Westinghouse
Electric Corporation

Energy Systems

Box 355
Pittsburgh Pennsylvania 15230-0355

NSD-NRC-97-4966
DCP/NRC0722
Docket No.: STN-52-003

January 31, 1997

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: T. R. QUAY

SUBJECT: INFORMAL CORRESPONDENCE

Dear Mr. Quay:

Please find attached correspondence that we are sending you formally. We have previously sent you this correspondence informally over the period December 11, 1996 through December 31, 1996.

Attachment 1 provides an index of the attached material as we discussed during our project meeting.

Please contact me on (412) 374-4334 if you have any questions concerning this transmittal.

C L Haag for BAM

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

/jml

Attachment

cc: N. J. Liparulo, Westinghouse (w/o Attachment)

E004
1/1

3065A

100118

Attachment 1 to Westinghouse Letter NSD-NRC-97-4966

DATE	ADDRESSEE	DESCRIPTION
12/11/96	Sebrosky	Material in preparation for 12/12 TH Uncertainty Long Term Cooling phone call
12/16/96	Jackson	Revised status detail for OITS 263
12/16/96	Huffman	SSAR markups for Vantage 5H fuel
12/16/96	Jackson	Changes to OITS status
12/17/96	Jackson	Notes from 12/17/96 phone call on HVAC
12/17/96	Jackson	SSAR markups to resolve item from 11/7/96 phone call - OITS 2890
12/17/96	Jackson	SSAR markups for section 9.4 to correct references
12/19/96	Bongarra	Markup changes for WCAP-14645
12/19/96	Huffman	Material in preparation for 12/20 phone call on adverse systems interaction report
12/19/96	Bongarra	Draft tier1 material for "Task Analysis" as discussed in 12/17//96 phone call
12/17/96	Landry	Draft of PRHR heat transfer correlation material
12/19/96	Quay	Weekly status of open items
12/20/96	Jackson	Changes to OITS to reflect 12/17 letter NSD-NRC-96-4917
12/20/96	Jackson	SSAR markup to resolve item 2.a from NRC 10/17 letter on HVAC
12/26/96	Quay	Open item status
12/26/96	Jackson	SSAR markup to resolve OITS 1195
12/27/96	Jackson	Suggested agenda for 12/31/96 fire protection phone call
12/26/96	Jackson	SSAR markup to resolve item 7.d.(2) of NRC 10/17/96 letter on HVAC
12/30/96	Jackson	SSAR markup to resolve zone of influence from 11/19/96 meeting
12/30/96	Jackson, et al	Changes in NRC status in OITS
12/30/96	Sebrosky	Changes in NRC status in OITS
12/27/96	Jackson	SSAR markup to resolve item 5.h of NRC 10/17/96 letter on HVAC
12/30/96	Jackson	SSAR markup to resolve OITS 1197
12/27/96	Jackson	SSAR markup to resolve item 7.e.(1) of NRC 10/17/96 letter on HVAC

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 30, 1996	NAME:	Jim Winters
TO:	Diane Jackson	LOCATION:	ENERGY CENTER - EAST
PHONE:	FACSIMILE:	PHONE:	Office: 412-374-5290
COMPANY:	USNRC	Facsimile:	win: 284-4887 outside: (412)374-4887
LOCATION:			

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The following pages are being sent from the Westinghouse Energy Center, East Tower, Monroeville, PA. If any problems occur during this transmission, please call:

WIN: 284-5125 (Janice) or Outside: (412)374-5125.

COMMENTS:

Diane

This is a markup which should resolve the "zone of influence" comment from our 11/19 meeting on fire protection. It should also resolve Key Issue 12.b. of you 12/6/96 key issues letter. It will be in Revision 11 of the AP600 SSAR unless we hear from you.

Jim Winters

cc: Butler
Lindgren
McIntyre
Cummins
Ron Vijuk
Winters
Hutchings
Jeanne Evans

Any damage which the fire is capable of causing is assumed to occur immediately. No credit is taken for proper operation of equipment or proper positioning of valves which are not protected from the effects of a postulated fire.

Zone of Influence

A postulated fire does not exceed the boundary of the fire area. For fire areas outside the main control room, remote shutdown workstation, and containment fire areas, all equipment in any one fire area is assumed to be rendered inoperable by the fire and re-entry into the fire area for repairs and operator actions is assumed to be impossible. However, no credit is taken for complete fire damage in cases in which complete damage is beneficial and partial damage is not. Chases for electrical cables, piping or ducts that pass through the fire area but are separated from it by 3-hour fire barriers are outside the zone of influence for that fire area.

Inside the containment fire area, potential fire damage is evaluated by fire zone. All equipment in any one fire zone is assumed to be rendered inoperable by the fire unless the fire protection analysis demonstrates otherwise. Class 1E electrical cables that are located in or pass through the fire zone but are separated from it by a 3-hour fire barrier are outside the zone of influence for that fire zone.

Independence of Affected Fire Areas

Only systems, components, and circuits free of fire damage are credited for achieving safe shutdown for a given fire. Systems, components, and circuits outside the zone of influence are considered free of fire damage if the effects of the fire do not prevent them from performing their required safe shutdown functions.

Event Assumptions

Plant accidents and severe natural phenomena are not assumed to occur concurrently with a postulated fire. Furthermore, a concurrent single active component failure (independent of the fire) is not assumed.

Offsite Power

A loss of offsite power is assumed concurrent with the postulated fire only when the safe shutdown evaluation indicates the fire could initiate the loss of offsite power.

Availability of Nonsafety-Related Systems

Only safety-related components and systems are assumed to be available to perform safe shutdown functions. (This is more stringent than required by BTP CMEB 9.5-1.) Fire protection and smoke control systems are assumed to function as designed to detect and mitigate the effects of the fire.

FAX TO:

BILL HUFFMAN
DIANE JACKSON
TOM KENYON
JOE SEBROSKY

Tomorrow, December 31. 1996, we will be changing the NRC Status for the following Open Items from "Active" or "Proposed" to "Action N", except where noted. Recommended changes were provided for many of these items, as well as others, by fax on December 9, 1996. NRC provided status designations for most of the items identified on December 9, but not the following. Various status designations were recommended on December 9. But to avoid unilateral disposition of the items, all will be designated "Action N". This will keep them active, recognize that Westinghouse plans no work on these items pending review by NRC, and avoid the use of "Active" or "Proposed", as we agreed.

Item	Branch	DSER Section	Notes
1999	PDST	1.1	
2024	HICB	16	
2040	TSB	16	
2442	HICB	16.1	
2457	HICB	16.1	
2045	SCSB	19	
2051	SRXB	19	
1458	SCSB	19.2.2.1-4	
1461	SCSB	19.2.3.3-2	
457	ECGB	3.8	
2018	PDST	6	
458	ECGB	6.2	
972	SCSB	6.2.1-1	
973	SCSB	6.2.1-2	
1009	SCSB	6.2.5.2-4	
2019	SCSB	6.3	
1101	EMCB	9.3.6-2	
1102	EMCB	9.3.6-3	

1697	SCSB	19.2	Not included in 12/9 fax.
1698	SCSB	19.2	Not included in 12/9 fax.
1699	SCSB	19.2	Not included in 12/9 fax.
1700	SCSB	19.2	Not included in 12/9 fax.
1701	SCSB	19.2	Not included in 12/9 fax.
1702	SCSB	19.2	Not included in 12/9 fax.
1703	SCSB	19.2	Not included in 12/9 fax.
1704	SCSB	19.2	Not included in 12/9 fax.
1707	SCSB	19.2	Not included in 12/9 fax.

Jim Winters
412-374-5290

FAX TO JOE SEBROSKY

December 30, 1996

Joe,

In accordance with our letter NSD-NRC-96-4913 of December 13, 1996, we will be changing the NRC Status of OITS items 4123 through 4144 to Action N unless we hear from you. We will do the change tomorrow (12-31-96). Note that this shouldn't be considered a unilateral action. Since we have not heard to the contrary, we assume the responses provided are sufficient for review. Please call if you have questions.

Jim Winters
412-374-5290

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 27, 1996	NAME:	Jim Winters
TO:	Diane Jackson	LOCATION:	ENERGY CENTER - EAST
PHONE:	FACSIMILE:	PHONE:	Office: 412-374-5290
COMPANY:	USNRC	Facsimile:	win: 284-4887 outside: (412)374-4887
LOCATION:			

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The following pages are being sent from the Westinghouse Energy Center, East Tower, Monroeville, PA. If any problems occur during this transmission, please call:

WIN: 284-5125 (Janice) or Outside: (412)374-5125.

COMMENTS:

Diane,

This markup should resolve Item 5.h in your 10/17/96 letter.

It will go into SSAR Revision 11 unless we hear from you.

cc: Lindgren
Butler
McIntyre
Cummins
Ron Vijuk
Winters
Hutchings
Jeanne Evans

Jim Winters

monitoring, and therefore requires no nuclear safety evaluation. Redundant safety-related isolation dampers are provided in the supply, return, and exhaust ducts penetrating the main control room. Therefore, there are no single active failures which would prevent isolation of the main control room envelope. Redundant main control room supply air radiation monitors are provided. The nuclear island nonradioactive ventilation system is designed so that safety-related systems, structures, or components are not damaged as a result of a seismic event.

9.4.1.4 Tests and Inspections

The nuclear island nonradioactive ventilation system is designed to permit periodic inspection of system components. Each component is inspected prior to installation. Components of each system are accessible for periodic inspection during normal plant operation. A system air balance test and adjustment to design conditions is conducted in the course of the plant preoperational test program. Airflow rates are measured and balanced within a tolerance of ± 10 percent of design flow rate in accordance with the guidelines of SMACNA HVAC systems, Testing, Adjusting and Balancing (Reference 19) except the supplemental air fultration units which are balanced in accordance with the guidelines of ASME N510 (Reference 3). Instruments are calibrated during testing. Automatic controls are tested for actuation at the proper setpoints. Alarm functions are checked for operability.

The supplemental air filtration unit, HEPA filters, and charcoal adsorbers are field tested in accordance with ASME N510 to verify that these components do not exceed a maximum allowable bypass leakage rate. Used samples of charcoal adsorbent are periodically tested to verify a minimum charcoal efficiency of 90 percent in accordance with Regulatory Guide 1.140, except that test procedures and test frequency are conducted in accordance with ASME N510.

The ductwork for the supplemental air filtration subsystem and portions of the main control room/technical support center HVAC subsystem that maintain the integrity of the main control room/technical support center pressure boundary during conditions of abnormal airborne radioactivity are tested for leak tightness in accordance with ASME N510, Section 6. The remaining supply and return/exhaust ductwork is field tested for leaktightness in accordance with SMACNA HVAC Duct Leakage Test Manual (Reference 18).

9.4.1.5 Instrumentation Applications

The nuclear island nonradioactive ventilation system is controlled by the plant control system except for the main control room isolation dampers, which are controlled by the protection and safety monitoring system. Refer to subsection 7.1.1 for a description of the plant control and plant safety and monitoring systems.

Temperature controllers are provided in the return air ducts to control the room air temperatures within the predetermined ranges. Temperature indication and alarms for the main control room return air, Class 1E electrical room return air, air handling unit supply air, supplemental filtration unit inlet air and charcoal adsorbers are provided to inform plant operators of abnormal temperature conditions.

Construction Class A, Leakage Class I bubble tight dampers. These dampers have safety-related operators that fail closed on loss of electrical power.

Tornado Protection Dampers

The tornado protection dampers are split-wing type and designed to close automatically. The tornado protection dampers are designed against the effect of 300 mph wind.

Shutoff and Balancing Dampers

Multiblade, two-position shutoff dampers are parallel-blade type. Multiblade, balancing dampers are opposed-blade type. Air handling unit and fan shutoff dampers are designed for maximum fan static pressure at shutoff flow and meet the performance requirements in accordance with ANSI/AMCA 500 (Reference 14). The supplemental air filtration subsystem dampers are constructed, qualified, and tested in accordance with ANSI/AMCA 500 or ASME N509 (Reference 2), Section 5.9.

Combination Fire/Smoke Dampers

Combination fire/smoke dampers are provided at duct penetrations through fire barriers to maintain the fire resistance ratings of the barriers. The combination fire/smoke dampers meet the design, leakage testing, and installation requirements of UL-555S (Reference 25).

Ductwork and Accessories

Ductwork, duct supports, and accessories are constructed of galvanized steel. Ductwork subject to fan shutoff pressures is structurally designed to accommodate fan shutoff pressures. Ductwork, supports, and accessories meet the design and construction requirements of SMACNA High Pressure Duct Construction Standards (Reference 16) and SMACNA HVAC Duct Construction Standards – Metal and Flexible (Reference 17). The supplemental air filtration and main control room/technical support center HVAC subsystem's ductwork that maintains integrity of the main control room/technical support center pressure boundary during conditions of abnormal airborne radioactivity are designed in accordance with ASME N509 (Reference 2), Section 5.10 to provide low leakage components necessary to maintain main control room/technical support center habitability.

, including the portion of the ductwork outside of the main control room envelope,

9.4.1.2.3 System Operation

9.4.1.2.3.1 Main Control Room/Technical Support Center HVAC Subsystem

Normal Plant Operation

During normal plant operation, one of the two 100 percent capacity supply air handling units and return/exhaust air fans operates continuously. Outside makeup air supply to the supply air handling units is provided through an outside air intake duct. The outside airflow rate is automatically controlled to maintain the main control room and technical support center areas

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	~~Diane Jackson~~ 12/27/96	NAME:	Jim Winters
TO:	Diane Jackson	LOCATION:	ENERGY CENTER - EAST
PHONE:	FACSIMILE:	PHONE:	Office: 412-374-5290
COMPANY:	USNRC.	Facsimile:	win: 284-4887 outside: (412)374-4887
LOCATION:			

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The following pages are being sent from the Westinghouse Energy Center, East Tower, Monroeville, PA. If any problems occur during this transmission, please call:

WIN: 284-5125 (Janice) or Outside: (412)374-5125.

COMMENTS:

Diane, Here is a markup for revision 11 of SSAR that should resolve open item 1197 from our 12/20/96 meeting. The attached list was compared with Tables 1 and 2, pages 11.5-8 thru 11.5-12 of SRP. SRP nomenclature was added to items that weren't obvious. Some SRP line items do not apply to AP600 since it doesn't have the item. Item 1197 should now be "Action N" in NRC Status.

Jim Winters

cc: Butler
Lindgren
McIntyre
Cummins
Ron Vijuk
Winters
Israelson
Jeanne Evans

Table 9.3.3-2 (Sheet 1 of 4)

LOCAL SAMPLE POINT NOT IN THE PRIMARY SAMPLING SYSTEM (NORMAL PLANT OPERATIONS)

Sample Point Name	Available Number of Points	Type of Sample[a]	Process Measurement
Liquid Sample			
1. CVS boric acid tank	1	Grab	pH, chlorine, fluorine, boron, silica, suspended solids, radioisotopic liquid, oxygen
2. CVS boric acid batching tank	1	Grab	Boron, chlorine, fluorine
3. Residual heat removal heat exchanger	2	Grab	Radioisotopic liquid, suspended solids, radioisotopic gas, gross specific activity, strontium, iron, tritium, hydrogen, I-131, conductivity, pH, oxygen, chlorine, fluorine, boron, aluminum, silica, lithium radioisotopic liquid, lithium radioisotopic particulate, magnesium, sulfate, calcium, lithium
4. PXS IRWST	1	Grab	pH, Oxygen, fluorine, boron, conductivity, gross specific activity, sodium, sulfate, silica
5. Main Steam Line (Outlet SG 1)	1	Continuous	Radiation monitor (See Section 11.5, Table 11.5-1)
6. Main Steam Line (Outlet SG 2)	1	Continuous	Radiation monitor (See Section 11.5, Table 11.5-1)
7. BDS steam generator blowdown	1	Grab	Tritium, gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
8. SFS purification (Upstream & downstream of SFS ion exchangers) (spent fuel pool treatment)	2	Grab	Conductivity, pH, chloride, silica, corrosion product metals, gross activity, corrosion product activity, fission product activity, I-131, tritium, turbidity, boron, corrosion product metals, organic impurities
9. PCS water storage tank	1	Grab	Hydrogen peroxide
10. RC drain tank (Reactor Coolant)	1	Grab	Gross radioactivity and identification and concentration of principal radionuclide and alpha emitters. Dissolved gases.

Table 9.3.3-2 (Sheet 2 of 4)

LOCAL SAMPLE POINT NOT IN THE PRIMARY SAMPLING SYSTEM (NORMAL PLANT OPERATIONS)

Sample Point Name	Available Number of Points	Type of Sample[a]	Process Measurement
11. WLS degasifier (downstream of degasifier discharge pump)	1	Grab	Dissolved gases
12. CCS component cooling surge tank	1	Grab	pH, sodium, chloride, silica, corrosion product metals, corrosion inhibitors
13. CCS loops (downstream of CCS pumps)	2	Grab	pH, sodium, chloride, silica, corrosion product metals, tritium, gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
14. CCS hot leg (upstream of CCS pumps)	1	Continuous	Radiation monitor (See Section 11.5, Table 11.5-1)
15. WLS discharge (liquid radwaste effluent)	2	Continuous	Radiation monitor (See Section 11.5, Table 11.5-1)
16. WLS effluent holdup tanks MT05A, B	2	Grab	Gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
17. WLS waste holdup tanks MT06A, B	2	Grab	Gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
18. WLS monitor tanks MT07A, B, C	3	Grab	Tritium, gross radioactivity and identification and concentration of principal radionuclide and alpha emitters. State and federal environmental discharge requirements such as pH, suspended solids, oil and grease, iron, copper, sodium nitrite
19. WLS ion exchanger pre-filter (downstream)	1	Grab	Suspended solids
20. WLS ion exchanger after-filter (downstream)	1	Grab	Suspended solids

Table 9.3.3-2 (Sheet 3 of 4)

LOCAL SAMPLE POINT NOT IN THE PRIMARY SAMPLING SYSTEM (NORMAL PLANT OPERATIONS)

Sample Point Name	Available Number of Points	Type of Sample[a]	Process Measurement
21. WLS chemical waste tank	1	Grab	Tritium, gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
22. WSS spent resin tank (liquid)	1	Grab	Tritium, gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
23. SES blowdown	1	Grab	Tritium, gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
24. WWS turbine building drain tank	2	Grab	Tritium, gross radioactivity and identification and concentration of principal radionuclde and alpha emitters
25. CPS spent resin sluice line (liquid)	1	Grab	Tritium, gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
Gaseous Sample			
26. VES MCR emergency air supply headers	2	Grab	Air quality, oxygen, carbon monoxide, carbon dioxide, contaminants
27. WGS effluent discharge to environment	1	Continuous	Radiation monitor (See Section 11.5, Table 11.5-1)
28. WGS inlet	1	Continuous	Oxygen, hydrogen, moisture
29. WGS carbon bed vault	1	Continuous	Hydrogen
30. WGS delay bed outlets MV02A, B	2	Grab	Moisture, noble gases, iodine, particulates, tritium
31. Condenser air removal system[b]	1	Grab	Iodine, noble gases, tritium
32. Gland seal system[b]	1	Grab	Iodine, noble gases, tritium

Table 9.3.3-2 (Sheet 4 of 4)

LOCAL SAMPLE POINT NOT IN THE PRIMARY SAMPLING SYSTEM (NORMAL PLANT OPERATIONS)

Sample Point Name	Available Number of Points	Type of Sample[a]	Process Measurement
33. Plant vent (including containment purge, auxiliary building ventilation, fuel storage and radwaste area ventilation discharge)	1	Continuous & Grab[c]	Iodine, noble gases, particulates

Notes:

a. This column shows methods to obtain a sample for analysis. "Grab" means that a grab sample is required for the intended analysis. Depending on the sampling condition, this grab sample can be obtained in the laboratory or in the grab sampling unit. "Continuous" means that the required analysis is performed via a probe that monitors the sampling steam continuously.

b. Continuous monitoring of discharge for radiation provided in turbine island vent (See Section 11.5, Table 11.5-1).

c. Includes analysis for tritium.

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 27, 1996	NAME:	Jim Winters
TO:	Diane Jackson	LOCATION:	ENERGY CENTER - EAST
PHONE:	FACSIMILE:	PHONE:	Office: 412-374-5290
COMPANY:	USNRC	Facsimile:	win: 284-4887 outside: (412)374-4887
LOCATION:			

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The following pages are being sent from the Westinghouse Energy Center, East Tower, Monroeville, PA. If any problems occur during this transmission, please call:

WIN: 284-5125 (Janice) or Outside: (412)374-5125.

COMMENTS:

Diane,

Here is the markup to resolve Item 7.e(1) from your 10/17/96 letter and our 12/17/96 telecon. It will go into Revision 11 of the SSAR unless we hear from you. I would like to show OITS Item 291 as "Action N" in the NRC Status.

Jim Winters

cc: Butler
Lindgren
McIntyre
Cummins
Ron Vijuk
Winters
Hutchings
Joanne Evans

The system conditions and filters outside air supplied to the containment for compatibility with personnel access during maintenance and refueling operations. Based on the maximum and minimum outside air normal temperature conditions shown in Chapter 2, Table 2-1, the system supplies air between 50 and 70°F. The air is distributed and conditioned within the containment by the containment recirculation system (subsection 9.4.6).

Radiologically Controlled Areas Outside Containment

The containment air filtration system provides filtration of exhaust air from the fuel handling area, auxiliary, or annex buildings to maintain these areas at a slightly negative pressure with respect to the adjacent areas when the radiologically controlled area ventilation system detects high airborne radioactivity or pressure differential. Refer to subsection 9.4.3 for a description of the radiologically controlled area ventilation system.

9.4.7.2 System Description

The containment air filtration system is shown in Figure 9.4.7-1.

9.4.7.2.1 General Description

The containment air filtration system consists of two 100 percent capacity supply air handling units, a ducted supply and exhaust air system with containment isolation valves and piping, registers, exhaust fans, filtration units, automatic controls and accessories. The supply air handling units are located in the south air handling equipment room of the annex building at elevation 158'-0". The supply air handling units are connected to a common air intake plenum, located at the south end of the fan room, and discharge the supply air towards the east containment recirculation cooling system (VCS) recirculation unit to distribute the purge air within the containment. Refer to subsection 9.4.6 for a description of the containment recirculation cooling system.

REPLACE WITH INSERT 9.4-42

The exhaust air filtration units are located within the radiologically controlled area of the annex building at elevation 135'-3" and 146'-3". The filtration units are connected to a ducted system with isolation dampers to provide HEPA filtration and charcoal adsorption of exhaust air from the containment, fuel handling area, auxiliary and annex buildings. A gaseous radiation monitor is located downstream of the exhaust air filtration units in the common ductwork to provide an alarm if abnormal gaseous releases are detected. The plant vent exhaust flow is monitored for gaseous, particulate and iodine releases to the environment. During containment purge, the exhaust air filtration units satisfy 10 CFR 50 Appendix I guidelines (Reference 20) for offsite releases and meets 10 CFR 20 (Reference 21) allowable effluent concentration limits when combined with gaseous releases from other sources. During conditions of abnormal airborne radioactivity in the fuel handling area, auxiliary and/or annex buildings, the filtration units provide filtered exhaust to minimize unfiltered offsite releases.

The size of the containment air filtration system supply and exhaust air lines that penetrate the containment pressure boundary is 36 inches in diameter. Each penetration includes an

INSERT 9.4-42

The common air intake plenum is located at the extreme south end of the annex building between elevation 135' and 152'. This plenum supplies air for the radiologically controlled area ventilation system, the containment air filtration system, the nuclear island non-radioactive ventilation system, the annex/auxiliary building non-radioactive HVAC system and the health physics and hot machine shop HVAC system. The intake is not protected from tornado missiles. The containment air filtration system supply air handling units then

FAX TO DIANE JACKSON
USNRC
December 27, 1996

Suggested Agenda for Fire Protection Telecon

Diane and Jeff,

Here is a list of the Open Items showing Action W in the NRC Status. I recommend that we go over them in the order shown as time permits. The ones we know Westinghouse still has work to do are listed last. Maybe we can end Tuesday's call with a focus on the outstanding items and a definitive path to resolution.

Item No.	Recommended Status	Comments
1919	Resolved	COL item is in SSAR
1921	Resolved	COL item is in SSAR
1114	Action N	Information is in SSAR. We have no other specific information requests.
3438	Action N	RAI response was forwarded by NSD-NRC-96-4817 of 9/10/96.
3439	Action N	RAI response was forwarded by NSD-NRC-96-4817 of 9/10/96.
3440	Action N	RAI response was forwarded by NSD-NRC-96-4817 of 9/10/96.
1996	Resolved	This was discussed in meetings with NRC on fire protection and on fire protection PRA.
317	Closed	Same as 1996.
1120	Action N	Air supplies are discussed in SSAR.
1122	Action N	Smoke Control is discussed in SSAR. Specific concerns are covered in other open items.
1124	Action N	Preoperational testing is discussed in SSAR.
3456	Action N	RAI response was forwarded by NSD-NRC-96-4834 of 10/4/96.
3457	Action N	RAI response was forwarded by NSD-NRC-96-4834 of 10/4/96.
3458	Action N	RAI response was forwarded by NSD-NRC-96-4834 of 10/4/96.

3459	Action N	RAI response was forwarded by NSD-NRC-96-4834 of 10/4/96.
3442	Action N	RAI response was forwarded by NSD-NRC-96-4834 of 10/4/96.
3460	Action N	RAI response was forwarded by NSD-NRC-96-4839 of 10/11/96.
3443	Action N	RAI response was forwarded by NSD-NRC-96-4839 of 10/11/96.
3444	Action N	RAI response was forwarded by NSD-NRC-96-4839 of 10/11/96.
3445	Action N	RAI response was forwarded by NSD-NRC-96-4839 of 10/11/96.
3447	Action N	RAI response was forwarded by NSD-NRC-96-4839 of 10/11/96.
3446	Action N	RAI response was forwarded by NSD-NRC-96-4839 of 10/11/96.
3448	Action N	RAI response was forwarded by NSD-NRC-96-4839 of 10/11/96.
321	Action N	New information is contained in SSAR
312	Action N	New information is contained in SSAR
310	Action N	New information is contained in SSAR
306	Action N	DID response is in SSAR
308	Action W	Per previous meetings
309	Action W	SSAR change required from previous meetings
323	Action W	Per previous meetings
324	Closed	Same as 323
314	Action W	Investigate design per previous meetings

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 26, 1996	NAME:	James Winters
TO:	Diane Jackson	LOCATION:	ENERGY CENTER - EAST
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COMPANY:	USNRC	Facsimile:	win: 284-4887 outside: (412)374-4887
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WIN: 284-5125 (Janice) or Outside: (412)374-5125.

COMMENTS:

Diane,

The attached markup should resolve item 7.1.(2) of your 10/17/96 letter and our 12/17/96 telecon. (OITS item 287). It will be included in Revision 11 of the SSAR unless we hear from you. I would like to change the NRC status for item 287 to "Action N."

Jim Winters

cc: Lindgren
Butler
McIntyre
Cummins
Ron Vijuk
Winters
Hutchings
Jeanne Evans

Containment Recirculation Fan Coil Units

Each fan coil unit assembly consists of two separate but physically connected 50 percent capacity fan coil units. Each fan coil unit assembly is comprised of a return air mixing plenum section with a physical barrier in the middle and three cooling coils attached to the sides of each plenum section. The cooling coils are counterflow finned tubular type. The cooling coils are rated and meet the performance requirements in accordance with ANSI/ARI 410 (Reference 12) and ASHRAE 33 (Reference 11).

The recirculation fans are vane axial upblast type, direct driven with a high efficiency wheel, adjustable blades and an inlet bell. The fans are mounted vertically on top of the mixing air plenum section. The fans are designed with a non-overloading two-speed motor. The high speed is used during normal operation and the low speed is used during high ambient air density operating conditions such as the integrated leak rate testing. The fans are designed and rated in accordance with ANSI/AMCA 210 (Reference 4), ANSI/AMCA 211 (Reference 5), and ANSI/AMCA 300 (Reference 6). Fans are factory tested and rated for performance in accordance with ANSI/AMCA 210, ANSI/AMCA 211 and ANSI/AMCA 300.

Pressure Relief Damper

Pressure relief dampers relieve high pressure differential across the ductwork to protect the equipment or components from possible damage resulting from abnormal containment pressure transients. The pressure relief dampers are the weight loaded type. INSERT 9.4-38

Ductwork and Accessories

Ductwork, accessories, and duct supports are constructed of galvanized steel and structurally designed to accommodate fan shutoff pressures. The ductwork meets the design, testing and construction requirements according to SMACNA HVAC Duct Construction Standards - Metal and Flexible. (Reference 17)

Balancing and Backdraft Dampers

Multiblade, balancing dampers are opposite-blade type. Backdraft dampers are provided to prevent reverse flow through the standby fan while the redundant fan is operating. The backdraft dampers also allow start up of the standby fan while the redundant fan remains in operation. The balancing and backdraft dampers are designed for the same differential pressure as the duct section in which they are located and meet the performance requirements in according with ANSI/AMCA 211 (Reference 5) and ANSI/AMCA500 (Reference 14).

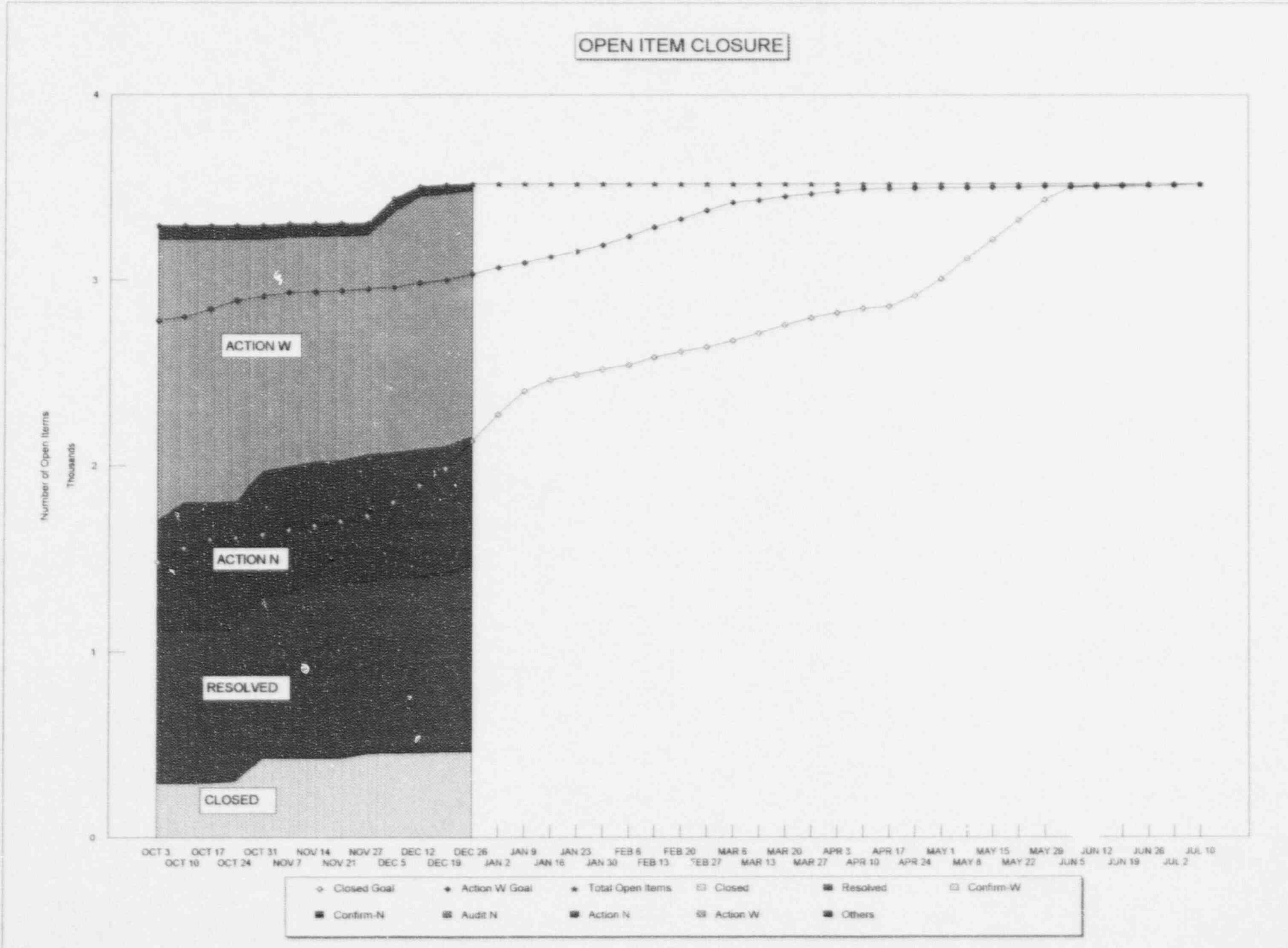
9.4.6.2.3 System Operation

Normal Plant Operation

During normal plant operation, one of the two 50 percent capacity fans in each fan coil unit assembly draws air from the upper levels of the operating floor and delivers cooling air

INSERT 9.4 - 38

The damper(s) will be placed in their standard design positions during final duct layout. They will be located so that the entire containment ring duct can be relieved without damage.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Number of Open Items
Thousands
4
3
2
1
0
ACTION W
ACTION N
RESOLVED
CLOSED
OCT 3
OCT 10
OCT 17
OCT 24
OCT 31
NOV 7
NOV 14
NOV 21
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DEC 5
DEC 12
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JAN 2
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MAY 1
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MAY 15
MAY 22
MAY 29
JUN 5
JUN 12
JUN 19
JUN 26
JUL 2
JUL 10
Closed Goal
Action W Goal
Total Open Items
Closed
Resolved
Confirm-W
Confirm-N
Audit N
Action N
Action W
Others

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 26 1996	NAME:	Jim Winters
TO:	Diane Jackson	LOCATION:	ENERGY CENTER - EAST
PHONE:	FACSIMILE:	PHONE:	Office: 412-374-5290
COMPANY:	USNRC	Facsimile:	win: 284-4887 outside: (412)374-4887
LOCATION:			

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WIN: 284-5125 (Janice) or Outside: (412)374-5125.

COMMENTS:

Diane

Here is markup to resolve item 1195 from our 11/20 meeting. It will be in SSAR Revision 11 unless we hear from you. I would like to change NRC status for 1195 to "Action N."

Jim Winters

cc: Lindgren
Butler
McIntyre
Cummins
Ron Vijuk
Winters
Hutchings
Israelson

Table 9.3.3-2 (Sheet 3 of 4)

LOCAL SAMPLE POINT NOT IN THE PRIMARY SAMPLING SYSTEM (NORMAL PLANT OPERATIONS)

Sample Point Name	Available Number of Points	Type of Sample[a]	Process Measurement
21. WLS chemical waste tank	1	Grab	Tritium, gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
22. WSS spent resin tank (liquid)	1	Grab	Tritium, gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
23. SES blowdown W	1 1	Continuous Grab	Radiation Monitor (See Section 11.5, Table 11.5-1) Tritium, gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
24. WWS turbine building drain tank	2	Grab	Tritium, gross radioactivity and identification and concentration of principal radionucl de and alpha emitters
25. CPS spent resin sluice line (liquid)	1	Grab	Tritium, gross radioactivity and identification and concentration of principal radionuclide and alpha emitters
Gaseous Sample			
26. VES MCR emergency air supply headers	2	Grab	Air quality, oxygen, carbon monoxide, carbon dioxide, contaminants
27. WGS effluent discharge to environment	1	Continuous	Radiation monitor (See Section 11.5, Table 11.5-1)
28. WGS inlet	1	Continuous	Oxygen, hydrogen, moisture
29. WGS carbon bed vault	1	Continuous	Hydrogen
30. WGS delay bed outlets MV02A, B	2	Grab	Moisture, noble gases, iodine, particulates, tritium
31. Condenser air removal system[b]	1	Grab	Iodine, noble gases, tritium
32. Gland seal system[b]	1	Grab	Iodine, noble gases, tritium

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FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 20, 1996	NAME:	Jim Winters
TO:	Diane Jackson	LOCATION:	ENERGY CENTER - EAST
PHONE:	FACSIMILE:	PHONE:	Office: 412-374-5290
COMPANY:	US NRC	Facsimile:	win: 284-4887 outside: (412)374-4887
LOCATION:			

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COMMENTS:

Diane

Here is the mock up that satisfies item 2.a from your 10/17 letter and our 11/7 telecon. Note that filter data is covered by another open item. Revision 11 of the SSAR will contain this information unless we hear from you. Thanks.

Jim Winters

cc: Lindgren
Butler
McIntyre
Ron Vijuk
Cummins
Winters
Vocic
Hutchings
Mahlab
Jeanne Evans

9.4.2.2.1 General Description

9.4.2.2.1.1 General Area HVAC Subsystem

of about 5100 ~~21000~~ scfm each

The general area HVAC subsystem serves personnel areas in the annex building outside the security area. The general area HVAC subsystem consists of two 50 percent capacity supply air handling units, a humidifier, a ducted supply and return air system, diffusers and registers, exhaust fan, automatic controls, and accessories. The air handling units are located on the low roof of the annex building at elevation 117′-6″. The units discharge into a ducted supply distribution system which is routed through the building to provide air into the various rooms and areas served via registers. An electric heating coil is provided in the branch supply duct to the men's and women's change rooms for tempering the supply air.

A humidifier is provided in the system to provide a minimum space relative humidity of 35 percent.

Air from the men's and women's locker, toilet, and shower facilities in the annex building is exhausted directly to atmosphere by an exhaust fan. Room air from the remaining areas served is recirculated back to the air handling unit via a ceiling return plenum and a return duct system. Outside make-up air is added to the return air stream at the air handling units to replace air exhausted from toilets and showers in the area served.

9.4.2.2.1.2 Switchgear Room HVAC Subsystem

The switchgear room HVAC subsystem serves electrical switchgear rooms in the annex building. The switchgear room HVAC system consists of two 100 percent capacity air handling units, a ducted supply and return air system, and automatic controls and accessories.

The air handling units are located in the north air handling equipment room in the annex building at elevation 135′–3″. The air handling units discharge into a common duct distribution system that is routed through the building to the rooms served. Air is returned to the air handling units from the rooms served by a return duct system.

9.4.2.2.1.3 Equipment Room HVAC Subsystem

The equipment room HVAC subsystem serves electrical and mechanical equipment rooms in the annex and auxiliary buildings. This subsystem also serves the security area offices and the central alarm station in the annex building. The equipment room HVAC system consists of two 100 percent capacity air handling units, two battery room exhaust fans, a toilet exhaust fan, a ducted supply and return air system, and automatic controls and accessories.

The air handling units are located in the north air handling equipment room in the annex building at elevation 135′-3″. The air handling units discharge into a common duct distribution system that is routed through the buildings to the various areas served. Air is returned to the air handling units from the rooms served (except the battery rooms and rest rooms) by a return duct system. Electric reheat coils are provided in the ductwork to areas

requiring close temperature control such as the security area offices and the central alarm station. Hot water unit heaters are provided in the north air handling equipment room to maintain the area above 50°F.

A humidifier is provided in the branch duct to the security areas to provide a minimum space relative humidity of 35 percent.

Each non-Class 1E battery room is provided with an individual exhaust system to prevent the buildup of hydrogen gas in the room. Each exhaust system consists of an exhaust fan, an exhaust air duct and gravity back draft damper located in the fan discharge. Air supplied to the battery rooms by the air handling units is exhausted to atmosphere. Air from the rest rooms is exhausted to atmosphere by a separate exhaust fan.

9.4.2.2.1.4 MSIV Compartment HVAC Subsystem

The main steam isolation valve compartment HVAC subsystem serves the two main steam isolation valve compartments in the auxiliary building that contain the main steam and feedwater lines routed between the containment and the turbine building. Each compartment is provided with separate heating and cooling equipment.

The main steam isolation valve compartment HVAC subsystem consists of two 100 percent capacity supply air handling units with ducted supply air distribution, automatic controls, and accessories for each main steam isolation valve compartment.

The air handling units are located directly within the space served. One unit in each compartment normally operates to maintain the temperature of the compartment. The air handling units can be connected to the standby power system, for investment protection, in the event of loss of the plant ac electrical system.

9.4.2.2.1.5 Mechanical Equipment Areas HVAC Subsystem

The mechanical equipment areas HVAC subsystem serves the demineralized water deoxygenating room, boric acid batching/transfer rooms, and air handling equipment rooms in the south end of the annex building.

The mechanical equipment areas HVAC subsystem consists of two 50 percent capacity air handling units, a ducted supply and return air system, automatic controls, and accessories.

The air handling units are located in the lower south air handling unit equipment room on elevation 135'-3" of the annex building.

9.4.2.2.1.6 Valve/Piping Penetration Room HVAC System

The valve/piping penetration room HVAC subsystem serves the valve/piping penetration room on elevation 100'-0" of the auxiliary building. The valve/piping penetration room HVAC

subsystem consists of two 100 percent capacity air handling units, a return air duct system, automatic controls and accessories. with supply fans of 1800 scfm each

The air handling units are located directly within the space served.

9.4.2.2.2 Component Description

The annex/auxiliary buildings HVAC system is comprised of the following major components. These components are located in buildings on the Seismic Category I Nuclear Island or in the annex building. The seismic design classification, safety classification and principal construction code for Class A, B, C, or D components are listed in Section 3.2. Tables 9.4.2-1 and 9.4.2-2 provide the design parameters for major defense-in-depth components of the system.

Air Handling Units

Air handling units with integral supply and return/exhaust fans are utilized in the equipment room HVAC subsystem, switchgear room HVAC subsystem, and the mechanical equipment areas HVAC subsystem. Each air handling unit consists of a return/exhaust fan, a return/exhaust air plenum, a low efficiency filter bank, a high efficiency filter bank, a hot water heating coil with integral face/bypass damper, a chilled water cooling coil, and a supply air fan.

Supply Air Handling Units

Supply air handling units are utilized in the general area HVAC subsystem, main steam isolation valve compartment HVAC subsystem, and the valve/piping penetration room HVAC subsystem. Each air handling unit consists of a low efficiency filter bank, a hot water heating coil, a chilled water cooling coil, and a supply fan. The general area HVAC subsystem air handling unit also includes a high efficiency filter bank and has face and bypass dampers on the heating coil.

Supply and Exhaust Air Fans

The supply and exhaust fans are centrifugal type, single width single inlet (SWSI) or double width double inlet (DWDI), with high efficiency wheels and backward inclined blades to produce non-overloading horsepower characteristics. Air handling unit fans that have little or no ductwork may utilize forward curved blades. The fans are designed and rated in accordance with ANSI/AMCA 210 (Reference 4), ANSI/AMCA 211 (Reference 5), and AMCA 300 (Reference 6).

Low Efficiency Filters and High Efficiency Filters

The low efficiency filters and high efficiency filters have a rated dust spot efficiency based on ASHRAE 52 (Reference 7). The filters meet UL 900 (Reference 8) Class I construction criteria.

	Temperature (°F)
Degasifier column	50 - 130
RNS and CVS pump rooms (pumps not operating)	50 - 104
RNS and CVS pump rooms (pumps operating)	50 - 130
Containment purge exhaust filter rooms (fans not operating)	50 - 104
Containment purge exhaust filter rooms (fans operating)	50 - 130
Liquid radwaste tank rooms	50 - 130
Liquid radwaste pump rooms	50 - 104
Spent resin equipment rooms	50 - 130
Radioactive pipe chases and valve rooms	50 - 130

Occupied Areas

Fuel handling area	50 - 96
Radiation chemistry laboratory	73 - 78
Primary sample room	73 - 78
Security rooms	73 - 78

9.4.3.2 System Description

The radiologically controlled area ventilation system consists of the following subsystems:

- Auxiliary/annex building ventilation subsystem
- Fuel handling area ventilation subsystem
- Radiation chemistry laboratory ventilation subsystem

The defense in depth portion of the system is shown in Figure 9.4.3-1.

9.4.3.2.1 General Description

9.4.3.2.1.1 Auxiliary/Annex Building Ventilation Subsystem

of about 21000 scfm each

The auxiliary/annex building ventilation subsystem serves radiologically controlled equipment, piping and valve rooms, adjacent access and staging areas, and the radiation chemistry laboratory ventilation subsystem. The auxiliary/annex building ventilation subsystem consists of two 50 percent capacity supply air handling units, a ducted supply and exhaust air system, isolation dampers, diffusers and registers, exhaust fans, automatic controls and accessories. The supply air handling units are located in the south air handling equipment room of the annex building at elevation 158'-0". The units discharge into a ducted supply distribution system which is routed through the radiologically controlled areas of the auxiliary and annex buildings. The supply and exhaust ducts have isolation dampers that close to isolate the auxiliary and annex buildings from the outside environment when high airborne radioactivity is detected in the exhaust air duct. The supply and exhaust ducts are configured so that two building zones may be independently isolated. The annex building, adjacent auxiliary building staging, equipment areas, and rooms served by the radiation chemistry laboratory ventilation

of about 9500 scfm each

9.4.3.2.1.2 Fuel Handling Area Ventilation Subsystem

The fuel handling area ventilation subsystem serves the fuel handling area, rail car bay/filter storage area, and the spent resin equipment and piping rooms. The fuel handling area ventilation subsystem consists of two 50 percent capacity supply air handing units, a ducted supply and exhaust air system, isolation dampers, diffusers, registers, exhaust fans, automatic controls and accessories. The ventilation airflow capacity is designed to maintain environmental conditions that support worker efficiency during fuel handling operations based on a maximum wetbulb globe temperature of 80°F (96°F drybulb) as defined by EPRI NP-4453 (Reference 22). The supply air handling units are located in the south air handling equipment room of the annex building at elevation 135'-3". The units discharge into a ducted supply distribution system which is routed to the fuel handling and rail car bay/filter storage areas of the auxiliary building. The supply and exhaust ducts are provided with isolation dampers that close when high airborne radioactivity in the exhaust air or high pressure differential with respect to the outside atmosphere is detected.

The exhaust air fans are located in the upper radiologically controlled area ventilation system equipment room at elevation 145'-9" of the auxiliary building. The supply and exhaust ductwork is arranged to exhaust the spent fuel pool plume and to provide directional airflow from the rail car bay/filter storage area into the spent resin equipment rooms. The exhaust fans discharge the exhaust air into the plant vent for monitoring of offsite airborne radiological releases.

The ventilation airflow dilutes potential airborne contamination to maintain the concentration at the site boundary within 10 CFR 20 (Reference 21) allowable effluent concentration limits and the internal room airborne concentrations within 10 CFR 20 occupational derived air concentration (DAC) limits during normal plant operation.

9.4.3.2.1.3 Radiation Chemistry Laboratory Ventilation Subsystem

of about 4300 scfm each

The radiation chemistry laboratory ventilation subsystem serves the radiation chemistry laboratory, primary sample room and auxiliary building security rooms. The radiation chemistry laboratory ventilation subsystem consists of two 100 percent capacity supply air handing units, a ducted supply air system, a humidifier, diffusers, registers, automatic controls and accessories. The supply air handling units are located in the south air handling equipment room of the annex building at elevation 158'-0". The supply air handling units are connected to the auxiliary/annex building ventilation subsystem supply air duct to utilize preconditioned and prefiltered outdoor air. Supplemental filtration is provided by the radiation chemistry laboratory ventilation subsystem for added cleanliness to support operation of sensitive equipment. A humidifier is located in the common supply air ductwork downstream of the supply air handling units. The radiation chemistry laboratory exhaust air is ducted to the auxiliary/annex building ventilation subsystem exhaust fans. The ventilation airflow dilutes room internal airborne radioactivity concentrations within 10 CFR 20 occupational derived air concentration (DAC) limits.

- Provide for radiation monitoring of exhaust air prior to release to the environment

- Maintain the radwaste building at a negative pressure with respect to ambient to prevent unmonitored releases from the radwaste building

The system maintains the following temperature based on maximum and minimum normal outdoor air temperature conditions shown below in Chapter 2, Table 2-1:

Room or Area	Temperatures (°F)
Processing areas and storage areas	50-105
Mechanical and electrical equipment rooms	50-105

9.4.8.2 System Description

9.4.8.2.1 General Description

The radwaste building HVAC system is a once-through ventilation system that consists of two integrated subsystems: the radwaste building supply air system and the radwaste building exhaust air system. The systems operate in conjunction with each other to maintain temperatures in the areas served while controlling air flow paths and building negative pressure.

The supply air system consists of two 50 percent capacity air handling units of about 9000 scfm each with a ducted air distribution system, automatic controls, and accessories. The air handling units are located in an electrical/mechanical equipment room on elevation 100′-0″ on the southwest side of the building. Each unit draws 100 percent outdoor air through individual louvered outdoor air intakes. The two units discharge into a common duct distribution system which is routed through the building. Branch connections from the main duct supply air through registers into the various areas served.

The exhaust air system consists of two 50 percent capacity exhaust centrifugal fans, an exhaust air duct collection system, and automatic controls and accessories. The airflow rates are balanced to maintain a constant exhaust design air flow through the fans. The exhaust fans are located in an equipment room on Elevation 100′-0″ in the northwest corner of the radwaste building.

The exhaust fans discharge to a common duct which is routed to the plant vent. A radiation monitor records activity in the discharge duct and activates an alarm in the main control room when excess activity in the effluent discharge is detected. The radiation monitoring system is described in Section 11.5.

The exhaust air collection duct inside the radwaste building exhausts air from areas and rooms where low levels of airborne contamination may be present. Exhaust connection points are provided to allow the direct exhaust of equipment located on the mobile systems. Where potential for significant airborne release exists, mobile systems include HEPA filtration. Back

9.4.9.2 System Description

The turbine building ventilation system consists of the following subsystems:

- General area heating and ventilation
- Electrical equipment and personnel work area HVAC
- Local area heating and ventilation
  - Lube oil reservoir room ventilation
  - Clean and dirty lube oil storage room ventilation
  - Auxiliary boiler room ventilation
  - Fire pump rooms heating and ventilation
  - Toilet area ventilation

9.4.9.2.1 General Description

9.4.9.2.1.1 General Area Heating and Ventilation

Most of the turbine building is supplied by the general area ventilation and heating subsystem. Air is exhausted from the turbine building to the atmosphere by roof exhaust ventilators. The roof exhaust ventilators pull in outside air through wall louvers located at elevations 100'-0", 117'-6", and 135'-3". Wall louvers are located at the operating deck to provide additional air during plant outage operations. The general area heating subsystem uses hot water unit heaters to provide local heating throughout the turbine building. During heating operation, the general area ventilation system is not operated.

9.4.9.2.1.2 Electrical Equipment and Personnel Work Area HVAC

The electrical equipment and personnel work area air conditioning subsystem serves electrical equipment areas (switchgear rooms, the electrical equipment room and the feedwater pump variable frequency drive power converter room) and personnel work areas (secondary sampling laboratory, office space at elevation 149'-0" and elevation 171'-0"). This subsystem is subdivided into two independent HVAC systems, one serving the electrical equipment areas and one serving the personnel work areas.

The electrical equipment HVAC system consists of two 50 percent capacity air handling units, a ducted supply and return air system, automatic controls, and accessories. The air handling units are located on elevation 149'-0" of the turbine building. The temperature of the rooms is maintained by thermostats which control the chilled water control valves for cooling and

the integral face/bypass dampers for heating. Outside air is mixed with recirculated air to maintain a positive pressure.

The personnel work area HVAC system consists of two 50 percent capacity air handling units, a ducted supply and return air system, automatic controls, and accessories. The air handling units are located on elevation 149'-0" of the turbine building. The temperature of the rooms is maintained by thermostats which control the chilled water control valves for cooling and the integral face/bypass dampers for heating. Electric reheat coils are provided in the ductwork to each room to maintain close temperature control. Outside air is mixed with recirculated air to maintain a positive pressure.

9.4.9.2.1.3 Local Area Heating and Ventilation

The lube oil reservoir room, clean and dirty lube oil storage room, toilet areas (facilities), and secondary sampling laboratory fume hood have centrifugal exhaust fans to remove flammable vapors, odors, or chemical fumes as required.

The auxiliary boiler room, diesel driven fire pump room, and motor driven fire pump rooms have exhaust ventilators to remove heat generated by the boiler equipment and fire pumps. Air is pulled from the general area of the turbine building through wall fire damper openings in the rooms and is exhausted outside of the turbine building to the atmosphere. Each fire pump room is heated by a hot water unit heater to provide freeze protection for the fire pumps. Hot water heating is not provided in the auxiliary boiler room, however, air is pulled from the general area of the turbine building to control space temperature in the boiler room.

9.4.9.2.2 Component Description

The turbine building ventilation system is comprised of the following major components. These components are located in the non-seismic turbine building.

HVAC Air Handling Units

Each air handling unit is a horizontal draw-through cabinet type consisting of a mixing box section, low efficiency filter, high efficiency filter, integral face/ bypass damper, hot water heating coil, chilled water cooling coil. The electrical equipment room air handling units include a return air fan and an exhaust fan. The personnel area air handling units include a supply air fan.

Exhaust Ventilators

The turbine building roof exhaust ventilators are hooded, direct driven, propeller type with pneumatic operated backdraft damper. Ventilators in the auxiliary boiler room and fire pump room are smaller, two-speed, propeller type with pneumatically actuated backdraft dampers. Ventilators in the lube oil rooms and restrooms are centrifugal type.

9.4.11.1.2 Power Generation Design Basis

The health physics and hot machine shop HVAC system provides the following functions:

- Provides conditioned air to work areas to maintain acceptable temperatures for equipment and personnel working in the areas

- Provides air movement from clean to potentially contaminated areas to minimize the spread of airborne contaminants

- Collects the vented discharges from potentially contaminated equipment in the area

- Provides for exhaust from welding booths, grinders and other miscellaneous equipment located in the hot machine shop

- Provides for radiation monitoring of exhaust air prior to release to the environment

- Maintains the access control area and hot machine shop at a slight negative pressure with respect to outdoors and the clean areas of the annex building to prevent unmonitored releases of radioactive contaminants

- Provides humidification to maintain a minimum of 35 percent relative humidity

The system maintains the following temperatures based on maximum and minimum normal outside air temperature conditions shown in Chapter 2, Table 2-1:

Room or Area	Temperatures (°F)
Health physics area	73-78
Hot machine shop	65-85

9.4.11.2 System Description

9.4.11.2.1 General Description

The health physics and hot machine shop HVAC system is a once-through ventilation system consisting of two integrated subsystems: a supply air system and an exhaust air system. The systems operate in conjunction with each other to satisfy the functional requirements of maintaining temperatures in the areas served while controlling air flow paths and area negative pressure.

of about 14000 scfm each

The supply air system consists of two 100 percent capacity air handling units with a ducted air distribution system and automatic controls. The air handling units are located in the lower south air handling equipment room on elevation 135'-3" of the annex building. The units draw 100 percent outdoor air through a louvered outdoor air intake plenum and discharge into a duct distribution system which is routed to the health physics and machine shop areas.

Table 9.4.2-1

COMPONENT DATA – ANNEX/AUXILIARY BUILDINGS NONRADIOACTIVE HVAC SYSTEM

Switchgear Room HVAC Subsystem
(Nominal Values)

Air Handling Units

Quantity	2
System capacity per unit (%)	100

Supply Fan Requirements

Type	Centrifugal
Design airflow (scfm)	31,000
Static pressure (in. wg)	6.5

Return/Exhaust Fan Requirements

Type	Centrifugal
Design airflow (scfm)	31,000
Static pressure (in. wg)	3.0

}—e

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FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 19, 1996	NAME:	Jim Winters
TO:	Ted Quay	LOCATION:	ENERGY CENTER - EAST
PHONE:	FACSIMILE:	PHONE:	Office: 412-374-5290
COMPANY:	USNRC	Facsimile:	win: 284-4887 outside: (412)374-4887
LOCATION:			

Cover + Pages 1 + 12

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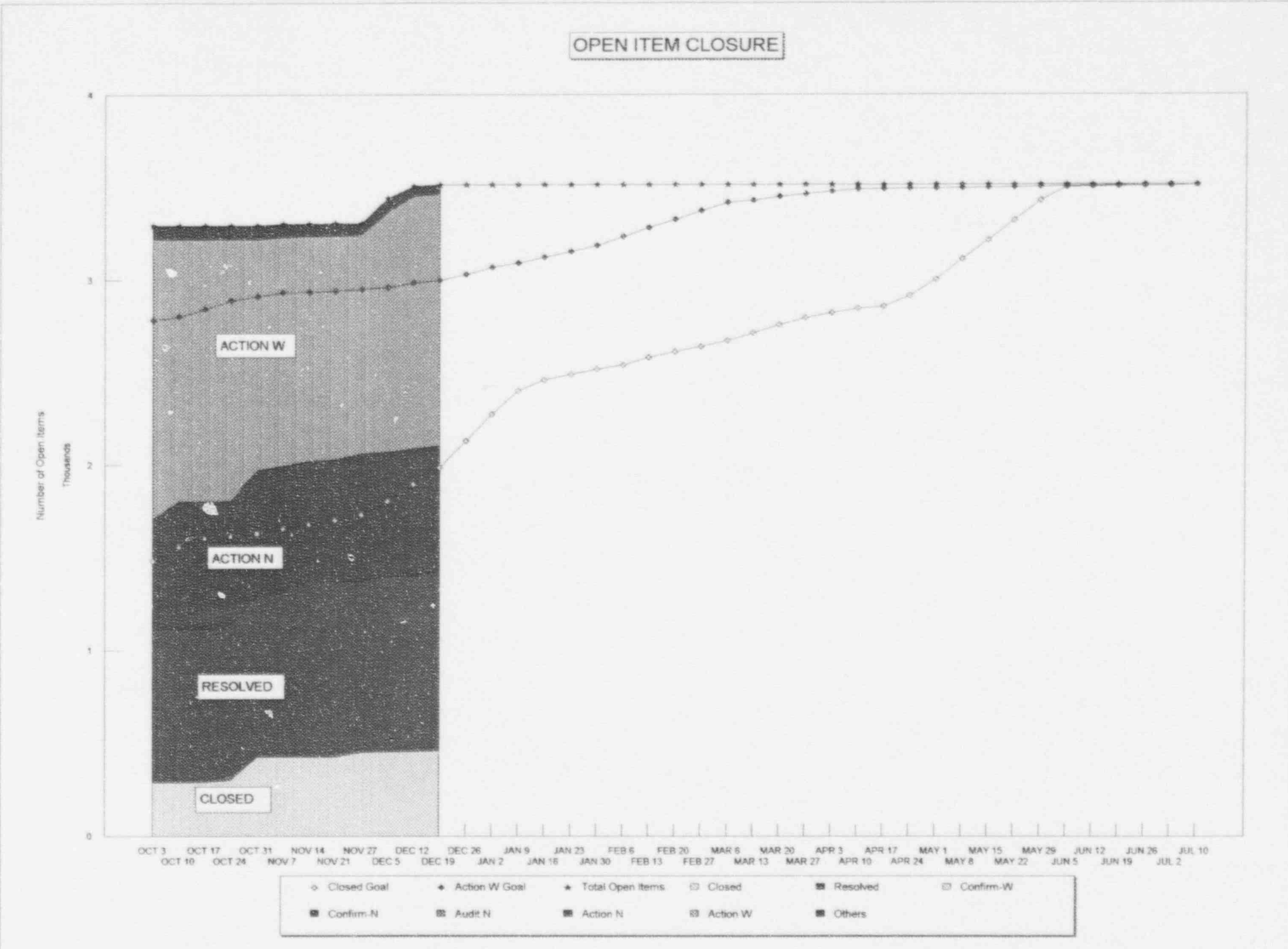
COMMENTS:

Ted

Here is weekly status on open items. The first curve is the 1997 way, which will start on Jan 2. Please pass this on to your PM's. Thanks.

Jim Winters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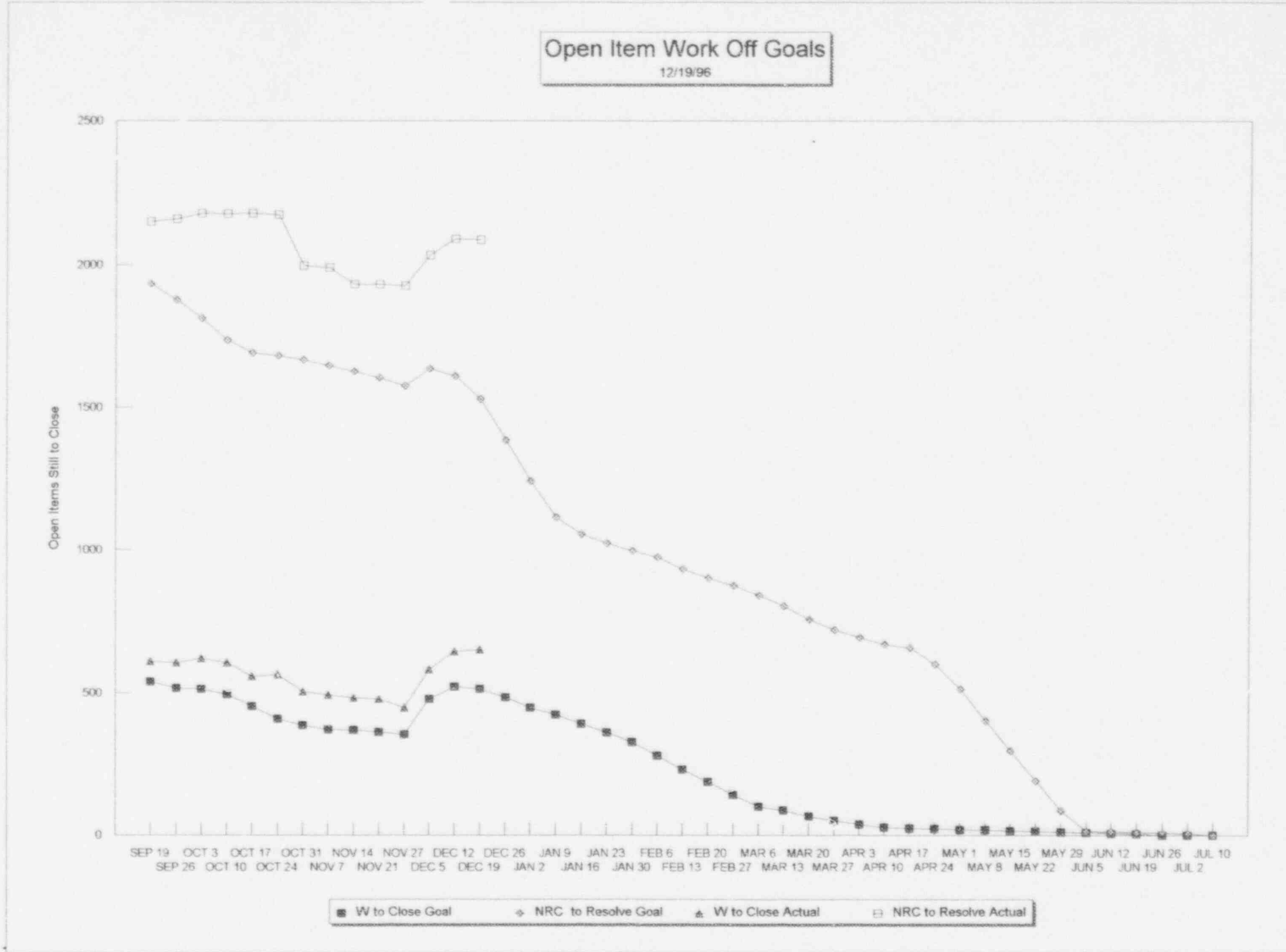
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NRC to Resolve Goal
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W GOAL	SEP 19	SEP 26	OCT 3	OCT 10	OCT 17	OCT 24	OCT 31	NOV 7	NOV 14	NOV 21	NOV 27	DEC 5	DEC 12	DEC 19	DEC 26	JAN 2	JAN 9	JAN 16	JAN 23
12/19/96																			
CHAP 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.2	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	1
3.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.6.2	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.6.3	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.8.2	3	3	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.8.3	9	9	9	9	9	9	9	9	9	9	9	6	3	0	0	0	0	0	0
3.8.4	6	6	6	6	6	6	6	6	6	6	6	6	6	4	2	0	0	0	0
3.8.5	12	12	12	12	12	12	12	12	12	12	12	12	9	6	3	0	0	0	0
3A &3F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CH. 42	0	8	8	8	8	8	8	6	4	2	0	0	0	0	0	0	0	0	0
3.9	10	7	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.10	3	3	3	3	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0
3.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
6.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
6.4	4	4	7	7	7	7	7	7	7	7	7	7	5	3	2	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 15	23	23	23	23	23	23	23	23	36	36	36	36	36	36	36	36	36	36	36
16.1	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
16.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 18	42	40	36	32	28	24	20	16	12	8	4	0	0	0	0	0	0	0	0
LEVEL 1	67	41	57	57	60	60	60	60	60	60	60	60	60	60	50	35	25	15	7
LEVEL 2/3	33	100	100	100	100	100	100	100	100	100	100	100	122	122	122	122	122	122	122
CHAP 19	57	[illegible]	5	5	5	5	5	8	8	8	8	8	8	8	8	8	8	8	8
CHAP 20	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
SSARREV	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
T/H UNC	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RTNSS	6	6	6	6	6	7	7	7	7	7	4	2	5	5	5	5	4	3	2
FCS PRA	19	19	19	19	19	0	0	0	0	1	1	1	0	0	0	0	0	0	0
ITAAC	18	18	18	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEST PRG	52	49	42	35	28	21	14	7	0	0	0	0	0	0	0	0	0	0	0
NOTRUMP	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	40	30
LOFTRAN		1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
WC/T	8	8	8	8	8	8	8	8	8	8	8	8	10	10	6	2	0	0	0
H&MT						13	13	13	13	20	20	20	20	20	20	20	20	20	20
LST						4	3	2	1	0	0	0	0	0	0	0	0	0	0
SCALING						12	12	12	12	12	12	12	12	12	12	12	12	12	12
W&MT						7	7	7	7	0	0	0	0	0	0	0	0	0	0
WATER						3	3	3	3	3	3	3	3	3	3	3	3	3	3
WGOTHIC	105	90	80	70	60	11	2	0	0	0	0	135	125	115	105	95	85	75	65
EY ISSUES													33	45	45	45	45	45	45
UNASSIGN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WG TOTAL	539	516	513	494	452	407	385	370	369	362	353	478	521	513	483	446	423	389	359

JAN 30	FEB 6	FEB 13	FEB 20	FEB 27	MAR 6	MAR 13	MAR 20	MAR 27	APR 3	APR 10	APR 17	APR 24	MAY 1	MAY 8	MAY 15	MAY 22	MAY 29	JUN 5	JUN 12
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4	4	4	4	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	36	36	36	36	36	36	25	16	8	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
122	100	75	45	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	8	8	8	8	8	8	5	4	2	1	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	20	20	20	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	45	35	25	15	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	45	45	45	45	43	35	30	26	24	22	20	18	16	14	12	10	8	6	4
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
326	280	231	187	141	100	86	66	51	38	27	24	22	20	18	16	14	11	9	7

JUN 19	JUN 26	JUL 2	JUL 10
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
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3	0	0	0
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0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
2			
0	0	0	0
5	0	0	0

N GOAL 12/19/96	SEP 19	SEP 26	OCT 3	OCT 10	OCT 17	OCT 24	OCT 31	NOV 7	NOV 14	NOV 21	NOV 27	DEC 5	DEC 12	DEC 19	DEC 26	JAN 2	JAN 9	JAN 16	JAN 23
CHAP 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 2	6	6	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.2	3	2	1	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2
3.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.6.2	4	4	4	4	4	4	4	4	4	4	3	2	1	0	0	0	0	0	0
3.6.3	10	10	7	21	21	21	21	18	15	12	9	6	3	0	0	0	0	0	0
3.7	14	14	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.8.2	12	12	12	12	12	12	12	12	12	12	9	6	3	0	0	0	0	0	0
3.8.3	15	15	15	15	15	15	15	15	15	15	15	10	5	0	0	0	0	0	0
3.8.4	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
3.8.5	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
3A &3F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CH 42	0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	8	6	4	2
3.9	42	42	43	43	43	43	43	36	29	22	15	8	0	0	0	0	0	0	0
3.10	7	7	7	7	7	7	7	7	7	7	6	5	4	3	2	0	0	0	0
3.11	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 4	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.2	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
6.3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4
6.4	12	12	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	12	10
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 7	19	19	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 9	167	111	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 13	35	35	30	20	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 14	74	74	74	74	74	74	60	48	36	24	12	0	0	0	0	0	0	0	0
CHAP 15	213	213	213	213	213	213	213	213	228	228	228	228	228	228	228	228	228	228	228
16.1	41	41	41	41	41	41	41	41	41	41	41	41	41	41	35	21	14	7	0
16.2	1	1	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 18	42	42	42	42	42	42	42	42	42	42	42	42	42	42	35	21	14	7	0
LEVEL 1	134	41	57	57	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
LEVEL 2/3	137	100	100	100	100	100	100	100	100	100	100	100	122	122	122	122	122	122	122
CHAP 19	147	266	266	266	266	266	266	269	269	269	269	269	269	269	269	269	269	269	269
CHAP 20	116	116	116	116	116	116	116	116	116	116	116	116	100	80	60	40	20	0	0
SSARREV	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
T/H UNC	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RTNSS	8	8	8	8	8	9	9	9	9	9	9	9	14	14	14	14	10	6	4
FCS PRA	37	37	37	37	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
ITAAC	11	11	11	11	11	11	11	11	11	10	8	6	4	2	0	0	0	0	0
TEST PRG	322	322	322	322	322	322	322	322	307	307	307	270	220	165	110	55	0	0	0
NOTRUMP	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
LOFTRAN	8	8	8	8	8	8	8	8	8	8	8	6	4	2	0	0	0	0	0
WC/T	8	8	8	8	8	8	8	8	8	8	8	8	10	10	10	10	10	10	10
H&MT						13	13	13	13	20	20	20	20	20	20	20	20	20	20
LST						4	4	4	4	4	4	4	4	4	3	2	1	0	0
SCALING						12	12	12	12	12	12	12	12	12	12	12	12	12	12
W&MT						7	7	7	7	0	0	0	0	0	0	0	0	0	0
WATER						3	3	3	3	3	3	3	3	3	3	3	3	3	3
WGOTHIC	132	132	132	132	132	93	93	93	93	93	93	228	228	228	177	142	110	95	85
EY ISSUES													33	45	45	45	45	45	45
UNASSIGN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NG TOTAL	1933	1876	1812	1737	1691	1682	1666	1647	1625	1603	1574	1636	1609	1529	1384	1241	1113	1054	1023

JAN 30	FEB 6	FEB 13	FEB 20	FEB 27	MAR 6	MAR 13	MAR 20	MAR 27	APR 3	APR 10	APR 17	APR 24	MAY 1	MAY 8	MAY 15	MAY 22	MAY 29	JUN 5	JUN 12
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	10	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	59	59	59	59	59	59	50	40	30	20	10	0	0	0	0	0	0	0	0
3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
228	228	228	228	228	228	228	228	228	228	228	228	182	143	107	70	35	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	60	45	35	25	15	7	0	0	0	0	0	0	0	0	0	0	0	0	0
122	122	122	122	122	122	122	122	122	122	122	122	122	122	95	75	50	25	0	0
269	269	269	269	269	269	269	269	269	269	269	269	269	222	176	132	88	44	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	53	53	53	53	53	40	30	20	10	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	7	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	20	20	20	20	12	8	4	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	12	12	12	10		6	4	2	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3	3	3	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	65	55	45	35		15	5	0	0	0	0	0	0	0	0	0	0	0	0
45	45	45	45	45		45	40	35	30	26	24	22	20	18	16	14	12	10	8
0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
996	973	932	901	875	841	803	756	720	693	669	657	599	511	400	297	191	85	14	12

JUN 19	JUN 26	JUL 2	JUL 10
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
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0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
3	3	3	0
1	1	1	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
6	4	2	0
0	0	0	0
10	8	6	0

W ACTUAL 12/19/96	SEP 19	SEP 26	OCT 3	OCT 10	OCT 17	OCT 24	OCT 31	NOV 7	NOV 14	NOV 21	NOV 27	DEC 5	DEC 12	DEC 19	DEC 26	JAN 2	JAN 9	JAN 16	JAN 23
CHAP 1	1	1	1	1	1	1	0	0	0	0	0	0	0	0					
CHAP 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2					
3.1	0	0	0	0	0	0	0	0	0	0	0	0	5	0					
3.2	2	2	2	2	9	9	9	9	9	9	9	9	3	13					
3.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
3.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
3.6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
3.6.2	3	3	3	3	3	3	1	1	1	1	0	0	0	0					
3.6.3	7	7	3	7	8	8	8	3	3	3	3	3	3	3					
3.7	6	6	4	4	4	4	4	3	3	3	4	4	4	4					
3.8.2	2	2	4	4	4	4	4	4	4	4	4	4	4	4					
3.8.3	9	12	16	16	16	16	16	16	16	16	16	16	16	16					
3.8.4	6	11	11	11	11	11	11	11	11	11	12	12	12	12					
3.8.5	12	12	12	12	12	12	12	12	12	12	7	7	7	7					
3A &3F	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
CH 42	0	8	8	8	8	8	8	8	8	8	8	8	3	3					
3.9	12	12	13	13	9	27	21	21	21	21	21	21	21	21					
3.10	3	3	3	3	0	2	2	0	1	0	1	0	1	0					
3.11	0	6	6	6	6	6	6	6	6	6	6	6	6	6					
3.12	2	2	7	7	7	7	5	3	1	2	1	2	2	2					
CHAP 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
CHAP 5	0	1	0	0	0	0	0	0	0	0	3	3	3	3					
6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
6.2	4	7	6	7	2	2	2	2	2	2	2	2	2	2					
6.3	1	1	1	1	0	0	0	0	0	0	0	0	0	0					
6.4	4	1	6	6	5	5	1	1	1	1	1	1	1	1					
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
6.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
CHAP 7	0	0	0	0	0	0	0	1	1	1	1	5	5	6					
CHAP 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
CHAP 9	27	24	16	16	9	3	3	6	6	5	5	5	6	4					
CHAP 10	3	3	5	5	5	5	3	3	3	3	3	3	3	3					
CHAP 11	1	1	1	1	1	1	1	1	0	0	0	0	0	0					
CHAP 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
CHAP 13	6	4	4	4	4	4	3	3	3	3	1	2	2	2					
CHAP 14	0	0	0	1	0	0	0	0	0	0	0	0	0	0					
CHAP 15	23	22	31	27	24	24	25	24	37	37	38	38	38	38					
16.1	0	1	1	1	0	0	0	0	0	0	0	0	1	1					
16.2	7	7	8	8	2	1	1	1	1	1	1	1	1	1					
CHAP 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
CHAP 18	42	42	42	42	16	16	8	8	8	8	8	3	3	3					
LEVEL 1	67	44	60	60	60	60	37	37	37	38	22	22	22	22					
LEVEL 2/3	33	100	100	100	100	100	100	89	80	80	80	75	98	98					
CHAP 19	57	0	2	2	2	2	1	4	4	4	4	4	4	4					
CHAP 20	1	1	1	1	1	1	1	1	1	1	1	2	2	2					
SSARREV	3	3	5	5	14	13	23	27	27	27	30	30	40	40					
T/H UNC	0	1	1	1	1	1	1	1	1	1	1	1	1	1					
RTNSS	6	8	6	6	8	9	10	10	10	10	10	9	15	15					
FCS PRA	19	0	0	0	0	0	0	0	0	1	1	1	1	1					
ITAAC	18	18	18	18	18	18	18	18	18	18	2	6	9	9					
TEST PRG	52	50	48	48	48	47	48	55	30	29	31	30	30	30					
NOTRUMP	53	53	53	53	53	53	38	38	39	39	39	39	39	39					
LOFTRAN	0	1	1	1	2	2	2	2	3	3	3	3	3	3					
WC/T	8	8	8	8	8	8	8	5	5	2	1	0	0	0					
H&MT						13	13	13	13	20	20	20	20	20					
LST						4	4	4	4	4	4	4	4	4					
SCALING						12	12	12	12	12	12	12	12	12					
W&MT						7	7	7	7	0	0	0	0	0					
WATER						3	3	3	3	3	3	3	3	3					
WGOTHIC	105	105	93	76	77	35	35	31	31	30	30	164	164	163					
EY ISSUES													33	45					
• UNASSIGN	5	12	9	8	-2	-6	-12	-14	-3	-4	-5	-4	-10	-16					
WA TOTAL	610	605	621	605	558	563	505	492	482	477	446	582	644	652	0	0	0	0	0

N ACTUAL 12/19/96	SEP 19	SEP 26	OCT 3	OCT 10	OCT 17	OCT 24	OCT 31	NOV 7	NOV 14	NOV 21	NOV 27	DEC 5	DEC 12	DEC 19	DEC 26	JAN 2	JAN 9	JAN 16	JAN 23
CHAP 1	8	8	9	8	8	8	8	8	8	8	8	8	8	8					
CHAP 2	6	10	10	10	10	10	10	10	10	10	10	10	10	10					
3.1	0	0	0	0	0	0		0	0	0	0	0	0	0					
3.2	3	3	3	3	10	10	10	10	10	10	10	10	4	4					
3.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
3.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
3.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1					
3.6.1	2	2	2	2	2	2	2	2	2	2	2	2	2	1					
3.6.2	4	6	4	4	4	4	4	4	4	4	4	4	4	0					
3.6.3	10	21	21	21	22	22	20	16	16	16	15	15	15	20					
3.7	14	14	14	14	14	14	14	14	14	14	14	14	14	12					
3.8.2	8	12	12	12	12	12	12	12	12	12	11	11	11	8					
3.8.3	15	22	22	22	22	22	22	22	22	22	22	22	22	22					
3.8.4	12	18	18	18	18	18	18	18	18	18	14	14	14	13					
3.8.5	18	18	18	18	18	18	18	18	18	18	18	17	17	11					
3A &3F	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
CH 42	0	10	10	10	10	10	10	10	10	10	10	10	10	10					
3.9	42	41	42	42	39	38	33	33	33	33	33	33	33	32					
3.10	7	7	7	7	5	7	7	7	5	5	7	7	5	7					
3.11	4	23	23	23	23	23	23	23	21	21	18	13	13	22					
3.12	13	13	13	13	13	13	13	9	13	13	13	8	10	13					
CHAP 4	2	2	2	2	2	1	1	1	1	1	1	1	1	1					
CHAP 5	30	28	27	27	27	27	27	27	27	26	23	21	20	20					
6.1	3	3	3	3	3	3	3	3	3	3	3	3	3	3					
6.2	59	67	67	68	67	67	67	67	67	66	67	67	67	67					
6.3	5	9	9	9	9	9	9	9	9	9	9	9	9	9					
6.4	12	11	18	16	15	15	14	14	14	14	14	14	14	14					
6.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1					
6.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
CHAP 7	19	16	15	15	15	15	15	16	16	16	16	8	6	6					
CHAP 8	11	9	9	9	9	9	9	9	9	9	9	9	9	9					
CHAP 9	162	164	161	161	161	161	162	163	163	163	164	163	166	164					
CHAP 10	33	32	31	31	31	31	31	31	31	31	31	24	24	24					
CHAP 11	46	46	46	46	46	46	46	46	46	46	45	46	46	46					
CHAP 12	2	2	2	2	2	2	2	2	2	2	2	2	2	2					
CHAP 13	35	35	35	35	35	35	34	34	34	34	30	31	31	31					
CHAP 14	74	82	82	82	82	82	82	82	82	82	82	82	82	82					
CHAP 15	213	224	227	227	225	225	226	226	181	181	184	184	182	184					
16.1	41	102	102	102	102	101	101	101	100	100	103	100	100	100					
16.2	1	1	2	1	1	1	1	1	1	1	1	1	1	1					
CHAP 17	5	5	5	5	5	5	5	5	5	5	5	5	5	5					
CHAP 18	42	48	48	48	48	48	48	48	48	48	48	47	47	46					
LEVEL 1	134	44	60	60	60	60	60	60	60	61	61	61	61	61					
LEVEL 2/3	137	100	100	100	100	100	101	101	101	101	101	101	123	123					
CHAP 19	145	262	264	264	264	264	263	253	252	252	253	252	252	251					
CHAP 20	116	117	117	117	117	117	117	117	117	117	117	107	107	107					
SSARREV	3	2	4	4	13	12	22	26	26	26	28	30	40	40					
T/H UNC	0	1	1	1	1	1	1	1	1	1	1	1	1	1					
RTNSS	8	10	9	9	11	11	12	13	13	13	13	13	18	18					
FCS PRA	37	0	0	0	0	0	0	0	0	1	1	1	1	1					
ITAAC	11	11	11	11	7	11	11	11	11	11	12	18	18	18					
TEST PRG	322	322	323	323	323	321	143	141	127	127	127	127	120	129					
NOTRUMP	53	53	53	53	53	53	53	53	54	54	54	54	54	53					
LOFTRAN	5	5	5	5	6	6	6	6	7	7	8	8	8	8					
WC/T	8	8	8	8	8	8	8	8	8	8	8	8	8	10					
H&MT						13	13	13	13	21	21	21	21	21					
LST						4	4	4	4	4	4	4	4	4					
SCALING						13	13	13	13	13	13	13	13	13					
W&MT						8	8	8	8	0	0	0	0	0					
WATER						4	4	4	4	4	4	4	4	4					
WGOTHIC	132	131	131	128	128	92	92	92	92	92	92	226	226	226					
EY ISSUES													33	45					
UNASSIGN	78	-21	-27	-23	-29	-39	-43	-36	-36	-36	-39	-32	-30	-55					
NA TOTAL	2152	2161	2180	2178	2179	2175	1997	1991	1932	1932	1927	2034	2091	2087	0	0	0	0	0

W DELTA 12/19/96	SEP 19	SEP 26	OCT 3	OCT 10	OCT 17	OCT 24	OCT 31	NOV 7	NOV 14	NOV 21	NOV 27	DEC 5	DEC 12	DEC 19	DEC 26	JAN 2	JAN 9	JAN 16	JAN 23
CHAP 1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0
3.1	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
3.2	2	2	2	2	9	9	9	9	9	9	9	9	1	11	-2	-2	-2	-2	-1
3.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.6.2	3	3	3	0	1	3	1	1	1	1	0	0	0	0	0	0	0	0	0
3.6.3	7	7	3	4	6	8	8	3	3	3	3	3	3	3	0	0	0	0	0
3.7	6	6	4	4	4	4	4	3	3	3	4	4	4	4	0	0	0	0	0
3.8.2	-1	-1	1	2	3	4	4	4	4	4	4	4	4	4	0	0	0	0	0
3.8.3	0	3	7	7	7	7	7	7	7	7	7	10	13	16	0	0	0	0	0
3.8.4	0	5	5	5	5	5	5	5	5	5	6	6	6	8	-2	0	0	0	0
3.8.5	0	0	0	0	0	0	0	0	0	0	-5	-5	-2	1	-3	0	0	0	0
3A &3F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CH 42	0	0	0	0	0	0	0	2	4	6	8	8	3	3	0	0	0	0	0
3.9	2	5	7	10	9	27	21	21	21	21	21	21	21	21	0	0	0	0	0
3.10	0	0	0	0	-3	0	1	0	1	0	1	0	1	0	0	0	0	0	0
3.11	0	6	6	6	6	6	6	6	6	6	6	6	6	6	0	0	0	0	0
3.12	2	2	7	7	7	7	5	3	1	2	1	2	2	2	0	0	0	0	0
CHAP 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 5	0	1	0	0	0	0	0	0	0	0	3	3	3	3	0	0	0	0	0
6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.2	0	3	2	3	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-4	-4	-4	-4	-4
6.3	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	0	0	0
6.4	0	-3	-1	-1	-2	-2	-6	-6	-6	-6	-6	-6	-4	-2	-2	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 7	0	0	0	0	0	0	0	1	1	1	1	5	5	6	0	0	0	0	0
CHAP 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 9	27	24	16	16	9	3	3	6	6	5	5	5	6	4	0	0	0	0	0
CHAP 10	3	3	5	5	5	5	3	3	3	3	3	3	3	3	0	0	0	0	0
CHAP 11	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
CHAP 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 13	6	4	4	4	4	4	3	3	3	3	1	2	2	2	0	0	0	0	0
CHAP 14	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 15	0	-1	8	4	1	1	2	1	1	1	2	2	2	2	-36	-36	-36	-36	-36
16.1	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	0	1	1	0	0	0	0	0
16.2	7	7	8	8	2	1	1	1	1	1	1	1	1	1	0	0	0	0	0
CHAP 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 18	0	2	6	10	-12	-8	-12	-8	-4	0	4	3	3	3	0	0	0	0	0
LEVEL 1	0	3	3	3	0	0	-23	-23	-23	-22	-38	-38	-38	-38	-50	-35	-25	-15	-7
LEVEL 2/3	0	0	0	0	0	0	0	-11	-20	-20	-20	-21	-24	-24	-122	-122	-122	-122	-122
CHAP 19	0	-5	-3	-3	-3	-3	-4	-4	-4	-4	-4	-4	-4	-4	-8	-8	-8	-8	-8
CHAP 20	0	0	0	0	0	0	0	0	0	1	1	2	2	2	0	0	0	0	0
SSARREV	0	0	2	2	11	10	20	24	24	24	27	27	37	37	-3	-3	-3	-3	-3
T/H UNC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1
RTNSS	0	2	0	0	2	2	3	3	3	3	6	7	10	10	-5	-5	-4	-3	-2
FCS PRA	0	-19	-19	-19	-19	0	0	0	0	0	0	0	1	1	0	0	0	0	0
ITAAC	0	0	0	0	18	18	18	18	18	18	2	6	9	9	0	0	0	0	0
TEST PRG	0	1	6	13	20	26	34	48	30	29	31	30	30	30	0	0	0	0	0
NOTRUMP	0	0	0	0	0	0	-15	-15	-14	-14	-14	-14	-14	-14	-53	-53	-53	-40	-30
LOFTRAN	0	0	0	0	1	1	1	2	3	3	3	3	3	3	0	0	0	0	0
WC/T	0	0	0	0	0	0	0	-3	-3	-6	-7	-8	-10	-10	-6	-2	0	0	0
H&MT						0	0	0	0	0	0	0	0	0	-20	-20	-20	-20	-20
LST						0	1	2	3	4	4	4	4	4	0	0	0	0	0
SCALING						0	0	0	0	0	0	0	0	0	-12	-12	-12	-12	-12
W&MT						0	0	0	0	0	0	0	0	0	0	0	0	0	0
WATER						0	0	0	0	0	0	0	0	0	-3	-3	-3	-3	-3
WGOTHIC	0	15	13	6	17	24	33	31	31	30	30	29	39	48	-105	-95	-85	-75	-65
EY ISSUES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-45	-45	-45	-45	-45
UNASSIGN	5	12	9	8	-2	-6	-12	-14	-3	-4	-5	-4	-10	-16	0	0	0	0	0
WD TOTAL	71	77	99	103	108	162	132	136	116	119	98	108	133	155	-438	-401	-378	-344	-314

N DELTA 12/19/96	SEP 19	SEP 26	OCT 3	OCT 10	OCT 17	OCT 24	OCT 31	NOV 7	NOV 14	NOV 21	NOV 27	DEC 5	DEC 12	DEC 19	DEC 26	JAN 2	JAN 9	JAN 16	JAN 23
CHAP 1	8	8	9	8	8	8	8	8	8	8	8	8	8	8	0	0	0	0	0
CHAP 2	0	4	6	8	10	10	10	10	10	10	10	10	10	10	0	0	0	0	0
3.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.2	0	1	2	3	10	10	10	10	10	10	10	10	2	2	-2	-2	-2	-2	-2
3.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
3.6.1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	0	0	0	0	0
3.6.2	0	2	0	0	0	0	0	0	0	0	1	2	3	0	0	0	0	0	0
3.6.3	0	11	14	0	1	1	-1	-2	1	4	6	9	12	20	0	0	0	0	0
3.7	0	0	7	14	14	14	14	14	14	14	14	14	14	12	0	0	0	0	0
3.8.2	-4	0	0	0	0	0	0	0	0	0	2	5	6	8	0	0	0	0	0
3.8.3	0	7	7	7	7	7	7	7	7	7	7	12	17	22	0	0	0	0	0
3.8.4	0	6	6	6	6	6	6	6	6	6	2	2	2	1	-12	-12	-12	-12	-12
3.8.5	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-7	-18	-18	-18	-18	-18
3A &3F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CH 42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-10	-8	-6	-4	-2
3.9	0	-1	-1	-1	-4	-5	-10	-3	4	11	18	25	33	32	0	0	0	0	0
3.10	0	0	0	0	-2	0	0	0	-2	-2	1	2	1	4	-2	0	0	0	0
3.11	0	19	21	23	23	23	23	23	21	21	18	13	13	22	0	0	0	0	0
3.12	13	13	13	13	13	13	13	9	13	13	13	8	10	13	0	0	0	0	0
CHAP 4	0	0	0	2	2	1	1	1	1	1	1	1	1	1	0	0	0	0	0
CHAP 5	30	28	27	27	27	27	27	27	27	26	23	21	20	20	0	0	0	0	0
6.1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	0	0
6.2	0	8	8	9	8	8	8	8	8	7	8	8	8	6	-59	-59	-59	-59	-59
6.3	0	4	4	4	4	4	4	4	4	4	4	4	4	4	-5	-5	-5	-5	-4
6.4	0	-1	3	1	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-15	-15	-15	-12	-10
6.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
6.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAP 7	0	-3	5	15	15	15	15	16	16	16	16	8	6	6	0	0	0	0	0
CHAP 8	11	9	9	9	9	9	9	9	9	9	9	9	9	9	0	0	0	0	0
CHAP 9	-5	53	106	161	161	161	162	163	163	163	164	163	166	164	0	0	0	0	0
CHAP 10	33	32	31	31	31	31	31	31	31	31	31	24	24	24	0	0	0	0	0
CHAP 11	46	46	46	46	46	46	46	46	46	46	45	46	46	46	0	0	0	0	0
CHAP 12	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0
CHAP 13	0	0	5	15	25	35	34	34	34	34	30	31	31	31	0	0	0	0	0
CHAP 14	0	8	8	8	8	8	22	34	46	58	70	82	82	82	0	0	0	0	0
CHAP 15	0	11	14	14	12	12	13	13	-47	-47	-44	-44	-46	-44	-228	-228	-228	-228	-228
16.1	0	61	61	61	61	60	60	60	59	59	62	59	59	59	-35	-21	-14	-7	0
16.2	0	0	0	-1	-1	-1	1	1	1	1	1	1	1	1	0	0	0	0	0
CHAP 17	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	0	0	0	0
CHAP 18	0	6	6	6	6	6	6	6	6	6	6	5	5	4	-35	-21	-14	-7	0
LEVEL 1	0	3	3	3	0	0	0	0	0	1	1	1	1	1	-60	-60	-60	-60	-80
LEVEL 2/3	0	0	0	0	0	0	1	1	1	1	1	1	1	1	-122	-122	-122	-122	-122
CHAP 19	-2	-4	-2	-2	-2	-2	-3	-16	-17	-17	-16	-17	-17	-18	-269	-269	-269	-269	-269
CHAP 20	0	1	1	1	1	1	1	1	1	1	1	-9	7	27	-60	-40	-20	0	0
SSARREV	0	-1	1	1	10	9	19	23	23	23	25	27	37	37	-3	-3	-3	-3	-3
T/H UNC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1
RTNSS	0	2	1	1	3	2	3	4	4	4	4	4	4	4	-14	-14	-10	-6	-4
FCS PRA	0	-37	-37	-37	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1
ITAAC	0	0	0	0	-4	0	0	0	0	1	4	12	14	16	0	0	0	0	0
TEST PRG	0	0	1	1	1	-1	-179	-181	-180	-180	-180	-143	-100	-36	-110	-55	0	0	0
NOTRUMP	0	0	0	0	0	0	0	0	1	1	1	1	1	0	-53	-53	-53	-53	-53
LOFTRAN	-3	-3	-3	-3	-2	-2	-2	-2	-1	-1	0	2	4	6	0	0	0	0	0
WC/T	8	8	8	8	8	-5	-5	-5	-5	-12	-12	-12	-12	-10	-20	-20	-20	-20	-20
H&MT	0	0	0	0	0	9	9	9	9	17	17	17	17	17	-3	-2	-1	0	0
LST	0	0	0	0	0	-8	-8	-8	-8	-8	-8	-8	-8	-8	-12	-12	-12	-12	-12
SCALING	0	0	0	0	0	6	6	6	6	13	13	13	13	13	0	0	0	0	0
W&MT	0	0	0	0	0	5	5	5	5	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
WATER	-8	-8	-8	-8	-8	-4	-4	-4	-4	-4	-4	-4	-6	-6	-10	-10	-10	-10	-10
WGOTHIC	0	-1	-1	-4	-4	-1	-1	-1	-1	-1	-1	-2	-2	-2	-177	-142	-110	-95	-85
EY ISSUES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-45	-45	-45	-45	-45
UNASSIGN	78	-21	-27	-23	-29	-39	-43	-36	-36	-36	-39	-32	-30	-55	0	0	0	0	0
ND TOTAL	219	336	395	464	517	532	374	380	343	365	392	430	512	613	-1339	-1196	-1068	-1009	-978

Winters, James

From: Winters, James
To: Lindgren, Donald A.
Cc: Winters, James; Butler, John C.; Mcintyre, Brian A.
Subject: Changes to OITS
Date: Friday, December 20, 1996 1:21PM

I have made the following changes to OITS to reflect our letter NSD-NRC-96-4917 of December 17, 1996.
W Status has been changed to "Closed" for all items in the letter.
NRC Status has been changed to "Cfrm-N" for those responses with SSAR revisions associated with them, e.g. 801, 802, 805, 807, 809, 1727, 1730, 1742, 1745, 1747, 1749, 1760, RAI 952.99 and RAI 952.96.
NRC Status has been changed to "Action N" for those responses with no SSAR revisions associated with them, e.g. 1716, 1731, and 1753.

I will fax this to Diane Jackson for her information.

Jim
x5290

To Butler -- Put in Informal NRC Transmittal Bin. Thanks Earl

COVER SHEET

FAX

To: Ralph Landry

Subject: PRHR Heat Transfer Correlation

Date: December 17, 1996

Pages: 17, including this cover sheet.

COMMENTS:

Ralph,

Attached is a draft copy of what we will be sending you on the above subject. If you get a chance to look at it, I'd appreciate any feedback you might have Wed. or Thurs. Will you be at ACRS meeting? If not, Larry indicated we might be get together after the meeting on level swell.

Thanks.

Earl

From the desk of...

Earl H. Novendstern
Manager, Advanced and VVER Plant Safety Analysis
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The analysis of the PRHR test data (WCAP-12980, revision 2) has indicated that the heat transfer correlations used for the PRHR, which were given in the original LOFTRAN Code Applicability Document, WCAP-14234, Appendix A, require modification. The table below summarizes the original PRHR heat transfer correlations used and the new correlations to be used.

Table 1		
Region	Original Heat Transfer Correlation Used	New Heat Transfer Correlation
Forced Convection Inside of the PRHR tubes	Petukhov-Popov	Dittus-Boelter
Natural Convection Heat Transfer Outside of the PRHR Tubes	Eckert-Jackson	McAdams
Boiling Heat Transfer Outside of the PRHR Tubes	Exponent Type Based on Phase 1 PRHR Data	Modified Rohsenow

The forced convection heat transfer on the inside of the PRHR tubes will use the Dittus-Boelter correlation. This correlation has been compared to the analyzed PRHR data as shown in Figure 9-3 from the revised PRHR test analysis report (WCAP-12980, revision 2). The generally more accepted Dittus-Boelter single-phase convective heat transfer correlation provides reasonable agreement with the PRHR data, particularly at higher Reynolds numbers. The comparisons presented in WCAP-12980 indicate that the Dittus-Boelter correlation is acceptable for calculating primary side PRHR heat transfer.

The natural convection heat transfer correlation used on the outside of the PRHR tubes, originally used in LOFTRAN, was the Eckert Jackson correlation. When comparisons of this correlation to the PRHR test data were made (at the bottom of the tubes), this correlation was best-estimate to slightly high relative to the data. The McAdams natural convection correlation was evaluated and found to give a better fit to the test data as seen in Figures 9-4 and 9-5 from WCAP-12980 Revision 2. Therefore, LOFTRAN analyses will change from Eckert-Jackson to McAdams for the natural convection heat transfer. It should be noted that for natural convection heat transfer in NOTRUMP and WCOBRA/TRAC McAdams is used.

Based on the PRHR test data results presented in WCAP-12908 Revision 1, the boiling data was originally fitted to an equation where heat flux was an exponential function of ΔT using the following form:

$$q_w'' = A\ \Delta T^B$$

where q_w'' = heat flux
ΔT = wall temperature minus saturation temperature
A & B = coefficients found from fits to Phase 1 PRHR test data

The steady state data from Phase 1 and Phase 2 tests were used to fit a modification of the Rohsenow nucleate boiling correlation. The Rohsenow correlation was selected since the Rohsenow parameters

are easy to calculate and do a good job of correlating nucleate boiling data and reflect the pressure dependency of the IRWST. The nominal fit to the PRHR data is shown in Figure 9-20 along with the upper and lower 95th percentile fits to the data. For the upper 95th percentile, this line is defined such that 95 percent of the data lie below this line. For the lower 95th percentile line, 95 percent of the data lies above the line. In future LOFTRAN analyses, the nominal fit for the Rohsenow correlation will be used for nucleate boiling heat transfer.

Use of the nominal Rohsenow fit is consistent with the approach used for other heat transfer regimes in the PRHR and in general with heat transfer models used elsewhere in plant safety analyses. Use of nominal, rather than the upper or lower 95th percentile of the correlation, is appropriate since adequate conservatism in the safety analysis is maintained by using many other independent conservative input assumptions used in the safety analysis. The analyses use a bounding approach where many of the plant parameters are assumed to be at the worst case upper or lower bound values. The safety analyses assumes maximum uncertainties on initial conditions such as RCS flow, RCS temperature, RCS pressure, pressurizer water volume and steam generator inventory. Uncertainties are also included in core neutron kinetics parameters, setpoints and actuation delays. For core decay heat, the ANS 1979 + 2 sigma model is used. For the PRHR model, uncertainties are included on PRHR volumes, surface areas, flow resistances, IRWST initial temperature and actuation time delays.

To quantify the sensitivity of the accident analyses to the uncertainty in the Rohsenow correlation, transients were run which used the upper 95 percentile line, the lower 95 percentile line and the nominal fit lines. A plant cooldown transient and a heatup transient which exercised the wide range of conditions expected in the PRHR were chosen. The cooldown transient analyzed was the inadvertent operation of the PRHR while at power. Operation of the PRHR at power will result in forced flow through the PRHR with high inlet temperatures. This transient will have relatively high heat fluxes and a higher proportion of the PRHR tube bundle will be in nucleate boiling. This transient will show the representative maximum overall deviation in heat transfer due to the uncertainty in the Rohsenow boiling heat transfer correlation.

As a representative heatup transient, the loss of normal feedwater event was chosen. During this transient the PRHR is operated under forced flow conditions and under natural circulation flow conditions. During a loss of normal feedwater and similar loss of steam generator heat sink transients, the PRHR provides the safety related means for long term core decay heat removal.

Figures 1 through 4 show the results of the inadvertent operation of the PRHR while at power analysis. Inadvertent operation of the PRHR at power causes an injection of relatively cold water into the reactor coolant system. This produces a reactivity insertion in the presence of a negative moderator temperature coefficient. Since the fluid in the PRHR heat exchanger is initially in equilibrium with the IRWST temperature, the initial flow out of the PRHR is significantly colder than the RCS fluid. Following this initial insurge, the PRHR outlet temperature increases and is limited by the cooling capacity of the PRHR. As shown in Figure 3, around 12 seconds there is a large peak in core power due to the initial insurge of cold fluid from the PRHR. After the original fluid in the PRHR fluid is purged, the temperature of the fluid exiting the PRHR increases and core power decreases to a value which is in equilibrium with the heat removal rate of the steam generators and the PRHR. For this event the peak core power achieved and the minimum DNBR are dependent on the initial volume of cold fluid in the PRHR and are independent of the magnitude of the PRHR heat transfer. PRHR heat transfer capacity only affects the final equilibrium power. As shown in Figure 1, with the RCPs running and the reactor at power conditions, the PRHR removes approximately 10% of rated plant power. The deviation in overall PRHR heat removal capacity due to the uncertainty in the Rohsenow nucleate boiling correlation is less than $\pm 0.7\%$ of plant rated power.

Figures 5 through 8 show the results of a complete loss of normal feedwater analysis using the upper 95 percentile line, the lower 95 percentile line and the nominal fit lines for the Rohsenow correlation. The PRHR total heat flux is shown in Figure 5. The reactor coolant pumps are running until just after 1000 seconds. While the RCPs are running, PRHR heat transfer is ~ 6 % of rated plant power. After the reactor coolant pumps are tripped, PRHR heat transfer drops to ~ 1% of rated plant power. During the period where pumps are running the, uncertainty in the boiling heat transfer coefficient causes a total deviation of less than ±0.5% of rated plant power. After the RCPs trip the difference in overall PRHR heat transfer is negligible. From Figure 6, the deviation in peak pressurizer water volume is +67 ft^3 to -42 ft^3. The peak pressurizer water volume occurs in all of the three cases at least 5 hours after the start of the transient. Figure 7 shows that there is no increase in peak RCS pressure due to the correlation uncertainty.

The use of the nominal fit for the Rohsenow boiling correlation is consistent with the other heat transfer regime correlations used and other conservative assumptions used in the analysis bound the correlation uncertainty.

In conclusion the uncertainty in the boiling heat transfer correlation has small or negligible impact on the results of the accident analysis and no impact on the licensing basis conclusions of the accident analyses. Westinghouse believes the application of the correlations are sufficiently conservative to address the data scatter observed in the tests and intends to utilize nominal values of the PRHR heat transfer correlations for the final Chapter 15 SAR analyses.

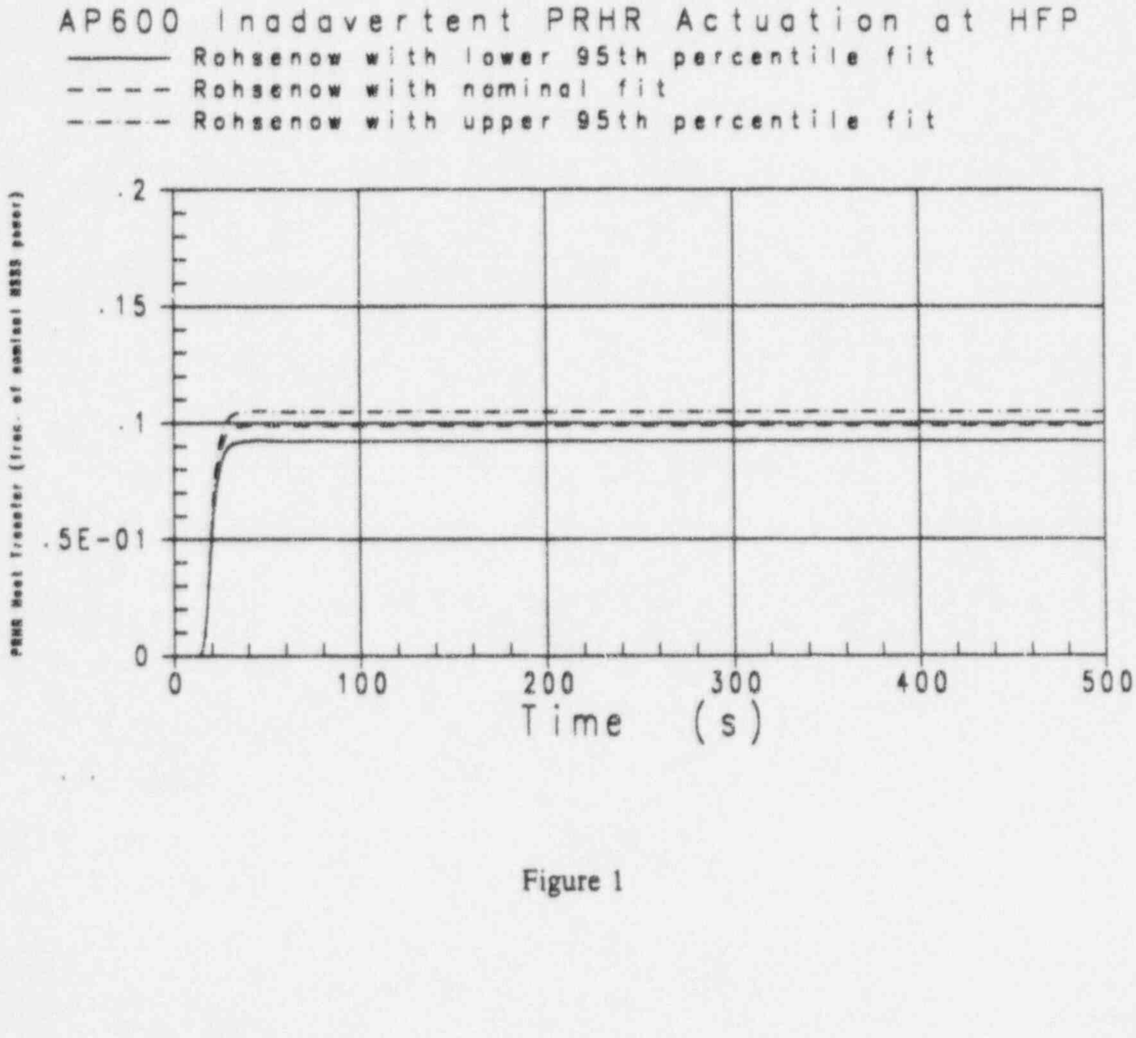
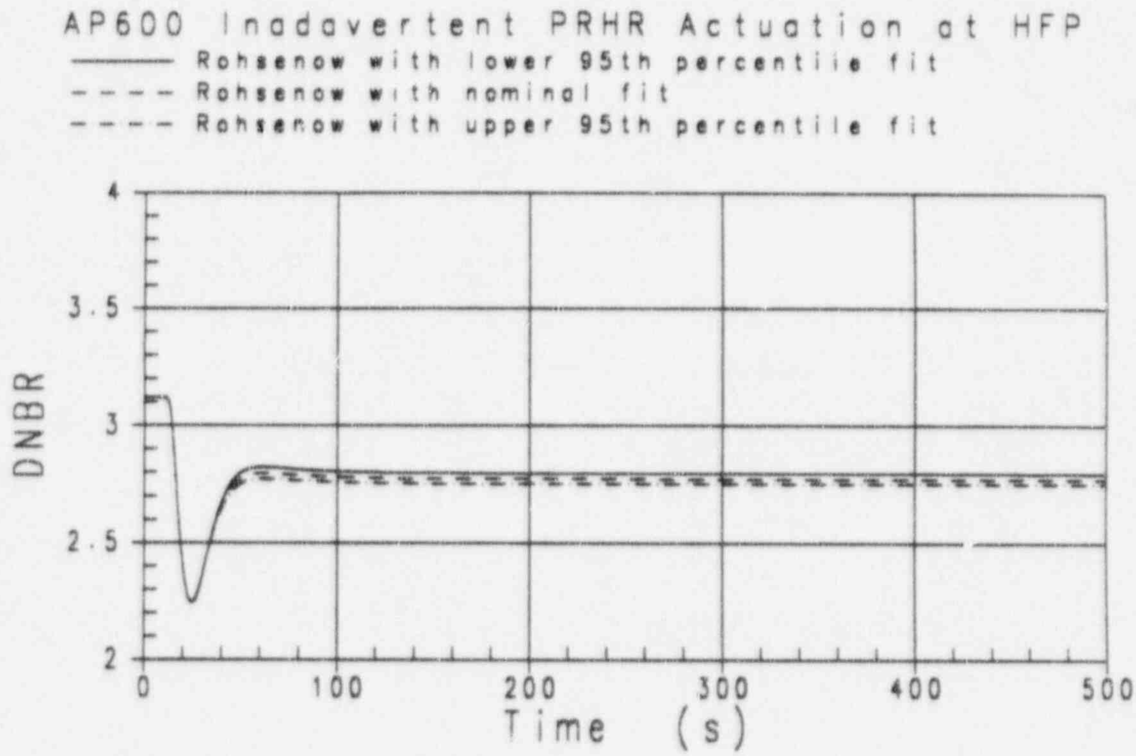

AP600 Inadavertent PRHR Actuation at HFP
Rohsenow with lower 95th percentile fit
Rohsenow with nominal fit
Rohsenow with upper 95th percentile fit
PRHR Heat Transfer (frac. of nominal NSSS power)
.2
.15
.1
.5E-01
0
0
100
200
300
400
500
Time (s)

Figure 1



AP600 Inadavertent PRHR Actuation at HFP
Rohsenow with lower 95th percentile fit
Rohsenow with nominal fit
Rohsenow with upper 95th percentile fit
DNBR
4
3.5
3
2.5
2
0
100
200
300
400
500
Time (s)

Figure 2

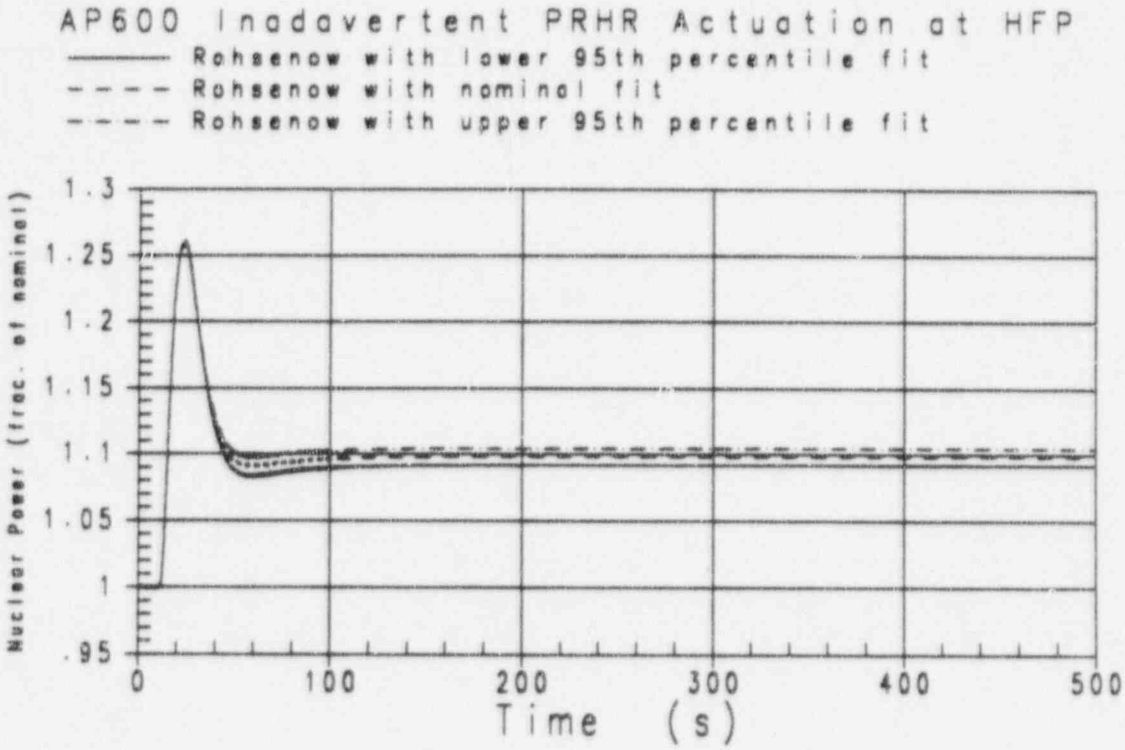

AP600 Inadavertent PRHR Actuation at HFP
Rohsenow with lower 95th percentile fit
Rohsenow with nominal fit
Rohsenow with upper 95th percentile fit
Nuclear Power (frac. of nominal)
1.3
1.25
1.2
1.15
1.1
1.05
1
.95
0
100
200
300
400
500
Time (s)

Figure 3

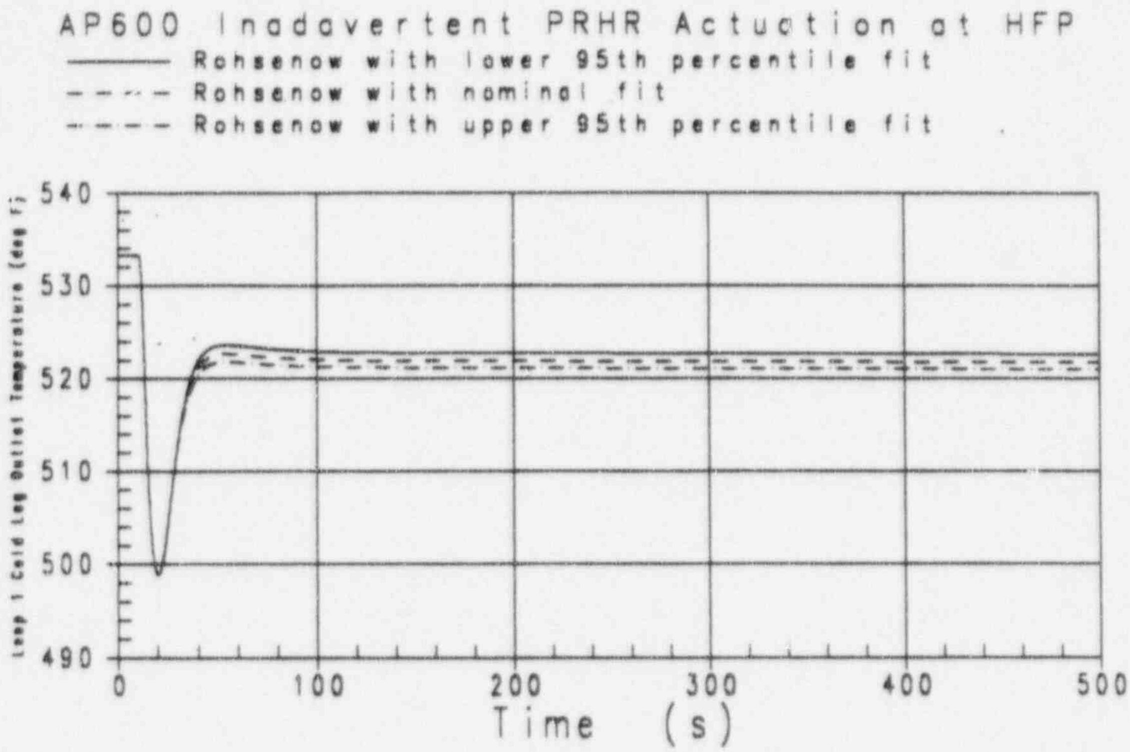

AP600 Inadvertent PRHR Actuation at HFP
Rohsenow with lower 95th percentile fit
Rohsenow with nominal fit
Rohsenow with upper 95th percentile fit
Loop 1 Cold Leg Outlet Temperature (deg F)
540
530
520
510
500
490
0
100
200
300
400
500
Time (s)

Figure 4

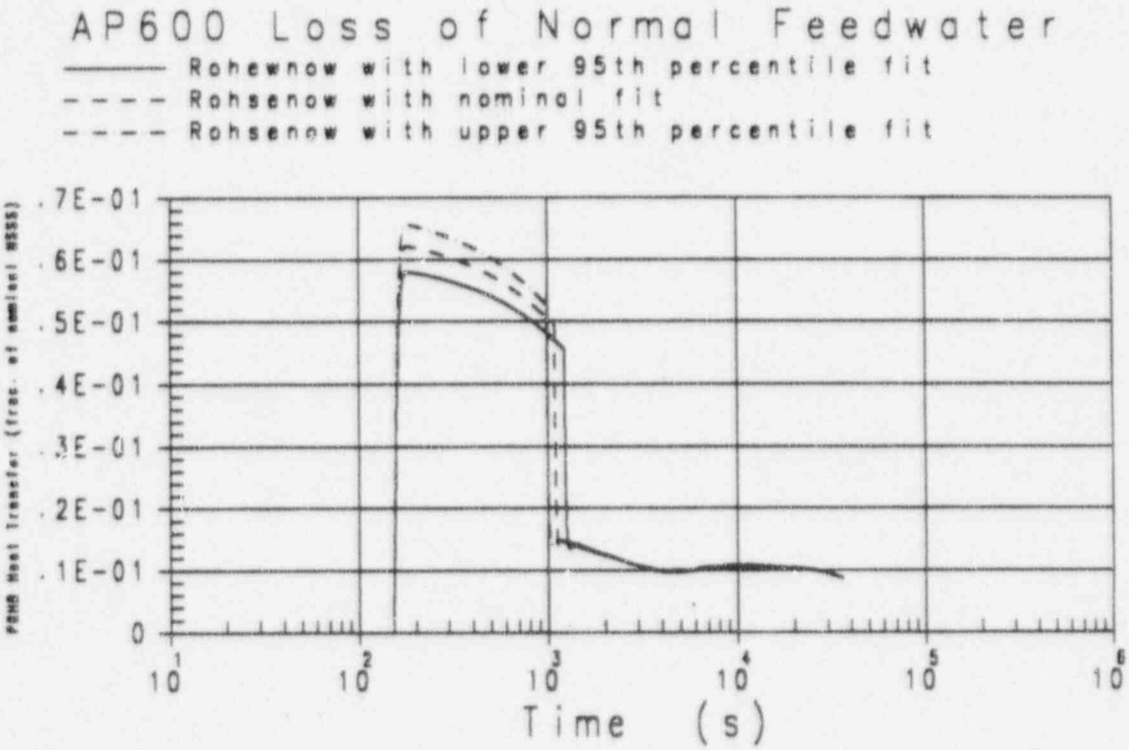

AP600 Loss of Normal Feedwater
Rohewnow with lower 95th percentile fit
Rohsenow with nominal fit
Rohsenow with upper 95th percentile fit
.7E-01
.6E-01
.5E-01
.4E-01
.3E-01
.2E-01
.1E-01
0
10^1
10^2
10^3
10^4
10^5
10^6
Time (s)

Figure 5

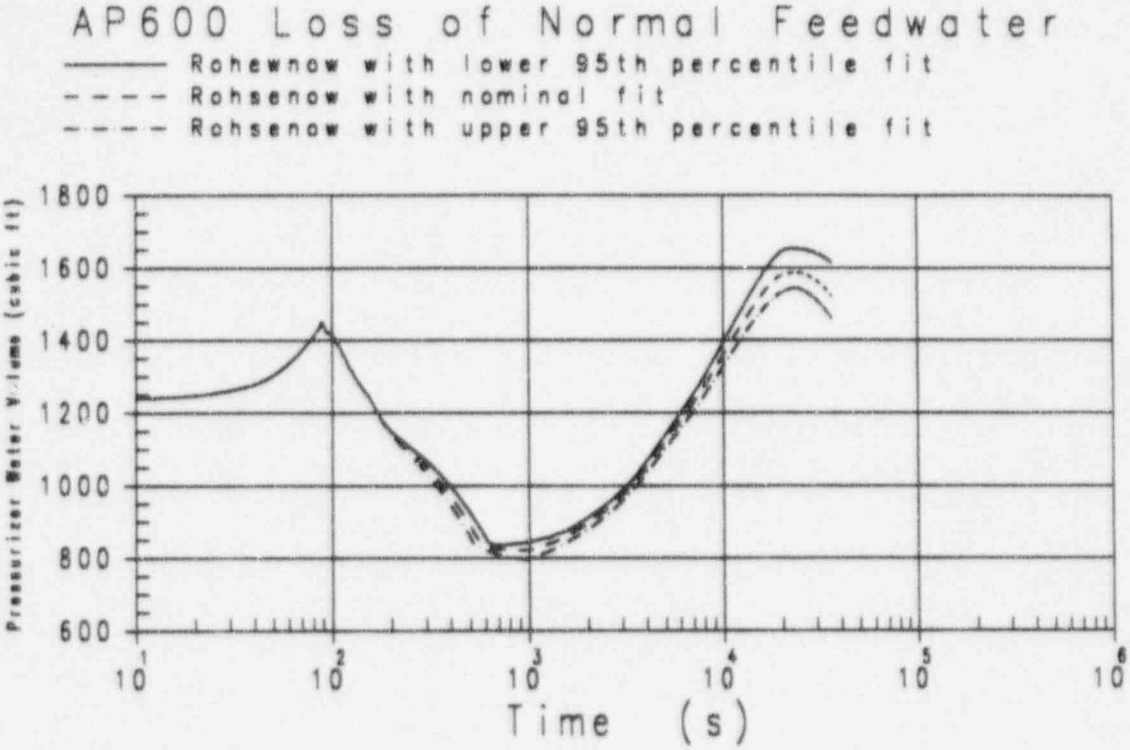

AP600 Loss of Normal Feedwater
Rohewnow with lower 95th percentile fit
Rohsenow with nominal fit
Rohsenow with upper 95th percentile fit
Pressurizer Water Volume (cubic ft)
1800
1600
1400
1200
1000
800
600
10^1
10^2
10^3
10^4
10^5
10^6
Time (s)

Figure 6

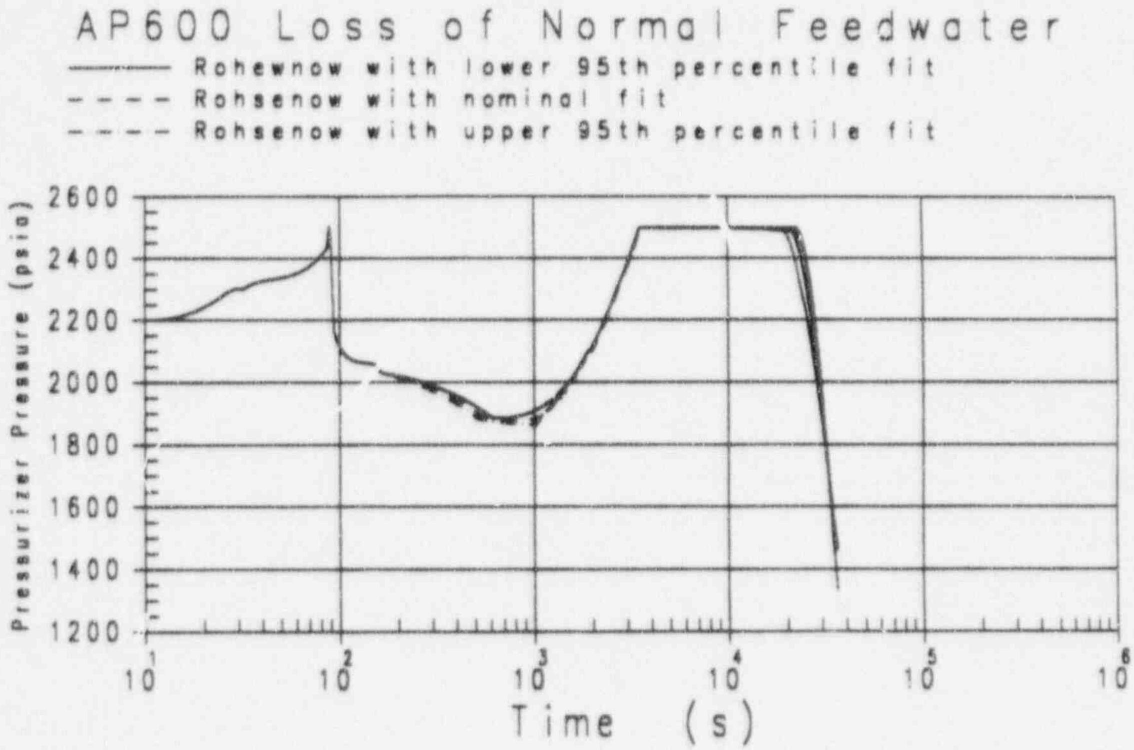

AP600 Loss of Normal Feedwater
Rohewnow with lower 95th percentile fit
Rohsenow with nominal fit
Rohsenow with upper 95th percentile fit
Pressurizer Pressure (psia)
2600
2400
2200
2000
1800
1600
1400
1200
10^1
10^2
10^3
10^4
10^5
10^6
Time (s)

Figure 7

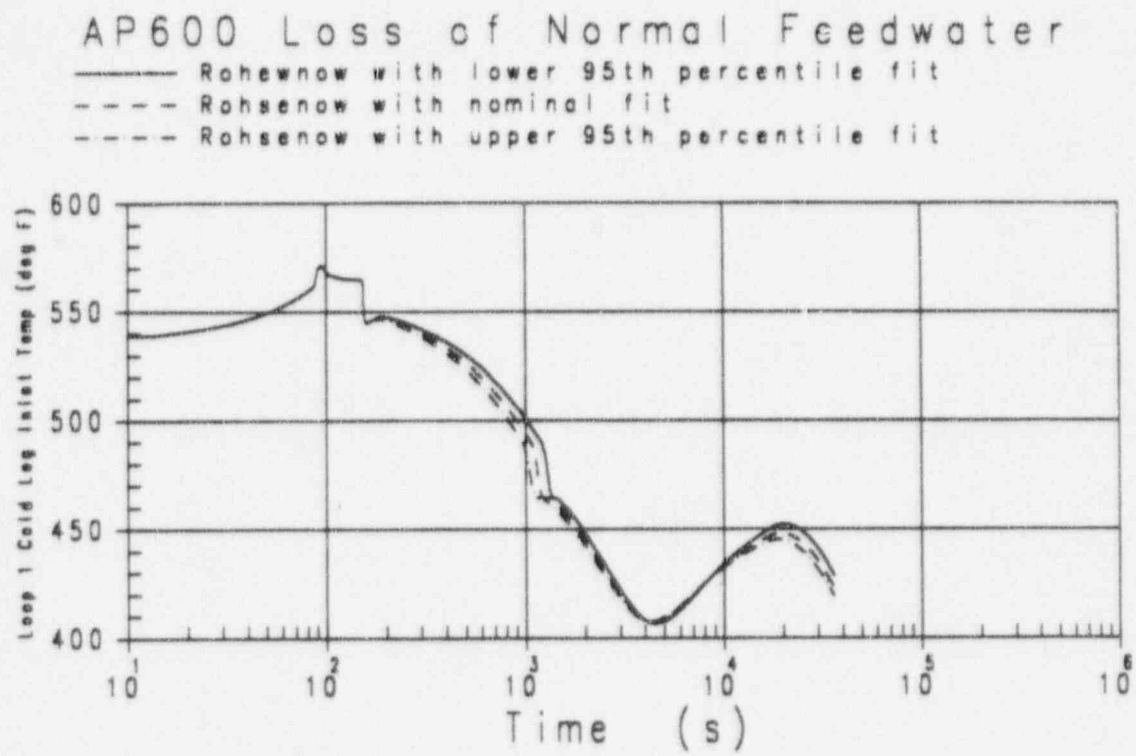

AP600 Loss of Normal Feedwater
Rohewnow with lower 95th percentile fit
Rohsenow with nominal fit
Rohsenow with upper 95th percentile fit
Loop 1 Cold Leg Inlet Temp (deg F)
600
550
500
450
400
10^1
10^2
10^3
10^4
10^5
10^6
Time (s)

Figure 8

Figures From WCAP-14234 Revision 2

** TX CONFIRMATION REPORT ** AS OF DEC 19 '96 17:49 PAGE.01

WETSD/RM 468 EC EAST

File

	DATE	TIME	TO/FROM	MODE	MIN/SEC	PGS	CMD#	STATUS
04	12/19	17:45	301 415 2968	EC--S	04'13"	004	078	OK

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 19, 1996	NAME:	Steve Kerch
TO:	Jim Bongarra	LOCATION:	Monroeville, PA. 15146
PHONE:	301-415-1046	PHONE:	412-374-5104
COMPANY:	NRC		
LOCATION:		FAX:	(412) 374-5099

Cover + Pages = 4 pages total

Jim Bongarra,

As promised during our conference call on Tuesday (December 17, 1996), attached is a draft of the Tier 1 material for "Task Analysis". Also included is the shell for the other 3 ITAACs (element 6, 7, and 10). This draft has been reviewed and approved by our management review team for ITAACs. Please review and comment on the draft material for Task Analysis. We believe that this response is consistent with the response that we discussed during our conference call. Please let us know as soon as possible whether this draft of the Task Analysis ITAAC is acceptable.

Thank You,
Steve Kerch
412-374-5104

Steve Kerch

Phone Number of Receiving Equipment: 301-415-2968

3.2 Human Factors Engineering

Design Description

The AP600 human-system interface (HSI) will be developed and evaluated based upon a human factors engineering (HFE) program and shall reflect human factors principles. The HSI scope applies to the main control room (MCR) and the remote shutdown room (RSR). The HSI scope provides the displays, controls, procedures, and alarms required for normal, abnormal and emergency plant operations. Implementation of the HFE program involves the completion of the following human factors engineering analyses and plans.

1. Task analysis is conducted in conformance with the task analysis implementation plan. Task analysis identifies the information and control requirements for the operators to make plant operating decisions and execute the tasks allocated to them.

2. Integration of human reliability analysis with the human factors engineering program (element 6)

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.
.

3. HSI design (element 7)

.
.
.

4. Human factors engineering verification and validation (element 10)
   Two parts:
   a. Develop the verification and validation plan
   b. Execute the plan and document the results

.
.

   Includes the following five activities:
   i) Task support verification
   ii) HFE design verification
   iii) Integrated system validation
   iv) Issue resolution verification
   v) Final plant HFE verification

.
.
.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 3.2-1 specifies the inspections, tests, analyses, and associated acceptance criteria for the HFE program.

Table 3.2-1
Inspections, Tests, Analyses, and Acceptance Criteria for the HFE Program

Design Commitment	Inspections, Test, Analyses	Acceptance Criteria
1. Task analysis is conducted in conformance with the task analysis implementation plan.	An inspection of the task analysis documentation will be performed.	i) A report exists and concludes that function based task analyses were conducted in conformance with the task analysis implementation plan and include the following functions: reactivity control; control of RCS boron concentration; control fuel and clad temperature; control of RCS coolant temperature, pressure, and inventory; provide RCS flow; control main steam pressure; control S/G inventory; control main condenser pressure; control containment pressure and temperature; provide hydraulic control of main turbine; primary and secondary boundary corrosion control. ii) A report exists and concludes that operational sequence analyses (OSAs) were conducted in conformance with the task analysis implementation plan. OSAs performed include the following: - plant heatup and startup from post refueling to 100% power; - reactor trip, turbine trip, and safety injection; - natural circulation cooldown; - loss of reactor or secondary coolant; - post LOCA cooldown and depressurization; - isolate faulted steam generator; - steam generator tube rupture; - response to nuclear power generation - ATWS; - loss of RCS inventory during shutdown; - loss of RNS during shutdown; - failure to manually actuate ADS; - failure to manually trip reactor via PMS, via DAS; - failure to recognize need for RCS depressurization (SLOCA/transient) - ADS valve testing during mode 1
2. Integration of human reliability analysis with HFE		
3. HSI design		

4.a. A human factors verification and validation		

Attached was sent to Joe Sebrosky
(and Alan Levin) via Fax.
Info to serve to lead the discussion
for the Dec. 12, 1996 telecom on T-H uncertainty
longterm recirc. issue.

C. Haag

The Role of Long-term Recirculation in the PRA

- Long-term recirculation is the final cooling phase that occurs for:
  - all LOCA events
  - other loss of heat sink events that lose RCS inventory through the pressurizer safety valves and actuate ADS

- Long-term recirculation will usually occur with the pumped RNS. The back-up to this is a natural circulation mode of cooling.

- The frequency of long-term natural circulation is approximately 7.5E-4 / year (once every 1333 years). If the RNS is assumed not to exist (as assumed in the Focused PRA), the frequency of the natural circulation mode is approximately 7.5E-3 / year (once every 133 years).

Methodology to Resolve Long-term Recirculation Issues for the PRA

- Analyses will be done to support the long-term recirculation success criteria for the PRA and to address T/H uncertainty concerns

- Cases to support the PRA and T/H Uncertainty Resolution will combine:

  - Methodology of Chapter 15 Long-term Cooling (i.e., windows operation of WCOBRA/TRAC and conservative decay heat)

  - PRA scenarios with equipment failures based on risk significance

- PRA cases will be sensitivities to the DBA cases with additional equipment failures

- The major equipment failures that are considered are:

  - CMTs and accumulators
  - ADS lines
  - Containment isolation

  The following table summarizes the status of this equipment for the risk significant success paths in the Focused PRA.

- The case definition has not been finalized, but will focus on two sensitivities to DBA:

  - With containment isolation and less ADS open
  - Without containment isolation and more ADS-4 open

High Level Summary of Risk Significance of Success Paths that go to Long-term Recirculation PRELIMINARY								
Description		Limiting Equipment					Focused PRA Success Path Frequency (/year)	Focused PRA CDF Increase (if it were core damage)
		CI	CMTs and Accums	ADS-4	ADS 1,2,3	Recirc Line		
DBA		Yes	4	3	All	2	6.8E-3	>100%
Less Venting Capacity	All ADS-4	Yes	2	4	None	1	7.0E-4	>100%
	3 ADS-4	Yes	3	3	None	1	1.5E-6	20%
	2 ADS-4	Yes	3	2	None	1	3.4E-7	4%
CI Failure		No	3	4	None	1	3.4E-6	44%

Notes:

1. All events that actuate ADS are considered in this table. This includes all LOCAs and other initiating events that develop into a LOCA through the pressurizer safety valves.

2. The summation of all success paths that are not on this table would result in an increase of <1% of the Focused PRA CDF and LRF if they were core damage rather than successful core cooling.

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 16, 1996	NAME:	Jim Wintons
TO:	Diane Jackson	LOCATION:	ENERGY CENTER - EAST
PHONE:	FACSIMILE:	PHONE:	Office: 412-374-5290
COMPANY:	USNRC	Facsimile:	win: 284-4887 outside: (412)374-4887
LOCATION:			

Cover + Pages 1 + 1

The following pages are being sent from the Westinghouse Energy Center, East Tower, Monroeville, PA. If any problems occur during this transmission, please call:

WIN: 284-5125 (Janice) or Outside: (412)374-5125.

COMMENTS:

Diane

The revised status detail, attached, for OITS item #263 provides responses for all parts of Item 7.a.(5) of your letter of 10/17/95 and our item 7.a.5 of telecon on 11/14/95.

Jim Winters

cc: Burton
McIntyre
Hutchings
Schulz
Wintons

AP600 Open Item Tracking System Database: Executive Summary   Date: 12/16/96

Selection: [item no] between 263 And 263 Sorted by Item #

Item No.	Branch	DSER Section/ Question	Type	Title/Description Detail Status	Resp Engineer	(W) Status	NRC Status	Letter No. /	Date
263	NRR/SPLB	9.4.1	MTG-OI		Winters/BPC	Closed	Resolved		

M9.4.1-3 (NUCLEAR ISLAND NON-RADIOACTIVE VENTILATION SYSTEM) Verify that the ductwork will be periodically visually examined and pressure tested to maintain positive pressure with respect to the adjacent areas such that any unfiltered inleakages inside the MCRE will be less than the maximum allowable for the associated design.

Closed per SSAR Rev. 3 section 9.4.1.2.3.
The following are provided in response to item 7.a.(5) of NRC letter dated October 17, 1996:
(1) SSAR was adequately revised per 11/14/96 telecon between NRC and Westinghouse.
(2) Since Revision 3, a design change was processed to remove the initiation of supplemental filtration upon a containment isolation signal. The supplemental air filtration units are normally in the standby mode. The radiation monitors located in the MCR supply air duct provide isolation signals to initiate the supplemental air filtration subsystem on detection of high airborne radioactivity. The control interlocks for initiation of the supplemental air filtration units by containment isolation signals was for the purpose of providing early protection of MCR/TSC operators from potential radioactivity releases from containment. There is no significant advantage in retaining this feature relative to minimizing operator doses, since radiation monitors at the MCR supply air duct will provide adequate protection. Deleting the control interlocks that provide initiation of supplemental air filtration units by containment isolation signals simplifies the control interlock design without affecting supplemental filtration unit performance or plant safety.
(3) The AP600 Technical Specifications include leak tightness requirements on the Main Control Room envelope. This includes periodic check of the VBS isolation dampers. See TechSpec section 3.7.6, Action C, and SR 3.7.6.5. In addition, the Inservice Testing portion of the SSAR addresses testing of the MCR envelope, including the VBS isolation dampers. See SSAR TAble 3.9-17.

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 16, 1996	NAME:	Jim Winters
TO:	Bill Huffman	LOCATION:	ENERGY CENTER - EAST
PHONE:	FACSIMILE:	PHONE:	Office: 412-374-5290
COMPANY:	USNRC	Facsimile:	win: 284-4887 outside: (412)374-4887
LOCATION:			

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The following pages are being sent from the Westinghouse Energy Center, East Tower, Monroeville, PA. If any problems occur during this transmission, please call:

WIN: 284-5125 (Janice) or Cutside: (412)374-5125.

COMMENTS:

Bill Huffman,

Here are the markups for Vantage 5H that I know about. If there should be more, please call. These will be in SSAR Revision 10 unless we here from you. This completes Actions 30 and 31 from our Near Term Actions List.

Jim Winters

cc: Butler
Lindgren
McIntyre
Ron Vijuk
Cummins
Winters
Jeanne Evans

4.4.2.2.1 DNB Technology

The primary DNB correlation used for the analysis of the AP600 fuel is the WRB-2 correlation. WCAP-10444-P-A (Reference 4) provides further details. This WRB-2 correlation applies to VANTAGE 5H fuel at AP600 conditions.

a modified

The WRB-2 DNB correlation was developed to take credit for the intermediate flow mixer grid design. A limit of 1.17 is applicable for the WRB-2 correlation. The measured critical heat flux plotted against predicted critical heat flux using the WRB-2 correlation is shown in WCAP-10444-P-A (Reference 4).

The applicable range of parameters for the WRB-2 correlation is:

Pressure	$1440 \leq P \leq 2490$ psia
Local mass velocity	$0.9 \leq G_{loc}/10^6 \leq 3.7$ lb/ft^2-hr
Local quality	$-0.1 \leq X_{loc} \leq 0.3$
Heat length, inlet to DNB location	$L_h \leq 14$ feet
Grid spacing	$10 \leq g_{sp} \leq 26$ inches
Equivalent hydraulic diameter	$0.37 \leq D_e \leq 0.51$ inches
Equivalent heated hydraulic diameter	$0.46 \leq D_h \leq 0.59$ inches

The WRB-2 correlation was developed based on mixing vane data and, therefore, is only applicable in the heated rod spans above the first mixing vane grid.

The W-3 DNB correlation, see Tong. L. S. (References 5 and 6), is used where the primary DNB correlation is not applicable.

The W-3 correlation, which does not take credit for mixing vane grids, is used to calculate DNBR values in the heated region below the first mixing vane grid. In addition, the W-3 correlation is applied in the analysis of accident conditions where the system pressure is below the range of the primary correlation. For system pressures in the range of 500 to 100 psia, the W-3 correlation limit is 1.45 (Reference 7). For system pressures greater than 1000 psia, the W-3 correlation limit is 1.30. The pressures associated with some of the steamline break statepoints are in the range of 300 to 500 psia. Using additional information, the W-3 correlation is shown to be applicable with these pressures and a correlation limit of 1.45.

A cold wall factor, described in WCAP-7695-L (Reference 8), is applied to the W-3 DNB correlation to conservatively account for the presence of the unheated thimble surfaces.

The approach for extending the DNB technology to methodologies that already have been approved is discussed in Section 6.0 of Reference 9.

The loss of flow and locked rotor events have flow rates at the time of minimum DNBR that are below the previously licensed lower limit of $G = 0.9 \times 10^6$ lb/ft^2-hr for the WRB-2 correlation. DNB testing was conducted to provide data to extend the WRB-2 correlation to these lower flows. A multiplier to the WRB-2 correlation was developed based on this data

Winters, James

From: Winters, James
To: Butler, John C.
Cc: Winters, James; Mcintyre, Brian A.
Subject: Change in NRC Status In OITS
Date: Monday, December 16, 1996 1:35PM

I changed the NRC Status for the following items in OITS to "Action N"

Items 3993, 4114, 4115 and 3449 based upon our letter NSD-NRC-96-4908, DCP/NRC0678 of December 10, 1996.

Items 1640 and 2414 based upon our letter NSD-NRC-96-4909, DCP/NRC0677 of December 10, 1996.

I will FAX this netmail to Diane Jackson for the record.

Thanks
Jim
x5290

Winters, James

From: Winters, James
To: Butler, John C.
Cc: Hutchings, Donald; Winters, James; Lindgren, Donald A.; Mcintyre, Brian A.
Subject: Notes from NRC HVAC telecon
Date: Tuesday, December 17, 1996 12:25PM

Here are my notes from this morning's (12/17/96) telecon with NRC (Jackson and Januck) on HVAC.

7.d.(1) - Action W - We need to list all systems in Table 3.2-3.

7.d.(2) - Action W - Revise Pressure Relief Damper description to include functionality commitment.

7.e.(1) - Action W - revise 9.4.7.2.1, first paragraph, to include information requested in NRC's 10/17/96 letter.

7.e.(2) - Action W - Same as 7.d.(1), OITS# 285.

7.f.(1) - Action W - Same as 7.d.(1), OITS# 285.

OITS 293 - Action W - Confirm sections 11.2 & 11.4 include proper requirements for HEPA filters on mobile equipment (1.140).

OITS 294 - Closed

OITS 295 - Closed

OITS 296 - Closed

7.f.(2) - Closed, part of 7.d.(1).

7.g.(1) - Action W - Same as 7.d.(1), OITS# 285.

7.h.(1) - Closed

7.h.(2) - (OITS 300) - Action W - revise 9.4.10.2.1.1 to describe the air intake louvers as being as high in the building as possible.

7.i.(1) - (OITS 304) - Action W - Provide justification of deletion of HEPA filters.

7.I.(2) - (OITS 302) - Action W - Same as 7.d.(1), OITS# 285.
- (OITS 305) - Action W - Include AHU capacities and filter efficiencies

Call if you have questions.

Jim
x5290

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	DECEMBER 17, 1996	NAME:	JIM WINTERS
TO:	DIANE JACKSON	LOCATION:	ENERGY CENTER - EAST
PHONE:	FACSIMILE:	PHONE:	Office: 412-374-5290
COMPANY:	US NRC	Facsimile:	win: 284-4887 outside: (412)374-4887
LOCATION:			

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The following pages are being sent from the Westinghouse Energy Center, East Tower, Monroeville, PA. If any problems occur during this transmission, please call:

WIN: 284-5125 (Janice) or Outside: (412)374-5125.

COMMENTS:

DIANE,

HERE IS OUR MARKUP TO RESOLVE ITEM 7.a.4 OF OUR 11/7/96 TELECON. IT CORRESPONDS TO ITEM 7.a.(4) OF YOUR 10/17/96 LETTER AND TO OITS # 2890. I AM CHANGING THE NRC Status OF 2890 to "ACTION N." THIS MARKUP WILL GO INTO REVISION 11 OF THE SSAR UNLESS WE HEAR FROM YOU.

Jim Winters

cc: BUTLER
LINDGREN
MCINTYRE
CUMMINS
RON VIJUK
WINTERS
MARK WILLS
HUTCHINGS
JEANNE EVANS

6.4 Habitability Systems

The habitability systems are a set of individual systems that collectively provide the habitability functions for the plant. The systems that make up the habitability systems are the:

- Nuclear island nonradioactive ventilation system (VBS)
- Main control room emergency habitability system (VES)
- Radiation monitoring system (RMS)
- Plant lighting system (ELS)

When a source of ac power is available, the nuclear island nonradioactive ventilation system (VBS) provides normal and abnormal HVAC service to the main control room (MCR), technical support center (TSC), instrumentation and control rooms, dc equipment rooms, battery rooms, and the nuclear island nonradioactive ventilation system equipment room.

When a source of ac power is not available to operate the nuclear island nonradioactive ventilation system, the main control room emergency habitability system (VES) is capable of providing emergency ventilation and pressurization for the main control room. The main control room emergency habitability system also provides emergency passive heat sinks for the main control room, instrumentation and control rooms, and dc equipment rooms.

Radiation monitoring of the main control room environment is provided by the radiation monitoring system. Smoke detection is provided in the VBS system. Emergency lighting is provided by the plant lighting system. Storage capacity is provided in the main control room for personnel support equipment.

6.4.1 Safety Design Basis

The safety design bases discussed here apply only to the portion of the individual system providing the specified function. The range of applicability is discussed in subsection 6.4.4.

6.4.1.1 Main Control Room Design Basis

The habitability systems provide coverage for the main control room pressure boundary as defined in subsection 6.4.2.1. The following discussion summarizes the safety design bases with respect to the main control room:

- The habitability systems are capable of maintaining the main control room environment suitable for prolonged occupancy throughout the duration of the postulated accidents discussed in Chapter 15 that require protection from the release of radioactivity. Refer to Section 3.1 and subsections 6.4.4 and 15.6.5.3 for a discussion on conformance with General Design Criterion 19. and to Section 1.9 for a discussion on conformance with Generic Issue B-66
- The main control room is designed to withstand the effects of an SSE and a design-basis tornado.

- Isolates the HVAC ductwork that penetrates the main control room boundary on high particulate or iodine concentrations in the main control room supply air or on extended loss of ac power to support operation of the main control room emergency habitability system as described in Section 6.4.

Those portions of the nuclear island nonradioactive ventilation system which penetrate the main control room envelope are safety-related and designed as seismic Category I to provide isolation of the main control room envelope from the surrounding areas and outside environment in the event of a design basis accident. Other functions of the system are nonsafety-related. HVAC equipment and ductwork whose failure could affect the operability of safety-related systems or components are designed to seismic Category II requirements. The remaining portion of the system is nonsafety-related and nonseismic.

The nuclear island nonradioactive ventilation system is designed to control the radiological habitability in the main control room within the guidelines presented in Standard Review Plan (SRP) 6.4 and NUREG 0696 (Reference 1), if the system is operable and ac power is available.

~~Although~~ the nuclear island nonradioactive ventilation system is not safety-related, However, the portions of the system that provide filtration of main control room/technical support center air during conditions of abnormal airborne radioactivity are designed, constructed, and tested in accordance with Generic Issue B-36 as described in Section 1.9, Regulatory Guide 1.140 as described in Appendix 1A, ASME N509 (Reference 2) and ASME N510 (Reference 3).

The nuclear island nonradioactive ventilation system is designed to provide a reliable source of heating, ventilation, and cooling to the areas served when ac power is available. The system equipment and component functional capabilities are to minimize the potential for actuation of the main control room emergency habitability system or the potential reliance on passive equipment cooling. This is achieved through the use of redundant equipment and components that are connected to standby onsite ac power sources.

9.4.1.1.2 Power Generation Design Basis

Main Control Room/Technical Support Center Areas

The nuclear island nonradioactive ventilation system provides the following specific functions:

- Controls the main control room and technical support center relative humidity between 25 to 60 percent

- Maintains the main control room and technical support center areas at a slightly positive pressure with respect to the adjacent rooms and outside environment during normal operations to prevent infiltration of unmonitored air into the main control room and technical support center areas

at a slightly positive pressure with respect to the surrounding areas and the outside environment.

The main control room/technical support center supply air handling units are sized to provide cooling air for personnel comfort, equipment cooling, and to maintain the main control room emergency habitability passive heat sink below its initial ambient air design temperature. The temperature of the air supplied by each air handling unit is controlled by temperature sensors located in the main control room return air duct to maintain the ambient air design temperature within its normal design temperature range by modulating the electric heat or chilled water cooling.

The outside air is continuously monitored by smoke monitors located at the outside air intake plenum and the return air is monitored for smoke upstream of the supply air handling units. The supply air to the main control room is continuously monitored for airborne radioactivity while the supplemental air filtration units remain in a standby operating mode.

The standby supply air handling unit and corresponding return/exhaust fans are started automatically if one of the following conditions shuts down the operating unit:

- Airflow rate of the operating fan is above or below predetermined setpoints.
- Return air temperature is above or below predetermined setpoints.
- Differential pressure between the main control room and the surrounding areas and outside environment is above or below predetermined setpoints.

Abnormal Plant Operation

INSERT 9.4-10

If high gaseous radioactivity is detected in the main control room supply air duct and the main control room/technical support center HVAC subsystem is operable, both supplemental air filtration units automatically start to pressurize the main control room and technical support center areas to at least 1/8 inch wg using filtered makeup air. After the room is pressurized, one of the supplemental air filtration units is manually shut down. The normal outside air makeup duct and the main control room and technical support center toilet exhaust duct isolation dampers close. The main control room/technical support center supply air handling unit provides cooling with recirculation air to maintain the main control room passive heat sink below its initial ambient air design temperature and maintains the main control room and technical support center areas within their design temperatures. The supplemental air filtration subsystem pressurizes the combined volume of the main control room and technical support center concurrently with filtered outside air. A portion of the recirculation air from the main control room and technical support center is also filtered for cleanup of airborne radioactivity. The main control room/technical support center HVAC equipment and ductwork that form an extension of the main control room/technical support center pressure boundary limit the overall infiltration (negative operating pressure) and exfiltration (positive operating pressure) rates to those values shown in Table 9.4.1-1 to maintain operator doses within allowable limits.

INSERT 9.4-10

Control actions are taken at two levels of radioactivity as detected in the main control room supply air duct. The first is "high" radioactivity based upon gaseous radioactivity instrumentation. The second is "high-high" radioactivity based upon either particulate or iodine radioactvity instruments.

If ac power is unavailable for more than a short period or if high particulate or iodine radioactivity is detected in the main control room supply air duct, the plant safety and monitoring system automatically isolates the main control room from the normal ventilation system by closing the supply, return, and toilet exhaust duct isolation dampers. Main control room habitability is maintained by the main control room emergency habitability system which is discussed in Section 6.4.

If a high concentration of smoke is detected in the outside air intake, an alarm is initiated in the main control room and the main control room/technical support center HVAC subsystem is manually realigned to the recirculation mode by closing the outside air and toilet exhaust duct isolation dampers. The main control room and technical support center toilet exhaust fans are tripped upon closure of the isolation dampers. The main control room/technical support center areas are not pressurized when operating in the recirculation mode. The main control room/technical support center HVAC supply air subsystem continues to provide cooling, ventilation, and temperature control to maintain the emergency habitability passive heat sink below its initial ambient air design temperature and maintains the main control room and technical support center areas within their design temperatures.

In the event of a fire in the main control room or technical support center, in response to heat from the fire or upon receipt of a smoke signal from an area smoke detector, the combination fire/smoke dampers close automatically to isolate the fire area. The subsystem continues to provide ventilation/cooling to the unaffected area and maintains the unaffected areas at a slightly positive pressure. The main control room/technical support center HVAC subsystem can be manually realigned to the once-through ventilation mode to supply 100 percent outside air to the unaffected area. Realignment to the once-through ventilation mode minimizes the potential for migration of smoke or hot gas from the fire area to the unaffected area. Smoke and hot gases can be removed from the affected area by reopening the closed combination fire/smoke damper(s) during the once-through ventilation mode. In the once-through ventilation mode, the outside air intake damper to the air handling unit mixing plenum opens and the return air damper to the air handling unit closes to provide 100 percent outside air to the supply air handling unit. In this mode, the subsystem exhaust air isolation damper opens to exhaust the return air directly to the turbine building vent.

Power is supplied to the main control room/technical support center HVAC subsystem by the plant ac electrical system. In the event of a loss of the plant ac electrical system, the main control room/technical support center ventilation subsystem is automatically transferred to the onsite standby diesel generators.

9.4.1.2.3.2 Class 1E Electrical Room HVAC Subsystem

The Class 1E electrical room HVAC equipment that serves electrical division A and C equipment is described in this section. The operation of the Class 1E electrical room HVAC equipment that serves electrical division B and D is similar.

** TX CONFIRMATION REPORT ** AS OF DEC 19 '96 16:47 PAGE.01

WETSD/RM 468 EC EAST

	DATE TIME	TO/FROM	MODE	MIN/SEC	PGS	CMD#	STATUS
32	12/19 16:40	301 415 2968	EC--S	06'33"	007	073	INC

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 19, 1996	NAME:	Steve Kerch
TO:	Jim Bongarra, John O'Hara, J. Higgins	LOCATION:	Monroeville, PA.
PHONE:	301-415-1046	PHONE:	412-374-5104
COMPANY:	NRC, BNL		
LOCATION:		FAX:	(412) 374-5099

Cover + Pages = 10 pages total

Reference (1): Westinghouse letter NSD-NRC-96-4874; "Progress Towards Resolving Element 2 and 4 Open Items for AP600"; December 16, 1996

To: Jim Bongarra (NRC), John O'Hara (BNL), Jim Higgins (BNL)

Attached is a "markup" of changes being made to WCAP-14645 (Rev. 1), "Human Factors Engineering Operating Experience Review Report For The AP600 Nuclear Power Plant". These changes have been approved by the AP600 management review team. Please note that only those pages with changes have been attached. As specified in Reference (1), this information is provided to address issues associated with DSER Open Item 18.3.3.1-2. Revision 2 of WCAP-14645 will incorporate these changes and will be transmitted to you via a letter. The transmittal letter will specify that Westinghouse reviewed the remaining 50% of the items from the BNL report and that no deficiencies were identified.

Steve Kerch
Steve Kerch
412-374-5104

Phone Number of Receiving Equipment:

J. Bongarra 301-415-2968
John O'Hara / J. Higgins 516-344-4900

** TX CONFIRMATION REPORT ** AS OF DEC 19 '96 16:57 PAGE.01

WETSD/RM 468 EC EAST

	DATE	TIME	TO/FROM	MODE	MIN/SEC	PGS	CMD#	STATUS
01	12/19	16:47	301 415 2968	EC--S	02'45"	003	073	OK
02	12/19	16:50	516 344 4900	G3--S	06'22"	010	073	OK

Westinghouse

FAX COVER SHEET

RECIPIENT INFORMATION		SENDER INFORMATION	
DATE:	December 19, 1996	NAME:	Steve Kerch
TO:	Jim Bongarra, John O'Hara, J. Higgins	LOCATION:	Monroeville, PA.
PHONE:	301-415-1046	PHONE:	412-374-5104
COMPANY:	NRC, BNL		
LOCATION:		FAX:	(412) 374-5099

Cover + Pages = 10 pages total

Reference (1): Westinghouse letter NSD-NRC-96-4874; "Progress Towards Resolving Element 2 and 4 Open Items for AP600"; December 16, 1996

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412-374-5104

Phone Number of Receiving Equipment: J. Bongarra 301-415-2968
John O'Hara / J. Higgins 516-344-4900

WCAP-14645 Rev. ~~1~~ 2

HUMAN FACTORS ENGINEERING OPERATING EXPERIENCE REVIEW REPORT FOR THE AP600 NUCLEAR POWER PLANT

December
~~October~~, 1996

AP600 Document Number: OCS-GJR-001

S. P. Kerch
R. M. Span

Westinghouse Electric Corporation
Energy Systems Business Unit
P.O. Box 355
Pittsburgh, Pennsylvania 15230-0355

3.0 RESULTS OF REVIEWING OPERATING EXPERIENCE ISSUES

Table 1 documents the NUREG-0711 Appendix B issues reviewed and how the AP600 design addresses these issues. Table 1 consists of five columns and provides the following information;

Column 1	Item
Column 2	Issue Reference
Column 3	Issue/Scope
Column 4	Human Factors Aspect/Human Performance Issue
Column 5	Human Factors/Human Performance Issue Addressed by AP600 Design

The numbers in column 1 are used throughout this document as a convenient means to reference the various issues. Column 2 identifies the reference document that presents the issue to be addressed. Column 3 identifies the specific issue/scope. Column 4 identifies the human factors aspect/human performance issue of the issue/scope identified in column 3. Column 5 documents how the AP600 design addresses the aspects/issues identified in column 4.

Tables 1, 2, and 3 also document the HFE-related issues which are not currently addressed by the AP600 design. These issues are identified in column 5 of Table 1 and in column 3 of Tables 2 and 3 by using the terminology "THIS ISSUE INPUT INTO THE DESIGN ISSUES TRACKING SYSTEM" typed in **bold** letters. Standard Safety Analysis Report (SSAR) subsection 18.2.4 provides a description of the design issues tracking system which includes tracking of HFE issues.

Column 5 of Table 1 also identifies which HFE issues are not applicable to the AP600 design. These are identified in column 5 of Table 1 by using the terminology "NOT APPLICABLE" typed in **bold** letters. Immediately after the bold type, the reason why the issue in not applicable to the AP600 is provided.

Column 5 of Table 1 may identify the issue or part of the issue as "the responsibility of the Combined License (COL) applicant." The following is a list of those items from Table 1 that are identified totally or partially as the responsibility of the COL applicant: 1, 21, 45, 48, 49, 50, 51, 58, 63, 64, 65, 67 through 70, 157, 168, and 170 through 180.

5.0 CONTENT AND RESOLUTION OF OPERATOR INTERVIEWS

1'ST ¶ → As part of the OER, Westinghouse has conducted operator interviews and observations during plant operations and after operating events. These interviews/observations are documented in Table 3. Column 1 of Table 3 identifies the reference that documents the operator interviews. Column 2 identifies the HFE-related issues applicable to the AP600 design, and column 3 documents how the AP600 design addresses the identified HFE-related issues.

3'rd ¶ → In column 3, some cross-referencing to Table 1 occurs where the identified issue is identical to an issue already documented in Table 1. Where the issue is not currently addressed by the AP600 design, an entry is made in column 3 stating "THIS ISSUE INPUT INTO THE DESIGN ISSUES TRACKING SYSTEM" typed in **bold** letters. The reference documents in Table 3 (References 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, and 3.8) are identified in the Reference list following Table 3.

this is the first sentence of the 2'nd ¶.

4'TH ¶ → Column 3 of Table 3 may identify the issue or part of the issue as "the responsibility of the Combined License (COL) applicant." The following is a list of those items from Table 3 that are identified totally or partially as the responsibility of the COL applicant: Ref. 3.1 items 1, 2, 3, 4, and 5; Ref. 3.2 items 2, 3, and 4; Ref. 3.4 items 1, 2, and 3; Ref. 3.5 item 6; Ref. 3.6 items 1 and 2; and Ref. 3.7/3.8 items 2, 4, and 6.

2'nd ¶ → see Insert

INSERT: 2'nd paragraph of Section 5.Ø

For each of the reference documents, the HFE-related issues were identified. Issues associated with or related to any of the ten elements of the Human Factors Engineering Program Review Model (ten elements defined by NUREG-0711) were identified as HFE-related issues and entered into column 2 of Table 3.

Replace with "Item 7"

TABLE 1 (Continued)

OPERATING EXPERIENCE REVIEW FOR THE AP600

Issues Addressed By NUREG 0711 Appendix B

Item	Issue Reference	Issue/Scope	Human Factors Aspect/Human Performance Issue	Human Factors/Human Performance Issue Addressed by AP600 Design
7	Item B.1 (7)	GI-51, Improving the reliability of open-cycle service water systems.	The buildup of clams, mussels, and corrosion products can cause the degradation of open cycle SWSs. Added instrumentation is one means of providing operators with the capability to monitor this buildup and take corrective action before loss of system functionality occurs.	The AP600 SWS and Circulating Water System (CWS) are nonsafety-related (NSR). The AP600 uses chemical control in the SWS (SSAR 9.2.1.2.2) and CWS (SSAR 10.4.5.2.2). The COL applicant will address the specific chemicals used for water chemistry control, algicide, and biocide applications, reflecting potential variations in site water chemistry and in micro and macrobiological life forms (SSAR 9.2.1.6 and 10.4.12.1 respectively). Chlorine residual is monitored in each system in order to assure that effective biocide treatment is being implemented.
8	Item B.1 (8)	GI-57, Effects of fire protection system actuation on safety-related equipment.	This issue resulted from spurious and inadvertent actuations of fire protection systems, often caused by operator errors during testing or maintenance. Design of systems should prevent such errors to the extent possible.	An explicit requirement exists to design the system such that inadvertent operations do not occur (SSAR 9.5.1.1.1, Rev. 4). There are no sprinkler systems or automatically initiated fire protection systems in areas containing safety-related components (5.1.2.1.4 - SSAR Rev. 4). Also an evaluation of the fire protection system integrity analysis is performed for safety-related systems. The system is designed to be in compliance with BTP CMEB 9.5-1.
9	Item B.1 (9)	GI-75, Generic implications of Anticipated Transient without Scram (ATWS)	This issue has many subissues, several of which are related to human factors, for example, scram data for post-scram analysis, capability for post-maintenance testing of reactor protection system, and a specific subissue titled "Review of human factors issues."	The AP600 includes a DAS that provides a diverse backup to the protection system. This system is a nonsafety-related instrumentation and control (I&C) system that is an expanded version of the ATWS Mitigation System Actuation Cabinets in the present generation Westinghouse nuclear power plants. One of the functional requirements of the DAS is to mitigate consequences of a failure to trip following an ATWS. The DAS provides a diverse, alternate means of automatically tripping the reactor and actuating specified ESF functions for selected events if the Protection and Safety Monitoring System (PMS) is unable to perform these functions as a result of common mode failure. A more detailed description of the DAS, including the diverse nature of the system, is found in SSAR subsection 7.7.1.11. The AP600 I&C systems includes a Data Display and Processing System (DDS). One of the functions provided by the DDS is a distributed computer function. The distributed computer function provides data acquisition, data storage, and computational functions to support operations, engineering plant information needs and emergency response information needs within a single system. The distributed computer function interacts with the plant operators through the operational display function and the plant information system. The distributed computer function provides many computational functions, including provisions for pre- and post-trip data for review and analysis, historical data storage and retrieval, and data logging. The AP600 PMS is a safety system of electrical and mechanical equipment that senses generating station conditions, and generates the signals to actuate reactor trip and ESFs that provide the equipment necessary to monitor plant safety-related functions during and following designated events (Reference SSAR Section 7.1). The PMS provides a high degree of reliability and fault tolerance for both operating and maintenance situations. SSAR subsection 7.1.2.10 describes the specific design features that provide this capability. SSAR subsection 7.1.2.12 describes the PMS test capabilities and design features. The AP600 reactor trip switchgear has four redundant safety divisions with each division containing two circuit breakers of the reactor trip switchgear (eight breakers total). As illustrated in SSAR Figure 7.1-7, the eight circuit breakers are arranged in a two-out-of-four logic configuration (Reference SSAR subsection 7.1.2.5).

Item 7

The AP600 service water system (SWS) and circulating water system (CWS) are nonsafety-related systems. The SWS utilizes freshwater in its design. The CWS is a site specific design. The SWS includes automatic self backwashing strainers and will be monitored for chlorine residual. In addition, instrumentation is provided in the SWS and the CWS to monitor system flow rate, pump discharge pressure; and heat exchanger inlet and outlet temperatures. The CWS also includes instrumentation to monitor condenser differential pressure. These instruments have readouts and alarms in the control room and are used to determine system performance at any given time and can, by trending, also be used to establish periodic maintenance plans to preclude loss of system functionality. Also, the SWS is designed with redundant pumps, heat exchangers and cooling tower cells to avoid plant shutdowns caused by a single component failure.

The COL will address the specific chemicals used for water chemistry control, algicide, and biocide applications, and in micro and macrobiological life forms (SSAR 10.4.12.1). The COL will also develop plant procedures to maintain the systems based upon the SSAR and Westinghouse technical documentation (SSAR 13.5 and 18.9).

TABLE 1 (Continued)

OPERATING EXPERIENCE REVIEW FOR THE AP600

Issues Addressed By NUREG 0711 Appendix B

Item	Issue Reference	Issue/Scope	Human Factors Aspect/Human Performance Issue	Human Factors/Human Performance Issue Addressed by AP600 Design
163	Subsection 5.1.3	LCSs -- General Considerations	HSI Consistency With Main Control Room The reviews undertaken for NUREG/CR-6146 involved 11 site visits to observe LCSs. At all of the plants, operators in the CR had access to computer-based displays in addition to conventional displays. These displays provided high-level information, e.g., indications that represented an integration of several parameters, of the value of a set of parameters plotted over time. However, in only one of the plants were such displays available at the shutdown panel. This issue may become more significant in advanced plant designs, where CRs are computer workstation-based, while the LCSs (such as the remote shutdown panel) are based on conventional HSI. In such a plant, operators at remote shutdown stations might be forced to gather information about the status of the plant and the effectiveness of their actions by unaccustomed means.	The workstation in the AP600 remote shutdown room will be identical to the Reactor Operator's workstation in the MCR. The M-MISs available at the operator's workstation in the MCR will also be available at the remote shutdown room workstation. Therefore, the operator will obtain plant information and control the plant from the remote shutdown workstation in the same manner as he does from the MCR workstation. The MMI and workstation design for an LCS will follow the same process, principles, guidelines, conventions and codings as was applied to the HSI in the MCR.
164	Section 5.2	LCSs -- Functional Centralization	Distribution of Safety Functions Functional Centralization (FC) refers to the manner in which the safety functions of LCSs are distributed throughout the plant. This embodies many of the systems engineering characteristics of LCSs and their functional organization. A plant with low FC has a wide distribution of safety functions on many local panels throughout the plant. Such plants also heavily use local control of individual components. A plant with high FC has all safety functions integrated into a single panel which contains all necessary controls and displays. FC affects human performance through its impact on such factors as communication workload, crew coordination, time to complete actions, and requirements for procedural complexity. In NUREG/CR-5572, it was shown that centralization of functions at multifunction control panels was associated with large potential reductions in risk. When considered at the design stage, the risk reduction benefit would be high.	The AP600 plant design is such that it has a high degree of FC, i.e., it has all safety functions integrated into a single panel which contains all necessary controls and displays. This panel is the reactor operator workstations in the MCR. The AP600 I&C architecture will be such that all process information that is available via the plant control system will be available throughout the plant. Communication ports will be located throughout the plant to allow workstations to be used locally at the equipment for "local control", monitoring activities, maintenance activities, or other functions. Local indication and/or controls will not be used except where required by code, regulatory requirements, URD or for operation of the process where portable interfaces with the plant control system would be a hindrance. Through the use of either portable or permanently installed interfaces and/or displays, plant personnel can access any monitored parameter in any location in the plant. By using this technique, local indicating devices will not generally be required and an auxiliary operator can monitor the whole system from one location.
165	Section 5.3	LCSs -- Valve Position Indication (VPI)	Lack of Local Valve Position Indication NUREG/CR-6146 found that many manual valves, even those found to be the most risk-significant manual valves, lacked local position indication. Without such explicit indication, the position of the valve is inferred from stem position (for rising stem valves) or determined by checking the valve in the closed direction. Both methods have potential problems, as discussed in the NUREG/CR. OER also identified incidents that were caused by poor or missing local VPI. The nature of the position indication should be appropriate to the use of the valve.	Where appropriate for the given manual valve type, the valve design specification will specify a local-reading mechanical position indication as a required design feature. Most valves will show their position by their mechanical properties. For example, a "rising stem" for gate valves may be used, while a 1/4-turn handwheel may be used for ball and butterfly valves.

Replace with "ITEM 165."

ITEM 165

The AP600 valve design specification PV03-Z0-001, ASME Class 1, 2, and 3 safety related gate and globe valves specifies that a local position indication device is required for these valves.

Manual valves identified as "risk-significant" will have valve position indication. The valve design specification will specify the type and details of the valve position indication as a required design feature for the respective valve. The criteria for determining "risk-significant" valves is found in SSAR section 16.2.

TABLE 1 (Continued)

OPERATING EXPERIENCE REVIEW FOR THE AP600

Issues Addressed By NUREG 0711 Appendix B

Item	Issue Reference	Issue/Scope	Human Factors Aspect/Human Performance Issue	Human Factors/Human Performance Issue Addressed by AP600 Design
168	Subsection 5.4.3	LCSs -- Miscellaneous Items	Personnel Overexposure Various areas of the plant have the potential for high radiation fields that could lead to personnel overexposure, therefore all plants have installed radiation detectors and alarms. Additionally, however, the malfunction of certain equipment can lead to very high radiation levels. This equipment includes incore instrument thimbles and traveling incore probes (TIP). There should be appropriate local warning devices (and perhaps also CR alarms) to alert personnel when equipment, such as TIPs and incore thimbles are not shielded and the potential exists for high radiation fields.	The AP600 incore instrumentation does not include TIPs or movable detectors. The incore thimble tubes are installed and not moved during plant operation. They do not present any potential for over-exposure of personnel to radiation while installed. These thimble tubes are withdrawn into the integrated head package prior to head removal in preparation for refueling. After thimble tube withdrawal, the integrated head is lifted and set down onto a thick bottom shielding plate. The shielding plate is attached and the head is then lifted into a shielded vault. The thimble tubes also do not present potential for over-exposure of personnel to radiation during shutdown. Area radiation monitors (ARMs) are provided to supplement the personnel and area radiation survey provisions of the AP600 health physics program described in Section 12.5 and to comply with the personnel radiation protection guidelines of 10 CFR 20, 50, 70, and Regulatory Guides 1.97, 8.2, 8.8, and 8.12. In addition to the installed detectors, periodic plant environmental surveillance is established. AP600 normal and accident plant radiation monitoring is described in SSAR Section 11.5. ~~Additional portable monitoring, including that required to meet NUREG-0737, Item III.D.3.3, is the responsibility of the COL applicant.~~
169	Subsection 5.4.4	LCSs -- Miscellaneous Items	Emergency Lighting Emergency lighting is required in the plant for personnel safety and for nuclear safety reasons. The two key nuclear safety areas requiring emergency lighting are the scenarios of 10 CFR 50, Appendix R, Section III.J and SBO. Operating experience has shown that NPPs have tended to pay less attention to the lighting requirements during an SBO scenario. A common practice is to depend on auxiliary operator use of flashlights. This can be a problem due to the potential unavailability of flashlights in an emergency and also because the physical use of one while operating equipment and communicating with the CR may be cumbersome.	The AP600 design includes extensive use of plant automation and distributed control. The distributed control system minimizes the need for LCSs to meet the requirements of either 10 CFR 50 Appendix R or 10 CFR 50.63 (SBO). Emergency lighting is provided in the MCR and the remote shutdown workstation to illuminate these areas for emergency operations upon loss of normal lighting. See the AP600 SSAR, Chapter 7 for a description of the plant control system. The emergency lighting system is described in AP600 SSAR subsection 9.5.3.2.2 The AP600 design includes two non-Class 1E diesel generators separated by a fire barrier. Following a fire, at least one of the diesel generators will be available to provide power to normal lighting in areas of the plant not damaged by the fire. During SBO the two non-Class 1E diesel generators are available to provide power to normal plant lighting. The onsite non-Class 1E diesel generators are described in AP600 SSAR, subsection 8.3.1.

12/17/96

Diane

Here is markup to correct references in Section 9.4. This should resolve Item 4 in your 10/17/96 letter and Item 4 in our 11/7/96 telecon. I'll attach a copy to our informal to formal transmittal. This will go into SSAR Revision 10.

Jim [signature]

Handcarried on 12/18/96

9.4 Air-Conditioning, Heating, Cooling, and Ventilation System

The air-conditioning, heating, cooling, and ventilation system is comprised of the following systems that serve the various buildings and structures of the plant:

- Nuclear island nonradioactive ventilation system (subsection 9.4.1)
- Annex/auxiliary buildings nonradioactive HVAC system (subsection 9.4.2)
- Radiologically controlled area ventilation system (subsection 9.4.3)
- Containment recirculation cooling system (subsection 9.4.6)
- Containment air filtration system (subsection 9.4.7)
- Radwaste building HVAC system (subsection 9.4.8)
- Turbine building ventilation system (subsection 9.4.9)
- Diesel generator building heating and ventilation system (subsection 9.4.10)
- Health physics and hot machine shop HVAC system (subsection 9.4.11)

9.4.1 Nuclear Island Nonradioactive Ventilation System

The nuclear island nonradioactive ventilation system (VBS) serves the main control room (MCR), technical support center (TSC), Class 1E dc equipment rooms, Class 1E instrumentation and control (I&C) rooms, Class 1E electrical penetration rooms, Class 1E battery rooms, remote shutdown area, reactor coolant pump trip switchgear rooms, adjacent corridors, and the passive containment cooling system (PCS) valve room during normal plant operation.

The main control room emergency habitability system provides main control room habitability in the event of a design basis accident (DBA) and is described in Section 6.4.

9.4.1.1 Design Basis

9.4.1.1.1 Safety Design Basis

The nuclear island nonradioactive ventilation system provides the following nuclear safety-related design basis functions:

- Monitors the main control room supply air for radioactive particulate and iodine concentrations

- Isolates the HVAC ductwork that penetrates the main control room boundary on high particulate or iodine concentrations in the main control room supply air or on extended loss of ac power to support operation of the main control room emergency habitability system

Those portions of the nuclear island nonradioactive ventilation system which penetrate the main control room envelope are safety-related and designed as seismic Category I to provide isolation of the main control room envelope from the surrounding areas and outside environment in the event of a design basis accident. Other functions of the system are nonsafety-related. HVAC equipment and ductwork whose failure could affect the operability of safety-related systems or components are designed to seismic Category II requirements. The remaining portion of the system is nonsafety-related and nonseismic.

The nuclear island nonradioactive ventilation system is designed to control the radiological habitability in the main control room within the guidelines presented in Standard Review Plan (SRP) 6.4 and **NUREG 0696 (Reference 1)**, if the system is operable and ac power is available.

Although the nuclear island nonradioactive ventilation system is not safety-related, the portions of the system that provide filtration of main control room/technical support center air during conditions of abnormal airborne radioactivity are designed, constructed, and tested in accordance with **ASME N509 (Reference 2)** and **ASME N510 (Reference 3)**.

The nuclear island nonradioactive ventilation system is designed to provide a reliable source of heating, ventilation, and cooling to the areas served when ac power is available. The system equipment and component functional capabilities are to minimize the potential for actuation of the main control room emergency habitability system or the potential reliance on passive equipment cooling. This is achieved through the use of redundant equipment and components that are connected to standby onsite ac power sources.

9.4.1.1.2 Power Generation Design Basis

Main Control Room/Technical Support Center Areas

The nuclear island nonradioactive ventilation system provides the following specific functions:

- Controls the main control room and technical support center relative humidity between 25 to 60 percent

- Maintains the main control room and technical support center areas at a slightly positive pressure with respect to the adjacent rooms and outside environment during normal operations to prevent infiltration of unmonitored air into the main control room and technical support center areas

- Isolates the main control room and/or technical support center area from the normal outdoor air intake and provides filtered outdoor air to pressurize the main control room and technical support center areas to a positive pressure of at least 1/8 inch wg when a high gaseous radioactivity concentration is detected in the main control room supply air duct

- Isolates the main control room and/or technical support center area from the normal outdoor air intake and provides 100 percent recirculation air to the main control room and technical support center areas when a high concentration of smoke is detected in the outside air intake

- Provides smoke removal capability for the main control room and technical support center areas

- Maintains the main control room emergency habitability system passive cooling heat sink below its initial design ambient air temperature limit of 80°F

The system maintains the following room temperatures based on the maximum and minimum outside air safety temperature conditions shown in Chapter 2, Table 2-1:

Area	Temperature (°F)
Main control room	67 - 78
Technical support center	67 - 78

Class 1E Electrical Rooms

The nuclear island nonradioactive ventilation system provides the following specific functions:

- Exhausts air from the Class 1E battery rooms to limit the concentration of hydrogen gas to less than 2 percent by volume

- Maintains the Class 1E electrical room emergency passive cooling heat sink below its initial design ambient air temperature limit of 75°F

- Provides smoke removal capability for the Class 1E electrical equipment rooms and battery rooms

The system maintains the following room temperatures based on the maximum and minimum outside air safety temperature conditions shown in Chapter 2, Table 2-1:

Area	Temperature (°F)
Class 1E battery rooms	67 - 73
Class 1E dc equipment rooms	67 - 78
Class 1E electrical penetration rooms	67 - 73
Class 1E instrumentation and control rooms	67 - 73
Corridors	67 - 73
Remote shutdown area	67 - 73
Reactor coolant pump trip switchgear rooms	67 - 73
HVAC equipment rooms	50 - 85

Passive Containment Cooling System Valve Room

The subsystem maintains the following room temperatures based on the maximum and minimum outside air safety temperature conditions shown in Chapter 2, Table 2-1:

Area	Temperature (°F)
Passive containment cooling system valve room	50 - 120

9.4.1.2 System Description

The nuclear island nonradioactive ventilation system is shown in Figure 9.4.1-1. The system consists of the following independent subsystems:

- Main control room/technical support center HVAC subsystem
- Class 1E electrical room HVAC subsystem
- Passive containment cooling system valve room heating and ventilation subsystem

9.4.1.2.1 General Description

9.4.1.2.1.1 Main Control Room/Technical Support Center HVAC Subsystem

The main control room/technical support center HVAC subsystem serves the main control room and technical support center areas with two 100 percent capacity supply air handling units, return/exhaust air fans, supplemental air filtration units, associated dampers, instrumentation and controls, and common ductwork. The supply air handling units and return/exhaust air fans are connected to common ductwork which distributes air to the main control room and technical support center areas. The main control room envelope consists of the main control room, shift supervisor office, tagging room, toilet, clerk room, and kitchen/operator area. The technical support center areas consist of the main technical support center operations area, conference rooms, NRC room, computer rooms, shift turnover room,

kitchen/rest area, and restrooms. The main control room and technical support center toilets have separate exhaust fans.

Outside supply air is provided to the plant areas served by the main control room/technical support center HVAC subsystem through an outside air intake duct that is protected by an intake enclosure located on the roof of the auxiliary building at elevation 153'-0". The supply, return and toilet exhaust ducts that penetrate the main control room envelope include redundant safety-related seismic Category I isolation dampers that are physically located within the main control room envelope. Redundant safety-related radiation monitors are located inside the main control room upstream of the supply air isolation dampers. These monitors initiate operation of the nonsafety-related supplemental air filtration units on high gaseous radioactivity concentrations and isolate the main control room from the nuclear island nonradioactive ventilation system on high particulate or iodine radioactivity concentrations. See Section 11.5 for a description of the main control room supply air radiation monitors.

Both redundant trains of supplemental air filtration units and one train of the supply air handling unit are located in the main control room mechanical equipment room at elevation 135'-3" in the auxiliary building. The other supply air handling unit subsystem is located in the main control room mechanical equipment room at elevation 135'-3" in the annex building. The main control room toilet exhaust fan is located at elevation 135'-3" in the auxiliary building. A humidifier is provided for each supply air handling unit. The supply air handling unit cooling coils are provided with chilled water from air-cooled chillers in the central chilled water system. See subsection 9.2.7 for the chilled water system description.

The main control room/technical support center HVAC subsystem is designed so that smoke, hot gases, and fire suppressant will not migrate from one fire area to another to the extent that they could adversely affect safe shutdown capabilities, including operator actions. Fire or combination fire and smoke dampers are provided to isolate each fire area from adjacent fire areas during and following a fire in accordance with **NFPA 90A (Reference 27)** requirements. These combination smoke/fire dampers close in response to smoke detector signals or in response to the heat from a fire. See Appendix 9A for identification of fire areas.

9.4.1.2.1.2 Class 1E Electrical Room HVAC Subsystem

The Class 1E electrical room HVAC subsystem serves the Class 1E electrical rooms, Class 1E instrumentation and control (I&C) rooms, Class 1E electrical penetration rooms, Class 1E battery rooms, spare Class 1E battery room, remote shutdown area and reactor coolant pump trip switchgear rooms. The A and C electrical divisions, spare battery room, and reactor coolant pump trip switchgear rooms are served by one ventilation subsystem; the B and D electrical divisions and remote shutdown workstation area are served by a second ventilation subsystem.

Each subsystem consists of two 100 percent capacity supply air handling units, return/exhaust air fans, associated dampers, controls and instrumentation, and common ductwork. The supply air handling units and return/exhaust air fans are connected to a common ductwork which distributes air to the Class 1E electrical rooms. The outside supply air intake enclosure

for the A and C subsystem is common to the main control room/technical support center intake located on the roof of the auxiliary building at elevation 153'-0". The outside supply air intake for the B and D subsystem is located separate from the main control room/technical support center air intake enclosure on the auxiliary building roof at elevation 153'-0". The exhaust ducts from the battery rooms are connected to the turbine building vent to remove hydrogen gas generated by the batteries.

The HVAC equipment which serves the A and C electrical divisions is located in the nuclear island nonradioactive ventilation system main control room/A and C equipment room at elevation 135'-3" in the auxiliary building. The HVAC equipment which serves the B and D division of Class 1E electrical equipment is located in the upper and lower nuclear island nonradioactive ventilation system B and D equipment rooms at elevation 117'-0" and at elevation 135'-3".

The supply air handling unit cooling coils are provided with chilled water from the air-cooled chillers in the central chilled water system. The two air handling units for each set of electrical divisions are provided with chilled water from redundant air-cooled chillers. Refer to subsection 9.2.7 for the chilled water system description.

Each subsystem for the Class 1E battery rooms is provided with two 100 percent capacity exhaust fans.

The Class 1E electrical room HVAC subsystem is designed so that smoke, hot gases, and fire suppressant does not migrate from one fire area to another to the extent that they could adversely affect safe shutdown capabilities, including operator actions. Separate ventilation subsystems are provided to serve the electrical division A and C equipment rooms and the electrical division B and D equipment rooms. The use of separate HVAC distribution subsystems for the redundant trains of electrical equipment prevents smoke and hot gases from migrating from one distribution division to the other through the ventilation system ducts. In addition, combination fire-smoke dampers are provided for Class 1E equipment rooms, including the remote shutdown workstation room, to isolate each fire area and block the migration of smoke and hot gases to or from adjacent fire areas in accordance with NFPA 90A requirements. These combination fire/smoke dampers close in response to smoke detector signals or in response to the heat from a fire. See Appendix 9A for identification of fire areas.

9.4.1.2.1.3 Passive Containment Cooling System Valve Room Heating and Ventilation Subsystem

The passive containment cooling system valve room heating and ventilation subsystem serves the passive containment cooling system valve room.

The subsystem consists of one 100 percent ventilating fan, two 100 percent capacity electric unit heaters, associated dampers, controls and instrumentation. The passive containment cooling system valve room heating and ventilation subsystem equipment is located in the passive containment cooling system valve room in the containment dome area at elevation 266'-0".

The exhaust fan draws outside air through an intake louver damper and directly exhausts to the environment.

9.4.1.2.2 Component Description

The nuclear island nonradioactive ventilation system is comprised of the following major components. These components are located in buildings on the Seismic Category I Nuclear Island and the Seismic Category II portion of the annex building. The seismic design classification, safety classification and principal construction code for Class A, B, C, or D components are listed in Section 3.2. Tables 9.4.1-1, 9.4.1-2 and 9.4.1-3 provide design parameters for major components in each subsystem.

Supply Air Handling Units

Each air handling unit consists of a mixing box section, a low efficiency filter bank, high efficiency filter bank, an electric heating coil, a chilled water cooling coil bank, and supply and return/exhaust air fans.

Supply and Return/Exhaust Air Fans

The supply and return/exhaust air fans are centrifugal type, single width single inlet (SWSI) or double width double inlet (DWDI), with high efficiency wheels and backward inclined blades to produce non-overloading horsepower characteristics. The fans are designed and rated in accordance with **ANSI/AMCA 210 (Reference 4)**, **ANSI/AMCA 211 (Reference 5)** and **AMCA 300 (Reference 6)**.

Supplemental Air Filtration Units

Each supplemental air filtration unit includes a high efficiency filter bank, an electric heating coil, a charcoal adsorber with upstream HEPA filter bank, a downstream postfilter bank and a fan. The filtration unit configurations, including housing, internal components, ductwork, dampers, fans and controls, and the location of the fans on the filtered side of units are designed and constructed to meet the performance requirements of **ASME N509** to satisfy the guidelines of Regulatory Guide 1.140.

Low Efficiency Filters, High Efficiency Filters, and Postfilters

The low efficiency filters and high efficiency filters have a rated dust spot efficiency based on **ASHRAE 52 (Reference 7)**. Filter minimum average dust spot efficiency is shown in Table 9.4.1-1 and 9.4.1-2. High efficiency filter performance upstream of HEPA filter banks meet the design requirements of **ASME N509**, Section 5.3. Postfilters downstream of the charcoal filters have a minimum DOP efficiency of 95 percent. The filters meet **UL 900** (**Reference 8**) Class I construction criteria.

HEPA Filters

HEPA filters are constructed, qualified, and tested in accordance with UL-586 (Reference 9) and ASME N509, Section 5.1. Each HEPA filter cell is individually shop tested to verify an efficiency of at least 99.97 percent using a monodisperse 0.3-μm aerosol.

Charcoal Adsorbers

Charcoal adsorbers and adsorbent media are constructed, qualified and tested in accordance with ASME N509, Section 5.2. Each charcoal adsorber is a single assembly with welded construction and 4-inch deep Type III rechargeable adsorber cell.

Electric Heating Coils

The electric heating coils are multi-stage fin tubular type. The electric heating coils meet the requirements of UL-1096 (Reference 10). The coils for the supplemental air filtration subsystem are constructed, qualified, and tested in accordance with ASME N509, Section 5.5.

Electric Unit Heaters

The electric unit heaters are single-stage or two-stage fin tubular type. The electric unit heaters are UL-listed and meet the requirements of UL-1025 (Reference 26) and the National Electrical Code (Reference 28).

Cooling Coils

The chilled water cooling coils are counterflow, finned tubular type. The cooling coils are designed and rated in accordance with ASHRAE 33 (Reference 11) and ANSI/ARI 410 (Reference 12).

Humidifiers

The humidifiers are packaged electric steam generator type which converts water to steam and distributes it through the air handling system. The humidifiers are designed and rated in accordance with ARI 620 (Reference 13).

Isolation Dampers

Nonsafety-related isolation dampers are bubble tight, single- or parallel-blade type. The isolation dampers have spring return actuators which fail closed on loss of electrical power. The isolation dampers are constructed, qualified, and tested in accordance with AMCA 500 (Reference 14) or ASME N509, Section 5.9.

The main control room envelope isolation dampers are seismically analyzed ANSI B31.1 butterfly valves that meet the performance and design requirements of ASME N509 for

Construction Class A, Leakage Class I bubble tight dampers. These dampers have safety-related operators that fail closed on loss of electrical power.

Tornado Protection Dampers

The tornado protection dampers are split-wing type and designed to close automatically. The tornado protection dampers are designed against the effect of 300 mph wind.

Shutoff and Balancing Dampers

Multiblade, two-position shutoff dampers are parallel-blade type. Multiblade, balancing dampers are opposed-blade type. Air handling unit and fan shutoff dampers are designed for maximum fan static pressure at shutoff flow and meet the performance requirements in accordance with ANSI/AMCA 500. The supplemental air filtration subsystem dampers are constructed, qualified, and tested in accordance with AMCA 500 or ASME N509, Section 5.9.

Combination Fire/Smoke Dampers

Combination fire/smoke dampers are provided at duct penetrations through fire barriers to maintain the fire resistance ratings of the barriers. The combination fire/smoke dampers meet the design, leakage testing, and installation requirements of UL-555S (Reference 25).

Ductwork and Accessories

Ductwork, duct supports, and accessories are constructed of galvanized steel. Ductwork subject to fan shutoff pressures is structurally designed to accommodate fan shutoff pressures. Ductwork, supports, and accessories meet the design and construction requirements of SMACNA High Pressure Duct Construction Standards (Reference 16) and SMACNA HVAC Duct Construction Standards – Metal and Flexible (Reference 17). The supplemental air filtration and main control room/technical support center HVAC subsystem's ductwork that maintains integrity of the main control room/technical support center pressure boundary during conditions of abnormal airborne radioactivity are designed in accordance with ASME N509, Section 5.10 to provide low leakage components necessary to maintain main control room/technical support center habitability.

9.4.1.2.3 System Operation

9.4.1.2.3.1 Main Control Room/Technical Support Center HVAC Subsystem

Normal Plant Operation

During normal plant operation, one of the two 100 percent capacity supply air handling units and return/exhaust air fans operates continuously. Outside makeup air supply to the supply air handling units is provided through an outside air intake duct. The outside airflow rate is automatically controlled to maintain the main control room and technical support center areas

at a sligh'ly positive pressure with respect to the surrounding areas and the outside environment.

The main control room/technical support center supply air handling units are sized to provide cooling air for personnel comfort, equipment cooling, and to maintain the main control room emergency habitability passive heat sink below its initial ambient air design temperature. The temperature of the air supplied by each air handling unit is controlled by temperature sensors located in the main control room return air duct to maintain the ambient air design temperature within its normal design temperature range by modulating the electric heat or chilled water cooling.

The outside air is continuously monitored by smoke monitors located at the outside air intake plenum and the return air is monitored for smoke upstream of the supply air handling units. The supply air to the main control room is continuously monitored for airborne radioactivity while the supplemental air filtration units remain in a standby operating mode.

The standby supply air handling unit and corresponding return/exhaust fans are started automatically if one of the following conditions shuts down the operating unit:

- Airflow rate of the operating fan is above or below predetermined setpoints.
- Return air temperature is above or below predetermined setpoints.
- Differential pressure between the main control room and the surrounding areas and outside environment is above or below predetermined setpoints.

Abnormal Plant Operation

If high gaseous radioactivity is detected in the main control room supply air duct and the main control room/technical support center HVAC subsystem is operable, both supplemental air filtration units automatically start to pressurize the main control room and technical support center areas to at least 1/8 inch wg using filtered makeup air. After the room is pressurized, one of the supplemental air filtration units is manually shut down. The normal outside air makeup duct and the main control room and technical support center toilet exhaust duct isolation dampers close. The main control room/technical support center supply air handling unit provides cooling with recirculation air to maintain the main control room passive heat sink below its initial ambient air design temperature and maintains the main control room and technical support center areas within their design temperatures. The supplemental air filtration subsystem pressurizes the combined volume of the main control room and technical support center concurrently with filtered outside air. A portion of the recirculation air from the main control room and technical support center is also filtered for cleanup of airborne radioactivity. The main control room/technical support center HVAC equipment and ductwork that form an extension of the main control room/technical support center pressure boundary limit the overall infiltration (negative operating pressure) and exfiltration (positive operating pressure) rates to those values shown in Table 9.4.1-1. Based on these values, the system is designed to maintain operator doses within allowable General Design Criteria (GDC) 19 limits.

If ac power is unavailable for more than a short period or if high particulate or iodine radioactivity is detected in the main control room supply air duct, which would lead to exceeding GDC 19 operator dose limits, the plant safety and monitoring system automatically isolates the main control room from the normal main control room/technical support center HVAC subsystem by closing the supply, return, and toilet exhaust duct isolation dampers. Main control room habitability is maintained by the main control room emergency habitability system which is discussed in Section 6.4.

If a high concentration of smoke is detected in the outside air intake, an alarm is initiated in the main control room and the main control room/technical support center HVAC subsystem is manually realigned to the recirculation mode by closing the outside air and toilet exhaust duct isolation dampers. The main control room and technical support center toilet exhaust fans are tripped upon closure of the isolation dampers. The main control room/technical support center areas are not pressurized when operating in the recirculation mode. The main control room/technical support center HVAC supply air subsystem continues to provide cooling, ventilation, and temperature control to maintain the emergency habitability passive heat sink below its initial ambient air design temperature and maintains the main control room and technical support center areas within their design temperatures.

In the event of a fire in the main control room or technical support center, in response to heat from the fire or upon receipt of a smoke signal from an area smoke detector, the combination fire/smoke dampers close automatically to isolate the fire area. The subsystem continues to provide ventilation/cooling to the unaffected area and maintains the unaffected areas at a slightly positive pressure. The main control room/technical support center HVAC subsystem can be manually realigned to the once-through ventilation mode to supply 100 percent outside air to the unaffected area. Realignment to the once-through ventilation mode minimizes the potential for migration of smoke or hot gas from the fire area to the unaffected area. Smoke and hot gases can be removed from the affected area by reopening the closed combination fire/smoke damper(s) during the once-through ventilation mode. In the once-through ventilation mode, the outside air intake damper to the air handling unit mixing plenum opens and the return air damper to the air handling unit closes to provide 100 percent outside air to the supply air handling unit. In this mode, the subsystem exhaust air isolation damper opens to exhaust the return air directly to the turbine building vent.

Power is supplied to the main control room/technical support center HVAC subsystem by the plant ac electrical system. In the event of a loss of the plant ac electrical system, the main control room/technical support center ventilation subsystem is automatically transferred to the onsite standby diesel generators.

9.4.1.2.3.2 Class 1E Electrical Room HVAC Subsystem

The Class 1E electrical room HVAC equipment that serves electrical division A and C equipment is described in this section. The operation of the Class 1E electrical room HVAC equipment that serves electrical division B and D is similar.

Normal Plant Operation

During normal plant operation, one of the redundant supply air handling units, return fans, and battery room exhaust fans operate continuously to provide room temperature control, to maintain the Class 1E electrical room emergency passive heat sink below its initial ambient air temperature, and to purge and prevent build-up of hydrogen gas concentration in the Class 1E Battery Rooms. The temperature of the air supplied by each air handling unit is controlled by temperature sensors located in the return air duct to maintain the room air temperature within the normal design range by modulating electric heating or chilled water cooling.

During normal plant operation, the exhaust airflow from the Class 1E battery rooms is vented directly to the turbine building vent to limit the concentration of hydrogen gas in the rooms to less than 2 percent by volume in accordance with the guidelines of Regulatory Guide 1.128.

The outside makeup air to the supply air handling units is provided through an outside air intake duct. The outside airflow rate is manually balanced during system startup to provide adequate makeup air for the battery room exhaust fans.

The standby supply air handling unit and the corresponding return/exhaust fans are started automatically if one of the following conditions occurs:

- Airflow rate of the operating fan is above or below predetermined set points
- Return air temperature is above or below predetermined setpoints

Abnormal Plant Operation

The operation of the Class 1E electrical room HVAC subsystem is not affected by the detection of airborne radioactivity in the main control room supply air duct of the main control room/technical support center HVAC subsystem. During a design basis accident (DBA), if the plant ac electrical system is unavailable, the Class 1E electrical room passive heat sink provides area temperature control. Refer to Section 6.4 for further details.

If a high concentration of smoke is detected in the outside air intake and an alarm is initiated in the main control room, the Class 1E electrical HVAC subsystem(s) can be manually aligned to the recirculation mode by closing the outside air intake damper to the air handling unit mixing plenum. This allows 100 percent room air to return to the supply air subsystem air handling unit. The subsystem continues to provide cooling, ventilation, and temperature control to maintain the areas served by the subsystem(s) within their design temperatures.

In the event of a fire in a Class 1E electrical room, in response to heat from the fire or upon receipt of a smoke signal from an area smoke detector, the combination fire/smoke dampers close automatically to isolate the fire area. The affected subsystem continues to provide ventilation/cooling to the remaining areas and maintains the remaining areas at a slightly positive pressure. Either or both subsystems can be manually realigned to the once-through ventilation mode to supply 100 percent outside air to the unaffected areas. Realignment to

the once-through ventilation mode minimizes the potential for migration of smoke and hot gases from a non-Class 1E electrical room or a Class 1E electrical room of one division into the Class 1E electrical room of another division. Smoke and hot gases can be removed from the affected areas by reopening the closed combination fire/smoke dampers during the once-through ventilation mode. In the once-through ventilation mode, the outside air intake damper to the air handling unit mixing plenum opens and the return air damper to the air handling unit closes to allow 100 percent outside air to the supply air handling unit. The subsystem exhaust air isolation damper also opens to exhaust room air directly to the turbine building vent.

The power supplies to the Class 1E electrical room HVAC subsystem are provided by the plant ac electrical system and the onsite standby diesel generators. In the event of a loss of the plant ac electrical system, the Class 1E electrical room HVAC subsystem is automatically transferred to the onsite standby diesel generators.

9.4.1.2.3.3 Passive Containment Cooling System Valve Room Heating and Ventilation Subsystem

Normal Plant Operation

The passive containment cooling system valve room ventilation fan exhausts room air to the outside environment to maintain room temperature within its normal design temperature range.

When heating is required, one of the two redundant electric unit heaters provides heating to maintain the passive containment cooling system valve room temperature above its minimum design temperature. The lead electric unit heater starts or stops when the room air temperature is above or below predetermined setpoints. The standby electric unit heater starts automatically if the room air temperature drops below a predetermined setpoint.

Abnormal Plant Operation

The power supplies to the passive containment cooling system valve room unit heaters are provided by the plant ac electrical system and the onsite standby diesel generators. In the event of a loss of the plant ac electrical system, the passive containment cooling system valve room unit heaters can be transferred to the onsite standby diesel generators by the operator.

The power supply to the passive containment cooling system valve room ventilation fan is provided by the plant ac electrical system. The room temperature is not expected to exceed 120°F, based on maximum ambient conditions and internal heat sources.

Following a fire in the passive containment cooling system valve room, smoke and hot gases can be removed from the area using portable exhaust fans and flexible ductwork.

9.4.1.3 Safety Evaluation

The nuclear island nonradioactive ventilation system has no safety-related function other than main control room envelope isolation and main control room supply air radioactivity

monitoring, and therefore requires no nuclear safety evaluation. Redundant safety-related isolation dampers are provided in the supply, return, and exhaust ducts penetrating the main control room. Therefore, there are no single active failures which would prevent isolation of the main control room envelope. Redundant main control room supply air radiation monitors are provided. The nuclear island nonradioactive ventilation system is designed so that safety-related systems, structures, or components are not damaged as a result of a seismic event.

9.4.1.4 Tests and Inspections

The nuclear island nonradioactive ventilation system is designed to permit periodic inspection of system components. Each component is inspected prior to installation. Components of each system are accessible for periodic inspection during normal plant operation. A system air balance test and adjustment to design conditions is conducted in the course of the plant preoperational test program. Airflow rates are measured and balanced in accordance with the guidelines of SMACNA HVAC systems, Testing, Adjusting and Balancing (Reference 19) except the supplemental air fultration units which are balanced in accordance with the guidelines of **ASME N510**. Instruments are calibrated during testing. Automatic controls are tested for actuation at the proper setpoints. Alarm functions are checked for operability.

The supplemental air filtration unit, HEPA filters, and charcoal adsorbers are field tested in accordance with **ASME N510** to verify that these components do not exceed a maximum allowable bypass leakage rate. Used samples of charcoal adsorbent are periodically tested to verify a minimum charcoal efficiency of 90 percent in accordance with Regulatory Guide 1.140, except that test procedures and test frequency are conducted in accordance with **ASME N510**.

The ductwork for the supplemental air filtration subsystem and portions of the main control room/technical support center HVAC subsystem that maintain the integrity of the main control room/technical support center pressure boundary during conditions of abnormal airborne radioactivity are tested for leak tightness in accordance with **ASME N510**, Section 6.

9.4.1.5 Instrumentation Applications

The nuclear island nonradioactive ventilation system is controlled by the plant control system except for the main control room isolation dampers, which are controlled by the protection and safety monitoring system. Refer to subsection 7.1.1 for a description of the plant control and plant safety and monitoring systems.

Temperature controllers are provided in the return air ducts to control the room air temperatures within the predetermined ranges. Temperature indication and alarms for the main control room return air, Class 1E electrical room return air, air handling unit supply air, supplemental filtration unit inlet air and charcoal adsorbers are provided to inform plant operators of abnormal temperature conditions.

Pressure differential indication and alarms are provided across each filter bank (except charcoal filters) to inform plant operators when filter changeout is necessary. Pressure

differential indication and alarms are provided to control the main control room and monitor the technical support center ambient room pressure differentials with respect to surrounding areas.

Radioactivity indication and alarms are provided to inform the main control room operators of gaseous, particulate, and iodine radioactivity concentrations in the main control room supply air duct. See Section 11.5 for a description of the main control room supply air duct radiation monitors and their actuation functions.

Smoke monitors are provided to detect smoke in the outside air intake duct to the main control room and the main control room and Class 1E electrical room return air ducts.

Airflow indication and alarms are provided to monitor operation of the supply and exhaust fans.

Relative humidity indication and alarms are provided to monitor the average relative humidity in the return air from the main control room/technical support center areas and the inlet air to the supplemental air filtration unit charcoal filters.

Status indication is provided to monitor fans, heaters and controlled dampers.

9.4.2 Annex/Auxiliary Buildings Nonradioactive HVAC System

The annex/auxiliary buildings nonradioactive HVAC system serves the nonradioactive personnel and equipment areas, electrical equipment rooms, clean corridors, and demineralized water deoxygenating room in the annex building, and the main steam isolation valve compartments, reactor trip switchgear rooms, and piping and electrical penetration areas in the auxiliary building.

9.4.2.1 Design Basis

9.4.2.1.1 Safety Design Basis

The annex/auxiliary buildings nonradioactive HVAC system serves no safety-related function and therefore has no nuclear safety design basis.

9.4.2.1.2 Power Generation Design Basis

The annex/auxiliary buildings nonradioactive HVAC system provides the following specific functions:

- Provides conditioned air to maintain acceptable temperatures for equipment and personnel working in the area
- Provides suitable environmental conditions for equipment in the main steam isolation valve (MSIV) compartments

- Prevents the buildup of hydrogen in non-Class 1E battery rooms to less than 2 percent hydrogen by volume

- Removes vitiated air from locker, toilet, and shower facilities

The system maintains the following room temperatures based on maximum and minimum normal outdoor air temperature conditions shown in Chapter 2, Table 2-1:

Room or Area	Temperatures (°F)
Normal Operation	
Offices, corridors (annex building)	73-78
Locker rooms, toilet rooms (annex building)	73-78
Central alarm station, security access area (annex building)	73-78
Non-Class 1E battery rooms (annex building)	60-90
Switchgear and battery charger rooms (annex building)	50-105
HVAC and mechanical equipment rooms (annex building)	50-105
MSIV compartments (auxiliary building)	50-105
Non-safety electrical penetration rooms (auxiliary building)	50-105
Reactor trip SWGR rooms (auxiliary building)	50-105
Valve/piping penetration room (auxiliary building)	50-105
Upset Conditions (Loss of Plant ac Electrical System)	
Switchgear rooms (annex building)	122 (maximum)
Battery charger rooms (annex building)	122 (maximum)

9.4.2.2 System Description

The annex/auxiliary buildings nonradioactive HVAC system consists of the following independent subsystems:

- General area HVAC subsystem
- Switchgear room HVAC subsystem
- Equipment room HVAC subsystem
- MSIV compartment HVAC subsystem
- Mechanical equipment areas HVAC subsystem
- Valve/Piping penetration room HVAC subsystem

The defense in depth portion of the system is shown in Figure 9.4.2-1.

9.4.2.2.1 General Description

9.4.2.2.1.1 General Area HVAC Subsystem

The general area HVAC subsystem serves personnel areas in the annex building outside the security area. The general area HVAC subsystem consists of two 50 percent capacity supply air handling units, a humidifier, a ducted supply and return air system, diffusers and registers, exhaust fan, automatic controls, and accessories. The air handling units are located on the low roof of the annex building at elevation 117'-6". The units discharge into a ducted supply distribution system which is routed through the building to provide air into the various rooms and areas served via registers. An electric heating coil is provided in the branch supply duct to the men's and women's change rooms for tempering the supply air.

A humidifier is provided in the system to provide a minimum space relative humidity of 35 percent.

Air from the men's and women's locker, toilet, and shower facilities in the annex building is exhausted directly to atmosphere by an exhaust fan. Room air from the remaining areas served is recirculated back to the air handling unit via a ceiling return plenum and a return duct system. Outside make-up air is added to the return air stream at the air handling units to replace air exhausted from toilets and showers in the area served.

9.4.2.2.1.2 Switchgear Room HVAC Subsystem

The switchgear room HVAC subsystem serves electrical switchgear rooms in the annex building. The switchgear room HVAC system consists of two 100 percent capacity air handling units, a ducted supply and return air system, and automatic controls and accessories.

The air handling units are located in the north air handling equipment room in the annex building at elevation 135'–3". The air handling units discharge into a common duct distribution system that is routed through the building to the rooms served. Air is returned to the air handling units from the rooms served by a return duct system.

9.4.2.2.1.3 Equipment Room HVAC Subsystem

The equipment room HVAC subsystem serves electrical and mechanical equipment rooms in the annex and auxiliary buildings. This subsystem also serves the security area offices and the central alarm station in the annex building. The equipment room HVAC system consists of two 100 percent capacity air handling units, two battery room exhaust fans, a toilet exhaust fan, a ducted supply and return air system, and automatic controls and accessories.

The air handling units are located in the north air handling equipment room in the annex building at elevation 135'-3". The air handling units discharge into a common duct distribution system that is routed through the buildings to the various areas served. Air is returned to the air handling units from the rooms served (except the battery rooms and rest rooms) by a return duct system. Electric reheat coils are provided in the ductwork to areas

requiring close temperature control such as the security area offices and the central alarm station. Hot water unit heaters are provided in the north air handling equipment room to maintain the area above 50°F.

A humidifier is provided in the branch duct to the security areas to provide a minimum space relative humidity of 35 percent.

Each non-Class 1E battery room is provided with an individual exhaust system to prevent the buildup of hydrogen gas in the room. Each exhaust system consists of an exhaust fan, an exhaust air duct and gravity back draft damper located in the fan discharge. Air supplied to the battery rooms by the air handling units is exhausted to atmosphere. Air from the rest rooms is exhausted to atmosphere by a separate exhaust fan.

9.4.2.2.1.4 MSIV Compartment HVAC Subsystem

The main steam isolation valve compartment HVAC subsystem serves the two main steam isolation valve compartments in the auxiliary building that contain the main steam and feedwater lines routed between the containment and the turbine building. Each compartment is provided with separate heating and cooling equipment.

The main steam isolation valve compartment HVAC subsystem consists of two 100 percent capacity supply air handling units with only low efficiency filters, ducted supply air distribution, automatic controls, and accessories for each main steam isolation valve compartment.

The air handling units are located directly within the space served. One unit in each compartment normally operates to maintain the temperature of the compartment. The air handling units can be connected to the standby power system, for investment protection, in the event of loss of the plant ac electrical system.

9.4.2.2.1.5 Mechanical Equipment Areas HVAC Subsystem

The mechanical equipment areas HVAC subsystem serves the demineralized water deoxygenating room, boric acid batching/transfer rooms, and air handling equipment rooms in the south end of the annex building.

The mechanical equipment areas HVAC subsystem consists of two 50 percent capacity air handling units, a ducted supply and return air system, automatic controls, and accessories.

The air handling units are located in the lower south air handling unit equipment room on elevation 135'-3" of the annex building.

9.4.2.2.1.6 Valve/Piping Penetration Room HVAC System

The valve/piping penetration room HVAC subsystem serves the valve/piping penetration room on elevation 100'-0" of the auxiliary building. The valve/piping penetration room HVAC

subsystem consists of two 100 percent capacity air handling units, a return air duct system, automatic controls and accessories.

The air handling units are located directly within the space served.

9.4.2.2.2 Component Description

The annex/auxiliary buildings HVAC system is comprised of the following major components. These components are located in buildings on the Seismic Category I Nuclear Island or in the annex building. The seismic design classification, safety classification and principal construction code for Class A, B, C, or D components are listed in Section 3.2. Tables 9.4.2-1 and 9.4.2-2 provide the design parameters for major defense-in-depth components of the system.

Air Handling Units

Air handling units with integral supply and return/exhaust fans are utilized in the equipment room HVAC subsystem, switchgear room HVAC subsystem, and the mechanical equipment areas HVAC subsystem. Each air handling unit consists of a return/exhaust fan, a return/exhaust air plenum, a low efficiency filter bank, a high efficiency filter bank, a hot water heating coil with integral face/bypass damper, a chilled water cooling coil, and a supply air fan.

Supply Air Handling Units

Supply air handling units are utilized in the general area HVAC subsystem, main steam isolation valve compartment HVAC subsystem, and the valve/piping penetration room HVAC subsystem. Each air handling unit consists of a low efficiency filter bank, a hot water heating coil, a chilled water cooling coil, and a supply fan. The general area HVAC subsystem air handling unit also includes a high efficiency filter bank and has face and bypass dampers on the heating coil.

Supply and Exhaust Air Fans

The supply and exhaust fans are centrifugal type, single width single inlet (SWSI) or double width double inlet (DWDI), with high efficiency wheels and backward inclined blades to produce non-overloading horsepower characteristics. Air handling unit fans that have little or no ductwork may utilize forward curved blades. The fans are designed and rated in accordance with ANSI/AMCA 210 (Reference 4), ANSI/AMCA 211 (Reference 5), and AMCA 300 (Reference 6).

Low Efficiency Filters and High Efficiency Filters

The low efficiency filters and high efficiency filters have a rated dust spot efficiency based on ASHRAE 52 (Reference 7). The filters meet UL 900 (Reference 8) Class I construction criteria.

Electric Heating Coils

The electric heating coils are multi-stage fin tubular type. The electric heating coils meet the requirements of UL 1096 (Reference 10).

Electric Unit Heaters

The electric unit heaters are single-stage or two-stage fin tubular type. The electric unit heaters are UL-listed and meet the requirements of UL 1025 (Reference 25) and the National Electric Code.

Shutoff, Control, Balancing, and Backdraft Dampers

Multiblade, two position shutoff dampers are parallel-blade type. Multiblade, control and balancing dampers are opposed-blade type. Backdraft dampers are provided to prevent backflow through shut down fans. Air handling unit and fan shutoff dampers are designed for maximum fan static pressure at shutoff flow. Dampers meet the performance requirements of ANSI/AMCA 500.

Fire Dampers

Fire dampers are provided at duct penetrations through fire barriers to maintain the fire resistance ratings of the barriers. The fire dampers meet the design and installation requirements of UL 555 (Reference 15).

Ductwork and Accessories

Ductwork, duct supports and accessories are constructed of galvanized steel. Ductwork subject to fan shutoff pressure is structurally designed for fan shutoff pressures. Ductwork, supports and accessories meet the design and construction requirements of SMACNA High Pressure Construction Standards (Reference 16) and SMACNA HVAC Duct Construction Standards - Metal and Flexible (Reference 17).

9.4.2.2.3 System Operation

9.4.2.2.3.1 General Area HVAC Subsystem

Normal Plant Operation

During normal plant operation, both supply air handling units and the toilet/shower exhaust fan operate continuously to maintain suitable temperatures in the areas served. The temperature of the air supplied by each handling units is controlled by individual temperature controls with their sensors located in the annex building main entrance. The temperature sensor sends a signal to a temperature controller which modulates the chilled water control valve and the face and bypass dampers across the supply air heating coil to maintain the area

within the design range. The switchover between cooling and heating modes is automatically controlled by the temperature controllers.

Supplemental heating is provided for the men's/women's change room areas by an electric reheat coil located in the supply air duct to the areas served. The reheat coil operates intermittently under the control of its temperature controller with sensor located in the women's change room, which modules the electric heating elements to maintain the space temperature in the change room areas within the design range.

The supply air is humidified by a common humidifier located in the ductwork downstream of the supply air handling units. A humidistat located in the main entrance of the annex building intermittently operates the humidifier to maintain a minimum space relative humidity of 35 percent in the area served.

The differential pressure drop across each supply unit filter bank is monitored, and individual alarms are actuated when any pressure drop rises to a predetermined level indicative of the need for filter replacement. To replace the filters on a supply unit, the affected supply fan is stopped and isolated from the duct system by means of isolation dampers. The toilet/shower exhaust fan is also stopped. During filter replacement, the system operates at approximately 50 percent capacity. This mode of operation will maintain a slight positive pressure in the building.

Abnormal Plant Operation

The general area HVAC subsystem is not required to operate during any abnormal plant condition.

9.4.2.2.3.2 Switchgear Room HVAC Subsystem

Normal Plant Operation

During normal plant operation, one air handling unit operates continuously to maintain the indoor temperatures in the two switchgear rooms. The temperature of the air supplied by the air handling unit is maintained at 62°F by a temperature controller based on outside ambient temperature conditions. When the outdoor air temperature is below 62°F, the temperature controller modulates the outside air, return air and exhaust air dampers of the air handling unit to mix return air and outside air in the proper proportion, and modulates the face and bypass dampers of the hot water heating coils to maintain a mixed air temperature of 62°F. A minimum amount of outside air is always provided for ventilation requirements. When the outdoor temperature is above 62°F, the outside air, return air and exhaust air dampers automatically reposition for minimum outside air and the temperature controller modulates the chilled water control valves to maintain the supply air at 62°F. The switchover between cooling and heating modes is automatically controlled by the supply air temperature controllers.

The differential pressure drop across each air handling unit filter bank is monitored and individual alarms are actuated when the pressure drop rises to a predetermined level indicative of the need for filter replacement. To replace the filters on an air handling unit, the unit is stopped and isolated from the duct system by means of isolation dampers. During filter replacement, the second air handling unit operates at full system capacity.

Abnormal Plant Operation

In the event of a loss of the plant ac electrical system, the air handling unit supply and return/exhaust fans are connected to the standby power system to provide ventilation cooling to the diesel bus switchgear. This cooling permits the switchgear to perform its defense in depth functions in support of standby power system operation. In this mode of operation, the switchgear rooms are cooled utilizing once-through ventilation using outdoor air. When in the once-through ventilation mode, the switchgear rooms will be maintained at or below 122°F. Equipment in these rooms that operate following a loss of the plant ac electrical system are designed for continuous operation at this temperature. To maintain the areas above freezing, the mixing dampers will modulate to maintain a supply air temperature of 62°F for outdoor temperatures below 62°F. For outdoor temperature above 62°F, the outside air, return air, and exhaust air dampers are positioned for a once-through flow.

9.4.2.2.3.3 Equipment Room HVAC Subsystem

Normal Plant Operation

During normal plant operation, one air handling unit and both battery room exhaust fans operate continuously to maintain the indoor temperatures in the equipment and security access areas served by the system.

The temperature of the air supplied by the air handling unit is maintained at 62°F by a temperature controller based on outside ambient temperature conditions. When the outdoor air temperature is below 62°F, the temperature controller modulates the outside air, return air and exhaust air dampers of the air handling unit to mix return air and outside air in the proper proportion, and modulates the face and bypass dampers of the hot water heating coils to maintain a mixed air temperature of 62°F. A minimum amount of outside air is always provided for ventilation requirements. When the outdoor air temperature is above 62°F, the outside air, return air and exhaust air dampers automatically reposition for minimum outside air and the temperature controller modulates the chilled water control valves to maintain the supply air at 62°F. The switchover between cooling and heating modes is automatically controlled by the supply air temperature controllers.

Electric reheat coils serving the security access areas are controlled by temperature controllers with sensors located in the areas served. The temperature sensor sends a signal to a temperature controller which modulates the electric heating elements to maintain the security access areas at their design temperatures. Hot water unit heaters operate intermittently to provide supplemental heating for the north air handling equipment room to maintain the area temperature above 50°F.

A humidistat located in the security access area intermittently operates the humidifier to maintain the security office area at a minimum space relative humidity of 35 percent.

The differential pressure drop across each air handling unit filter bank is monitored, and individual alarms are actuated when the pressure drop rises to a predetermined level indicative of the need for filter replacement. To replace the filters of an air handling unit, the unit is stopped and isolated from the duct system by means of isolation dampers. During filter replacement, the second air handling unit operates at full system capacity.

A temperature controller opens the outside air intake and starts and stops the elevator machine room exhaust fan as required to maintain room design temperature conditions. A local thermostat controls the electric unit heater.

Abnormal Plant Operation

In the event of a loss of the plant ac electrical system, the air handling unit supply and return/exhaust fans are connected to the standby power system to provide ventilation cooling to the dc switchgear and invertors. This cooling permits that equipment to perform its defense in depth functions. In this mode of operation, the rooms are cooled utilizing once-through ventilation using outdoor air. When in the once-through ventilation mode, the dc switchgear and invertor areas will be maintained at or below 122°F. Equipment in those areas that operate following a loss of the plant ac electrical system are designed for continuous operation at this temperature. To maintain the areas above freezing, the mixing dampers will modulate to maintain a supply air temperature of 62°F for outdoor temperatures below 62°F. For outdoor temperature above 62°F, the outside air, return air, and exhaust air dampers are positioned for a once-through flow.

9.4.2.2.3.4 MSIV Compartment HVAC Subsystem

Normal Plant Operation

During normal plant operation, one of the main steam isolation valve compartment air handling units in each compartment operates continuously in a recirculation mode to maintain the indoor temperature in the equipment area served by the system. A temperature controller modulates the chilled water and hot water control valves serving the operating unit to maintain the compartment temperature at or less than 105°F and above a minimum of 50°F. The switchover between cooling and heating modes is automatically controlled by the area temperature controller.

The differential pressure drop across each air handling unit filter bank is monitored and individual alarms are actuated when the pressure drop rises to a predetermined level indicative of the need for filter replacement. An air handling unit may be shutdown for filter replacement or other maintenance as required, with the other air handling unit in the same compartment operating to maintain the area temperature.

Abnormal Plant Operation

The main steam isolation valve compartment HVAC subsystem is not required to operate during abnormal plant conditions.

9.4.2.2.3.5 Mechanical Equipment Areas HVAC Subsystem

During normal plant operation, the air handling units operate continuously to maintain the indoor temperatures in the areas served. The temperature of the air supplied by each air handling unit is controlled by individual temperature controls with their sensors located in the upper south air handling equipment room. The temperature sensor sends a signal to a temperature controller which modulates the face and bypass dampers across the supply air heating coil and the chilled water control valve to maintain the mechanical equipment areas within the design temperature range. The switchover between cooling and heating modes is automatically controlled by the area temperature controller.

Differential pressure drop across each air handling unit filter bank is monitored, and individual alarms are actuated when pressure drop rises to a predetermined level indicative of the need for filter replacement. During filter replacement, the system operates at approximately 50 percent capacity.

Abnormal Plant Operation

The mechanical equipment areas HVAC subsystem is not required to operate during abnormal plant conditions.

9.4.2.2.3.6 Valve/Piping Penetration Room HVAC Subsystem

Normal Plant Operation

During normal plant operation, one air handling unit operates continuously in a recirculation mode to maintain the indoor temperature in the room. A temperature controller modulates the chilled water control valve and opens and closes the hot water control valve serving the operating unit to maintain the area temperature at or less than 105°F and above a minimum of 50°F. The switchover between cooling and heating modes is automatically controlled by the area temperature controller.

The differential pressure drop across each air handling unit filter bank is monitored, and individual alarms are actuated when the pressure drop rises to a predetermined level indicative of the need for filter replacement.

Abnormal Plant Operation

The valve/piping penetration room HVAC subsystem is not required to operate during abnormal plant conditions.

9.4.2.3 Safety Evaluation

The annex/auxiliary buildings nonradioactive HVAC system has no safety-related function and therefore requires no nuclear safety evaluation.

9.4.2.4 Tests and Inspections

The annex/auxiliary buildings nonradioactive HVAC system is designed to permit periodic inspection of system components. Each component is inspected prior to installation. Components of each system are accessible for periodic inspection during normal plant operation. A system air balance test and adjustments to design conditions are made during the plant preoperational test program. Air flow rates are measured and balanced in accordance with the guidelines of **SMACNA HVAC Systems - Testing, Adjusting, and Balancing (Reference 19)**. Instruments are calibrated during testing. Automatic controls are tested for actuation at the proper setpoints. Alarm functions are checked for operability.

9.4.2.5 Instrumentation Applications

The annex/auxiliary buildings nonradioactive HVAC system operation is controlled by the plant control system (PLS). Refer to subsection 7.1.1 for a discussion of the plant control system.

Temperature controllers and thermostats maintain the proper space temperatures. Supply air temperature is controlled by either sensing local room temperature or by sensing the supply air temperature in the air handling unit discharge duct, depending on the subsystem. Unit heaters are controlled by local thermostats. Temperature indication and alarms are accessible locally via the plant control system.

Temperature is indicated for each air handling unit supply air discharge duct, except for local recirculation units such as those in the main steam isolation valve compartment and valve/piping penetration room.

Operational status of fans is indicated in the main control room. The fans and air handling units can be placed into operation or shutdown from the main control room or locally.

Differential pressure indication is provided for each of the filters in the air handling units and an alarm for high pressure drop is provided for each air handling unit.

Airflow is indicated for the air handling unit and exhaust fan discharge ducts. Alarms are provided for low air flow rates in the fan discharge ducts.

An alarm is provided for smoke in discharge ducts from the air handling units.

Position indicating lights are provided for automatic dampers.

9.4.3 Radiologically Controlled Area Ventilation System

The radiologically controlled area ventilation system (VAS) serves the fuel handling area of the auxiliary building, and the radiologically controlled portions of the auxiliary and annex buildings, except for the health physics and hot machine shop areas which are provided with a separate ventilation system (VHS).

9.4.3.1 Design Basis

9.4.3.1.1 Safety Design Basis

The radiologically controlled area ventilation system serves no safety-related function and therefore has no nuclear safety design basis.

9.4.3.1.2 Power Generation Design Basis

The radiologically controlled area ventilation system provides the following functions:

- Provides ventilation to maintain the equipment rooms within their design temperature range
- Provides ventilation to maintain airborne radioactivity in the access areas at safe levels for plant personnel
- Maintains the overall airflow direction within the areas it serves from areas of lower potential airborne contamination to areas of higher potential contamination
- Maintains each building area at a slightly negative pressure to prevent the uncontrolled release of airborne radioactivity to the atmosphere or adjacent clean plant areas
- Automatically isolates selected building areas from the outside environment by closing the supply and exhaust duct isolation dampers and starting the containment air filtration system when high airborne radioactivity in the exhaust air duct or high ambient pressure differential is detected. See subsection 9.4.7 for a description of the containment air filtration system.

The system maintains the following room temperatures based on the maximum and minimum normal outside air temperature conditions shown in Chapter 2, Table 2-1:

Access and Equipment Areas	Temperature (°F)
Corridors and staging areas	50 - 104
HVAC equipment room	50 - 104
Spent fuel pool pump and heat exchanger rooms	50 - 104
Rail car bay/filter storage area	50 - 104
Gaseous radwaste equipment rooms	50 - 104

	Temperature (°F)
Degasifier column	50 - 130
RNS and CVS pump rooms (pumps not operating)	50 - 104
RNS and CVS pump rooms (pumps operating)	50 - 130
Containment purge exhaust filter rooms (fans not operating)	50 - 104
Containment purge exhaust filter rooms (fans operating)	50 - 130
Liquid radwaste tank rooms	50 - 130
Liquid radwaste pump rooms	50 - 104
Spent resin equipment rooms	50 - 130
Radioactive pipe chases and valve rooms	50 - 130

Occupied Areas

Fuel handling area	50 - 96
Radiation chemistry laboratory	73 - 78
Primary sample room	73 - 78
Security rooms	73 - 78

9.4.3.2 System Description

The radiologically controlled area ventilation system consists of the following subsystems:

- Auxiliary/annex building ventilation subsystem
- Fuel handling area ventilation subsystem
- Radiation chemistry laboratory ventilation subsystem

The defense in depth portion of the system is shown in Figure 9.4.3-1.

9.4.3.2.1 General Description

9.4.3.2.1.1 Auxiliary/Annex Building Ventilation Subsystem

The auxiliary/annex building ventilation subsystem serves radiologically controlled equipment, piping and valve rooms, adjacent access and staging areas, and the radiation chemistry laboratory ventilation subsystem. The auxiliary/annex building ventilation subsystem consists of two 50 percent capacity supply air handling units, a ducted supply and exhaust air system, isolation dampers, diffusers and registers, exhaust fans, automatic controls and accessories. The supply air handling units are located in the south air handling equipment room of the annex building at elevation 158′-0″. The units discharge into a ducted supply distribution system which is routed through the radiologically controlled areas of the auxiliary and annex buildings. The supply and exhaust ducts have isolation dampers that close to isolate the auxiliary and annex buildings from the outside environment when high airborne radioactivity is detected in the exhaust air duct. The supply and exhaust ducts are configured so that two building zones may be independently isolated. The annex building, adjacent auxiliary building staging, equipment areas, and rooms served by the radiation chemistry laboratory ventilation

subsystem are aligned to one zone. The other zone includes primarily radwaste equipment rooms, pipe chases, and adjacent access corridors located in the auxiliary building. A radiation monitor is located in the exhaust air duct from each zone.

The exhaust air fans are located in the upper radiologically controlled area ventilation system equipment room at elevation 145'-9" of the auxiliary building. The exhaust air ductwork is routed to minimize the spread of airborne contamination by directing the supply airflow from the low radiation access areas into the radioactive equipment and piping rooms with a greater potential for airborne radioactivity. Additionally, the exhaust air ductwork is connected to the radioactive waste drain system (WRS) sump to maintain the sump atmosphere at a negative air pressure to prevent the exfiltration of potentially contaminated air into the surrounding area. The exhaust air ductwork is connected to the radwaste effluent holdup tanks to prevent the potential buildup of airborne radioactivity or hydrogen gas within these tanks. The exhaust fans discharge the exhaust air into the plant vent for monitoring of offsite airborne radiological releases.

The ventilation airflow dilutes potential airborne contamination to maintain the concentration at the site boundary within **10 CFR 20 (Reference 21)** allowable effluent concentration limits and the internal room airborne concentrations within **10 CFR 20** occupational derived air concentration (DAC) limits during normal plant operation.

Unit coolers are located in the normal residual heat removal system (RNS) and chemical and volume control system (CVS) pump rooms because they have significant cooling loads on an intermittent basis when large equipment is operating. Each unit cooler is sized to accommodate 100 percent of its corresponding pump cooling load. The unit coolers are provided with chilled water from redundant trains of the central chilled water system (VWS) low capacity subsystem. The normal residual heat removal pump room unit coolers have two cooling coils per unit cooler so that chilled water supplied by either train A or train B alone can support concurrent operation of both normal residual heat removal system pumps. The two chemical and volume control makeup pump room unit coolers are connected to redundant trains of the chilled water system; however, operation of either the train A or train B unit cooler alone maintains the common makeup pump room temperature conditions and supports operation of either makeup pump.

Heating coils are located in the supply air ducts serving plant areas that require supplemental heating during periods of cold outside air temperature conditions. Electric unit heaters provide supplemental heating in the middle annulus.

The upper annulus is separated from the middle annulus area of the auxiliary building by a concrete floor section and flexible seals that connects the containment steel shell to the shield building. The annulus seal provides a passive barrier during normal plant operation or when the auxiliary building is isolated, preventing the exfiltration of unmonitored releases from the middle annulus to the environment.

9.4.3.2.1.2 Fuel Handling Area Ventilation Subsystem

The fuel handling area ventilation subsystem serves the fuel handling area, rail car bay/filter storage area, and the spent resin equipment and piping rooms. The fuel handling area ventilation subsystem consists of two 50 percent capacity supply air handing units, a ducted supply and exhaust air system, isolation dampers, diffusers, registers, exhaust fans, automatic controls and accessories. The ventilation airflow capacity is designed to maintain environmental conditions that support worker efficiency during fuel handling operations based on a maximum wetbulb globe temperature of 80°F (96°F drybulb) as defined by **EPRI NP-4453 (Reference 22).** The supply air handling units are located in the south air handling equipment room of the annex building at elevation 135'-3". The units discharge into a ducted supply distribution system which is routed to the fuel handling and rail car bay/filter storage areas of the auxiliary building. The supply and exhaust ducts are provided with isolation dampers that close when high airborne radioactivity in the exhaust air or high pressure differential with respect to the outside atmosphere is detected.

The exhaust air fans are located in the upper radiologically controlled area ventilation system equipment room at elevation 145'-9" of the auxiliary building. The supply and exhaust ductwork is arranged to exhaust the spent fuel pool plume and to provide directional airflow from the rail car bay/filter storage area into the spent resin equipment rooms. The exhaust fans discharge the exhaust air into the plant vent for monitoring of offsite airborne radiological releases.

The ventilation airflow dilutes potential airborne contamination to maintain the concentration at the site boundary within **10 CFR 20 (Reference 21)** allowable effluent concentration limits and the internal room airborne concentrations within **10 CFR 20** occupational derived air concentration (DAC) limits during normal plant operation.

9.4.3.2.1.3 Radiation Chemistry Laboratory Ventilation Subsystem

The radiation chemistry laboratory ventilation subsystem serves the radiation chemistry laboratory, primary sample room and auxiliary building security rooms. The radiation chemistry laboratory ventilation subsystem consists of two 100 percent capacity supply air handing units, a ducted supply air system, a humidifier, diffusers, registers, automatic controls and accessories. The supply air handling units are located in the south air handling equipment room of the annex building at elevation 158'-0". The supply air handling units are connected to the auxiliary/annex building ventilation subsystem supply air duct to utilize preconditioned and prefiltered outdoor air. Supplemental filtration is provided by the radiation chemistry laboratory ventilation subsystem for added cleanliness to support operation of sensitive equipment. A humidifier is located in the common supply air ductwork downstream of the supply air handling units. The radiation chemistry laboratory exhaust air is ducted to the auxiliary/annex building ventilation subsystem exhaust fans. The ventilation airflow dilutes room internal airborne radioactivity concentrations within 10 CFR 20 occupational derived air concentration (DAC) limits.

9.4.3.2.2 Component Description

The radiologically controlled area ventilation system is comprised of the following major components. These components are located in buildings on the Seismic Category I Nuclear Island and the Seismic Category II portion of the annex building. The seismic design classification, safety classification and principal construction code for Class A, B, C, or D components are listed in Section 3.2. Table 9.4.3-1 provides design parameters for major defense in depth components in the system.

Supply Air Handling Units

Each supply air handling unit consists of a low efficiency filter bank, a high efficiency filter bank, a hot water heating coil bank, a chilled water cooling coil bank, and a supply fan. The radiation chemistry laboratory supply air handling units only consist of a high efficiency filter bank, a hot water heating coil bank and a supply fan.

Supply and Exhaust Air Fans

The supply and exhaust air fans are centrifugal type, single width single inlet (SWSI) or double width double inlet (DWDI), with high efficiency wheels and backward inclined blades to produce non-overloading horsepower characteristics. The fans are designed and rated in accordance with ANSI/AMCA 210 (Reference 4), ANSI/AMCA 211 (Reference 5), and AMCA 300 (Reference 6).

Unit Coolers

Each unit cooler consist of a low efficiency filter bank, a chilled water cooling coil bank and a supply fan. The normal residual heat removal system pump room unit coolers have redundant cooling coil banks.

Low and High Efficiency Filters

The low efficiency filters and high efficiency filters have a rated dust spot efficiency based on ASHRAE 52 (Reference 7). The filters minimum average dust spot efficiencies for the defense in depth filters are shown in Table 9.4.3-1. The filters meet UL 900 (Reference 8) Class I construction criteria.

Electric Unit Heaters

The electric unit heaters are single-stage or two-stage fin tubular type. The electric unit heater are UL-listed and meet the requirements of UL-1025 (Reference 26) and National Electric Code.

Heating Coils

The heating coils are hot water, finned tubular type. The outside supply air heating coils are provided with integral face and bypass dampers to prevent freeze damage when modulating the heat output. Coils are performance rated in accordance with **ARI 410** (Reference 12).

Cooling Coils

The chilled water cooling coils are counterflow, finned tubular type. The cooling coils are designed and rated in accordance with ASHRAE 33 (Reference 11) and **ANSI/ARI** 410 (Reference 12).

Humidifier

The humidifier is a packaged electric steam generator type which converts water to steam and distributes it through the supply duct system. The humidifier is performance rated in accordance with **ARI 620 (Reference 13).**

Fire Dampers

Fire dampers are provided at duct penetrations through fire barriers to maintain the fire resistance rating of the barriers. The fire dampers meet the design, testing and installation requirements of **UL-555 (Reference 15).**

Shutoff and Balancing Dampers

Multiblade, two-position shutoff dampers are parallel-blade type. Multiblade, balancing dampers are opposed-blade type. Air handling unit and fan shutoff dampers are designed for maximum fan static pressure at shutoff flow and meet the performance requirements of **ANSI/AMCA 500.**

Isolation Dampers

Isolation dampers are bubble tight, single- or parallel-blade type. The isolation dampers have spring return actuators which fail closed on loss of electrical power or loss of air pressure. The isolation dampers are constructed, qualified and tested in accordance with **AMCA 500 (Reference 14).**

Ductwork and Accessories

Ductwork, duct supports and accessories are constructed of galvanized steel. Ductwork subject to fan shutoff pressure is structurally designed for fan shutoff pressures. Ductwork, supports and accessories meet the design and construction requirements **of SMACNA High Pressure Duct Construction Standards (Reference 16) and SMACNA HVAC Duct Construction Standard - Metal and Flexible (Reference 17).**

9.4.3.2.3 System Operation

9.4.3.2.3.1 Auxiliary/Annex Building Ventilation Subsystem

Normal Plant Operation

During normal plant operation, both supply air handling units and both exhaust fans operate continuously to ventilate the areas served on a once-through basis. The supply airflow rate is modulated to maintain the areas served at a slightly negative pressure differential with respect to the outside environment. The exhaust air is unfiltered and directed to the plant vent for discharge and monitoring of offsite gaseous releases.

The temperature of the supply air is controlled by temperature sensors located in the supply air ducts. When the supply air temperature is low, the face and bypass dampers across the supply air hot water heating coil are modulated to heat the supply air. Local thermostats operate supply duct heating coils and unit heaters to provide supplemental heating for building areas that have conductive heat loss to the outside environment during periods of cold outside temperature conditions. When the supply air temperature is high, the flow of chilled water is modulated to cool the supply air. The ventilation air is continuously monitored by smoke monitors located in the common ductwork downstream of the supply air handling units and upstream of the exhaust fans.

A supply air handling unit is automatically shut down if one of the following conditions is detected:

- Airflow rate of the fan is below a predetermined setpoint
- Supply air temperature is below a predetermined setpoint

Each chemical and volume control system makeup pump and normal residual heat removal system pump unit cooler automatically starts whenever the associated pump receives a start signal or a high room temperature signal.

The gaseous radwaste equipment areas have sufficient ventilation to remove hydrogen gas that may leak from the radwaste equipment into the equipment rooms to maintain the concentration of hydrogen below a safe level of about 1 percent. Instrumentation available to monitor hydrogen concentration is listed in Table 11.3-2.

Abnormal Plant Operation

If high airborne radioactivity is detected in the exhaust air from the auxiliary or annex buildings, the supply and exhaust duct isolation dampers automatically close to isolate the affected area from the outside environment. The containment air filtration system mitigates the exfiltration of unfiltered airborne radioactivity by maintaining the isolated zone at a slightly negative pressure with respect to the outside environment and adjacent unaffected plant areas. The auxiliary annex building ventilation subsystem remains in operation at a

reduced capacity if either the auxiliary or annex building is not isolated. A disruption in the normal ventilation airflow rate that causes a high pressure differential with respect to the outside environment causes the same automatic actuations. The containment air filtration system maintains a slightly negative pressure differential with respect to the outside environment until operation of the auxiliary/annex building ventilation subsystem is restored. Refer to subsection 9.4.7 for a description of the containment air filtration system.

If smoke is detected in the supply or exhaust air ducts, an alarm is initiated in the main control room. The auxiliary/annex building ventilation subsystem remains in operation unless plant operators determine that there is a need to manually shut down the subsystem. In the event of a fire occurring within the auxiliary or annex buildings, local fire dampers automatically isolate the HVAC ductwork penetrating the fire area when the local air temperature exceeds predetermined setpoints.

In the event of a loss of the plant ac electrical system, the unit coolers serving the normal residual heat removal, and chemical and volume control pump rooms can be powered by the onsite standby diesel generators.

9.4.3.2.3.2 Fuel Handling Area Ventilation Subsystem

Normal Plant Operation

During normal plant operation, both supply air handling units and both exhaust fans operate continuously to ventilate the areas served on a once-through basis. The supply airflow rate is modulated to maintain the areas served at a slightly negative pressure differential with respect to the outside environment. The exhaust air is unfiltered and directed to the plant vent for discharge and monitoring of offsite gaseous releases.

The temperature of the supply air is controlled by temperature sensors located in the supply air ducts. When the supply air temperature is low, the face and bypass dampers across the supply air hot water heating coil are modulated to heat the supply air. A local thermostat provides supplemental heating in the rail car bay/filter storage area by controlling a supply duct heating coil. When the supply air temperature is high, the flow of chilled water is modulated to cool the supply air. The ventilation air is continuously monitored by a smoke monitor located in the common ductwork downstream of the supply air handling units and by a monitor upstream of the exhaust fans.

A supply air handling unit is automatically shut down if one of the following conditions is detected:

- Airflow rate of the operating fan is below a predetermined setpoint

- Supply air temperature is below a predetermined setpoint

Abnormal Plant Operation

If high airborne radioactivity is detected in the exhaust air from the fuel handling area, the supply and exhaust duct isolation dampers automatically close to isolate the fuel handling area from the outside environment. The containment air filtration system mitigates exfiltration of unfiltered airborne radioactivity by maintaining the isolated zone at a slightly negative pressure differential with respect to the outside environment and adjacent unaffected plant areas. A disruption in the normal ventilation airflow rate that causes a high pressure differential with respect to the outside environment causes the same automatic actuations. The containment air filtration system maintains a slightly negative pressure differential with respect to the outside environment until operation of the fuel handling area ventilation subsystem is restored. Refer to subsection 9.4.7 for a description of the containment air filtration system.

If smoke is detected in the supply or exhaust air ducts, an alarm is initiated in the main control room. The fuel handling area subsystem remains in operation unless plant operators determine that there is a need to manually shut down the subsystem. In the event of a fire occurring within the fuel handling area, fire dampers automatically isolate the HVAC ductwork penetrating this fire area when the local air temperature exceeds predetermined setpoints.

9.4.3.2.3.3 Radiation Chemistry Laboratory Ventilation Subsystem

Normal Plant Operation

During normal plant operation, one of two supply air handling units operates continuously to ventilate the areas served on a once-through basis. The supply airflow rate is modulated to maintain the radiation chemistry laboratory at a slightly negative pressure differential with respect to the adjacent access corridor. The exhaust air is unfiltered and directed to the plant vent by the auxiliary/annex building ventilation subsystem for monitoring of gaseous offsite releases.

The temperature of the supply air is controlled by a temperature sensor located in the radiation chemistry laboratory. When the radiation chemistry laboratory room air temperature is low, hot water valves to the supply air hot water heating coils are opened to maintain the room temperature within its normal design temperature range. The security room and primary sample room temperature conditions will vary according to the demand for supplemental heat in the radiation chemistry laboratory. A humidifier maintains the relative humidity in the areas served above 35 percent for personnel comfort during periods of low outside humidity conditions. The exhaust air from the radiation chemistry laboratory and primary sample room is continuously monitored by a smoke monitor located in the common exhaust air ductwork.

The operating supply air handling unit is automatically shut down and the standby unit is started if the supply airflow rate is below a predetermined setpoint.

Abnormal Plant Operation

If high airborne radioactivity is detected in the exhaust air from the annex building (which includes the exhaust air from the areas served by the radiation chemistry laboratory ventilation subsystem), the annex building supply and exhaust air isolation dampers close and the radiation chemistry laboratory supply air handling unit fan is automatically shut down. The containment air filtration system provides filtered exhaust to maintain the isolated zone at a slightly negative pressure differential with respect to the outside environment and adjacent unaffected plant areas. Other abnormal conditions causing closure of the annex building isolation dampers also shut down the radiation chemistry laboratory supply air handling unit fans.

If smoke is detected in the common exhaust air duct from the radiation chemistry laboratory and primary sample room, an alarm is initiated in the main control room. The radiation chemistry laboratory remains in operation unless plant operators determine that there is a need to manually shut down the subsystem. In the event of a fire occurring within the areas served, the HVAC ductwork penetrating fire barriers close if the local air temperature exceeds predetermined setpoints.

9.4.3.3 Safety Evaluation

The radiologically controlled area ventilation system has no safety-related function and therefore requires no nuclear safety evaluation.

The isolation dampers for the fuel handling area, auxiliary and annex buildings are provided to help keep normal plant releases below **10 CFR 20** limits and **10 CFR 50 Appendix I** guidelines in the event of an abnormal release of airborne radioactivity.

9.4.3.4 Tests and Inspections

The radiologically controlled area ventilation system is designed to permit periodic inspection of system components. Each component is inspected prior to installation. Components of each system are accessible for periodic inspection during normal plant operation. A system air balance test and adjustment to design conditions is conducted in the course of the plant preoperational **test program**. Airflow rates are measured and balanced in accordance with the guidelines of **SMACNA HVAC Systems – Testing, Adjusting and Balancing (Reference 19).** Instruments are calibrated during testing. Automatic controls are tested for actuation at the proper setpoints. Alarm functions are checked for operability.

9.4.3.5 Instrumentation Applications

The radiologically controlled area ventilation system is controlled by the plant control system (PLS). Refer to subsection 7.1.1 for a discussion of the plant control system.

Temperature controllers maintain the proper air temperatures and provide indication and alarms. Main control room temperature indication is provided for the normal residual heat

removal system pump rooms, and the chemical and volume control makeup pump room to allow room temperatures to be verified during pump operation without requiring personnel access to these rooms.

Operational status of fans and dampers is indicated in the main control room. Fans and air handling units can be placed into operation or shut down from the main control room.

Differential pressure indication and high differential pressure alarms are provided for the filters in the air handling units and room coolers. Pressure differential indication and alarms are provided to control the negative pressure in the radiologically controlled areas of the auxiliary and annex buildings.

Radioactivity indication and alarms are provided to inform the main control room operators of gaseous radioactivity concentrations in the exhaust ducts from the fuel handling area and radiologically controlled areas of the auxiliary and annex buildings.

Flow indication and alarms are provided to alert plant operators to equipment malfunctions.

Smoke alarms are provided.

9.4.4 Balance-of-Plant-Interface

Not applicable to AP600.

9.4.5 Engineered Safety Features Ventilation System

Not applicable to AP600.

9.4.6 Containment Recirculation Cooling System

The containment recirculation cooling system controls building air temperature and humidity to provide a suitable environment for equipment operability during normal operation and shutdown.

9.4.6.1 Design Basis

9.4.6.1.1 Safety Design Basis

The containment recirculation cooling system serves no safety-related function and therefore has no nuclear safety design basis. The containment recirculation system is not required to mitigate the consequences of a design basis accident or loss of coolant accident.

9.4.6.1.2 Power Generation Design Basis

The containment recirculation cooling system provides the following functions:

- Controls the containment thermal environment to maintain an average bulk air temperature below 120°F during normal operation

- Controls the containment thermal environment to maintain an average bulk air temperature below 70°F and above 50°F for personnel accessibility and equipment operability during refueling and plant shutdown

- Maintains a homogeneous containment temperature and pressure during containment integrated leak rate testing (ILRT)

- Maintains a homogeneous containment temperature and pressure during a loss of the plant ac electrical system

- Controls the reactor cavity area average concrete temperature to less than 150°F with a maximum local area temperature of 200°F

9.4.6.2 System Description

The containment recirculation cooling system is shown in Figure 9.4.6-1.

9.4.6.2.1 General Description

The containment recirculation cooling system is comprised of two 100 percent capacity skid-mounted fan coil unit assemblies with a total of four 50 percent capacity fan coil units which connect to a common duct ring header and distribution system. Each fan coil unit contains a fan and associated cooling coil banks. The two fan coil unit assemblies are located on a platform at elevation 149′ 7′, approximately 180 degrees apart to provide a proper return air and mixing pattern through the ring header. The top of the ring header is approximately at elevation 176′-6″. The ring header and the fan assemblies are designed to provide uniform air and temperature distribution inside the containment, considering the possibility that one fan coil assembly may be out of service.

The cross-connections between the central chilled water system piping for containment cooling and hot water heating system piping for containment heating are located outside the containment. The water piping inside containment is common to both the central chilled water system and hot water heating system.

9.4.6.2.2 Component Description

The containment recirculation cooling system is comprised of the following components. These components are located in buildings on the Seismic Category I Nuclear Island. Table 9.4.6-1 provides design parameters for the major components of the system.

Containment Recirculation Fan Coil Units

Each fan coil unit assembly consists of two separate but physically connected 50 percent capacity fan coil units. Each fan coil unit assembly is comprised of a return air mixing plenum section with a physical barrier in the middle and three cooling coils attached to the sides of each plenum section. The cooling coils are counterflow finned tubular type. The cooling coils are rated and meet the performance requirements in accordance with ASHRAE/ARI 410 (Reference 12) and ASHRAE 33 (Reference 11).

ANSI

The recirculation fans are vane axial upblast type, direct driven with a high efficiency wheel, adjustable blades and an inlet bell. The fans are mounted vertically on top of the mixing air plenum section. The fans are designed with a non-overloading two-speed motor. The high speed is used during normal operation and the low speed is used during high ambient air density operating conditions such as the integrated leak rate testing. The fans are designed and rated in accordance with ANSI/AMCA 210 (Reference 4), ANSI/AMCA 211 (Reference 5), and ANSI/AMCA 300 (Reference 6). Fans are factory tested and rated for performance in accordance with ANSI/AMCA 210, ANSI/AMCA 211 and ANSI/AMCA 300.

Pressure Relief Damper

Pressure relief dampers relieve high pressure differential across the ductwork to protect the equipment or components from possible damage resulting from abnormal containment pressure transients. The pressure relief dampers are the weight loaded type.

Ductwork and Accessories

Ductwork, accessories, and duct supports are constructed of galvanized steel and structurally designed to accommodate fan shutoff pressures. The ductwork meets the design, testing and construction requirements according to SMACNA HVAC Duct Construction Standards - Metal and Flexible. (Reference 17)

Balancing and Backdraft Dampers

Multiblade, balancing dampers are opposite-blade type. Backdraft dampers are provided to prevent reverse flow through the standby fan while the redundant fan is operating. The backdraft dampers also allow start up of the standby fan while the redundant fan remains in operation. The balancing and backdraft dampers are designed for the same differential pressure as the duct section in which they are located and meet the performance requirements in according with ANSI/AMCA 211 and ANSI/AMCA500 (Reference 14).

Reference 5

9.4.6.2.3 System Operation

Normal Plant Operation

During normal plant operation, one of the two 50 percent capacity fans in each fan coil unit assembly draws air from the upper levels of the operating floor and delivers cooling air

through the ring duct and the secondary ductwork distribution system to the cubicles, compartments, and access areas above and below the operating floor. In addition, cooling air is delivered to the reactor cavity and reactor support areas to maintain appropriate local area and concrete temperatures. The normal supply temperature is 60°F in order to meet the environmental design requirements during various modes of operation.

As the supply air absorbs the heat released from various components inside containment, return air rises through vertical passages and openings due to its lower density to the upper containment level where it is again drawn into the fan coil units, cooled, dehumidified, and recirculated.

The standby fan coil units will be started automatically if one of the following events occurs:

- Air discharge flow rate from the operating fans decreases to a predetermined setpoint
- Air discharge temperature from the operating fan coil unit is above or below a predetermined setpoint
- Electrical and/or control power is lost

Fan coil unit supply fans are connected to 480V buses with backup power supply from the onsite standby diesel generators. Following a reactor shutdown when the outside air temperature is below a predetermined temperature, the fan coil units cooling water supply will be manually realigned by the operators from the central chilled water system to the hot water heating system. Refer to subsection 9.2.7 for further details.

Shutdown and Refueling Operation

During reactor shutdown, the system maintains the average bulk air temperature within appropriate limits for personnel access and maintenance. In addition, a steam generator maintenance space ventilation subsystem with a portable exhaust air filtration unit is available. The maintenance ventilation subsystem is designed to protect maintenance personnel and to control the spread of airborne contamination from the steam generator compartments to the other containment areas. The steam generator maintenance space ventilation subsystem consists of permanently installed exhaust ductwork with flexible hose connections in the vicinity of the steam generator channel heads. The other end of ductwork can be connected to a portable exhaust air filtration unit. During maintenance ventilation subsystem operation, flexible hoses can be connected to the exhaust ductwork to allow the portable exhaust air filtration unit to clean up and exhaust the compartment air to containment atmosphere, the supply air distribution system to each steam generator compartment is isolated by closing dampers. Local exhaust connections with flexible hoses can be connected to the maintenance ventilation subsystem ductwork or piping to be used for clean up of localized airborne contamination.

Integrated Leak Rate Testing Operation

During integrated leak rate testing, fan coil unit operation is controlled by the main control room operator. The fan coil unit vaneaxial fans are operated at low speed to prevent the fan motors from exceeding their rated horsepower while equalizing the containment air temperature and pressure which could affect the containment integrated leak rate testing results. The recirculation fan coil units draw air from the upper levels of the operating floor and deliver airflow through the ring header and its distribution ductwork that is connected to equipment compartments, cubicles, and access areas above and below the operating floor.

Abnormal Plant Operation

The containment recirculation system is not required to mitigate the consequences of a design basis fuel handling accident or a loss of coolant accident. If the system is available following abnormal operational transients, it can be operated at reduced speed for post-event recovery operations to lower the containment temperature and pressure.

The power supplies to the containment recirculation cooling system are provided by the plant ac electrical system and the onsite standby diesel generators. In the event of a loss of the plant ac electrical system, the containment recirculation components can be connected to the onsite standby diesel generators in accordance with the optional electrical load sequencing.

9.4.6.3 Safety Evaluation

The containment recirculation cooling system has no safety function and therefore requires no nuclear safety evaluation. The containment recirculation cooling system is designed to preclude damage to safety-related systems, structures, or components as a result of a seismic event.

9.4.6.4 Tests and Inspections

The containment recirculation cooling system is designed to permit periodic inspection of system components. Each component is inspected prior to installation. Components of the system are accessible for periodic inspection. A system air balance test and adjustment to design conditions is conducted in the course of the plant preoperational test program. Instruments are calibrated during testing. Automatic controls are tested for actuation at the proper setpoints. Alarm functions are checked for operability.

The system airflows are balanced in accordance with **SMACNA HVAC Systems – Testing, Adjusting and Balancing (Reference 19).**

9.4.6.5 Instrumentation Application

The containment recirculation cooling system is controlled by the plant control system. Process indication and alarm signals are locally accessible through the plant control system. Refer to subsection 7.1.1 for a description of the plant control system.

Temperature controllers are provided in the ring headers of the corresponding containment recirculation fan coil unit which provide an input signal to modulate the central chilled water system supply valves to the cooling coils. The containment volumetric average high and low temperature are monitored and alarmed when the temperature is out of the normal operating range. The ambient temperature in a specific equipment compartment or areas of the containment are monitored and alarmed.

The discharge flowrate from each containment recirculation fan unit is monitored and low flow condition is alarmed to alert the operator for a manual start of the spare fan unit. Flow to the reactor cavity is also monitored and low flow condition is alarmed.

9.4.7 Containment Air Filtration System

The containment air filtration system (VFS) serves the containment, the fuel handling area and the other radiologically controlled areas of the auxiliary and annex buildings, except for the hot machine shop and health physics areas which are served by a separate ventilation system.

9.4.7.1 Design Basis

9.4.7.1.1 Safety Design Basis

The containment air filtration system serves no safety-related function, other than containment isolation, and therefore has no nuclear safety design basis except for containment isolation. See subsection 6.2.3 for a description of the containment isolation system.

9.4.7.1.2 Power Generation Design Basis

Containment Area

The containment air filtration system provides the following functions:

- Provides intermittent flow of outdoor air to purge the containment atmosphere of airborne radioactivity during normal plant operation, and continuous flow during hot or cold plant shutdown conditions to provide an acceptable airborne radioactivity level prior to personnel access

- Provides intermittent venting of air into and out of the containment to maintain the containment pressure within its design pressure range during normal plant operation

- Directs the exhaust air from the containment atmosphere to the plant vent for monitoring, and provides filtration to limit the release of airborne radioactivity at the site boundary within acceptable levels

- Monitors gaseous, particulate and iodine concentration levels discharged to the environment through the plant vent

The system conditions and filters outside air supplied to the containment for compatibility with personnel access during maintenance and refueling operations. Based on the maximum and minimum outside air normal temperature conditions shown in Chapter 2, Table 2-1, the system supplies air between 50 and 70°F. The air is distributed and conditioned within the containment by the containment recirculation system (subsection 9.4.6).

Radiologically Controlled Areas Outside Containment

The containment air filtration system provides filtration of exhaust air from the fuel handling area, auxiliary, or annex buildings to maintain these areas at a slightly negative pressure with respect to the adjacent areas when the radiologically controlled area ventilation system detects high airborne radioactivity or pressure differential. Refer to subsection 9.4.3 for a description of the radiologically controlled area ventilation system.

9.4.7.2 System Description

The containment air filtration system is shown in Figure 9.4.7-1.

9.4.7.2.1 General Description

The containment air filtration system consists of two 100 percent capacity supply air handling units, a ducted supply and exhaust air system with containment isolation valves and piping, registers, exhaust fans, filtration units, automatic controls and accessories. The supply air handling units are located in the south air handling equipment room of the annex building at elevation 158'-0". The supply air handling units are connected to a common air intake plenum, located at the south end of the fan room, and discharge the supply air towards the east containment recirculation cooling system (VCS) recirculation unit to distribute the purge air within the containment. Refer to subsection 9.4.6 for a description of the containment recirculation cooling system.

The exhaust air filtration units are located within the radiologically controlled area of the annex building at elevation 135'-3" and 146'-3". The filtration units are connected to a ducted system with isolation dampers to provide HEPA filtration and charcoal adsorption of exhaust air from the containment, fuel handling area, auxiliary and annex buildings. A gaseous radiation monitor is located downstream of the exhaust air filtration units in the common ductwork to provide an alarm if abnormal gaseous releases are detected. The plant vent exhaust flow is monitored for gaseous, particulate and iodine releases to the environment. During containment purge, the exhaust air filtration units satisfy 10 CFR 50 Appendix I guidelines (Reference 20) for offsite releases and meets 10 CFR 20 (Reference 21) allowable effluent concentration limits when combined with gaseous releases from other sources. During conditions of abnormal airborne radioactivity in the fuel handling area, auxiliary and/or annex buildings, the filtration units provide filtered exhaust to minimize unfiltered offsite releases.

The size of the containment air filtration system supply and exhaust air lines that penetrate the containment pressure boundary is 36 inches in diameter. Each penetration includes an

inboard and outboard branch connection with 16 inch diameter containment isolation valves that are opened when the containment air filtration system is connected to the containment. The ends of the 36 inch containment penetrations are capped for possible future addition of a high volume purge system. In the event of a loss-of-coolant accident (LOCA) while the containment air filtration system is aligned to containment, there will not be a significant release of radioactivity during closure of the 16 inch diameter supply and exhaust valves. The maximum time for valve closure is 5 seconds, based on **Branch Technical Position CSB 6-4 to Standard Review Plan 6.2.4 (Reference 23).**

The exhaust air containment penetrations also serve as a connection for the containment integrated leak rate test system to pressurize and depressurize the containment during integrated leak rate testing. Otherwise, the containment air filtration exhaust subsystem is not involved with the containment integrated leak rate test and is isolated from the containment during this time period.

9.4.7.2.2 Component Description

The containment air filtration system is comprised of the following components. These components are located in buildings on the Seismic Category I Nuclear Island and the Seismic Category II portion of the annex building. The seismic design classification, safety classification and principal construction code for Class A, B, C, or D components are listed in Section 3.2. Table 9.4.7-1 provides design parameters for the major components of the system.

Supply Air Handling Units

Each supply air handling unit consists of a low efficiency filter bank, a high efficiency filter bank, a hot water heating coil bank, a chilled water cooling coil bank and a supply fan.

Exhaust Air Filtration Units

Each exhaust air filtration unit consists of an electric heater, an upstream high efficiency filter bank, a HEPA filter bank, a charcoal adsorber with a downstream postfilter bank, and an exhaust fan. The filtration unit configurations, including housing, internal components, ductwork, dampers, fans, and controls, are designed and constructed to meet the performance requirements of **ASME N509** to satisfy the guidelines of Regulatory Guide 1.140. Refer to **Table 9.4-1** for a summary of the containment air filtration system filtration efficiencies and **Appendix 1A** for a comparison of the containment air filtration system exhaust air filtration units with Regulatory Guide 1.140.

Isolation Dampers

Isolation dampers are bubble tight, single-blade or parallel-blade type. The isolation dampers have spring return actuators which fail closed on loss of electrical power or instrument air. The design and construction of the isolation dampers is in accordance with **AMCA 500 or ASME N509 (References 14 and 2).**

Pressure Differential Control Dampers

Pressure differential control dampers utilize opposed-blade type construction and meet the performance requirements of ANSI/AMCA 500 or ASME N509, Section 5.9.

Supply and Exhaust Fans

The supply and exhaust air fans are centrifugal type, single width single inlet (SWSI), with high efficiency wheels and backward inclined blades to produce non-overloading horsepower characteristics. Fan performance is rated in accordance with ANSI/AMCA 210 (Reference 4), ANSI/AMCA 211 (Reference 5) and AMCA 300 (Reference 6).

Containment Penetrations

The containment penetrations include containment isolation valves, interconnecting piping, and vent and test connections with manual test valves. The containment isolation components that maintain the integrity of the containment pressure boundary after a LOCA are classified as Safety Class B and seismic Category I. Seismic Category I debris screens are mounted on Safety Class C, seismic Category I pipe to prevent entrainment of debris through the supply and exhaust openings that may prevent tight valve shutoff. The screens are designed to withstand post-LOCA pressures.

The containment isolation valves inside and outside the containment have air operators. The valves are designed to fail closed in the event of loss of electrical power or air pressure. The valves are controlled by the protection and plant safety monitoring system as discussed in subsection 7.1.1. The valves shut tight against the containment pressure following a design basis accident.

Ductwork and Accessories

Ductwork, duct supports and accessories are constructed of galvanized steel. Ductwork subject to fan shutoff pressures is structurally designed to accommodate fan shutoff pressures. The system air ductwork inside containment meets seismic Category II criteria so that it will not fall and damage any safety-related equipment following a safe shutdown earthquake. Ductwork, supports and accessories meet the design and construction requirements of SMACNA High Pressure Duct Construction Standards (Reference 16) and SMACNA HVAC Duct Construction Standard - Metal and Flexible (Reference 17). The exhaust air ductwork and supports meet the design and construction requirements of ASME N509, Section 5.10. (Reference 2).

Shutoff and Balancing Dampers

Multiblade, two-position shutoff dampers are parallel-blade type. Multiblade, balancing dampers are opposed-blade type. Air handling unit and fan shutoff dampers are designed for maximum fan static pressure at shutoff flow and meet the performance requirements of

ANSI/AMCA 500. The containment exhaust air dampers meet the design and construction criteria of ASME N509, Section 5.9.

Fire Dampers

Fire dampers are provided where the ductwork penetrates a fire barrier to maintain the fire resistance rating of the fire barriers. The fire dampers meet the design and installation requirements of UL-555 (Reference 15).

Low Efficiency Filters, High Efficiency Filters, and Postfilters

Low and high efficiency filters are rated in accordance with ASHRAE Standard 52 (Reference 7). The minimum average dust spot efficiencies of the filters are shown in Table 9.4.7-1. High efficiency filter performance upstream of HEPA filter banks meet the design requirements of ASME N509, Section 5.3. Postfilters located downstream of the charcoal adsorbers have a minimum DOP efficiency of 95 percent. The filters meet UL 900 Class I construction criteria (Reference 8).

HEPA Filters

HEPA filters are constructed, qualified, and tested in accordance with ASME N509, Section 5.1 (Reference 2). Each HEPA filter cell is individually shop tested to verify an efficiency of at least 99.97 percent using a monodisperse 0.3-μm aerosol.

Charcoal Adsorbers

Charcoal adsorbers and adsorbent media are constructed, qualified and tested in accordance with ASME N509, Section 5.2 (Reference 2). Each charcoal adsorber is a single assembly with welded construction and 4-inch deep Type III rechargeable adsorber cell.

Electric Heating Coils

The electric heating coils are fin tubular type. The electric heating coils meet the requirements of UL-1096 (Reference 10). The coils are constructed, qualified and tested in accordance with ASME N509, Section 5.5.

Heating Coils

The heating coils are hot water, finned tubular type. The heating coils are provided with integral face and bypass dampers to prevent freeze damage when modulating the heat output. Coils are performance rated in accordance with ARI 410 (Reference 12).

Cooling Coils

The chilled water cooling coils are counterflow, finned tubular type. The cooling coils are designed and rated in accordance with ASHRAE 33 (Reference 11) and ANSI/ARI 410 (Reference 12).

9.4.7.2.3 System Operation

Normal Plant Operation

During normal plant operation, the containment air filtration system operates on a periodic basis to purge the containment atmosphere as determined by the main control room operator to reduce airborne radioactivity or to maintain the containment pressure within its normal operating range. One supply air handling unit provides outdoor air that is filtered, cooled, or heated to the containment areas above the operating floor. The airflow rate is controlled to a constant value by modulating the supply fan inlet vanes to compensate for filter loading or changes in containment pressure. The cooling coils are supplied with chilled water from the central chilled water system (VWS) to cool and/or dehumidify the outside supply air. The heating coils are supplied with hot water by the hot water heating system (VYS). Refer to subsections 9.2.7 and 9.2.10 for descriptions of the central chilled water and hot water heating systems.

The temperature of the air supplied by each air handling unit is controlled by temperature sensors located in the supply air duct. When the supply air temperature is low, the face and bypass dampers across the supply air heating coil are modulated to heat the supply air. When the supply air temperature is high, the flow of chilled water is modulated to cool the supply air. The supply air is continuously monitored by a smoke monitor located in the common ductwork downstream of the supply air handling units.

The airflow rate through the exhaust filters is controlled to a constant value when the exhaust filters are connected to the containment by modulating the exhaust fan inlet vanes to compensate for filter loading or changes in system resistance caused by single or parallel fan operation, or changes in containment pressure. The exhaust lines from the containment include a pair of isolation dampers arranged in parallel to restrict the airflow to maintain the exhaust filter plenums at a negative air pressure when the containment is positively pressurized. Based on predetermined setpoints, the operators select the appropriate damper to open. This prevents exfiltration of unfiltered air from bypassing the filters.

The filtered exhaust air from the containment is discharged to the atmosphere through the plant vent by the exhaust fan. The gaseous effluents in the plant vent are monitored for radioactivity levels before the air is discharged to the environment. Refer to Section 11.5 for a description of the plant vent radiation monitor.

During single subsystem operation, the standby supply and exhaust air units can be started manually by the operator if the operating train fails.

Prior to and during plant shutdown, one or both trains of the containment air filtration system can be operated to remove airborne radioactivity prior to personnel access. During cold ambient conditions, the supply air is heated by the hot water heating system. The exhaust filter unit electric heater controls the relative humidity of the exhaust air entering the charcoal adsorber below 70 percent.

When both trains are operated concurrently, the containment air filtration system provides a maximum airflow rate equivalent to approximately 0.25 air changes per hour. This airflow rate provides adequate ventilation for personnel inside containment during refueling operations.

Abnormal Plant Operation

The containment isolation valves in the supply and exhaust air lines automatically close when containment isolation signals are initiated by the protection and safety monitoring system or diverse actuation system. Refer to subsections 6.2.3, 7.7.1.11 and 7.3 for discussions of the containment isolation system, diverse actuation system and protection and safety monitoring system.

Main control room operators can connect the containment air filtration system to the containment for cleanup of potential airborne radioactivity while the containment remains isolated if a containment high radiation signal is not present.

If high airborne radioactivity or pressure differential is detected in the fuel handling area, the auxiliary and/or annex buildings, the radiologically controlled area ventilation system isolates the affected area from the outside environment and starts the containment air filtration exhaust subsystem to maintain a slight negative pressure differential in the isolated zone(s). The airflow rate through the exhaust fan is maintained at a constant value by modulating the fan inlet vanes. An outside air makeup damper modulates to control the exhaust airflow rate through the HEPA and charcoal filters to maintain the isolated area(s) at a slightly negative pressure. The containment air filtration system is automatically isolated from the containment, if purging is in progress and the standby exhaust filter train does not start. If both exhaust trains are connected to the containment, one exhaust train is automatically isolated from the containment and realigned to the isolated area(s). The exhaust subsystem can be manually connected to the onsite diesel generators if there is a loss of ac power.

The containment air filtration system is not required to mitigate the consequences of a design basis fuel handling accident or a loss of coolant accident. If the exhaust air filtration units are operational and ac power is available, they may be used to support post-event recovery operations. The plant vent high range radiation detectors monitor effuents discharged into the plant vent.

If smoke is detected in the common supply air duct, an alarm is initiated. The system remains in operation unless plant operators determine that there is a need to manually shut down the supply air handling units. Fire dampers are provided for HVAC ductwork that passes through a fire barrier in order to isolate each fire zone in the event of a fire.

9.4.7.3 Safety Evaluation

The containment air filtration system has no safety-related function, other than containment isolation, and therefore requires no nuclear safety evaluation. The containment isolation function is evaluated in subsection 6.2.3.

The failure of equipment and ductwork will not reduce the functioning of safety-related systems, structures or components that are required to close to maintain containment isolation integrity after a design basis accident. Ductwork that is located inside containment whose failure may affect any safety-related equipment is designed to seismic Category II requirements.

9.4.7.4 Tests and Inspections

The radiologically controlled area ventilation system is designed to permit periodic inspection of system components. Each component is inspected prior to installation. Components of each system are accessible for periodic inspection during normal plant operation. The exhaust subsystem is balanced to provide airflow in accordance with the guidelines of **ASME N510** **(Reference 3)**. The supply air subsystem airflow rate is measured and balanced in accordance with the guidelines of **SMACNA HVAC Systems – Testing, Adjusting and Balancing** **(Reference 19)**. Instruments are calibrated during testing. Automatic controls are tested for actuation at the proper setpoints. Alarm functions are checked for operability.

The tests and inspections of the containment isolation valves associated with the containment air filtration system are discussed in subsections 6.2.3 and 6.2.5.

HEPA filters and charcoal adsorbers are field tested in accordance with **ASME N510** **(Reference 3)** to verify that these components do not exceed a maximum allowable bypass leakage. Samples of charcoal adsorbent are periodically tested to verify a minimum charcoal efficiency of 90 percent in accordance with Regulatory Guide 1.140 except that test procedures and test frequency are conducted in accordance with **ASME N510**.

The exhaust ductwork and filter plenums are field tested for leak tightness in accordance with **ASME N510, Section 6**.

9.4.7.5 Instrumentation Application

The containment air filtration system operation is controlled by the plant control system (PLS) except for the containment isolation valves which are controlled by the protection and safety monitoring system (PMS) and diverse actuation system (DAS). Refer to subsection 7.1.1 for a discussion of the plant control system, protection and safety monitoring system, and diverse actuation system. Automatic protection and safety monitoring system actuations of these valves are discussed in Section 7.3; the diverse actuation system signals are discussed in subsection 7.7.1.11.

Temperature controllers maintain the proper supply air temperature. Temperature indication and alarms are provided to inform operators of abnormal temperature conditions for supply air and charcoal adsorbers.

Pressure differential indication and alarms are provided to inform plant operators when air filter changeout is necessary.

Status indication and alarms are provided to monitor operation of fans, controlled dampers and controlled valves. Fans can be placed into operation or shut down from the main control room.

Relative humidity indication and an alarm are provided to monitor the relative humidity of the air upstream of the containment air filtration exhaust air charcoal adsorbers.

Radioactivity indication and alarms are provided to inform the main control room operators of the concentration of gaseous radioactivity in the containment air filtration system exhaust duct and gaseous, particulate and iodine concentrations in the plant vent. See Section 11.5 for a description of these radiation monitors.

Flow indication and alarms are provided to alert plant operators to equipment malfunctions.

9.4.8 Radwaste Building HVAC System

The radwaste building HVAC system serves the radwaste building which includes the clean electrical/mechanical equipment room and the potentially contaminated HVAC equipment room, the packaged waste storage room, the waste accumulation room, and the mobile systems facility.

9.4.8.1 Design Basis

9.4.8.1.1 Safety Design Basis

The radwaste building HVAC system serves no safety-related function and therefore has no nuclear safety design basis.

9.4.8.1.2 Power Generation Design Basis

The radwaste building HVAC system provides the following functions:

- Provide conditioned air to work areas to maintain acceptable temperatures for equipment and personnel working in the areas
- Provide confidence that air movement is from clean to potentially contaminated areas to minimize the spread of airborne contaminants
- Collect the vented discharges from potentially contaminated equipment

- Provide for radiation monitoring of exhaust air prior to release to the environment
- Maintain the radwaste building at a negative pressure with respect to ambient to prevent unmonitored releases from the radwaste building

The system maintains the following temperature based on maximum and minimum normal outdoor air temperature conditions shown below in Chapter 2, Table 2-1:

Room or Area	Temperatures (°F)
Processing areas and storage areas	50-105
Mechanical and electrical equipment rooms	50-105

9.4.8.2 System Description

9.4.8.2.1 General Description

The radwaste building HVAC system is a once-through ventilation system that consists of two integrated subsystems: the radwaste building supply air system and the radwaste building exhaust air system. The systems operate in conjunction with each other to maintain temperatures in the areas served while controlling air flow paths and building negative pressure.

The supply air system consists of two 50 percent capacity air handling units with a ducted air distribution system, automatic controls, and accessories. The air handling units are located in an electrical/mechanical equipment room on elevation 100′-0″ on the southwest side of the building. Each unit draws 100 percent outdoor air through individual louvered outdoor air intakes. The two units discharge into a common duct distribution system which is routed through the building. Branch connections from the main duct supply air through registers into the various areas served.

The exhaust air system consists of two 50 percent capacity exhaust centrifugal fans, an exhaust air duct collection system, and automatic controls and accessories. The airflow rates are balanced to maintain a constant exhaust design air flow through the fans. The exhaust fans are located in an equipment room on Elevation 100′-0″ in the northwest corner of the radwaste building.

The exhaust fans discharge to a common duct which is routed to the plant vent. A radiation monitor records activity in the discharge duct and activates an alarm in the main control room when excess activity in the effluent discharge is detected. The radiation monitoring system is described in Section 11.5.

The exhaust air collection duct inside the radwaste building exhausts air from areas and rooms where low levels of airborne contamination may be present. Exhaust connection points are provided to allow the direct exhaust of equipment located on the mobile systems. Where potential for significant airborne release exists, mobile systems include HEPA filtration. Back

draft dampers are provided at each mobile system connection to prevent blowback through the equipment in the event of exhaust system trip.

9.4.8.2.2 Component Description

The radwaste building HVAC system is comprised of the following major components. These components are located in the non-seismic radwaste building.

Supply Air Handling Units

Each air handling unit consists of a plenum section, a low efficiency filter bank, a high efficiency filter bank, a hot water heating coil, a chilled water cooling coil bank, and a supply fan with automatic inlet vanes.

Supply and Exhaust Air Fans

The supply and exhaust fans are centrifugal type, single width single inlet (SWSI) or double width double inlet (DWDI), with high efficiency wheels and backward inclined blades to produce non-overloading horsepower characteristics. The fans are designed and rated in accordance with **ANSI/AMCA 210 (Reference 4)**, **ANSI/AMCA 211 (Reference 5)**, and **AMCA 300 (Reference 6)**.

ANSI/

Low Efficiency Filters and High Efficiency Filters

The low efficiency filters and high efficiency filters have a rated dust spot efficiency based on **ASHRAE 52 (Reference 7)**. The filters meet **UL 900 (Reference 8)** Class I construction criteria.

Hot Water Unit Heaters

The hot water unit heaters consist of a fan section and hot water heating coil section factory assembled as a complete and integral unit. The unit heaters are either horizontal discharge or vertical downblast type. The coil ratings are in accordance with **ANSI/ARI 410 (Reference 12)**.

Cooling Coils

The chilled water cooling coils are counterflow, finned tubular type. The cooling coils are designed and rated in accordance with **ASHRAE 33 (Reference 11)** and **ANSI/ARI 410 (Reference 12)**.

Heating Coils

The hot water heating coils are counterflow, finned tubular type. The heating coils are designed and rated in accordance with **ASHRAE 33 (Reference 11)** and **ANSI/ARI 410 (Reference 12)**.

Shutoff, Control, and Balancing Dampers

Multiblade, two position shutoff dampers are parallel-blade type. Multiblade, control and balancing dampers are opposed-blade type. Air handling unit and fan shutoff dampers are designed for maximum fan static pressure at shutoff flow. Dampers meet the performance requirements of ANSI/AMCA 500.

Fire Dampers

Fire dampers are provided at duct penetrations through fire barriers to maintain the fire resistance ratings of the barriers. The fire dampers meet the design and installation requirements of UL 555 (Reference 15).

Ductwork and Accessories

Ductwork, duct supports and accessories are constructed of galvanized steel. Ductwork subject to fan shutoff pressure is structurally designed for fan shutoff pressures. Ductwork, supports and accessories meet the design and construction requirements of SMACNA High Pressure Construction Standards (Reference 16) and SMACNA HVAC Duct Construction Standards - Metal and Flexible (Reference 7).

9.4.8.2.3 System Operation

Normal Plant Operation

During normal operation, both supply air handling units and both exhaust fans operate continuously to maintain suitable temperatures in the radwaste building. The radwaste building supply air flow is automatically modulated to maintain a negative pressure in the building. Electric interlocks between the truck access doors and the supply fan flow controller permits the supply air to drop to 6000 cfm below the exhaust flow when any truck bay door is open. This creates a flow into the building through the open door.

Differential pressure drop across the supply units filter banks is monitored, and individual alarms are actuated when any pressure drop rises to a predetermined level indicative of the need for filter replacement. To replace the filters on a supply unit, the affected supply fan and exhaust fan are stopped and isolated from the duct system by means of isolation dampers. During filter replacement, the supply and exhaust systems operate at 50 percent capacity. In this mode of operation, radwaste processing operations are adjusted to obtain acceptable temperature in the radwaste building.

The hot water unit heaters in the mobile systems facility are not normally required to operate to maintain the general building temperature. These heaters operate, in response to local thermostat control, to temper air entering the building when a truck access door is opened.

The hot water unit heater in the electrical/mechanical room operates in response to local thermostat control to maintain the required minimum temperature.

Abnormal Plant Operation

The radwaste building HVAC system is not required to operate during any abnormal plant condition.

9.4.8.3 Safety Evaluation

The radwaste building HVAC system has no safety-related function and therefore requires no nuclear safety evaluation.

9.4.8.4 Tests and Inspections

The radwaste building HVAC system is designed to permit periodic inspection of system components. Each component is inspected prior to installation. Components of each system are accessible for periodic inspection during normal plant operation. A system air balance test and adjustment to design conditions is conducted in the course of the plant preoperational test program. Air flow rates are measured and balanced in accordance with the guidelines of SMACNA HVAC systems - Testing, Adjusting and Balancing (Reference 19). Instruments are calibrated during testing. Automatic controls are tested for actuation at the proper setpoints. Alarm functions are checked for operability.

9.4.8.5 Instrumentation Applications

The radwaste building HVAC system operation is controlled by the plant control system (PLS). Refer to subsection 7.1.1 for a discussion of the plant control system.

Temperature controllers and thermostats maintain the proper space temperatures. Supply air temperature is controlled by sensing the temperature in the mobile systems facility and the electrical/mechanical equipment room. Unit heaters are controlled by local thermostats. Temperature indication and alarms are accessible locally via the plant control system.

Temperature is indicated for each air handling unit supply air discharge duct.

Operational status of fans is indicated in the main control room. The fans and air handling units can be placed into operation or shutdown from the main control room.

Differential pressure indication is provided for each of the filters in the air handling units and an alarm for high pressure drop is provided for each air handling unit.

Airflow is indicated for the air handling unit and exhaust fan discharge ducts. Alarms are provided for low air flow rates in the fan discharge ducts.

An alarm is provided for high radiation in the main exhaust duct to the vent stack.

An alarm is provided for smoke in the common discharge duct from the supply air handling units.

Position indicating lights are provided for automatic dampers.

9.4.9 Turbine Building Ventilation System

The turbine building ventilation system (VTS) operates during startup, shutdown, and normal plant operations. The system maintains acceptable air temperatures in the turbine building for equipment operation and for personnel working in the building.

9.4.9.1 Design Basis

9.4.9.1.1 Safety Design Basis

The turbine building ventilation system serves no safety-related function and therefore has no nuclear safety design basis.

9.4.9.1.2 Power Generation Design Basis

The turbine building ventilation system provides the following functions:

- Maintains acceptable temperatures for equipment operation
- Provides for removal of chemical fumes from the secondary sampling laboratory room, flammable vapors from the lube oil reservoir room and the clean and dirty lube oil storage room, and vitiated air from the toilets
- Provides conditioning air to maintain acceptable temperatures for electrical equipment rooms and personnel work areas
- Maintains the following temperatures based on the maximun and minimum normal outside air temperature conditions shown in Chapter 2 Table 2-1:
  - General area (operating deck, intermediate levels, and base slab) . . . . 50-105°F
  - Auxiliary boiler room . . . . 50-105°F
  - Fire pump rooms (diesel and motor driven) . . . . 50-105°F
  - Electrical equipment rooms (switchgear room 1, switchgear room 2, electrical equipment room, and variable frequency drive [VFD] power converter room) . . . . 50-105°F
  - Personnel work areas (Secondary sampling laboratory, office space at elevation 149'-0" and elevation 171'-0") . . . . 73-78°F

9.4.9.2 System Description

The turbine building ventilation system consists of the following subsystems:

- General area heating and ventilation
- Electrical equipment and personnel work area HVAC
- Local area heating and ventilation
  - Lube oil reservoir room ventilation
  - Clean and dirty lube oil storage room ventilation
  - Auxiliary boiler room ventilation
  - Fire pump rooms heating and ventilation
  - Toilet area ventilation

9.4.9.2.1 General Description

9.4.9.2.1.1 General Area Heating and Ventilation

Most of the turbine building is supplied by the general area ventilation and heating subsystem. Air is exhausted from the turbine building to the atmosphere by roof exhaust ventilators. The roof exhaust ventilators pull in outside air through wall louvers located at elevations 100′-0″, 117′-6″, and 135′-3″. Wall louvers are located at the operating deck to provide additional air during plant outage operations. The general area heating subsystem uses hot water unit heaters to provide local heating throughout the turbine building. During heating operation, the general area ventilation system is not operated.

9.4.9.2.1.2 Electrical Equipment and Personnel Work Area HVAC

The electrical equipment and personnel work area air conditioning subsystem serves electrical equipment areas (switchgear rooms, the electrical equipment room and the feedwater pump variable frequency drive power converter room) and personnel work areas (secondary sampling laboratory, office space at elevation 149′-0″ and elevation 171′-0″). This subsystem is subdivided into two independent HVAC systems, one serving the electrical equipment areas and one serving the personnel work areas.

The electrical equipment HVAC system consists of two 50 percent capacity air handling units, a ducted supply and return air system, automatic controls, and accessories. The air handling units are located on elevation 149′-0″ of the turbine building. The temperature of the rooms is maintained by thermostats which control the chilled water control valves for cooling and

the integral face/bypass dampers for heating. Outside air is mixed with recirculated air to maintain a positive pressure.

The personnel work area HVAC system consists of two 50 percent capacity air handling units, a ducted supply and return air system, automatic controls, and accessories. The air handling units are located on elevation 149'-0" of the turbine building. The temperature of the rooms is maintained by thermostats which control the chilled water control valves for cooling and the integral face/bypass dampers for heating. Electric reheat coils are provided in the ductwork to each room to maintain close temperature control. Outside air is mixed with recirculated air to maintain a positive pressure.

9.4.9.2.1.3 Local Area Heating and Ventilation

The lube oil reservoir room, clean and dirty lube oil storage room, toilet areas (facilities), and secondary sampling laboratory fume hood have centrifugal exhaust fans to remove flammable vapors, odors, or chemical fumes as required.

The auxiliary boiler room, diesel driven fire pump room, and motor driven fire pump rooms have exhaust ventilators to remove heat generated by the boiler equipment and fire pumps. Air is pulled from the general area of the turbine building through wall fire damper openings in the rooms and is exhausted outside of the turbine building to the atmosphere. Each fire pump room is heated by a hot water unit heater to provide freeze protection for the fire pumps. Hot water heating is not provided in the auxiliary boiler room, however, air is pulled from the general area of the turbine building to control space temperature in the boiler room.

9.4.9.2.2 Component Description

The turbine building ventilation system is comprised of the following major components. These components are located in the non-seismic turbine building.

HVAC Air Handling Units

Each air handling unit is a horizontal draw-through cabinet type consisting of a mixing box section, low efficiency filter, high efficiency filter, integral face/ bypass damper, hot water heating coil, chilled water cooling coil. The electrical equipment room air handling units include a return air fan and an exhaust fan. The personnel area air handling units include a supply air fan.

Exhaust Ventilators

The turbine building roof exhaust ventilators are hooded, direct driven, propeller type with pneumatic operated backdraft damper. Ventilators in the auxiliary boiler room and fire pump room are smaller, two-speed, propeller type with pneumatically actuated backdraft dampers. Ventilators in the lube oil rooms and restrooms are centrifugal type.

Unit Heaters

Unit heaters are the down-blow type with propeller type fans directly connected to the fan motor. Each unit heater is equipped with a four-way discharge outlet.

Electric Duct Heaters

Electric duct heaters are open grid type. The duct heaters are UL-listed for zero clearance and meet requirements of NFPA 70.

Reference 28 ✓

Humidifiers

A humidifier is a packaged electric steam generator type which converts water to steam and distributes it through the air handling system. The humidifier is designed and rated in accordance with ARI 620.

Reference 13 ✓

Fire Dampers

Fire dampers are provided at HVAC duct penetrations through fire barriers to maintain fire resistance ratings of the barriers. The fire dampers meet the design and installation requirements of UL-555 as applicable.

Reference 15 ✓

9.4.9.3 System Operation

9.4.9.3.1 General Area Heating and Ventilation

The general area ventilation system is manually controlled. Roof exhaust ventilators are manually started and stopped as required to satisfy space temperature conditions. Wall louvers located at the ground floor and the two intermediate levels of the turbine building are normally open during ventilation operation. The wall louvers located at the operating floor are manually opened to increase ventilation air to the area during outage operations. The operating floor louvers normally remain closed during power operation.

Hot water unit heaters are controlled automatically or manually. In the automatic mode, the heater fan motors are thermostatically controlled by their respective space thermostats. The plant hot water heating system (VYS) supplies hot water to the unit heaters.

9.4.9.3.2 Electrical Equipment and Personnel Work Area HVAC

During normal operation, the two air handling units of the electrical equipment HVAC system operate continuously and the two air handling units of the personnel work area HVAC system operate continuously. The chilled water coils are supplied from the plant central chilled water system (VWS) and the hot water coils are supplied from the plant central hot water heating system.

9.4.9.3.3 Local Area Heating and Ventilation

The ventilation operation for the lube oil reservoir room and the clean and dirty lube oil storage room is similar. Each centrifugal exhaust fan runs continuously to prevent the accumulation of chemical fumes or flammable vapors in its respective room.

The ventilation operation for the auxiliary boiler room, diesel driven fire pump room, and motor driven fire pump room is similar. Each directly driven, two-speed wall exhaust ventilator is automatically or manually controlled. In the automatic mode, the exhaust ventilator motor is thermostatically controlled by a two-stage room thermostat. In the manual mode the exhaust ventilator runs continuously at high speed until it is manually stopped.

The heating operation for the auxiliary boiler room depends upon pulling air from the turbine building general area. A heating thermostat is provided in the boiler room to control the operation of the exhaust fan below 50°F. The boiler room exhaust fan starts at low speed and continues to run until the space temperature rises above 50°F.

To provide heating of the diesel driven and motor driven fire pump rooms, hot water unit heater fan motors are controlled by their respective space thermostats in the automatic mode, or heater fans run continuously in the manual mode. The plant hot water heating system supplies hot water to the unit heaters.

The toilet area exhaust fans run continuously.

9.4.9.4 Safety Evaluation

The turbine building ventilation system has no safety-related function and therefore requires no nuclear safety evaluation.

There is no safety-related equipment in the turbine building.

9.4.9.5 Tests and Inspections

The turbine building ventilation system is designed to permit periodic inspection of system components during normal plant operation. System air balance testing and adjustments for the electrical equipment and personnel work areas are conducted in accordance with SMACNA (Reference 19). ✓

Fans are factory tested and rated in accordance with ANSI/AMCA 210 (Reference 4). Water coils are factory tested and rated in accordance with ANSI/ARI 410 (Reference 12). ✓

Ductwork is leak tested in accordance with SMACNA (Reference 18). ✓

9.4.9.6 Instrumentation Applications

The turbine building ventilation system is controlled by the plant control system.

Temperature indication and controllers control the room air temperatures within a predetermined range.

Temperature indication is provided to allow surveillance of room and space temperatures in the turbine building.

Differential pressure indication is provided for the air filters in each air handling unit. Alarms are provided for high pressure drops across the air filters.

9.4.10 Diesel Generator Building Heating and Ventilation System

The diesel generator building heating and ventilation system serves the standby diesel generator rooms, electrical equipment service modules, and diesel fuel oil day tank vaults in the diesel generator building and the two diesel oil transfer modules located in the yard near the fuel oil storage tanks.

9.4.10.1 Design Basis

9.4.10.1.1 Safety Design Basis

The diesel generator building heating and ventilation system serves no safety-related function and therefore has no nuclear safety design basis.

9.4.10.1.2 Power Generation Design Basis

The diesel generator building heating and ventilation system provides the following functions:

- Provides sufficient quantities of ventilation air to maintain acceptable temperatures within the generator rooms for equipment operation and reliability during periods of diesel generator operation in order for the onsite standby power system to perform its defense in depth functions

- Provides adequate heating and ventilation for suitable environmental conditions for maintenance personnel working in the diesel generator room when the generators are not in operation

- Provides suitable environmental conditions for equipment operation in each diesel generator electrical equipment service module under the various modes of diesel generator operation

- Prevents the accumulation of combustible vapors and dissipate their concentration in the fuel oil day tank vault

- Provides adequate heating and ventilation to maintain acceptable temperature within the diesel oil transfer module enclosures

The system maintains the following room temperatures based on ambient outside air temperature conditions of 95°F (summer) and -5°F (winter):

Area	Design Minimum (°F)	Temperature Maximum (°F)
Diesel Generator Area		
Diesel Generator On	None	130
Diesel Generator Off	50	105
Service Module		
Diesel Generator On	50	105
Diesel Generator Off	50	105
Diesel Oil Transfer Module Enclosure	50	105

9.4.10.2 System Description

The diesel generator building heating and ventilation system is shown in Figure 9.4.10-1.

The system consists of the following subsystems:

- Normal heating and ventilation subsystem
- Standby exhaust ventilation subsystem
- Fuel oil day tank vault exhaust subsystem
- Diesel oil transfer module enclosures ventilation and heating subsystem

9.4.10.2.1 General Description

9.4.10.2.1.1 Normal Heating and Ventilation System

The normal heating and ventilation subsystem serves the diesel generator building. Each diesel generator train is provided with independent ventilation and heating equipment for the building areas serving that diesel generator train.

Each normal heating and ventilation subsystem for a diesel generator train consists of one 100 percent capacity engine room air handling unit which ventilates the diesel generator room, one 100 percent capacity service module air handling unit which ventilates the electrical equipment service module, an exhaust system for the fuel oil storage vault and electric unit heaters in the diesel generator area.

The engine room air handling units are located above the electrical equipment service module with supply and return ducts in the diesel generator room.

The service module air handling units are located above the service module with supply and return ducts into the module.

Electric unit heaters are provided in the diesel generator room to maintain the space at a minimum temperature of 50°F when the diesel generators are off.

9.4.10.2.1.2 Standby Exhaust Ventilation Subsystem

The standby exhaust ventilation subsystem for each diesel generator room consists of two 50 percent capacity roof mounted exhaust fans and motor operated air intake dampers mounted in the exterior walls of the room.

9.4.10.2.1.3 Fuel Oil Day Tank Vault Exhaust Subsystem

Each fuel oil day tank vault is continuously ventilated by a centrifugal exhaust fan. The exhaust fans are mounted on the roof of the vault and ducted to draw air from one foot above the vault floor and from above the oil containment dike to remove any oil fumes generated in the space. Air is drawn into the vault from the diesel generator room through an opening protected with a fire damper.

9.4.10.2.1.4 Diesel Oil Transfer Module Enclosures Ventilation and Heating Subsystem

Each diesel oil transfer module enclosure is ventilated by a roof mounted exhaust fan. Outside air is drawn into the enclosure through manually operated louvered air intakes. The louvers are closed for winter operation when heating is required. An electric unit heater is provided in each enclosure to maintain the space at a minimum temperature of 50°F.

9.4.10.2.2 Component Description

The diesel generator building heating and ventilation system is comprised of the following major components. These components are located in the non-seismic diesel-generator building. The seismic design classification, safety classification and principal construction code for Class A, B, C, or D components are listed in Section 3.2. Tables 9.4.10-1 through 9.4.10-4 provide design parameters for major components in the system.

Supply Air Handling Units

Each air handling unit consists of a mixing box section, a low efficiency filter bank, a high efficiency filter bank, and a supply fan. Electric heating coils are provided for the service module air handling units for module heating.

Supply and Exhaust Air Fans

The supply and exhaust fans are centrifugal type, single width single inlet (SWSI) or double width double inlet (DWDI), with high efficiency wheels and backward inclined blades to produce non-overloading horsepower characteristics. The fans are designed and rated in accordance with ANSI/AMCA 210 (Reference 4), ANSI/AMCA 211 (Reference 5), and ANSI/AMCA 300 (Reference 6).

Low Efficiency Filters and High Efficiency Filters

The low efficiency filters and high efficiency filters have a rated dust spot efficiency based on ASHRAE 52 (Reference 7). Filter minimum average dust spot efficiency is shown in Table 9.4.10-1. The filters meet UL 900 (Reference 8) Class I construction criteria.

Electric Heating Coils

The electric heating coils are multi-stage fin tabular type. The electric heating coils meet the requirements of UL 1096 (Reference 10).

Roof Exhaust Fans

The standby exhaust fans are roof mounted, direct drive upblast ventilators. The fans are equipped with gravity dampers that open when the fan operates and close when the fan is shut down. The diesel oil transfer module enclosure exhaust fans are direct driven centrifugal fan roof ventilators. The ventilators are equipped with gravity dampers that open when the fan operates and close when the fan is shut down.

Electric Unit Heaters

The electric unit heaters are single-stage or two-stage fin tubular type. The electric unit heaters are UL-listed and meet the requirements of UL 1025 (Reference 25) and the National Electric Code.

Shutoff, Control, Balancing, and Backdraft Dampers

Multiblade, two-position shutoff dampers are parallel-blade type. Multiblade, control and balancing dampers are opposed-blade type. Backdraft dampers are provided to prevent backflow through shut down fans and to relieve pressure from the service module and diesel generator building. Dampers meet the performance requirements of ANSI/AMCA 500.

Fire Dampers

Fire dampers are provided at duct penetrations through fire barriers to maintain the fire resistance ratings of the barriers. The fire dampers meet the design and installation requirements of UL 555 (Reference 15).

Ductwork and Accessories

Ductwork, duct supports and accessories are constructed of galvanized steel. Ductwork subject to fan shutoff pressure is structurally designed for fan shutoff pressures. Ductwork, supports and accessories meet the design and construction requirements of SMACNA High Pressure Construction Standards (Reference 16) and SMACNA HVAC Duct Construction Standards - Metal and Flexible (Reference 17).

9.4.10.2.3 System Operation

9.4.10.2.3.1 Normal Heating and Ventilation Subsystem

Normal Plant Operation

During normal plant operation, each engine room air handling unit operates continuously when the diesel generator is not operating and outdoor air is required for room cooling. Each air handling unit has 100 percent cooling capacity for the engine room served by the unit. The engine room air handling unit is not required to operate when the diesel generator in the engine room served operates. The unit draws outdoor air through a louvered air intake and mixes it with return air from the engine room in required proportion to satisfy a thermostat located in the space served. Excess outside air supplied to the engine room is discharged to outdoors via a gravity relief damper.

Each service module air handling unit operates continuously, providing 100 percent cooling and heating capacity for the service module served by the unit. The unit draws outside air through a louvered air intake and mixes it with return air from the service module in required proportion to satisfy a space thermostat located in the service module. Excess outside air supplied to the service module flows into the diesel engine area via a wall mounted relief damper. The electric heating coil in the service module air handling unit is controlled by a separate space thermostat. The service module air handling unit operates continuously regardless of diesel generator status.

The engine room electric unit heaters operate as required to maintain the minimum room temperature when the diesel generators are not operating. No specific minimum room temperature is maintained when the diesel generators operate. Local space thermostats turn the unit heaters on and off as required for temperature control.

Abnormal Plant Operation

The engine room air handling units and unit heaters are not required to operate during any abnormal plant condition. This equipment is not required to operate when the diesel generators operate.

The service module air handling units operate continuously during normal plant operation or when the diesel generators operate during a loss of the plant ac electrical system.

9.4.10.2.3.2 Standby Exhaust Ventilation Subsystem

Normal Plant Operation

During normal plant operation, the standby exhaust fans operate in conjunction with the diesel generators. Each exhaust fan has 50 percent cooling capacity for the engine room served by the fan. The fans for an engine room start when the diesel generator in that room is started. The fans shut down when the diesel generator is stopped and the engine room temperature

satisfies the standby exhaust fan temperature controllers. One or both standby exhaust fans are required to operate to maintain the engine room temperature depending on the outdoor ambient temperature.

The motor operated air intake dampers automatically open when the fans start and close when both fans shut down.

The standby exhaust ventilation system is not required to operate when the diesel generators are not operating.

Abnormal Plant Operation

The standby exhaust ventilation system is required to operate to support diesel generator operation during loss of offsite power. System operation is identical to that for normal plant operation.

9.4.10.2.3.3 Fuel Oil Day Tank Vault Exhaust Subsystem

Normal Plant Operation

During normal plant operation, each fuel oil day tank vault exhaust fan operates continuously. The fans are manually started and shut down. Each exhaust fan has 100 percent capacity for ventilation of the day tank vault served by the fan.

Abnormal Plant Operation

The fuel oil day tank vault exhaust subsystem is not required to operate during any abnormal plant condition.

9.4.10.2.3.4 Diesel Oil Transfer Module Enclosures Ventilation and Heating Subsystem

Normal Plant Operation

During normal plant operation, each diesel oil transfer module enclosure exhaust fan operates during warm outdoor ambient conditions under control of a temperature controller to maintain the enclosure below the maximum indoor design temperature. The unit heaters operate as required during the winter to maintain the minimum design enclosure temperature. The operable outside air intake louvers are manually opened for the cooling season and manually set closed during the winter heating season.

Abnormal Plant Operation

The diesel oil transfer module enclosure ventilation and heating subsystem is required to operate to support diesel generator operation during loss of the plant ac electrical system. System operation is identical to that for normal plant operation.

9.4.10.3 Safety Evaluation

The diesel generator building heating and ventilation system has no safety-related function and therefore requires no nuclear safety evaluation.

9.4.10.4 Tests and Inspection

The diesel generator building heating and ventilation system is designed to permit periodic inspection of system components. Each component is inspected prior to installation. Components of each system are accessible for periodic inspection during normal plant operation. A system air balance test and adjustment to design conditions is conducted in the course of the plant preoperational test program. Air flow rates are measured and balanced in accordance with the guidelines of **SMACNA HVAC Systems - Testing, Adjusting, and Balancing (Reference 19).** Instruments are calibrated during testing. Automatic controls are tested for actuation at the proper setpoints. Alarm functions are checked for operability.

9.4.10.5 Instrumentation Applications

The diesel generator building heating and ventilation system operation is controlled by the plant control system. Refer to subsection 7.1.1 for a discussion of the plant control system.

Temperature controllers and thermostats maintain the proper space temperatures. Temperature indication and alarms are accessible locally via the plant control system.

Operational status of fans is indicated in the main control room. All fans and air handling units can be placed into operation or shutdown from the main control room or locally.

Differential pressure indication is provided for each of the filters in the air handling units and an alarm for high pressure drop is provided for each air handling unit.

9.4.11 Health Physics and Hot Machine Shop HVAC System

The health physics and hot machine shop HVAC system serves the personnel decontamination area, frisking and monitoring facilities, radiation monitor calibration area, and health physics facilities on the 100′-0″ elevation of the annex building and the hot machine shop on the 107′-2″ elevation of the annex building.

9.4.11.1 Design Basis

9.4.11.1.1 Safety Design Basis

The health physics and hot machine shop HVAC system serves no safety-related function and therefore has no nuclear safety design basis.

9.4.11.1.2 Power Generation Design Basis

The health physics and hot machine shop HVAC system provides the following functions:

- Provides conditioned air to work areas to maintain acceptable temperatures for equipment and personnel working in the areas
- Provides air movement from clean to potentially contaminated areas to minimize the spread of airborne contaminants
- Collects the vented discharges from potentially contaminated equipment in the area
- Provides for exhaust from welding booths, grinders and other miscellaneous equipment located in the hot machine shop
- Provides for radiation monitoring of exhaust air prior to release to the environment
- Maintains the access control area and hot machine shop at a slight negative pressure with respect to outdoors and the clean areas of the annex building to prevent unmonitored releases of radioactive contaminants
- Provides humidification to maintain a minimum of 35 percent relative humidity

The system maintains the following temperatures based on maximum and minimum normal outside air temperature conditions shown in Chapter 2, Table 2-1:

Room or Area	Temperatures (°F)
Health physics area	73-78
Hot machine shop	65-85

9.4.11.2 System Description

9.4.11.2.1 General Description

The health physics and hot machine shop HVAC system is a once-through ventilation system consisting of two integrated subsystems: a supply air system and an exhaust air system. The systems operate in conjunction with each other to satisfy the functional requirements of maintaining temperatures in the areas served while controlling air flow paths and area negative pressure.

The supply air system consists of two 100 percent capacity air handling units with a ducted air distribution system and automatic controls. The air handling units are located in the lower south air handling equipment room on elevation 135'-3" of the annex building. The units draw 100 percent outdoor air through a louvered outdoor air intake plenum and discharge into a duct distribution system which is routed to the health physics and machine shop areas.

Humidification is controlled to maintain a minimum 35 percent relative humidity via a steam humidifier.

The exhaust air system consists of two 100 percent capacity exhaust centrifugal fans with ductwork and automatic controls, and a separate machine shop exhaust fan and high efficiency filter for exhausting from machine tools and other localized areas in the hot machine shop. The exhaust fans are located in the staging and storage area on elevation 135'-3" of the annex building. The machine shop exhaust fan and filter are located locally in the machine shop. The air flow rates are balanced to maintain a constant exhaust design air flow through the fans.

The exhaust fans discharge to a common duct which is routed to the plant vent stack. A radiation monitor measures activity in the common discharge duct downstream of the exhaust fans and activates an alarm in the main control room when excess activity in the effluent discharge is detected. The radiation monitoring system is described in Section 11.5.

Individual flexible exhaust duct branches are provided to machine tools. The flexible ducts are connected to a hard duct manifold which is connected to a filter and exhaust fan. The exhaust fan discharges into the main system exhaust ductwork.

9.4.11.2.2 Component Description

The health physics and hot machine shop HVAC system is comprised of the following major components. These components are located in the Seismic Category II portion of the annex building.

Supply Air Handling Units

Each air handling unit consists of a low efficiency filter bank, a high efficiency filter bank, a hot water heating coil, a chilled water cooling coil bank, and a supply fan with automatic inlet vanes.

Supply and Exhaust Air Fans

The supply and exhaust fans are centrifugal type, single width single inlet (SWSI) or double width double inlet (DWDI), with high efficiency wheels and backward inclined blades to produce non-overloading horsepower characteristics. The fans are designed and rated in accordance with **ANSI/AMCA 210 (Reference 4)**, **ANSI/AMCA 211 (Reference 5)**, and **AMCA 300 (Reference 6)**.

Low Efficiency Filters and High Efficiency Filters

The low efficiency filters and high efficiency filters have a rated dust spot efficiency based on **ASHRAE 52 (Reference 7)**. Filter minimum average dust spot efficiency is shown in Table 9.4.11-1. The filters meet **UL 900 (Reference 8)** Class I construction criteria.

Cooling Coils

The chilled water cooling coils are counterflow, finned tubular type. The cooling coils are designed and rated in accordance with ASHRAE 33 (Reference 11) and ANSI/ARI 410 (Reference 12).

Heating Coils

The hot water heating coils are counterflow, finned tubular type. The heating coils are designed and rated in accordance with ASHRAE 33 (Reference 11) and ANSI/ARI 410 (Reference 12).

Humidifier

The humidifier is a packaged electric steam generator type which converts water to steam and distributes it through the air handling system. The humidifier is designed and rated in accordance with ARI 620 (Reference 13).

Shutoff, Control and Balancing Dampers

Multiblade, two position shutoff dampers are parallel-blade type. Multiblade, control and balancing dampers are opposed-blade type. Air handling unit and fan shutoff dampers are designed for maximum fan static pressure at shutoff flow. Dampers meet the performance requirements of ANSI/AMCA 500.

Fire Dampers

Fire dampers are provided at duct penetrations through fire barriers to maintain the fire resistance ratings of the barriers. The fire dampers meet the design and installation requirements of UL 555 (Reference 15).

Ductwork and Accessories

Ductwork, duct supports and accessories are constructed of galvanized steel. Ductwork subject to fan shutoff pressure is structurally designed for fan shutoff pressures. Ductwork, supports and accessories meet the design and construction requirements of SMACNA High Pressure Construction Standards (Reference 16) and SMACNA HVAC Duct Construction Standards - Metal and Flexible (Reference 17).

9.4.11.2.3 System Operation

Normal Plant Operation

During normal operation, one supply air handling unit and one exhaust fan operate continuously to maintain suitable temperatures in the health physics and hot machine shop areas of the annex building. The supply air flow is automatically modulated to maintain a

negative pressure in the areas served with respect to the outdoors. Differential pressure controllers, with sensors in the general health physics area and sensors mounted outdoors (shielded from wind effects), modulate the automatic inlet vanes of the supply fan to maintain area negative pressure. In addition, a separate differential pressure controller with a sensor in the hot machine shop modulates a damper in the supply air duct to the hot machine shop to maintain a negative pressure in the shop with respect to outdoors.

The temperature in the health physics area is maintained within the design range by a temperature controller located in the area, which modulates the control valve on the chilled water supply lines to the cooling coil and the face and bypass damper of the heating coil.

Abnormal Plant Operation

The health physics and hot machine shop HVAC system is not required to operate during any abnormal plant condition.

9.4.11.3 Safety Evaluation

The health physics and hot machine shop HVAC system has no safety-related functions and therefore requires no nuclear safety evaluation.

9.4.11.4 Tests and Inspections

The health physics and hot machine shop HVAC system is designed to permit periodic inspection of system components. Each component is inspected prior to installation. Components of each system are accessible for periodic inspection during normal plant operation. A system air balance test and adjustment to design conditions is conducted during the plant preoperational test program. Air flow rates are measured and balanced in accordance with the guidelines of **SMACNA HVAC Systems - Testing, Adjusting and Balancing (Reference 19).** Instruments are calibrated during testing. Automatic controls are tested for actuation at the proper setpoints. Alarm functions are checked for operability.

9.4.11.5 Instrumentation Application

The health physics and hot machine shop HVAC system operation is controlled by the plant control system. Refer to subsection 7.1.1 for a discussion of the plant control system.

Temperature controllers maintain the proper space temperature. Supply air temperature is controlled by sensing the temperature in the general health physics area.

Temperature is indicated for each air handling unit supply air discharge duct.

Operational status of fans is indicated in the main control room. The fans and air handling units can be placed into operation or shutdown from the main control room.

Differential pressure indication is provided for each of the filters in the air handling units and an alarm for high pressure drop is provided for each air handling unit.

Airflow is indicated for the air handling unit and exhaust fan discharge ducts. Alarms are provided for low air flow rates in the fan discharge ducts.

An alarm is provided for high radiation in the main exhaust duct to the vent stack.

An alarm is provided for smoke in the common discharge duct from the supply air handling units.

Position indicating lights are provided for automatic dampers.

9.4.12 Combined License Information

This section has no requirement for information to be provided in support of the Combined License application.

9.4.13 References

1. "Functional Criteria For Emergency Response Facilities," USNRC NUREG 0696.
2. "Nuclear Power Plant Air-Cleaning Units and Components," ASME N509-1989.
3. "Testing of Nuclear Air-Cleaning Systems," ASME N510-1989.
4. "Laboratory Method of Testing Fans for Rating Purposes," ANSI/AMCA 210-85.
5. "Certified Ratings Program Air Performance," ANSI/AMCA 211-85.
6. "Reverberant Room Method of Testing Fans For Rating Purposes," ANSI/AMCA 300-85.
7. "Methods of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter," ASHRAE 52-76.
8. "Test Performance of Air-Filter Units," UL-900, 1986.
9. "High-Efficiency, Particular, Air-Filter Units," UL-586, 1985.
10. "Electric Central Air Heating Equipment," UL-1096, 1986.
11. "Methods of Testing for Rating Forced Circulation Air Cooling and Air Heating Coils," ASHRAE 33-78.
12. "Forced-Circulation Air Cooling and Air Heating Coils," ANSI/ARI 410-91.

13. "Self-Contained Humidifiers," ARI 620-80.

14. "Testing Methods for Louvers, Dampers, and Shutters," ANSI/ AMCA 500-83.

15. "Fire Dampers," UL-555, 1990.

16. "High-Pressure Duct Construction Standards," SMACNA, 1975.

17. "HVAC Duct Construction Standards - Metal and Flexible," SMACNA, 1985.

18. "HVAC Duct Leakage Test Manual," SMACNA, 1985.

19. "HVAC Systems - Testing, Adjusting, and Balancing," SMACNA, 1983.

20. Code of Federal Regulations, Title 10, Part 50, Appendix I.

21. Code of Federal Regulations, Title 10, Part 20.

22. "Heat-Stress Management Program for Nuclear Power Plants," EPRI NP-4453 by Westinghouse Electric Corporation, dated February 1986.

23. Branch Technical Position CSB 6-4 to "Containment Isolation System," Standard Review Plan 6.2.4 of NUREC-0800 Rev. 2, July 1981.

24. "Military Specification Filter, Particulate, High-Efficiency, Fire Resistant," MIL-F-51068D.

25. "Leakage Rated Dampers for Use in Smoke Control System," UL-555S, 1993.

26. "Electric Air Heaters," UL-1025, 1991.

27. "Installation of Air Conditioning and Ventilation Systems," NFPA 90A, 1993.

28. "National Electrical Code," NFPA 70, 1990.

Date: December 19, 1996

Subject: Preliminary Responses to Questions, Comments, and Discussion Items Concerning the AP600 Adverse Systems Interaaction Report

To: Bill Huffman

From: Robin Nydes

Here are the responses we have drafted so fa: for our telecon tomorrow morning at 10:00 am. I am trying to get another conference room (since it is the connection in our room 322 that is bad) and will let you know the phone number tomorrow morning.

What is not attached are responses to 33, 38-43, 47, 49, and 51 but we will be ready to discuss them tomorrow morning.

cc: Chuck Brockhoff
Mike Corletti
Mark Wills
Selim Sancaktar
Terry Schulz
Rick Wright
Bill Brown
Gene Piplica

RESPONSES TO QUESTIONS, COMMENTS, AND DISCUSSION ITEMS
CONCERNING THE WESTINGHOUSE AP600
ADVERSE SYSTEMS INTERACTION REPORT

The Adverse Systems Interactions report does a reasonably good job in describing interactions between single components and/or systems in the AP600. However, there appears to be relatively little consideration of "integral" effects: for instance, the cumulative impact of operating several non-safety systems for a period after which the passive systems might be required to operate. The staff recognizes that the actual plant response to a transient or accident may depend upon operator (or automatic) actuation of the "defense-in-depth" (DID) systems. The staff is concerned, however, that the integral-systems impact of operating several DID systems, either in parallel or serially, may affect the plant's thermal-hydraulic state sufficiently to compromise the ability of the passive systems to "take over" should they be required at a later time, in the event that an accident or transient worsens, or if some or all of the DID systems were to fail or be shut off. Has Westinghouse evaluated these types of integral and time-dependent effects?

Overview Comments

1. Section 2.2.10 discusses interactions between the normal residual heat removal system (RNS) and two passive systems - the core makeup tank (CMT) and the in-containment refueling water storage tank (IRWST). The possibility of RNS flow delaying CMT drainage is discussed and stated to be beneficial because it could prevent unnecessary actuation of the stage-4 ADS valves. However, there appears to be some "scenario-specific" interactions which are not obviously beneficial. If, for instance, during a small break LOCA, the RCS pressure were to holdup in the range of the RNS pump shutoff head (after actuation of ADS-1,2, and 3), the possibility of the RNS holding the CMT check valves closed (or at least inhibiting draining) while minimal injection flow is occurring could result in greater than expected RCS inventory depletion before ADS-4 actuates. In a direct vessel injection (DVI) DEG line break, one injection path is open to containment, and it would appear that RNS injection into the intact DVI line would be shut off by the RCS pressure on that side, but on the broken side, the RNS pumps would provide flow, which would be dumped into the sump through the break. This has the dual effect of shutting off the CMT discharge check valves and depleting IRWST inventory. The intact-side CMT would have to drain to actuate the fourth stage ADS, which would require significant inventory loss through the break. Furthermore, to postulate a possible "worst case" sequence, suppose the pumps were secured or failed just as the RCS reached a pressure at which the pumps would normally start to inject. In this scenario, a substantial amount of IRWST water has been dumped into the sump, reducing the injection head, and the system must still depressurize from around 200 psi down to less that 10 psi (relative to the containment) to allow IRWST injection. The transition to sump injection (lower head) would be relatively early, with greater decay heat than assumed on the SSAR analysis. In addition, not only would the RNS rapidly deplete the IRWST inventory during a DVI DEG break, but it also appears that it could continue to operate drawing suction flow from the recirculation sump as the net positive suction head shifted from the IRWST to the recirculation sump. Could this conceivably result in a flow by-pass of the core via the following path. Specifically, RNS suction would take suction on the containment recirculation sump and pump it to the two DVI lines; the broken DVI line would spill water back to the sump; the intact DVI line would return some water to the reactor vessel downcomer but a percentage of this injection flow would be short-circuited out the vessel side of the broken DVI line. No passive sump recirculation would be expected because of the RNS discharge pressure would be holding the sump recirculation check valves closed.

Westinghouse should determine if the above scenarios need to be considered and/or analyzed. The analyses should ascertain: (a) if enough inventory could be lost to uncover the core; (b) the possibility of flow by-pass of the core if RNS continued to operate with a DVI DEG break; (c) the worst case effect of the reduction in IRWST injection head and early transition to sump injection with higher decay heat levels if RNS flow were stopped by an operator after a large quantity of water from the IRWST has been pumped by the RNS into the recirculation sump.

It might benefit the staff if more details were provided on the specific initiation of RNS as a low head injection, active, defense-in-depth system for LOCAs. The procedures provided in the ERGs do not seem to clarify these questions.

a. When exactly would operators be instructed to align RNS to inject? When would the operators be expected to start the pumps (i.e., after an "S" signal or other specific time in the event)? When, would the operators be expected to secure the pumps?

b. What happens if the operators make an error in aligning, stopping, or starting the RNS?

The staff would also like more details on what analysis has been done related to the above described scenarios. For example, are there potential intermediate break sizes for which the RNS pumps cannot inject sufficient flow to the RCS, but can block enough CMT flow to create a problem? Were these scenarios considered in the PRA?

Response:

This comment postulates several scenarios regarding the interaction of the RNS and the passive injection sources (CMTs and IRWST). This response will address each one individually as follows:

"If, for instance, during a small break LOCA, the RCS pressure were to holdup in the range of the RNS pump shutoff head...the possibility of the RNS holding the CMT check valves closed (or at least inhibiting draining) while minimal injection flow is occurring could result in greater than expected RCS inventory depletion before ADS-4 actuates."
The phenomenon as discussed above cannot occur. The RNS can only prevent the CMTs from draining if it provides sufficient injection flow via the shared direct vessel injection (DVI) line, to increase the pressure in the discharge of the CMT line to prevent gravity draining of the CMT. This can only occur if the flow rate in the DVI line due to the RNS is greater than the flow rate that would occur if only the CMTs were draining. If, as postulated above, the RCS pressure held up near the shutoff head of the RNS, then the RNS pumps would inject very little (or not at all). In this case, the CMTs would drain as designed, since they are at RCS pressure (due to the cold leg balance line). See the attached Figure 1.

"In a DVI DEG line break...RNS injection ...has the dual effect of shutting off the CMT check valves and depleting IRWST inventory."
In such a break, the RNS, if operating, would spill the IRWST to the containment sump. This will be bounded by the SSAR long-term cooling analysis scheduled for submittal next year. However, the ASI of stopping of the CMT injection at an RNS flow rate less than CMT design flow will cannot occur as discussed above. Furthermore, the RNS would not inject a significant amount in this scenario due to the interconnected RNS system that would preferentially feed the spilling DVI line.

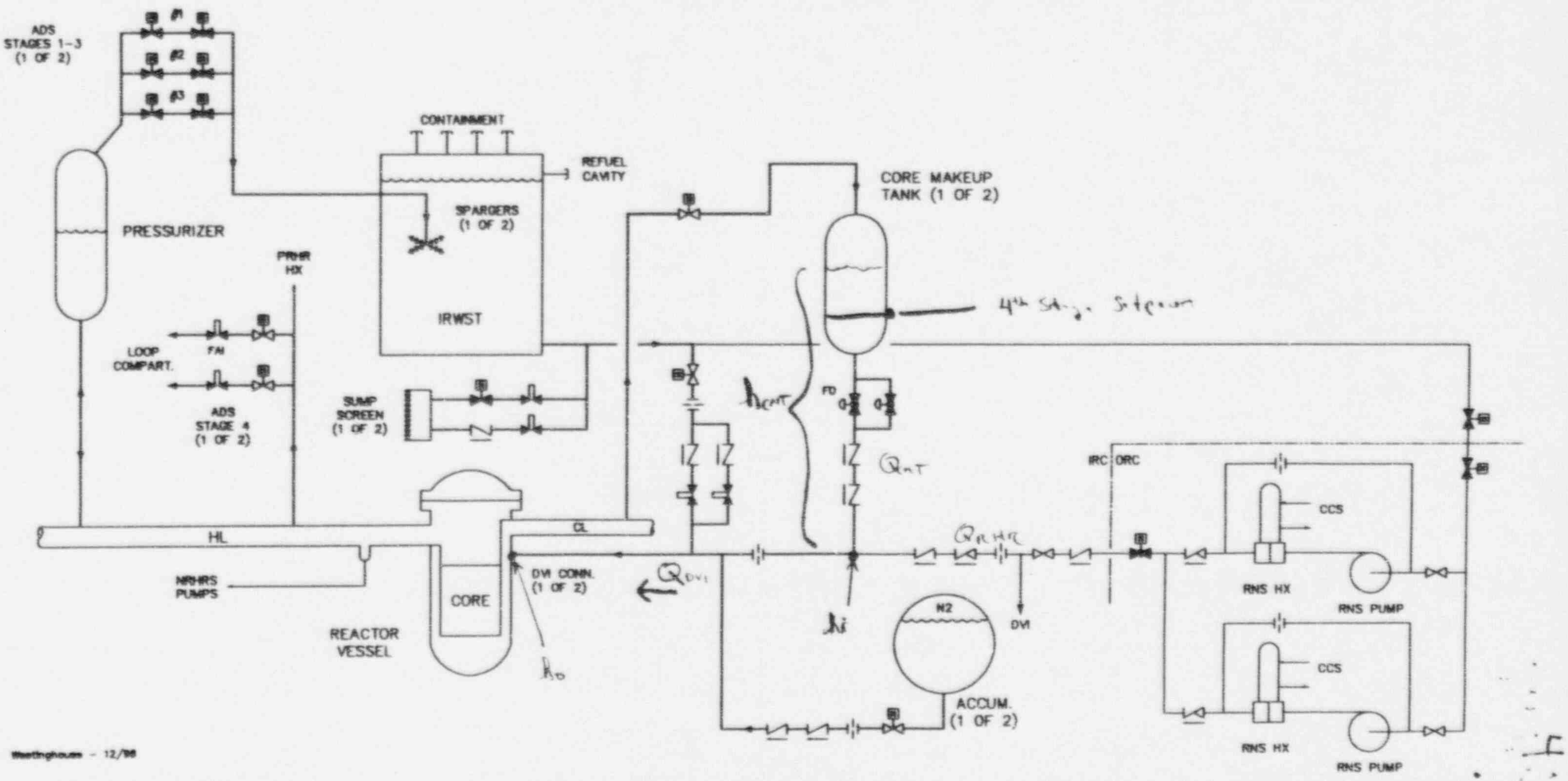
$(h_1 - h_0) = k_{DVI} Q_{DVI}^2$ $Q_{DVI} = Q_{RHR} + Q_{CMT}$

$(h_{CMT} - h_1) = k_{CMT} Q_{CMT}^2$

$Q_{RHR} \uparrow$ $Q_{DVI} \uparrow$ $h_1 \uparrow$ $h_1 > h_{CMT}$ $Q_{CMT} = 0$

Figure 1 for Q1.

PASSIVE CORE COOLING / NORMAL RHR SYSTEM



Westinghouse - 12/96

a. The ERGs provide the guidance for when the operator is instructed to align the RNS. (Upon decreasing CMT level). This can be added to the ASI Report for completeness. If the operators are able to determine that a broken DVI line had occurred (by noticing that one CMT had drained while the other was relatively full, the IRWST injection with RCS pressures high, and RNS injection with the RCS pressure above the shutoff head of the pumps). For these cases, the operators could decide to stop the RNS pumps. However, the SSAR analyses will conservatively bound RNS operation that could adversely effect the safety of the plant (i.e. RNS is not credited in design basis LOCAs, and is considered in the LTC analysis where RNS operation can adversely impact the draining of the IRWST.

b. No additional adverse interactions other than those discussed above can result from operation of the RNS post-accident.

2. The report contains no analyses, just descriptive material. There are several mentions of "sensitivity analyses," but no references to where the results might be found (except where they've been incorporated into the SSAR). There is no indication of what the sensitivity analyses have (or have not) considered as relevant "sensitivities."

Response:

This is a general comment which cannot be addressed without a more specific example.

3. Injection of saturated water due to energy input to IRWST is mentioned several times, as is the beneficial ("quenching") effect of injecting subcooled water. There are a number of interactions that can cause the IRWST water to become saturated prior to injection to the RCS. Westinghouse should confirm that in the Chapter 6/15 analyses, that saturated conditions are assumed in the IRWST to minimize the beneficial effect of subcooled injection or explain why the assumption is not necessary.

Response:

The range of initial IRWST temperatures assumed in the design basis safety analyses is: $50°F < T < 120°F$. Of all the Chapters 6 and 15 analyses, IRWST injection only occurs for a LOCA. For the LOCA analyses, the maximum initial IRWST temperature (120°F) is assumed for conservatism. During the course of a LOCA, the IRWST is heated up by PRHR heat transfer and ADS injection. Test data shows that there is significant temperature stratification in the IRWST, such that the portion of the IRWST below the PRHR tubes remains subcooled for an extended length of time. This phenomenon is modeled by the LOCA analysis codes (WCobra/Trac and NOTRUMP) for the IRWST injection in the small and large break LOCA analyses of Chapter 15.6. Saturated water injection occurs during long-term cooling following a LOCA event and is modeled in the Chapter 15.6 long term cooling analysis as appropriate.

Specific Comments and Questions from Detailed Review

4. The discussion on fan coolers (pp. 2-17 - 2-18) appears to be focused on an extreme situation without regard for other potential adverse conditions. For example; recent concerns were raised regarding operating PWRs via Westinghouse's Nuclear Safety Advisory Letter on containment fan coolers. Are there any high heat load conditions (such as during DBA or Severe Accidents) for the AP600 in which the cooling water system supplying non-safety-related fan coolers

(Chilled Water) might be subject to water hammer or other potentials for containment bypass? Could operation of the fan coolers with chilled water isolated by a containment isolation signal result in overpressurization of the chilled water line or flashing/water hammers if the heated chilled water lines from the fan coolers were suddenly unisolated?

The Chapter 9 SSAR description of the fan coolers state that they have two speed motors. The high speed is used for normal conditions and the low speed is used during high containment air density conditions - such as those that might be present during DBA or severe accidents. How is fan speed controlled during accident conditions. Since this is a non-safety related function, how is operation of the fans in fast speed prevented in a high steam environment. Does the fan control circuitry automatically shift to low speed in accident conditions? Are there interlocks to prevent operators from manually shifting to high speed when conditions may be inappropriate in containment. Is there any potential for the fans to catastrophically fail if operated at high speed in a dense steam environment thereby creating a possible adverse system interaction which could damage the chill water cooling coils (Containment bypass scenario)? The emergency response guidelines (ERGs) for reactor trip or safety injection, AE-0, step 22, does not specify at what speed the fans should be operating under safety injection conditions.

Response:

Westinghouse is currently reviewing the design and operation of the AP600 fan coolers and chilled water system with regard to the recent concerns raised about fan coolers for operating plants. It is expected that this review will conclude that the AP600 fan coolers are not susceptible to damaging water hammer or other potentials for containment bypass. The AP600 fan cooler/chilled water system is not required to function to remove heat from the containment following any DBA or Severe Accident. In addition, the AP600 fan coolers and associated chilled water piping and isolation valves are designed for 320°F and 200 psig, and therefore cannot be subjected to overpressure/overtemperature conditions as a result of elevated pressure and temperature conditions expected inside the containment.

When this review is completed, Westinghouse will provide additional discussion on this fan cooler concern, as it applies to the AP600 design, including the operation of the fan cooler fans and emergency response guidelines.

5. The discussion in item 2.2.1 (p. 2-7) refers to events after actuation of an "S" signal. However, there are safety system actuations that occur without immediate generation of an "S" signal--such as CMT actuation due to low pressurizer level. Does this discussion apply to that possibility as well?

Response:

Actuation of the CMTs on low pressurizer level can occur prior to an "S" signal. The discussion presented in 2.2.1 would apply regardless.

6. At the bottom of p. 2-8, Westinghouse states that operation of two RCPs in the loop opposite the PRHR heat exchanger could result in reverse flow through the PRHR heat exchanger and possible degrade its effectiveness. Is this concern also possible with just one RCP operating in the opposite loop from the PRHR HX? Are there any control interlocks that prevent this condition? The necessity of avoiding this situation does not appear to be called out in the

AP600 ERGs (See step 10 of AES-0.1 for instance). Are there any common-cause failures (other than loss of an electrical bus, which has been precluded) that could cause the two PRHR-side RCPs to trip and the other two pumps to stay on?

Response:

No, this concern only applies to two pumps in the opposite SG. There are no control interlocks that address this.

In the steps that specify the RCPs to be restarted, it states to start pump 1A and 1B with a note that these pumps should be run to provide pressurizer spray. The potential ASI with PRHR is mentioned in the revised ERG background document (to be provided by the end of the year) under the Knowledge section for these steps.

No other common-cause failures that would result in this scenario were identified.

The AP600 Technical Specifications (3.5.4 and 3.5.5) address this issue, by requiring at least one pump in loop one to be operating. This prevents the operators from operating in this way at lower modes.

7. On p. 2-9, the pressurizer heaters are stated to be assumed to trip on "S" signal actuation. Is this a safety-related function? Similarly, what about the isolation valve actuations in the letdown system? Are all actuations initiated by the PLS non-safety-related? What is the impact of a loss of instrument ac power that would preclude the PLS from actuating these isolation functions?

Another function not specifically indicated as being safety-related or non-safety-related is the SFW isolation on low RCS CL temperature (p. 2-15). Please confirm which applies.

Response:

As discussed in Section 2.2.13, the pressurizer heater block on a CMT actuation signal is performed by the PLS and is credited in the SSAR accident analysis. This is a safety-related function accomplished with nonsafety-related components (breakers for the pressurizer heaters).

Regarding letdown isolation, there are both safety-related and nonsafety-related isolation of the letdown line. As the AP600 letdown line is a containment isolation line, it closes on an S signal (PMS) as well as PLS isolation on pressurizer level. In addition, the letdown line and purification line are isolated on low pressurizer water level by the PMS. The following table provides the complete list of PMS and PLS isolation functions associated with pressurizer level. A version of this table could be included in the ASI report.

Pressurizer Level Setpoint		I&C System	Nominal Setpoints			
			No-Load		Full-Load	
			% of span	volume (ft^3)	% of span	volume (ft^3)
High-3	Reactor Trip	PMS	92.0	1360	92.0	1360
High-2	CVS Makeup Valves Isolation	PMS	67.0	1023	67.0	1023
Maximum Nominal Level			51.2	811	65.8	1008
	Letdown Open (Standby)[1]	PLS	50	794	65	996
	Makeup Pump Stop (Standby)[1]	PLS	45	727	60	929
	Letdown Open (Borate/Dilute)[1]	PLS	40	660	55	862
	Letdown Close[1]	PLS	35	593	50	794
High-1	CVS Makeup Valves Isolation (Post-"S")	PMS	30.0	525	30.0	525
	Makeup Pump Start (Standby)[1]	PLS	30	525	45	727
Minimum Nominal Level			25.3	463	40.0	657
Low-1	CVS Purification Isolation Pressurizer Heater Trip	PMS	20.5	397	20.5	397
	Makeup Pump Stop (Post-"S")	PLS	20.0	391	20.0	391
	Makeup Pump Start (Post-"S")	PLS	10.0	256	10.0	256
Low-2	CMT Actuation	PMS DAS	7.0	215	7.0	216

[1] Approximate Setpoints

8. On p. 2-10, is there any way that operation of the CVS purification loop could cause a thermally stratified single phase flow, which could result in cyclical thermally-induced fatigue stresses?

Response:

As discussed in SSAR section 3.9, thermal stratification has been evaluated for the AP600. The CVS purification line that connects to the PRHR line that connects to the steam generator has been evaluated and found to be insusceptible to thermal stratification. This analysis is currently under review by the NRC.

9. On p. 2-13, interactions due to hydrogen evolution are not considered important due to the concentration and solubility of the gas at RCS operating pressure. What happens when the system is cooled and depressurized, especially when proceeding to either hot or cold shutdown?

Is there any way for sufficient hydrogen to get into the PRHR HX to degrade the natural circulation driving force?

Response:

The operating concentration of hydrogen in the RCS is in the range of 25 to 50 cc/Kg. This corresponds to the saturation level of hydrogen in the RCS at pressures between ~25 to 50 psia. This means that hydrogen out-gassing would not occur at RCS pressure above ~50 psia. Prior to transition to hot or cold shutdown, the RCS hydrogen concentration is reduced to less than 5 cc/Kg. Therefore, RCS out-gassing could not occur until the RCS is near atmospheric conditions. Per the Technical Specifications, PRHR operation is not required once the RCS is depressurized. The final stage of RCS depressurization during shutdown occurs after the RCPs are tripped off. Until then, the RCS pressure is maintained at or above 300 psia. Therefore, at the relatively low hydrogen concentrations in the RCS (5 - 50 cc/Kg), out-gassing that could jeopardize PRHR operation at shutdown is not a concern.

10. Have any events been identified in which the operation of the startup feedwater system could delay the initiation of the PRHR system in such a way as to be detrimental to safety (e.g., if the SFW system ran for a while and then failed)?

Response:

No. As discussed in the report, if the SFW pumps delayed PRHR operation, and then subsequently stopped, PRHR would be actuated on low SG level and low SFW flow. This would occur later in time, with lower decay heat. This case is bounded by the case where no SFW flow actuates, and PRHR is actuated earlier with higher decay heat levels.

11. For the Plant Control System (Section 2.2.13), what impact does the loss of offsite power followed by starting and sequential loading of these systems on the non-safety diesels have on system interactions?

Response:

None. As discussed in this report, nonsafety-related systems are assumed to operate following an accident if their operation can be shown to be detrimental to plant safety. Therefore, for a loss of offsite power coincident with an accident, if operation of a nonsafety system was shown to be detrimental, then it is assumed in the SSAR Chapter 15 analysis.

12. Isolation of the RCDT to prevent overpressurization (p. 2-26) is indicated to be non-safety-related. What are the implications of failure to accomplish this isolation? Is a tank rupture credible? If so, what potential systems interactions might occur?

Response:

If RCDT isolation was not accomplished, then the tank could be ruptured, and a small amount of ADS flow could be diverted from the IRWST to the sump. Due to the small 1" line that connects the ADS header to the RCDT, the amount of bypass would be insignificant. In addition, any steam flow that bypassed the sparger would condense and collect in the containment. Since the RCDT is located at the bottom of containment, and will flood anyway due to the LOCA, the effect is negligible.

13. Component cooling water (CCS) is discussed in Section 2.2.17. This system has direct interfaces with the RCS. Westinghouse should consider a discussion of the system's capability of withstanding pressurization to RCS pressure as a result of a leak from the RCS into the CCS and how the potential for an intersystem LOCA is mitigated.

Response:

Yes. A discussion of this issue will be added to Section 2.2.17.

14. Is there any potential for interactions between the spent fuel pool cooling system (Section 2.2.19) and the RNS that could impact IRWST inventory?

Response:

As discussed in the report, there are several interactions between the RNS and IRWST, and the SFS and IRWST, but there are no interactions between the SFS and the RNS that could affect IRWST water level.

15. CMT/accumulator interactions are discussed in Section 2.3.1.1. Nitrogen from the accumulators is claimed to have no impact on CMT operation. This may not be completely accurate if there is some means by which the CMTs could refill late in an event (as observed in the OSU tests - although this has been regarded as resulting from a scaling distortion in the facility). Also, some ERG instructions permit the operator to isolate the accumulator. Is there any way that the operator could interfere with accumulator injection by incorrectly shutting the isolation MOV while the accumulator still has substantial water in it? Westinghouse should consider addressing CMT refill in Section 2.3.1.9 on CMT/RCS interactions as well.

Response:

Section 2.3.1.1 does not state that accumulator nitrogen has no impact on CMT operation. The statement is, "The potentially adverse interaction between the accumulator nitrogen and the CMT is insignificant". This is because nitrogen is not discharged until the accumulators are almost fully depressurized, at a pressure of less than ~ 100 psig. Any potential nitrogen discharge will not be important to CMT operation because the CMT will have already discharged most of its injection volume before the accumulators empty. Therefore, any potentially adverse interaction on CMT operation is too late to be significant to CMT operation.

There are no significant adverse interactions expected if the CMTs refill late in an event since the IRWST provides injection flow at that time, once the RCS is depressurized. Therefore, nitrogen impact on CMT operation is not expected to cause any significant adverse interactions for the plant.

The accumulator discharge isolation valves are kept in a similar condition to those for current plants, with the discharge motor-operated valve open and the breaker racked out once specified plant conditions are established during plant startup (normally above 1000 psig in the reactor coolant system and continuing the startup process). This increases the reliability of accumulator injection following an event by preventing the valves from inadvertently closing.

In addition, the actuation circuity for the accumulator discharge isolation valves has a confirmatory open signal in the event that the circuit breakers for the valves are installed for any

reason during plant operation. The confirmatory open signal prevents the operator from closing the discharge isolation valves until the actuation signal is removed. The actuation signal is a safety injection signal and the safety injection signal can only be cleared following an event once the SI termination criteria in ERGs/EOPs, which require stable plant conditions following the event, are satisfied.

Therefore, the actuation circuitry design precludes the operator from incorrectly interfering with accumulator injection by shutting the discharge isolation valve when the accumulator has substantial water in it, following an event where safety injection is required.

Finally, the Emergency Response Guidelines provide extremely limited cases where the operator is permitted to isolate the accumulators to prevent interfering with accumulator injection. The Emergency Response Guidelines have been revised so that the only time operators are directed to close the accumulator discharge isolation valves is during a small LOCA when makeup from the nonsafety-related chemical and volume control system is available and the operators are using the post-LOCA cooldown and depressurization procedure.

16. The discussion of CMT/IRWST interactions in Section 2.3.1.2 appears to be focused on SBLOCAs, in claiming that minimal interactions occur between these two ECC systems. What about LBLOCAs, where the ADS is not required to depressurize the plant, and IRWST injection may begin (based on differential pressure) while the CMTs have considerable inventory?

Response:

Section 2.3.1.2 states that "For most LOCA events, there is not a significant amount of injection overlap between these two injection sources. Flow rates from these sources are relatively low, and interactions between these two sources are not considered significant."

This statement was made in the report recognizing that some breaks, such as larger LOCAs, can result in a period of time with injection overlap between these two sources, due to the plant response to the event (such as the specific case described above). However, there are no significant adverse interactions that occur for those LOCA events where there may be parallel injection operation of the CMTs and the IRWST.

In addition, the amount of inventory in the CMTs at the time of parallel injection can vary with the specific LOCA event. By design, the CMTs will not have a "considerable inventory" when IRWST injection begins, even for larger LOCAs. This is because of specific actuation interlocks for the IRWST injection squib discharge isolation valves.

For a large break LOCA, the plant depressurizes quickly with the accumulators providing a large initial injection flow to provide vessel refill and core reflooding. The CMTs then provide subsequent injection flow until sometime later in the event, when they reach the Low-2 CMT level and an automatic actuation signal is generated to open the fourth stage ADS valves and the IRWST injects as the next injection source.

The IRWST cannot provide injection until the CMTs are nearly empty because the IRWST discharge isolation valves are actuated on the same signal that actuates the 4th stage ADS signal -- a Low-2 CMT level.

The difference in IRWST injection timing for a larger LOCA event is that as soon as the 4th Stage ADS and IRWST actuation signal is generated, the IRWST may begin to inject for this event, in parallel with the final stage of ADS depressurization provided by the 4th Stage valves. By this time in the event, the first three ADS stages will have already sequenced, but the plant depressurization has already occurred due to leakage and venting out the break. Therefore, IRWST injection initiates somewhat earlier than for smaller LOCAs which would not have fully depressurized the RCS by the time the ADS fourth stage actuation signal is generated. Therefore, for smaller LOCAs, some additional ADS depressurization would have to occur before the IRWST would begin to inject. This would further reduce the CMT level when parallel CMT and IRWST injection occurs.

For this larger LOCA event, the relatively small remaining volumes of the CMTs below the Low-2 CMT level setpoint will inject through an 8-inch injection line by gravity flow into the direct vessel injection lines. This is in parallel with IRWST injection into the same lines, through parallel 6-inch injection lines. At this time, the IRWST level (pressure compensated by containment pressure) is expected to be at a higher physical elevation than the CMT levels (pressure compensated by RCS pressure). Combined injection flow from both sources in parallel is expected and desired. These two parallel injection flow paths are complementary, working together to ensure injection flow is maintained in parallel with steam venting from the ADS and out the break. The specific injection flow contribution from each injection source is not as important as maintaining the total required injection flow and core cooling, and preventing core uncovery.

For LOCA events, including larger LOCAs, the parallel injection of the CMT and IRWST increases the reliability of injection and does not present an adverse interaction. This parallel injection flow was designed into the AP600 through the use of the direct injection lines for all three safety-related injection sources.

17. The discussion on CMT/PRHR interactions does not take into account the possible role of the PRHR in system-wide interactions, such as those observed in OSU testing.

Response:

The system-wide CMT / PRHR interactions were considered in development of Section 2.3.1.4.

CMT recirculation operation cools the RCS and, therefore, impacts PRHR HX effectiveness since the PRHR heat removal capability will decrease with lowering RCS temperatures as the temperature difference between the RCS and IRWST decreases. When the CMT recirculation and associated RCS cooling slows, the RCS can heat up somewhat because PRHR HX may not be able to match decay heat at lower RCS temperatures. The RCS then subsequently heats up slightly to a temperature where the PRHR can match the core decay heat rate.

18. Accumulator/IRWST interactions are discussed in Section 2.3.2.1. The implication that these two systems have little potential for interaction does not take into account "cascading" effects, i.e., depending on break size and location, accumulator injection could interfere with CMT injection, delaying ADS-4 actuation and opening of the IRWST isolation valves. This "indirect" effect is also not discussed in Section 2.3.2.7, on accumulator/RCS interactions.

Response:

A difference in break size and location can result in changes in the specific response of the passive core cooling system components and the timing and duration of their various injection flows. Therefore, there can be some indirect effects on IRWST operation due to variations in accumulator injection.

As stated in Section 2.3.2.1, "...there are no intervals of significant injection overlap between these two components so that sharing a common injection line does not result in any significant interactions."

This statement is intended to imply that for the range of events observed and analyzed in the system design, which includes a range of break sizes and locations, that overall there were no significant adverse interactions that prevented these two passive components from successfully providing core cooling and keeping the core covered during these events.

19. Accumulators are stated not to have significant interactions with the steam generators (Section 2.3.2.5). Are there any scenarios in which flow oscillations could occur, due to maintenance of natural circulation flow through the steam generator, at pressures low enough to have accumulator injection? If so, what is the potential for interaction between the two systems?

Response:

The accumulators do not significantly or directly impact the SGS from the two perspectives considered in the report (integrity of the SGS boundary and SGS heat removal). No significant adverse interactions have been identified.

From the perspective of SGS integrity, the accumulator will not have any adverse systems interactions.

For some events where PRHR cooling can result in a reduction in the RCS pressure below the accumulator static gas pressure, a small amount of accumulator injection can occur. However, this injection is provided through the direct vessel injection lines and into the reactor vessel cold leg downcomer plenum, where it is mixed with the flow from the four RCS cold legs. The impact of the this relatively small accumulator injection flow depends on the flow conditions in the core at the time of discharge, but it only provides indirect effects on the SGS conditions and does not have any significant adverse interactions with the SGS. Therefore, no significant adverse interactions are identified in Section 2.3.2.5. At no time does nitrogen inject during such events.

This small amount of relatively cool water added to the reactor coolant system from the accumulator can have some oscillatory effect on RCS natural circulation flow conditions, similar to transient effects resulting from other system changes such as varying the SGS feedwater addition rate or steam discharge rate. When these kinds of changes occur under natural circulation flow conditions, the natural circulation flow will vary in proportion to the magnitude of the change and then re-establish a new equilibrium natural circulation flow and heat removal conditions via either the SGS or the PRHR.

In order to inject a large volume from the accumulators, the RCS pressure would have to decrease sufficiently low that the resulting RCS voiding would uncouple the steam generators

from heat removal and core cooling. This amount of voiding in the RCS is not expected without a primary system break, which would prevent any significant adverse interactions between the accumulators and steam generators.

Also see the response to question 36.

20. Section 2.3.3.1, on IRWST/containment interactions, does not address the late-phase oscillations observed in OSU testing, and the possible impact of those oscillations on sump injection. In addition, the OSU tests indicated the possibility of flow from the sump back into the IRWST. It would seem appropriate for Westinghouse to address these interactions, and show that adverse effects are not expected.

Response:

These effects are discussed in the OSU Test Analysis Report. It was concluded that long-term cooling is not adversely affected by these oscillations or by the possibility of flow from the sump back into the IRWST. Therefore, there are no additional adverse interactions between these components related to these two concerns.

See the response to question 36.

21. Section 2.3.3.2, on IRWST/PRHR interactions, appears to be inconsistent with the interaction that is discussed in the immediately previous section of the report, i.e., spurious opening of the recirculation isolation valves. In this case, such an event would deprive the PRHR of its cooling water, creating a potential adverse interaction. In addition, at the end of the section, Westinghouse states that the difference in IRWST temperature has "no significant effect" on gravity injection. However, experimental data indicate that a hot IRWST drains more rapidly.

Response:

The impact of containment recirculation on the PRHR is discussed in Section 2.3.4.1 (Containment Recirculation - Passive Residual Heat Removal Heat Exchanger) and is not addressed in Section 2.3.3.2.

Section 2.3.4.1 should include the following paragraph to address the potential interactions of spurious containment recirculation actuation on the PRHR heat exchanger. This additional paragraph essentially repeats the information provided in the last paragraph in Section 2.3.3.1 that discusses the spurious opening of the containment recirculation valves in relation to IRWST and containment recirculation interactions.

"An adverse interaction can occur due to spurious opening of the containment recirculation isolation valves. This occurs if the line with the motor-operated valve and explosive valve is opened and the IRWST starts to gravity drain to containment, causing floodup of containment. This event does not result in any plant transient, but it does have some adverse effects if the IRWST is allowed to drain significantly. The spurious opening of these valves is prevented by the instrumentation and control design. The response to spurious opening of the containment recirculation isolation valves is to confirm that the actuation is spurious and then to take operator actions to close the motor-operated valve. This is not a significant interaction since it does not cause a plant transient and there is sufficient time, alarms, and indications to allow the operators to diagnose the problem and take the corrective actions required. In addition, if the

motor-operated isolation valve spuriously opened to initiate draining, it is expected that it would again function properly to close and terminate the IRWST flow."

Section 2.3.3.2 discusses interactions between the IRWST and the PRHR heat exchanger and, therefore, the last part of this question related to the PRHR impact on IRWST temperature is included in this section.

It is recognized that the PRHR heating of the IRWST water increases the water temperature, which does affect the gravity injection flow rate. However, the expected range of water temperature variations is not expected to provide any significant adverse systems interactions on the gravity injection capability.

The last sentence in the question is not clear in stating that the "experimental data indicate that a hot IRWST drains more rapidly" than when the IRWST water is cold. Given all other identical conditions, this is not expected to be the case.

For a system with the same injection line piping flow resistance, system pressure, and IRWST overpressure, the gravity injection elevation head for cold water is larger than for warm water and, therefore, the gravity injection flow is greater. If the experimental data indicates that the hot IRWST drains more rapidly, then different plant conditions must exist such that some other parameter(s) than only the injection water temperature must have been different.

22. Section 2.3.3.4 (IRWST/PCCS) does not discuss the effect that containment pressure has on IRWST actuation. Since IRWST injection is a function of the difference between RCS and containment pressure, elevated containment pressure will affect the timing of inception of flow from the IRWST to the RCS. A similar comment applies to Section 2.3.4.3 (containment recirc/PCCS), since containment backpressure will have an impact on timing of IRWST injection and, subsequently, sump injection.

Response:

The containment pressure does affect the timing for the actuation of both IRWST gravity injection and containment gravity recirculation since it affects both the gravity injection overpressures and RCS venting backpressures. However, these interactions were implicitly considered in the report since the system design must accommodate the range of containment pressures that will exist following the Chapter 15 design basis accidents.

As stated in the report, these design interactions have been confirmed as part of the testing and plant analyses. Therefore, no significant adverse interactions have been identified for the IRWST or containment recirculation resulting from the containment pressures maintained by the passive containment cooling following the design basis events.

23. Section 2.3.5.1, PRHR/ADS, primarily focuses on the impact of IRWST heating on ADS behavior. Consideration should be given to discussing an indirect interaction, via the RCS, in which PRHR cooling reduces RCS temperature, affecting pressurizer inventory and thereby impacting operation of ADS 1/2/3. Another indirect interaction involves ADS-4; again, PRHR operation affects fluid conditions at ADS-4 actuation, which may be more or less important, depending on the scenario.

Response:

The end of the first paragraph in Section 2.3.5.1 specifically addresses this interaction by stating that "PRHR HX cooling prior to ADS operation can also impact the initial RCS pressure when ADS actuates. These design interactions have been confirmed as part of the testing and plant analyses." Therefore, no significant adverse interactions have been identified for the ADS (both Stages 1/2/3 in the pressurizer and Stage 4 in the hot legs) resulting from the RCS pressures established by the PRHR following the design basis events and prior to ADS actuation.

24. In Section 2.3.5.2, Westinghouse states there are no direct interactions between the PRHR and the PCCS. In the case of long term cooling using PRHR, is there a possibility that PCCS operation is needed to keep sufficient water in the IRWST (via condensation return) to allow the PRHR HX to continue to operate? That is, if the PCCS was not providing containment cooling, could enough water inventory, due to boil off of the IRWST, be entrained or held up in the containment to impact continued operation of the PRHR?

Response:

There are no direct interactions between these the PRHR and the PCS as discussed in Section 2.3.5.2.

However, Section 2.3.3.4 discusses the interactions between the IRWST and the PCS once the PRHR actuates and increases the IRWST temperature sufficiently high to initiate steaming to containment. As discussed in this section, the PCS interacts with the IRWST to affect both the IRWST temperature by establishing the long-term saturation temperature and level being affected by the condensation rate and operation of the PXS condensate return valves. Long-term cooling using PRHR would be expected following non-LOCA events.

Without condensate return, the IRWST inventory is sufficient to allowed continued PRHR operation for up to 72 hours. However, IRWST level will continue to decrease during this time period, causing more of the PRHR HX tube surface area to become uncovered over time. But at the same time, the core decay heat is decreasing and PRHR operation is adequate to provide core cooling during this time period.

PCS actuation is required to function as a heat sink during this time period to prevent an increase in containment pressure, but providing PCS condensate return to maintain the IRWST level during this time period is not required. This more detailed information is discussed in the AP600 SSAR.

25. Section 2.3.5.3 addresses the PRHR and SGS interactions. However, there is no discussion on the early-phase, system-wide oscillations observed in the SPES-2 integral systems tests (during the period in which flow through a SG was maintained). These oscillations (or oscillations of a similar character) were also observed in the SGTR test in the SPES-2 facility. Westinghouse should consider addressing the impact of these oscillations. A similar comment is relevant to Section 2.3.6.2 (ADS/SGS).

Response:

See the response to question 36.

26. Section 2.3.5.5 (PRHR/RCS) does not consider the effect of the PRHR on RCS inventory and thermal-hydraulics. Further, the issue of stratification in the primary system and its possible impacts are not addressed.

Response:

Section 2.3.5.5 does specifically address the PRHR effect on RCS inventory and highlights some thermal-hydraulic effects; however, the specific aspects of interest in the first sentence above, beyond thermal stratification, need to be clarified.

Paragraph 2 discusses both forced flow heat removal from reactor coolant pumps and natural circulation flow heat removal, single-phase and two-phase heat transfer, and the IRWST heatup. Paragraph 2 continues with the statement that "As the RCS cools down and contracts, RCS voiding may occur, which can eventually change the PRHR HX transfer process to steam condensation heat transfer..."

The issue of thermal stratification is not specifically discussed, however, the final statement in this section is intended to bound the identified design interactions. The last sentence states that "These design interactions have been confirmed as part of the testing and plant analyses."

The discussions in Sections 2.3.3.4 and 2.3.4.3 will be revised to specifically address this comment by including information related to thermal stratification interactions.

27. The last paragraph of Section 2.3.6.1 (ADS/PCCS) states that PCCS performance affects the ADS via containment backpressure. It is not clear that this is true all of the time. If the ADS is in critical flow, it would appear that containment pressure should have little effect on ADS flow. In the late ADS-4 phase, containment pressure will affect the transition to subcritical flow, depressurization rate, and--ultimately--IRWST injection. These same comments are relevant, as well, to Section 2.3.7.3 (PCCS/RCS), since the ADS flow impacts both RCS inventory and timing of IRWST and sump injection for maintenance of long-term core cooling.

Response:

The PCS does affect containment pressure by cooling the containment, which condenses the steam in the atmosphere and helping to reduce the pressures that occur following an event. The focus of this comments in Section 2.3.6.1 related to containment effects on ADS performance are primarily associated with the very late stages of the depressurization process.

It is clearly recognized that at RCS pressures that are much higher than the expected range of containment pressures (early in an event), that critical flow exists from the ADS stages and containment pressure variations have no significant impact on ADS performance until the transition to subcritical flow is approached as the RCS continues to depressurize.

Later in the ADS depressurization sequence when RCS pressure is much lower and decreasing, approaching about twice the existing containment pressures, the operation of the ADS moves out of a critical flow regime. At this late time in the depressurization, and later, the existing containment pressure, which is significantly affected by PCS operation, has more significant effects on both RCS injection and ADS vent flow.

The discussion in Section 2.3.6.1 also briefly discusses the expected transitory response of the RCS to injection and venting process changes, as well as with core decay heat changes.

The discussions for Sections 2.3.6.1 and 2.3.7.3 will be revised to clarify this issue.

28. Section 2.3.7 addresses PCCS/containment interactions, and discusses only spurious operation of the PCCS. It does not address at all the failure of the PCCS, e.g., effects on containment if no water cooling were available to augment external containment heat transfer.

Response:

The purpose of this report is to evaluate potential adverse systems interactions related to the design basis licensing analyses identified in Chapter 15 of the AP600 SSAR and the associated PRA analyses for these events. The scope of this report is to address the design basis operation of the identified systems, including credible single failures that are postulated to occur in the operation and associated safety analyses for these safety-related systems.

This report is not intended to address potential adverse systems interactions for either beyond-design-basis accidents or for severe accident conditions, including beyond-design-basis failures of systems and components that would be required for either of these circumstances to occur.

The failure of passive containment cooling to actuate can only occur with beyond-design-basis component failures due to multiple failures of redundant safety-related valves. The containment interactions that occur for the beyond-design-basis failure of the passive core cooling system to actuate are outside the scope of this report.

<u>Human Factors</u>

29. In addition to human factor related concerns raised in question 1, 4, 6, and 15 above, several other human reliability issues could be elaborated on in this report.

a. The operator has the capability, in a station blackout, to override the automatic ADS actuation just prior to 24 hours. The rationale for including this actuation, as understood by the staff, is to ensure that sufficient battery power is available to open the ADS valves. Suppose that an operator overrides the actuation at 24 hr (minus), but then finds at some time thereafter (say, 36 hours) that it is necessary to actuate the ADS. What are the effects of such a scenario? Is sufficient power available? When does power cease to be available? What alternatives would the operator have if power were not available? Are there other situations in which delaying an action (either actuating a system or overriding its actuation) could have a significant impact on plant response?

b. At the end of Section 2.3.6.2, Westinghouse states that the AP600 ERGs provide guidance on manual actuation of ADS-1 to terminate an SGTR event. How is this addressed in terms of human reliability? What if the operator makes an error and causes actuation of the entire ADS system?

Response

a. During a prolonged station blackout event, it is intended that the manual override of the timer-driven ADS actuation would be implemented no later than 22 hours into the event.

Loads supplied by the 24-hour battery are de-energized at the time of the override decision. This would allow battery conservation. Thus, it is expected that these batteries would have at least a two-hour charge for a later ADS re-actuation, if needed.

If the event continues beyond 24 hours, the 72-hour batteries allow the operators to monitor the plant parameters to decide if ADS actuation is needed. Operator action of ADS re-actuation would also include opening of the squib valves for IRWST injection and containment recirculation functions. Also, there is ample time before the 22nd hour is reached to evaluate the plant conditions and decide whether the manual ADS override is needed or not.

Written procedures would be provided for the above described operator actions of overriding and re-establishing of ADS actuation following a prolonged station blackout event.

Since the batteries are conserved, as described above, sufficient power is available for re-actuation of ADS during the 22-72 hour time frame. The actuation power is available in the 24-hours batteries after 72 hours. Offsite resources may be invoked to retain the plant monitoring function.

In the spectrum of events studied for AP600, the above-discussed action is the only known case where overriding a safety-related system is envisioned, and it applies to a rare event (e.g. station blackout) which is made even more improbable by considering it be prolonged over 20 hours.

b. If the operator makes an error and actuates the entire ADS system in the above mentioned case, the ADS operation will successfully reduce the RCS pressure, thereby terminating the primary to secondary leak. This success path is already modeled in the AP600 PRA, in the SGTR event trees, as one of the multiple success paths in a SGTR event.

The operator action of manual ADS-1 actuation (labeled as ADF-MAN01 in the PRA) is credited in the PRA only if CVS, SFW, and condenser are available and operator action of pressurizer spray actuation fails. ADF-MAN01 is assigned a failure probability of 0.5. However, the commission error described in the question is not quantified. No adverse conditions that would lead to compounding such a commission error have been identified; in the absence of such conditions, the probability of such a commission error is expected to be low (e.g. at the order of 0.0001).

30. Errors of commission are discussed on pp. 3-15 and 3-16, and are specifically connected to actions in the ERGs. Please address the following questions and comments:

a. What is the impact if the operator fails to start the CVS pump, since starting a pump is "a part of the expected response to the event"?

b. With regard to SFW pump interactions in an SGTR, are there any consequences if the operator fails to follow the procedure discussed?

c. Concerning spent fuel pool cooling system interactions (bottom of p. 3-16), Westinghouse states that the effects of SFP accidents "develop slowly" and are thus of insignificant risk. How fast could such events be diagnosed? What is the impact of these events on shutdown risk?

Response:

a. In the SGTR event, the aligned CVS pump is expected to start automatically (due to low pressurizer water level); credit is given for the manual actuation of the standby pump, if the auto start fails. In that case, if the operator action fails, then the CVS would not be operational. This condition is explicitly modeled in the PRA (by CVN-MAN03 operator action) and is incorporated into the risk profile of the plant.

b. As modeled in PRA, in the SGTR event tree, the SFW system is expected to actuate automatically due to low SG water level in the faulted SG; the operator action by procedures is credited if the automatic actuation does not take place. If the operator action also fails, then the next success path would be entered; namely the successful isolation of the faulted SG; CMT injection; and passive RHR operation. This success path does not take credit for decay heat removal by the secondary side.

c. SFP level and temperature are monitored in the main control room and are also alarmed. So the SFP accidents due to loss of cooling or water level can be diagnosed immediately. The impact of these events on shutdown risk is insignificant. If the SFP cooling is lost, it takes several days before the boil-off reduces the SFP level to the point where it needs to be replenished; this allows ample opportunity for response to the event. Even the fastest conceivable water level loss event (inadvertent draining of SFP water to the IRWST during refueling when the gate is open) takes 8 hours to reduce the water level to the point where it needs to be replenished. This event is easily diagnosable in the main control room and can be terminated by closing the diversion valves to the IRWST or installing the gate. Thus, the SFP events are not further analyzed in shutdown PRA.

Miscellaneous General Comments

31. Westinghouse should discuss what consideration was given to "indirect" interactions due to instrumentation and controls systems and/or transitory effects (although some credit is taken for the ability of I&C design to "minimize spurious signals" that might cause adverse interactions). For instance, closure of turbine stop valves could create a level transient (or an indication of a level transient) that could actuate the PRHR system. INEL predicts this could happen. It is not clear what the ultimate effect would be for: LOCAs (initiates PRHR operation before "S" signal would normally operate); non-LOCA transients and AOOs (could start PRHR operation earlier than might otherwise be the case, resulting in additional inventory shrinkage -- the ultimate effect is likely to be scenario dependent); or spurious actuation (spurious actuation of PRHR system). If nothing else, the adverse interaction could simply be more actuations over plant lifetime than the PRHR system is designed for.

Response:

As stated in this comment, the issue is not a safety concern, but rather one of plant operation following a transient. Westinghouse has selected the PRHR actuation setpoints to avoid actuation on a turbine trip. Actuation of PRHR for such an event is bounded by the accident analysis provided in SSAR Chapter 15.2.3 for Turbine Trip.

32. The emphasis in the report is on passive-passive and passive-active interactions that can directly affect the passive safety systems. Are there any "active-active" interactions of interest, i.e., an interaction between two active systems that could act to impede (or cause spurious actuation of)

a passive system? This could include secondary or tertiary effects, such a feedback from the turbine/generator system through the steam generator to the primary loop. For example: Table 2-1 does not show any systems beyond the secondary side of the RCS. How about effects deriving from: turbine/generator (e.g., closing of stop valves causing level transient in SG that actuates PRHR); other indirect interactions--such as transients caused by malfunctions of the EHC system; interactions caused by spurious actuation of the reactor protection system or failure of turbine-over-speed protection.

Response:

Spurious actuation of passive systems are evaluated in the SSAR Chapter 15 analysis. Therefore, any combination of active systems that could cause a spurious actuation of a safety system is bounded by the analysis presented in Chapter 15 of the SSAR. This report identifies interactions that could occur that could degrade the performance of the safety systems once they have been actuated. Any such interactions identified should then be accounted for in the SSAR Chapter 15 accident analysis.

33. There are interactions noted that involve the spent fuel cooling system. One rationale given for a low level of concern is that "spent fuel pool accidents are not deemed to be of risk significance." It is not clear that this is consistent with our expressed concern with shutdown risks, or with the recent technical issue on the SFP cooling system, which are still under discussion with Westinghouse.

34. Many actions described in the report involving valve position changes are noted as "safety-related." Examples include: CVS isolation valves (p.2-11); main feedwater isolation functions (discussed on p. 2-14; these are not explicitly stated to be safety-related, but are assumed by the reviewer to be so); SG blowdown line isolation functions (discussed on p. 2-17); containment sump pump isolation (p. 2-26); primary sampling system (not stated to be safety-related but assumed by the reviewer to be p. 2-27 - 2-28); spent fuel pool cooling system isolation (also assumed to be safety related by the reviewer, p. 2-29). Are they all single-failure proof?

Response:

Yes, these isolation functions stated are safety-related and are designed to be tolerant of single-failures.

35. Minor comment: Even if the condensate return lines (non-safety-related) function properly (see p. 2-37, third paragraph in Section 2.3.1.5), some condensate may end up in the sump rather than the IRWST.

Response:

Yes.

36. Section 2.3.3.3, on IRWST/ADS interactions, does not consider any of the oscillatory behavior noted in the AP600 integral systems tests, including both oscillations at the start of IRWST injection, and the late phase oscillations. In both of these cases, the ADS-4 configuration appears to play an important role in the development and characteristics of the oscillations. Westinghouse should consider including a discussion of this behavior and evaluate the possibility

of adverse effects. Since these oscillations also affect the RCS, the same comments apply to Section 2.3.3.7. These oscillations are also relevant to the Sections 2.3.4.2 (containment recirc/ADS), 2.3.4.6 (containment recirc/RCS), and 2.3.6.4 (ADS/RCS).

Response:

The oscillatory behavior noted in the AP600 integral systems tests was considered in the evaluation of the adverse systems interactions, but were not explicitly discussed in the report.

Additional comments will be added to the following sections of this report to indicate that the oscillatory behavior noted during the AP600 testing does not cause any significant adverse systems interactions for these components since satisfactory core cooling can be maintained and core uncovery is prevented. In addition, the observed oscillations during the testing were damped.

2.3.2.5	Accumulator - SG
2.3.3.1	IRWST - Containment
2.3.4.2	Containment Recirc - ADS
2.3.4.6	Containment Recirc - RCS
2.3.5.3	PRHR - SG
2.3.6.2	ADS - SG
2.3.6.4	ADS - RCS

37. Loss of instrument air in its entirety or partially can have significant impact on both active and passive systems (CMT, PRHR, Containment Isolation of active systems). Although it is recognized that the air operated valves will fail to their safe position, there could be substantial impact on the overall behavior of the plant due to the shear number of systems affected. Since loss of instrumentation as an initiating event and on a system bases has been examined in the PRA, it would seem appropriate that Westinghouse address the PRA insights on potential adverse system interactions from the loss of instrument air in this report.

Response:

The following insights relate to loss of instrument air from the PRA study:

1. For safety related systems and functions, the valves that need to change position either do not use air, or fail safe after loss of air. An example of fail safe case is the CMT AOVs, which open upon loss of air, signal, or DC power. Such an opening would not create any adverse system interactions. The same comments apply to the passive RHR valves. Moreover, the type of AOVs used in these two safety related systems are different to minimize potential common cause failures.

2. For non-safety related functions, SFW control valves are air operated and would be affected by loss of air. To allow use of these valves after such an event, air bottles are provided. Moreover, these valves can be manually and locally controlled.

3. For CVS system air operated valves, upon loss of instrument air, the auxiliary spray line isolation valve fails closed; the charging stop valve fails open; the makeup pump suction header valve fails aligned to the boric acid tank; makeup flow control valve fails open.

Therefore, CVS is still able to provide flow to the reactor control system via the normal system flow path, but the pressurizer auxiliary spray is unavailable.

4. The AP600 PRA models the effects of loss of air on safety related and non-safety related systems. The PRA study shows that the instrument air system is not a risk significant system. Also, the contribution of the loss of instrument air initiating event to the plant core damage frequency is very small (0.1%). The fail-open design of passive RHR and CMT system air operated valves provides reliable actuation of these systems in loss of offsite power and station blackout events, and contributes to the reduction of risk due to these events.

38. Will spurious opening of the CMT discharge valves (not due to a CMT actuation signal), cause the RCPs to trip? For example, loss of air to the CMT discharge valve will result in them failing open - will this cause the RCPs to trip? If not, what adverse effects would this cause?

39. The adverse effects of cold weather on the operation of the PCCS appears to merit some consideration. For instance, under extremely cold temperature conditions, it is conceivable that the annulus floor drains at the bottom of the containment annulus could ice up. Actuation of the PCCS would result in cooling water not evaporated from the containment vessel water accumulating in the lower annulus. Enough water accumulation could eventually affect annulus air flow and degrade PCCS operation. In addition, icing of the distribution bucket and weirs could affect distribution of PCCS flow on containment.

40. The stage 1, 2, and 3 ADS discharge lines have vacuum breakers to prevent water hammer following ADS actuation. What are the consequences of ADS actuation with the breakers unseated such that ADS discharge is diverted directly into containment rather than quenched in the IRWST? How is the position of the vacuum breakers determined and monitored?

41. The pressurizer safety relief valve discharge lines appear to have a drain line connection to the ADS valve discharge lines. It would seem that actuation of the ADS valves could pressurize the safety relief valves discharge line and blow the rupture disk. What adverse effects would this have on system operations? In addition, if ADS-1 is used manually to depressurize, will the operator have to manually close the drain line isolation valve to the RCDT?

42. In order for the IRWST to function properly, it must directly communicate with the containment atmosphere. Steam and pressure venting capabilities of the IRWST are discussed in the SSAR but there does not appear to be any description of the vacuum relief assurance for the IRWST. The staff assumes that the IRWST design will have a vacuum relief design sufficiently sized to permit required drain down. However, has the possibility of clogging or obstruction of the vacuum relief paths been considered along with any adverse effect this would have on IRWST draining? Westinghouse should consider including a discussion on this in the adverse systems interaction report and a description of the venting design in the SSAR. This concern would also be applicable to vacuum venting design and potential for clogging/obstructions for the PCCS tank.

43. Are there any adverse interactions or effects possible from ADS blowdown on the IRWST level instrumentation?

44. The passive autocatalytic recombiners (PARS) are designed to prevent hydrogen buildup from DBA events from exceeding 4 percent. In a severe accident context, the hydrogen concentrations

in containment could approach 10 percent. Are there any adverse consequences from the PAR operating in this higher hydrogen concentration environment (such as overheating or flaming of the gas discharged from the PARs)?

Response:

In the event of a severe accident, hydrogen ignitors would be used for the purpose of burning hydrogen generated in containment before high concentrations are reached. In the event that the PARs continue operating in a higher hydrogen concentration environment, there would be no adverse effect due to a postulated elevated exhaust temperature emanating from the PARs because the PARs are placed in locations for which elevated exhaust temperatures do not effect other equipment inside containment.

45. The main control room habitability system maintains control room air pressure with pressure relief dampers. What are the consequences of a failure of one of these dampers?

Response:

A failure of one of the pressure relief dampers is compensated for by closing one of the pressure relief isolation valves upstream of the damper. Two redundant pressure relief flow paths are provided to account for a single failure, such as a damper. One flow path has sufficient vent area to accommodate the air delivery from both trains of emergency air storage tanks.

46. What controls are provided to ensure the quality of the air in the main control room habitability system air storage tanks? Has the possibility of degradation of the air quality in the storage tanks with time been considered (due to material coatings, grease, other unidentified contaminants within the tanks that could gradually sublime and mix with the air)?

Response:

The emergency air storage tanks are steam cleaned by the vendor, dried, and filled with dry nitrogen prior to shipment. After arriving on site, the tanks are purged of nitrogen and filled with clean, dry air, which meets the specifications established by the VES system. The quality of air stored in the tanks is ensured by periodically extracting a grab sample from the system and performing a lab analysis of the sample. The sample interval will be established by the COL applicant.

47. Is it possible for a secondary side break or rupture (within containment) to cause and actuation of the ADS system? Under such circumstances, significant additional water inventory will be added to containment; are there any adverse conditions possible from such a scenario (such as boron dilution)?

48. Section 2.3.6.4 of the adverse systems interaction report states that a "spurious ADS LOCA is a terminable LOCA event, [although] operators are not instructed to terminate ADS." Please explain this statement. Information in Table 3-1 differs in that it states that "procedures exist to terminate the event" [spurious ADS]. How would a spurious ADS be terminated?

Response:

The comments above are contained in Section 3.4 and the associated Table 3-1 that refer to a specific event discussed in Section 2.3.6.4 (ADS / RCS) -- spurious ADS during power operation. Section 3.4 specifically addresses the evaluation of potential human commission errors related to these two passive safety-related subsystems.

For clarification, there are two potential types of spurious ADS actuations will be addressed by this response:

- A system-level ADS actuation signal that results in the sequencing of ADS Stages 1-3
- A nonsystem-level actuation, such as a single ADS line that spuriously opens

For the system-level case, a spurious ADS is an event that can be terminated. But like any safety-related actuation signal, termination is allowed only under some very specific conditions. In general, termination of any plant safeguards actuation signal in the Emergency Operating Procedures (EOPs) is performed in order to restore the plant after plant conditions have become stable and subsequent plant recover is anticipated using specific plant procedures.

If a spurious system-level ADS occurs, the EOPs would confirm that proper systems responses occurred and that at some point in the procedures, stable plant conditions exist and are being maintained that allow the actuation signal to be reset and the safety-related systems to be removed from service.

So the statement in Section 3.4 is correct, meaning that under the specific termination criteria in the EOPs, the system-level ADS actuation signal could be reset and the plant restore to a stable condition with the ADS system removed from service (by closing the ADS valves).

However, the statement that the operators are not instructed to terminate ADS is intended to show that the automatic ADS actuation would not be interrupted so that only partial actuation occurs and that the plant is in an intermediate condition where termination is not allowed -- and under conditions that would probably not meet the associated termination criteria.

In the ADS design, there are two separate actuation signals:

- Actuation of the Stage 1 to 3 timing sequence
- Subsequent Stage 4 actuation if CMT level continues to decrease

The operators would not be allowed to interfere with the Stage 1 to 3 sequence until it was completed and conditions to terminate safety-related systems were satisfied. If stable conditions existed that did not require the additional Stage 4 actuation on a continually decreasing CMT level, such as through recovery of RCS inventory using the nonsafety-related chemical and volume control system makeup pumps, then the operators could terminate ADS operation at this time.

For the second case listed above, where a system-level actuation has clearly not been generated and the spurious ADS actuation involves spurious opening (such as the spurious opening of both series valves in a single ADS line), the operators would be expected to confirm that the system-level actuation signal is not present and then to attempt to manually close at least one of the two spuriously open series ADS valves in the affected line to stop the spurious RCS depressurization.

These operators actions would be equivalent to operator actions in currently licensed plants to close a spuriously opened, safety-related steam generator atmospheric power-operated relief valve, that was opened in a condition outside of its normal actuation conditions due to a malfunction in the automatic actuation circuitry, to stop a spurious steam generator depressurization.

49. Extensive effort is being placed on the human factors design of control room operator controls for the AP600. For example, manual actuation of the ADS requires two separate operator actions. Experience indicates that many human factors related events are a result of errors during testing or maintenance of I&C components. In the case of a spurious ADS signal, Westinghouse states in Table 3-1 that the most likely human error may be related to testing or maintenance of instrumentation. Related specifically to the ADS-4 squib valves, what protection is provided by the design of the ADS-4 actuation circuitry to prevent an inadvertent discharge of a squib valve during surveillance testing, trouble shooting, or repairs being conducted inside the applicable I&C cabinets in the PMS system. For example, what measures would prevent a technician from accidently performing a continuity check on the electrical leads to a squib valve explosive charge (assuming that such a check could result in the firing of the charge)? Are there any other systems in which an inadvertent actuation due to maintenance or I&C could have significant adverse effects.

50. Related to the human factors aspects of question 29 above concerning actions following an extended station blackout, there may be a need for operators to take some additional actions if temperature limits are being approached in the I&C cabinets due to lack of normal control room cooling. What actions could the operator be expected to take and is there a potential for errors of commission or omission? What would be the consequences of a such errors?

Response

As discussed below, there is no need for operator actions for cooling I&C cabinet rooms, or the control room during the 72-hour period following an extended station blackout or loss of ventilation system. Thus, there are no postulated omission or commission errors.

The temperature in the I&C rooms following a loss of the nuclear island non-radioactive ventilation system remains below 120°F over a 72 hour period. If cooling is required beyond 72 hours, the room doors are opened and cooling is achieved via natural circulation. Alternatively, portable fans with flexible ducting may be obtained from offsite, and used to deliver convection cooling to each of the electrical equipment rooms using ambient air, as needed.

The same discussion applies to the main control room.

51. There appears to be the possibility of adverse effects following the termination of an abnormal event. For example, the CMTs could be actuated during an event which is then successfully terminated after a period of CMT recirculation. This would leave the CMTs full of hot water at elevated pressure. What potential interactions could occur as the CMTs are cooled? How are these interactions prevented or mitigated? In general, have interactions of this type (i.e., recovery from terminable sequences) been considered?