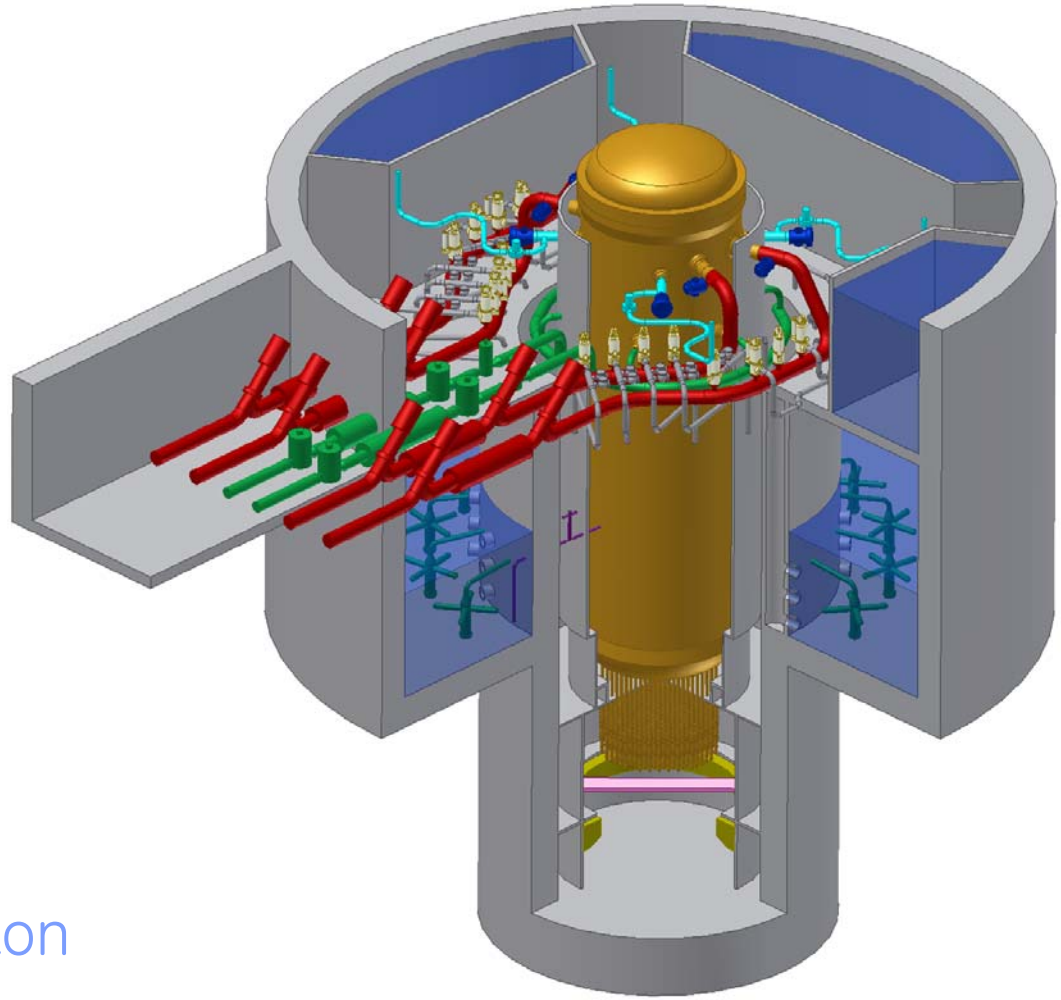
ESBWR Auxiliary Systems

Overview



Presented by Hugh Upton
September 27, 2005

ESBWR Auxiliary Systems Overview

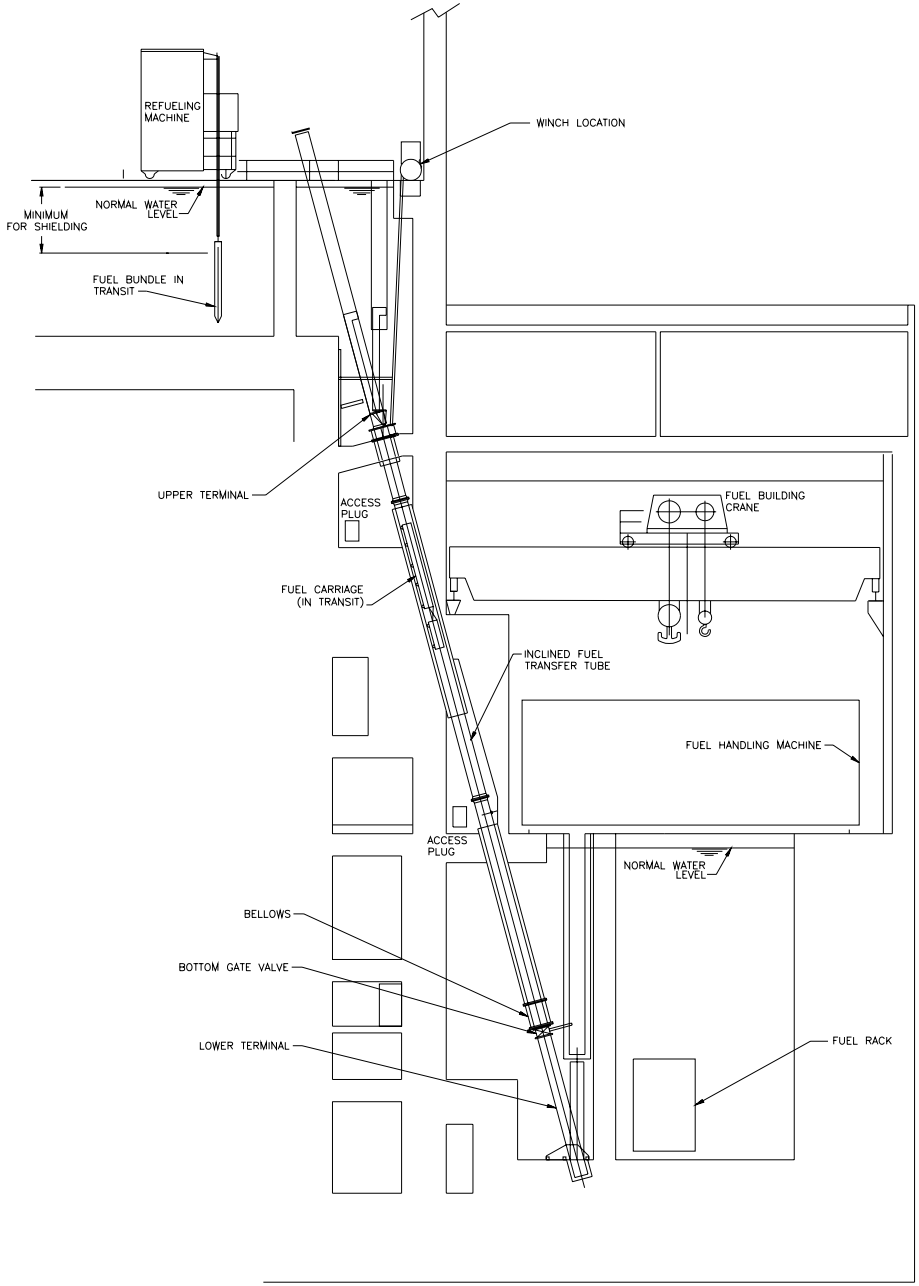
- New Fuel Storage
- Spent Fuel Storage
- Fuel and Auxiliary Pools Cooling System (G21) – J. Deaver
- Reactor Component Cooling Water System (P21)
- Chilled Water System (P25)
- Standby Liquid Control System (C41) – J. Deaver
- Control Building HVAC System (U77)
- Fuel Building HVAC System (U98)
- Reactor Building HVAC System (U40)
- Drywell Cooling System (T41)
- Containment Inerting System (T31)
- Fire Protection System (U43)

New Fuel Storage

- Located in the RB buffer pools on the Operating Floor
  - Capacity 60% of full core
  - Racks are side loaded and have double rows of storage positions
  - Racks are floor mounted
- Designed to ensure fully loaded array is subcritical by at least 5% $\Delta k/k$
- Designed to protect fuel assemblies/fuel bundles from damage for all credible events
- All racks are constructed in accordance with QA requirements of 10 CFR 50 Appendix B
- Racks are classified as non-safety and Seismic Category I
- Designed to withstand impact from a falling fuel assembly
- Material used for construction meet ASTM specifications

Spent Fuel Storage

- Spent Fuel Storage Racks are top entry racks
- Designed to ensure fully loaded array is subcritical by at least 5% $\Delta k/k$
- Neutron-absorbing material (an integral part of the array) assures k_{eff} does not exceed 0.95 for all normal and abnormal conditions.
- Located in the spent fuel pool in the FB
  - Provides storage for 10 calendar years of plant operation plus a full core off load
- 154 bundles of spent fuel storage is available in the buffer pool to provide operational flexibility
- Racks are classified as non-safety and Seismic Category I
- Designed to withstand impact from a falling fuel assembly
- Material used for construction meet ASTM specifications
- Spent Fuel Storage Pool has adequate water shielding over spent fuel
  - On loss of FAPCS SFP cooling, sufficient water above spent fuel to allow boiling for 72 hrs and still have 3.0m
- Spent fuel is transferred from the RB Operating floor to the FB spent fuel pool via the Inclined Fuel Transfer Tube (IFTT)



Inclined Fuel Transfer Tube (IFTT)

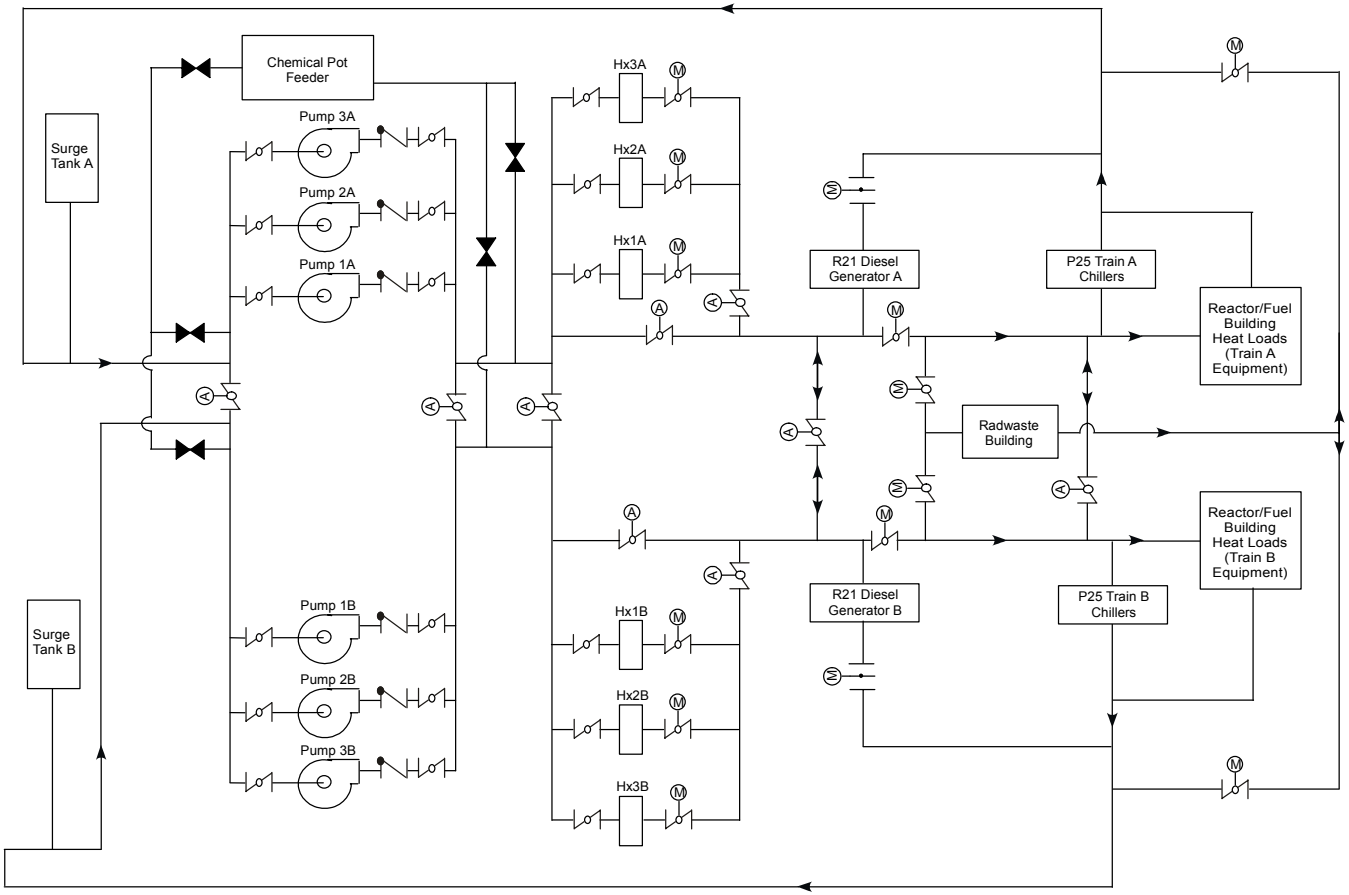
Fuel and Auxiliary Pools Cooling System (G21)

- FAPCS to be presented by J. Deaver

Reactor Component Cooling Water System (P21)

- System does not perform any safety-related function.
- Provides cooling water to plant auxiliary equipment during normal operation, cooldown and shutdown operation.
- No single active failure nor credible single passive component failure will result in loss of active nuclear island cooling.
- System is powered from the PIP busses so that it operates during a LOPP.
- Designed to limit leakage of radioactive components to the environment.
- Consists of two 100% capacity independent and redundant trains.
- Heat loads include:

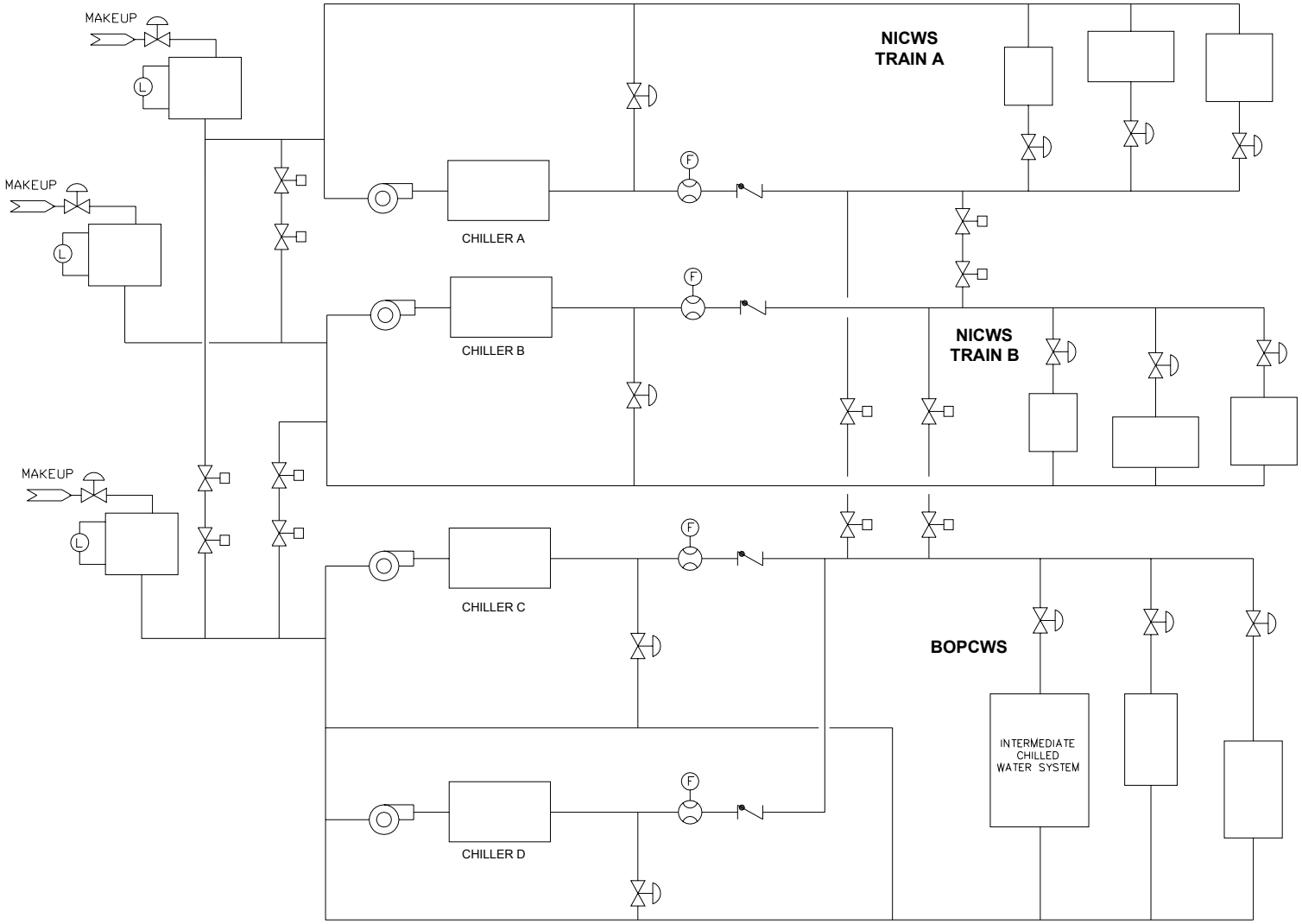
CWS:	8.6 MW	29.4 MBtu/h
Radwaste Building	2.1 MW	7.2 MBtu/h
Diesel Generator A	14.3 MW	48.8 MBtu/hr
Total Train A:	61.6 MW	210 MBtu/h
Nominal Heat Load Contributions (Train B)		
RWCU/SDC:	28 MW	95.6 MBtu/h
FACPS	8.6 MW	29.4 MBtu/h
Diesel Generator B	14.3 MW	48.8 MBtu/hr
Total Train B:	50.9 MW	174 MBtu/h
Other:	1.9 MW	6.6 MBtu/h
Total Train A&B:	114 MW	390 MBtu/h



Reactor Component Cooling Water System (P21)

Chilled Water System (P25)

- System does not perform any safety-related function.
- CWS consists of Nuclear Island Chill Water Subsystem (NICWS) and Balance of Plant Chilled Water Subsystem (BOPCWS).
- Provides chilled water (7° C (44.6° F)) to plant equipment
  - Assumes 35° C (95° F) RCCWS and TCCWS cooling water
- NICWS is powered from the PIP busses so that it operates during a LOPP.
- CWS is designed as Seismic Cat II criteria when located in Seismic Cat I buildings
- NICWS and BOPCWS are independent subsystems but interconnected
- Chilled water is provided to cooling coils of AHU's and other coolers in RB, CB, TB, RWB, SB, EB, FB, TSC and Hot Machine Shop
- NICWS provides chilled water to the Drywell Cooling System (T41) DW air coolers
- NICWS consists of two 100% capacity redundant and independent trains
- BOPCWS consists of one 100% capacity independent train with crossties to both NICWS trains



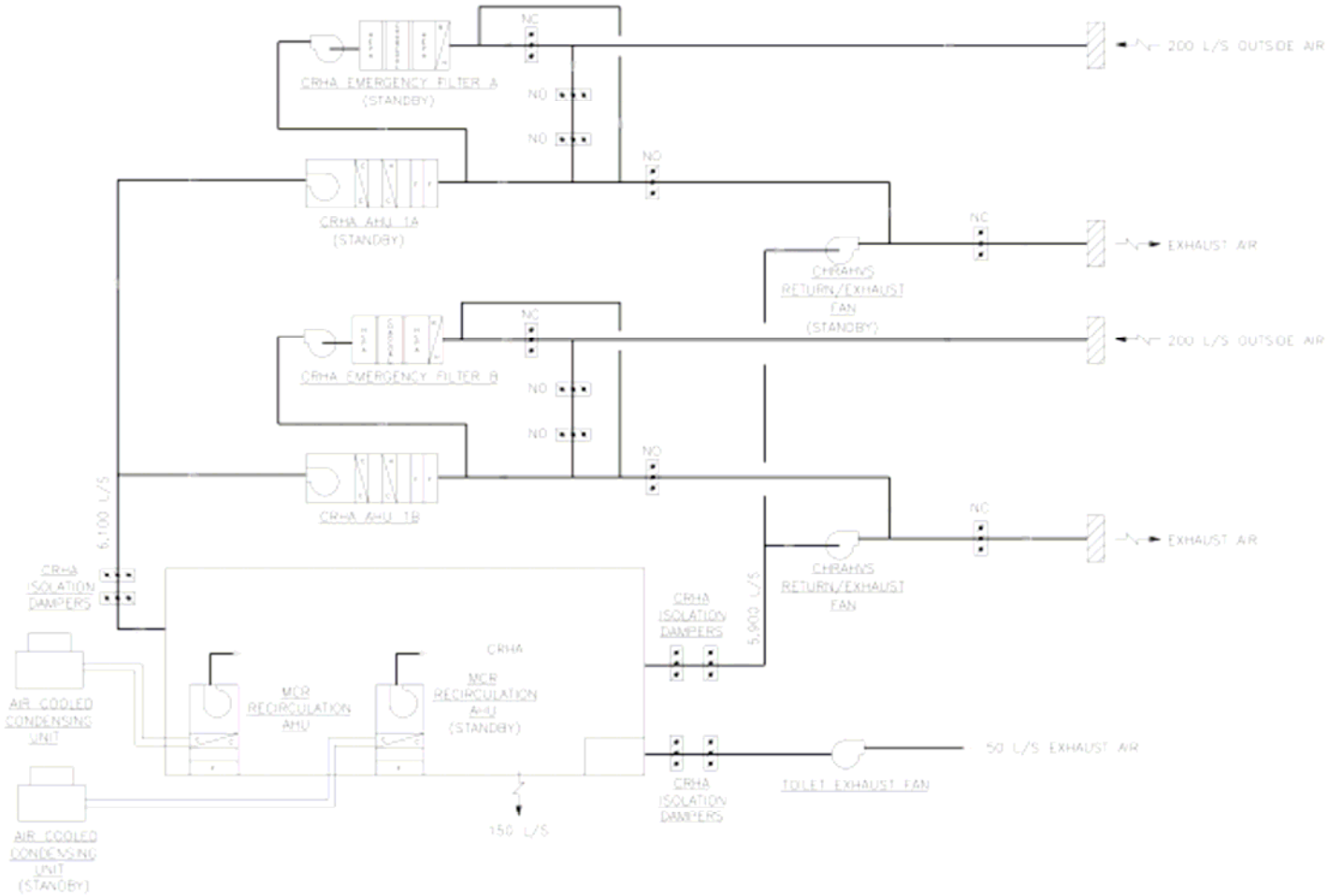
Chilled Water System (P25)

Standby Liquid Control System (C41)

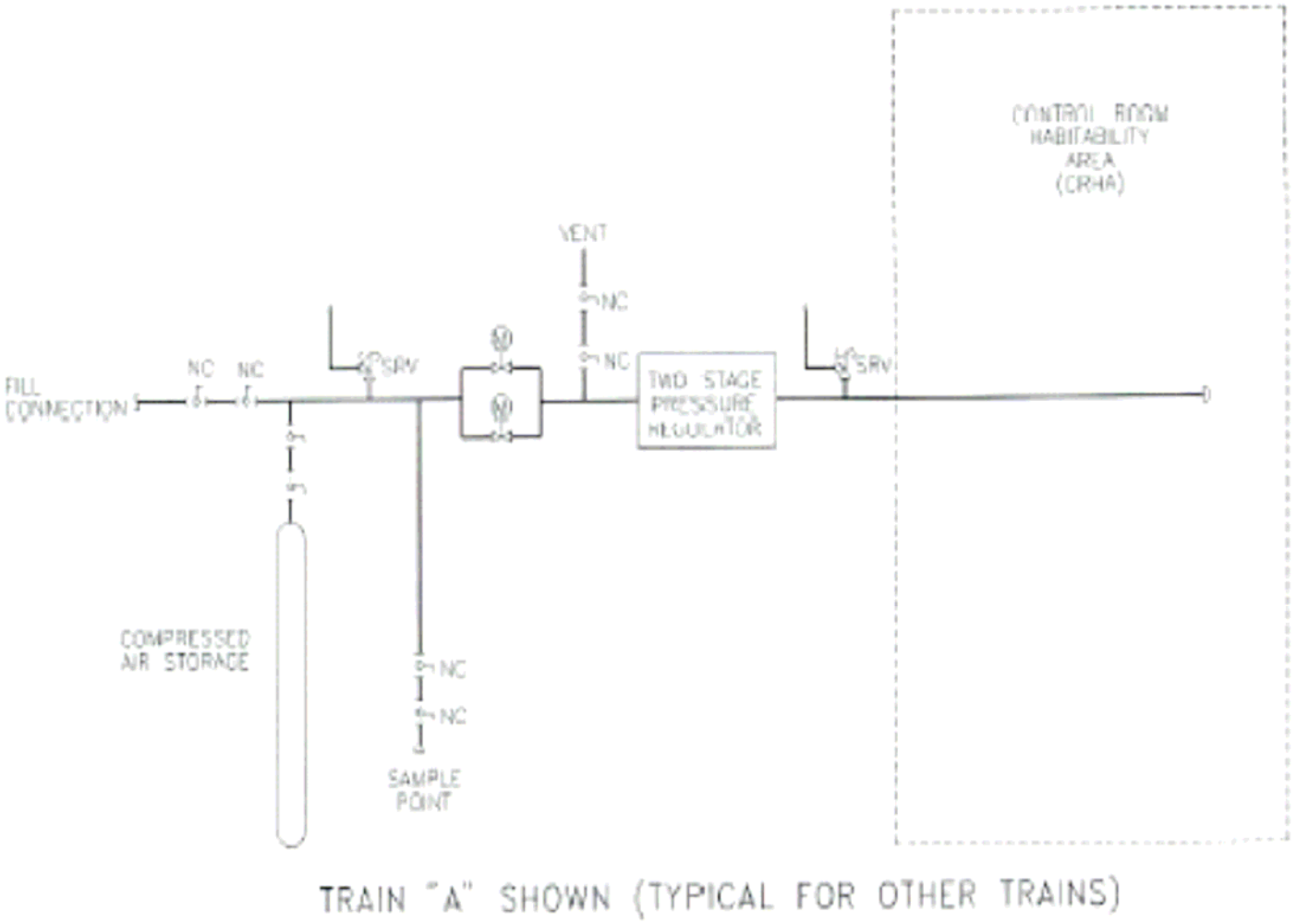
SLCS to be presented by J. Deaver

Control Building HVAC System (U77)

- Consists of three subsystems: CR Habitability Area HVAC Subsystem (CRHAHVS), Emergency Breathing Air System (EBAS) and CB General Area HVAC (CBGAHVS)
- CRHAHVS serves the MCR and associated support areas
- EBAS provides pressurized bottled air to the Control Room Habitability Area (CRHA) during radiological events and in the event of a SBO.
- Most of the components of U77 are non-safety related
  - CRHA envelope, isolation dampers and EBAS are safety related
  - EBAS is automatically initiated on isolation of the CRHA envelope
  - CRHA structures and components are Seismic Cat I
- On detected high radiation or toxic gas the air inlet and exhaust dampers of CRHAHVS will close and MCR air is recirculated with no outside air makeup.
- An Emergency Filter Unit (EFU) with a HEPA filter and charcoal filters is available to serve the CRHA if power is available
- No single active failure can result in loss of system performance
- During SBO MCR temperature rise is only 8.3° C (15 ° F) after 72 hours.



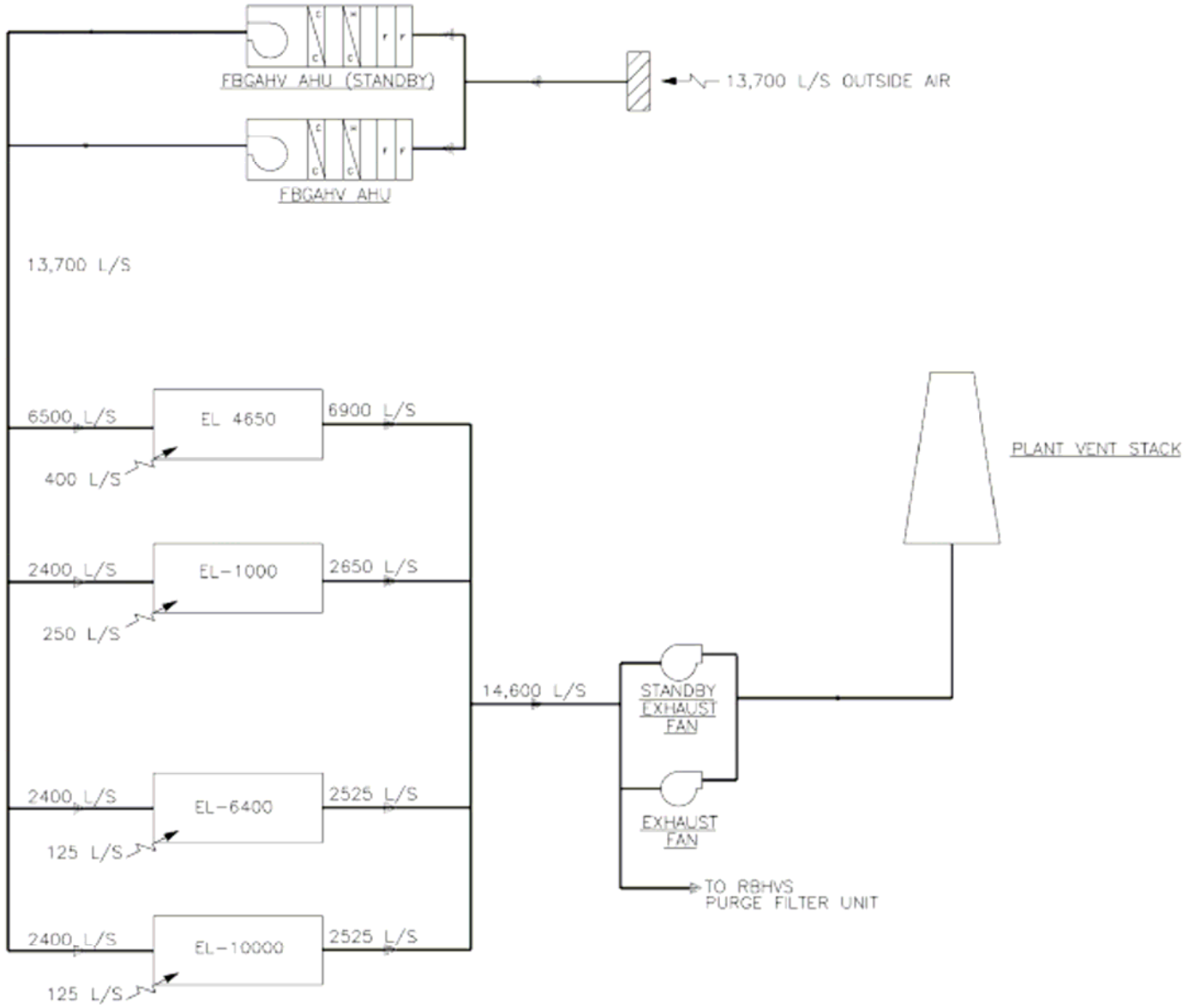
Control Building HVAC System (U77)



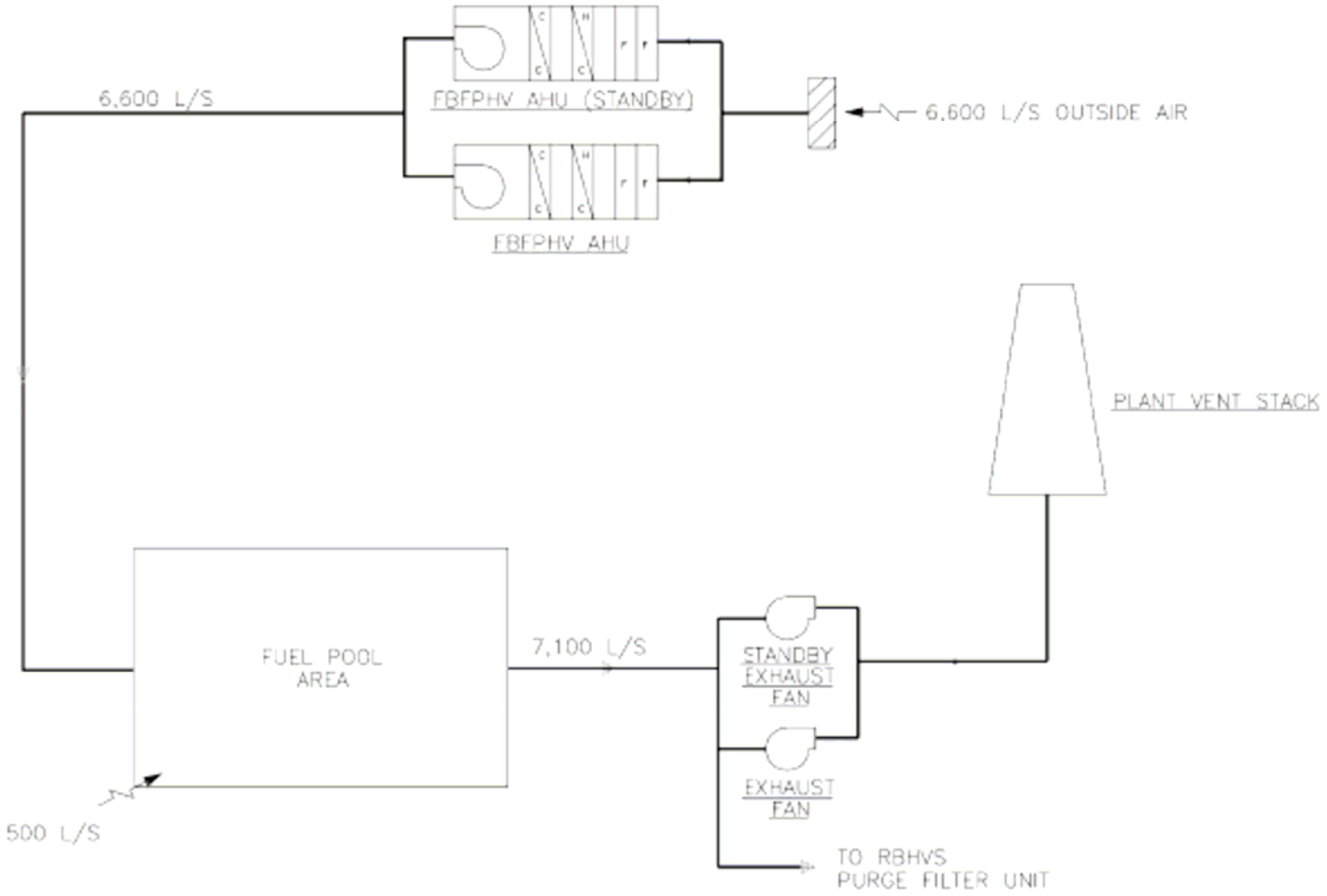
Emergency Breathing Air System (EBAS)

Fuel Building HVAC System (U98)

- Fuel Building Heating Ventilation and Air Conditioning System (FBHVS) provides HVAC to FB General Areas, Spent Fuel Pool and equipment area.
- FBHVS is nonsafety-related except isolation dampers and ducting penetrating FB boundary.
- The system automatically isolates in the event of fuel handling accident or other radiological accident.
- Consists of two subsystems: FB General Area Heating Ventilation and Air Conditioning Subsystem (FBGAHV) and FB Spent Fuel Pool Heating Ventilation and Air Conditioning Subsystem (FBFPHV)



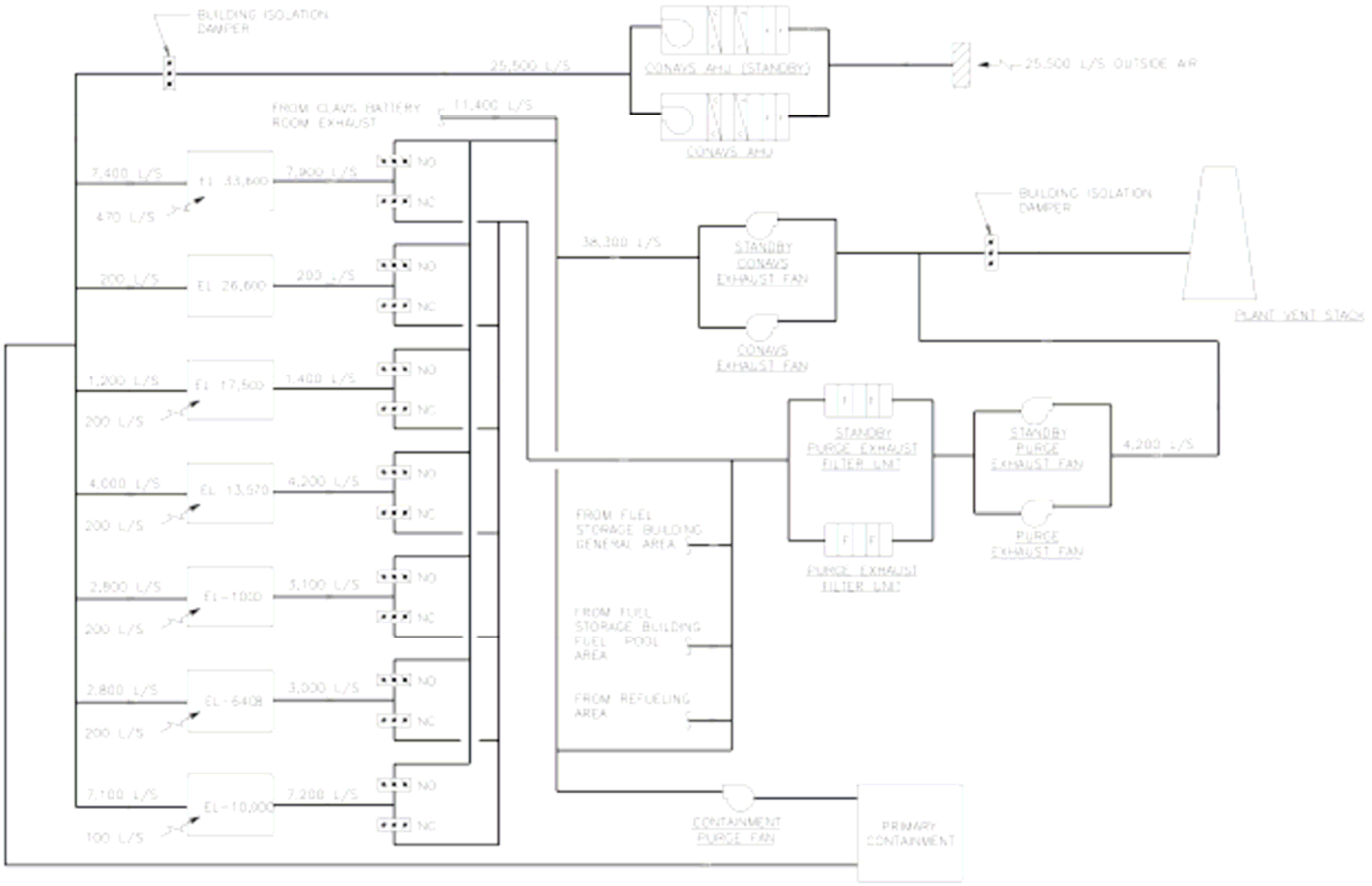
FB General Area HVAC Subsystem



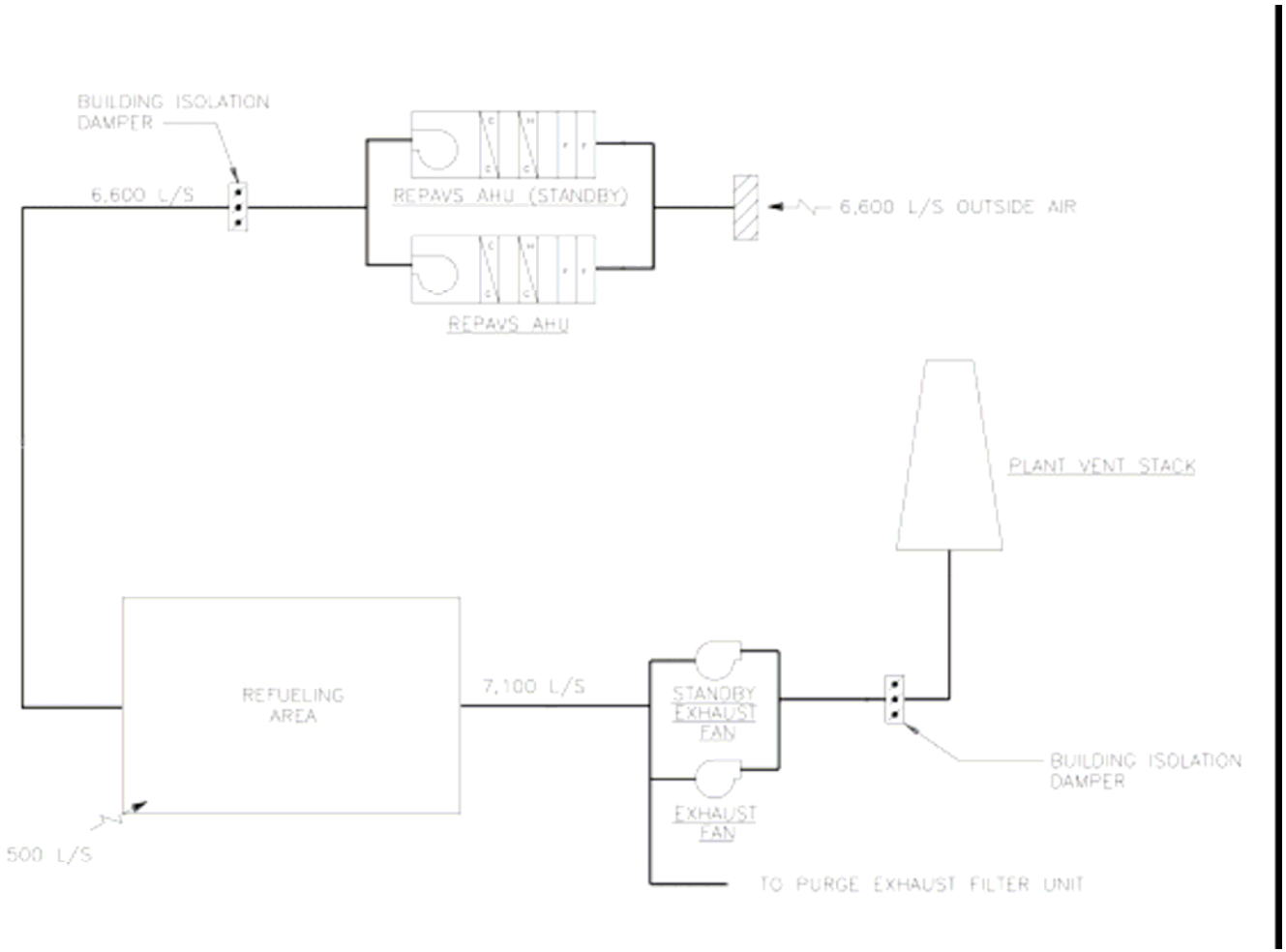
FB Spent Fuel Pool HVAC Subsystem

Reactor Building HVAC System (U40)

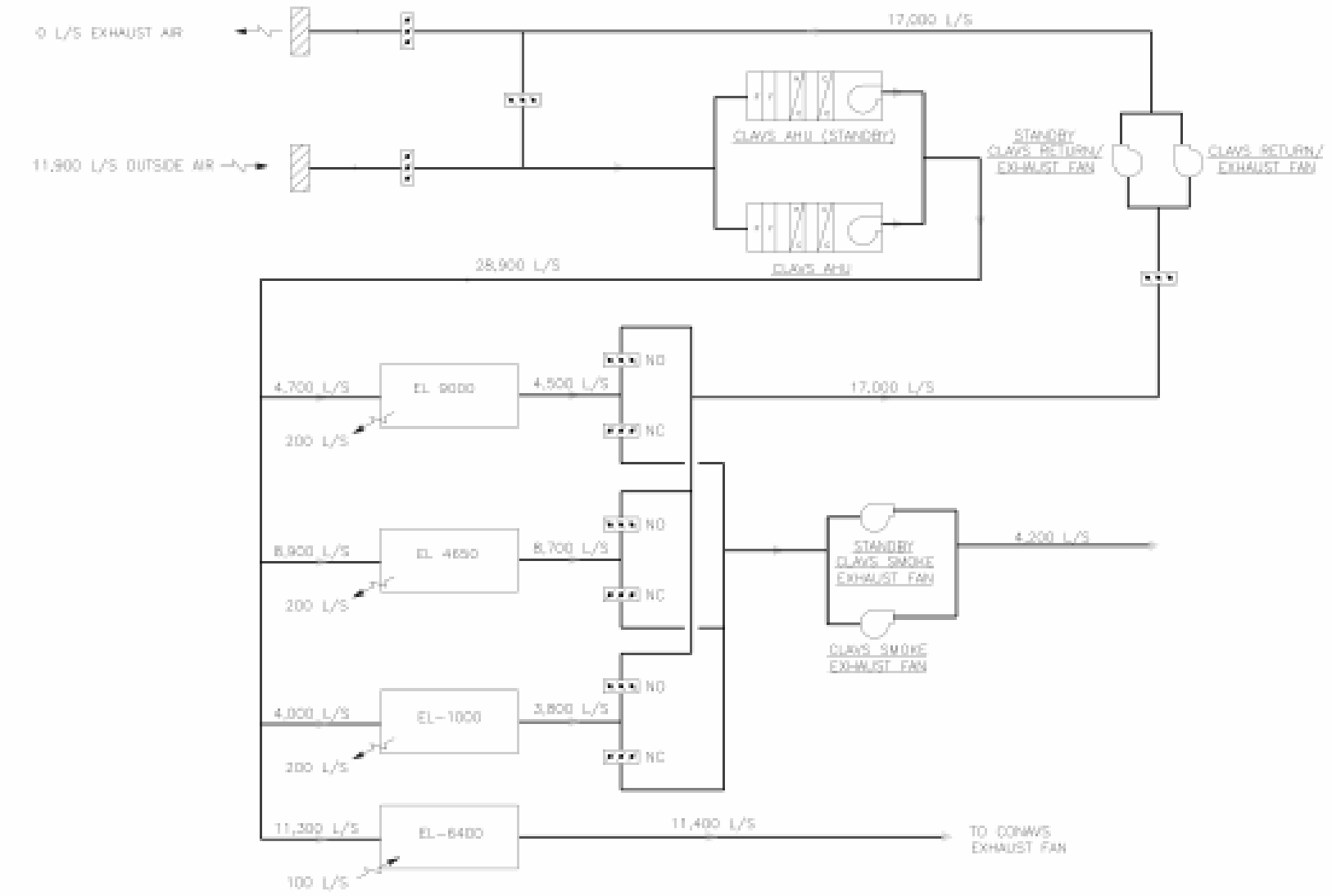
- RB Heating, Ventilation and Air Conditioning System (RBHVS) serves RB potentially contaminated areas, the refueling area and non-radiologically controlled areas of the RB.
- RBHVS is nonsafety-related except isolation dampers and ducting penetrating RB boundary and associated controls
- System consists of three Subsystems: RB Contaminated Area HVAC Subsystem (CONAVS), Refueling and Pool Area HVAC Subsystem (REPAVS) and the RB Clean Area HVAC Subsystem (CLAVS)
- CONAVS and REPAVS are once thru systems and consist of redundant AHUs, exhaust fans and building isolation dampers.
  - CONAVS Includes primary containment purge exhaust fan, recirculation AHUs and unit heaters
  - Air is exhausted from potentially contaminated areas of RB via purge exhaust fan to plant stack
- CLAVS is a recirculation ventilation system with redundant AHUs, return/exhaust fans and smoke exhaust fans
- In the event of a fire fire dampers close to isolate the fire area - exhaust fans are used for smoke removal



RB Contaminated Area HVAC Subsystem (CONAVS)



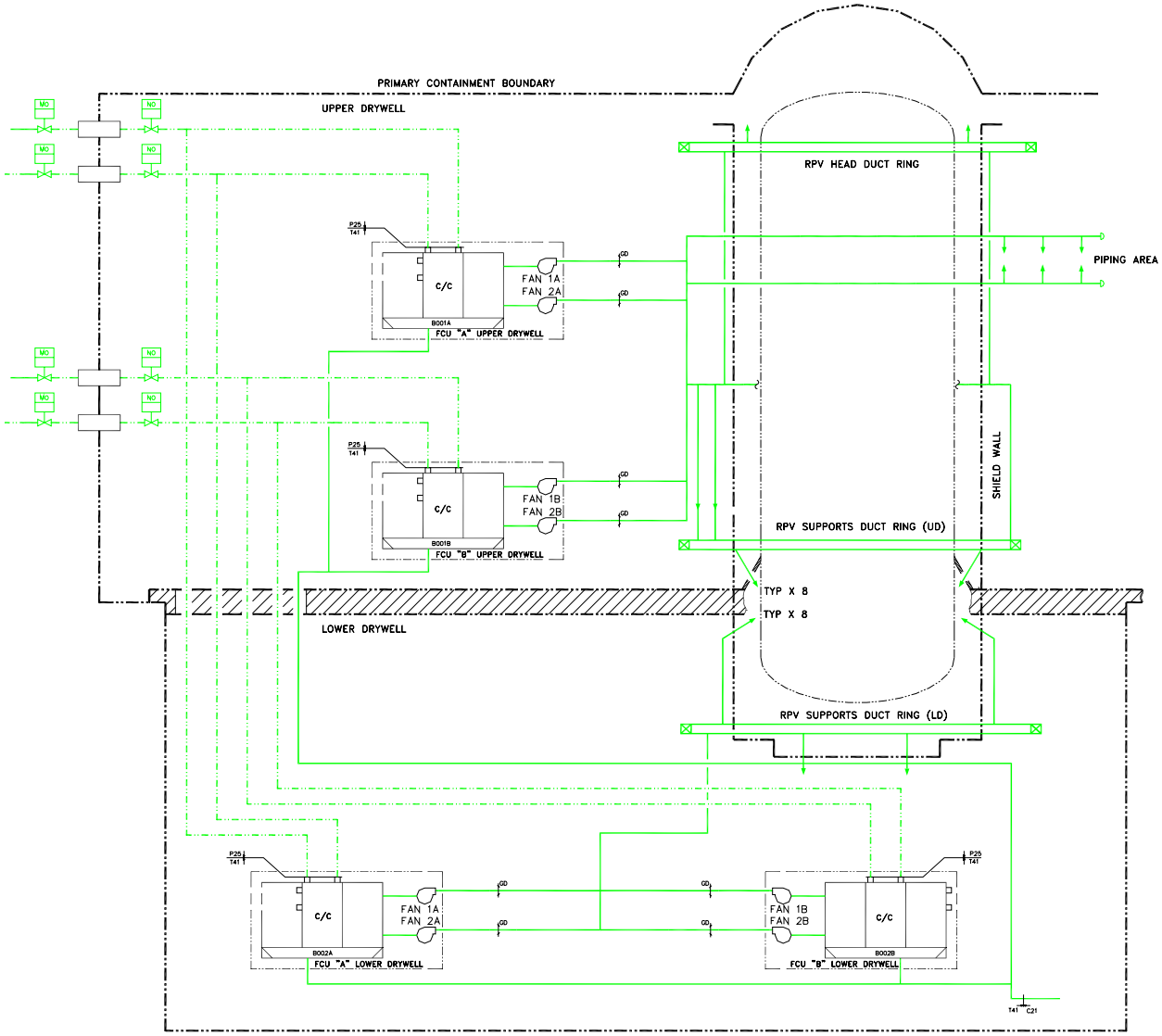
RB Refueling & Pool Area HVAC Subsystem (REPAVS)



RB Clean Area HVAC Subsystem (CLAVS)

Drywell Cooling System (T41)

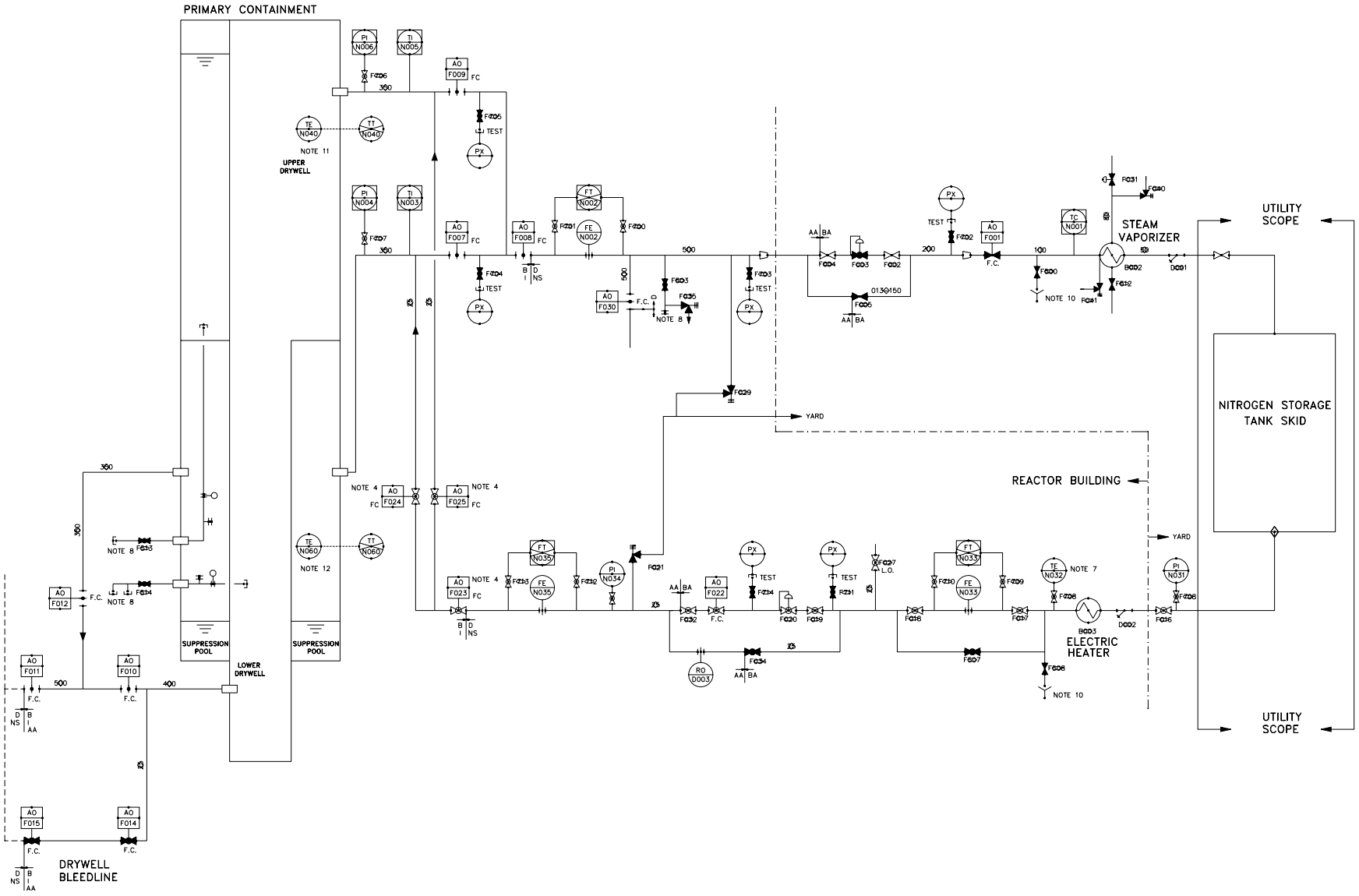
- Drywell Cooling System (DCS) is classified as a nonsafety-related, Seismic Cat II system
- DCS maintains upper and lower drywell temperatures within limits during normal operation, accelerates DW cool down going from hot to cold shutdown, assists in purging DW N_2 during shutdown, maintains DW environmental conditions during outages and limits DW temperatures during a LOPP
- DCS is a closed loop recirculation air/N_2 cooling system with no outside air/N_2 introduced
- Ducts distribute cooled, recirculated air/N_2 thru diffusers and nozzles
- DCS consists of four FCUs, two 50% capacity FCUs in the upper and two 50% capacity FCUs in the lower DW
- Each FCU consists of a cooling coil and two fans – only one is normally in operation the other is in standby
- Chilled Water System provides cooling water to the FCU cooling coils
- The DCS is power off of the PIP busses and is supplied power by the standby DG on a LOPP



Drywell Cooling System (T41)

Containment Inerting System (T31)

- Containment Inerting System (CIS) is classified as a nonsafety-related system.
- System is design to establish containment inerted atmosphere of < 4% O_2 by volume in < 4 hours and < 2% O_2 in the next 8 hrs.
- Maintains containment O_2 level < 3% during normal, abnormal and accident conditions.
- Maintains slight positive pressure during normal, abnormal and accident conditions to prevent air in-leakage.
- N_2 gas makeup supply has capacity to maintain + 4.8 kPaG (0.7psig) in containment.
- System has sufficient capacity to replenish 0.5 % RCCV volumes per day based on the containment operating pressure.
- CIS permits de-inerting the containment for safe access in < 12 hrs.
- CIS is design to relieve containment pressure during a severe accident before uncontrolled containment failure could occur.
  - This operation is performed manually
  - Function was previously performed by Containment Over Protection System



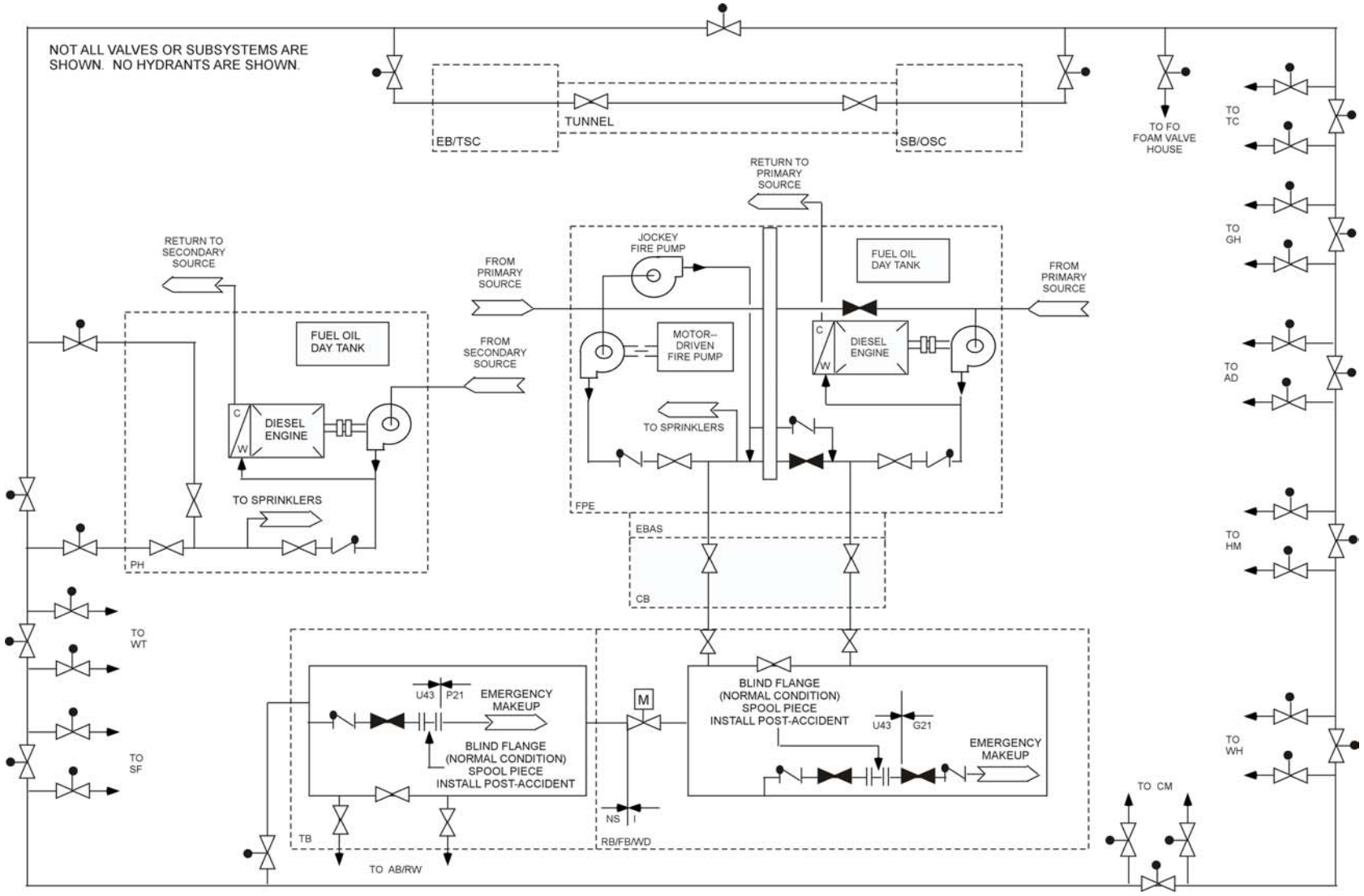
Containment Inerting System (T31)

Fire Protection System (U43)

- Fire Protection System is classified as a nonsafety-related system although it is subject to RTNSS requirements
- System is designed with defense in depth to achieve the required degree of reactor safety. System is designed to:
  - Control the spread and extinguish fires in all plant areas using fixed and/or portable fire fighting equipment,
  - Provide automatic fire detection and annunciation,
  - Provide maximum firewater demand assuming a single failure,
  - Preclude loss of function during a seismic event,
  - Preclude loss of fire water supply - two separate and independent fire water sources are connected to FPS
  - Ensure no single failure caused by an MELB can impair both the primary and backup fire suppression system
  - Provide a source of on site makeup water to FAPCS for the IC/PCC pools 72 hrs after a LOCA for 7 days.

Fire Protection System (U43)

- Fixed automatic Fire suppression systems are installed in areas having a high fire hazard rating
- Building standpipes and hose stations are provided in major buildings
- Portable fire extinguishers are strategically located throughout the plant
- Comprehensive fire detection, alarm, supervisory control, and indication provided thru out the plant.
- Operation of system is automatic – can be locally controlled
- Main fire panel alarm panel is located in MCR
- Three 50% capacity firewater pumps provides 100% of demand assuming worst-case fire within NI.
  - Two NI fire pumps are located on top on a Seismic Cat I structure – lead pump is motor drive, backup pump is diesel driven
  - The second diesel driven fire pump is located remotely from the NI fire pumps and provides backup
  - Fuel oil tanks for diesel driven fire pumps has capacity for approximately 8 hrs.



Fire Protection System (U43)