April 15, 1994

Docket No. 52-003

APPLICANT: Westinghouse Electric Corporation

FACILITY: AP600

SUBJECT: SUMMARY OF MEETING TO PRESENT AN OVERVIEW OF THE AP600 DESIGN

On March 22, 1994, representatives of the Nuclear Regulatory Commission and Westinghouse met to discuss the overall design features of the AP600. Enclosure 1 is a list of attendees. Enclosure 2 is the slide presentation made by Westinghouse.

Westinghouse discussed the design philosophy used while developing the AP600 design. The designer then discussed the safety- and non-safety-related systems of the AP600, including the reactor systems, the instrumentation and controls, the electrical power system, and the balance-of-plant mechanical and fluid systems. Westinghouse also discussed the plant layout, using a scale model of the plant.

Original Signed By,

Thomas J. Kenyon, Project Manager
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and License Renewal, NRR

Enclosures:
As stated

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DATE	04/13/94	04/14/94	04/14/94

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Westinghouse Electric Corporation

Docket No. 52-003

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WESTINGHOUSE AP600
MEETING ATTENDEES
MARCH 22, 1994

Name	Organization
Thomas Kenyon	NRR/PDST
Andrea Sterdis	Westinghouse
Ty Schuly	Westinghouse
D. O'Connel	Bechtel
Shou-nien Hou	NRR/SRXB
Alan Levin	NRR/SRXB
Don McPherson	NRR/DSSA
Tsong-Lun Chu	BNL
Bob Youngblood	Brookhaven
Jim Lyons	NRR/SPLB
Ralph Architzel	NRR/PDST
Kris Shembarger	NRR/PDST
Narin Trehan	NRR/EELB
Tony Attard	NRR/SRXB
Frank Orr	NRR/SRXB
Skip Young	NRR/PSGB
David Diec	NRR/SRXB
David R. Dickerson	South Company
Kaz Campe	NRR/DSSA
Jim Lazevnick	NRR/EELB
Angel Coella	NRR/EELB
Tim Mitts	Battelle PNL
Juan Peralta	NRR/DRIL
S. B. Sun	NRR/SRXB
Frank Talbot	NRR/RPEB
Rafael Ledesma	NRR/HICB
Suzie Wittenberg	NRR/HICB
Mario Gareri	NRR/HICB
Clay S. Mayberry	NRR/SPLB
Reno Alamsyah	RES-NRC
Chang-Yang Li	NRR/SPLB
Y. C. (Rene) Li	NRR/EMEB
Jin-Sien Guo	NRR/SPLB
Y. Gene Hsii	NRR/SRXB
George Thomas	NRR/SRXB
Chris Hoxie	NRR/SCSB
Michael Snodderly	NRR/SCSB
Janak H. Raval	NRR/SPLB
Harold Walker	NRR/SPLB
Jeff Holmes	NRR/SPLB
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Donald Carlson	RES/RPSB
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Bintoto Asi	BATAN/IND.
Hulbert Li	NRR/HICB
Nick Saltos	NRR/SPSB
Jack Wheeler	DOE
Forrest T. Johnson	Westinghouse
J. Sorenson	

Enclosure 1

WESTINGHOUSE ELECTRIC CORPORATION

PRESENTATION

TO

UNITED STATES

NUCLEAR REGULATORY COMMISSION

March 22, 1994

0009als/1

Enclosure 2

WESTINGHOUSE ELECTRIC CORPORATION

PRESENTATION

TO

UNITED STATES

NUCLEAR REGULATORY COMMISSION

March 22, 1994

0009als/1

INTRODUCTION

ANDREA L. STERDIS

ADVANCED PLANT SAFETY AND LICENSING

AGENDA

- Introduction — Andrea L. Sterdis
  - Project Organization
  - Schedule
- Plant Systems Overview — Terry Schulz
  - Design Approach
  - Safety-Related System Design
  - Nonsafety-Related System Design
  - System Shutdown Capability
  - Levels of Defense
  - Regulatory treatment of nonsafety-related systems
- Instrumentation and Control — Dave Vaglia
  - I & C Systems
  - Man-machine Interface

AGENDA (continued)

- Electrical Power — Dave Dickerson
  - Main ac power
  - Onsite standby power
  - Class 1E and non-Class 1E dc and UPS
  - Lighting
  - Communications
- BOP Mechanical / Fluid Systems — Mike O'Connor
  - Auxiliary fluid systems
  - HVAC
  - Steam and power conversion
  - Water and waste treatment
  - Mechanical handling systems
- Plant Layout / Structures — Tom Johnson
  - Separation
  - Rad waste facilities

AP600 TEAM

- Westinghouse
  - Program management
- Bechtel Power Corporation
- Southern Company Services
- Burns & Roe Company
- MK-Ferguson Company
- Avondale Industries, Inc
- Chicago Bridge & Iron Services, Inc
- Others

DESIGN CERTIFICATION SUBMITTALS

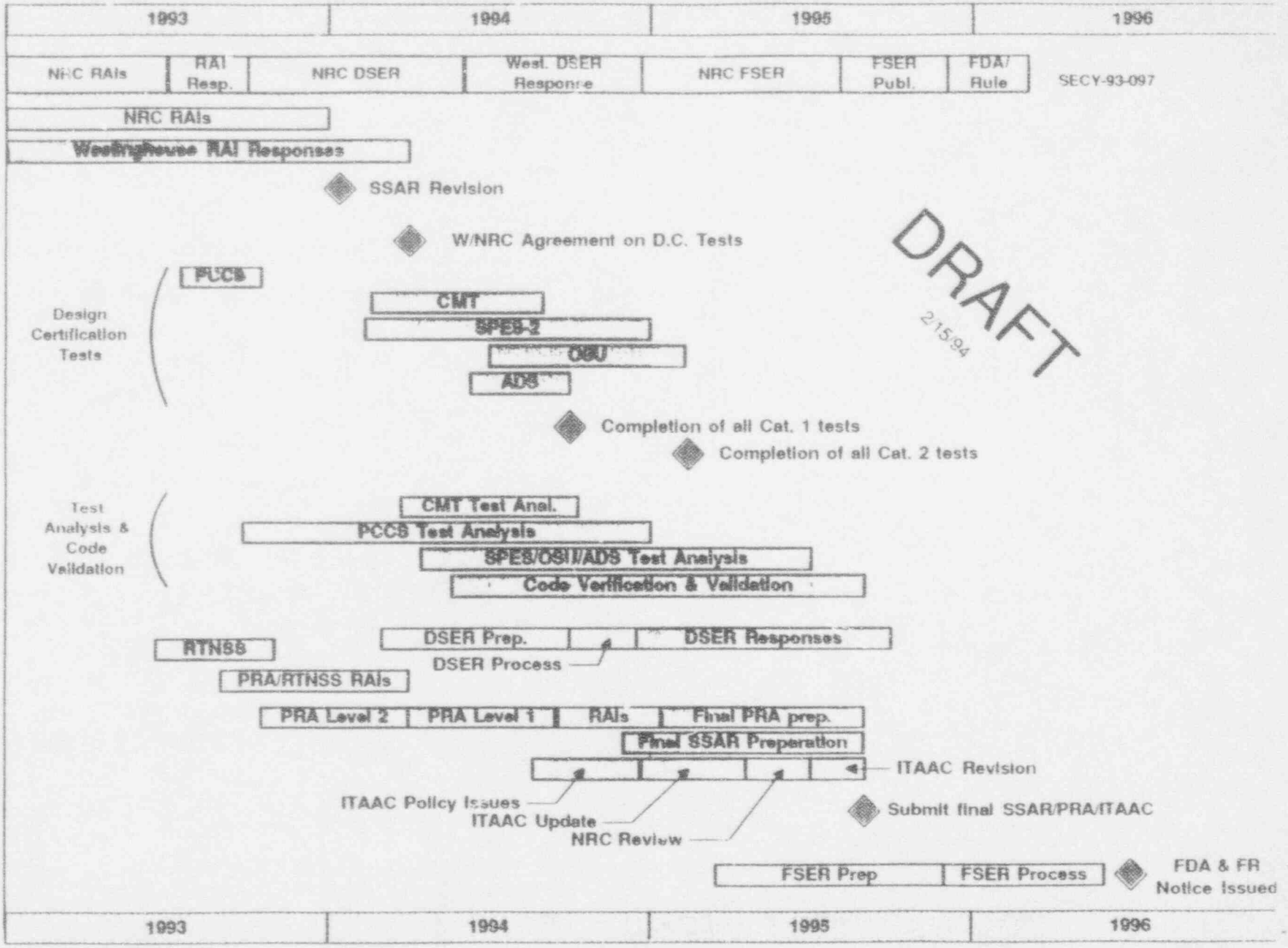
- June 26, 1992
  - SSAR
  - PRA
- December 1992
  - ITAAC / Tier 1 Information
  - NEPA / SAMDA
  - Operating Experience Review
- Requests for Additional Information
  - Approximately 1400 received
  - 1211 responses

SSAR STRUCTURE

AP600

- Follows RG 1.70, Revision 3 format and content
- General sections with overall applicability
  - Section 1.9
    - Regulatory Guide conformance
    - TMI items (10 CFR 50.34 (f))
    - GSIs / USIs
    - ALWR issues (SECY 90-016)
    - SRP compliance
  - Section 3.1
    - GDC compliance
  - Section 3.2 and Appendix 3D
    - SSC classification

AP600 DESIGN CERTIFICATION SCHEDULE



AP600
PLANT SYSTEMS
OVERVIEW

T. L. SCHULZ
SYSTEMS ENGINEERING

AP600 PLANT SYSTEMS OVERVIEW

1. **Design Approach**

2. **Safety-Related System Design**
   - Passive Core Cooling, Passive Containment Cooling, Containment, Containment H2 Control, SG System

3. **Nonsafety-Related System Design**
   - Chemical Volume and Control, Normal RHR, Component Cooling Water, Startup Feedwater, Main Feedwater, Main Steam, Radwaste (Liquid, Gas, Solid)

4. **System Shutdown Capability**
   - Long Term (>72 hr)
   - Shutdown Modes

5. **Levels Of Defense**

6. **Regulatory Treatment of Nonsafety-Related Systems**

1. Design Approach

AP600 DESIGN PROCESS

- **Iterative design development**
  - Plant design criteria / goals
  - Systems design
    - Lessons learned (operations, analysis, PRA)
  - Safety analysis
    - Single failure, conservative assumptions
  - Risk and severe accident analysis
    - Common mode failures, best estimate assumptions
  - Plant arrangement and modularization studies
- **Several iterations completed before SSAR submitted**

AP600 PLANT DESIGN

- **Greatly simplify plant**
  - Cost, construction, maintenance, operation, and safety
- **Reduced cost of power, less than fossil or large nuclear plants**
- **Five year lead time, three year construction**
- **Licensing certainty**
  - Certification, reduced public risk, passive safety-related systems
- **Reduced financial risk to utility**
- **No plant prototype**
  - Proven components and systems
- **90% plant availability, 100 man-rem ORE**
- **Standard design for wide range of sites**

AP600 PLANT FEATURES

- **Increased margins**
  - Lower reactor power density
  - Larger pressurizer
- **Simplified loop configuration with canned pumps**
- **Passive safety-related systems**
- **Digital instrumentation and control systems**
  - Advanced control room
- **Enhanced plant arrangement and construction**
  - Modular construction

AP600 SYSTEMS DESIGN

- **Greatly simplify systems**
  - Cost, construction, maintenance, operation, and safety

- **Provide passive safety-related systems**
  - Use "natural" driving forces only
  - One-time alignment of active valves
  - No support systems after actuation
  - Reduced operator dependency

- **Provide active nonsafety-related systems**
  - Redundant active equipment powered by nonsafety-related diesels
  - Minimize unnecessary use of passive safety-related systems
  - Reduced risk to utility and public

AP600 SAFETY SYSTEMS

- **Provide passive safety-related systems**
  - Greatly simplify construction, maintenance, operation, ISI / IST
  - Mitigate design basis accidents without use of nonsafety-related systems
  - NRC PRA goals without nonsafety-related systems
  - EPRI PRA goals with nonsafety-related systems

- **Safety-related systems design features**
  - Only passive processes; no "active" pumps, diesels, ...
  - Conservative design for DBA; margins, single failure criteria
  - Best estimate design for PRA; common mode failures
  - Greatly reduce need for operator actions

- **Safety-related equipment design features**
  - Reliable / experience based equipment
  - Improve inservice testing / inspection
  - Reg Guide 1.26 Quality Group A, B, or C; Seismic I design
  - Availability controlled by Tech Spec with shutdown requirements
  - Reliability Assurance Program
  - Tier I description and ITAAC

AP600 NON-SAFETY DID SYSTEMS

- **Provide nonsafety-related defense-in-depth systems**
  - Reliably support normal operation
  - Minimize challenges to passive safety-related systems
  - Not required to mitigate design basis accidents
  - Not required for NRC PRA goals; used for EPRI PRA goals

- **Nonsafety-related DID systems design features**
  - Redundancy for more probable failures, automatic control
  - Power from offsite / onsite sources (nonsafety-related diesels)
  - Separation from safety-related systems

- **Nonsafety-related DID equipment design features**
  - Reliable / experience-based equipment
  - Reg Guide 1.26 Quality Group D; limited hazard protection
  - Short term availability by plant procedures without shutdown requirements (RTNSS)
  - Long term availability by Reliability Assurance Program
  - Less detailed Tier I description and ITAAC

2. Safety-Related System Design

AP600 PASSIVE SAFETY FEATURES

- **Passive decay heat removal**
  - Natural circulation HX connected to RCS

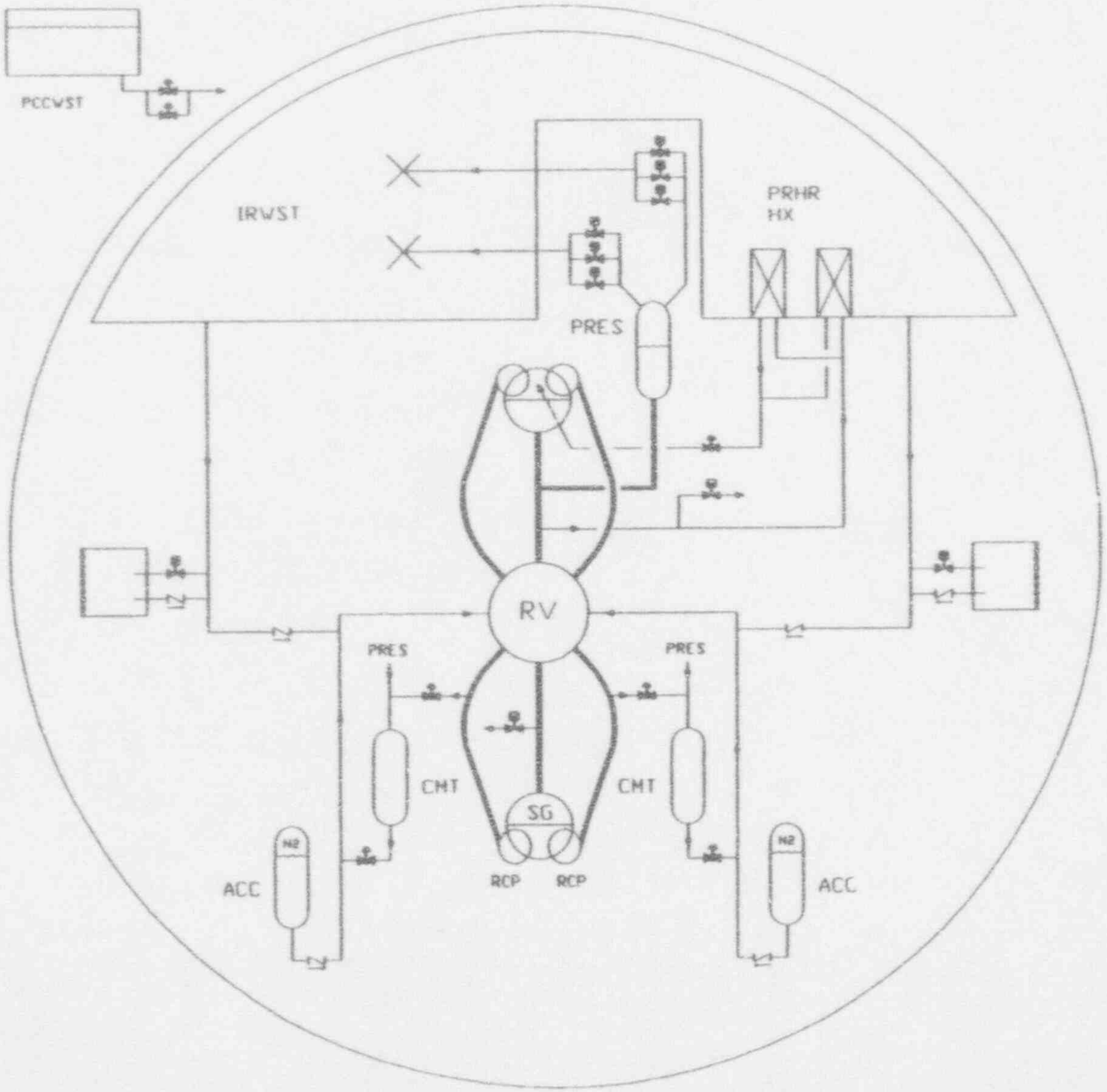
- **Passive safety injection**
  - N2 pressurized accumulators
  - Gravity drain core makeup tanks (RCS pressure)
  - Gravity drain refueling water storage tank (containment pressure)
  - Automatic RCS depressurization

- **Passive containment cooling**
  - Steel containment shell transfers heat to natural circulation of air and evaporation of water drained by gravity

- **Passive HVAC**
  - Compressed air for habitability of main control room
  - Concrete walls for heat sink (MCR and I&C rooms)

AP600 PASSIVE SAFETY FEATURES

AP600



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AP600 DECAY HEAT REMOVAL

- **Startup feedwater system**
  - Non-safety feedwater for normal shutdowns and transients
  - Two motor-driven pumps feed all SGs
  - Water supplied from deaerating heater or CST
  - Automatic start and flow control, auto load on nonsafety-related diesels

- **Passive RHR heat exchanger**
  - Safety-related cooling when startup feedwater unavailable and for non-LOCA accidents
  - Two heat exchangers connected directly to RCS
  - Forced flow with RCP; natural circ without RCP
  - Automatic actuation opens redundant valves (fail-open)
  - PRHR HX located in IRWST, provides heat sink, boils in 2-3 hr
  - Passive containment cooling provides ultimate heat sink

- **RCS feed and bleed**
  - Provides backup to SFW and PRHR HX for PRA events
  - Feed from CMT/Accum/IRWST, bleed through ADS
  - Automatic actuation of CMT on high RCS temp with low SG level

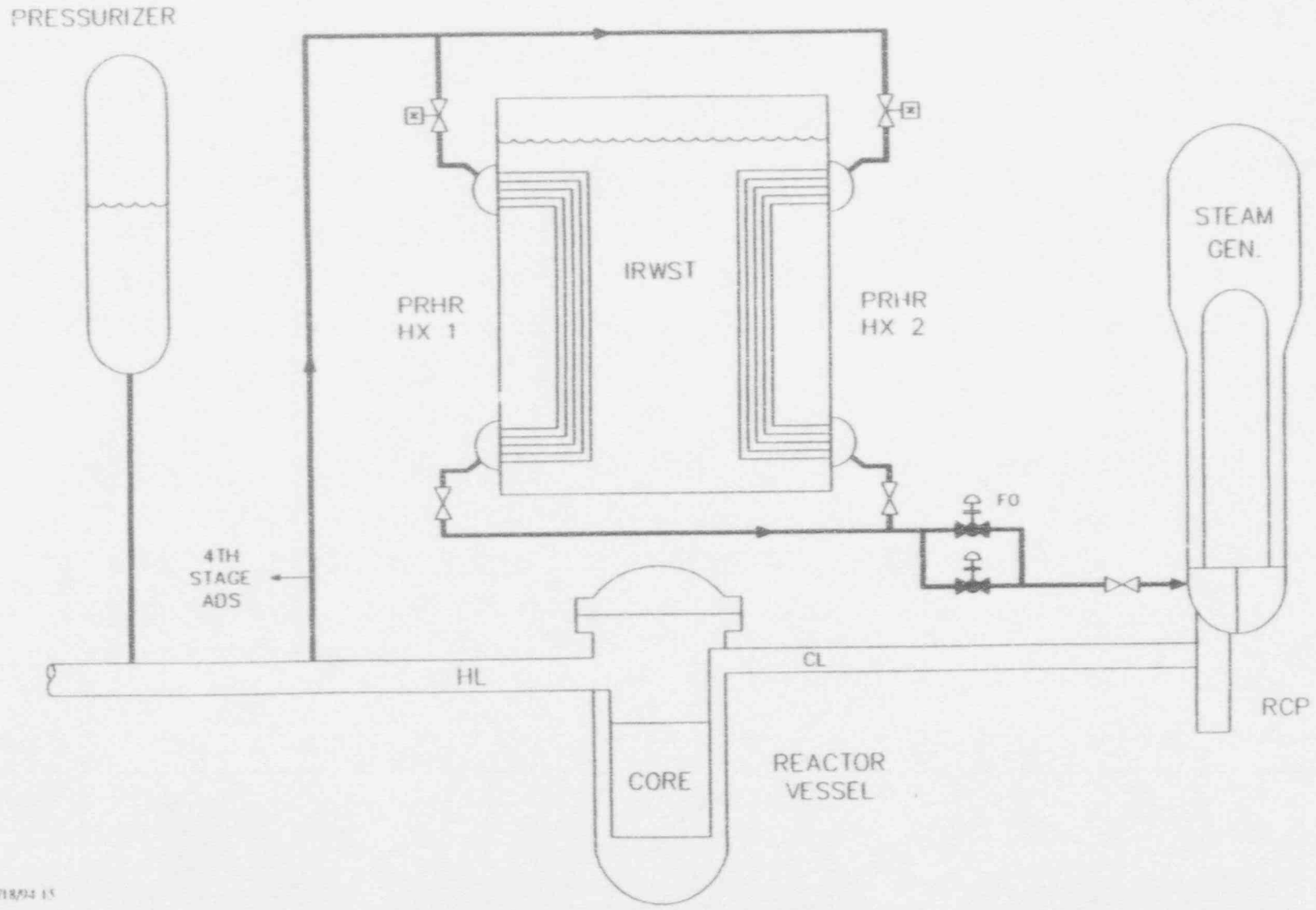
AP600 PRHR HX FUNCTIONS

- **Nonsafety-related functions**
  - None

- **Defense-in-depth functions**
  - Remove heat from RCS to mitigate ATWT

- **Safety-related functions**
  - Remove heat from RCS to mitigate transients
  - Remove heat from RCS to terminate SG tube rupture flow
  - Cooldown/maintain RCS at long term safe shutdown temperature

AP600 PRHR HX



AP600 RCS MAKEUP

- **CVS makeup pumps**
  - Nonsafety-related makeup for normal plant operation
  - Can accommodate 3/8" break without safety injection
  - Two motor-driven centrifugal pumps
  - Automatic control and loading on nonsafety-related diesels

- **Core makeup tanks**
  - Safety makeup to RCS when CVS unavailable or for larger leaks
  - Two tanks provide makeup by gravity at any RCS pressure
  - Automatic actuation opens redundant valves (fail open), each CMT
  - Provides significant makeup before ADS; 3 gpm leak for 100 hr

- **PXS tanks and ADS**
  - Safety injection for LOCA (DBA); feed/bleed cooling (PRA)
  - Two CMT, two Accumulators and one IRWST provide injection
  - Four stages ADS provide controlled depressurization of RCS
  - Accum backup CMT (PRA)

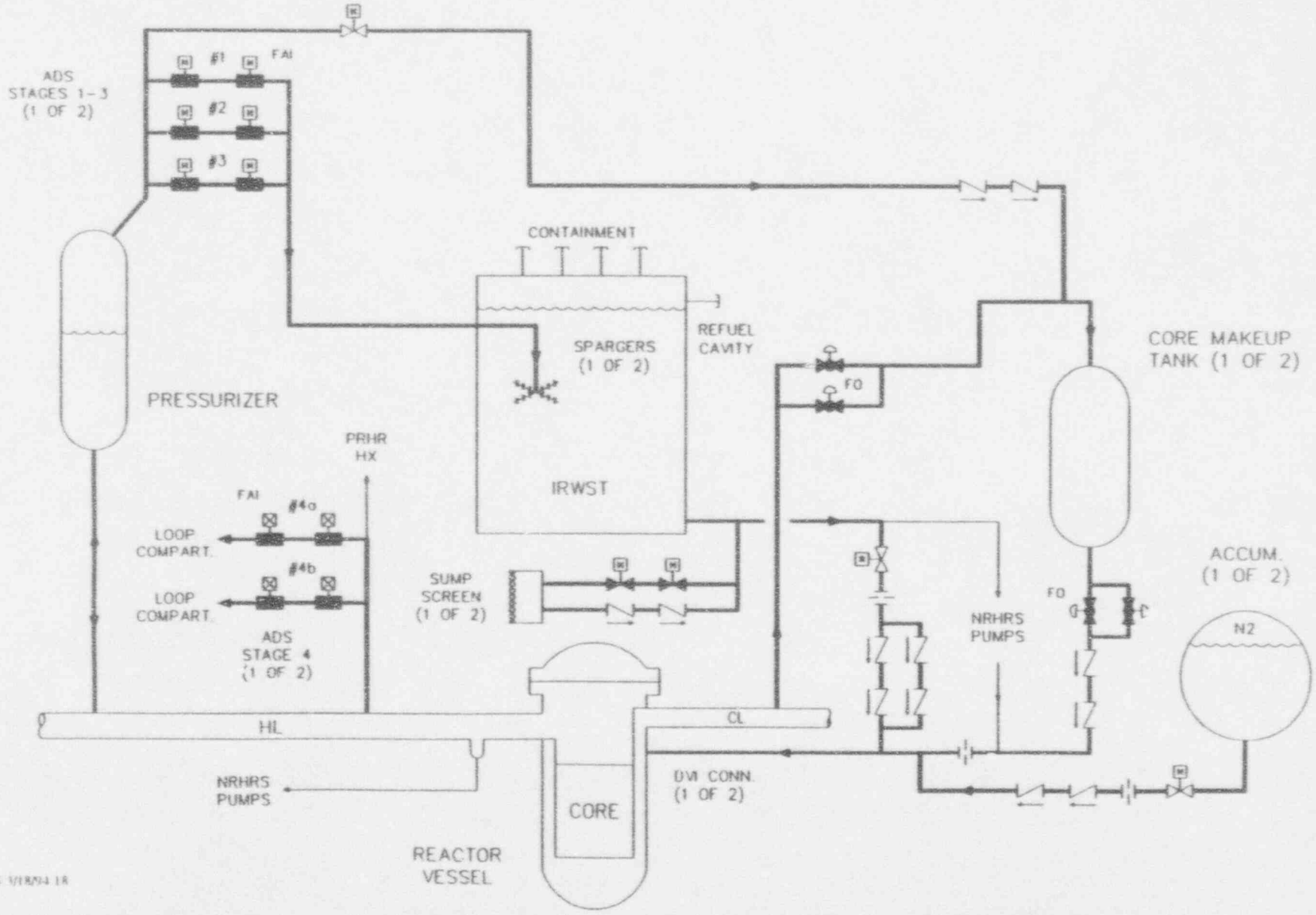
AP600 PASSIVE SI FUNCTIONS

- **Nonsafety-related functions**
  - Store water used for flooding of refueling cavity during refueling

- **Defense-in-depth functions**
  - Borate RCS to provide long term shutdown for ATWT
  - PRA related special functions
    - Passive "feed/bleed" cooling to backup SFW and PRHR HX
    - Use CMT or accum without other (CMF) for small LOCA
    - Use ADS stage 1/2/3 or stage 4 without other (CMF) for LOCAs

- **Safety-related functions**
  - RCS makeup for leakage during transients and SGTR without ADS
  - RCS makeup and boration to mitigate steam line breaks without ADS
  - RCS injection to mitigate LOCAs with ADS
  - RCS makeup and boration to support long term safe shutdown without ADS

AP600 PASSIVE SAFETY INJECTION



AP600 PXS CHANGES

- **Design changes since SSAR submittal (6/92)**
  - Described in 2/15/94 report to NRC

- **CMT changes**
  - Revise actuation of PRHR HX, Pzr Heater, CVS, ADS
  - Add CMT inlet diffuser
  - Add DVI nozzle venturi

- **PRHR HX changes**
  - Revise inlet valve arrangement

- **ADS changes**
  - Change to isolation valve / control valve arrangement
  - Reduce stage 1/2/3 valves effective flow area
  - Change stage 1/2/3 valves to dc, motor-operated with unspecified body type
  - Change Stage 4 configuration to 2/HL vs 1/HL flow paths
  - Change Stage 4 valves to unspecified type

AP600 CONTAINMENT COOLING

- **Containment fan coolers**
  - Nonsafety-related heat removal during normal operation and transients
  - 2 coolers, each with redundant fans
  - Heat sink provided by chilled water, CCW, SW, cooling towers
  - Automatic control and loading on diesels

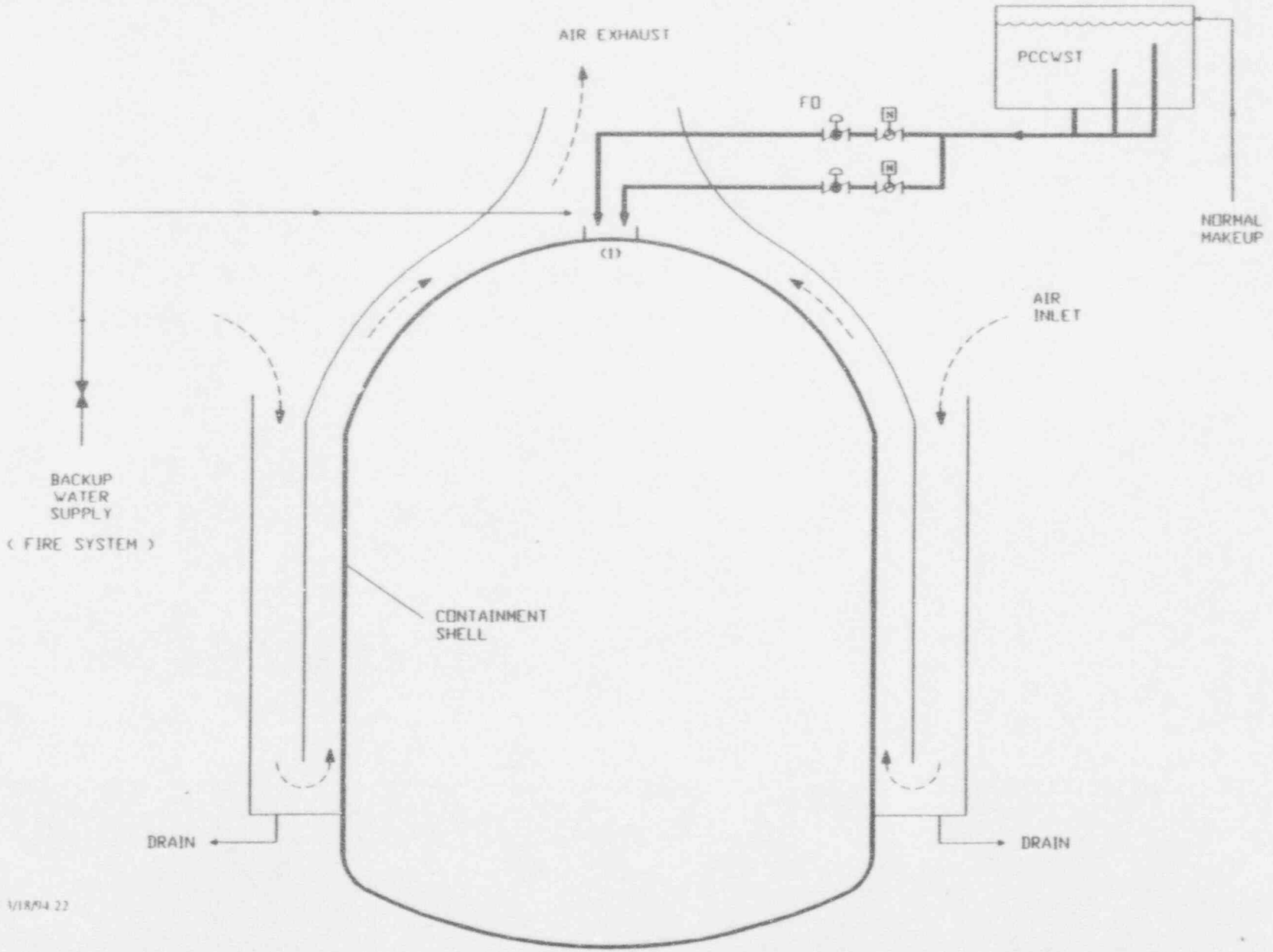
- **Passive Containment Cooling System**
  - Provides safety heat removal
    - Fan coolers unavailable or during large energy releases
  - Containment shell cooled by water evaporation
    - Water drains by gravity from elevated tank
    - Air circulates by natural circulation
  - Automatic actuation opens redundant air operated valves, fail open

- **Other Containment Cooling Features**
  - Boiling of water on containment vessel
  - Fire protection pumps or temporary supplies
  - Natural circulation of air, without any water

AP600 PCS FUNCTIONS

- **Nonsafety-related functions**
  - None
- **Defense-in-depth functions**
  - PRA related functions
    - Prevent containment overpressure with air only cooling during LOCAs
- **Safety-related functions**
  - Remove heat from containment to mitigate LOCA / steam line breaks
  - Cooldown/maintain containment at low pressure indefinitely
    - < 1/2 design pressure with offsite assistance in 72 hr
    - < design pressure without offsite assistance

AP600 PASSIVE CONTAINMENT COOLING



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AP600 CONTAINMENT

- **Containment vessel**
  - Steel pressure vessel (CS SA537 class 2), 1 5/8" thick
  - 45 psig design pressure
  - 130' ID, 121' high operating deck to dome
  - Main equipment hatch, operating deck, elev 135'
  - Auxiliary equipment hatch, elev 107'
  - Personnel hatches (2), elev 107' and 135'

- **Containment isolation**
  - Fewer penetrations (40 vs 100)
  - Fewer open penetrations
  - Isolation valve types
    - Check valves (IRC)
    - Fail-closed, air-operated valves
    - 1E dc-powered, motor-operated valves
  - Large containment shutdown purge lines eliminated

AP600 CONTAINMENT RADIATION

- **More realistic source term**
  - Release begins gradually at 1 hour, not instantaneous
  - Iodine form predominantly particulate
- **Radiation removal mechanisms**
  - Decay, deposition
  - Sedimentation (gravity)
  - Aerosol removal (steam condensation)
- **Passive pH control System**
  - Sodium hydroxide stored in tank inside containment
  - High radiation automatically drains tank into containment
  - Minimum pH is 7.0
- **Internal spray not required**
  - Calculated 30-day Thyroid dose is 161 rem (300 rem limit)
  - Calculated 30-day whole body dose is 10 rem (25 rem limit)

AP600 CONTAINMENT H2 CONTROL

- **Design basis accident**
  - Slow, limited release of H2
  - H2 buildup controlled by redundant recombiners (IRC)
    - Powered by nonsafety-related ac sources including nonsafety-related diesels or temporary connections, needed in 6.5 days

- **Severe accident**
  - Faster, larger release of H2
  - Moderate H2 buildup limited by containment volume
    - 13% H2 concentration for 75% zirc water reaction
  - H2 buildup controlled by igniters
    - 10% H2 concentration for 100% zirc water reaction
    - 58 igniters located at important containment locations
    - Powered by nonsafety-related ac sources including nonsafety-related diesels

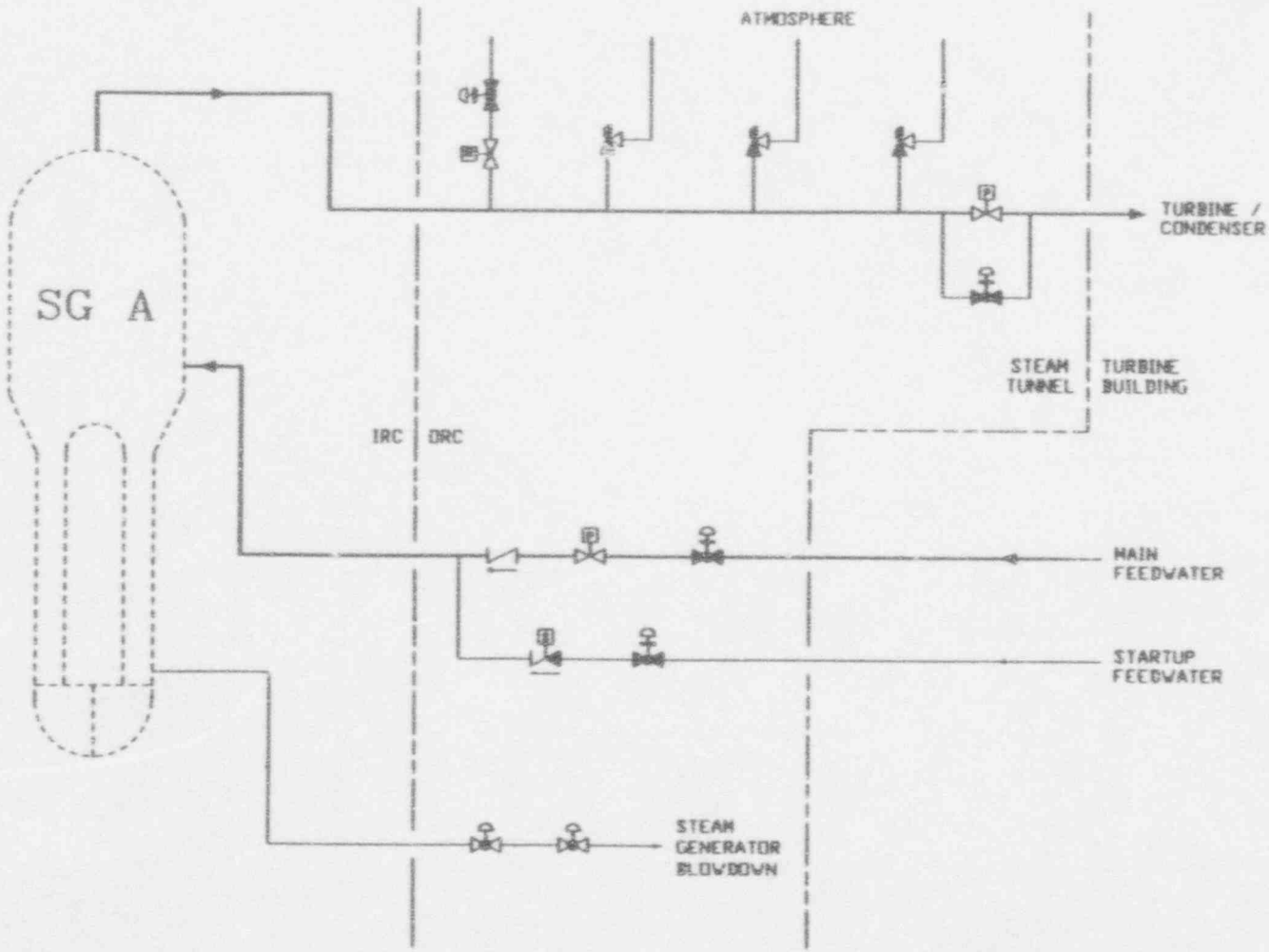
AP600 SG SYSTEM

- **Nonsafety-related functions**
  - Transports / controls main feedwater to SG during power operation
  - Transports/controls startup feedwater to SG during normal shutdown operation
  - Transports steam to main steam system during power and normal shutdown operation
  - Provides alternate steam release path during normal shutdowns when condenser not available

- **Defense-in-depth functions**
  - Remove decay heat during anticipated transients

- **Safety-related functions**
  - Provide SG overpressure protection
  - Provide short term decay heat removal by relief of steam from SG
    - Only uses initial SG water inventory
  - Provides isolation of SG during accidents

AP600 SG SYSTEM SKETCH



3. Nonsafety-Related System Design

AP600 CVS FUNCTIONS

- **Nonsafety-related functions**
  - RCS makeup for leaks and cooldown contraction
  - RCS boration / dilution control
  - RCS chemistry control
  - Limit buildup of RCS radiation

- **Defense-in-depth functions**
  - RCS makeup and boration
  - Pressurizer auxiliary spray

- **Safety-related functions**
  - RCS pressure boundary isolation
  - Containment isolation
  - Dilution accident isolation
  - Excessive RCS makeup isolation

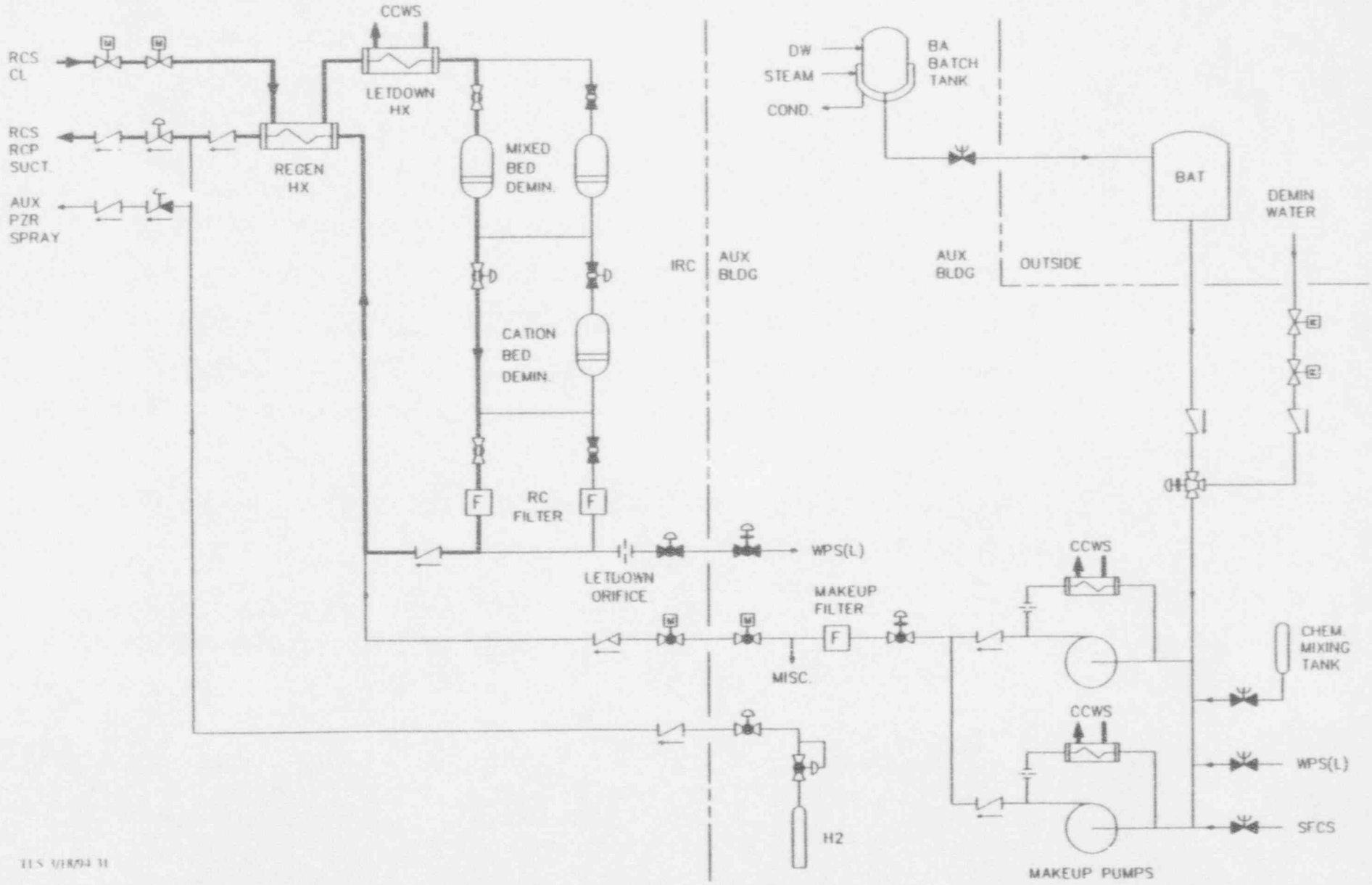
AP600 CVS FEATURES

- **Simplifications**
  - No RCP seal injection required
  - Volume control tank, continuous degasing eliminated
  - Boron thermal regeneration system eliminated
  - Boron recycle system (evaporators) eliminated
  - Reactor makeup water system eliminated

- **Purification improved**
  - Located inside containment
  - Greater flow rates during all modes, including shutdown

- **Boric acid concentration reduced**
  - 2.5 wt %
  - No heat tracing or room heating

AP600 CVS SKETCH



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AP600 NORMAL RHR FUNCTIONS

- **Nonsafety-related functions**
  - Cool RCS for normal shutdowns
  - Cool IRWST if it becomes heated during power operation
  - Prevent ADS stage 4 opening during anticipated ADS

- **Defense-in-depth functions**
  - Cooling of RCS during shutdown operation
  - Cooling of IRWST during PRHR HX operation
  - Overpressure protection of RCS at low temperatures
  - Low pressure RCS injection

- **Safety-related functions**
  - RCS pressure boundary isolation
  - Containment isolation

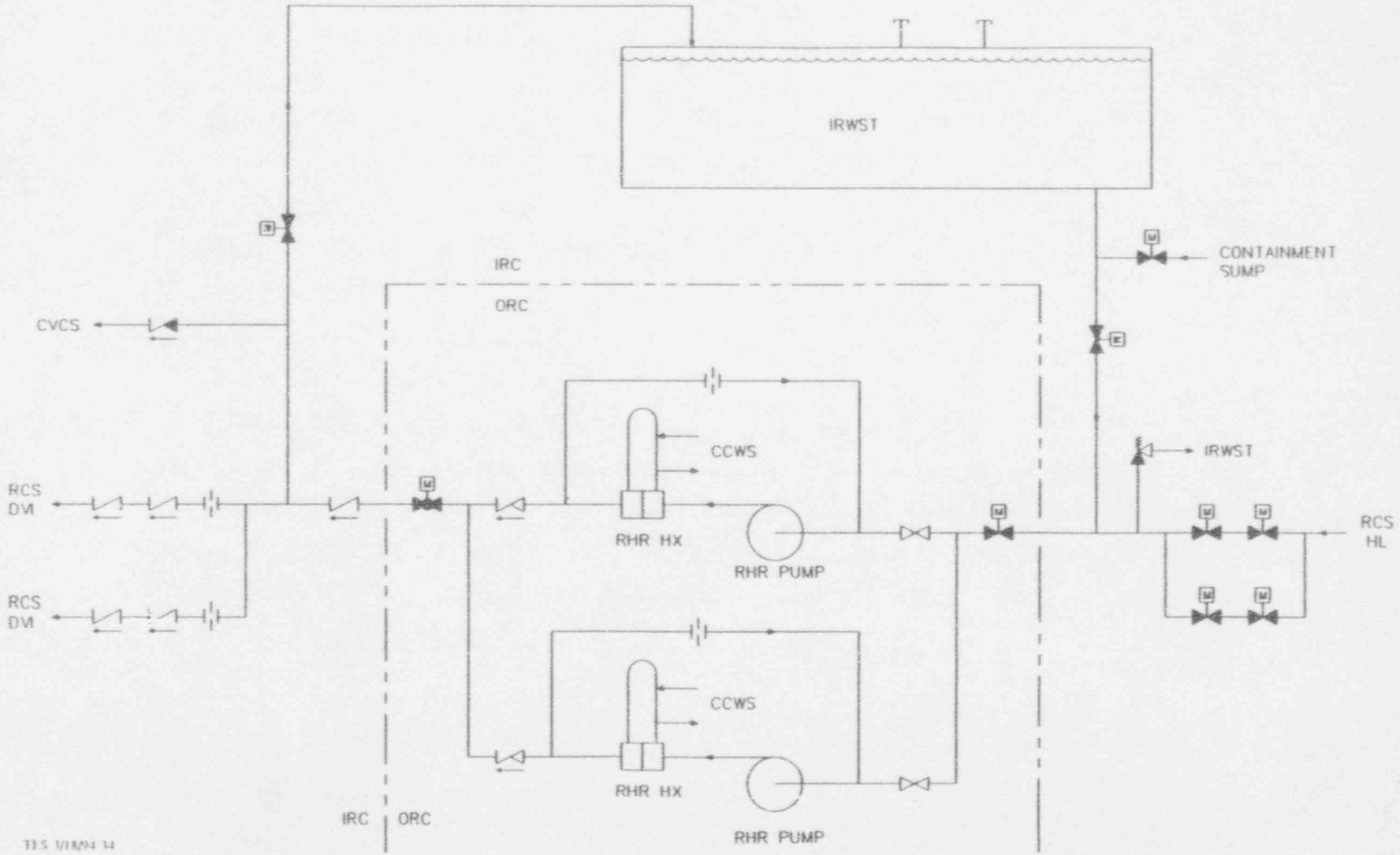
AP600 RNS FEATURES

- **Mid-loop improvements**
  - RHR operations controlled from main control room
  - Redundant, narrow-range HL level with control room readout and alarm
  - Redundant core exit temperature with control room readout and alarm
  - Stepped-nozzle suction connection to HL eliminates air entrainment
  - Sufficient NPSH provided for full RHR flow with saturated water
  - Suction line routing is self venting
  - Rugged RHR pump design

- **Interfacing-system LOCA improvements**
  - 900 psig design pressure
    - Rupture pressure greater than RCS pressure
  - Additional isolation valve

- **RTNSS requires both pumps for mid-loop**
  - Plant administrative procedures, not tech spec

AP600 RNS SKETCH



AP600 COMPONENT COOLING WATER

- **Nonsafety-related functions**
  - Transfer heat from radioactive components to service water system during all normal modes of plant operation
    - RNS and SFS HX
    - CVS mini-flow HX
    - Other nonsafety-related components

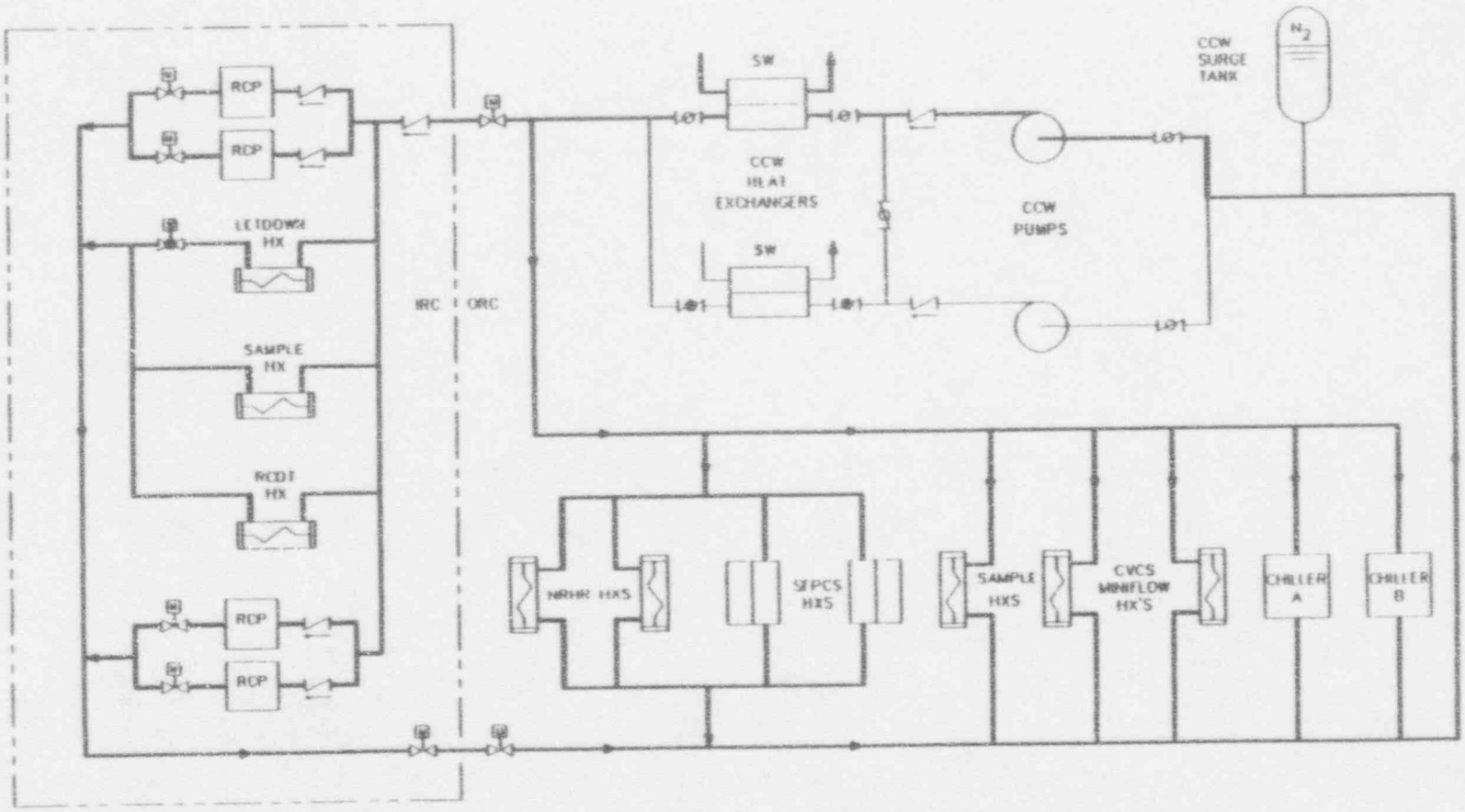
- **Defense-in-depth functions**
  - Transfer heat to service water system
    - RNS HX for RCS cooling
    - CVS makeup pump mini-flow heat exchangers
    - SFS HX for spent fuel pit cooling

- **Safety-related functions**
  - Containment isolation

AP600 CCW FEATURES

- **Simplified design**
  - Single piping train with redundant pumps / HX
  - Plate HX reduces layout space, improves maintainability
- **Water chemistry improved**
  - Chromates eliminated, eliminates hazardous waste

AP600 CCW SKETCH



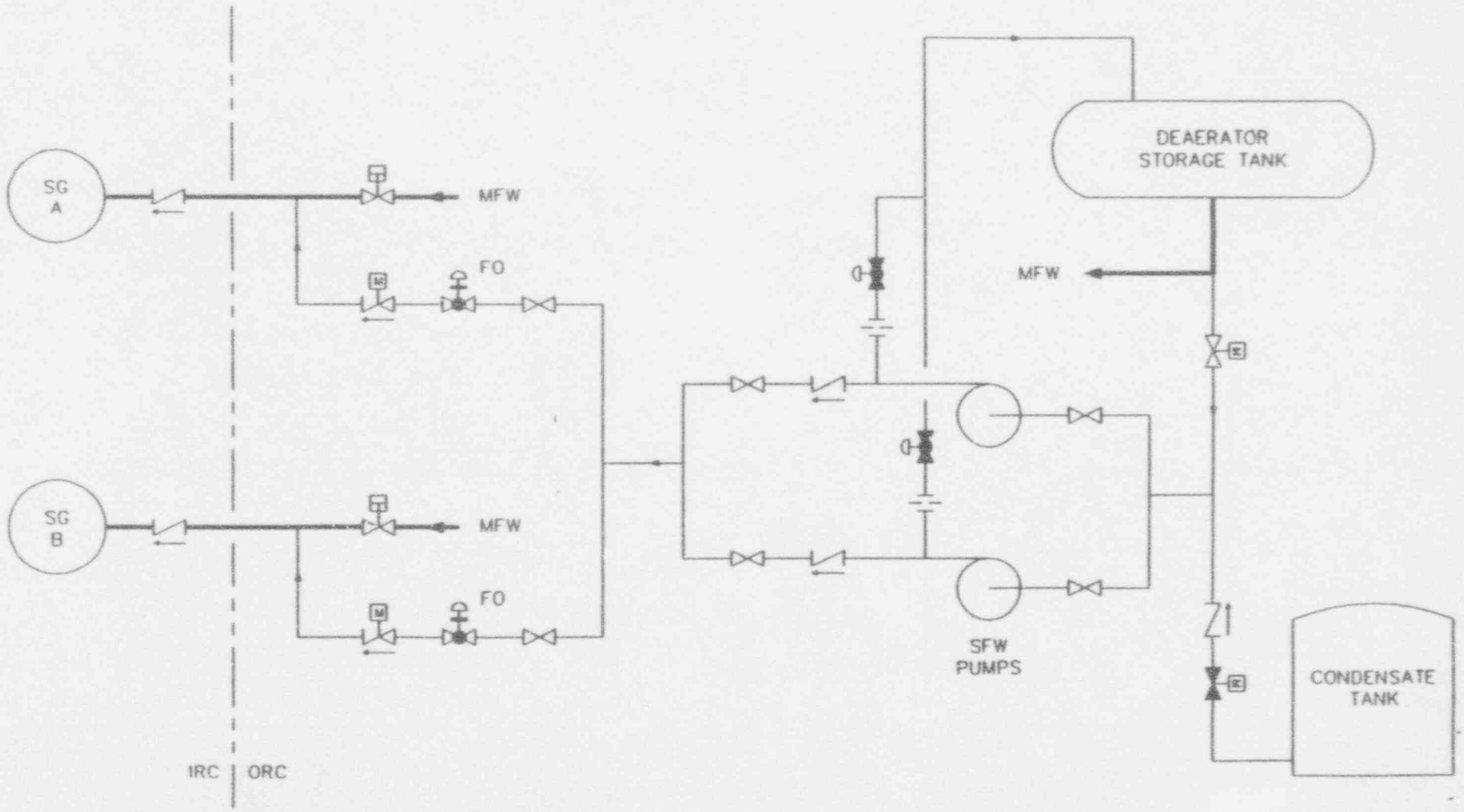
AP600 STARTUP FW FUNCTIONS

- **Nonsafety-related functions**
  - Support RCS cooldown for normal shutdowns
  - Prevent PRHR HX operation during anticipated transients
- **Defense-in-depth functions**
  - Automatic SG feedwater for anticipated transients
- **Safety-related functions**
  - None

AP600 SFW FEATURES

- **Simplified design**
  - Single piping train with redundant pumps
  - Steam turbine pumps eliminated
- **Potential for RCS overcooling reduced**
  - Flow to SG controlled
    - Initially to fixed flow
    - Later to SG level
- **Transients on SG FW piping / nozzle reduced**
  - SFW suction source is deaerating heater, 250F

AP600 SFW SKETCH



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AP600 SPENT FUEL PIT SYSTEM

- **Nonsafety-related functions**
  - Cool and purify spent fuel pit water
  - Purify IRWST after refueling
  - Purify refueling cavity (IRC) during refueling

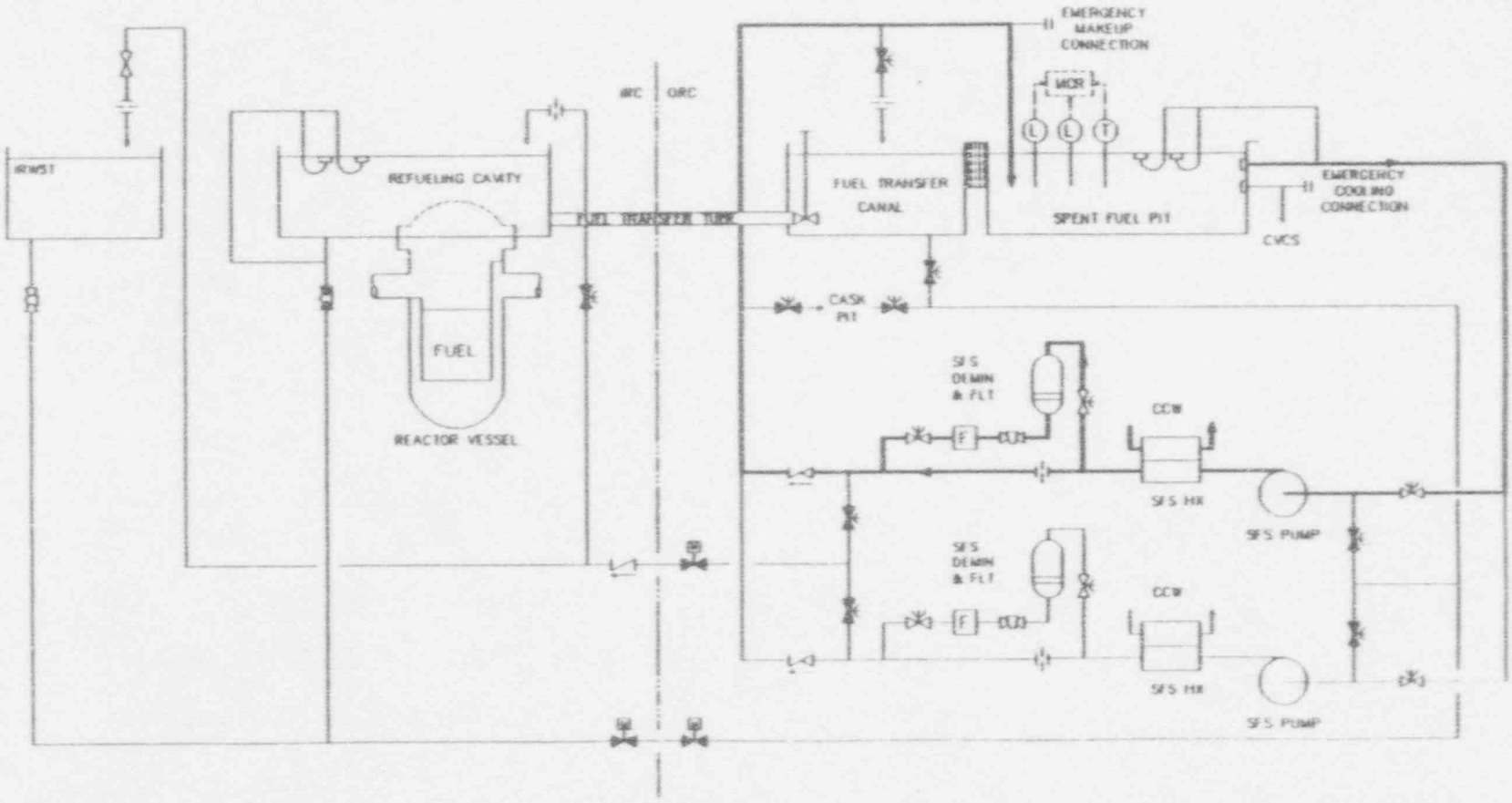
- **Defense-in-depth functions**
  - Cool spent fuel pit water

- **Safety-related functions**
  - None

AP600 SFS FEATURES

- **Simplified design**
  - Purification pumps and skimmer pumps eliminated
  - Single piping train with redundant pumps / HX
- **Improved purification**
  - IRWST purification during power operation
  - Refueling cavity purification during refueling
- **Spent fuel pit inventory**
  - Provides safety-related spent fuel cooling
  - Loss cooling / makeup for 7 days (BOL), 3 days emergency core unload
  - Makeup available from onsite sources and temporary sources
  - Doses within NRC limits

AP600 SFS SKETCH



AP600 RAD WASTE SYSTEMS

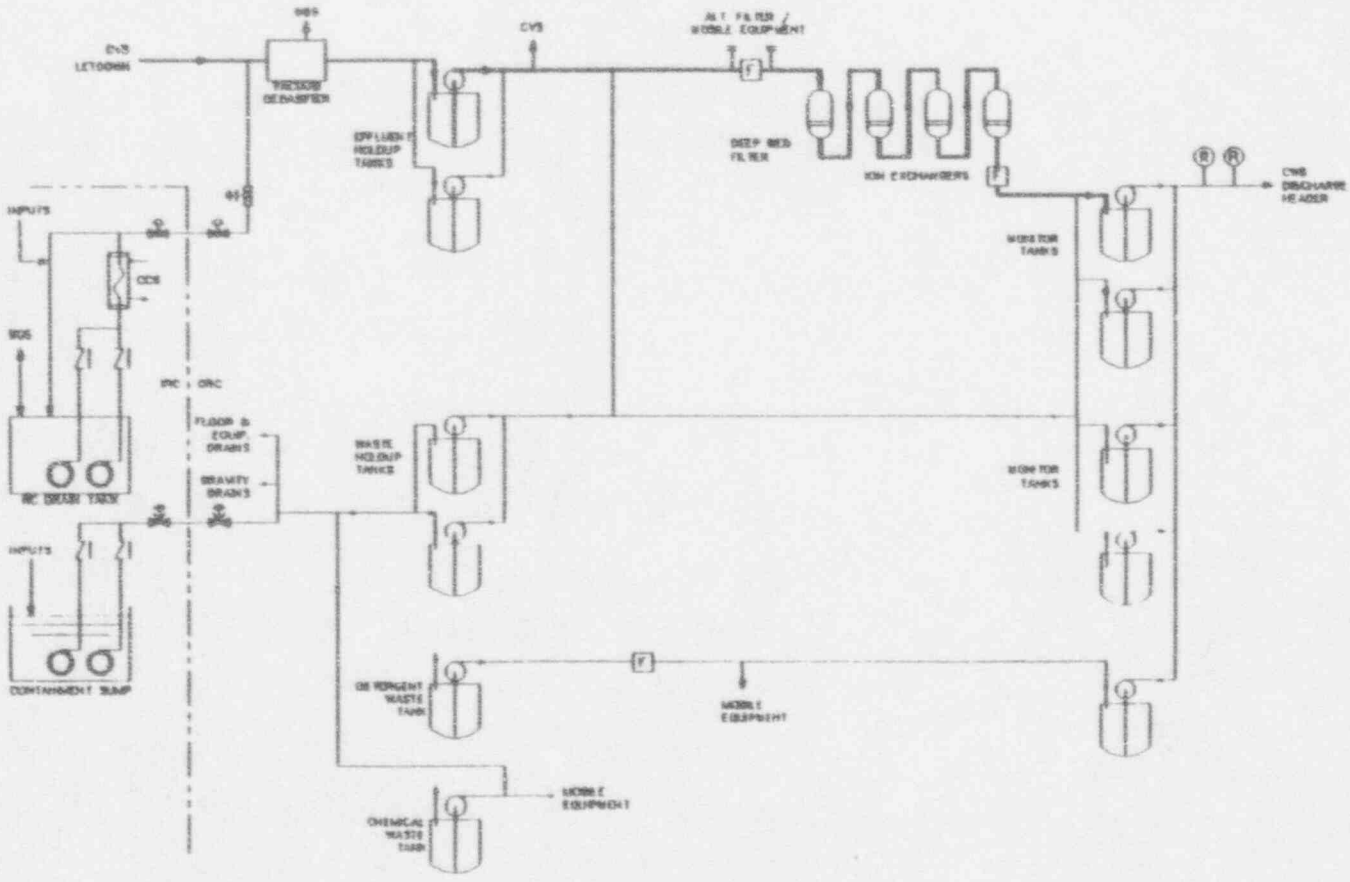
- **Nonsafety-related functions**
  - Limit / control release of radiation during normal plant operation
    - Both liquid and gaseous releases
- **Defense-in-depth functions**
  - None
- **Safety-related functions**
  - None

AP600 RAD WASTE SYSTEMS

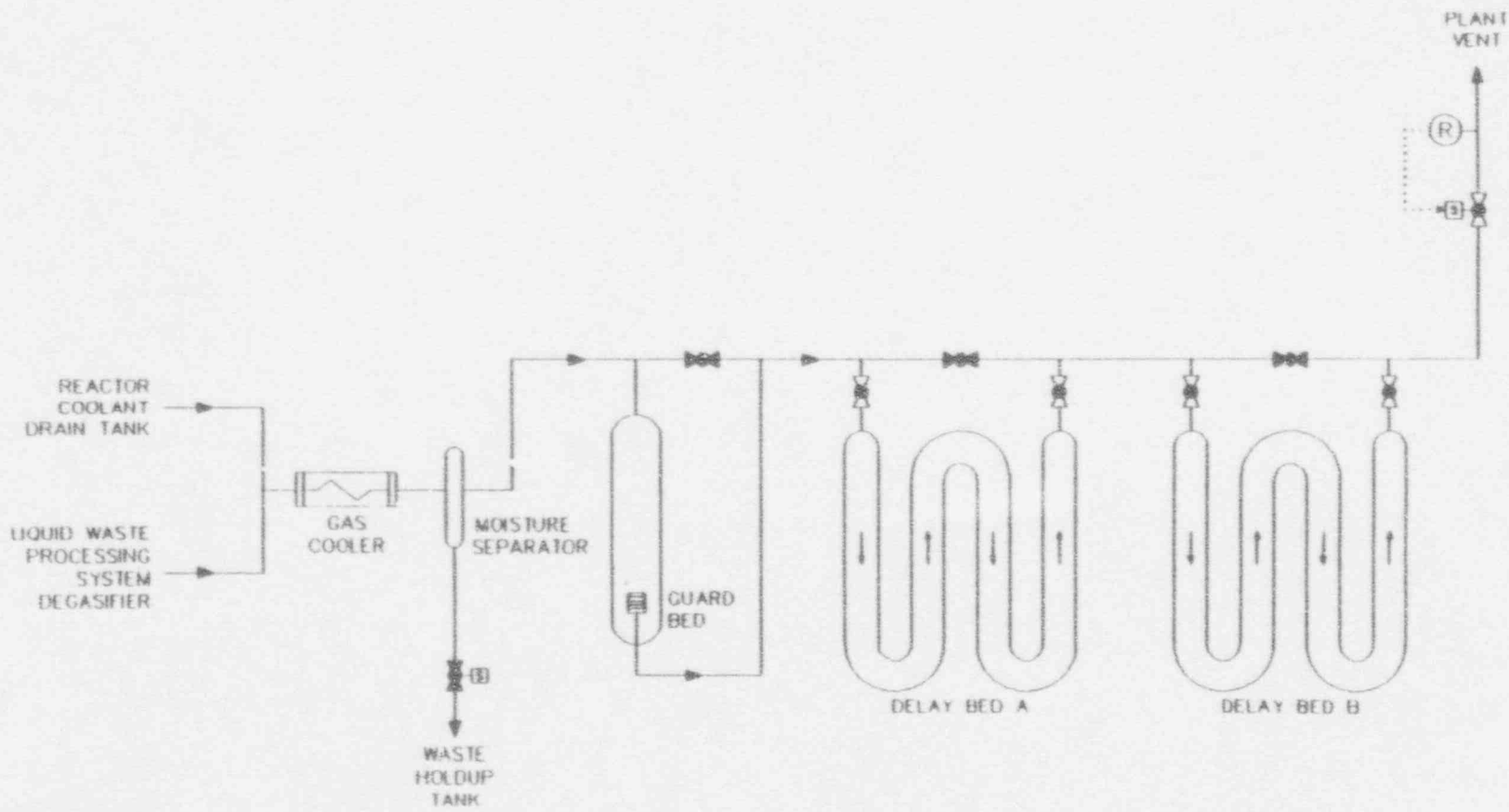
- **Liquid rad waste features**
  - Greatly simplified
    - Ion exchange process, no evaporator
    - Reduced solid waste generation
  - Reduced inputs
    - Load follow with rods not boron
    - RCP seals eliminated

- **Gaseous rad waste features**
  - Greatly simplified
    - Charcoal beds
    - No compressors, storage tanks, chillers
    - No continuous degassing required, good historic fuel performance

AP600 LIQUID RAD WASTE SKETCH



AP600 GASEOUS RAD WASTE SKETCH



4. Shutdown Capability

AP600 POST 72 HOUR ACTIONS

- **Long-term passive safety-related system operation**
  - Core cooling and ultimate heat sink remain available indefinitely
    - >> 72 hours, without operator action or offsite support
  - Other safety-related functions require limited offsite support after 72 hours
    - Use readily accessible / transportable equipment and supplies
    - Safety-related connections provided to engage temporary equipment
  - Installed nonsafety-related systems NOT required to sustain safety-related functions
    - Recovery to cold conditions accomplished when nonsafety-related systems are made available

AP600 POST 72 HOUR ACTIONS

- **Safety-related system extended support actions**
  - Makeup water to the containment
    - Not needed for one month assuming DBA containment leakage
  - Makeup water to the passive containment cooling water storage tank
    - Air cooling alone maintains containment pressure below design
  - Electrical power for post-accident monitoring instrumentation
  - Electrical power to the hydrogen recombiners
    - Only needed for events where containment hydrogen buildup occurs
  - Breathable air for control room air pressurization
    - Only required in case of significant radiation releases from plant
  - Cooling for control room
    - Only required in hot weather conditions
  - Cooling for post-accident monitoring equipment rooms
    - Only required in hot weather conditions
  - Makeup water to the spent fuel pit
    - Required after 7 days at BOL, 72 hr for emergency core unload

AP600 SHUTDOWN CAPABILITY

- **Functions provided during all shutdown modes**
  - First line of defense is nonsafety-related DID systems
    - Reliable, address lessons-learned
    - Not required for safety case (SSAR)
  - Passive systems provide safety-related defense

- **Passive safety-related systems can function during shutdowns**
  - Hot shutdown, hot standby, cold shutdown, mid-loop, refueling
  - Same modes of operation as during accidents from power
  - Less demanding conditions (lower decay / sensible heat)

- **Passive safety-related systems availability controlled by Tech Spec**
  - Defined in SSAR, Chapter 16

AP600 SHUTDOWN CAPABILITY

- **Hot standby mode**
  - Same as at-power
- **Hot shutdown mode**
  - Same as at power, except accumulator not required <1000 psia
- **Cold shutdown (filled) mode**
  - Same as at-power, except
    - Accum and containment not required
- **Cold shutdown (drained) mode**
  - See next overhead
- **Refueling shutdown mode**

  Refueling cavity provides >6 hr heatup, >72 hr to fuel uncovery

AP600 DRAINED SHUTDOWN CAPABILITY

- **Nonsafety-related systems**
  - Heat removal; RNS
  - RCS makeup; CVS, RNS
  - Containment; fan coolers

- **Safety-related systems**
  - Heat removal; passive feed / bleed
    - 23 min heatup to boiling, 2.3 hr to core uncovery
  - RCS makeup; IRWST (ADS)
  - Containment cooling; PCS
  - Tech Spec require
    - IRWST operable, ADS stage 1-3 open, PCS
    - Containment closure
      - Equipment hatches closed, air locks open but operable
      - Maintenance cables / pipes use permanent or temporary (5x12") penetrations

5. Levels Of Defense

AP600 LEVELS OF DEFENSE

- **AP600 provides multiple levels of defense**
  - First is usually nonsafety-related, active systems
  - At least one is safety-related, passive systems
  - Passive systems provide additional defense-in-depth

- **Illustrated by charts / tables**

  -Flow charts
    - Anticipated sequence of system actuation
    - Includes both automatic and manual
  - Actuation table
    - Shows I&C system and electrical support
    - Control (PLS), protection (PMS), diverse (DAS) instrumentation and control
    - dc and ac electrical power

AP600 LEVELS OF DEFENSE

- **Example events**

Initial Condition	Accident
- Full power	- Loss of offsite power
- Full power	- SG tube rupture
- Full power	- Small LOCA
- Mid-Loop	- Loss of offsite power
- Refueling	- Loss offsite power

6. Regulatory Treatment of Nonsafety-Related Systems

AP600 RTNSS PROCESS

- **Process agreed to between industry and NRC**

- **Key elements of process**
  - Focused PRA (removal of nonsafety-related systems mitigation)
  - Initiating event evaluation
  - Deterministic evaluations
    - ATWS rule
    - Loss all ac power rule
    - Post-72 hour actions
    - Adverse systems interactions
    - Containment performance
    - Seismic considerations

- **Westinghouse evaluation of AP600 RTNSS submitted to NRC 9/93**
  - WCAP-13856
  - Proposed PRA revisions

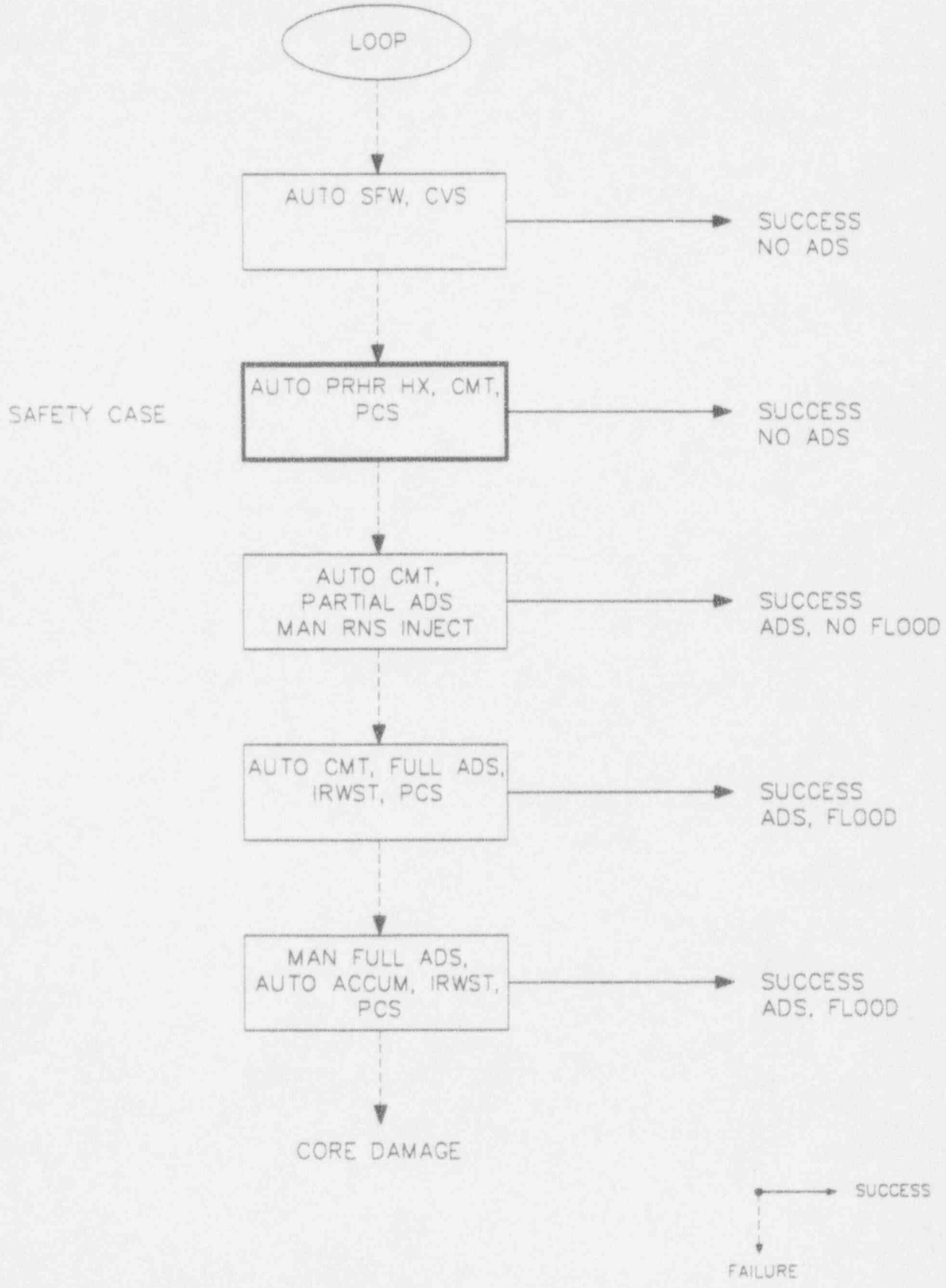
AP600 RTNSS RESULTS

- **Focused PRA**
  - No nonsafety-related SSCs identified as important
    - No nonsafety-related system mitigation functions required to meet NRC safety goals

- **Initiating event evaluation**
  - Several turbine island systems identified as important
    - No additional regulatory oversight proposed
  - RNS and supporting systems identified as important for mid-loop
    - Operating procedures developed requiring availability during mid-loop

- **Deterministic evaluations**
  - Portions of DAS identified as important for ATWS rule
    - Operating procedures developed requiring availability at-power

AP600 – LOSS OF OFFSITE POWER



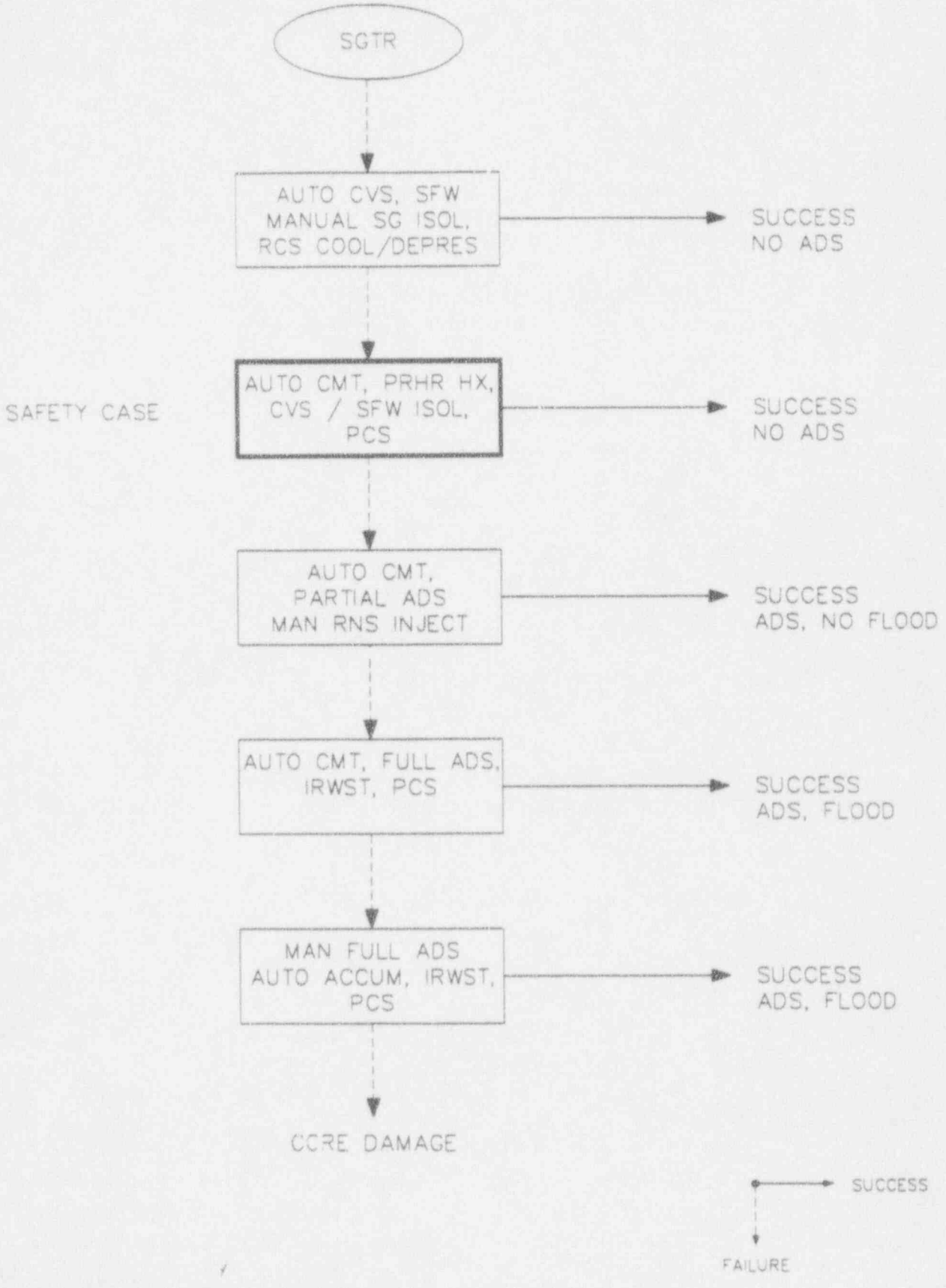
Plant: **AP600**

Event: **LOSS OFFSITE POWER** at **FULL POWER**

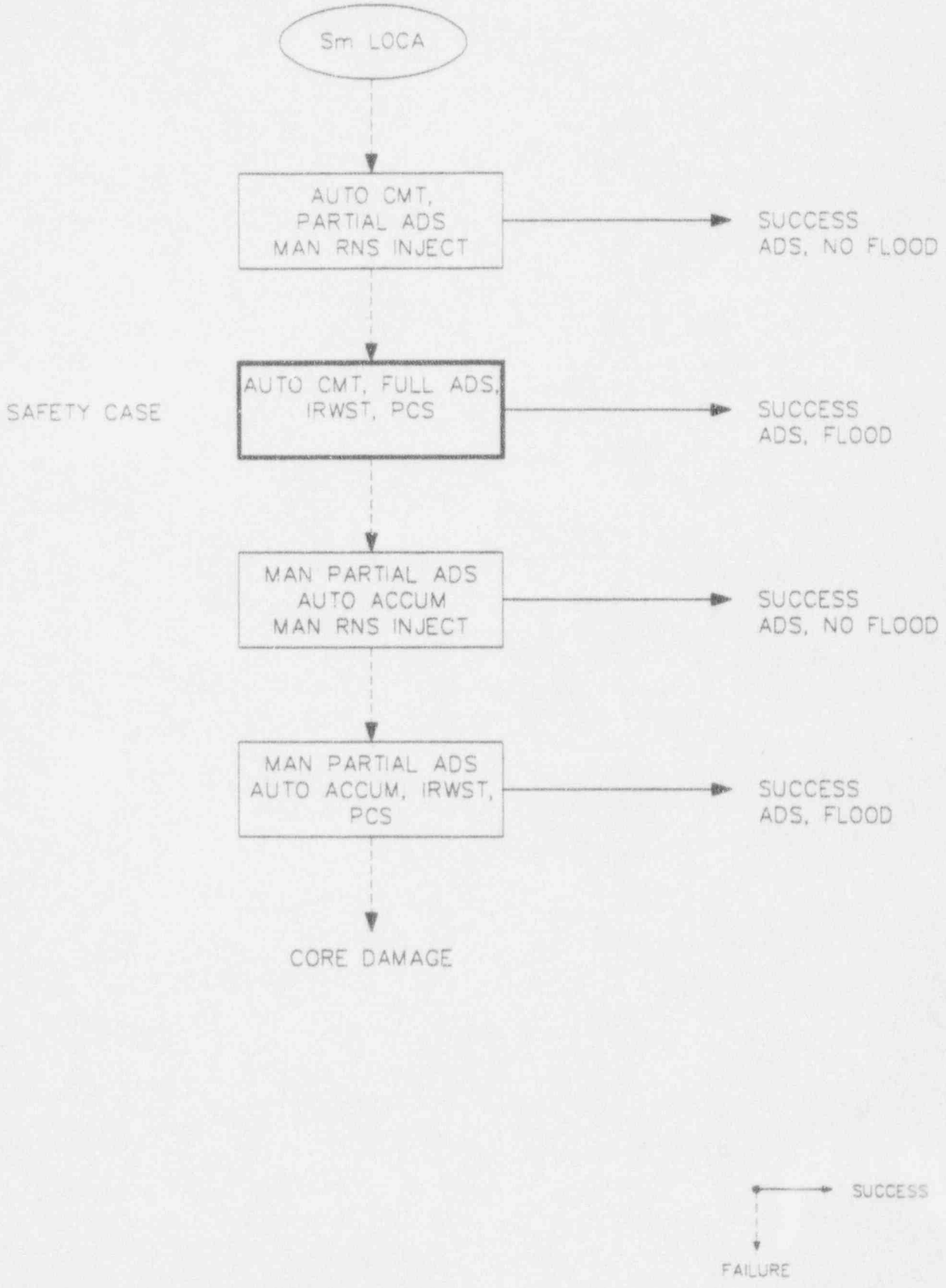
Function System Order of Use	Actuation / Electrical Systems					
	Non-Safety			Safety		Diverse
	PLS	DC	AC	PMS(1)	DC	DAS
o Reactor Shutdown						
1. Control Rods	-	-	-	A	-	-
2. Control Rods	-	-	-	-	-	A
3. Ride Out (2)	M	Yes	Yes	-	-	A
o RCS Inventory Control						
1. CVS	A	Yes	Yes	-	-	-
2. CMT	-	-	-	A	-	-
3. CMT	-	-	-	-	-	A
4. CMT, RNS, part ADS	M	Yes	Yes	A	Yes	-
5. CMT, IRWST, full ADS	-	-	-	A	Yes	-
6. Accum, RNS, part ADS	M	Yes	Yes	M	Yes	-
7. Accum, IRWST, full ADS	-	-	-	-	Yes	M
o RCS Heat Removal						
1. SFW	A	Yes	Yes	-	-	-
2. PRHR HX	-	-	-	A	-	-
3. PRHR HX	-	-	-	-	-	A
4. CMT, RNS, part ADS	M	Yes	Yes	A	Yes	-
5. CMT, IRWST, full ADS	-	-	-	A	Yes	-
6. Accum, RNS, part ADS	M	Yes	Yes	M	Yes	-
7. Accum, IRWST, full ADS	-	-	-	-	Yes	M
o Containment Cooling						
1. Fan Coolers	A	Yes	Yes	-	-	-
2. CV external air, water drain	-	-	-	A	-	-
3. CV external air, water drain	-	-	-	-	-	A
4. CV external water fire sys only	M	Yes	Yes	-	-	-
5. CV external air only	-	-	-	-	-	-

Notes:
1) Safety components have safety related MCB manual controls via both individual soft control switches and dedicated system level switches.
2) Reactor is shut down by negative moderator temperature coefficient as the coolant heats up. Requires automatic RCS pressure relief, turbine trip, and PRHR HX actuation. Also requires manual CMT or CVS boration.

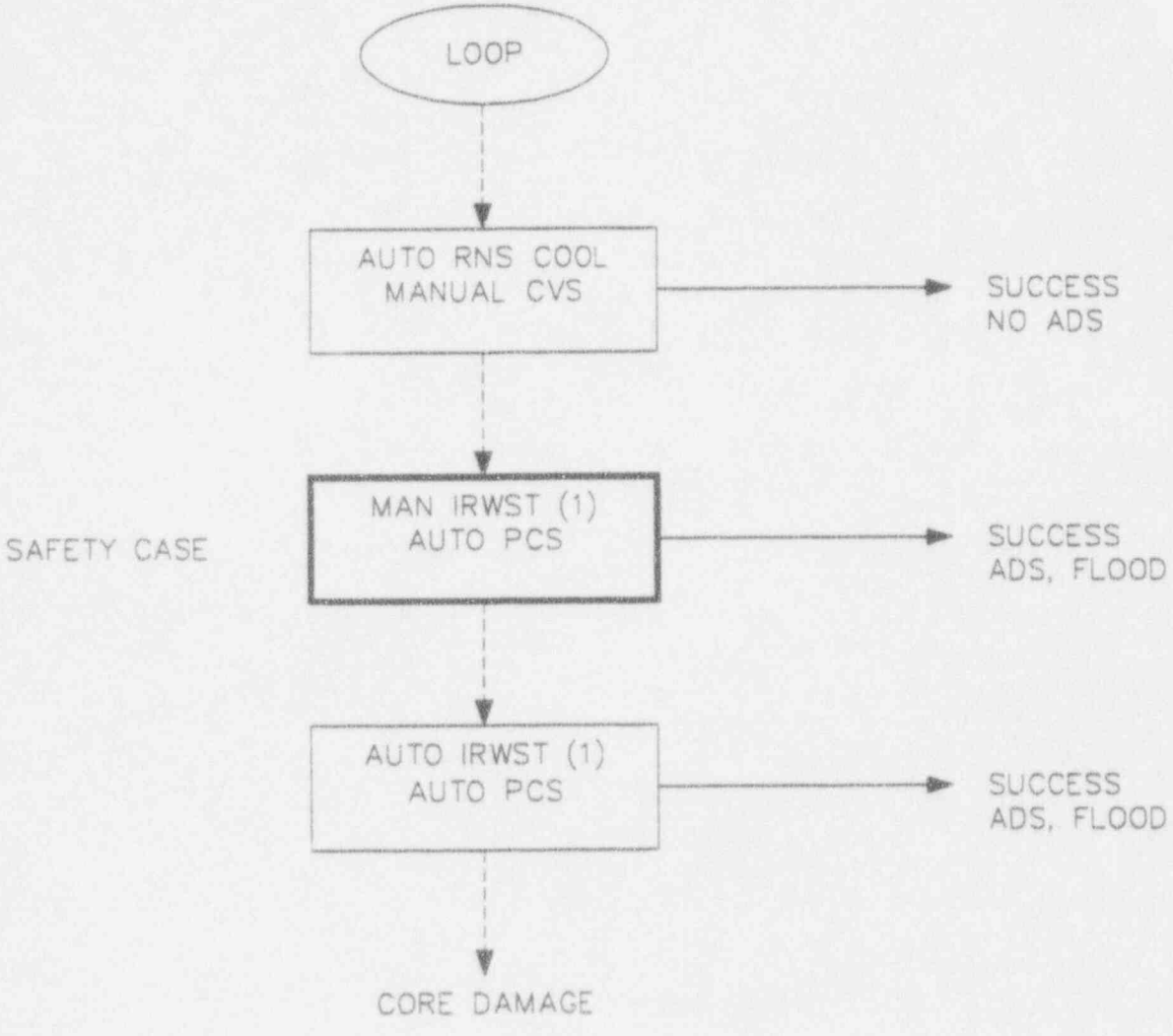
AP600 – SG TUBE RUPTURE



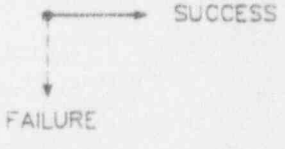
AP600 – SMALL LOCA (1–10")



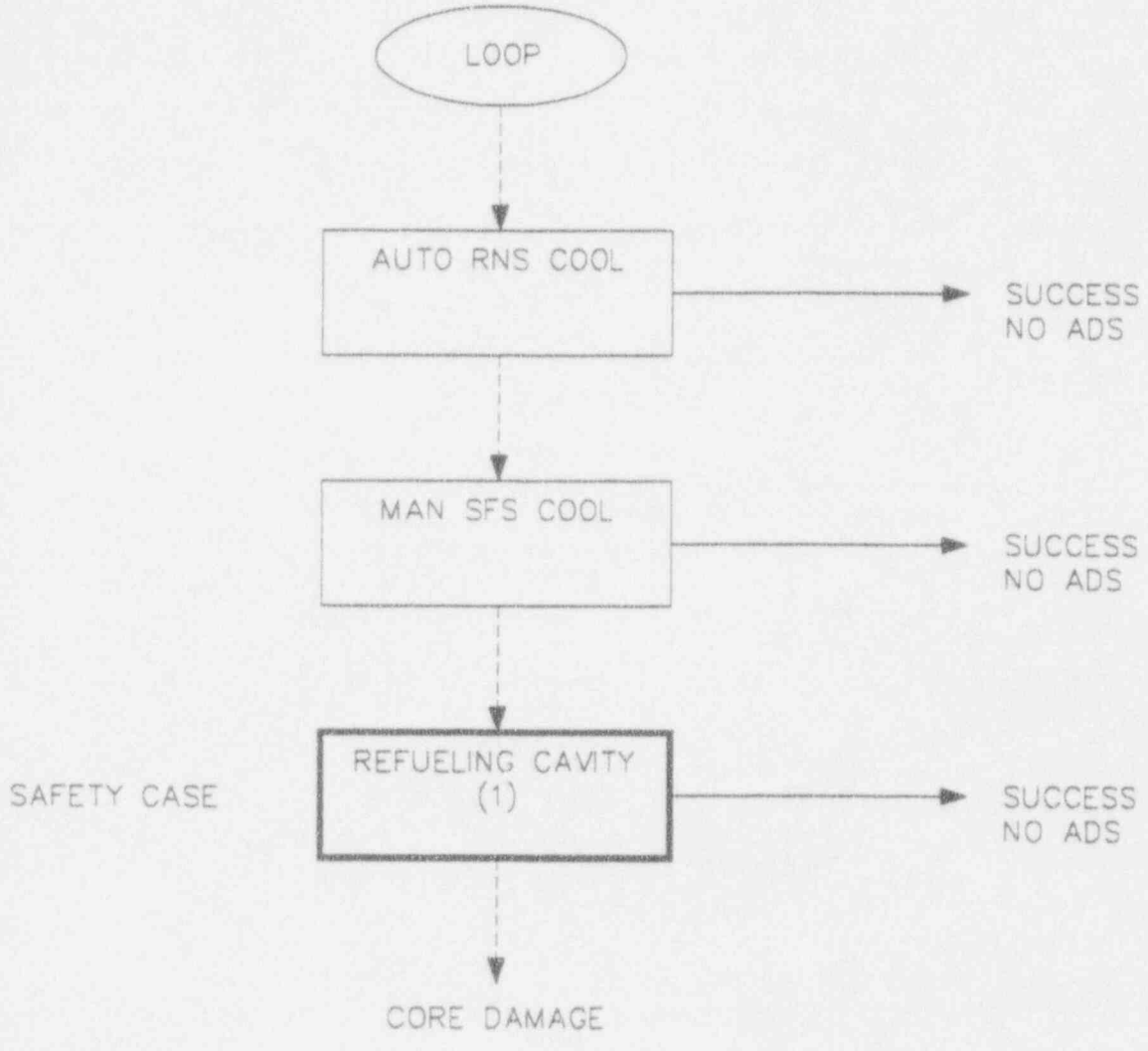
AP600 - LOSS OF OFFSITE POWER (MID-LOOP)



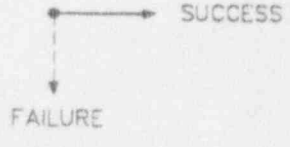
NOTE (1) ADS STAGES 1,2,3 WILL BE OPEN DURING MID-LOOP



AP600 – LOSS OF OFFSITE POWER (REFUELING)



NOTE (1) EITHER CLOSE CONTAINMENT OR PROVIDE ADDITIONAL MAKEUP AFTER 72 HR.



AP600 INSTRUMENTATION AND CONTROL SYSTEMS

DAVID J. VAGLIA
PLANT INSTRUMENTATION AND CONTROL SYSTEMS

file: AP6ARCH.PRE

AP600 I&C Agenda

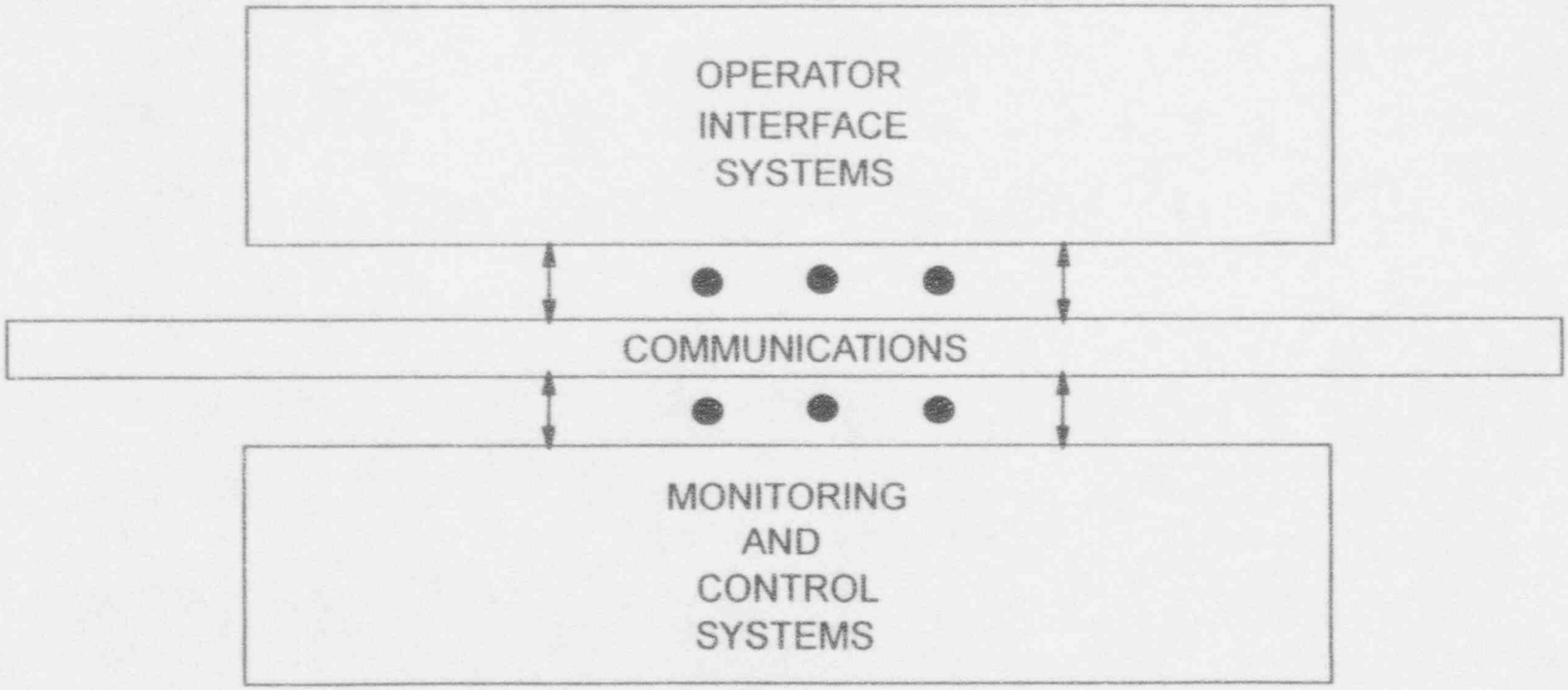
- I&C Architecture
- Major I&C Systems
- Defense In Depth
- Man-Machine Interface Design
  - Control Room Design
  - Major Subsystems

Major I&C Architecture Design Issues

AP600

- Segmentation
- Fault Tolerance
  - Single Failure
- Isolation of Protection and Control
- Functional Diversity
- Separation/Independence
- EMI/RFI Tolerance
- Bypass Capability

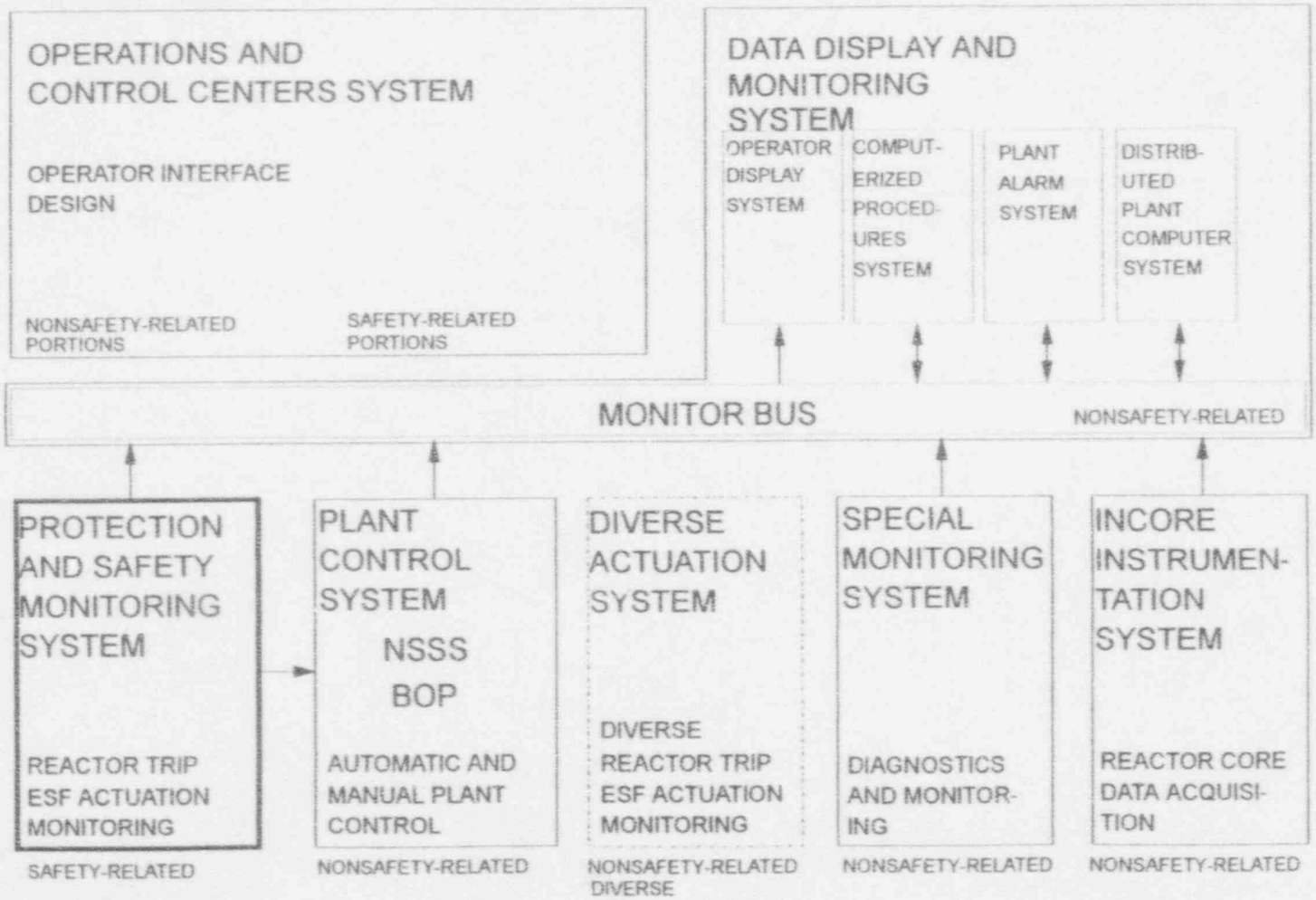
AP600 Instrumentation and Control Organization



AP600 Instrumentation and Control System Architecture

- Distributed, microprocessor based, architecture -- fault tolerant
- Lower Level - Systems that interact with plant
- Upper Level - Systems that interact with operator
- Communication -- Multiplexed, data links and data highways

AP600 Instrumentation and Control System Architecture



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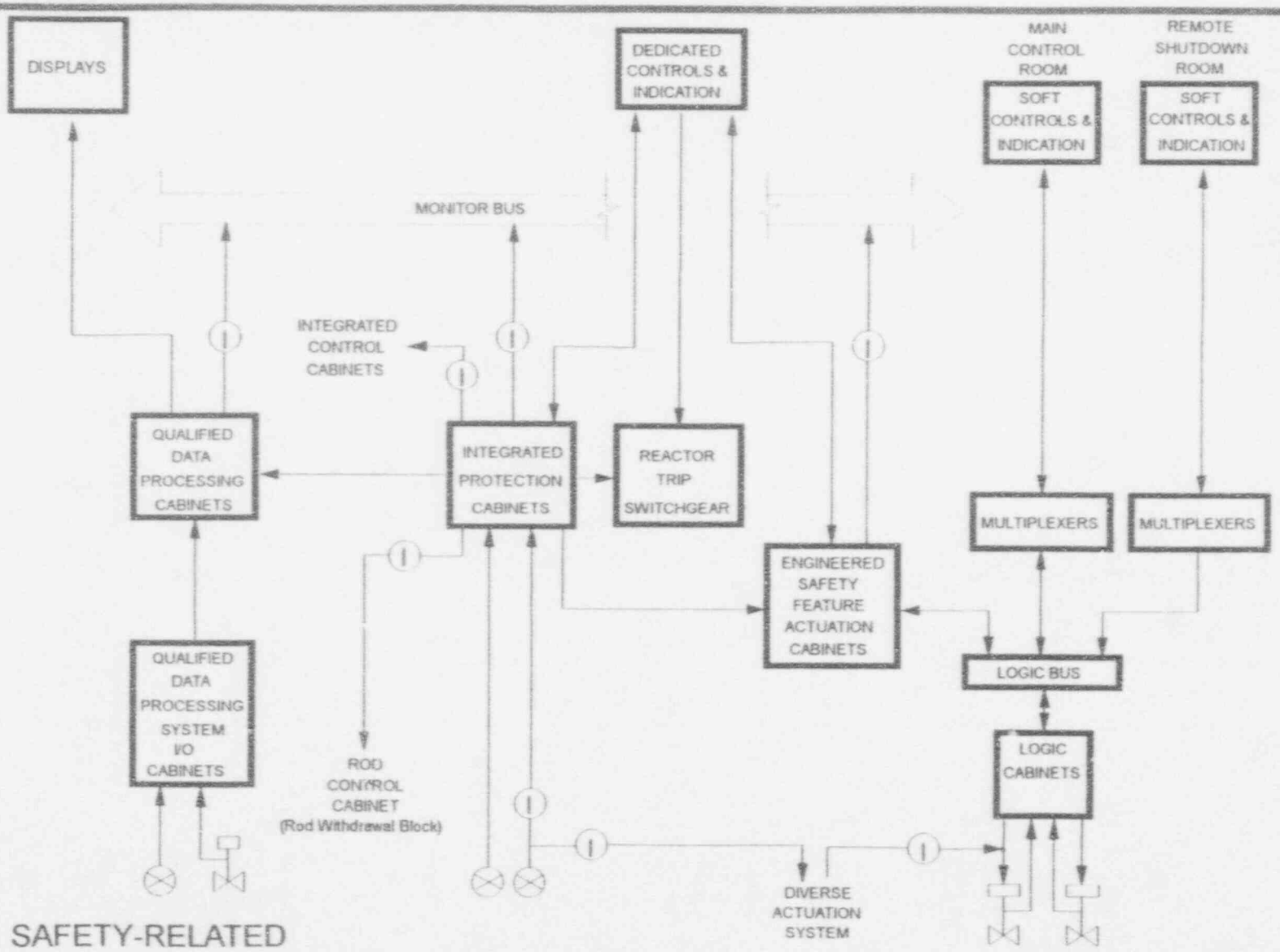
Protection and Safety Monitoring System Architecture

AP600



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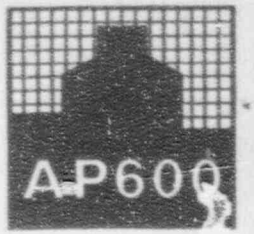
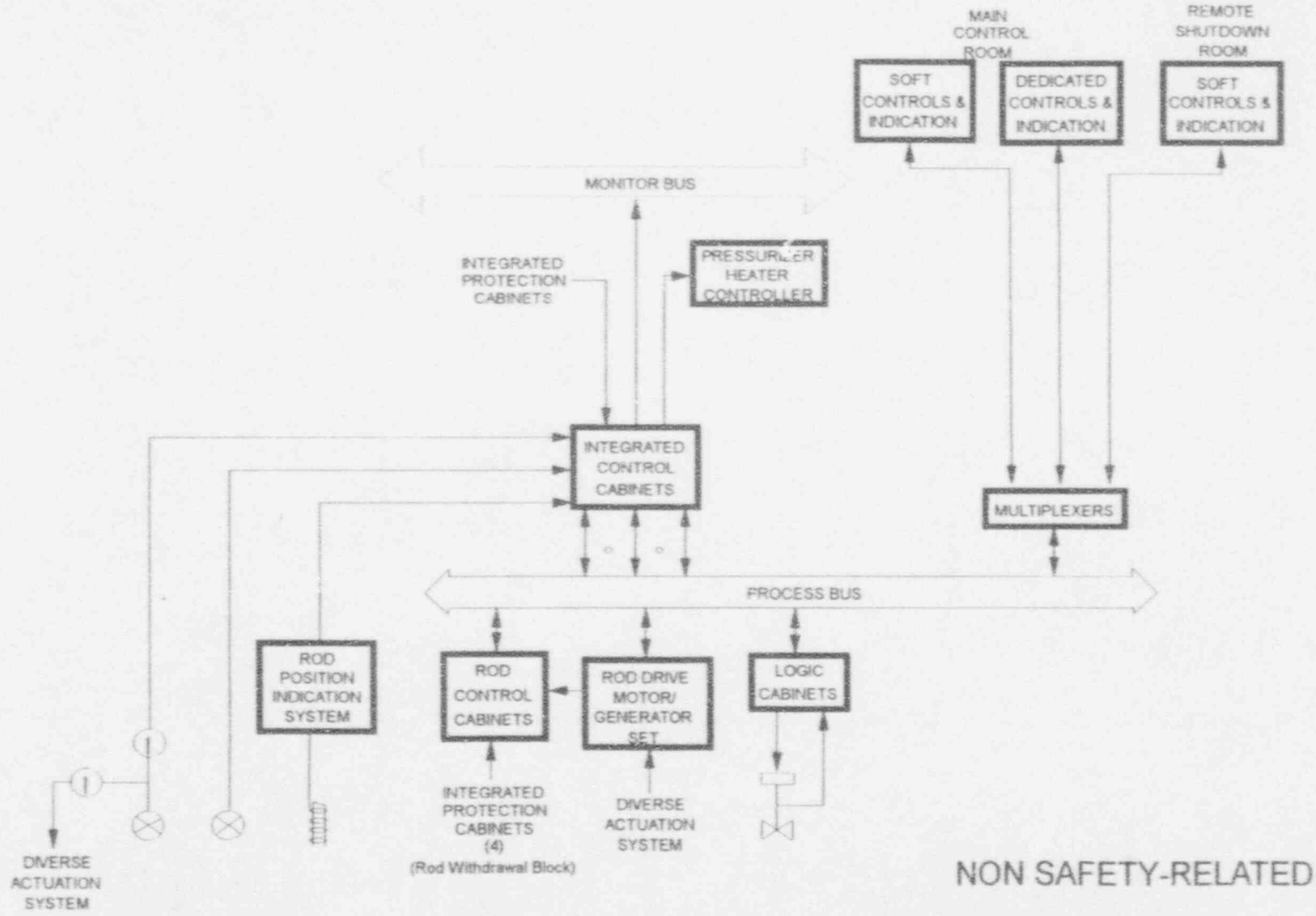
Protection and Safety Monitoring System



- Functions
  - Reactor Trip (Safety Related)
  - ESF Actuation (Safety Related)
  - Safety Related Plant Parameter Monitoring
  - Acquire Plant Sensor Data for Plant Control System
- Automatic and Manual Actuations Provided
- Manual Actuations are at function level and component level

Plant Control System Architecture

AP600



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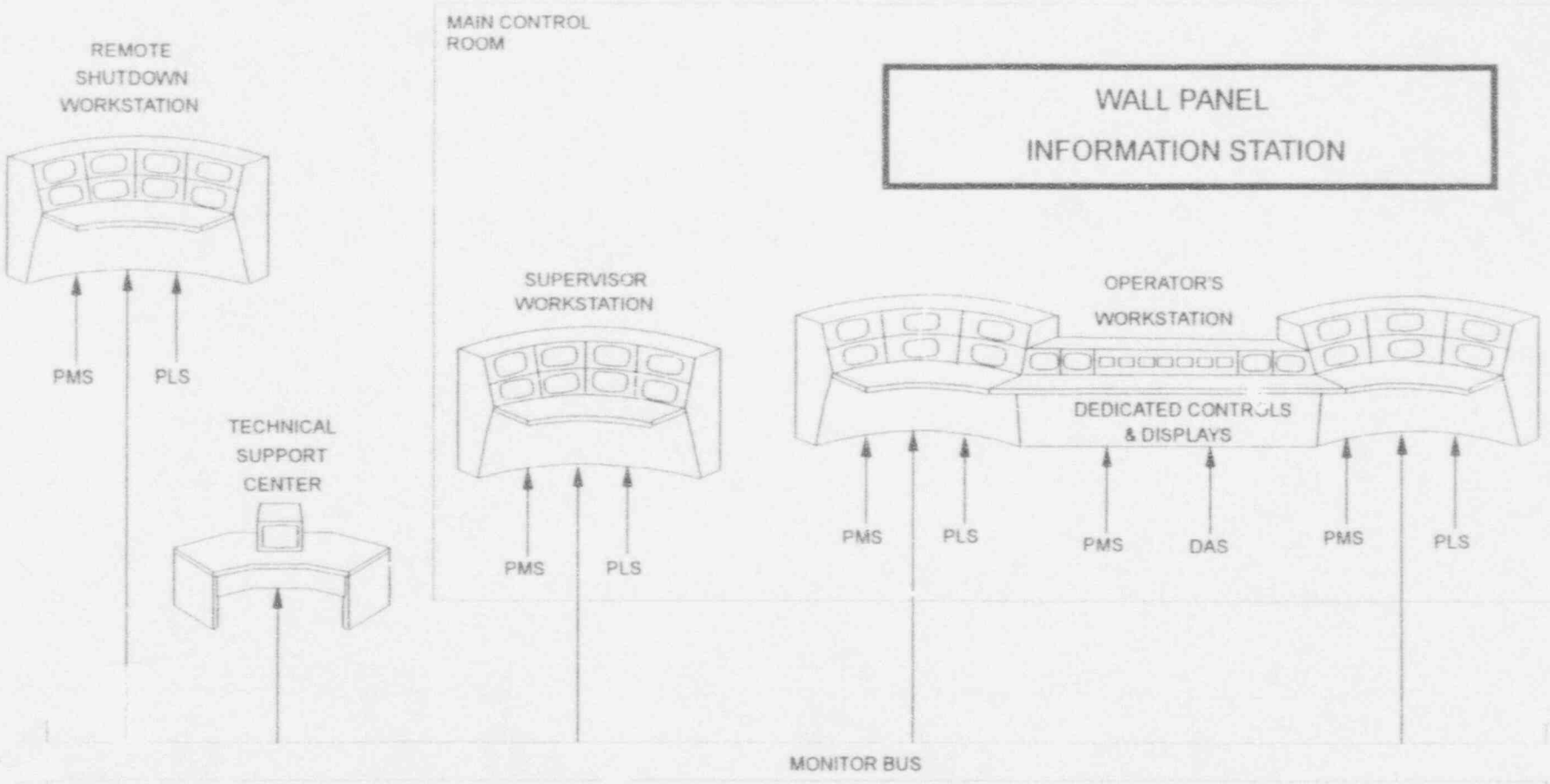
AP600

Plant Control System

- Plant Control Functions include
  - Reactor Power
  - Primary System Pressure
  - Pressurizer Level
  - Steam Generator Level
  - Feedwater Flow
  - Other NSSS Control Functions
  - Other BOP Control Functions
    - Does not include Turbine/Generator Control

Operations and Control Centers System Architecture

AP600



PMS - PROTECTION AND SAFETY MONITORING SYSTEM
PLS - PLANT CONTROL SYSTEM
DAS - DIVERSE ACTUATION SYSTEM

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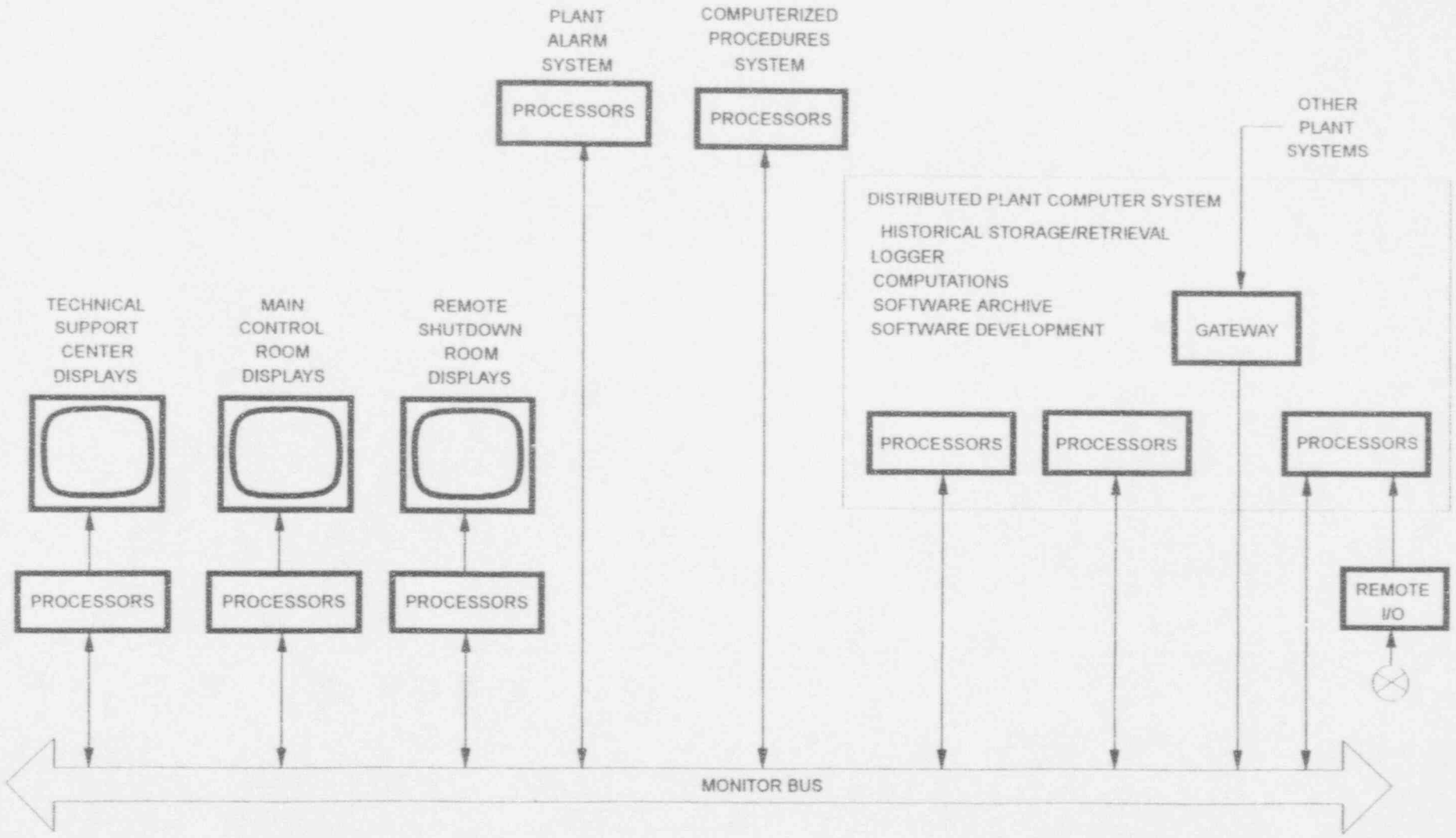
Operations and Control Centers System

AP600

- Functions - Human Factors Design
  - Main Control Room
  - Remote Shutdown Room
  - Operator Display Design
  - Alarm System Design
  - Interactive Procedures Design

Data Display and Processing System Architecture

AP600



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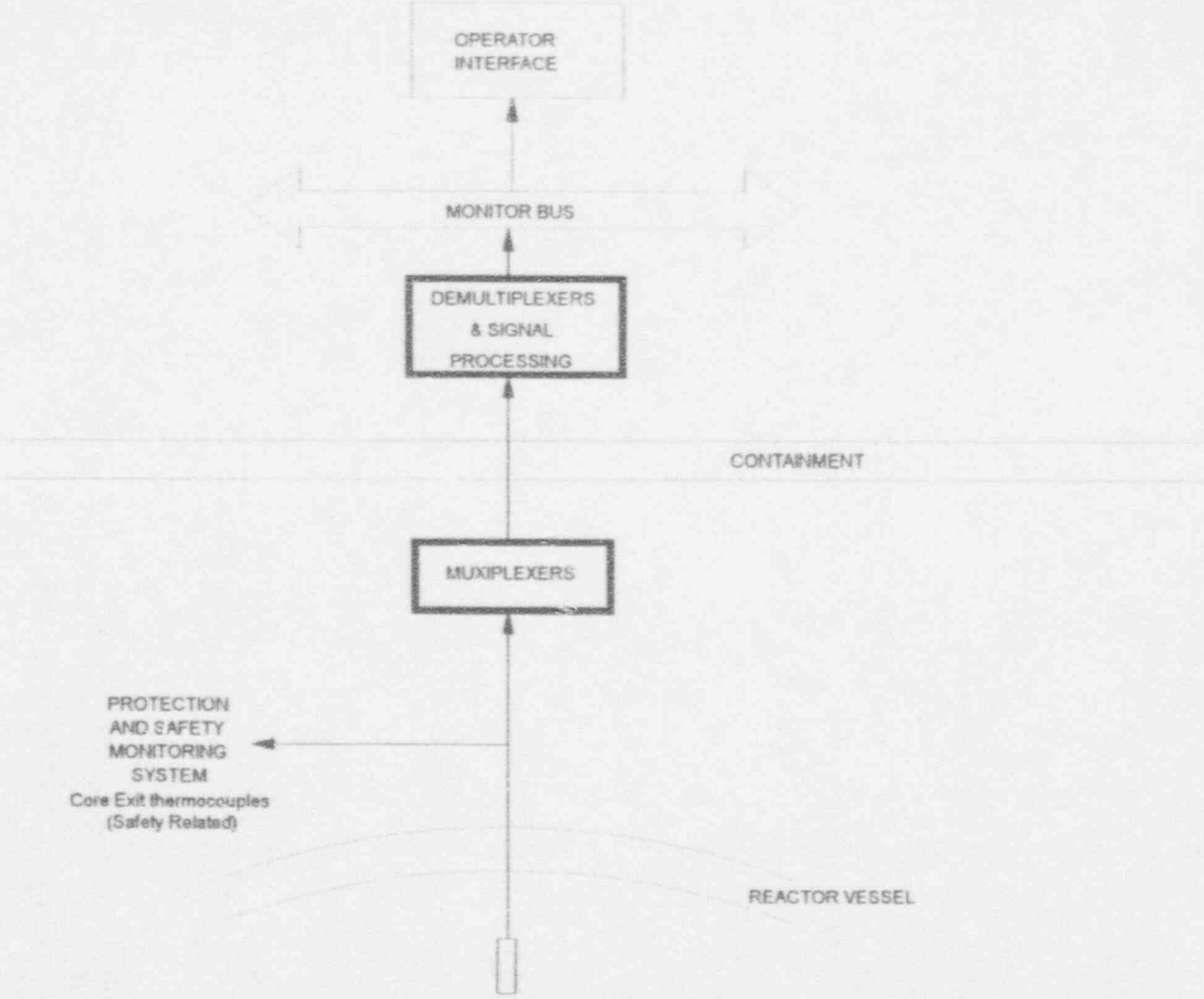
Data Display and Processing System

AP600

- Functions
  - Operator Displays
  - Plant Alarm System
  - Plant Computer System
    - Core Calculations
  - Interactive Procedures
  - Historical Data Storage and Retrieval
  - Plant Data Logging

Incore Instrumentation System Architecture



NON SAFETY-RELATED

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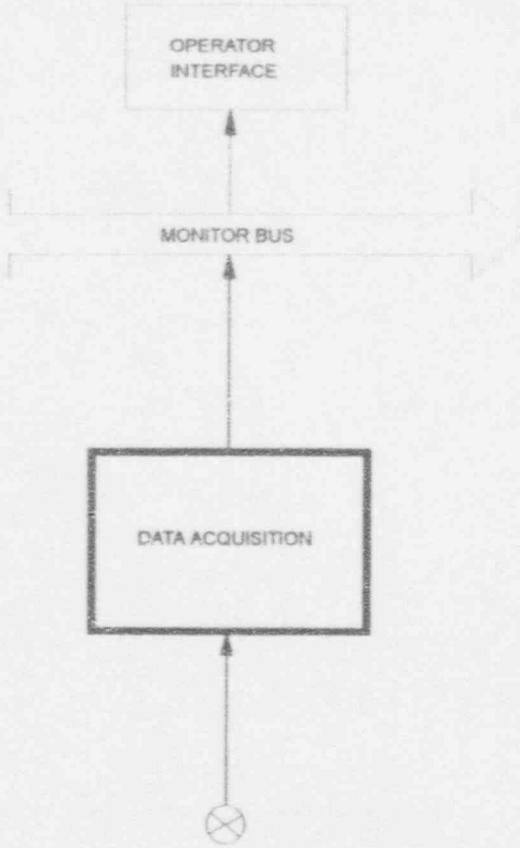
Incore Instrumentation System

AP600

- Functions
  - Provides Nuclear Flux Level Data from inside the reactor vessel
  - Provides mounting for Core Exit Thermocouples

Special Monitoring System Architecture



CONCEPTUAL
NON SAFETY-RELATED

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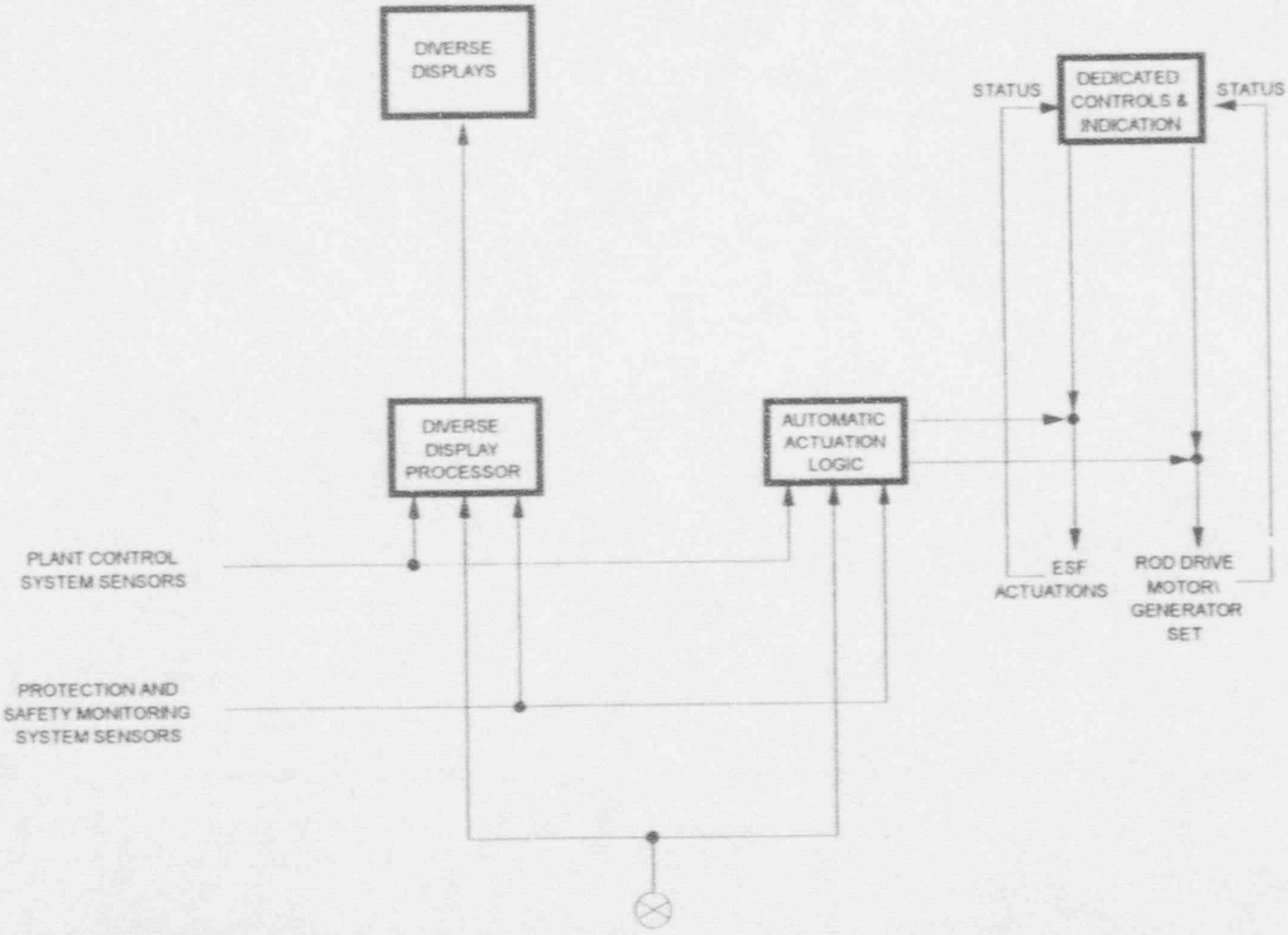
Diverse Actuation System Architecture



NON SAFETY-RELATED

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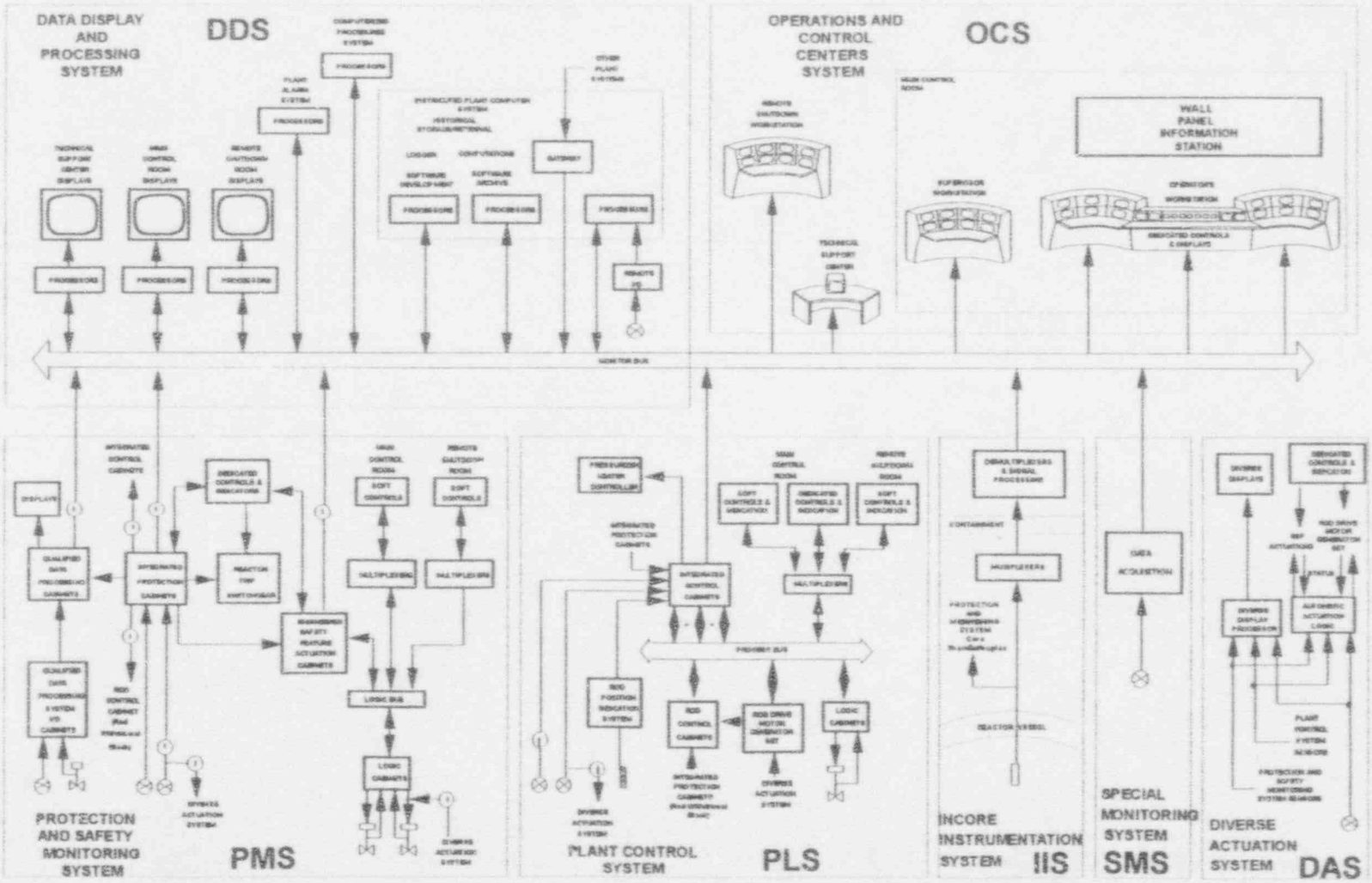
AP600 Instrumentation & Control Architecture



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Defense In Depth

AP600

- Issue
  - How To Economically Protect Against Common Mode Failure
  - Basis
    - NUREG-0493, A Defense in Depth and Diversity Assessment of the RESAR-414 Integrated Protection System
    - a Structured Approach to Evaluating Effects of Common Mode Failures
  - Reference: AP600 Defense in Depth and Diversity Report, WCAP-13633

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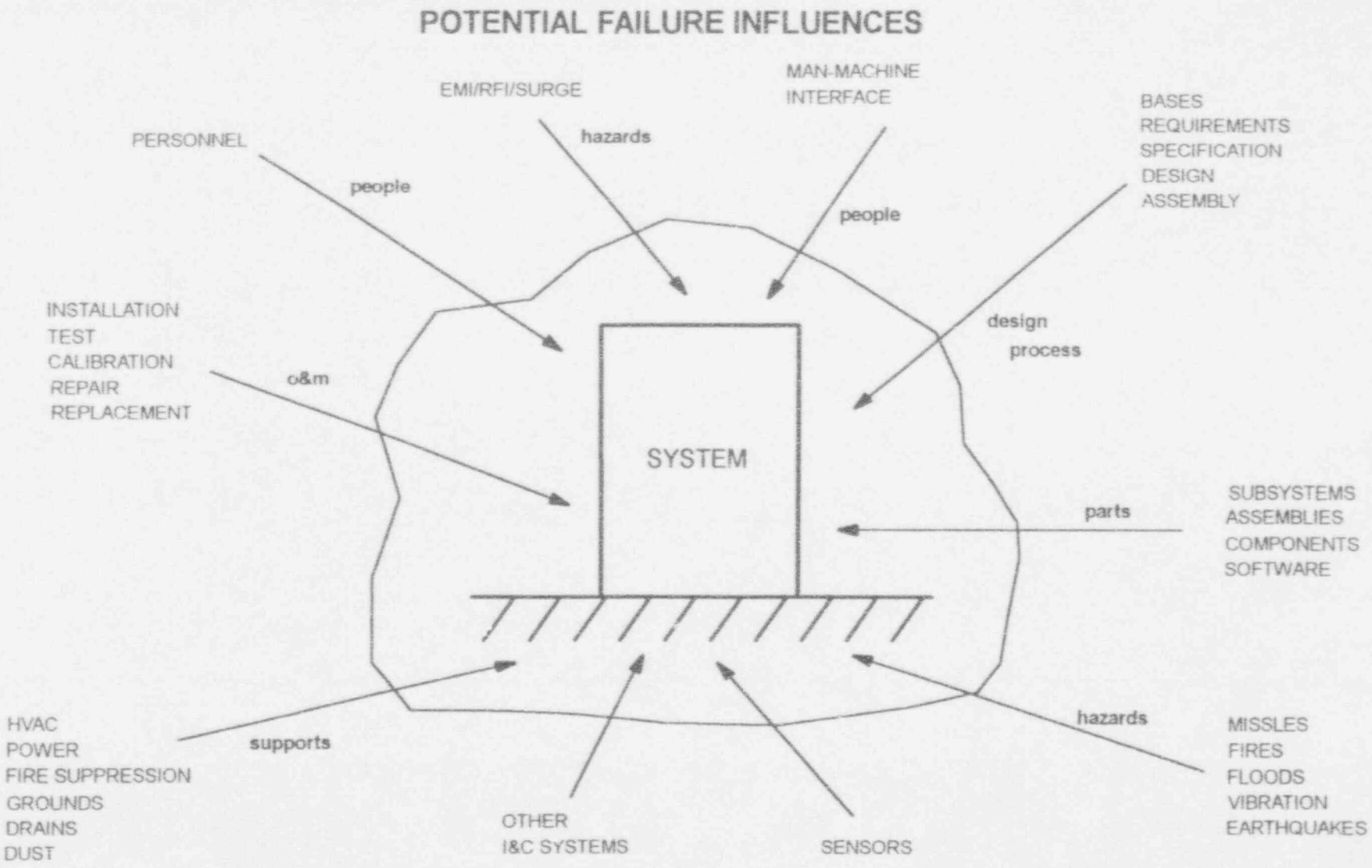
Defense in Depth



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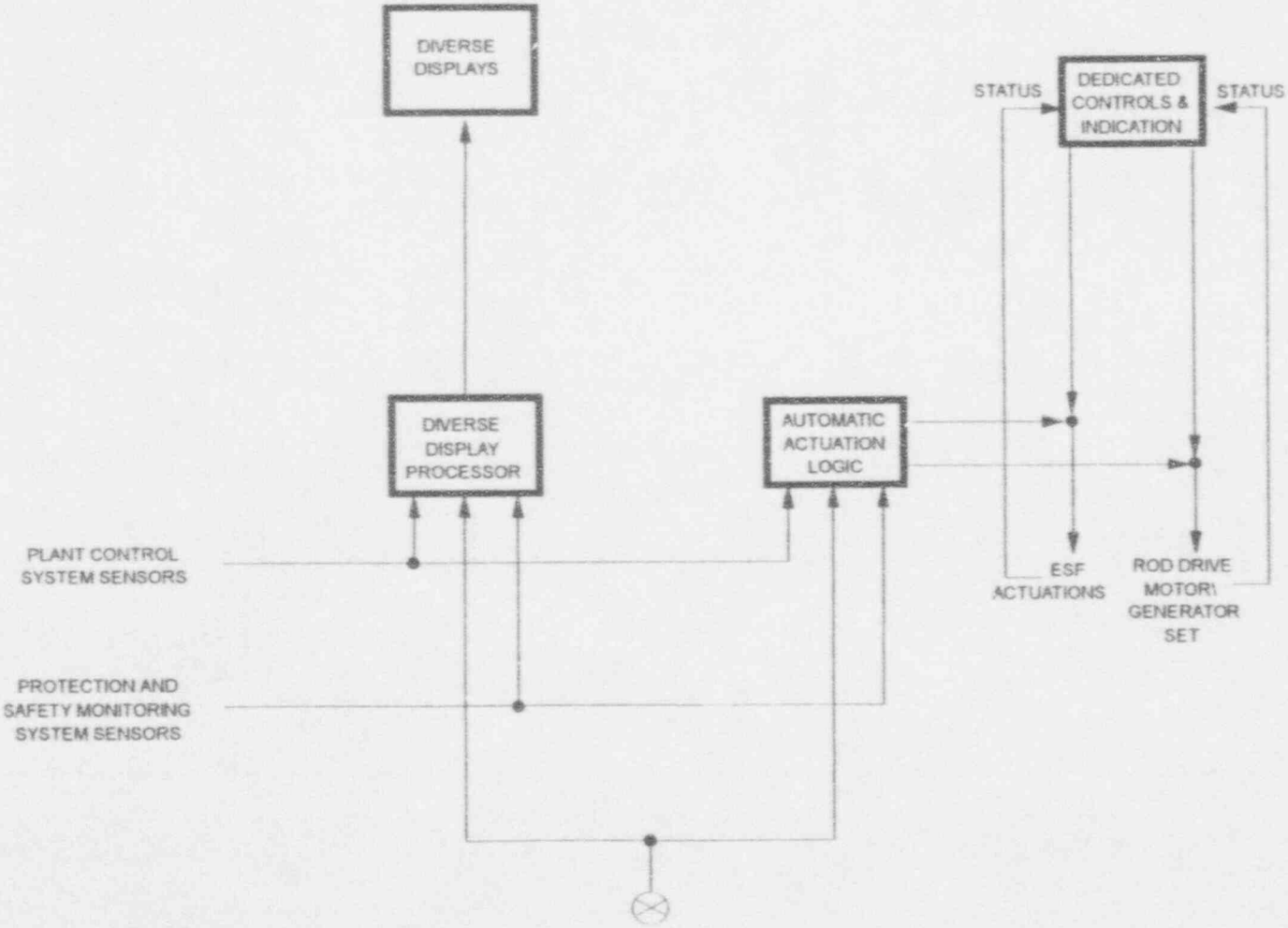
Diverse Actuation System Architecture



NON SAFETY-RELATED

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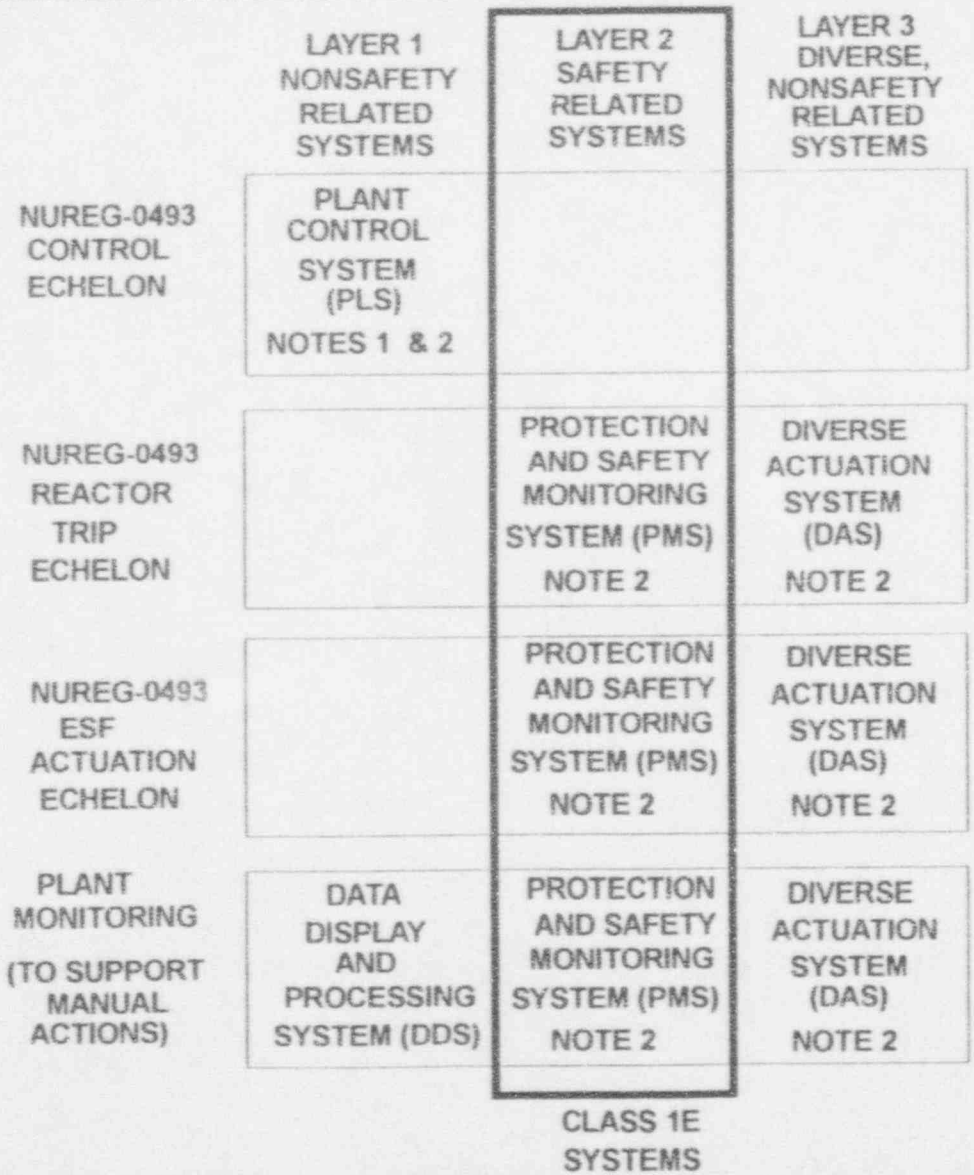
AP600

Diverse Actuation System

- Functions
  - NonSafety Related, Diverse Reactor Trip
  - NonSafety Related, Diverse ESF Actuation
  - NonSafety Related, Diverse Plant Parameter Monitoring
  - Automatic, Diverse Component Actuation
  - Manual, Diverse Component Actuation

AP600 Instrumentation and Control Echelons of Defense



NOTES:

1) THE PLS FUNCTIONS TO ENABLE THE PLANT TO MAINTAIN CONDITIONS WITHIN OPERATING LIMITS AND ALSO PROVIDES AUTOMATIC AND MANUAL ACTUATIONS OF THE NON-SAFETY RELATED DEFENSE-IN-DEPTH SYSTEMS

2) AUTOMATIC AND MANUAL ACTIONS PROVIDED IN THE PLS, PMS, AND DAS

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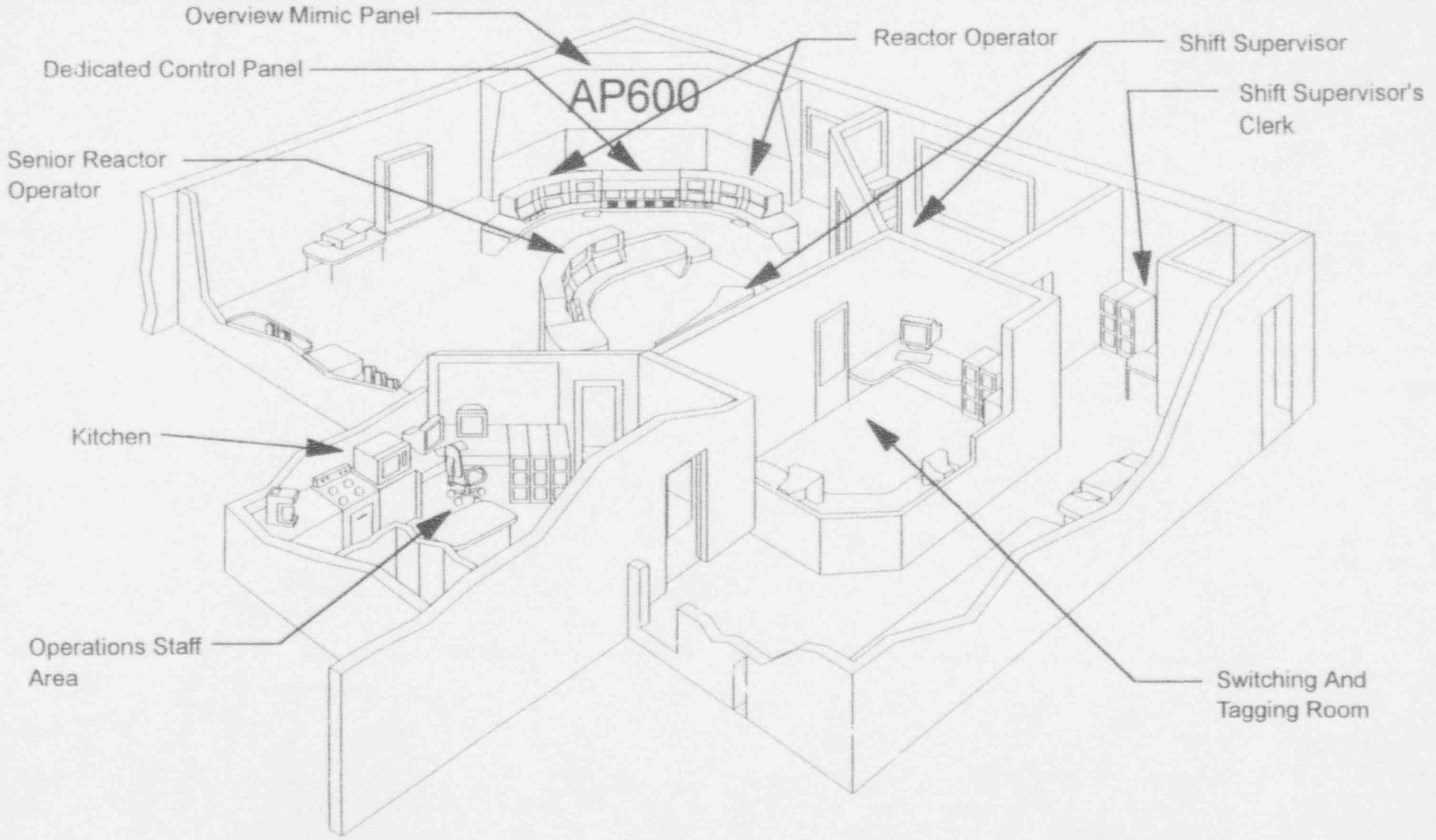
Control Room Design



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Man-Machine Interface Subsystems Of An Advanced Control Room

AP600

- Advanced Alarm Management
- Computerized Procedures
- Soft Controls - Application
- Advanced Information Display Techniques
  - Workstation Displays
  - Wall Panel Information System

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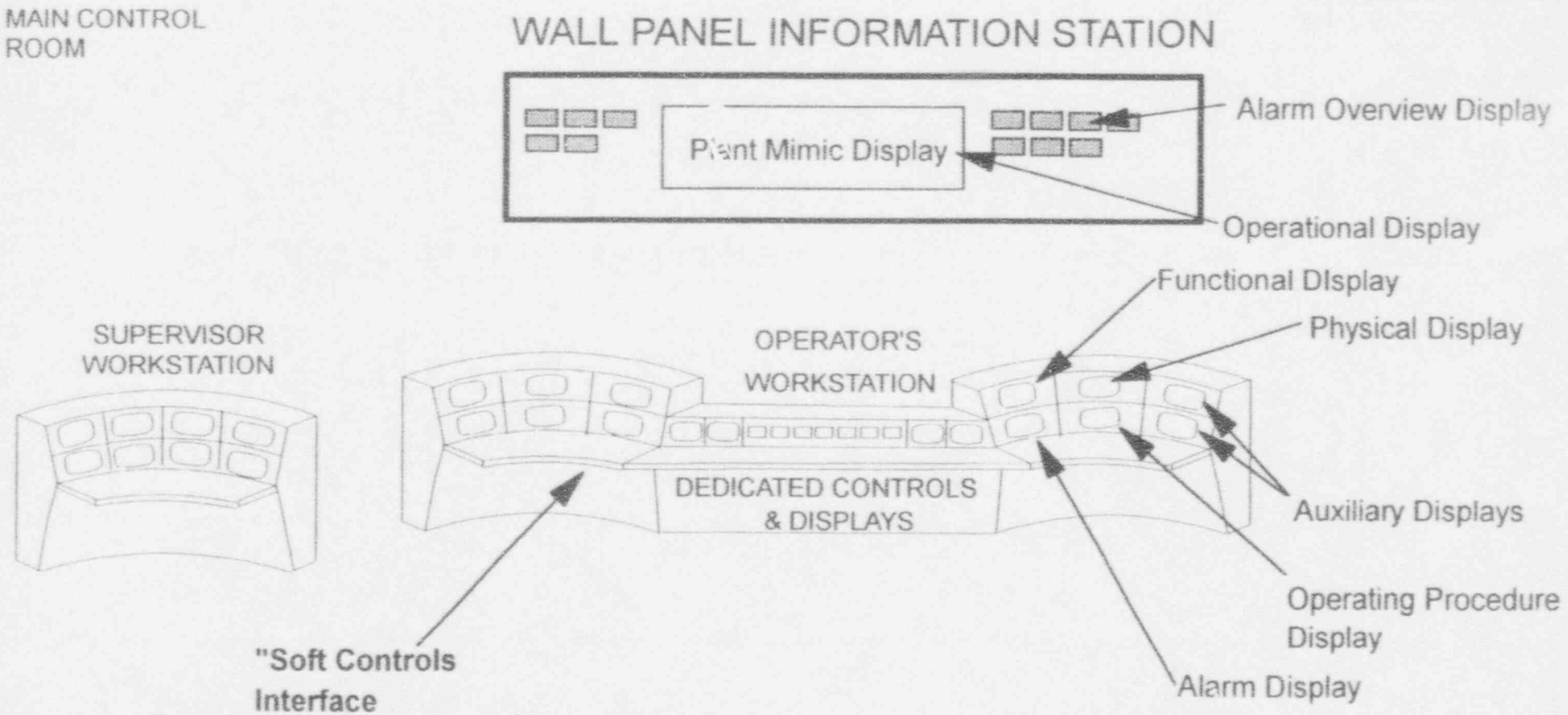
Operations and Control Centers Architecture



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Advanced Alarm Management

AP600

- Goal
  - Keep the Operators Mentally Ahead of the Event
- Approach
  - Alert the Operator to Problems
  - Indicate the Area in Which the Abnormality is Occurring
  - Identify Current Plant State by Indicating Functional Nature of Abnormality
  - Convey Links Between Equipment States and Process States
  - Prioritize to Avoid Alarm Avalanche

AP600

Computerized Procedures

- Goal
  - Provide Effective Computerized Plant Procedures
- Approach
  - Support Operator Vigilance by Monitoring and Reporting on Long Term Concerns
  - Monitor and Report on the State of the Equipment being Addressed
  - Link Procedure to Alarms and Controls
  - Provide Robust Off-Line Tool to Make Procedure Building Easy

file: AP6ARCH.PRE

Advanced Information Display Techniques

AP600

- Goal
  - Present Data Effectively
- Approach
  - Represent Problem Space in Both Physical and Functional Terms
  - Integrate with Other Control Room Resources Such as Alarm System and Control Devices
  - Ensure that Casual Monitoring is Easily Accomplished and that Individual Parameters are Easily Located
  - Provide Situation Awareness / Crew Coordination

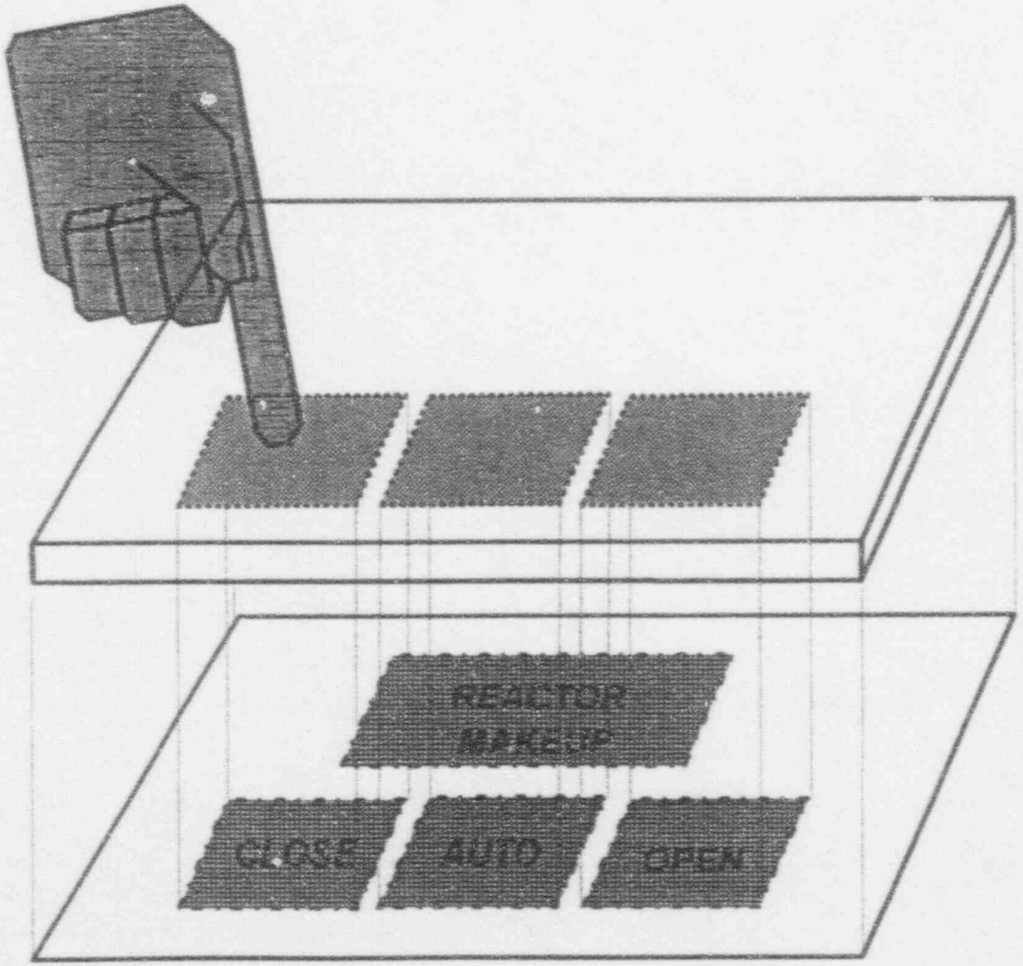
AP600

Soft Controls Application

- Goal
  - Make Soft Controls Useful to Humans
- Approach
  - Navigation
    - Make Control Easy to Find Relative to Alarm Message or Through Casual Monitoring
  - Discrepancy Indication
    - Make Demand vs Actual Discrepancies Easily Detectable
  - Links With Controlled Equipment
    - Make Relationship Easily Seen
  - Make Slips Detectable or Preventable

AP600

Soft Control Technology



SOFT
CONTROL
TOUCH
SCREEN

SOFT
CONTROL
DISPLAY
DEVICE

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AP600
ELECTRICAL SYSTEMS
OVERVIEW

David R. Dickerson
Southern Company Services

MAIN AC POWER -- DESIGN BASIS

- Nonsafety-related
  - Comprised of normal, preferred, maintenance, and standby power supplies
  - Normal supply from main generator through 2 unit aux transformers (UATs)
  - Preferred supply from grid by back-feeding through main step-up transformer
  - Maintenance source provided through reserve aux transformer (RAT)
  - Standby power from 2 onsite diesel generators

- Defense-in-depth
  - All power supplies capable of supplying permanent nonsafety-related loads
  - Permanent nonsafety-related loads functionally redundant and supplied from redundant 4160 vac busses
  - Each permanent nonsafety-related load bus supplied by dedicated diesel generators

- Safety-related
  - None

MAIN AC POWER -- FUNCTIONS

- Nonsafety-related
  - Supplies safe and reliable power for plant normal operation, startup, and orderly shutdown
- Defense-in-depth
  - Supplies safe and reliable power to the plant's permanent nonsafety-related loads
- Safety-related
  - None

MAIN AC POWER -- DESIGN FEATURES

- Nonsafety-related
  - Two UATs with identical ratings supply the 4160 vac busses
  - RAT is same capacity as UAT
  - System designed to supply maximum demand of loads served without exceeding the continuous rating of electrical equipment
  - System designed to interrupt the maximum fault current without exceeding the fault current rating of the electrical equipment
  - Functionally redundant loads are arranged in load groups
  - 4160 vac system
    - Six busses (each capable of being supplied from either the UATs or the RATs)
    - Functionally redundant loads are supplied from separate load groups
    - Supply loads greater than 250 hp
  - 480/277 vac system
    - Ten load centers
    - Functionally redundant loads supplied from separate load groups
    - Supply loads greater than 100 hp through 250 hp
    - Motor control centers (MCCs) supply loads from 0.5 hp through 100 hp
    - MCCs located in general vicinity of the loads they serve

MAIN AC POWER -- DESIGN FEATURES

- Defense-in-depth
  - Two independent 4160 vac busses
  - Each 4160 vac bus capable of being supplied from either UAT, RAT, or a diesel generator
  - Functionally redundant
  - Six 480 vac load centers

- Safety-related
  - Only safety-related function is tripping of reactor coolant pumps via two Class E 4160 vac breakers connected in series

ONSITE STANDBY POWER -- DESIGN BASIS

- Nonsafety-related
  - None

- Defense-in-depth
  - Supplies ac power to permanent nonsafety-related loads in the event of a main generator trip concurrent with the loss of the preferred power source
  - Diesel generators are automatically connected to their dedicated 4160 vac system after reaching rated voltage and frequency
  - Generators are loaded sequentially
  - Each diesel generator and its associated auxiliaries are completely independent

- Safety-related
  - None

ONSITE STANDBY POWER -- FUNCTIONS

- Nonsafety-related
  - None
- Defense-in-depth
  - Detect a loss of offside power event and automatically start and sequence loads, without operator action
- Safety-related
  - None

ONSITE STANDBY POWER -- DESIGN FEATURES

- Nonsafety-related
  - Each unit capable of being manually paralleled with the normal plant supply for periodic testing

- Defense-in-depth
  - Only one diesel generator required for supplying defense-in-depth systems
  - Maximum loadings are evaluated for the plant operating in hot standby, cool down, and shutdown modes
  - Generators sized for the "worst case" conditions
  - Capable of supplying design load within 120 seconds of a start signal
  - Automatic load sequencer
  - Capable of recovering from a load step 110% greater than the most severe load step in the planned load profile
  - Maximum voltage dip -- 20% of rated
  - Maximum frequency dip -- 10% of rated
  - Voltage and frequency restored to 10% and 2%, respectively, in less than 60% of planned load sequence time interval
  - Capable of operating at no load for at least 2 hours

- Safety-related
  - None

CLASS E DC AND UPS -- DESIGN BASIS

- Nonsafety-related
  - None

- Defense-in-depth
  - None

- Safety-related
  - Sized to achieve and maintain safe shutdown for the plant for 72 hours without load shedding
  - Four independent divisions, any 3-of-4 can shut down the plant safely and maintain it in a safe shutdown condition
  - Spare battery and charger have sufficient capacity to permit continuous plant operation
  - Capability to connect any one 125 vdc switchboard to the spare battery and charger
  - Meets single failure criterion (GDC 17)
  - Fault tolerant

CLASS E DC AND UPS -- FUNCTIONS

- Nonsafety-related
  - Each bank has a battery monitoring system to monitor open-circuit conditions and monitor battery voltage
  - The battery monitoring system provides trouble alarms and is NOT required to support any safety-related functions

- Defense-in-depth
  - None

- Safety-related
  - Provides uninterruptible power for the plant instrumentation, control, monitoring, and other vital functions required for plant startup, normal operation, and normal or emergency shutdown
  - Provides power for required dc and ac instrument loads following loss of offside power and onsite ac power sources
  - Provides power for normal and emergency lighting in the MCR and remote shutdown area

CLASS E DC AND UPS -- DESIGN FEATURES

- Nonsafety-related
  - Battery monitoring system

- Defense-in-depth
  - None

- Safety-related
  - Four independent, Class E vdc divisions -- A, B, C, D
  - Each division has one 24-hour battery bank
  - Divisions B and C each have one 72-hour battery bank
  - 24-hour battery banks for control functions not needed after 24 hours
  - Monitoring and lighting requirements supported for 72 hours
  - Each bank has its own battery charger supplied from the diesel backed busses
  - Each bank has inverters to supply uninterruptible power for plant instrumentation and controls at 208Y/120 vac
  - DC system is ungrounded so that a single ground fault will not preclude operation
  - Spare battery capable of replacing any 24-hour or 72-hour bank while maintaining electrical isolation and physical separation
  - Designed to Seismic Category 1 requirements
  - 72-hour post-accident monitoring via portable diesel generators

NON-CLASS E DC AND UPS -- DESIGN BASIS

- Nonsafety-related
  - Two separate systems supplying separate load groups
  - Spare battery and charger available
  - Continuous and reliable source during all modes of plant operation
  - Sized to provide a continuous and reliable source for non-Class E dc loads for 2 hours

- Defense-in-depth
  - Provide DC/UPS power for plant permanent nonsafety-related loads

- Safety-related
  - None

NON-CLASS E DC AND UPS -- FUNCTIONS

- Nonsafety-related
  - Provides uninterruptible power for the instrumentation, control, and monitoring required for plant startup, normal operation, and shutdown of the unit for investment protection
  - Provides the required power for investment protection loads following a loss of offside or onsite ac power sources

- Defense-in-depth
  - Provides DC/UPS power for plant permanent nonsafety-related loads

- Safety-related
  - None

NON-CLASS E DC AND UPS -- DESIGN FEATURES

- Nonsafety-related
  - Two independent sources
  - Functionally redundant
  - Sized for worst case operating mode
  - Each bank has its own battery charger supplied from diesel-backed busses
  - Each bank has an inverter to supply power at 208Y/120 vac
  - DC system is ungrounded so that a single ground fault will not preclude operation
  - Spare battery available to replace either bank while maintaining electrical isolation and physical separation

- Defense-in-depth
  - 2-hour capacity

- Safety-related
  - None

PLANT LIGHTING -- DESIGN BASIS

- Nonsafety-related
  - Two load groups with each "staggered"
  - Two independent sources
  - Provide necessary lighting for activities following loss of ac power sources
- Defense-in-depth
  - None
- Safety-related
  - Lighting in the MCR and remote shutdown area will be powered from the Class E DC and UPS

PLANT LIGHTING -- FUNCTIONS

- Nonsafety-related
  - Provide normal lighting to meet the visual requirements of the plant
  - Provide emergency lighting for access and egress as required
- Defense-in-depth
  - None
- Safety-related
  - Provide lighting for 72-hour coping period

PLANT LIGHTING -- DESIGN FEATURES

- Nonsafety-related
  - Backed from onsite diesel generators
  - Maintain miscellaneous task lighting for 8 hours following loss of onsite ac power sources
  - Provide a capability for remote control to allow operators to control lighting levels in various areas of the plant

- Defense-in-depth
  - None

- Safety-related
  - Provide lighting in the MCR and remote shutdown area for 72 hours
  - Designed to Seismic Category 1 requirements

COMMUNICATIONS -- DESIGN BASIS

- Nonsafety-related
  - Provide reliable voice communications during normal operations and credible abnormal, accident, and emergency situations
  - Broadcast alarm signal for plant-wide emergency situations
  - Minimize radio frequency interference for all electrical components
- Defense-in-depth
  - None
- Safety-related
  - None

COMMUNICATIONS -- FUNCTIONS

- Nonsafety-related
  - Adequate communication means between all areas of the plant for operations and maintenance during all modes of plant operation
  - Compatible with internal and external communication systems
  - Provide selected personnel immediate access through dedicated channels to external organizations and plant personnel
  - Clear and intelligible communications
  - Operational to perform warning and alarm communication functions during loss of all ac power

- Defense-in-depth
  - None

- Safety-related
  - None

COMMUNICATIONS -- DESIGN FEATURES

- Nonsafety-related
  - Portable, wireless telephone system
  - Plant-wide telephone-page system
  - Private automatic branch exchange system
  - Sound-powered communication system

- Defense-in-depth
  - None

- Safety-related
  - None

BALANCE OF PLANT SYSTEMS

D. Michael O'Connor
Bechtel Power Corporation

AP600

BALANCE OF PLANT SYSTEMS

- AUXILIARY FLUID SYSTEMS
- HVAC SYSTEMS
- STEAM AND POWER CONVERSION SYSTEMS
- WATER AND WASTE TREATMENT SYSTEMS
- MECHANICAL HANDLING SYSTEMS

BALANCE OF PLANT SYSTEMS

Auxiliary fluid systems

		WBS
	• Compressed and instrument air	CAS
	• Cooling tower makeup and blowdown	CBS
	• Component cooling water	CCS
	• Circulating and service water chem injection	CLS
	• Cooling tower	CTS
	• Circulating water	CWS
	• Standby diesel and auxiliary boiler fuel oil	DOS
*	• Fire protection	FPS
	• Plant gas	PGS
	• Secondary sampling	SSS
*	• Service water	SWS
	• Turbine building closed cooling water	TCS
	• Containment leak rate test	VUS
*	• Central chilled water	VWS

BALANCE OF PLANT SYSTEMS (Cont'd)

HVAC Systems

		WBS
*	• Radiologically controlled area ventilation	VAS
*	• Nuclear island nonradioactive ventilation	VBS
*	• Containment recirculation cooling	VCS
*	• Main control room habitability	VES
*	• Containment air filtration	VFS
	• Health physics and hot machine shop HVAC	VHS
	• Containment hydrogen control	VLS
	• Pump house building ventilation	VPS
	• Radwaste building HVAC	VRS
	• Turbine building ventilation	VTS
	• Annex/Aux bldg nonradioactive ventilation	VXS
	• Hot water heating	VYS
	• Diesel generator building ventilation	VZS

BALANCE OF PLANT SYSTEMS (Cont'd)

Steam and power conversion systems

		WBS
	• Auxiliary steam supply	ASS
	• Steam energy blowdown	BDS
*	• Condensate	CDS
	• Condenser tube cleaning	CES
	• Turbine island chemical feed	CFS
	• Condenser air removal	CMS
	• Condensate polishing	CPS
	• Main and startup feedwater	FWS
	• Gland seal	GSS
	• Generator hydrogen and CO_2	HCS
	• Heater drain	HDS
	• Hydrogen seal oil	HSS
	• Main turbine and generator lube oil	LOS
	• Main steam	MSS
*	• Main turbine	MTS
	• Stator cooling	SCS

BALANCE OF PLANT SYSTEMS (Cont'd)

Water and waste treatment systems

	WBS
• Storm drain	DRS
• Demineralized water treatment	DTS
• Demineralized water transfer and storage	DWS
• Potable water	PWS
• Gravity and roof drain collection	RDS
• Raw water	RWS
• Sanitary drainage	SDS
• Turbine building vents, drains, and relief	TDS
• Waste water	WWS

BALANCE OF PLANT SYSTEMS (Cont'd)

Mechanical handling systems

	WBS
• Fuel handling and refueling	FHS
• Mechanical handling	MHS

AUXILIARY FLUID SYSTEMS

AP600

FIRE PROTECTION SYSTEM

Design Bases

Nonsafety-related

- Supply fire water at req'd pressure, flowrate and duration
  - Satisfy demand of automatic sprinkler systems
  - 750 gpm hose stream allowance
  - Minimum two-hour water supply
- Maintain 100% of fire pump capacity, following:
  - Failure of one fire pump, or
  - Loss of offsite power

Defense-in-depth

- Provide seismically qualified fire water subsystem
  - Manual firefighting only
  - Protect areas containing safe shutdown equipment
  - 75 gpm for any two hose stations

AUXILIARY FLUID SYSTEMS (Cont'd)

FIRE PROTECTION SYSTEM (Cont'd)

Design Bases (Cont'd)

Safety-related

- None

AUXILIARY FLUID SYSTEMS (Cont'd)

FIRE PROTECTION SYSTEM (Cont'd)

Functions

Nonsafety-related

- Detect and locate fires promptly
- Control and extinguish fires in plant areas
- Protect personnel
- Limit property loss
- Minimize radiological releases

Defense-in-depth

- Ability to protect safe shutdown equipment after an SSE

AUXILIARY FLUID SYSTEMS (Cont'd)

FIRE PROTECTION SYSTEM (Cont'd)

Functions (Cont'd)

Safety-related

- None

AUXILIARY FLUID SYSTEMS (Cont'd)

FIRE PROTECTION SYSTEM (Cont'd)

Design Features

<u>Nonsafety-related</u>

- Consists of related subsystems:
  - Fire detection and alarm
  - Nonseismic fire water supply (pumps)
  - Automatic fire suppression
  - Manual fire suppression
- Two fresh water storage tanks
- Two 100% capacity fire pumps
- Jockey pump
- Underground yard main
- Foam system used in diesel generator bldg only
- No Halon or $C0_2$ flooding systems used

AUXILIARY FLUID SYSTEMS (Cont'd)

FIRE PROTECTION SYSTEM (Cont'd)

Design Features (Cont'd)

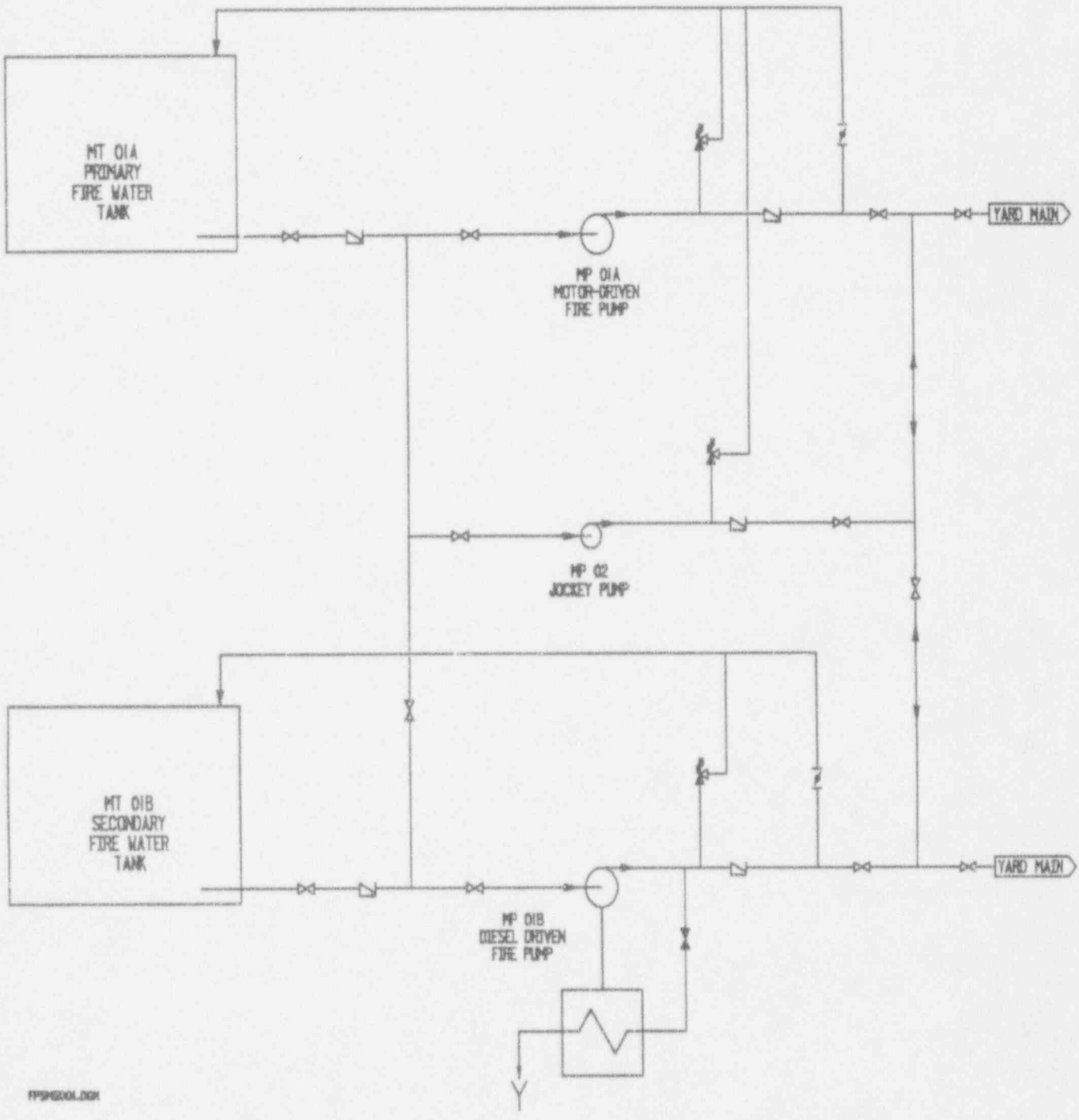
Defense-in-depth

- Seismic Category I gravity feed from PCS tank
  - Passive design
  - Supplies standpipes in safe shutdown area

Safety-related

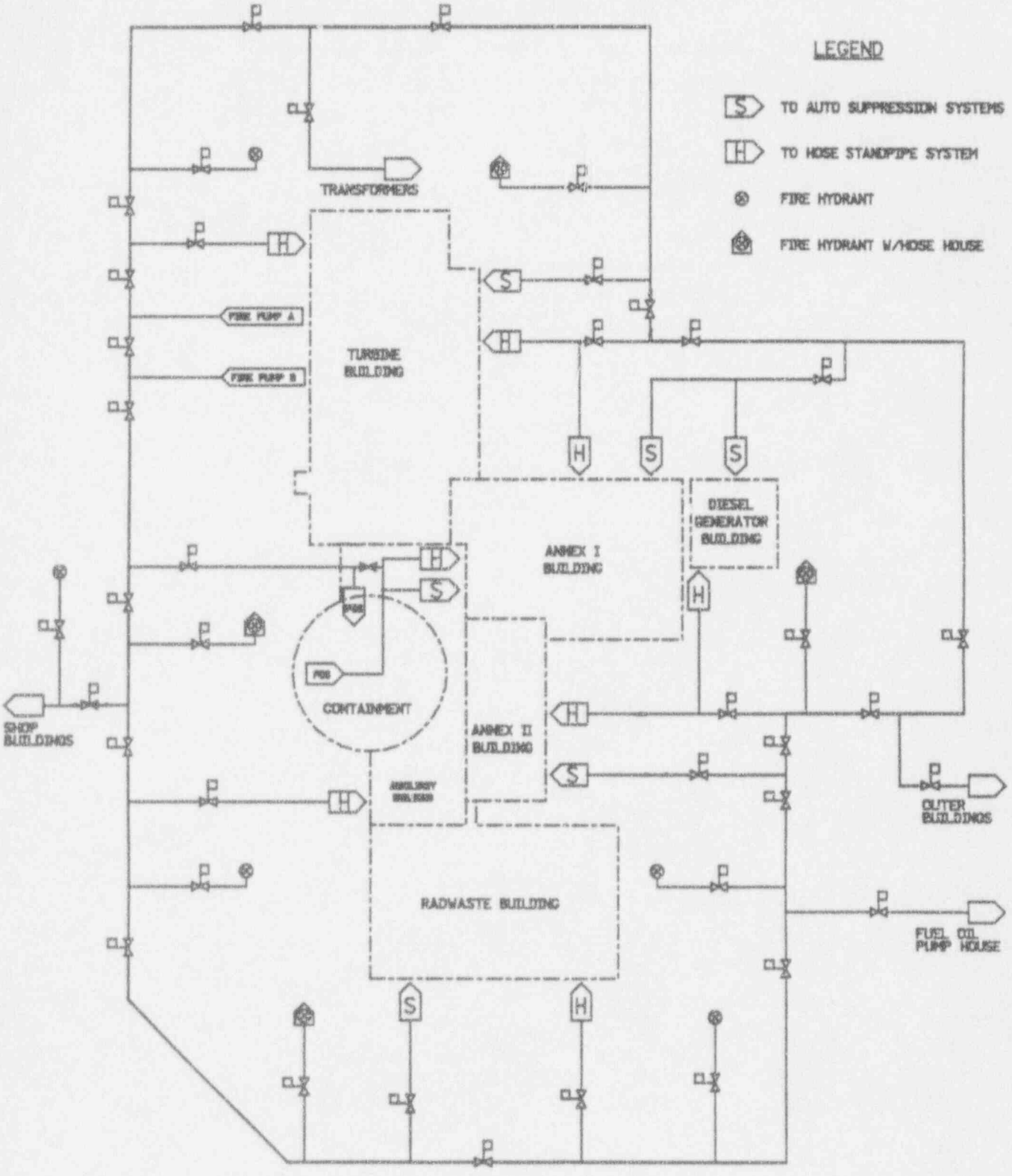
- None

AP600
FIRE PROTECTION SYSTEM (FPS)



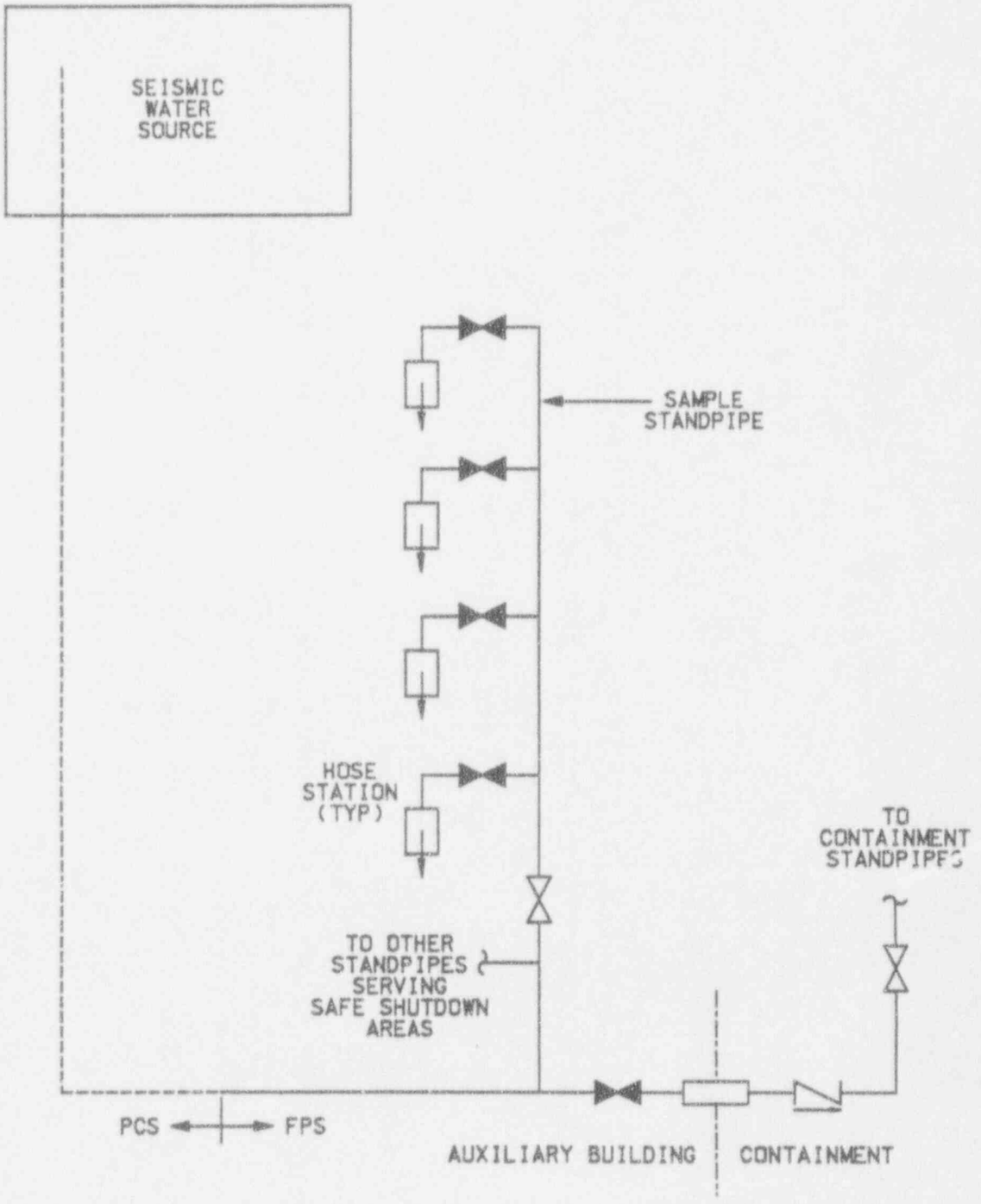
SCHEMATIC DIAGRAM
FIRE WATER SUPPLY

AP600
FIRE PROTECTION SYSTEM (FPS)



SCHEMATIC DIAGRAM
FIRE WATER DISTRIBUTION

AP600
FIRE PROTECTION SYSTEM (FPS)



Seismically Qualified Standpipe System

AUXILIARY FLUID SYSTEMS (Cont'd)

SERVICE WATER SYSTEM

Design Bases

Nonsafety-related

- Provide cooling water to component cooling water (CCS) heat exchangers for normal operation
- Reject heat to the environment through cooling tower
- Chemically treated for corrosion protection

Defense-in-depth

- Provide heat sink for RNS via CCS under abnormal conditions
- Provide heat removal from SFS via CCS under abnormal conditions
- Single active component failure proof
- Capable of operation in event of LOOP

AUXILIARY FLUID SYSTEMS (Cont'd)

SERVICE WATER SYSTEM (Cont'd)

Design Bases (Cont'd)

Safety-related

- None

AUXILIARY FLUID SYSTEMS (Cont'd)

SERVICE WATER SYSTEM (Cont'd)

Functions

Nonsafety-related

- Support CCS for normal operation heat removal

Defense-in-depth

- Support CCS for defense-in-depth operation heat removal from RNS and SFS
- Provide uninteruptable service

Safety-related

- None

AUXILIARY FLUID SYSTEMS (Cont'd)

SERVICE WATER SYSTEM (Cont'd)

Design Features

Nonsafety-related

- Vertical, wet pit, centrifugal pumps take suction from cooling tower basin
- Mechanical draft cooling tower
- In-line strainers

Defense-in-depth

- Two 100% redundant trains with common return piping
- Automatically aligned to standby diesels on LOOP

Safety-related

- None

CHILLED WATER SYSTEM

Consists of:

- High capacity subsystem
- Low capacity subsystem

AUXILIARY FLUID SYSTEMS (Cont'd)

CHILLED WATER SYSTEM (Cont'd)
(High Capacity Subsystem)

Design Bases

Nonsafety-related

- Chillers sized based on 10°F ΔT of supply and return
- Centralized subsystem for normal HVAC support
- 100% redundancy for key subsytem components
- Supply 44°F chilled water to normal HVAC
- Manual backup power from standby diesels for investment protection
- Protection against freezing

Defense-in-depth

- None

CHILLED WATER SYSTEM (Cont'd)
(High Capacity Subsystem)

Design Bases (Cont'd)

Safety-related

- Containment isolation for VCS coils supply and return

AUXILIARY FLUID SYSTEMS (Cont'd)

CHILLED WATER SYSTEM (Cont'd)
(High Capacity Subsystem)

Functions

Nonsafety-related

- Provide heat removal for normal HVAC components
- Provide heat removal for VCS

Defense-in-depth

- None

Safety-related

- Provide containment isolation to preserve containment integrity for DBA

AUXILIARY FLUID SYSTEMS (Cont'd)

CHILLED WATER SYSTEM (Cont'd)
(High Capacity Subsystem)

Design Features

Nonsafety-related

- Two 100% capacity equipment trains
- Cross-connect at pump discharge
- Bypass around pump \ chiller for constant flow
- 40% glycol solution for freeze protection
- Intertie with hot water system for VCS coils

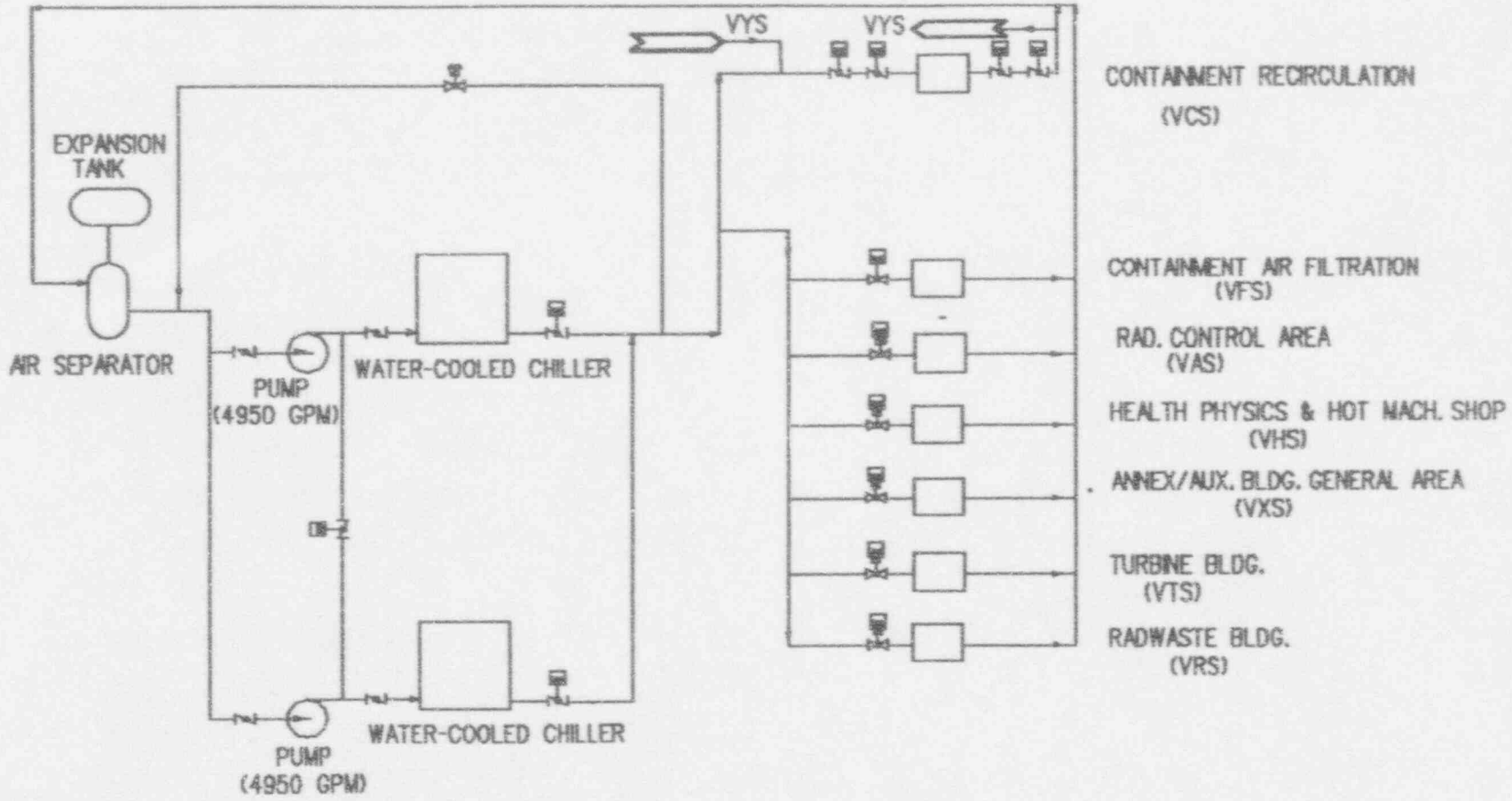
Defense-in-depth

- None

Safety-related

- Containment isolation valves and associated piping

AP600
CHILLED WATER SYSTEM (VWS)



HIGH CAPACITY SUBSYSTEM

AUXILIARY FLUID SYSTEMS (Cont'd)

CHILLED WATER SYSTEM (Cont'd)
(Low Capacity Subsystem)

Design Bases

Nonsafety-related

- Chillers sized based on 10°F ΔT of supply and return
- 40°F chilled water for optimization of equipment size
- Supply 40°F chilled water to key HVAC components for normal operation
- Protection against freezing

Defense-in-depth

- Dedicated subsystem for defense-in-depth HVAC support
- Single active failure proof
- Automatic backup power from standby diesels
- Supply 40°F chilled water to defense-in-depth HVAC for key components

CHILLED WATER SYSTEM (Cont'd)
(Low Capacity Subsystem)

Design Bases (Cont'd)

Safety-related

- None

AUXILIARY FLUID SYSTEMS (Cont'd)

CHILLED WATER SYSTEM (Cont'd)
(Low Capacity Subsystem)

Functions

Nonsafety-related

- Provide cooling for key HVAC system normal operation

Defense-in-depth

- Provide cooling for defense-in-depth HVAC system operation

Safety-related

- None

AUXILIARY FLUID SYSTEMS (Cont'd)

CHILLED WATER SYSTEM (Cont'd)
(Low Capacity Subsystem)

Design Features

Nonsafety-related

- 40% glycol solution for freeze protection

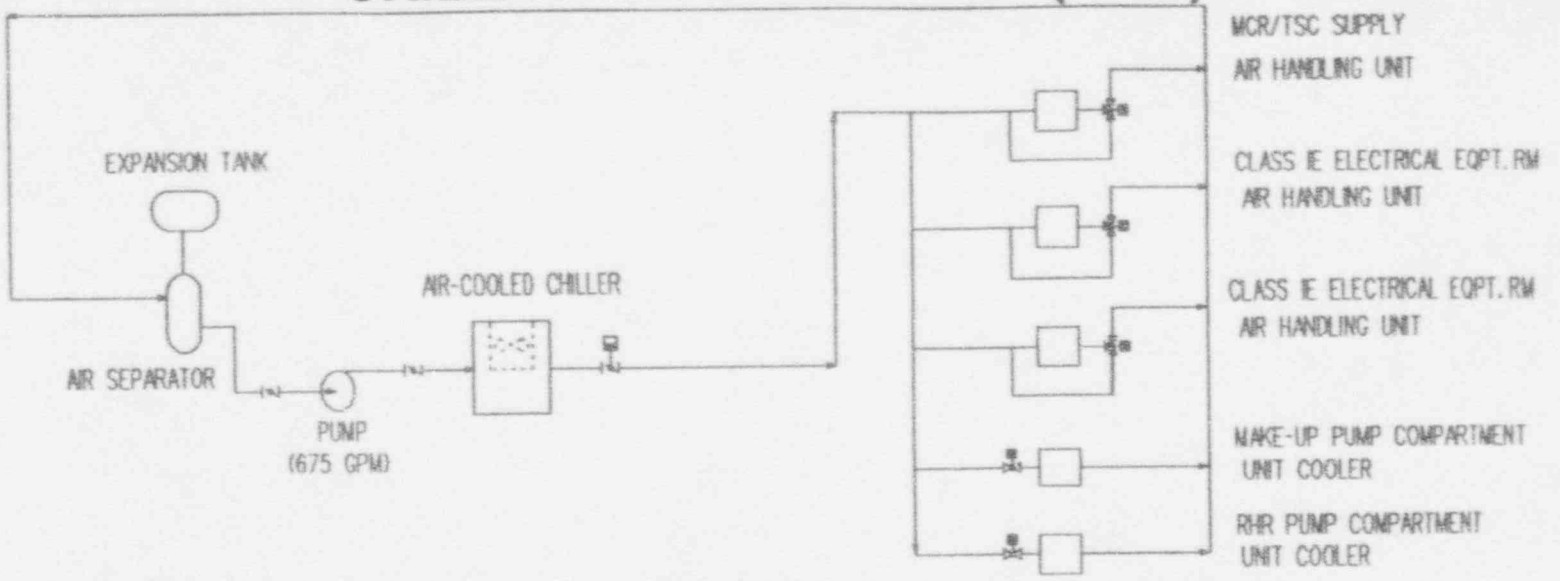
Defense-in-depth

- Two 100% redundant trains - no common pipe / equipment
- Supplies chilled water to VBS AHUs, NRHR and makeup pump room coolers

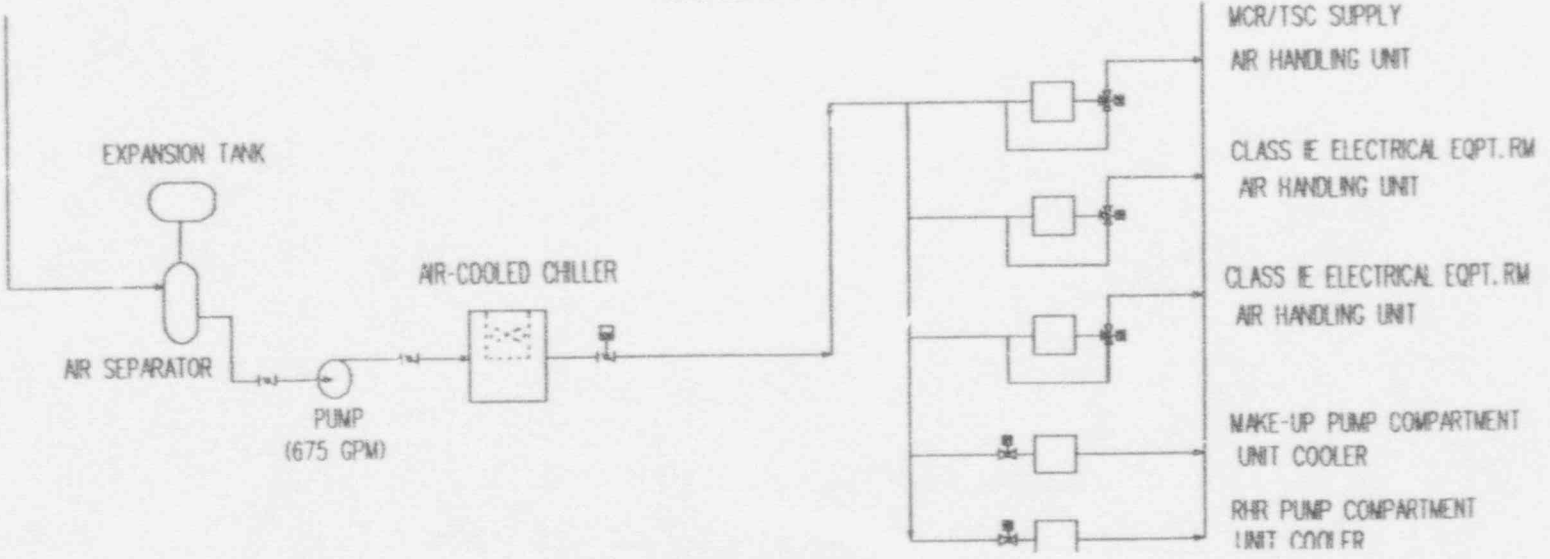
Safety-related

- None

AP600
CHILLED WATER SYSTEM (VWS)



TRAIN A



TRAIN B

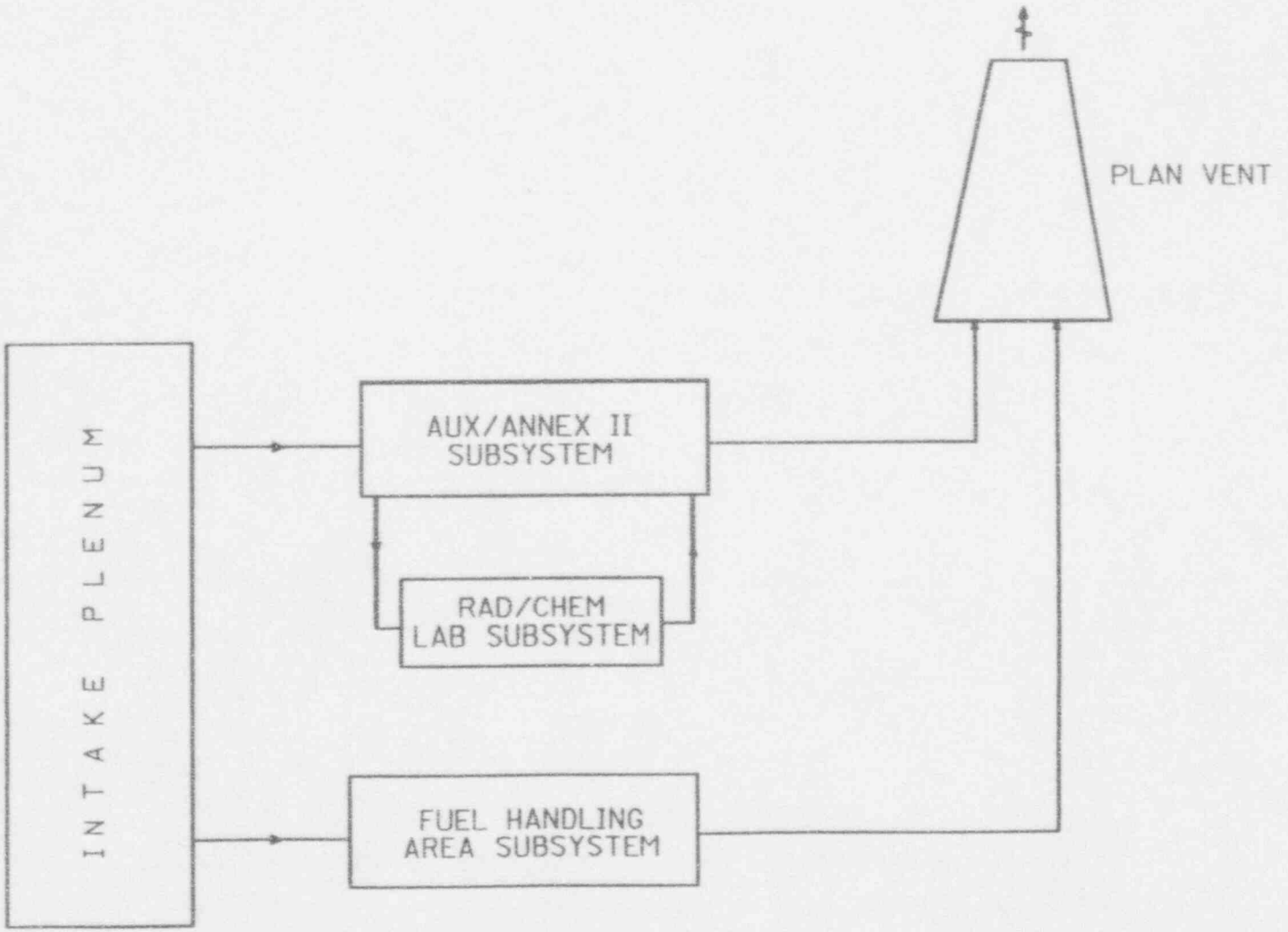
LOW CAPACITY SUBSYSTEM

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM

Consists of:

- Auxiliary/Annex building subsystem
- Fuel handling area subsystem
- Radiation chemistry laboratory subsystem

AP600
RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (VAS)



HVAC SYSTEMS (Cont'd)

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Auxiliary/Annex II Bldg Subsystem)

Design Bases

Nonsafety-related

- Cooling and heating capacity based on AP600 site parameters
- Maintain normal ambient temperature ranges:
- Unoccupied radwaste equipment areas 50°F - 130°F
- Other equipment and access areas 50°F - 104°F
- Unfiltered exhaust complies with 10CFR50, Appendix I
- Exhaust air monitored for radioactivity
- High airborne radioactivity isolates unfiltered exhaust and starts filtered exhaust subsystem (VFS)

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Cont'd) (Auxiliary/Annex II Bldg Subsystem)

Design Bases (Cont'd)

Defense-in-depth

- Maintain maximum ambient temperature:
  - RNS and CVS pump rooms (pumps running) 130°F
- Auto transfer of RNS and CVS pump room coolers to standby diesels on LOOP

Safety-related

- None

HVAC SYSTEMS (Cont'd)

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Cont'd) (Auxiliary/Annex II Bldg Subsystem)

Functions

Nonsafety-related

- Maintain normal ambient air temperatures for equipment
- Maintain normal airflow direction for ALARA
- Maintain Aux/Annex II buildings at negative ambient pressure
- Monitor and isolate unfiltered exhaust when radioactivity is detected and start filtered exhaust (VFS)

Defense-in-Depth

- Support RNS and CVS pump operation by maintaining ambient room design temperatures

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Cont'd) (Auxiliary/Annex II Bldg Subsystem)

Functions (Cont'd)

Safety-related

- None

HVAC SYSTEMS (Cont'd)

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Cont'd) (Auxiliary/Annex II Bldg Subsystem)

Design Features

Nonsafety-related

- Two 50% percent supply and exhaust air subsystems
- Redundant isolation dampers on supply and exhaust
- Two separate isolation zones
- Local unit coolers for RNS and CVS pump rooms

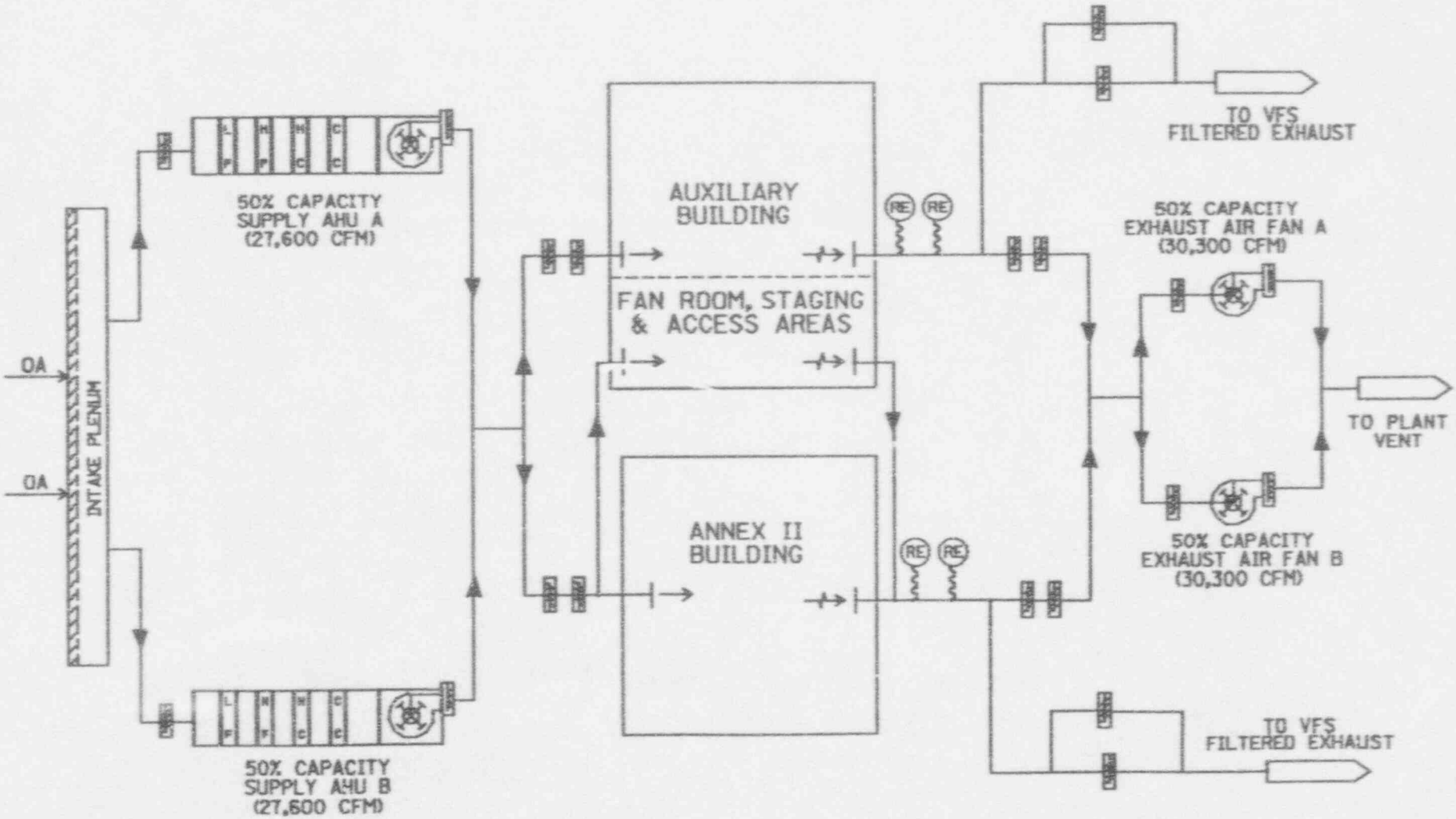
Defense-in-depth

- Dedicated unit cooler for each RNS and CVS pump

Safety-related

- None

AP600
RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (VAS)



AUXILIARY/ANNEX II BUILDING VENTILATION SUBSYSTEM

HVAC SYSTEMS (Cont'd)

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Fuel Handling Area Subsystem)

Design Bases

Nonsafety-related

- Cooling and heating capacity based on AP600 site parameters
- Maintain normal ambient temperature ranges:
  - Normal plant operation 50°F - 104°F
  - Refueling Activities 80°F WBGT (maximum)
- Unfiltered exhaust complies with 10CFR50, Appendix I
- Exhaust air monitored for radioactivity
- High airborne radioactivity isolates unfiltered exhaust and starts filtered exhaust system (VFS)

Defense-in-depth

- None

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Cont'd) (Fuel Handling Area Subsystem)

Design Bases (Cont'd)

Safety-related

- None

HVAC SYSTEMS (Cont'd)

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Cont'd) (Fuel Handling Area Subsystem)

Functions

Nonsafety-related

- Maintain ambient air temperatures for refueling personnel
- Exhaust air above spent fuel pool
- Maintain FHA at negative ambient air pressure
- Isolate unfiltered exhaust when radioactivity is detected
- Start filtered exhaust (VFS)

Defense-in-depth

- None

Safety-related

- None

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Cont'd) (Fuel Handling Area Subsystem)

Design Features

Nonsafety-related

- Two 50% percent supply and exhaust air subsystems
- Redundant isolation dampers on supply and exhaust

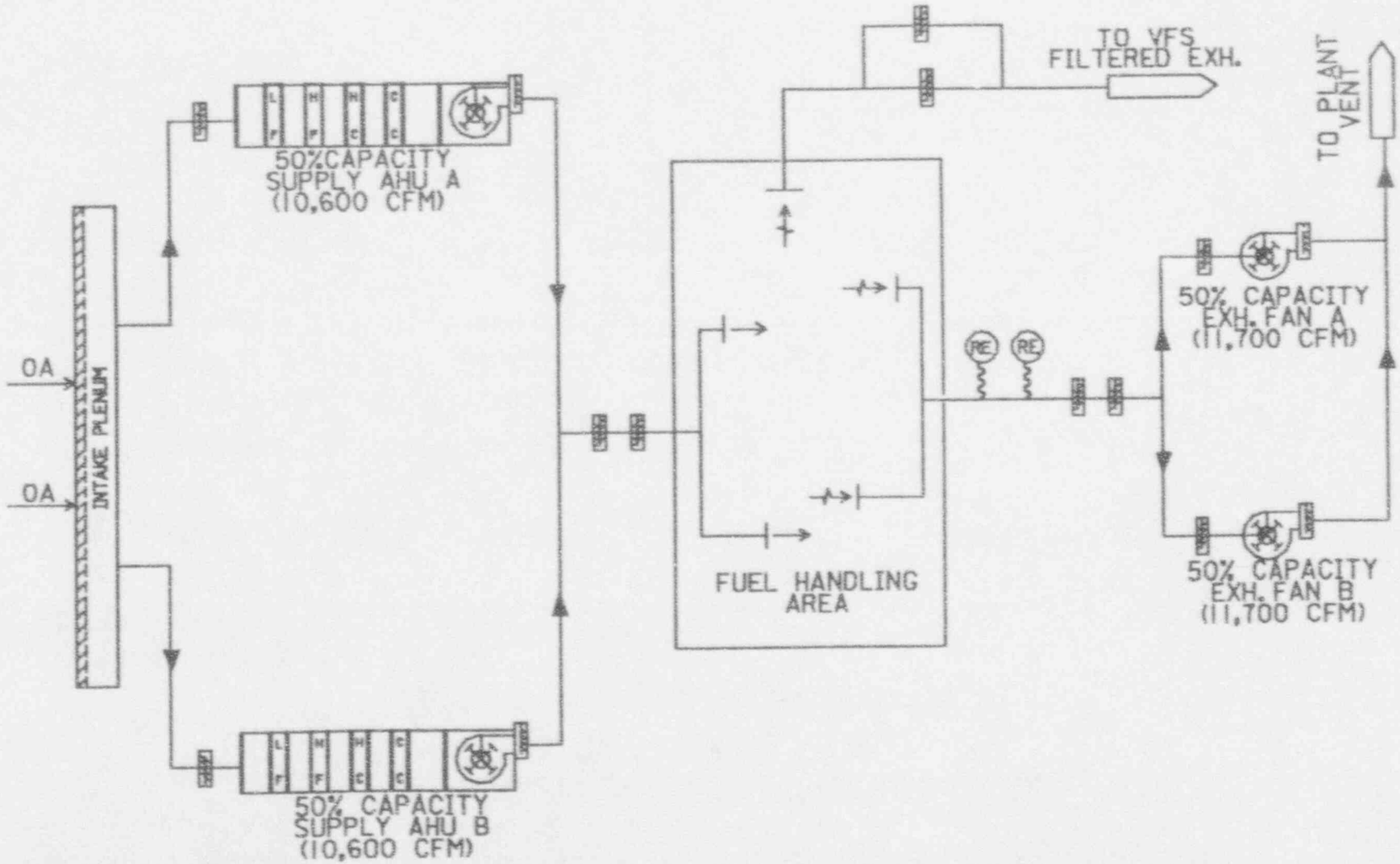
Defense-in-depth

- None

Safety-related

- None

AP600
RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (VAS)



FUEL HANDLING AREA VENTILATION SUBSYSTEM

HVAC SYSTEMS (Cont'd)

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Radiation Chemistry Laboratory)

Design Bases

Nonsafety-related

- Normal ambient air temperature range 73°F-78°F
- Relative humidity range 35-50%
- Filtered supply air to support sensitive equipment
- Filtered exhaust to capture airborne particulates

Defense-in-depth

- None

Safety-related

- None

HVAC SYSTEMS (Cont'd)

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Cont'd) (Radiation Chemistry Laboratory)

Functions

Nonsafety-related

- Maintain ambient air conditions for personnel comfort
- Provide dust free environment for sensitive equipment

Defense-in-depth

- None

Safety-related

- None

RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (Cont'd) (Radiation Chemistry Laboratory)

Design Features

Nonsafety-related

- Two 100% supply and exhaust air filtration subsystems
- Connected to Auxiliary II Building supply and exhaust ductwork

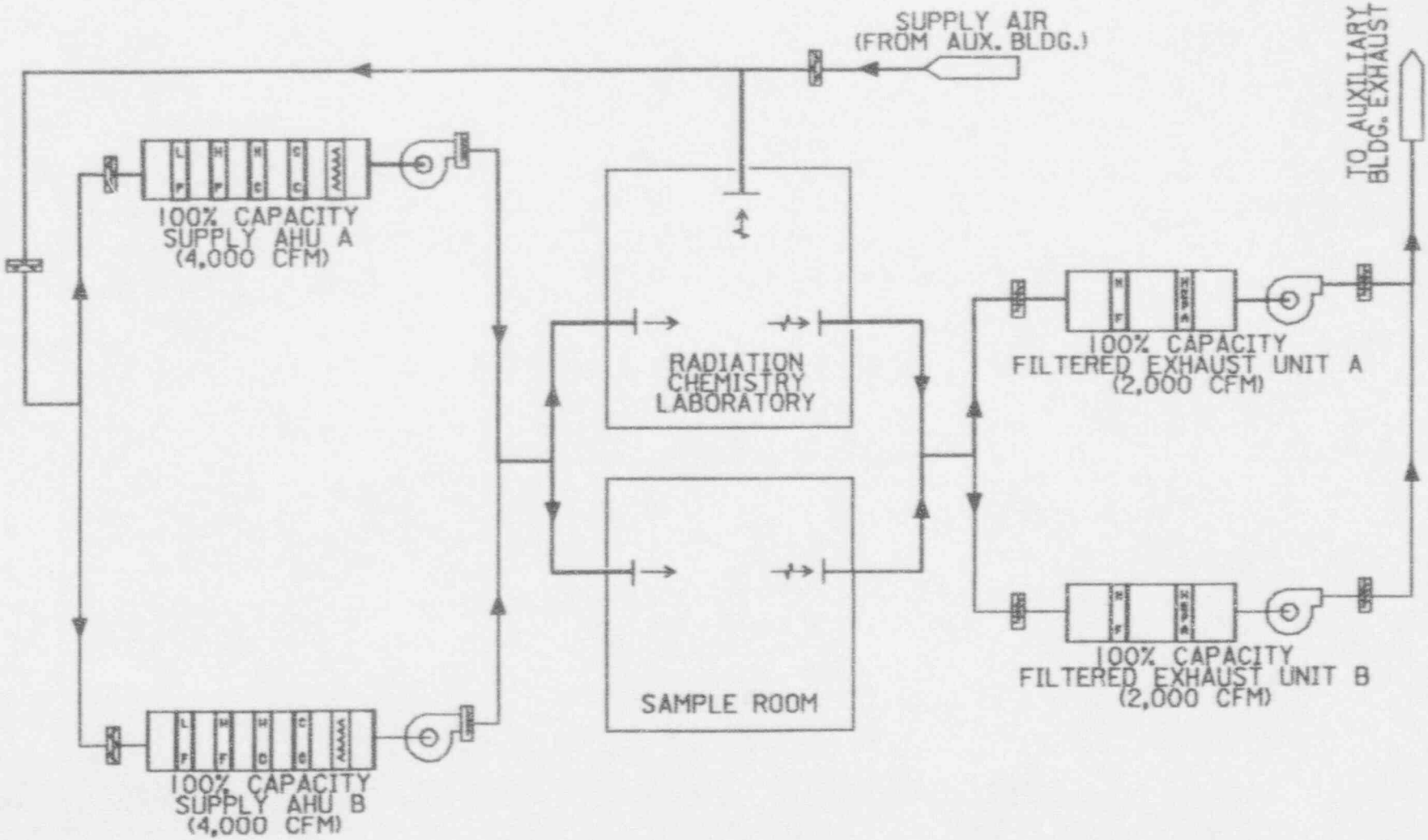
Defense-in-depth

- None

Safety-related

- None

AP600
RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM (VAS)



RADIATION CHEMISTRY LABORATORY VENTILATION SUBSYSTEM

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM

Consists of:

- MCR/TSC subsystem
- Class 1E electrical rooms subsystem
- PCS valve room HV subsystem

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (MCR/TSC HVAC Subsystem)

Design Bases

Nonsafety-related

- Maintan MCR at:
  - 70±3°F ambient temperature
  - Capable of maintaining between 73°F to 78°F
  - 25% to 60% relative humidity range
  - Slightly positive pressure

- Maintan TSC at:
  - 73°F to 78°F ambient temperature
  - 25% to 60% relative humidity range
  - Slightly positive pressure

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (MCR/TSC HVAC Subsystem)

Design Bases (Cont'd)

Defense-in-depth

- Maintain passive cooling heat sinks initial temp. ≤ 80°F
- Protect MCR/TSC personnel when radiation, smoke, or toxic chemicals is detected
- MCR/TSC≥ ⅛" WG when high radiation is detected
- Auto transfer to standby diesel on LOOP

Safety-related

- Provide MCR envelope isolation and start emergency habitability system on detection of high-high radiation

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (MCR/TSC HVAC Subsystem)

Functions

Nonsafety-related

- Control MCR/TSC ambient environment during normal operation

Defense-in-depth

- Nonsafety-related defense-in-depth for MCR habitability
- Maintain passive cooling heat sink ambient temperature
- Filter makeup air to MCR/TSC during high radiation
- MCR/TSC recirculation mode when smoke is detected from external fire (toxic chemicals are site specific)
- Provide smoke removal capability for internal fire

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (MCR/TSC HVAC Subsystem)

Functions (Cont'd)

Safety-related

- Isolate MCR and initiate emergency habitability system on high-high radiation, if required

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (Cont'd) (MCR/TSC HVAC Subsystem)

Design Features

Nonsafety-related

- Two 100% capacity trains with common ductwork
- Kitchen and toilet exhaust fan

Defense-in-depth

- Tornado protection damper in the outside air intake duct
- Redundant smoke detectors in the outside air intake duct
- Operable during or after DBA if ac power is available
- Supplemental air filtration on high radiation, containment isolation, or manual actuation
- Support provided by defense-in-depth systems such as chilled water and standby diesels

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (Cont'd) (MCR/TSC HVAC Subsystem)

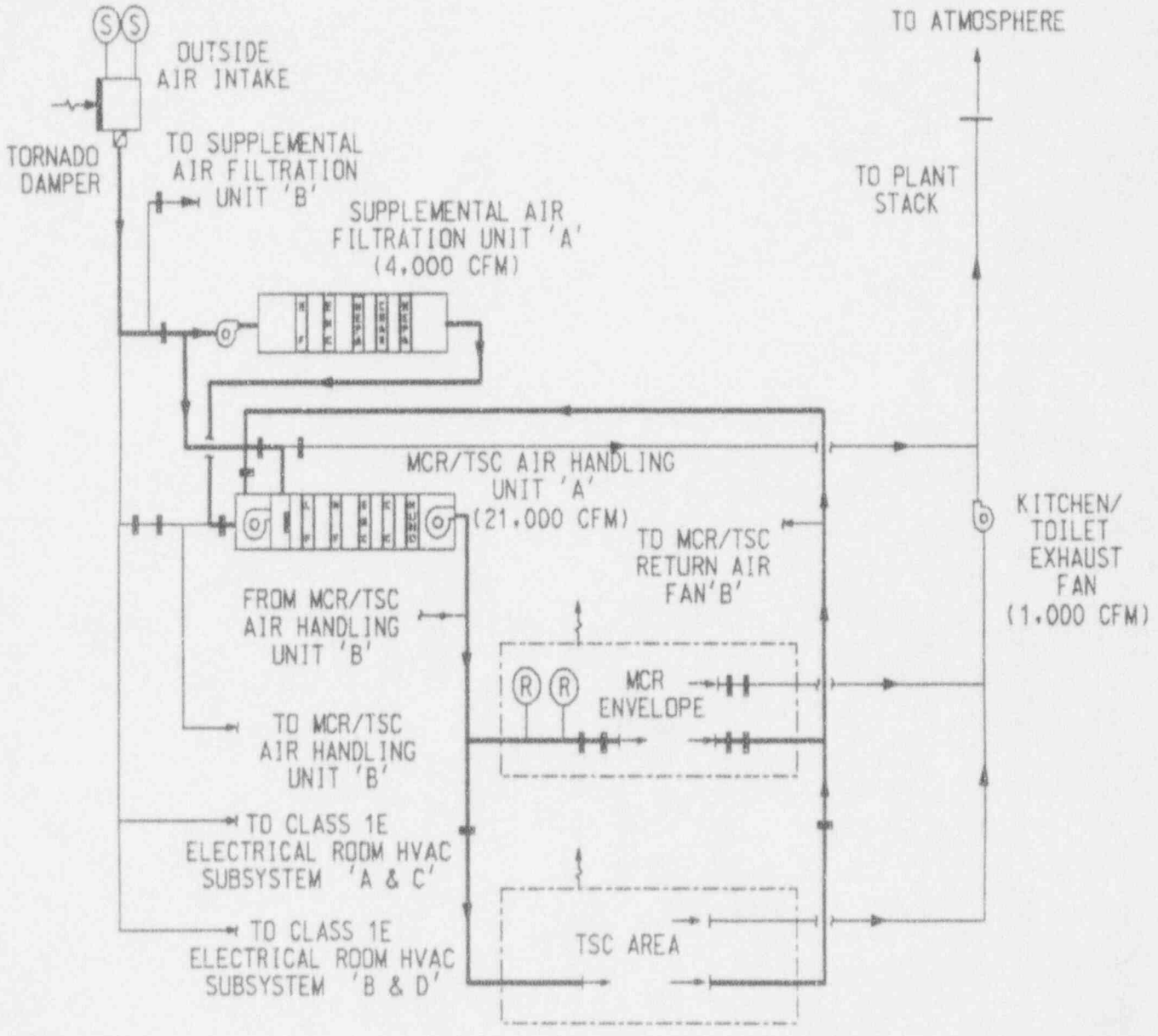
Design Features (Cont'd)

Safety-related

- Redundant safety-related radiation monitors in MCR supply duct
- Redundant safety-related/Seismic I isolation dampers for MCR envelope

AP600

NI NON-RADIOACTIVE VENTILATION SYSTEM (VBS)



MCR/TSC HVAC SUBSYSTEM

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (Class 1E Electrical Room HVAC Subsystem)

Design Bases

Nonsafety-related

- Maintain Class 1E electrical rooms at:
  - 70±3°F ambient temperature
  - Slightly positive pressure
- Maintain Class 1E battery rooms at:
  - 70±3°F ambient temperature
  - Limit hydrogen gas less than 2% by volume

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (Class 1E Electrical Room HVAC Subsystem)

Design Bases (Cont'd)

Defense-in-depth

- Maintain passive cooling heat sinks initial temp. $\leq 80°F$
- Auto transfer to standby diesel on LOOP
- Provide smoke removal capability for internal fire

Safety-related

- None

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (Class 1E Electrical Room HVAC Subsystem)

Functions

Nonsafety-related

- Control Class 1E electrical room ambient environment during normal operation

Defense-in-depth

- Control passive cooling heat sink ambient temperature
- Provide smoke removal capability for internal fire

Safety-related

- None

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (Class 1E Electrical Room HVAC Subsystem)

Design Features

Nonsafety-related

- Two 100% capacity trains for division A & C rooms
- Two 100% capacity trains for division B & D rooms

Defense-in-depth

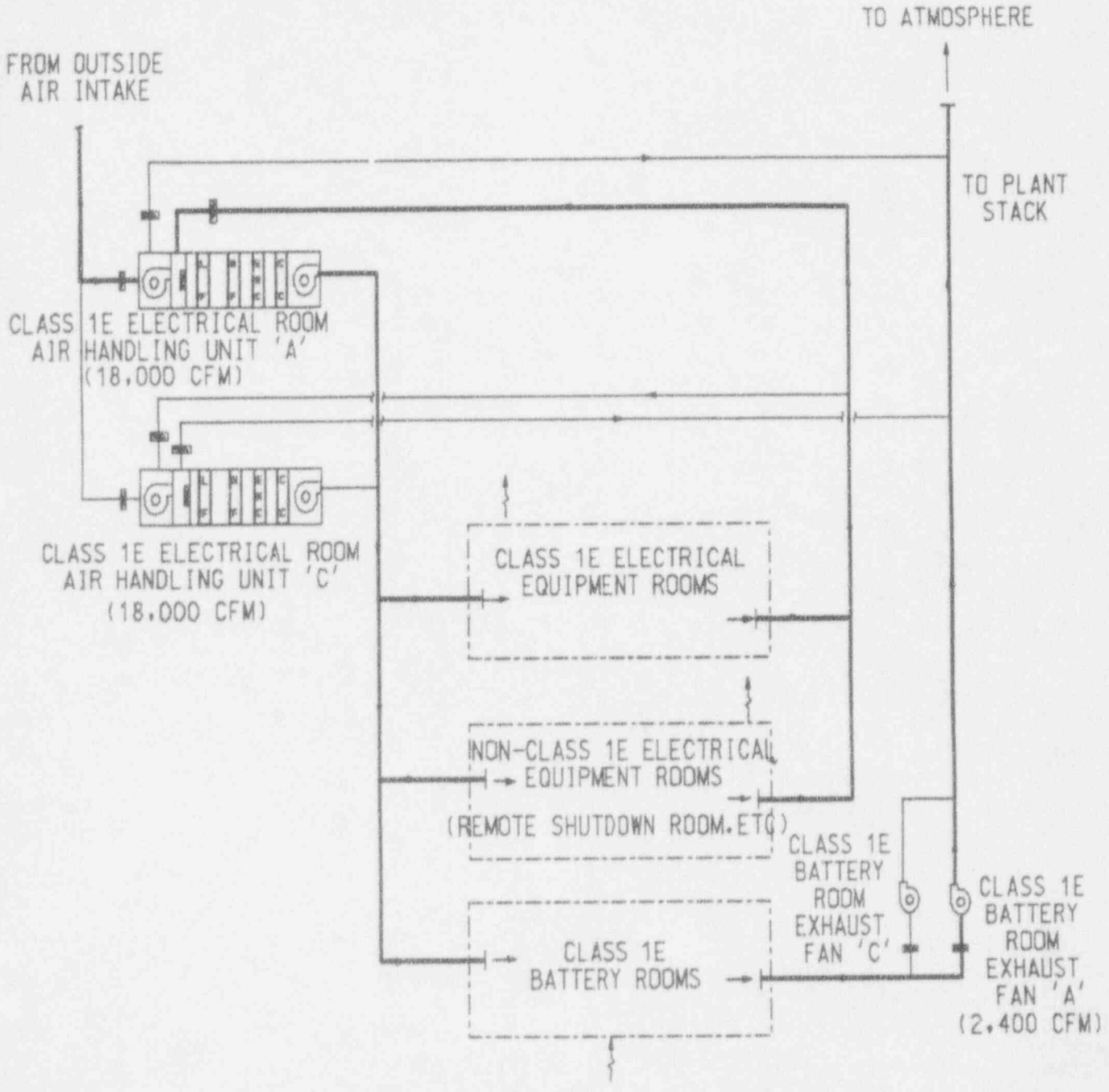
- Operable during or after DBA if ac power is available
- Support provided by defense-in-depth systems such as chilled water and standby diesels

Safety-related

- None

AP600

NI NON-RADIOACTIVE VENTILATION SYSTEM (VBS)



CLASS 1E ELECTRICAL ROOM HVAC SUBSYSTEM "A" AND "C"

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (PCS Valve Room HV Subsystem)

Design Bases

Nonsafety-related

- Maintain PCS valve room ambient temperature between 50°F to 120°F
- Maintain air circulation for personnel comfort during maintenance/inspection

Defense-in-depth

- Maintain PCS valve room initial temperature $\geq$ 50°F
- Auto transfer to standby diesel on LOOP

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (PCS Valve Room HV Subsystem)

Design Bases (cont'd)

- Safety-related
  - None

Functions

Nonsafety-related

- Control PCS valve room ambient temperature during normal operation

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (PCS Valve Room HV Subsystem)

Functions

Defense-in-depth

- Prevent freezing of PCS piping and valves

Safety-related

- None

HVAC SYSTEMS (Cont'd)

NUCLEAR ISLAND NONRADIOACTIVE VENTILATION SYSTEM (PCS Valve Room HV Subsystem)

Design Features

Nonsafety-related

- Two 100% capacity trains electric unit heaters
- One 100% capacity ventilating exhaust fan

Defense-in-depth

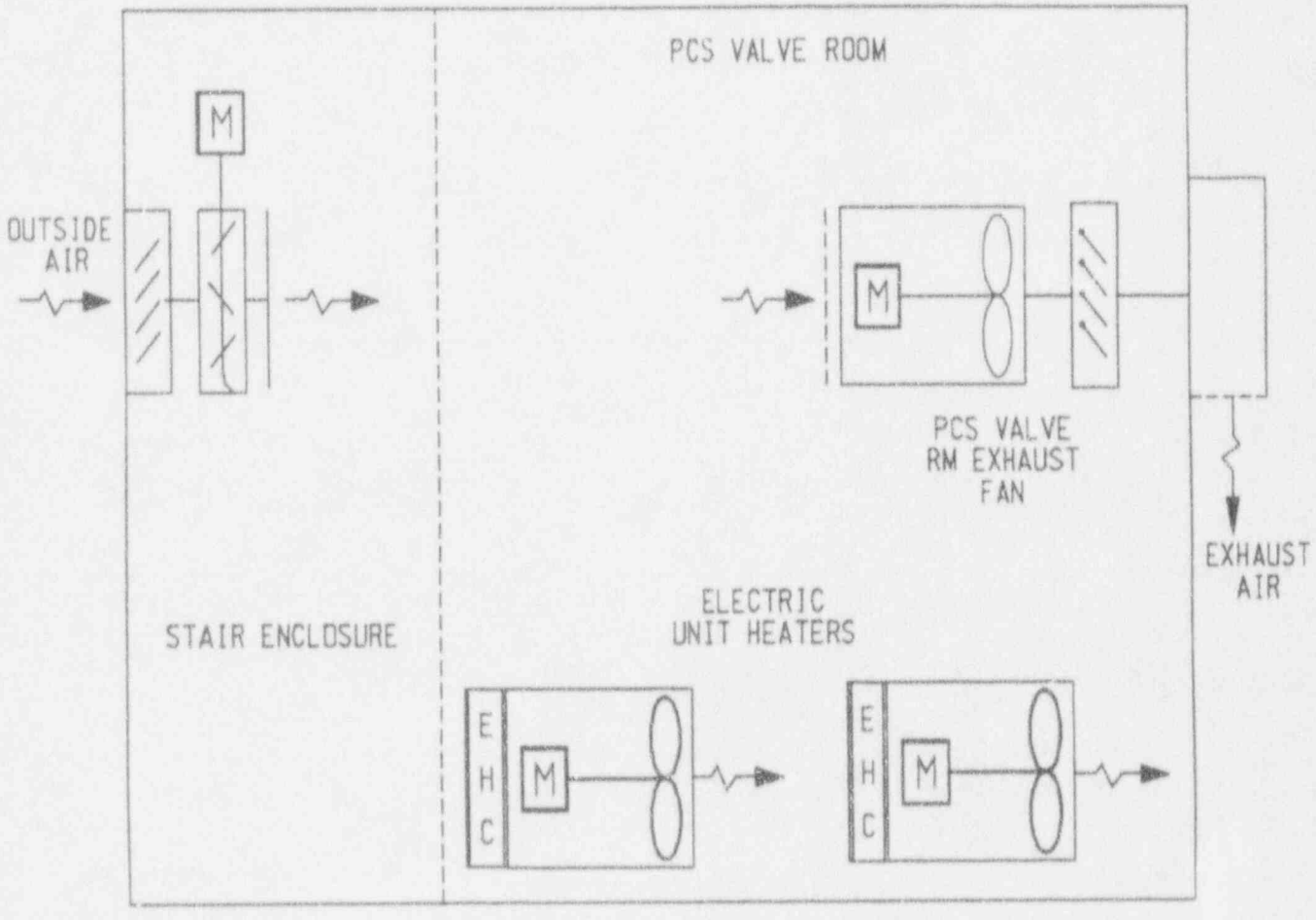
- Electric unit heaters are operable during or after DBA if ac power is available

Safety-related

- None

AP600

NI NON-RADIOACTIVE VENTILATION SYSTEM (VBS)



PCS VALVE ROOM HV SUBSYSTEM

HVAC SYSTEMS (Cont'd)

CONTAINMENT RECIRCULATION COOLING SYSTEM (VCS)

Consists of:

- Containment recirculation fan coil unit subsystem
- Reactor cavity cooling subsystem

HVAC SYSTEMS (Cont'd)

CONTAINMENT RECIRCULATION COOLING SYSTEM
(Containment recirculation fan coil unit subsystem)

Design Bases

Nonsafety-related

- Control containment environment during normal operation, refueling and plant shutdown
- Maintain sufficient mixing for homogeneous containment environment during ILRT testing
- Manual backup power from standby diesels

Defense-in-depth

- None

Safety-related

- None

HVAC SYSTEMS (Cont'd)

CONTAINMENT RECIRCULATION COOLING SYSTEM
(Containment recirculation fan coil unit subsystem)

Functions

Nonsafety-related

- Control containment average bulk air temperature below 120°F during normal opertion
- Control containment access area temperature between 50°F to 70°F during refueling and plant shutdown
- Provide homogeneous containment environment during ILRT
- Maintain homogeneous containment temperature and pressure on LOOP when ac power is available

Defense-in-depth

- None

HVAC SYSTEMS (Cont'd)

CONTAINMENT RECIRCULATION COOLING SYSTEM
(Containment recirculation fan coil unit subsystem)

Functions (Cont'd)

Safety-related

- None

Design Features

Nonsafety-related

- Two 100% capacity trains with common ductwork
  - Four 50% capacity two speed fans
  - Eight 25% capacity cooling coil banks
- Cooling coil banks supplied by chilled water or hot water
- Operates at reduced speed during ILRT at elevated pressure
- Operates on LOOP when ac power is available

CONTAINMENT RECIRCULATION COOLING SYSTEM
(Containment recirculation fan coil unit subsystem)

Design Features (Cont'd)

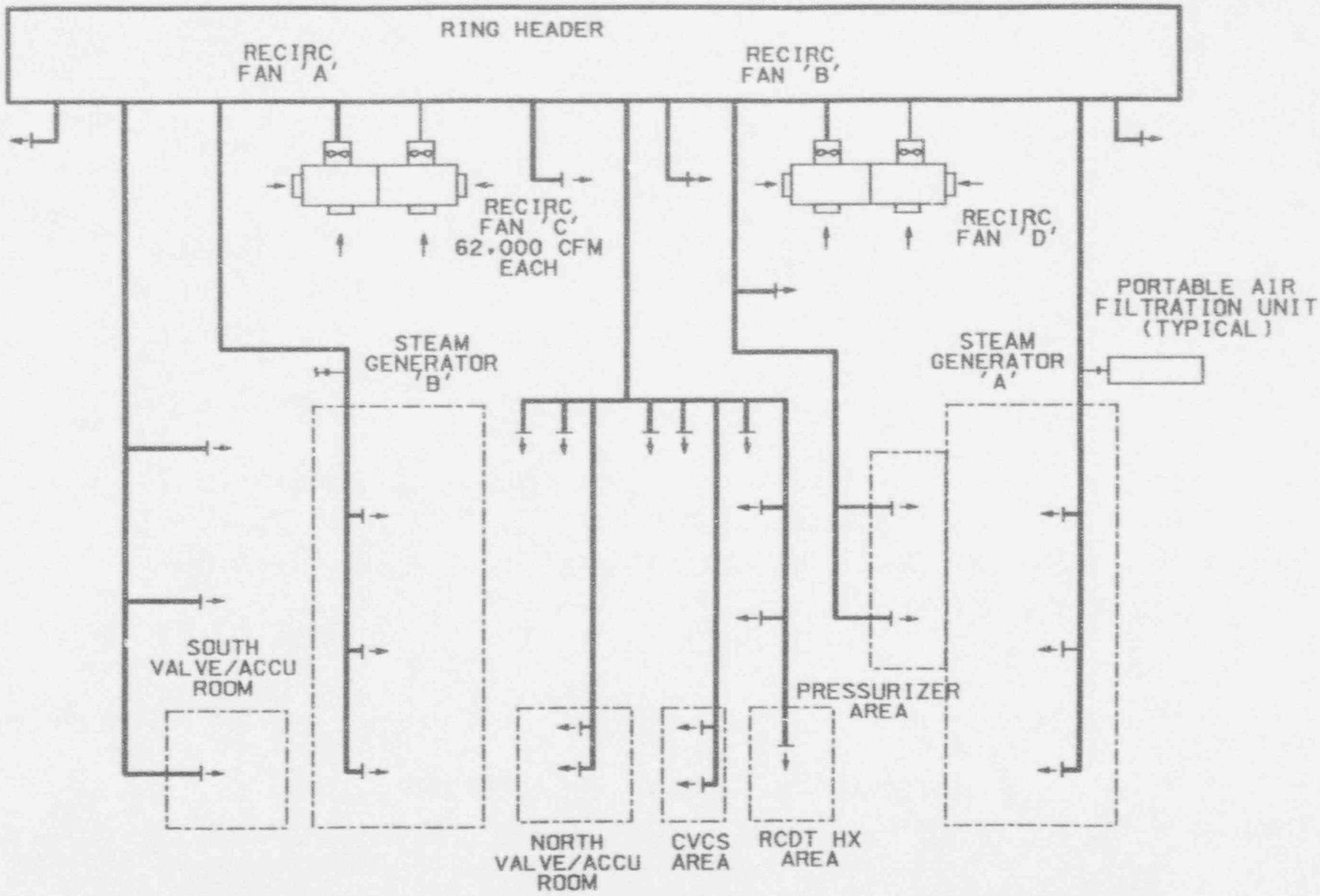
Defense-in-depth

- None

Safety-related

- None

AP600 CONTAINMENT RECIRCULATION COOLING SYSTEM (VCS)



CONTAINMENT RECIRCULATION FAN COIL UNIT SUBSYSTEM

HVAC SYSTEMS (Cont'd)

CONTAINMENT RECIRCULATION COOLING SYSTEM
(Reactor cavity cooling subsystem)

Design Bases

Nonsafety-related

- Control reactor cavity area average concrete temperature to 150°F with a maximum local area temperature of 200°F
- Manual backup power from standby diesels

Defense-in-depth

- None

Safety-related

- None

HVAC SYSTEMS (Cont'd)

CONTAINMENT RECIRCULATION COOLING SYSTEM
(Reactor cavity cooling subsystem)

Functions

Nonsafety-related

- Control reactor cavity area concrete temperature during normal operation
- Maintain homogeneous reactor cavity temperature and pressure on LOOP when ac power is available

Defense-in-depth

- None

Safety-related

- None

HVAC SYSTEMS (Cont'd)

CONTAINMENT RECIRCULATION COOLING SYSTEM
(Reactor cavity cooling subsystem)

Design Features

Nonsafety-related

- Two 100% capacity trains with common ductwork
- Operates at reduced speed during ILRT at elevated pressure
- Operates on LOOP when ac power is available

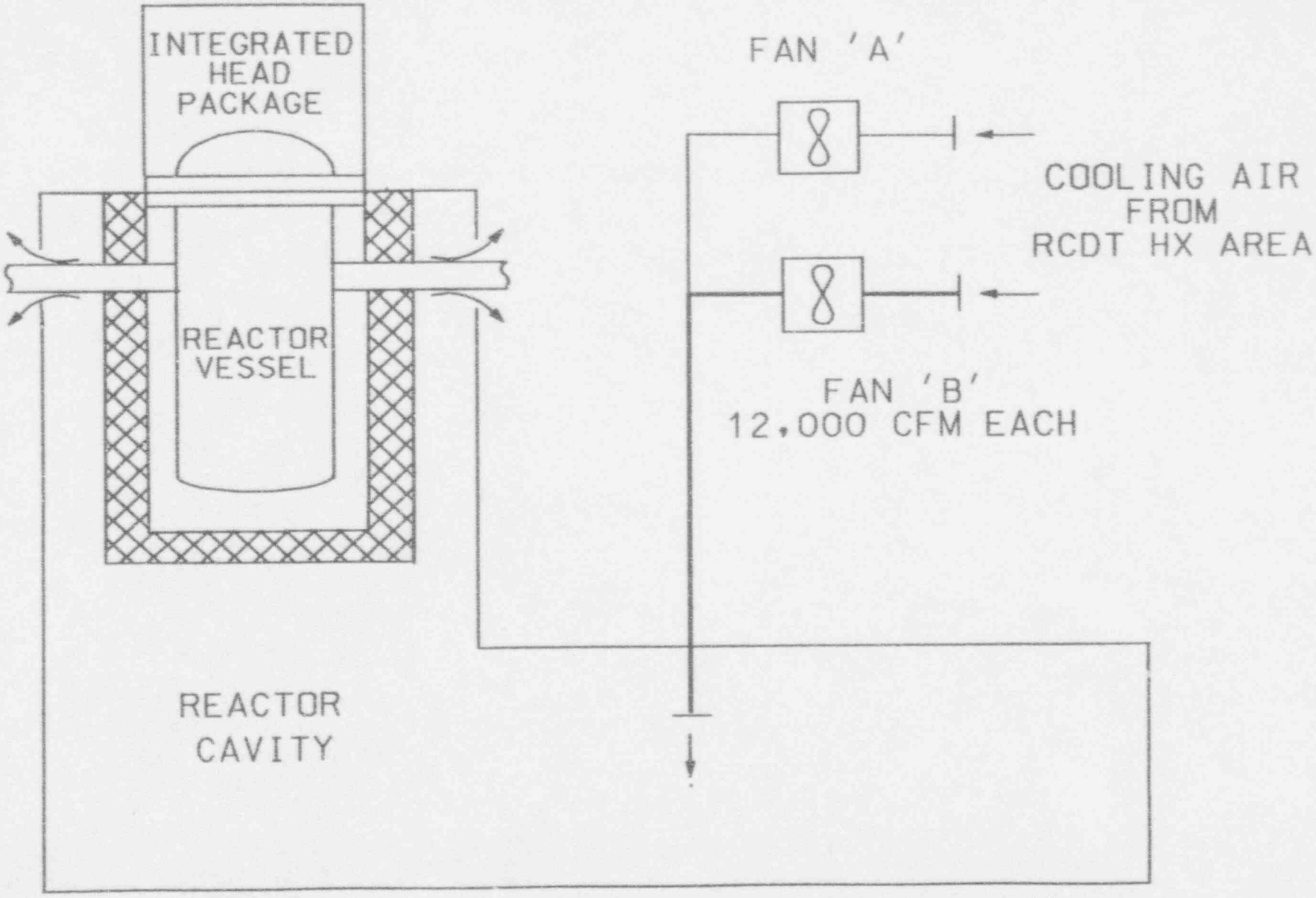
Defense-in-depth

- None

Safety-related

- None

AP600 CONTAINMENT RECIRCULATION COOLING SYSTEM (VCS)



REACTOR CAVITY COOLING SUBSYSTEM

HVAC SYSTEMS (Cont'd)

MAIN CONTROL ROOM HABITABILITY SYSTEM

Design Bases

Nonsafety-related

- None

Defense-in-depth

- None

Safety-related

- Single failure proof, Seismic Category 1, Class 1E, ASME Section III, Safety Class 3
- Maintain breathable air standards with $C0_2$ Levels less than 1% by volume

MAIN CONTROL ROOM HABITABILITY SYSTEM (Cont'd)

Design Bases (Cont'd)

- Maintain MCR pressure $\geq$ ⅛″ WG relative to adjoining areas
- Limit MCR temperature following DBA to 15°F in 72 hours with loss of ac power

HVAC SYSTEMS (Cont'd)

MAIN CONTROL ROOM HABITABILITY SYSTEM (Cont'd)

Functions

Nonsafety-related

- None

Defense-in-depth

- None

Safety-related

- Provide breathable air under DBA conditions
- Prevent ingress of radioactive contaminants
- Protect sensitive equipment from high temperature

HVAC SYSTEMS (Cont'd)

MAIN CONTROL ROOM
HABITABILITY SYSTEM (Cont'd)

Design Features

Nonsafety-related

- None

Defense-in-depth

- None

Safety-related

- Two 100% capacity independent trains
- Emergency air storage bottles, valves and distribution piping
- Supplies 20 cfm air for breathing and pressurization
- Initiate on high-high radiation level detected by VBS

CONTAINMENT AIR FILTRATION SYSTEM

Design Bases

Nonsafety-related

- Maintain normal containment airborne radioactivity per 10CFR20
- Maintain normal offsite airborne releases from containment per 10CFR20 and 10CFR50, Appendix I
- 99 percent HEPA filter efficiency per RG 1.140
- 90 percent charcoal adsorber efficiency per RG 1.140
- Temper outdoor air supplied to containment compatible with refueling activities (50-70°F)
- Provide filtered exhaust when high radioactivity is detected in the Aux/Annex II buildings and the fuel handling area exhaust air
- Filtered exhaust is single active component failure proof

CONTAINMENT AIR FILTRATION SYSTEM (Cont'd)

Design Bases (Cont'd)

Defense-in-depth

- None

Safety-related

- Containment isolation components are classified as safety Class B and seismic Category I
- Provide containment isolation of supply and exhaust lines within 5 seconds after a LOCA signal per SRP 6.2.4
- Single active failure proof

HVAC SYSTEMS (Cont'd)

CONTAINMENT AIR FILTRATION SYSTEM (Cont'd)

Functions

Nonsafety-related

- Support personnel access into containment during normal plant operation, pre-shutdown, shutdown and refueling
- Provide pressure control during normal plant operation
- Provide filtered exhaust from Auxiliary/Annex II Bldgs and FHA for high radioactivity conditions

Defense-in-depth

- None

CONTAINMENT AIR FILTRATION SYSTEM (Cont'd)

Functions (Cont'd)

Safety-related

- Maintain integrity of containment pressure boundary for DBA

CONTAINMENT AIR FILTRATION SYSTEM (Cont'd)

Design Features

Nonsafety-related

- Two 4,000 cfm supply and exhaust air subsystems
- Both subsystems (8,000 cfm) may be connected to the containment for continuous or intermittent operation at any time
- Exhaust air is filtered by a single HEPA filter bank and a 4 inch deep charcoal adsorber
- Manual connection of filtered exhaust to standby diesels

Defense-in-depth

- None

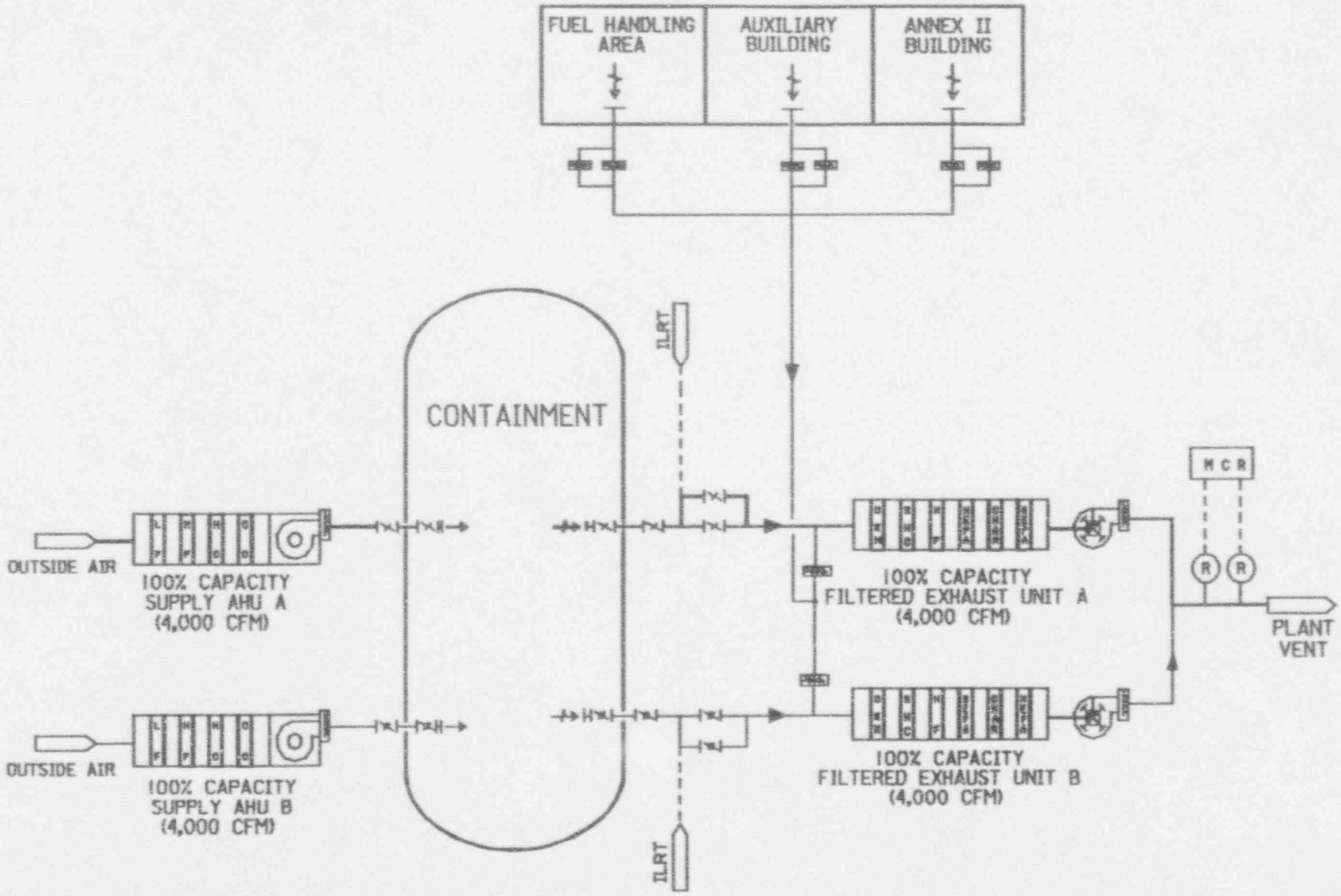
CONTAINMENT AIR FILTRATION SYSTEM (Cont'd)

Design Features (Cont'd)

Safety-related

- Four 12" diameter containment penetrations
- Containment isolation valves use pneumatic operators that fail closed
- Seismic Category I debris screens are provided between the containment atmosphere and isolation valves

AP600
CONTAINMENT AIR FILTRATION SYSTEM (VFS)



CONTAINMENT AIR FILTRATION SUPPLY AND EXHAUST SUBSYSTEMS

CONDENSATE SYSTEM

Design Bases

Nonsafety-related

- Provides continuous supply of condensate to feedwater system (FWS)
- Capable of 100% reactor power with one pump out of service
- Failure of one pump will not cause turbine or reactor trip
- Condenser storage for at least 3 minutes of full-load operating flow
- Can accommodate 10% step or 5%/min ramp load changes
- Can accommodate 100% load rejection

Defense-in-depth

- None

CONDENSATE SYSTEM (Cont'd)

Design Bases (Cont'd)

Safety-related

- None

STEAM AND POWER CONVERSION SYSTEMS (Cont'd)

CONDENSATE SYSTEM (Cont'd)

Functions

Nonsafety-related

- Support FWS in providing feedwater to steam generators at required temperature, pressure and flow

Defense-in-depth

- None

Safety-related

- None

STEAM AND POWER CONVERSION SYSTEMS (Cont'd)

CONDENSATE SYSTEM (Cont'd)

Design Features

Nonsafety-related

- Three 50% capacity, single speed, canned pumps
  - Auto start standby pump
  - Minimum flow protection
  - Three pump operation for abnormal conditions
- 33% capacity condensate polishing
- Main condenser
  - Twin shell, single pass, multi-pressure
  - Titanium tubes, welded tubesheets
  - Excess storage/surge capacity
  - Auto makeup/overflow
  - Dearating
  - Tube cleaning by CES

STEAM AND POWER CONVERSION SYSTEMS (Cont'd)

CONDENSATE SYSTEM (Cont'd)

Design Features

- Low pressure feedwater heaters
  - Five stages including deaerator
  - Two stage string in condenser neck
  - Two full flow heaters
  - Stainless steel tubes, welded tubesheets

<u>Defense-in-depth</u>

- None

<u>Safety-related</u>

- None

STEAM AND POWER CONVERSION SYSTEMS (Cont'd)

MAIN TURBINE SYSTEM

Design Bases

Nonsafety-related

- Provides baseload operation or load follow capability consistent with NSSS
- Automatic trip on abnormal conditions
- Provides proper drainage of piping to prevent water from entering turbine
- Provides extraction steam for regenerative feedwater heating

Defense-in-depth

- None

STEAM AND POWER CONVERSION SYSTEMS (Cont'd)

MAIN TURBINE SYSTEM (Cont'd)

Design Bases (Cont'd)

Safety-related

- None

STEAM AND POWER CONVERSION SYSTEMS (Cont'd)

MAIN TURBINE SYSTEM (Cont'd)

Functions

Nonsafety-related

- Support generator in converting thermal energy into electric power

Defense-in-depth

- None

Safety-related

- None

STEAM AND POWER CONVERSION SYSTEMS (Cont'd)

MAIN TURBINE SYSTEM (Cont'd)

Design Features

Nonsafety-related

- 1800 rpm, tandem-compound, four-flow reheat unit with 47″ last stage blades
- One double flow high pressure turbine
- Two double flow low pressure turbines
- Two external moisture separator / reheaters
- One stage of reheating
- Spring mounted support system

Defense-in-depth

- None

MAIN TURBINE SYSTEM (Cont'd)

Design Features (Cont'd)

Safety-related

- None