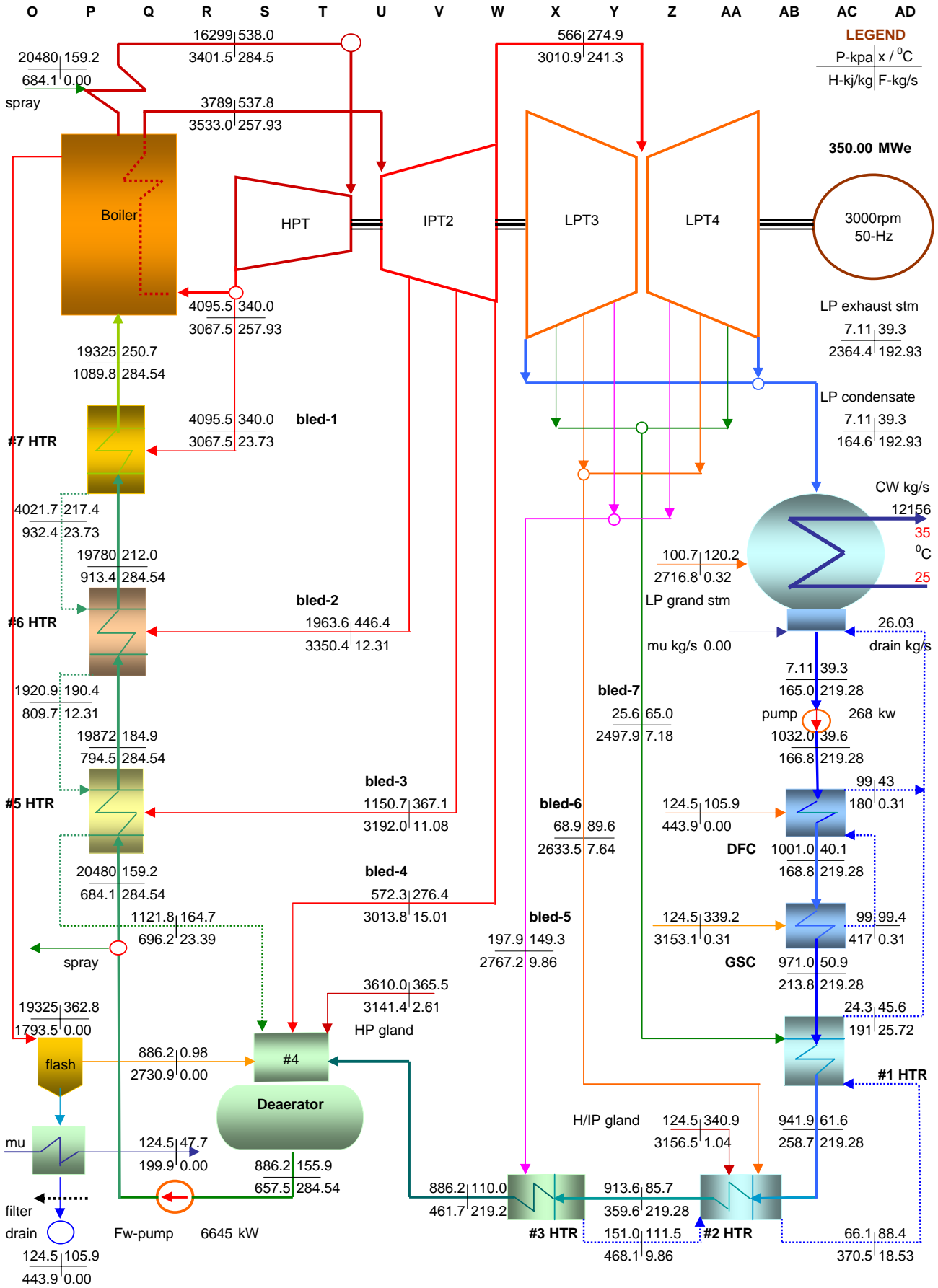


Heat Balance

EIM 1

| A | B | c | D | E | F | G | H | I | J | K | L | M | N | |
|----|-------------------------------------|--|----------------|-----------------|---|----------------|-----------|------------------------------------|---------------------------|----------------------|-----------------|------------------|------------------|--|
| 02 | OEM Design Point | Efficiencies basis on heat balance calculation/calibration | | | | | | Steam parameters | | kpa | °C/x | kJ/kg | | |
| 03 | Steam flow factors | factor | | | Leak-off fraction | design | | | Economizer inlet | | 19325 | 250.67 | 1089.76 | |
| 04 | Turbine proper | 1.0000 | | | Stop valve | 0.0002 | 0.0002 | | Boiler main steam | | 16299 | 538.02 | 3401.50 | |
| 05 | Gland to Dea | 0.0092 | | | HP gland | 0.0099 | 0.0099 | | Sprayed main stm | | 16299 | 538.02 | 3401.50 | |
| 06 | Gland to #2htr | 0.0037 | | | IP gland | 0.0033 | 0.0033 | | Reheater cold stm | | 4095.5 | 340.04 | 3067.529 | |
| 07 | Gland to GSC | 0.0011 | | | LP gland | 0.0011 | 0.0011 | | Reheater hot stm | | 3788.7 | 537.81 | 3532.96 | |
| 08 | LP gland to Cond | 0.0011 | | | plant leak | 0.0000 | | | Sprayed reheat stm | | 3788.7 | 537.81 | 3532.96 | |
| 09 | Turbine flow total | 1.0150 | | | By-pass fraction | design | | | HP turbine stm inlet | | 16299 | 538.02 | 3401.50 | |
| 10 | Boiler evaporation | 1.0150 | | | HP spray | 0.0000 | 0.0000 | | HP turbine stm exit | | 4095.5 | 340.04 | 3067.53 | |
| 11 | Boiler blowdown | 0.0000 | | | RH spray | 0.0000 | 0.0000 | | IP turbine stm inlet | | 3788.7 | 537.81 | 3532.96 | |
| 12 | Boiler feed water | 1.0150 | | | IP cooling | 0.0000 | 0.0000 | | IP turbine rotor cool | | 3788.7 | 537.81 | 3532.96 | |
| 13 | Bd flash | °C/x | kJ/kg | | IP-LPgsc | 0.0034 | 0.0034 | | IP turbine stm exit | | 572.26 | 276.37 | 3013.80 | |
| 14 | blr-drum | 362.84 | 1793.5 | | Plant efficiencies | | calibrate | | LP turbine stm inlet | | 565.66 | 274.89 | 3010.90 | |
| 15 | flash stm | 0.98 | 2730.9 | | Boiler | 0.925 | 0.925 | | LP turbine stm exit | | 7.110 | 0.91 | 2364.38 | |
| 16 | sat water | 174.70 | 739.8 | | Mechanic | 0.985 | 0.985 | | Condensate outlet | | 7.110 | 39.32 | 164.59 | |
| 17 | mu-inlet | 25.00 | 104.88 | | Generator | 0.984 | 0.984 | | Gland stm to Dea | | 3610.0 | 365.51 | 3141.44 | |
| 18 | flash drain | 105.87 | 443.86 | | Bfw-pump | 0.839 | 0.839 | | Gland stm to #2htr | | 124.50 | 340.85 | 3156.54 | |
| 19 | mu-outlet | 47.73 | 199.86 | | Flash-tank | 0.990 | 0.990 | | Gland stm to GSC | | 124.50 | 339.17 | 3153.12 | |
| 20 | Blowdown factors | | | | Dea level / Fwp inlet-p / enthalpy-rise / temp | | | | GSC sat-liq to DFC | | 100.70 | 99.83 | 418.33 | |
| 21 | flash stm | 0.0000 | | | Dea:m/kpa/kj/kgk | 33.70 | 886.20 | 1.901 | Gland to Condenser | | 100.70 | 120.18 | 2716.77 | |
| 22 | flash drain | 0.0000 | | | Fwp:kJ/kg/Δh/°C | 679.28 | 25.93 | 159.1 | IP / LP press-drop | | 1.16% | 7.31 | kJ/kg.k | |
| 23 | make-up | 0.0000 | | | Cond-p:kJ/kg°C | 165.59 | 166.79 | 39.64 | RH heat: | 1502.55 | RH gain: | 465.43 | kJ/kg | |
| 24 | | | | | | | | | | | | | | |
| 25 | Bled stm | design | kpa | °C | kJ/kg | quality | | Htr-inlet | design | kpa | sat °C | sat kJ/kg | liq kJ/kg | |
| 26 | B1>#7htr | 4095.5 | 4095.5 | 340.04 | 3067.53 | 1.00 | | #7htr-B1 | 4021.7 | 4021.7 | 250.65 | 2800.2 | 1088.97 | |
| 27 | B2>#6htr | 1963.6 | 1963.6 | 446.36 | 3350.37 | 1.00 | | #6htr-B2 | 1920.9 | 1920.9 | 210.34 | 2796.4 | 899.30 | |
| 28 | B3>#5htr | 1150.7 | 1150.7 | 367.07 | 3191.97 | 1.00 | | #5htr-B3 | 1121.8 | 1121.8 | 184.94 | 2780.4 | 784.99 | |
| 29 | B4>Dea | 572.26 | 572.26 | 276.37 | 3013.80 | 1.00 | | #4-Dea-B | 555.72 | 555.7 | 155.87 | 2752.1 | 657.52 | |
| 30 | B5>#3htr | 197.88 | 197.88 | 149.29 | 2767.24 | 1.00 | | #3htr-B5 | 151.00 | 151.0 | 111.57 | 2693.7 | 467.97 | |
| 31 | B6>#2htr | 68.946 | 68.948 | 89.60 | 2633.50 | 0.989 | | #2htr-B6 | 66.121 | 66.12 | 88.47 | 2657.7 | 370.49 | |
| 32 | B7>#1htr | 25.580 | 25.580 | 65.00 | 2497.89 | 0.948 | | #1htr-B7 | 24.338 | 24.34 | 64.39 | 2617.3 | 269.48 | |
| 33 | BFW exit | calibrate | kpa | °C | kJ/kg | δ°C | | GSC | calibrate | 99.3 | 99.44 | 2675.1 | 416.68 | |
| 34 | #7htr | 19325 | 19325.0 | 250.67 | 1089.75 | 0.012 | | | | | | | | |
| 35 | #6htr | 19780 | 19780 | 212.00 | 913.44 | 1.65 | | Htr drain | ref δ°C | δ°C correct°C | kJ/kg | design | | |
| 36 | #5htr | 19872 | 19872 | 184.94 | 794.49 | 0.00 | | #7htr | -8.00 | -33.22 | 217.44 | 932.38 | 932.38 | |
| 37 | Dea/Fwp | 20480 | 20480 | 159.22 | 684.06 | 0.14 | | #6htr | -8.00 | -19.92 | 190.43 | 809.73 | 809.73 | |
| 38 | #3htr | 886.2 | 886.2 | 109.96 | 461.69 | 1.61 | | #5htr | -8.00 | 5.62 | 164.70 | 696.20 | 696.20 | |
| 39 | #2htr | 913.6 | 913.6 | 85.72 | 359.60 | 2.75 | | #3htr | 0.00 | -0.03 | 111.54 | 468.13 | 468.13 | |
| 40 | #1htr | 941.9 | 941.9 | 61.64 | 258.74 | 2.75 | | #2htr | 0.00 | -0.02 | 88.44 | 370.46 | 370.46 | |
| 41 | GSC | 971.0 | 971.0 | 50.89 | 213.78 | 48.55 | | #1htr | 0.00 | -18.78 | 45.61 | 190.96 | 190.96 | |
| 42 | DFC | 1001.0 | 1001.0 | 40.12 | 168.81 | 59.32 | | DFC | 0.00 | -56.4 | 43.04 | 180.22 | 419.08 | |
| 43 | Cond-p | 1032.0 | 1032.0 | 39.64 | 166.84 | 0.00 | | | | | | | | |
| 44 | | | | | | | | | | | | | | |
| 45 | Bled frac | design | htr-eff | fraction | defect | deficit | | Turbine flow/power output | | kg/s-in | kg/s-out | kWe | | |
| 46 | #7htr | 0.08341 | 0.990 | 0.08341 | 0.7777 | 0.0649 | | P1 stage (#7htr) flows/work | | 284.53 | 23.73 | 92102 | | |
| 47 | #6htr | 0.04326 | 0.990 | 0.04326 | 0.6562 | 0.0284 | | P2 stage (#6htr) flows/work | | 260.80 | 12.31 | 46155 | | |
| 48 | #5htr | 0.03893 | 0.990 | 0.03893 | 0.5508 | 0.0214 | | P3 stage (#5htr) flows/work | | 248.49 | 11.08 | 38149 | | |
| 49 | Dea | 0.05276 | 0.997 | 0.05276 | 0.4322 | 0.0228 | | P4 stage (Dea) flows/work | | 237.41 | 15.01 | 40999 | | |
| 50 | #3htr | 0.03465 | 0.985 | 0.03465 | 0.2681 | 0.0093 | | P5 stage (#3htr) flows/work | | 222.40 | 9.86 | 52525 | | |
| 51 | #2htr | 0.02684 | 0.992 | 0.02684 | 0.1791 | 0.0048 | | P6 stage (#2htr) flows/work | | 212.54 | 7.64 | 27552 | | |
| 52 | #1htr | 0.02524 | 0.985 | 0.02524 | 0.0889 | 0.0022 | | P7 stage (#1htr) flows/work | | 204.91 | 7.18 | 26931 | | |
| 53 | Balance | aft-Dea: | 0.76905 | Reheat: | 0.9065 | 0.0890 | | Condensing stage flows/work | | 197.73 | 197.73 | 25587 | | |
| 54 | | | | | | | | Total flows kg/s / total work | | 284.53 | 284.53 | 350000 | | |
| 55 | Total plant steam/water flow | | | kg/h | kg/h | kg/h | | Design flow/hr/s/output kWe | | 1024313 | 284.53 | 377503 | | |
| 56 | Boiler:evap / feed / makeup | | | 1039721 | 1024328 | 15 | | Heat-Q:turbine/boiler/pipe-eff | | 2800113 | 2835746 | 0.987 | | |
| 57 | Boiler:blow / flash / drain | | | 10 | 5 | 5 | | Plant-eff / HR / Tbn-HR kJ/kg | | 0.406 | 8871 | 8000.3 | | |
| 58 | Turbine:HP / RH / LP inlets | | | 1024313 | 928543 | 868832 | | Stm rate:plant / tbn / coal-rate | | 2.927 | 2.927 | 0.303 | | |
| 59 | LP turbine stm condense | | | 694561 | | | | Fwp kWe cap: LP / HP / total | | 268 | 6645 | 6913 | | |



| status | net eff | total output | net pwr output | plant heat rate | turb heat rate | plant stm rate | turb stm rate | 7000kcal-sce |
|---------|---------|--------------|----------------|-----------------|----------------|----------------|---------------|--------------|
| condens | 0.406 | 356.91 MW | 350.00 MW | 8871 kj/kWh | 8000 kj/kWh | 2.927 kg/kWh | 2.927 kg/kWh | 0.303 kg/kWh |

OEM design point gland stm flows:

| source | kg/hr | kJ/kg | exit point |
|----------|--------|--------|------------|
| HP valve | 239.5 | 3400.8 | gland-c |
| HP inlet | 3704.0 | 3067.5 | dearator |
| HP exit | 4039.7 | 3067.5 | dearator |
| HP inlet | 965.24 | 3067.5 | #2 htr |
| HP exit | 1226.1 | 3067.5 | #2 htr |
| HP inlet | 74.843 | 3067.5 | gland-c |
| HP exit | 85.729 | 3067.5 | gland-c |
| IP inlet | 1650.2 | 3488.3 | dearator |
| IP inlet | 876.79 | 3488.3 | #2 htr |
| IP inlet | 113.85 | 3488.3 | gland-c |
| IP exit | 671.32 | 3013.8 | #2 htr |
| IP exit | 102.06 | 3013.8 | gland-c |
| IP-LPgsc | 499.06 | 3013.8 | gland-c |
| LP exit | 1139.4 | 2716.8 | cond |

| Sum: | dearator | #2 htr | gland-c | cond |
|-----------------|----------|--------|---------|---------------|
| mix flow | 9393.9 | 3739.4 | 1115.0 | 1139.4 kg/hr |
| mix enth | 3141.4 | 3156.5 | 3153.1 | 2716.8 kJ/kg |
| pipe-p | 3990 | 124.5 | 124.5 | 100.7 kpa-mcr |
| pipe-p | 3610 | 124.5 | 124.5 | 100.7 kpa-ecr |
| fraction | 0.0092 | 0.0037 | 0.0011 | 0.0011 |

| Shaft | HP-valve | HP-shaft | IP-shaft | LP-shaft | kg/hr |
|-----------------|----------|----------|----------|----------|-------|
| fraction | 0.0002 | 0.0099 | 0.0033 | 0.0011 | |

Fraction=flow/total-flow (1024313 kg/hr=284.5314 kg/s) **1E+06**

OEM design point bled stm flows:

| source | kg/hr | fraction | exit point |
|----------|---------|----------|------------|
| HPexh1 | 85435.0 | 0.08341 | #7 htr |
| IP-bled2 | 44314.6 | 0.04326 | #6 htr |
| IP-bled3 | 39875.3 | 0.03893 | #5 htr |
| IP-exh4 | 54040.1 | 0.05276 | #4-Dea |
| Lp-bled5 | 35494.1 | 0.03465 | #3 htr |
| LP-bled6 | 27488.6 | 0.02684 | #2 htr |
| LP-bled7 | 25852.5 | 0.02524 | |

OEM design point by-pass stm flows:

| source | kg/hr | fraction | exit point |
|----------|-------|----------|------------|
| Dea/bfw1 | 0 | 0 | Blr-SH |
| Dea/bfw1 | 0 | 0 | Reheater |
| IP exh8 | 3502 | 0.00342 | LP gsc |

Off-Design efficiency check

| location | design | $\delta\eta$ |
|----------|--------|--------------|
| #7htr | 0.990 | 0.00 |
| #6htr | 0.990 | 0.00 |
| #5htr | 0.990 | 0.00 |
| Dea | 0.997 | 0.00 |
| #3htr | 0.985 | 0.00 |
| #2htr | 0.992 | 0.00 |
| #1htr | 0.985 | 0.00 |