± 1.5°C
many (*)	PCC3 temperatures	± 1.5°C

(*) It is required that 30% of the pool temperature sensors and 50% of the tube wall and fluid sensors be available. The available pool sensors must include at least one of the three lowest elevations. The available tube wall and fluid sensors must include at least 40% of the probes above and below the horizontal mid-plane of the tube bundle. Within these constraints, the test engineer has responsibility and authority to judge whether or not sufficient PCC3 temperature sensors are operable to initiate tests.

Table 5.6: PANDA THERMOCOUPLES ENHANCED CALIBRATION SUMMARY

Batch No	Roll ID No.	Number of Roll Sample Calibrated	Number of PANDA TC Calibrated	Total Number of TC in PANDA
1	1.584.7R	6	3	3
	1.584.12R	4	12	12
2	2.384.2	1	—	20
	2.384.5	2	—	9
	2.384.6	2	—	13
	2.384.7	2	—	2
	2.384.8	2	—	11
3	3.1089.2	2	—	40
4	5.0993.1	2	14	14
	5.0993.2	2	25	26
5	5.0193.17	2	3	3
	5.0193.18	2	—	53
	5.0193.20	2	—	11
6	5.1292.1	2	44	44
	5.1292.2	2	22	22
	5.1292.3	2	—	4
	5.1292.4	2	2	2
	5.1292.5	2	3	3
	5.1292.8	2	15	15
	5.1292.11	2	—	43
	5.1292.13	2	1	1
	5.1292.14	2	—	67
	5.1292.15	2	—	24
	Total	51	144	442
			32.6%	100%

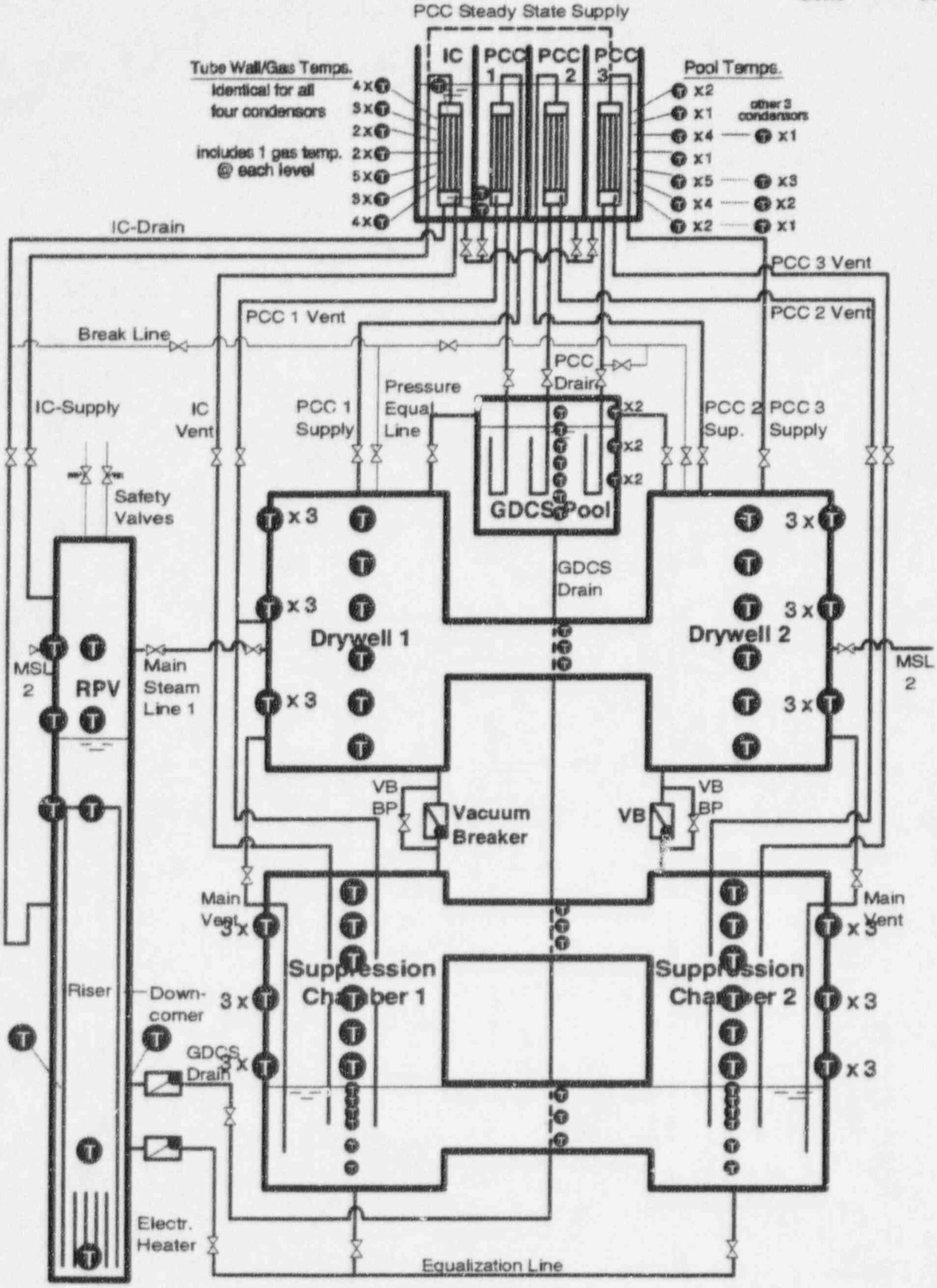

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Fig. 5.1: PANDA Instrumentation: Condensor, Pool, and Vessel Temperatures.

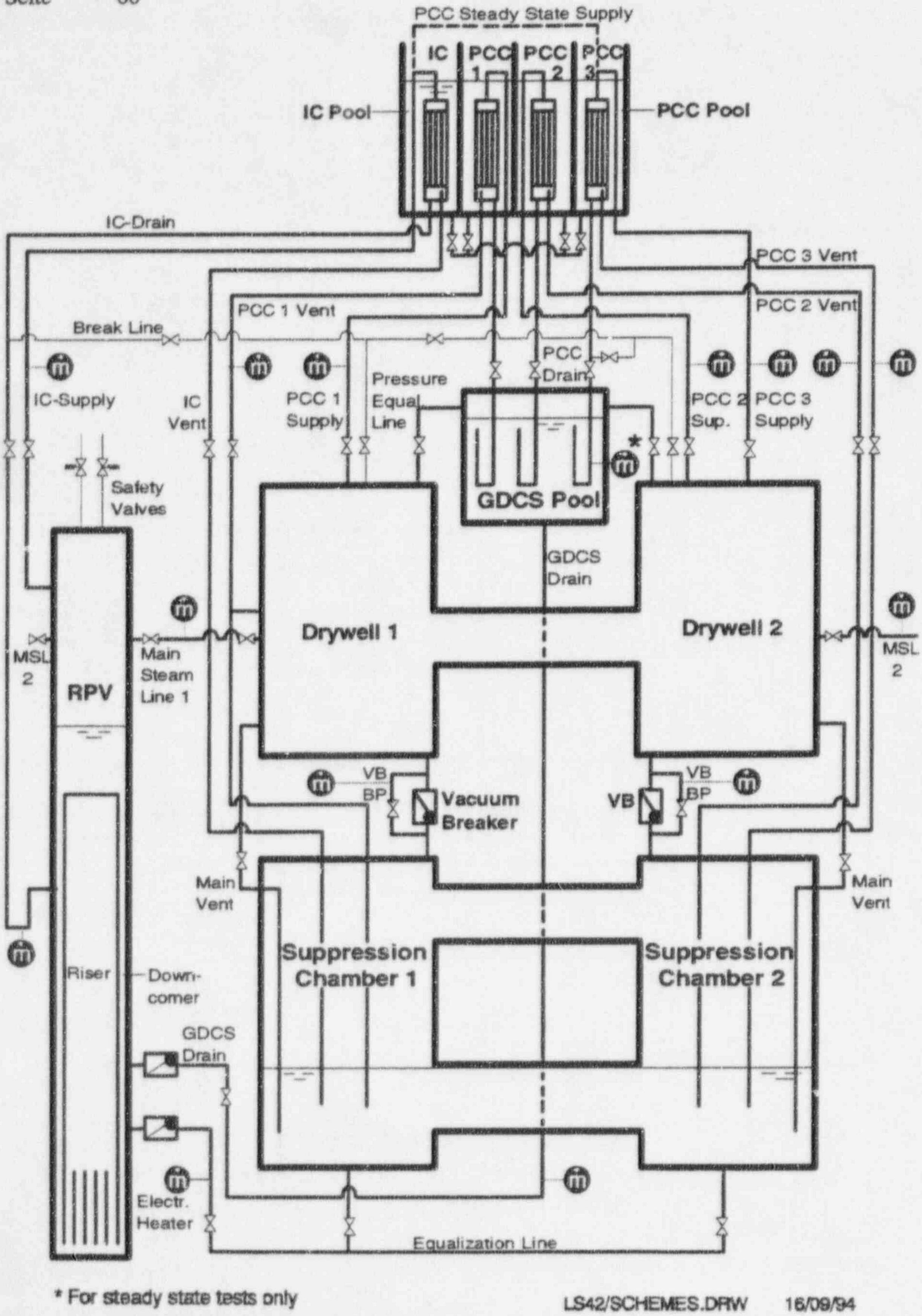

Fig. 5.2: PANDA Instrumentation: Mass Flow Rates.

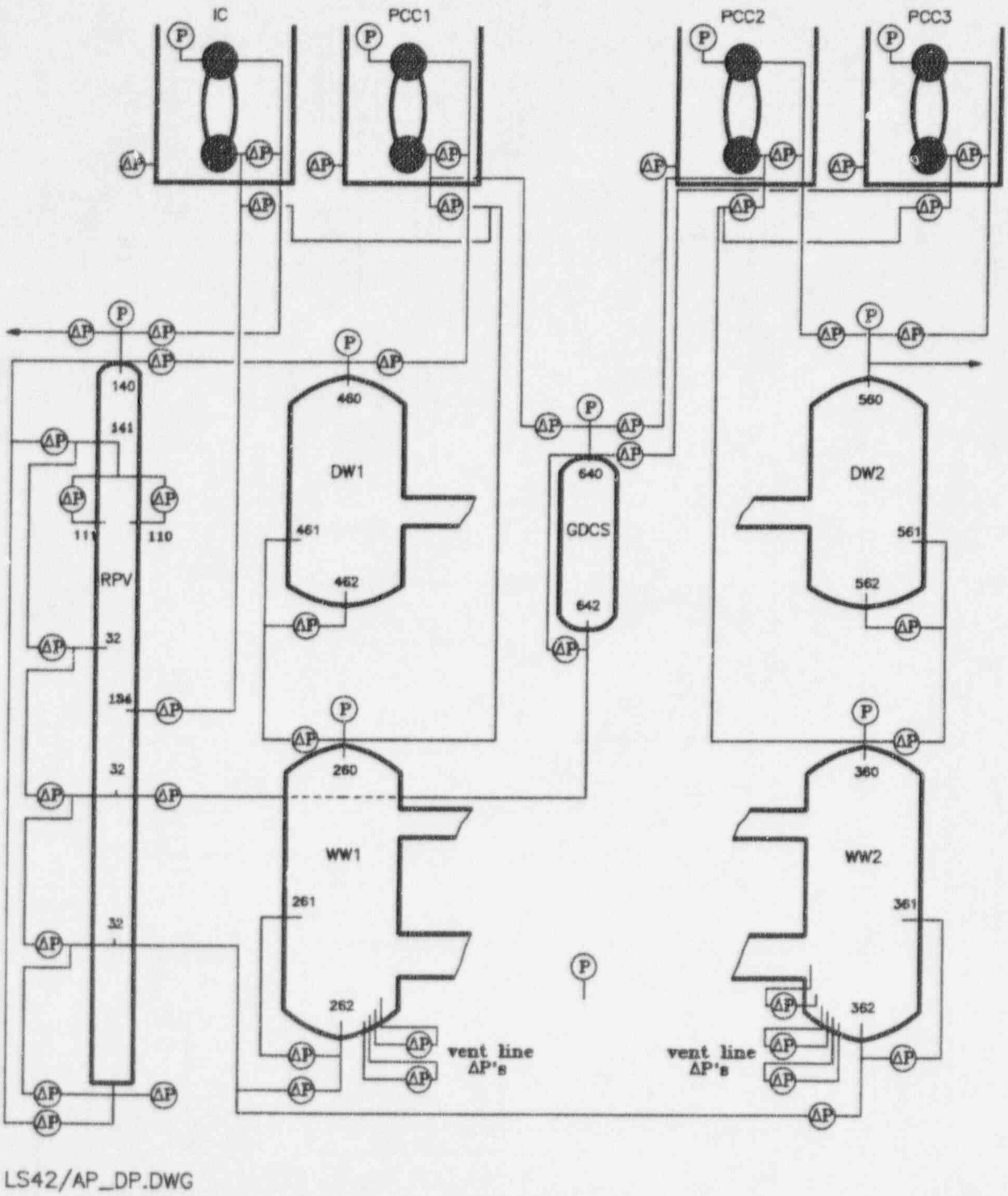

Fig. 5.3: PANDA Instrumentation: Absolute and Differential Pressures.

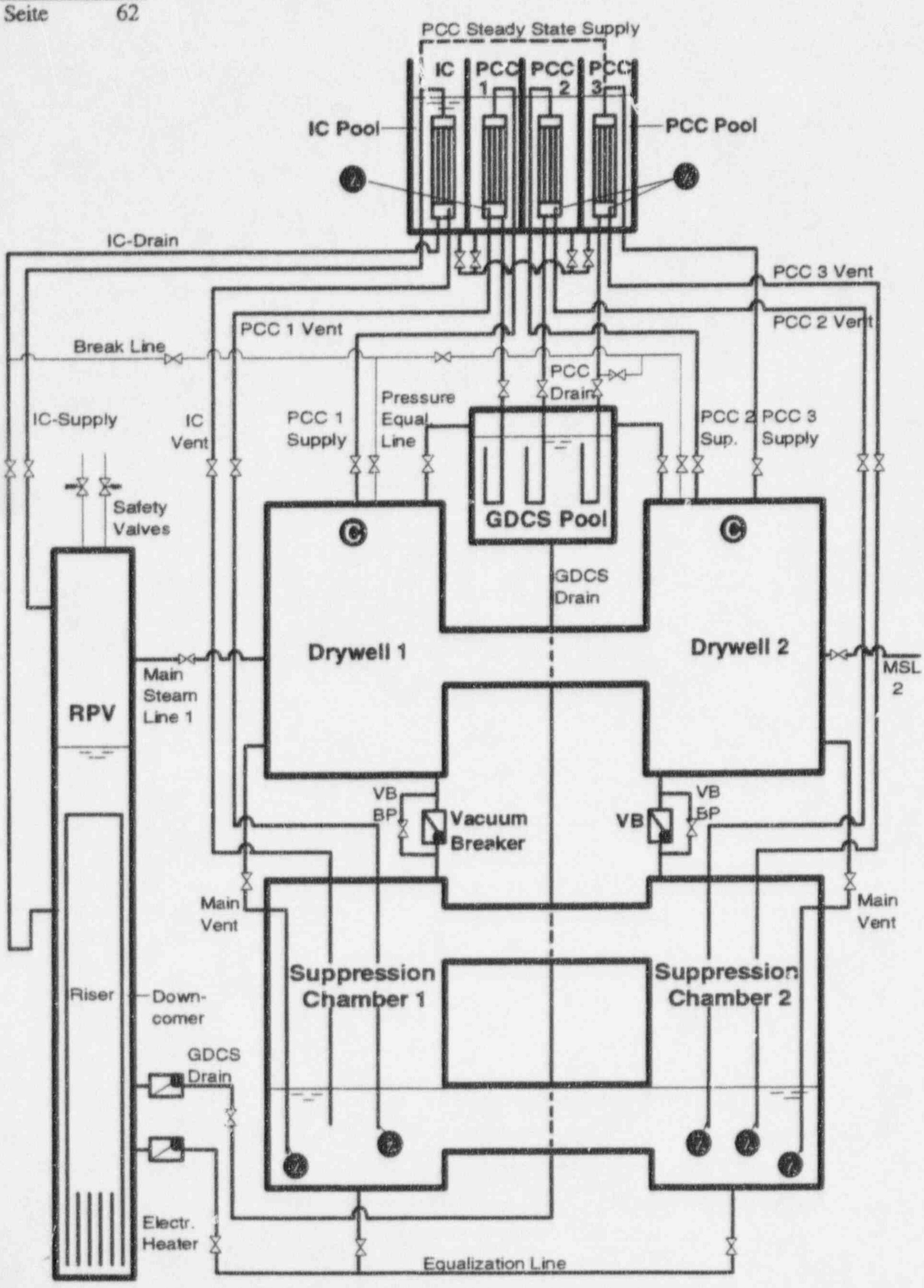

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Fig. 5.4: PANDA Instrumentation: Oxygen Sensors and Phase Detectors.

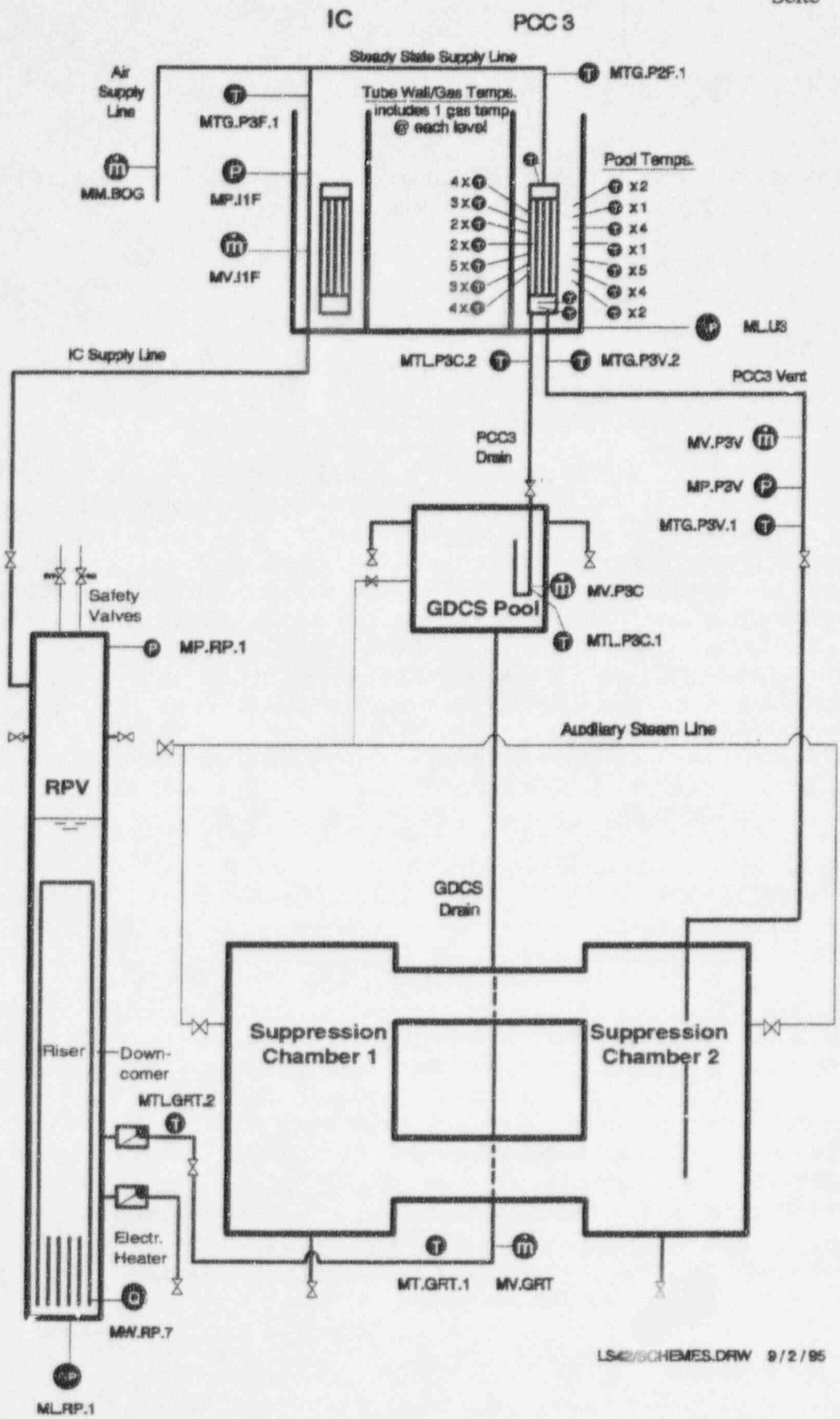

Fig. 5.5: PANDA Steady State Test Instrumentation/Configuration

6. DATA ACQUISITION SYSTEM AND RECORDING

The data acquisition system (DAS) for PANDA is an integrated system which measures signals and converts them to engineering units and records the data.

6.1 Hardware configuration

The data acquisition system consists of components completely integrated in order to enable the user to perform all the significant actions connected with the data acquisition process. Figure 6-1 gives a schematic of the PANDA data acquisition and control system.

The DAS is made up of a HP 3852 main frame plus four HP 3853 extenders. The main frame and each extender contain a HP 44704 16 bit high speed voltmeter and several HP 44713 24 channel multiplexers in which 24 PSI produced preamplifier/active filter units are integrated. The number of multiplexers depends on the extender. The sensor cables are connected to the terminal module of a multiplexer and the signals are then amplified and filtered in the PSI produced unit. The gain of the preamplifiers is 40 and the active filter is a second order low pass Butterworth function filter set to 18 Hz. This setting is low enough to eliminate 50 Hz signals which might be introduced through power supplies, and high enough not to filter out any data from the 0.5 Hz scan rate of the DAS. The amplified and filtered signal then is fed into one of the multiplexers.

The main frame and the four extenders are located on five different levels of the PANDA facility. The main frame is located at a height of 2 meters. The extenders are located at heights of 6 m, 10 m, 14 m, and 18 m. This reduces the amount of cabling required and minimizes electrical noise due to long cables.

There are a total of 30 multiplexers spread over the five different levels. The multiplexed analog signals are read by the high speed voltmeters which are located on each level. The voltmeters have a 320 mV range and the output is digital data.

The system operates in a continuous scan mode. Readings that are not requested are discarded. The channel list is stored in the digital voltmeters. The 720 channels may be scanned at a maximum rate of once every 2 seconds. The scan rate must be manually set in the software. Parallel measurements are made in the main frame and all four extenders. The data is stored in the digital voltmeter, and then transferred over a digital connection to an output buffer in the HP3852 mainframe. The mainframe then sends a service request call to a HP-1000A990, which processes the data acquisition program and controls the data storage. The HP-1000A990 detects the service request call, reads the data and sends the data to the conversion program. The conversion program converts the binary digital signal into engineering units and then distributes the data to disk storage, to a printer (when requested), and to a HP workstation for further data storage and/or transfer to a process visualization program on a IBM compatible PC.

6.2 Software qualification

The data acquisition system software will be qualified by performing the following actions:

1) check that the instrument conversion constants are correctly input and allocated in the DAS
2) check that the conversion formulas are correctly inserted in the DAS
3) send calibrated voltage signals to the DAS input channels (simulation of the sensor signals) and verify that:
   - the wiring (sensor to terminal module to preamplifier/filter to multiplexer) is correct.
   - the voltage reading is correct.
   - the conversion to engineering units is correctly applied (by comparing the DAS conversion results with the same signal conversion carried out by hand calculations).

These verifications will be performed once for both directly measured quantities and for derived quantities. The results of the verifications will be archived in the DRF. If an instrument is replaced, the verification for that instrument will be repeated. The instrument zeros will be verified for critical instruments before each series of tests.

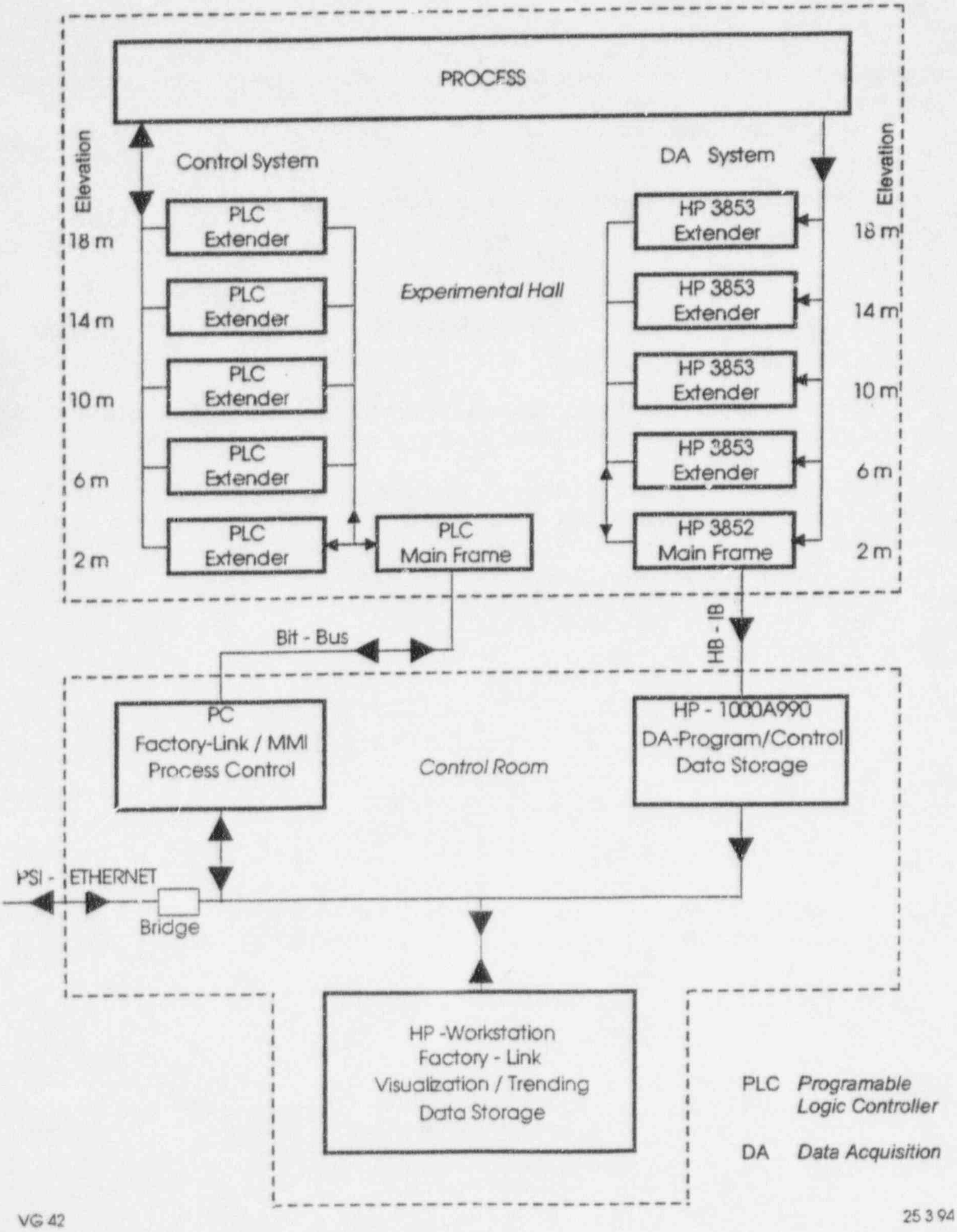

Fig. 6.1: PANDA FACILITY: Control and Data Acquisition System

7. DATA ANALYSIS AND RECORDS

This section describes the data analysis for both the steady-state (S Series) and transient (M-Series) tests in PANDA.

7.1 Data Reduction/Conversion to Engineering Units

7.1.1 Temperature

Temperatures measurements used to calculate fluid and gas densities for mass flow measurements are made with Pt100 resistance temperature detectors. Each Pt100 output is converted by a power supply/amplifier to a linear 4-20 mA current output, which is in turn converted into a voltage for the PANDA data acquisition system by a 0.4Ω load resistor. The amplifiers are calibrated so that 4 and 20 mA correspond to 0°C and 200°C, respectively.

The remaining temperatures are measured using K-type chromel-alumel thermocouples. Groups of 23 thermocouples are routed to isothermal blocks where the reference junction temperatures are measured by a thermistor. The thermistor voltage is converted to a temperature using a look-up table in the data acquisition system. This temperature is then converted to a K-type thermocouple voltage using look-up tables generated according to National Institute of Standards and Technology (NIST) monographs (April 1993) for the International Temperature Scale (ITS-90).

The temperatures measured by the thermocouples are determined by adding the K-type voltage of the thermistor to the measured thermocouple voltage. This sum is converted to a thermocouple temperature using a third set of look-up tables taken from the same source of monographs. After this standard conversion, individual corrections are applied as described in Section 5.5.1 on thermocouple calibrations.

7.1.2 Absolute Pressure

Absolute pressure transmitters provide a current output that is converted to a voltage by a 0.4Ω load resistor dedicated to each channel, and this voltage is measured by the data acquisition system. The measured voltage **V** is converted to an absolute pressure using the following relation:

$$P = V * a + b - \rho g h \tag{7.1}$$

where the constants **a** and **b** have been determined through instrument calibration as described in [4]. The final term accounts for the hydrostatic head of the water column (of height h) isolating the transmitter from the hot atmosphere within the PANDA vessels. The density ρ, calculated in most cases at 20°C, is considered constant.

7.1.3 Differential Pressure

Output from each differential pressure transmitter is measured by the data acquisition system in the same manner as described for the absolute pressure transmitters. The measured voltage is converted to a differential pressure using the following:

$$\Delta P = V * a + b - \rho g d \tag{7.2}$$

where the terms **a** and **b** are again the calibration constants and the calibration procedure is detailed in [4]. The final term accounts for the difference between the hydrostatic heads of the reference leg water columns. This is calculated by multiplying the difference between the two pressure tap elevations, **d**, by the water column density ρ and the gravitational acceleration **g**.

For some differential pressure measurements (i.e. along the IC/PCC vent lines) one pressure leg is gas filled. For these cases the hydrostatic heads of the gas reference column must also be taken into account. The conversion to differential pressure is therefore sligthly modified:

$$\Delta P = V * a + b - g\,(\rho d + \rho_g L) \tag{7.3}$$

where ρ_g is the gas density in the gas reference leg and $\boldsymbol{L}$ is the vertical height of the gas leg.

7.1.4 Level

The single phase or two phase (collapsed) water levels for closed vessels are calculated from measurements of differential pressure. Using the differential pressure as calculated in eqn. 7.2, the following relation provides the collapsed water level between the two pressure taps:

$$L = -\frac{\Delta P + \rho_g g * d}{g * (\rho_l - \rho_g)} \tag{7.4}$$

The gas density ρ_g is included to account for the head generated by the gas layer above the water surface, and **d** is again the vertical distance between the two pressure taps. The gas layers in the RPV, drywells, and GDCS are assumed to be pure steam while gas layers in the wetwells are assumed to be pure air. The air density is calculated from the perfect gas law using temperature and absolute pressure measurements of the wetwell gas space.

For the open IC/PCC-Pools the differential pressure measurements used for calculating the pool levels are gage pressure measurements. Using the differential pressure as calculated in eqn. 7.2, the following , slightly modified, relation provides the pool level:

$$L = \frac{\Delta P + g \rho_g d}{g (\rho_l - \rho_g)} \tag{7.5}$$

where ρ_g is the ambient air density.

7.1.5 Flowrate

Gas flowrates are determined with vortex flow meters, which are calibrated in terms of volumetric flow. The calibration curves have the following form:

$$\dot{V} = V * a + b \tag{7.6}$$

Mass flow rates are then calculated from the measured volumetric flow, absolute pressure, and gas temperature:

$$\dot{m} = \dot{V} * \left[\rho_v + \frac{M P_{nc}}{\Re T} \right] \tag{7.7}$$

where $\Re$ is the gas constant and **M** is the molecular weight of air. The vapor density ρ_v is set equal to the saturation density at the measured gas temperature **T**. The noncondensable partial pressure $\mathbf{P_{nc}}$ is the difference between the absolute pressure $\mathbf{P_a}$ and the vapor partial pressure at the saturation temperature **T**.

Liquid flowrates are measured with ultrasonic flow meters. Like the vortex flow meters, these instruments are calibrated in terms of volumetric flow, and the calibration curve takes the same form as that given in eqn. 7.6. The calibration is valid only for single phase flow and so the mass flow rate is simply:

$$\dot{m} = \dot{V} * \rho_l \tag{7.8}$$

where the liquid density is calculated using the Pt100 temperature measurement located downstream of the flow meter.

A hot film flow meter measures air flow from the auxiliary air system into PANDA. The meter generates a 4-20 mA output that is proportional to the mass flow rate and has been calibrated in Germany in conformance with standards issued by the German equivalent of the National Bureau of Standards.

7.1.6 Oxygen Sensors

The noncondensable gas partial pressure is measured in selected locations using zirconia oxygen sensors. The sensor generates a voltage dependent upon the ratio of the oxygen partial pressures on the measurement and reference sides of the zirconia element [5]. This voltage, measured directly by the data acquisition system, is used with the following equation to calculate the noncondensable pressure:

$$P_{nc} = P_b e^{V/CT} \tag{7.9}$$

where **T** is the measured sensor head temperature, and **C** is a constant equal to 0.02154 mV/°K. Air at atmospheric pressure is used as the reference gas and so $\mathbf{P_b}$ is the measured barometric pressure.

7.1.7 Phase Indicator

Electrical conductivity sensors are used to detect the presence or absence of liquid at the vent line inlet and outlets, and at the bottom of the LOCA vent lines. When the probe tip is immersed in liquid, an electric circuit is completed, the other way around, when the probe tip is surrounded by gas, the circuit is open. The conversion to engineering units produces from this a real value of 1.0 and 0.0 for gas and liquid, respectively.

7.1.8 Power Measurement

The power of the electrical heaters in the RPV is measured by a wattmeter (3 phase, arbitrary waveform) which provide a current output that is converted to a voltage by a 0.4 Ω load resistor. The measured voltage **V** is converted to an electrical power using the following relation:

$$N = V * a + b \tag{7.10}$$

where the constants **a** and **b** are based on the ordered configuration for the wattmeters.

7.1.9 Condensor Energy Balance

The power transferred to the condenser water pool is written as products of specific enthalpy and mass flow rate at the condenser inlet, exit (vent), and drain (description of symbols see Table 7.1)

$$Q = \dot{m}_i h_i - \dot{m}_e h_e - \dot{m}_d h_d \tag{7.11}$$

It is advantageous to eliminate either the vent or condensate flow measurement from the energy balance. The energy balance can then be formulated in two different ways; the first is written by writing the vent mass flow rate in terms of the drain and inlet mass flow rates. The inlet air and steam flow rates are measured separately before mixing and so the energy balance is written as:

$$Q = \left(\dot{m}_v h_v + \dot{m}_A h_A\right)\Big|_i - \left[\left(\dot{m}_v + \dot{m}_A\right)\Big|_i - \dot{m}_d\right] h_e - \dot{m}_d h_d \tag{7.12}$$

Now the above expression is written in terms of measured quantities. The inlet air mass flow rate is measured directly while the inlet steam mass flow rate is calculated from a volumetric flow rate measurement and the steam density. The condensate mass flow rate is also derived from a volumetric flow rate measurement and so the energy balance is now:

$$Q = \left(\dot{V}_v \rho_v h_v + \dot{m}_A h_A\right)\Big|_i - \left[\left(\dot{V}_v \rho_v + \dot{m}_A\right)\Big|_i - \dot{V}_d \rho_d\right]\left(x_v h_v + x_A h_A\right)\Big|_e - \dot{V}_d \rho_d h_d \tag{7.13}$$

where $\dot{V}$ is the measured volumetric flow rate. Enthalpies and densities are calculated from temperature measurements and steam tables. The steam and air mass fractions ($\mathbf{x}_v$ and $\mathbf{x}_A$) are calculated from their respective densities at the vent. The former is taken from a steam table and the latter is calculated by subtracting the vapor partial pressure from the total pressure and using the perfect gas law. It is assumed that the air and vapor velocities in the vent are equal.

The second energy balance, which can be used as a check against the first, is formulated in terms of inlet and vent flow rates, which eliminates the drain flow rate measurement:

$$Q = \left(\dot{m}_v h_v + \dot{m}_A h_A\right)\Big|_i - \left(\dot{m}_v h_v + \dot{m}_A h_A\right)\Big|_e - \left[\left(\dot{m}_v + \dot{m}_A\right)\Big|_i - \left(\dot{m}_v + \dot{m}_A\right)\Big|_e\right] h_d \qquad (7.14)$$

The condensor energy balance in terms of measured quantities is now written as:

$$Q = \left[\dot{V}_v \rho_v (h_v - h_d) + \dot{m}_A (h_A - h_d)\right]\Big|_i - \left[\rho_v (i_v - h_d) + \frac{(P_T - P_V) M_A}{\Re T}(h_A - h_d)\right]\dot{V}\Bigg|_e \qquad (7.15)$$

where M_A and $\Re$ are the molecular weight of air and universal gas constant, respectively. As indicated, all quantities in the first and second terms are evaluated at the inlet and exit conditions, respectively, except the drain enthalpy, which is evaluated at the measured condensate temperature.

If the condensor reaches a true steady state, the inlet air flow rate is identical to the exit air flow rate. Thus equation 7.13 can be simplified to:

$$Q = \dot{V}_{v_i} \rho_{v_i} \left(h_{v_i} - h_{v_e}\right) + \dot{m}_{A_i} \left(h_{A_i} - h_{A_e}\right) - \dot{V}_d \rho_d \left(h_d - h_{v_e}\right) \qquad (7.16)$$

and equation. 7.15 can be simplified to:

$$Q = \dot{V}_{v_i} \rho_{v_i} \left(h_{v_i} - h_d\right) + \dot{m}_{A_i} \left(h_{A_i} - h_{A_e}\right) - \dot{V}_e \rho_{v_e} \left(h_{v_e} - h_d\right) \qquad (7.17)$$

Energy balance accuraces will depend on the drain and vent flow values. For most cases, where the air fraction is low, eqn. 7.16 will be more accurate than eqn. 7.17. Equation 7.16 will be used to calculate the PCC condenser heat transfer in the steady state tests because of the relatively high drain flow fraction. Equation 7.17 will be used to confirm the results.

Each of the above measured quantities is described in the Table 7.1. Also given are the process identifications for each flow and temperature measurement used in the energy balance. The process identification for temperatures used to calculate enthalpies and steam partial pressures are also listed. Note that the energy balance will not be calculated on line with the DAS software, i.e., during the experiment, but rather during data processing and analysis (cf. Section 7.2).

7.2 Data Processing and Analysis

7.2.1 Pretest

During the preconditioning of the test facility the operators will monitor the required instrumentation identified for these tests in Table 5.4. The operators will check whether or not redundant measurements are consistent and perform other congruency checks as possible to verify that the instrumentation and data acquisition system are working correctly.

7.2.2 Post-test/Quick Look

After each test, a quick look at the data will be performed in order to provide the information necessary to proceed with the next test. This quick look will be focused on identification of required instruments which have failed and verification that the objectives of the test were achieved. This quick look will include a cursory review of time history plots covering the full test duration for all of the required instruments.

7.2.3 Post-test/Apparent Test Results Report Inputs

Following completion of the tests described in Section 9, data reduction will be performed to support preparation of the Apparent Test Results Reports (ATR). This data reduction will include time history plots of all the required measurements covering the full test duration. In addition digital data tables for the key parameters will be prepared with averages and standard deviations of these key parameters over the test duration. These results will be reviewed and reported in the ATR.

7.2.4 Post-test/Data Transmittal Report

The Data Transmittal Report (DTR) will transmit all the data for the steady state tests. It will provide detailed information on the test facility configuration, test instrumentation, test conditions and the format for the data. In addition, samples of key data will be presented in tables and plots.

7.3 Data Records

The digitally acquired data will be recorded in real time for the entire duration of the test. Immediately after the test, a copy of the data file will be created on magnetic tape in order to have a permanent record of the data file. Also to be recorded with this data file are all information required to perform subsequent processing of the data.

7.4 Data Sheets

The following data sheets will be prepared for each test for inclusion in the Design Record File (DRF). The test identification code will be printed on each sheet.

1) print table containing the list of the measurements with their main characteristics (identification, span, calibration constants, associated error, location on the facility, measurement channel number and sampling frequency)
2) print tables of digital values of the recorded signals in engineering units for all required measurements for selected test periods
3) print tables of mean, standard deviation, minimum and maximum value of all the required measurements in engineering units during selected test periods
4) graphs of all required measurements as a function of time (time histories) for selected test periods. Graphs may show groups of up to 8 test measurements.
5) print table showing the position (status) of all valves.

Table 7.1: Condensor energy balance parameters.

Symbol	Description	Process Identification		
		Inlet	Vent	Drain
h_A	Air specific enthalpy (J/kg)	ambient temp.	MTG.P3V.1	–
h_d	Condensate specific enthalpy (J/kg)	--	--	MTL.P3C.2
h_v	Vapor specific enthalpy (J/kg)	MTG.P3F.1	MTG. P3V.1	–
$\dot{m}_A$	Air mass flow rate (kg/s)	MM.B0G	--	--
P_v	Vapor partial pressure (Pa)	MTG.P3F.1	MTG. P3V.1	–
P_T	Total pressure (Pa)	MP.I1F	MP.P3V	–
T	Gas/fluid temperature (°C)	MTG.P3F.1	MTG.P3V.1	MTL.P3C.2
$\dot{V}$	Volumetric flow (m^3/s)	MV.I1F	MV.P3V	MV.GRT
ρ_v	Steam density (kg/ m^3)	MTG.P3F.1	MTG.P3V.1	–
ρ_d	Condensate density (kg/ m^3)	--	--	MTL.P3C.2

8. SHAKEDOWN TESTS

Shakedown Tests were conducted accordly to Rev. 0 of this document. The following changes in the TP&P were made as a consequence of these Shakedown Tests:

- Configuration:
  Check valve CK.GRT in the GDCS Drain Line removed
- Procedure
  - RPV water level (ML.RP.1) reduced to ≅ 3.0 m
  - GDCS temperature preconditioning to ≅ 393K
  - Manual control of Wetwell backpressure

The purposes of the shakedown tests are to:

- confirm test facility stability (i.e. ability to reach a steady state)
- confirm adequacy of data acquisition system
- confirm ability to control pressure and flow rates
- confirm the adequacy of the test procedures for the steady state matrix tests.

The tests will entail steady-state condensing of pure steam or steam/air mixtures in the PCC3 unit. The PANDA facility will be configured in the same manner as the steady state matrix tests, described in Section 3.4 and Section 9. The reference test numbers are from Section 9. The detailed test procedure with its check lists are contained in the PANDA Steady State Test Procedure (Part II of this document).

8.1 General description of test SD-01 (Reference Test S3)

This first shakedown test is intended to test all systems to be used during the steam/air matrix tests described in Section 9. Steam from the RPV and air will be fed directly to PCC3 where the steam will be condensed. The pressure will be controlled from the wetwell tanks such that the pressure at the inlet to PCC3 will be 300 kPa. The pressure will be controlled by the venting of air/steam from the wetwell tanks. The PCC pool water level will be maintained at the normal water level.

8.2 General description of test SD-02 (Reference Test S6)

This shakedown test is to be run to check out the facility for its pure steam test setup, i.e. with closed PCC3 vent line. Steam only will be fed directly from the RPV to PCC3 where it will be condensed. The steam flow rate (0.26 kg/s) will be approximately equal to the condensing capacity of the PANDA PCC at 3 bars. With a closed PCC3 vent line the condenser inlet pressure will float to match exactly the condensing capacity for the given flow.

9. TEST MATRIX

9.1 Test Description

A series of steady state tests will be conducted using one of the PANDA PCC condensers. The facility will be configured as described in Section 3 to inject known flowrates of saturated steam and air directly to the PCC3 heat exchanger. The condenser inlet pressure will be maintained at 300 kPa for all tests with air flow by controlling the wetwell pressure. The pool surface elevation in WW2 will be low relative to the PCC3 vent line exit elevation. The steam and air flow to the heat exchanger will be controlled and measured. In addition, the condenser drain flow and vent flow will be measured. Four tests are planned with various air flows and a constant steam flow of 0.195 kg/sec. In addition, two tests with no air flow will be run. One with the same steam flow as for the steam/air tests and one with a steam flow equivalent to that expected to match the steam condensing capacity of the condenser at 3 bars. For these tests with no air flow, the PCC3 vent will be closed as described in Section 8.2. The test conditions and the corresponding tests in PANTHERS and GIRAFFE (Phase 1, Step 1) are:

PANDA Test No.	Steam Flow (kg/s)	Air Flow (kg/s)	PANTHERS Test Condition No.	GIRAFFE Phase 1,Step 1 Test No.
S1	0.195	0	41	2
S2	0.195	0.003	9	4
S3	0.195	0.006	15	6
S4	0.195	0.016	18	8
S5	0.195	0.034***	23	10
S6	0.26	0	43	3

Tests S1 through S6 will be run with the PCC3 upper and lower headers uninsulated. Following Test S6, insulation will be added to the upper and lower headers to make the heat removal from the PCC tubes relative to the heat removal from the headers more representative of the SBWR (detailed description in Section 3.4 and Figure 3-5). Following addition of the insulation to the PCC3 headers, Tests S3, S5 and S6 will be repeated as tests S7 through S9 to determine the steady-state heat removal with the headers and vent line insulated.

*** It may not be possible for the PANDA air supply to deliver this flowrate. If this flowrate cannot be reached, the test will be done at the maximum air flowrate which can be reached.

PANDA Test No.	Steam Flow (kg/s)	Air Flow (kg/s)	PANTHERS Test Condition No.	GIRAFFE Phase 1,Step 1 Test No.
S7	0.195	0.006	15	6
S8	0.195	0.034***	23	10
S9	0.26	0	43	3

Additional conditions are:

The PCC3 Upper Header Pressure is 300 kPa for tests S2 through S5, S7 and S8.
The PCC3 Upper Header Pressure is the attainable pressure for S1, S6 and S9.

The PCC3 Pool Level for all tests (S1 through S9) has to be 24.3 m above PANDA facility reference elevation, or 4.5 m above bottom of PCC3 pool.

Tests S2 through S5, S7 and S8 will be conducted with air injection directly into the PCC3 condenser inlet line downstream of the vortex flow meter used to measure the steam flow to the condenser. The air flowrate will be provided by the auxiliary air system and the air flowrate will be measured with a hot-film flow meter.

9.2 Acceptance Criteria

In order to assure the objectives of these tests are met, it is necessary for:

1) all the required instrumentation defined in Section 5.6 and Table 5.5 to be operational, and

2) the mean values over the 10 minute test period for the following test conditions must be within the specified ranges:

- PCC3 Upper Header Pressure = reference matrix value ± 4 kPa
- Steam Flow to PCC3 = reference matrix value ± 5%
- Air Flow to PCC3 = reference matrix value ± 5%
- PCC3 Pool Level = reference matrix value ± 20 cm

3) the standard deviation about the mean over the 10 minute test period for the four test conditions listed above must be equal to or less than the specified tolerance in order to assure steady state conditions (see Section 9.3). For example, the standard deviation about the mean for the air or steam flow should be equal to or less than 5%:

*** It may not be possible for the PANDA air supply to deliver this flowrate. If this flowrate cannot be reached, the test will be done at the maximum air flowrate which can be reached.

9.3 Definition of Steady State

Steady-state conditions are defined as conditions for which the mean values of all four parameters specified in Section 9.2 are within the ranges specified, and the standard deviation about the mean for each of these four parameters is equal to or less than the tolerance specified in Section 9.2. These mean and standard deviation values should be within these ranges for the 10 minute test period for the test to be acceptable.

On-line Steady-state Conditions Evaluation and Data Recording

The test data should be recorded over a time period longer than the 10 minute test period. The data recording period should be selected by the test engineer to be long enough so that there is high confidence that a 10 minute period can be selected for post-test data reduction which will meet the criteria in Section 9.2.

Test conditions conformance to the criteria will be rigorously evaluated during the post-test data reduction. The conditions will be evaluated on-line during the test performance by the test engineer's review of time history plots of the four parameters listed in Section 9.2, since the capabilities to do rigorous calculations of mean and standard deviation values on-line at PANDA do not exist at present. The test engineer will do visual estimates of the mean from the time history plots of the parameters listed in Section 9.2 to determine if they are within the range specified. He will also do visual estimates of the the magnitude of the oscillations of each of these parameters about their mean values. (See Figure 9.1 for example). By using the peak values to assess parameter oscillations it will be assured that the standard deviation is with its required range. When the visual evaluations based on the time history plots indicate that the criteria has been met for a period of approximately 5 minutes, the test data recording period will be initiated.

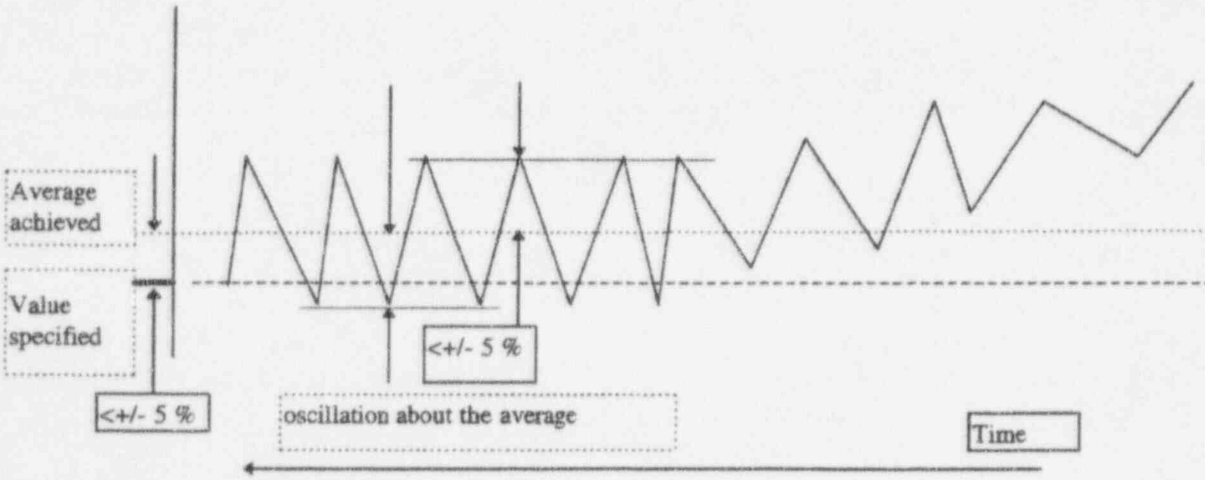

Fig. 9.1: On-Line Steady-state Conditions Evaluation (Example)

10. REPORTS

Two brief Apparent Test Results (ATR) report will be prepared covering the results for all steady state tests based on the data reduction described in Section 7.2.3. There will be one ATR for tests S1 through S6, and a second ATR for tests S7 through S9. The ATRs will summarize the apparent results. The format for this report will include: test number, test objective, test date, data recording period, reference test time, names of data files, list of failed or unavailable instruments considered to be required for the test, list of pressure and differential pressure instruments with zero not in tolerance or over-range during test, deviations from test procedure, problems, table of results (average and standard deviation for all required measurements) and time history plot of flow rate measurements over the test duration. The ATR report is a verified report, approved by the PSI PANDA Project Manager, and will be transmitted to the Test Requestor (GE) within approximately one week of the completion of the steady state test.

The Data Transmittal Report (DTR) containing all the data for all the steady state tests will be issued approximately two months after the tests are performed. The DTR will be verified before it is issued, approved by the PSI PANDA Project Manager, and then be transmitted to the Test Requestor.

11. QUALITY ASSURANCE REQUIREMENTS

11.1 References

The PANDA tests shall be performed in conformance with the requirements of the PANDA Test Specification [6], NQA-1 [7], 10 CFR 50 Appendix B [8] and the GE PANDA Project Control Plan [9]

11.2 Audit Requirements

GE Nuclear Energy reserves the right to perform one or more audits to verify that the PANDA Project Control Plan is in place and being followed. When GE performs these audits, PSI will make all requested test records and personnel available for review.

11.3 Notification

PSI has the responsibility to notify GE Nuclear Energy with documentation of:

(a) any changes in the test procedure,

(b) any failure of the test device(s) or system(s) to meet performance requirements,

(c) any revisions or modifications of the test device(s) or system(s), and

(d) the dates when tests are expected to be performed.

12. TEST HOLD/DECISION POINTS

This Test Plan and Procedures Document must have been reviewed and approved by GE's Test Requestor and PSI's PANDA Project Manager before the steady-state testing described in Section 9 can be performed.

One additional hold/decision point will occur after the shakedown tests described in Section 8. GE's Test Requestor and PSI's PANDA Project Manager must approve the test configuration, instrumentation, and conditions for the tests described in Section 9 (Tests S1 through S9), after the shakedown tests (SD-01 and SD-02) have been completed and the results have been reviewed.

13. REFERENCES

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[4] LOMPERSKI S., "PANDA pressure transmitter calibration", TM-42-94-09, September 1994.

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[6] GE Document 25A5587, PANDA Test Specification.

[7] ANSI/ASME NQA-1-1983 and Addenda NQA-1a-1983.

[8] 10 CFR 50 Appendix B.

[9] GE PANDA Project Control Plan, PPCP-QA-01.

[10] LOMPERSKI S., DREIER J., WILKINS C., "Error Analysis for PANDA Instrumentation", PSI Report TM-42-95-03 / ALPHA503-A, February 1995.

PART II: TEST PROCEDURES

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00 Introduction

The following Steady State Test Procedure describes all test phases, including the preconditioning processes. This procedure is applicable to all Steady State Tests with steam/air mixtures and pure steam given by the Test Matrix and has been evaluated and verified with the Shake Down Tests. Due to the increased condensation rate occuring with pure steam flow through the PCC3, the initial conditions must be modified; A description of the modifications in configuration and procedures is given in n°200.

The initial conditions have been defined according to the anticipated steady state, which determines all preconditioning and test sequences. A summary of the whole operation course is given in section 02.

01 Initial Conditions

The PANDA configuration used for the Steady State Tests differs from that needed for the transient tests. The initial conditions are not defined for the whole facility, but only for the components included in this specific configuration. The test configuration includes the RPV, Wetwells, GDCS, PCC3 and PCC3 pool.

The chosen initial conditions are based upon the fixed parameters desired for each experiment such as condenser inlet pressure and gas flow rate. These conditions may not exactly match the steady state that the facility will reach before measurements begin; they are only an estimation of that state under the desired test conditions. Therefore, it is not necessary to exactly match the vessel initial conditions shown below.

Measurements begin only after the entire facility has reached a steady state, vessels are preconditioned to the anticipated steady state.

Vessel initial conditions are as follows:

01.1 Steam / Air Tests

PCC3 Condenser (X.P3):	condenser inlet pressure maintained at 300 kPa
Reactor Pressure Vessel (V.RP):	pressure equals to 300 kPa => T=Tsat=407K no air water level elevation at 2500 mm => ML.RP.1=3.0 m
PCC3 Condenser Pool (V.U3):	pressure equals atmospheric pressure P=Patm≅98 kPa => T=Tsat≅371K water level at elevation 24300 mm => ML.U3=4.5 m
GDCS tank (V.GD):	pressure at 300 kPa temperature at about the same as the condensate temperature T=393K => Psteam≅200 kPa & Pair≅100 kPa no water

Suppression Chambers (V.S1 V.S2): same pressure conditions as in X.P3 during the test and high temperature to avoid condensation
P=300 kPa
T=407K => Psteam≅300 kPa
almost no air
no water

01.2 Pure Steam Tests

PCC3 Condenser (X.P3): condenser inlet pressure for Test S1 at P≅300kPa
for Test S6 and S9 at P≅350kPa

Reactor Pressure Vessel (V.RP): pressure equals to 300 kPa => T=Tsat=407K for Test S1
350 kPa=> T=Tsat=412K for Tests S6 and S9
no air
water level elevation at 2500 mm => ML.RP.1=3.0 m

PCC3 Condenser Pool (V.U3): pressure equals atmospheric pressure
P=Patm≅98 kPa => T=Tsat≅371K
water level at elevation 24300 mm => ML.U3=4.5 m

GDCS tank (V.GD): pressure at 280 kPa for Test S1
330 kPa for Tests S6 and S9
temperature at about the same as the condensate temperature
T=393K => Psteam≅200 kPa & Pair≅ 80 kPa for Test S1
130 kPa for Tests S6 and S9
no water

Suppression Chambers (V.S1 V.S2): 20 kPa pressure reduction against X.P3 during the test
P=280 kPa for Test S1 and 330 kPa for Tests S6 and S9
T=404K
no water

02 Preconditioning Schedule

All preconditioning phases are separately described later in this procedure. The preconditioning steps shown here (phase n°20 through n°71) can be deviated from as needed to achieve the initial conditions listed in phase n°01. It is not necessary to adhere strictly to these preconditioning steps or record the performance of these steps, because they will not affect the test results. The important phases which will affect the test results are listed in the Checklist in Attachment 1. These steps will be strictly followed. The schedule given in Table 1 shows an overview of all sequences, i.e. facility startup, preconditioning, test and end of test operation. Each phase is represented by a dark rectangle with the corresponding estimated duration written inside.

After the facility startup, the RPV is used as heat source for the preconditioning of the other vessels. Since water filling, steam and/or air injection are independent processes, several phases can be conducted simultaneously. The GDCS is heated by hot water filling while the gas is vented to atmosphere. After that process has been completed, the Suppression Chambers structure is heated by steam injection. The PCC3 pool conditioning is performed by transferring water at ~373K from the GDCS to the pool. The initial conditions are then adjusted before test is conducted. After all PANDA components are separately conditioned, the required test configuration is set before adjusting steady state initial conditions and performing the test.

The total preconditioning duration would be about 10 hours if all phases were performed sequentially, but performing some phases in parallel shortens the overall duration to about 8 hours. Some uncertainty in the total time necessary for preconditioning is due to the processes indicated by "xxx" symbols in Table 1. The duration of these phases is not accurately known at this stage.

Note: All numbers given for start conditions (temperatures, pressures, levels etc) and elapse time calculations are based on the assumption, that preconditioning starts under the following conditions:

- all vessels are drained from water and contain air at ambient pressure
- facility temperature is 283K
- available power ist limited to 600 kW

If different start conditions are found, the individual steps have to be appropriately modified at the test engineer's direction.

Phase	time in seconds
10 - Preparation	xxx
21 - RPV Filling	7000
22 - RPV Heating	12100
31 - GDCS Heating	9000
41 - SCs Heating	8800
51- PCC3 Pool Filling	800
32 - GDCS Pressurization	380
61 - PCC3 pressurization	xxx
71 - Adjust RPV Conditions	xxx
80 - Configuration Setup	xxx
85 - PCC3 Pool Heating	xxx
90 - Test Conditions Setup	2300
100- Test	900
110- End of Test	xxx

Remark: xxx symbols refer to phases, for which duration has not been estimated

Table 1: Steady State Test Preconditioning Schedule

10 Preparation - Establish Initial Configuration

Before starting any preconditioning process, the facility is set into a specific state, which must allow facility operations from the PANDA WARTE (PANDA Control Room). The configuration must be set in order to avoid any hardware manipulation during test or preconditioning processes. Data Acquisition and Control Systems considered as tools to set up the facility must be properly turned on. And as last preparation phase, the auxiliary water system is filled to allow pumps operation.

The phase n°11 describes the start of the PANDA Software, while the valve setup is explained in the section n°12. The phase n°13 consists of the auxiliary water system filling.

11 Control System and DAS Setup

- Ethernet connection is isolated from PSI network (Unplug ETHERNET connecter)
- Run Factory Link Software on HP-UNIX workstation (cf. DAS and Control Syst. User's Guide)
- Run DAS software (cf. DAS User's Guide)
- Run Factory Link Software on PC (cf. Control Syst. User's Guide)
- Switch all local controllers on "external" and "automatic" state

12 Valve Alignment

- Set valve positions according to the START UP status

13 Auxiliary Water System Filling

- Water Auxiliary System Filling

20 RPV Setup for Vessel Preconditioning

As the heat source for the whole preconditioning process, the RPV must be capable of producing steam for vessel heating or providing hot water to the auxiliary water system. In order to establish conditions to generate steam, the RPV is first heated to 373K, while most of the air is purged by venting to the atmosphere. Not all air is purged at this temperature, but this does not affect the vessel preconditioning. Pure steam conditions are only required for the tests. Then the RPV is heated to about 400K to supply the auxilliary water system heat exchanger.

The RPV water level must be higher than the riser (elevation 10500 mm) and lower than the main steam lines; it is set for the preconditioning phase to elevation11000 mm.

The water filling is described by the phase n°21 and the heating in the next phase n°22.

During the phase n°22, the auxiliary steam system lines are connected to the RPV to avoid pressure difference.

21 Water Filling

21.0 Check RPV Parameters

- Check water level *ML.RP.1≅0.00 m <=> M(RPVwater)=0.00 ton*

Comment: - *M(RPV-water)* corresponds to the amount of water contained in the RPV.

21.1 Supply water until level elevation equals 11000 mm

- Open control valve CC.RPV

  ML.RP.1=11.5 m => ΔM(water)=13.7 ton

  MV.BOD=2.0 l/s => t=7000 sec

- Fill preheater heating side with water - Open valves CB.HRH, CB.HFH

21.2 Check RPV Parameters

- Check water level

  ML.RP.1=11.5 m => ΔM(water)=13.7 ton

22 Heating / Purging

22.0 Check RPV Parameters

- Check pressure — *MP.RP.1≅100 kPa*
- Check fluid temperature — *MTF.RP.1...5≅283K*
- Check structure temperature — *MTI.RP.1...3≅283K*

22.1 Heat until temperature equals 373K and vent gas space to atmosphere

- Heaters on: — *MW.RP.7=600 kW*
  T=373K => ΔT=90K
  M(RPV-water)=13.7 ton — *=> ΔQ=5.16 GJ*
  M(structure)=8.00 ton — *=> ΔQ=0.36 GJ*
  => ΔQ=5.52 GJ *=> t=9300 sec*
- Close control valve: CC.RPV
- Open valves CC.MS1, CB.B1S

  T=400K => ΔT=27K
  M(RPV-water)=13.7 ton — *=> ΔQ=1.55 GJ*
  M(structure)=8.00 ton — *=> ΔQ=0.11 GJ*
  => ΔQ=1.66 GJ *=> t=2800 sec*
- Heaters off: — *MW.RP.7=0 kW*

Comment: - two subphases to emphasize the valve opening.

22.2 Check RPV Parameters

- Check fluid temperature — *MTF.RP.1...5≅400K*
- Check structure temperature — *MTI.RP.1...3≅400K*
- Check pressure — *MP.RP.1≅247 kPa*
- Check water level — *ML.RP.1=12.3 m <=> M(RPVwater)=13.7 ton*

30 GDCS Setup

As condensate tank and in order to measure the water flow rate in the return line, the GDCS conditions require no water level and a pressure of 300 kPa. To maintain that pressure, the initial temperature is chosen equal to that from the condensate coming from the PCC3, 393K.

Starting the GDCS preconditioning process from atmospheric conditions, we first heat the tank to 373K by hot water filling, then in a second stage with steam to 393K and finally pressurize the vessel by air injection. Heating the GDCS by hot water filling assures homogeneous temperature; in order to also fill the PCC3 drain line, the tank must be filled to a level higher than the condensate drain line outlet level, which is at elevation 17025 mm. The air is vented by water filling to the atmosphere. The second stage of preconditioning to 393K by steam and the pressurization phase with air is performed after the PCC3 pool filling phase.

The phase n°31 describes the Structure Heating (1) with hot water. The phase n°32 describes Structure Heating (2) by steam injection and phase n°33 the pressurization with air.

31 Structure Heating (1)

31.0 Check GDCS Parameters

- Check fluid temperature *MTF.GD.1...7≅283K*
- Check structure temperature *MTI.GD.1...6≅283K*

31.1 RPV Setup for Heat Exchanger Operation

- Check RPV parameters:
  fluid temperature *MTF.RP.1...5≅400K*
  pressure *MP.RP.1≅247 kPa*
  water level *ML.RP.1=12.3 m <=> M(RPVwater)=13.7 ton*
- Heaters on: *MW.RP.7=600 kW*

31.2 GDCS Filling with Water at 373K

- Operation of auxiliary water system
  Pump P.HFH on *flow=17 l/s*
  Open valves CB.GDL, CB.AXL, CB.HFA, CB.FFA, CB.DXA
  Close valve CB.CFA

  Setup control valve CC.BHA *MTL.BHA=373K*
  Setup control valve CC.BCA *MTL.BCA=473K*
  Setup control valve CC.BUV *MP.GD=100kPa*
  Open valve CB.GDV

  Pump PC.B0D o *MV.B0D=1.7 l/s*

  ML.GD=5.4 m =>ΔM(water)=15.4 ton *MV.B0D=1.7 l/s* *=> t=9000 sec*

- End of GDCS filling

  Pump PC.HFH off *flow=0.0 l/s*
  Pump PC.B0D off *MV.B0D=0.0 l/s*
  Return to Valve Startup Status for Auxiliary Water System
  (Close valves CB.DXA, CB.GDL)

- Heaters off: *MW.RP.7=0.0 kW*

- Fill PCC3 drain line - Open CB.P3C

- Close CB.P3C when the line is filled

31.3 Check GDCS and RPV Parameters

- Check GDCS parameters
  fluid temperature *MTF.GD.1...7≅373K*
  pressure *MP.GD≅100 kPa*
  water level *ML.GD=5.4 m <=> M(GDCS-water)=15.4 ton*

- Check RPV parameters:
  fluid temperature *MTF.RP.1...5≅400K*
  pressure *MP.RP.1≅247 kPa*
  water level *ML.RP.1=12.3 m <=> M(RPVwater)=13.7 ton*

Preconditioning continues with phase n°40

32 Structure Heating (2)

The phases n°32 and n°33 are perfomed after the PCC3 Pool Filling (phase n°50)

32.0 Check GDCS Parameters

- Check water level *ML.GD≅0.7 m*
- Check pressure *MP.GD≅100 kPa*
- Check wa. temperatures *MTO.GD.1...6≅373K*

32.1 Check RPV Parameters

- Fluid temperatures *MTF.RP.1...5≅407K*
- Pressure *MP.RP.1≅300 kPa*
- Water Level *ML.RP1≅10.5 m M(water)=11.7 ton*

32.2 Steam Injection / Water Drain

GDCS wall temperatures shall reach 393K / 200kPa and water remaining after phase n°50 has to be drained to the RPV.

- Open connection V.RP to V.GD
  Open valves CB.GDS
- Open valves CB.GRT.1 and CB.GRT.2
- Check GDCS water level *ML.GD≅0 m*
- Close CB.GRT1, CB.GRT.2
- Check GDCS wall temperatures, if uneven vent to the atmosphere in intervalls: control pressure/temperatures with CC.BUV
- Close connection V.RP to V.GD – Close CB.GDS

32.3 Check GDCS and RPV Parameters

- Check GDCS pressure *MP.GD≅200 kPa*
- Check GDCS wall temperatures *MTO.GD.1...6≅393K*
- Check GDCS water level *ML.GD≅0 m*
- Check RPV water level *ML.RP.1≅11.9 m*

33 Pressurization

33.0 Check GDCS Parameters

- Check water level *ML.GD≅0.0 m*
- Check pressure *MP.GD≅200 kPa*
- Check wall temperatures *MTO.GD.1...6≅393K*

33.1 Air injection until GDCS pressure equals 300 kPa

- Close C0.I1G.1
- Open connection auxiliary air system V.PG to V.GD - Open valves CB.GDG, CB.B0G, CC.B0G.2

  ΔPair≅100 kPa, T=373K & Vol(V.GD)=17.66 m3 => ΔM(air)=11.5 kg
  MM.B0G=30 g/s => t=380 sec

- Close connection auxiliary air system V.PG to V.GD - Close valves CC.B0G.2, CB.B0G, CB.GDG

33.2 Check GDCS Parameters

- Check pressure *MP.GD=300 kPa*
- Check wall temperatures *MTO.GD.1...6≅393K*

Preconditioning continues with phase n°60

40 Suppression Chamber Setup

The test conditions require to maintain a constant pressure during the test course at about the same as the condenser inlet pressure. In order to easily satisfy that condition, the temperature is defined to avoid condensation of the steam, which may be vented through the PCC3 vent line. Corresponding to saturated condition at the condenser inlet, the temperature is set at about 407K. Most of the air is purged to the atmosphere and the pressure is controlled by the vent control valve CC.S1V.

Both vessels are simultaneously heated by steam injection. That heating process is described in the phase n° 41.

41 Structure Heating

41.0 Check SC's and RPV Parameters

- Check SC's parameters:

Pressure	*MP.S1≅100 kPa*
	MP.S2≅100 kPa
Gas temperature	*MTG.S1.1...6≅283K*
	MTG.S2.1...6≅283K
Water temperature	*MTL.S1.1...6≅283K*
	MTL.S2.1...6≅283K
Structure temperature	*MTI.S1.1...9≅283K*
	MTI.S2.1...9≅283K
Water level	*ML.S1≅0.0 m*
	ML.S2≅0.0 m

- Check RPV parameters:

fluid temperature	*MTF.RP.1...5≅400K*
pressure	*MP.RP.1≅247 kPa*
water level	*ML.RP.1=12.3 m <=> M(RPV-water)=13.7 ton*

41.1 Steam injection to V.S1 and V.S2 in parallel until SC temperature equals 407K

- Heaters on: *MW.RP.7=600 kW*

- Open connection: V.RP to V.S1 and V.RP to V.S2 - Open valves CB.S1S, CB.S2S

  $T=283K \Rightarrow \Delta T(SC's)=133K$
  $M(SC's\text{-}structure) \cong 72.7\ ton \Rightarrow \Delta Q(SC\text{-}structure)=4.85\ GJ \Rightarrow \Delta M(heating\ steam) \cong 2000\ kg$
  $T(RPV)=407K \Rightarrow \Delta T=6K$
  $M(RPV\text{-}water)=13.7\ ton \quad \Rightarrow \Delta Q=0.34\ GJ$
  $M(structure)=8.00\ ton \quad \Rightarrow \Delta Q=0.03\ GJ$
  $\Rightarrow \Delta Q=0.37\ GJ$

  $\Rightarrow \Delta Q=5.22\ GJ \quad \Rightarrow MW.RP.7=600\ kW \quad \Rightarrow t=8800\ sec$

- Vent intermittently CC.S1.V to achive equal wall temperatures and *MP.S1≅300 kPa*

- Close connection: V.RP to V.S1 and to V.S2 - Close valves CB.S1S, CB.S2S

- Heaters off: *MW.RP.7=0 kW*

41.2 Check SC's and RPV Parameters

- Check SC's parameters:

Pressure	*MP.S1≅300 kPa*
	MP.S2≅300 kPa
Gas temperature	*MTG.S1.1...6≅407K*
	MTG.S2.1...6≅407K
Water temperature	*MTL.S1.1...6≅407K*
	MTL.S2.1...6≅407K
Structure temperature	*MTI.S1.1...9≅407K*
	MTI.S2.1...9≅407K
Water level	*ML.S1≅0.0 m*
	ML.S2≅0.0 m

- Check RPV parameters:

fluid temperature	*MTF.RP.1...5≅407K*
pressure	*MP.RP.1≅300 kPa*
water level	*ML.RP.1≅10.5 m* <=> *M(RPVwater)=11.7 ton*

50 PCC3 Pool Filling

The phase n°51 describes the PCC3 pool filling. The pool conditioning is performed by transferring water at ~373K from the GDCS to the PCC3 pool.

51 Water Filling

51.0 Check PCC3 Pool, GDCS, SC's and RPV Parameters

- Check PCC3 Pool Parameters
  water level *ML.U3≅0.0 m*

- Check GDCS parameters:
  fluid temperature *MTF.GD.1...7≅373K*
  pressure *MP.GD≅100 kPa*
  water level *ML.GD=5.4 m* <=> *M(GDCS-water)=15.4 ton*

51.1 Supply water from V.GD to PCC3 Pool until level equals elevation 24500 mm

- Open connection V.GD to V.U3 - Open valves CB.GDL, CB.B0L, CB.LXA, CB.AXU, CB.B0U, CB.B2U, CB.U3U

- Turn on PC.B0A *MV.B0A=17.0 l/s*

ML.U3=4.70 m => *ΔM(U3-water)=13.70 ton* => *t=800 sec*

- Turn off PC.B0A

- Close connection V.GD to V.U3 - Close valves CB.U3U, CB.GDL, CB.LXA, CB.AXU

- Close vent valves CC.BUV

51.2 Check PCC3 Pool and GDCS Parameters

- Pool water level *ML.U3=4.70 m*

- Water temperature *MTL.U3.1 ... 19≅350K*

- GDCS water level *ML.GD≅0.7 m*

Step back to phase n°32 and n°33

60 PCC3 Condenser Pressurization

To protect the integrity of the PCC3 condenser instrumentation, the feed line and its instrumentation and the feed line valve, only a small pressure difference should exist between the RPV and the condenser before opening the valve. Therefore the condenser is pressurized to 300 kPa by filling it with air through the steady state test air supply line.

That phase is performed just after the GDCS pressurization, which takes place after the PCC3 pool filling.

61 Pressurization

61.0 Check X.P3 Parameters

- Check pressure *MP.I1F≅100kPa*

61.1 PCC3 pressurization until the inlet line pressure equals 300 kPa

- Connect auxiliary air system V.PG to X.P3 - Open valves C0.I1G.1, CB.B0G
- Setup CC.B0G.2 *MM.B0G≅6g/s*

  MP.I1F≅300kPa
- Close connection auxiliary air system – Close valves CC.B0G.2, CB.B0G

Comments:

- The time needed to pressurize the condenser and the feed line is short; due to the small volume. Do not exceed the indicated mass flow setting.

61.2 Check X.P3 Parameters

- Check pressure *MP.I1F≅300kPa*

70 RPV Initial Conditions Setup for Steady State Test

After using the RPV as a heat source for the vessel preconditioning, the thermodynamic state in the vessel may not and the water level does not match the desired initial conditions; water level, pressure and temperature must be adjusted.

Assuming saturated conditions and a negligable air partial pressure, we set the desired pressure by adjusting the temperature. Cooling is achieved by supplying cold water and/or by venting steam to the atmosphere. Heating is performed by using RPV heater.

The water level setup and the adjusting of RPV initial conditions are described in the phase n°71

71 Adjust RPV Initial Conditions

71.0 Check RPV Parameters

- Check fluid temperature *MTF.RP.1...5≅407K*
- Check structure temperature *MTI.RP.1...3≅407K*
- Check pressure *MP.RP.1≅300 kPa*
- Check water level *ML.RP.1=11.9 m <=> M(RPVwater)=13.2 ton*

71.1 RPV Water Cooling to ~ 325K

- Check Start up Valve Alignment
  Fill Auxiliary Water System to at least IC-pool elevation 19800 mm, *ML.0 > 0 m*
- Cooling setup
  Setup control valve CC.BCA for maximum cooling *MTL.BCA=0°C*
  Setup control valve CC.BHA *MTL.BHA=100°C*
  Pump PC.B0A on, set speed to maximum *MV.B0A=20 l/s*
  Setup cooling water flow
  Check C0.B0W, C0.B0Y open
  Open CB.CFW
  Setup control valve CC.CRW *MTL.CRW=10°C*
- Cooling
  Pump PC.HFH on
  Check RPV water temperature *MTF.RP.4...5≅325K*
  MTL.RP.1...2≅325K

Note: Top layer of RPV water is supposed to remain hot (stratification) and, if so, RPV pressure is maintained

- Reset Auxiliary Water System
  Pump PC.HFH off
  Pump PC.B0A reduce speed, later off
- Set valve positions according to start up status

71.2 RPV Water Level Setup – Drain Water until Level equals Elevation 3000 mm

Maximum allowed drain temperature is < 30°C. Therefore, RPV drain flow has to be mixed with cooling water.

- Set cooling water flow to maximum *MTL.CRW.=0°C*
- Drain RPV, open C0.RPY
  Monitor level *ML.RP1.=3.5 m*
  Monitor temperature *MTF.RP5≤ 330K*
- Shutdown
  Close C0.RPY
  Setup CC.CRW gradually increase MTL.CRW to maximum
  Close CB.CFW

71.3 RPV Heating – Adjusting of Temperatures (407K) and Pressure (300 kPa)

- Heaters on *MW.RP.7≅600 kW*
- Monitor: fluid temperatures *MTF.RP.1...5≅407K*
  pressure *MP.RP.1≅300 kPa*
- Heaters off *MW.RP.7=0 kW*
- Close CB.B1S

71.4 Check RPV Parameters

- Check fluid temperature *MTF.RP.1...3≅407K*
- Check structure temperature *MTI.RP.1...3≅407K*
- Check pressure *MP.RP.1≅300 kPa*
- Check water level *ML.RP.1≅3.5 m <=> M(RPVwater)=3.8 ton*

80 Configuration Setup

The PANDA facility is now at the desired initial conditions; all components have been preconditioned independently and are now connected according to the required steady state test configuration. That configuration setup process is given in the phases n°81 to n°84. The allowed pressure tolerances for the pressures in the phases n°81 to n°84 is 20 kPa.

81 Connect V.S2 to V.GD (Through the Auxiliary Steam System Line)

81.1 Check SC's and GDCS pressures

MP.S2=300kPa
MP.GD=300kPa

Open valves CB.S2S, CB.GDS

82 Connect X.P3 to V.S2 (Through the PCC3 Vent Line)

82.1 Check SC's and PCC3 pressures

MP.S2=300kPa
MP.I1F=300kPa

Open valve CB.P3V

83 Connect X.P3 to V.GD (Through the PCC3 Drain Line)

83.1 Check GDCS and PCC3 pressures

MP.GD=300kPa
MP.I1F=300kPa

Open valve CB.P3C

84 Connect V.GD to V.RP (Through the GDCS Return Line)

84.1 Check GDCS and RPV pressures

MP.GD=300kPa
MP.RP=300kPa

Open valve CB.GRT.2. CB.GRT.1

85 PCC3 Pool Heating to Saturation

- Heaters on *MW.RP.7≅576 kW*

  Monitor PCC3 pool temperatures *MTL U3.1...19≅373K*
- Heaters off *MW.RP.7=0*

90 Test Conditions Setup

The facility now satisfies the required test configuration according to the TP&P (ALPHA 410) Section 3.4; and its state is close to the desired initial conditions. The test conditions are now set up and data recording is performed after the entire facility has reached steady behavior. The phases n°91 to n°93 describe these processes establishing of test conditions.

91 Start Air Injection

91.1 Air flow setting

- Open valve CB.B0G
- Set up control valve CC.B0G.2 to *MM.B0G= ... kg/s*

Comments:

- the air flow depends on the test conditions and is defined in the Steady State Test Matrix

92 Adjust Steady State Test Conditions

92.0 Check RPV and PCC3 pressures

MP.RP.1≅300 kPa
MP.I1F≅300 kPa

92.1 Steam flow setting

- Heaters on: *MW.RP.7=.... kW*
- Open valve CB.I1F

92.2 Check Steam Flow *MV.I1F=.... kg/s*

Note: Steam flow = 0.195 kg/s ⇒ Heater power = 432.4 kW
Steam flow = 0.26 kg/s ⇒ Heater power = 576.0 kW

93 Control Pressure in Suppression Chamber

93.1 Pressure control by venting to atmosphere

- Set up control valve CC.S2V *to MP.S2=300 kPa*
  (expected range for manual control: 10% to 15% opening)

Comment:

- the SC pressure is set in order to establish the required condenser inlet pressure; it might be slightly lower than 300 kPa.

94 Confirm Valve Status

94.1 Printout valve status report

- Compare to reviewed and approved Test Valve Status for test being performed.
- Attach 'Valve Status Report to Attachment 1.

100 Test

The test measurements can only begin after the facility has reached steady state. Different parameters are checked and data are recorded when the condenser conditions are considered as steady. That is described in the phase n°101

101 Data Recording (at least 15 min.)

101.0 Check Steady State - Check parameters until they reach steady behavior according to the acceptance criteria (TP&P 9.2 and 9.3)

- Check pressure *MP.I1F≅300 kPa ± 4 kPa*
- Check steam and air flow *MV.I1F=.... kg/s ± 5%*
  MM.B0G=... kg/s ± 5%
- Check PCC3 pool level *ML.U3=4.50 m ± 0.20 m*
- Adjust, if necessary, the air flow, the steam flow, the condenser pressure and/or the PCC3 pool level.

Comments:

- steady state must be established according to the conditions given in the TP&P Section 9.3.
- the air flow depends on the test conditions, it is defined in the Steady State Test Matrix

101.1 Data Recording (at least for 15 min.)

- DAS operation according to the DAS User's Guide. => *t=900 sec*

110 End of Test

After at least 15 minutes of data recording at steady conditions, the test is completed and the facility is shut down or another steady state test is performed. In this case, the test conditions are adjusted to satisfy the next experiment conditions (start from phase n°90). If no new test is performed, heaters are turned off, air injection is stopped and all facility components are isolated from each other. The phase n°111 describes the end of data recording while the n°112 explains the facility shut down.

111 End of Data Recording

111.0 Stop Data Recording (cf DAS User's Guide)

111.1 Save Test Data (cf. Control System User's Guide)

111.2 Prepare for next test according to phase n°90 for mixed flow tests, go to n°200 for pure steam tests or shut down the facility (phase n°112)

112 Facility Shut Down

112.0 Stop Steam Flow

- Heaters off *MW.RP.7 = 0 kW*
- Close valve *CB. I1F*

112.1 Stop Air Flow

- Setup control valve *CC.B0G.2 to MM.B0G = 0 kg/s*
- Close valve *CB. B0G*

112.2 Isolating Vessels and PCC3

- Close valves *CB.GRT.1. CB.GRT.2*
- Close valve *CB.P3C*
- Close valve *CB.P3V*
- Close valves *CB.GDS, CB.S2S*
- Check valve positions according to the START UP status

112.3 End of DAS and Control System Operation

- Stop DAS (cf. DAS User's Guide)
- Stop Factory link on PC (cf. Control System User's Guide)
- Stop Factory link on HP-UNIX (cf. Control System User's Guide)

200 Pure Steam Tests

For the Pure Steam Tests (S1, S6, S9) the Steady-State Tests acceptance criteria as stated in sections 9.2 and 9.3 remain unchanged. However, the condenser inlet pressure is not predetermined but found as the principle result of tests which are conducted in accordance with the following test procedure. To reach and maintain pure steam conditions in the condenser, the facility configuration, preconditioning and operation as described above for the Mixed Flow Tests must be modified.

For the Pure Steam Tests the condenser inlet pressure is not controlled; instead, the inlet pressure will be found by having the system float to the pressure for which the condenser performance exactly matches the given steam flow (henceforth: equilibrium pressure). If, with the mixed flow configuration of the test facility maintained, in the course of this floating process the condensing capacity were not reached (i.e. approaching steady state from a higher than equilibrium pressure) an undefined part of the condenser would be blanketed in some way, e.g. by air sucked back from WWs. To avoid such air contamination for the Pure Steam Tests the WWs are disconnected from the condenser, i.e. the condenser vent line is closed. The remaining facility configuration is therefore a simple closed circuit:

$$RPV \rightarrow PCC3 \rightarrow GDCS \rightarrow RPV$$

However, to assure pure steam conditions the condenser is intermittently purged to the WW, where a slightly lower pressure is maintained than in the condenser header. Pure steam conditions are reached when, after purging the condenser to the WWs, the system recovers to the same pressure as before purging.

To have control of the effective <condenser> – <WW> pressure difference (for venting) requires the WWs to be preconditioned, similarly as for the Mixed Flow Tests. The pressure difference between the condenser and the WW is then maintained by operator-controlled venting of the WWs to the atmosphere.

To properly engage the GDCS return flow measurement, an appropriate inlet flow length for the flow meter is required. With the given geometrical line arrangement and with the RPV running at low water level, a sufficient inlet flow length can only be established by reducing the GDCS pressure by ~20 kPa against the RPV pressure. This is accomplished by operator-controlled venting of the GDCS to the atmosphere.

The described operator-controlled venting processes imply that preconditioning is completed at a higher than equilibrium pressure because venting evidently allows for pressure reductions only. Hence, a "top-down-approach" is followed for the floating of the system pressure, i.e. the system has to be preconditioned to a pressure which is higher than the equilibrium pressure.

210 Preheating and Purging of Vessels

This phase is performed after End of Test (phase n°111.2) or after PCC3 Pool Heating (phase n°85).

The Pure Steam Tests require higher system temperatures / pressures to approach equilibrium pressure in a top-down strategy. The system is brought to a higher pressure and air is vented from RPV and GDCS. (Note: Heaters are still on. Valves are aligned for Mixed Flow Tests, except steam and air supply to the condenser which is closed.)

211 Reset Facility

–	Close valve	CB. I1F	
–	Reset control valve Close valve	CC.B0G.2 CB.B0G	*MM.B0G=0*
–	Close valves	CB. P3C, CB.P3V CB.GRT.1, CB.GRT.2 CB.S2S, CB.GDS	

212 Purge RPV

–	Setup control valve	CC.RPV	*→ 100%*
–	Check saturation		$MP.RP.1=P_{sat}$ *(MTF.RP. 1...3)*
–	Reset / close valve	CC.RPV	

213 Purge GDCS

–	Open valves	CB.B1S, CB.GDS	
–	Setup control valve Open valve	CC.BUV CB.GDV	*MP.BUV≅250 kPa*
–	Check saturation		$MP.GD=P_{sat}$ *(MTF.GD. 1...7)*
–	Reset / close valves	CB. GDV, CC.BUV	

214 Preheat System

–	Setup heaters		*MW.RP.7=600 kW*
–	Check pressure		$MP.S1 \le MP.GD$

- Open valves CB.S1S, CB.S2S
- Monitor pressure *MP.RP.1 ≤ 350 kPa*
- Heaters off *MW.RP.7=0 kW*
- Close valves CB.B1S, CB.GDS, CB.S1S, CB.S2S

215 Check System Parameters

- Pressure *MP.RP1≅350 kPa*
- Water levels *ML.RP1≅3.2 m*
  ML.U3≅4.7 m

220 PCC3 Setup

The condenser needs to be pressurized, connected to the steam feed line and purged of air.

221 PCC3 Pressurization

- Follow phase n°61 instructions, but *MP.I1F≅350 kPa*
- Close valve C0.I1G.1

222 Connect PCC3 to RPV and WW

222.1 Check Pressures

MP.RP.1≅350 kPa
MP.I1F≅350 kPa
MP.S2≅350 kPa

222.2 Connect X.P3

- Connect to RPV:
  Open valve CB.I1F
- Connect to WW:
  Open valve CB.P3V

223 Purge PCC3

- Setup Control Valve CC.S1V
- Monitor X.P3 pressure *MP.I1F*
- Vent to atmosphere by opening CC.S1V as appropriate
- Close valve CB.P3V while venting with CC.S1V
- Reset / Close valve CC.S1V

230 Test Conditions Setup

The circuit for the Pure Steam Tests is closed by connecting the GDCS to the condenser and the RPV (phase n°231). In this configuration the PCC3 pool is reheated to saturation (phase n°232). Heating power is adjusted to produce the given steam flow (phase n°233). WWs and GDCS are vented to ~ 20 kPa below RPV pressure (phase n°234). While the system will now approach equilibrium pressure WW and GDCS pressure have do be readjusted (phase n°234) and the condenser periodically purged (phase n°235). If the system mean pressure is constant (i.e. equilibrium pressure) and recovers after PCC purging to the same pressure as was prevailing before purging (i.e. pure steam conditions) the system is ready for the test (phase n°240).

231 Connect GDCS to PCC3 and RPV

- Check pressures *MP.I1F* *MP.GD*
- Open valves CB.P3C, CB.GRT.1, CB.GRT.2

232 Reheating PCC3 Pool

- Check temperatures *MTL.U3.1...19 ≤ ~373K*
- If subcooled, reheat V.U3
  Setup heaters *MW.RP.7=600 kW*
- Monitor temperatures *MTL.U3.1...19 ≤ ~373K*
- Continue with phase n°233 ff while this phase is running

233 Setup Test Heating Power

- Adjust heaters to required power for given steam flow *MW.RP.7=... kW*
  S1: 432 kW
  S6 and S9: 576 kW
  Compensate for system heat losses, as appropriate

234 Reduce WW and GDCS Pressure

234.1 Venting WW

- Setup control valve CC.S1V *MP.S1≅330 kPa*
- Maintain pressure difference of 20 kPa below condenser inlet pressure
- Reset / close valve CC.S1V
- Monitor pressure difference through phase n°240 *<MP.I1F> - <MP.S1>≅20 kPa*
  Reiterate this phase as appropriate

234.2 Venting GDCS

- Setup control valve CC.BUV — *MP.GD≅330 kPa*
- Open valve CB.GDV
- Maintain pressure difference of 20 kPa below condenser inlet pressure
- Reset / close valve CC.BUV
- Monitor pressure difference through phase n°240 — *<MP.I1F> – <MP.GD> ≅ 20 kPa*
  Reiterate this phase as appropriate

235 Purging of PPC3

- Monitor system pressures — *MP.RP.1*, *MP.I1F*
- Open valve CB.P3V for 15s (fully open position)
  Close valve CB.P3V
- Reiterate this phase in 10 min. to 15 min. intervalls, as appropriate. Proceed to phase n°240 when system pressures satisfy test acceptance criterion for steady state and system pressure fully recovers after purging.

240 Pure Steam Test

When steady-state conditions are met (phase n°241) test data are recorded (phase n°242). If test is successful according to acceptance criteria as stated in Section 9.2 and 9.3, following options exist for continuing work:

a) facility shut-down

b) continue with pure steam tests

c) continue with mixed flow tests

241 Check System Parameters

- Check levels RPV — *ML.RP1≅3.0 m*
  PCC3 Pool — *ML.U3=4.5 m +20 cm – 0 cm*
- Check steam flow for magnitude and steady-state criterion — *MV.I1F=..... kg/s*
- Check pressures:
  - PCC upper header pressure — *MP.I1F*
    - check for steady state condition
    - check for pure steam condition
  - GDCS and WWs
    - check for 20 kPa lower pressure than in PCC3 upper header

242 Data Recording

- Record data for at least 15 min. (cf. DAS User's Guide)
- Monitor system behavior with respect to acceptance criteria
- Stop data recording (cf. DAS User's Guide)
- Save test data (cf. Control System User's Guide)

243 End of Test

- IF facility has to be shut down

  Close valve CB.GDV

GO TO phase n°112

- ELSE IF additional testing is scheduled

  Check water levels; refill as necessary — *ML.RP.1≅3.2 m*, *ML.U3≅4.7 m*

  - IF an additional test with pure steam at lower flow rate is scheduled

GO TO phase n°232

  - ELSE Close valves CB.GDV, CB.GRT.1, CB.GRT2, CB.I1F, CB.P3C

    - IF additional testing with pure steam at equal or higher flow rate is scheduled

      Open valves CB.B1S, CB.GDS

GO TO phase n°214

    - IF mixed flow tests are scheduled

      Open valve CB.B1S

GO TO phase n°41 Continue according to the procedure, but omit phase n°51

  - END IF

- END IF

ATTACHMENT 1

Checklist

Steady State Test Number ______:

Completion of Procedure Phase n°	Date / Time	Signatures Performer/Reviewer
11		
12		
81.1		
82.1		
83.1		
84.1		
91.1		
92.1		
92.2		
93.1		
94.1		
101.0		
101.1		
111.0		
111.1		

GEP-95-20
4 August 1995

TO: G. Varadi

SUBJECT: Additional PANDA Steady State Tests to Evaluate Test Repeatability and PCC Hea[illegible] Heat Transfer

Note that this letter supercedes GEP-95-19.

This is to request that PSI perform four additional steady state tests (S10 through S13) in the PANDA test facility The purpose of these tests is investigate the repeatability of the steady state test results and to quantify the change in total PCC heat removal with the PCC pool level reduced to the bottom of the upper header of the PCC condenser. These tests are all to be conducted without the PCC headers insulated.

Tests S10, S11 and S12 will be conducted with the conditions for Tests S3/S7, S5/S8, and S6/S9, respectively, to evaluate the repeatability of results for these tests. Test S12 will also provide a current reference test for the demonstration of the effect of reduced PCC pool level on PCC heat removal. Test S13 will be run at the same conditions as Test S12 (S6/S9), except the PCC pool level will be near the bottom of the upper PCC header.

For all four of these additional tests, both the lower and upper header for PCC3 should be uninsulated. The tests should be done at the conditions specified in ALPHA-410, Rev. 2 and in conformance with the criteria and procedures defined in ALPHA-410, Rev. 2 with one exception. The only exception is that the PCC pool level for Test S13 should be set so that the pool surface is near the bottom of the upper header for PCC3 during the test operation. This pool level is to be achieved by maintaining the PCC3 pool level during the test at 2.70 ± 0.05 m above the bottom of the PCC pool as determined with instrument ML.U3. Water should be added to the pool continuously at a rate which approximately ma[illegible]hes the pool boiloff rate to maintain this water level.

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