KINGS KEPCO INTERNATIONAL NUCLEAR GRADUATE SCHOOL

Sizing of Low Pressure Feedwater Heaters for the AM600

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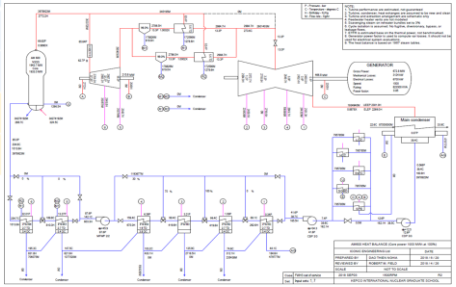
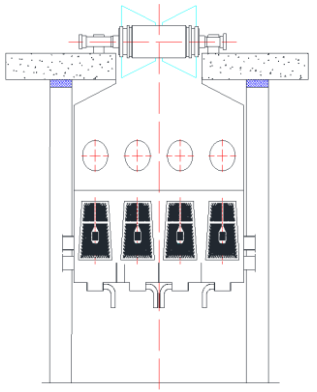
• An overall design which emphasizes simplicity, reduced component count, easy maintenance, and reliability for 'newcomer' countries

	Conventional	AM600
No. of HPT Rotors	1	1
No. of HPT Flows	2	1
No. of LPT Rotors	2	1
No. of LPT Flows	4	2



LP FWH OOS	Operating Power (% Rated)	% Bypass Flow (vs. Rated)
1	100%	30%
2	100%	30%
3	100%	30%
4	100%	30%



Objective of the AM600

- A nuclear steam cycle which can produce energy in the range of 600 to 700 MWe when paired with an NSSS which supplies steam in the range of 1800 to 2000 MWt

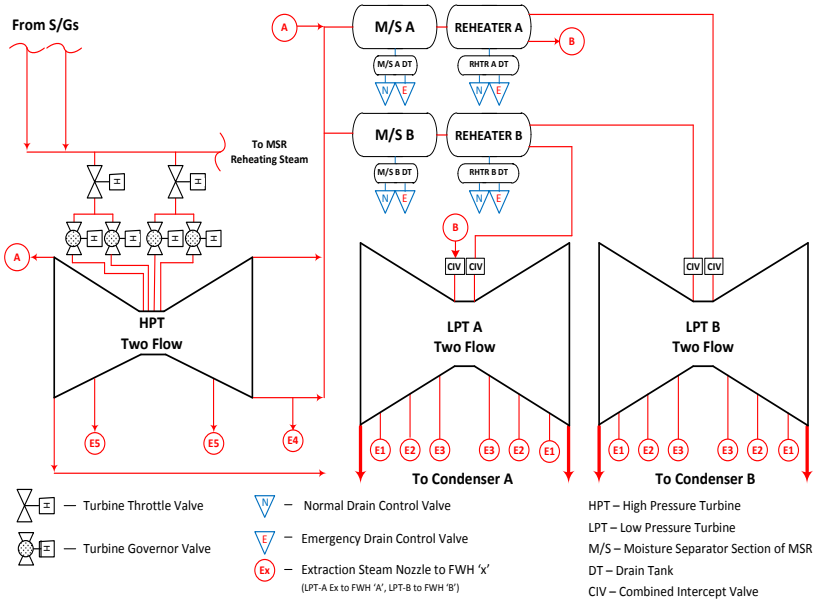
- An overall design which emphasizes simplicity, reduced component count, easy maintenance, and reliability for 'newcomer' countries

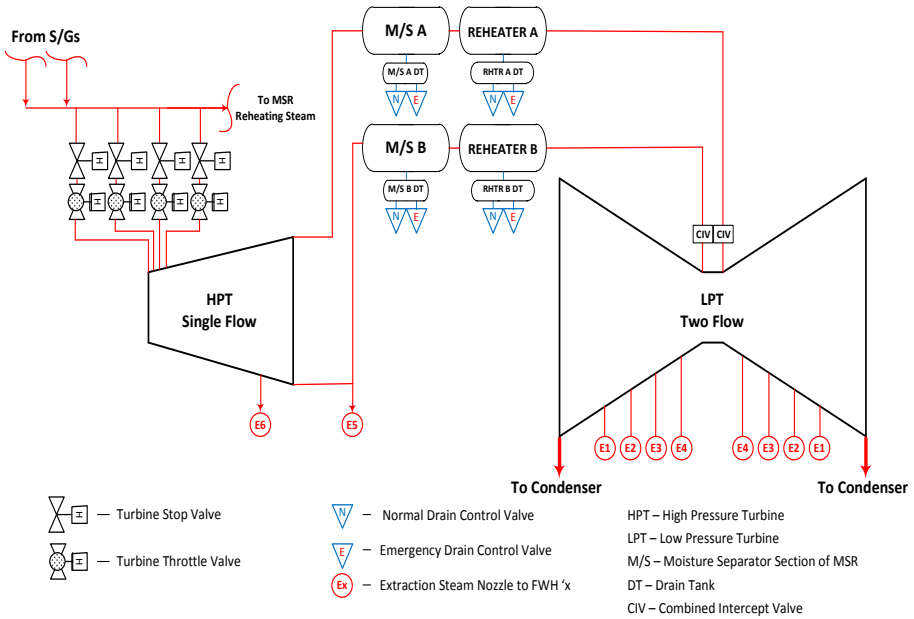
- An electrical output compatible with smaller electrical grids and load flows

- A simplified turbine-generator shaft-line which is robust in relation to torsional vibration associated with grid interface, seasonal and daily variation in grid frequency and large electrical disturbances

Nuclear Steam Cycle – Conventional vs. AM600

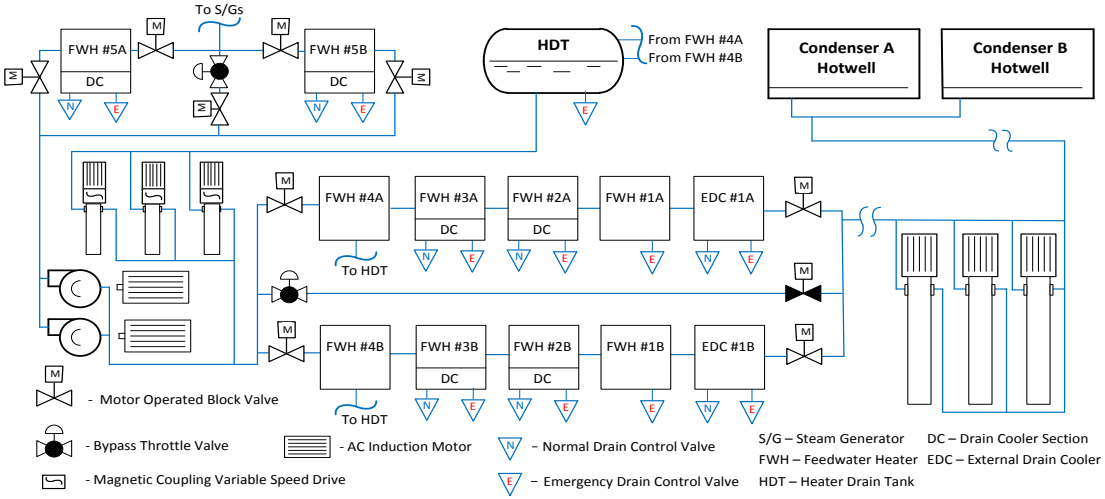
Steam Side

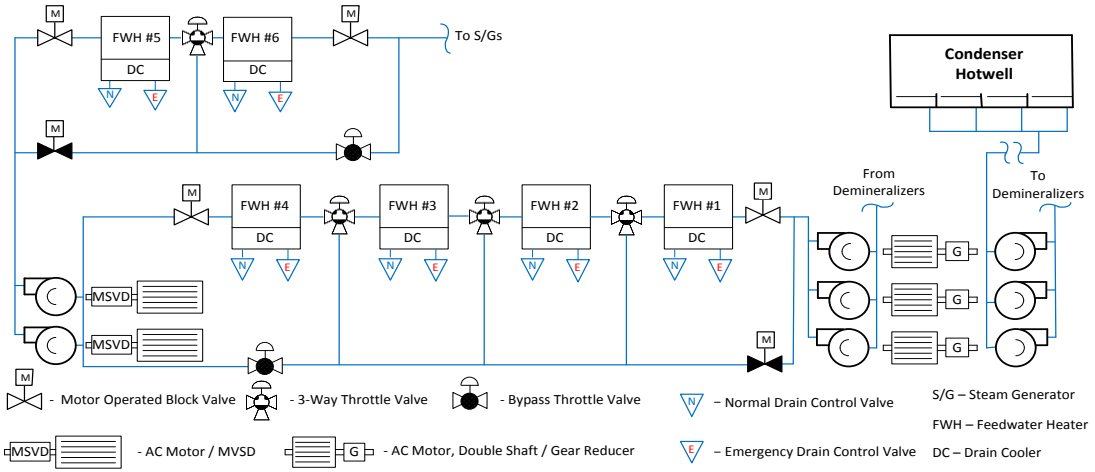




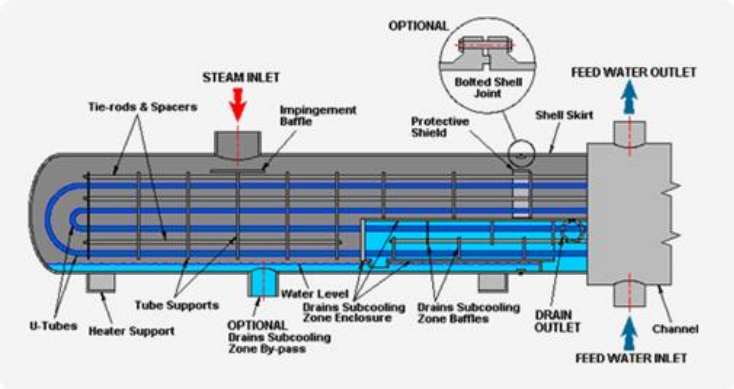
AM600 Steam Cycle – Conventional vs. AM600

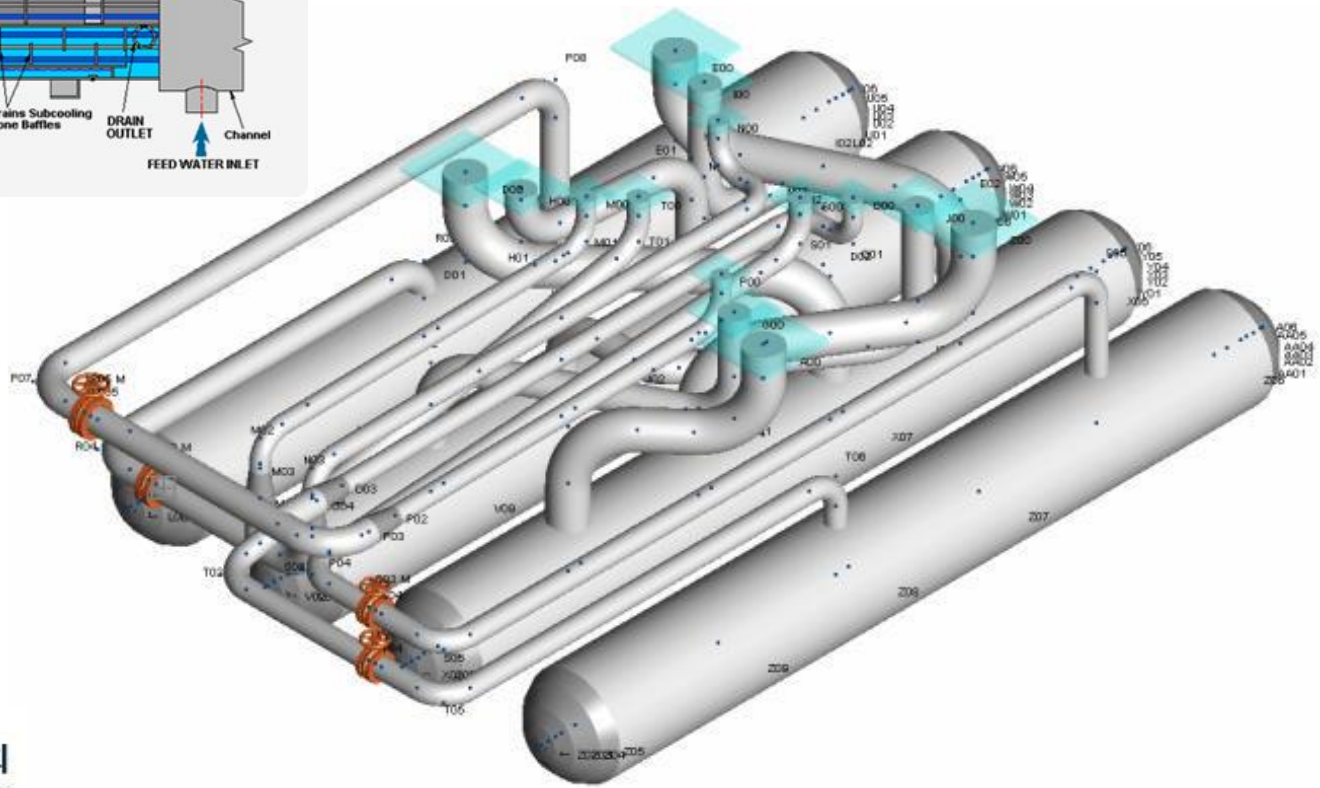
Water Side





Arrangement of FWHs Inside the Condenser Neck





Size Constraint on LP FHW Diameter

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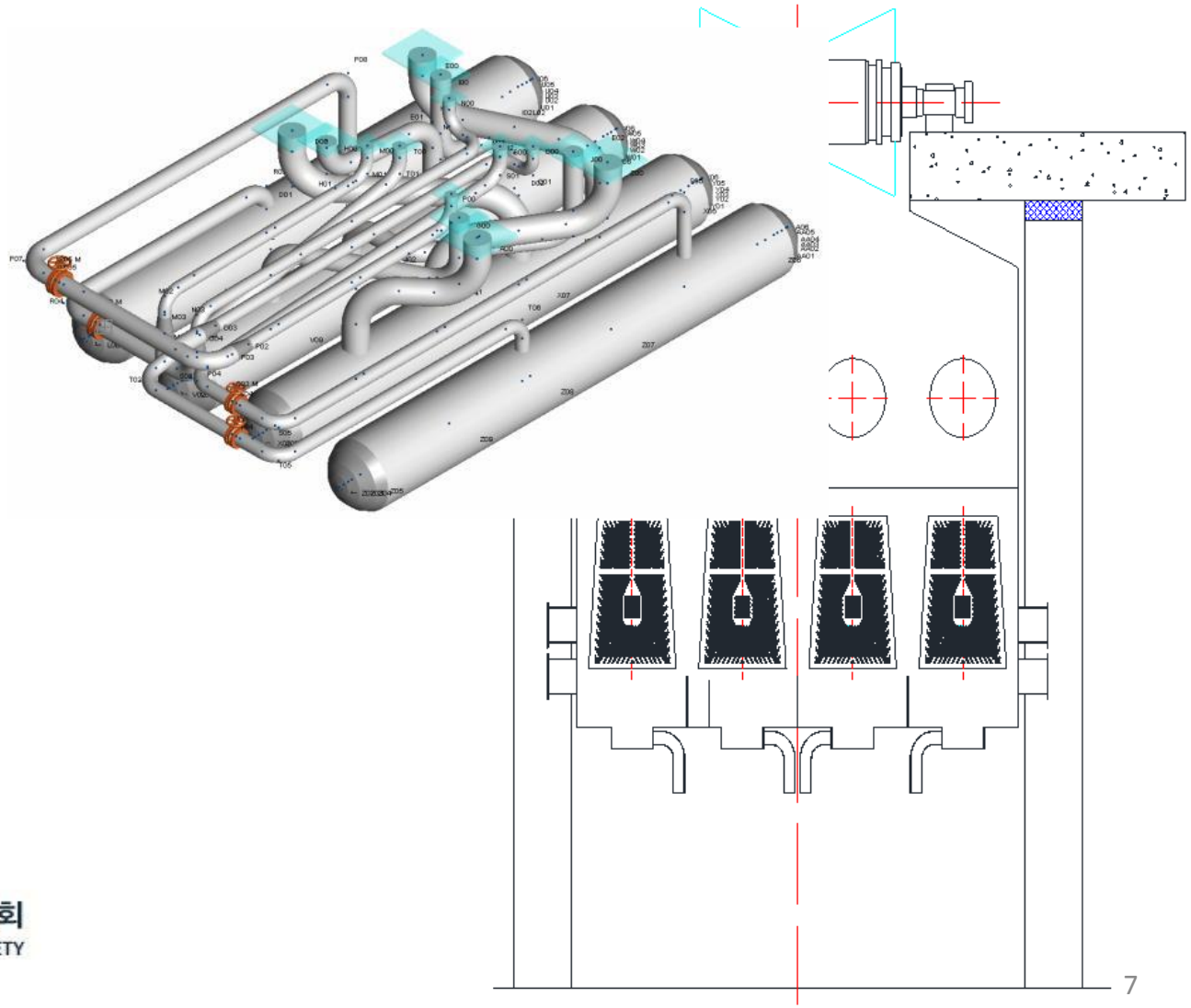
All LP FWHS must Fit within Neck Region

Need Clearance for Steam Flow from LPT Exhaust to Condenser Bundles



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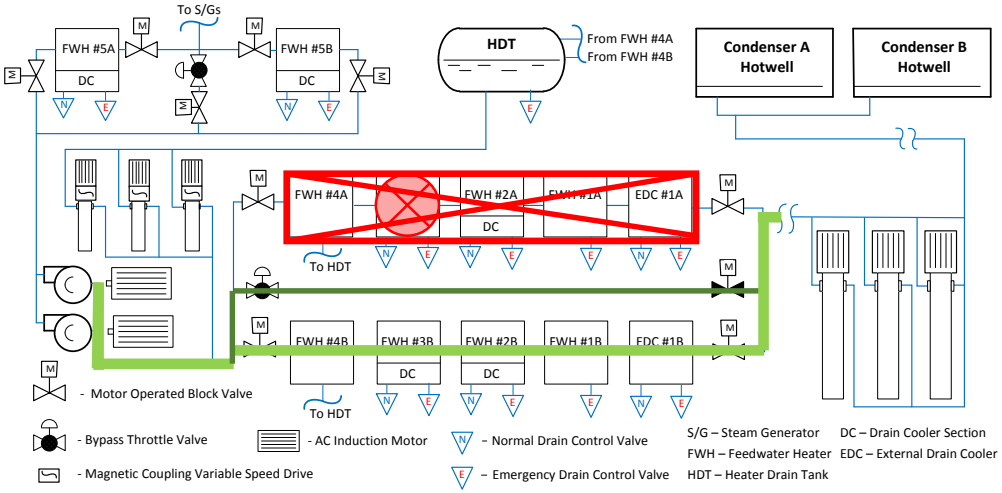
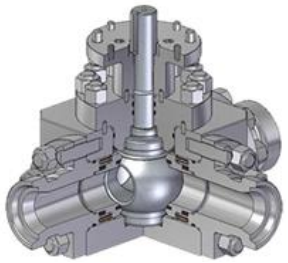
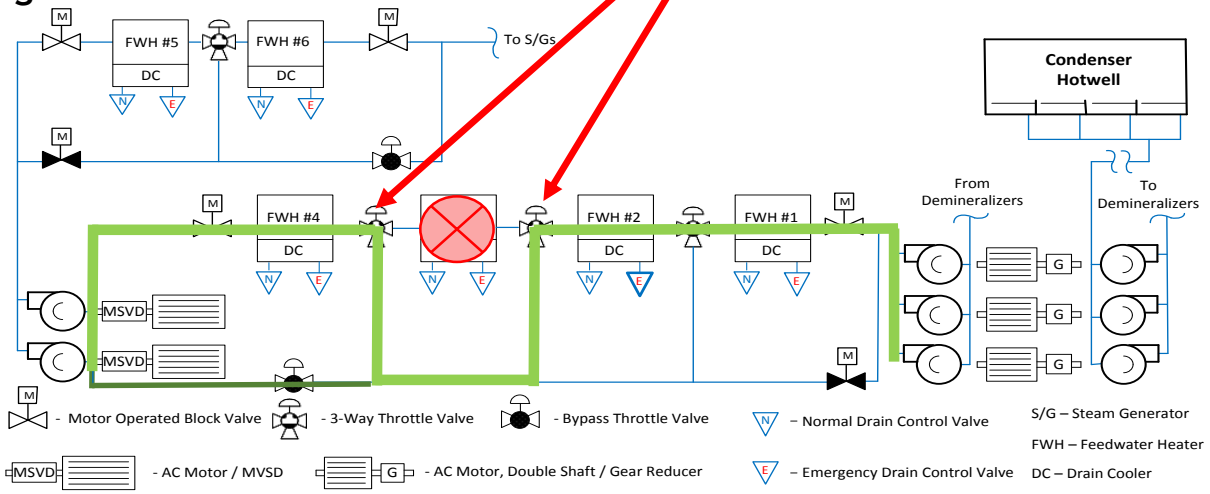
Feedwater Heater Out Of Service



Conventional 600 MWe Design

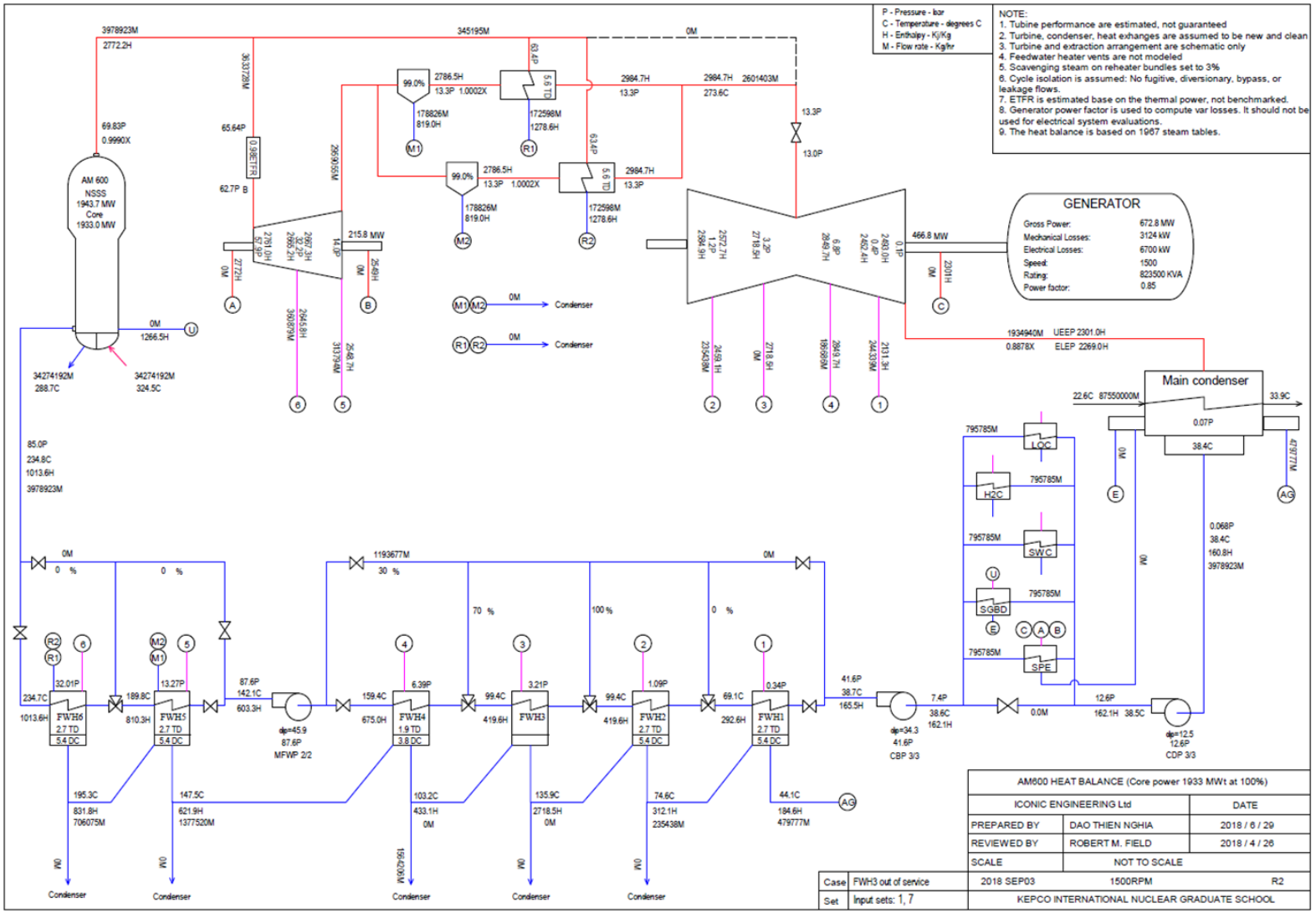
Three-way Metal Seated Ball Valve





AM600 Design

Heat Balance



Operating Conditions

- Analysis aims at establishing the limiting power operating levels of FWH OOS given constraints on LP FWH sizing within the condenser neck

LP FWH OOS	Operating Power (% Rated)	% Bypass Flow (vs. Rated)
1	100%	30%
2	100%	30%
3	100%	30%
4	100%	30%

Tubing and Nozzle Calculations

The number of tubes is calculated to limit tubeside velocity to 3 m/s (HEI recommendation).

This number is then increased by 5% to allow for the tube plugging margin.

The number and size for steam inlet nozzles is also determined to limit velocity at the entrance to the shell. Depending on steam pressure, this limit is ~45 to 70 m/s (HEI recommendation).

LP FWH	No. 3/4" Tubes (20 BWG)	No. of ES Nozzles	ES Nozzle Size (NPS)
1	1685	4	36
2	1716	2	36
3	1754	2	24
4	1803	1	24

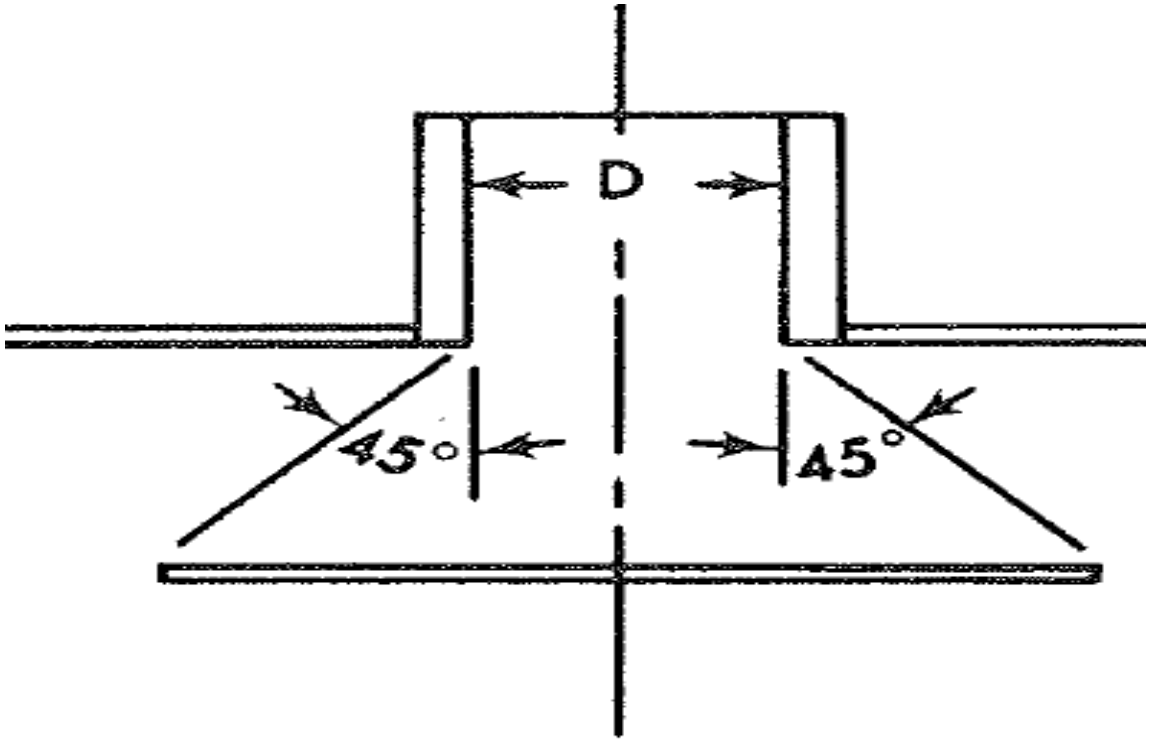
Shell Diameter

Using the number of U-tubes and the shell diameter, the installed diameter of the LP FWHs can be determined.

FWH No.	Tube Bundle Diameter (mm)	Bundle To Shell Top Clearance (mm)	Bundle To Shell Bottom Clearance (mm)	Other (Shell Wall Thickness, Insulation) (mm)	Installed Diameter (mm)
1	1583	224	180	68.5	2056
2	1597	185	160	68.5	2011
3	1614	150	140	68.5	1973
4	1635	150	120	68.5	1974

Steam Escape Velocity in FWH Shell

- ***The steam escape velocity(exiting the 45o cone below) must be limited to avoid excessive vibration and erosion damage.***
- ***This velocity is checked for both VWO and FWH out-of-service conditions.***
- ***The design discussed here meets the established guidelines for limiting steam escape velocity.***



Conclusions

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- Heater Shell Diameter was established using industry Codes and standards, and accepted engineering practice
- Condenser layout and design is ongoing using the FWH installed shell diameters established here.
- For FWH Out-of-Service, heat balance analysis determined the operating conditions for analysis (mass flow rate, pressure, and enthalpy of water and steam flows)
- Heat balance results were checked against the dimensioned FWHS and the following parameters were found to be acceptable:
  - ✓ tubeside volumetric flow rate,
  - ✓ steam inlet velocity,
  - ✓ steam escape velocity,
  - ✓ shellside drain cooler volumetric flow, and
  - ✓ normal and emergency drain control valve sizing.

THANK YOU

감사합니다