High Pressure Turbine Replacement- Proposed Design

	U1 Proposed Design Tests, Actual Cond Press,			U1 Proposed Des
	U1 92% HP	U1 92% HP	U1 92% HP	U1 92% HP
	VWO 6,750 kpph	VWO 6,900 kpph	VWO 6,975 kpph	VWO 7,100 kpph
Gross Power (Mw)	930.0	948.0	956.9	971.5
NTCHR (Btu/kwh)	7,874	7,784	7,889	7,859
Throttle flow (kpph)	**6,750**	**6,900**	**6,975**	**7,100**
Throttle press (psia)	2,412.2	2,412.2	2,412.2	2,512.2
Throttle temp (°F)	1,000	1,000	1,000	1,000
Hot Reheat temp (°F)	1,000	1,000	1,000	1,000
Reheater flow (kpph)	5,437.5	5,573.5	5,641.6	5,691.2
% Reheater press drop (%)	6	6	6	6
Reheater duty (MBtu/h)	1,178	1,193	1,199	1,241
High Pressure Turbine				
Efficiency (%)	92	92	92	92
Wheel power (Mw)	297.6	300.2	301.5	311.0
% Total Wheel power	31.6	31.2	31.1	31.6
Section press drop (psi)	1,748.9	1,734.4	1,727.1	1,818.7
1st stg shell press (psia)	1,982.9	1,982.9	1,982.9	2,065.1
1st stg press drop (psi)	356.9	356.9	356.9	371.7
4th stg ext press (psia)	1,133.1	1,133.1	1,133.1	1,180.1
4th stg ext enthalpy (Btu/lb)	1,370.9	1,370.9	1,370.9	1,368.1
Exhaust press (psia)	590.9	605.4	612.7	618.1
Exhaust enthalpy (Btu/lb)	1,301.2	1,303.6	1,304.8	1,299.2
Intermediat Pressure Turbine				
Efficiency (%)	91.19	91.20	91.19	91.29
Wheel power (Mw)	281.2	288.2	291.7	294.2
% Total Wheel power	29.8	30.0	30.1	29.9
8th stg bowl press (psia)	544.29	557.71	564.43	569.35
Section press drop (psi)	417.03	427.41	432.61	436.44
Exhaust press (psia)	127.26	130.3	131.8	132.91
Exhaust enthalpy (Btu/lb)	1,338.4	1,338.1	1,337.9	1,337.7
Low Pressure Turbines				
Wheel power (Mw)	363.8	372.4	376.8	379.4
% Total Wheel power	38.6	38.8	38.8	38.5
LPA exhaust press ("hg)	3.87	3.97	4.02	4.1
LPB exhaust press ("hg)	2.89	2.95	2.98	3.03
LPC exhaust press ("hg)	2.70	2.75	2.78	2.82

IP7010417

High Pressure Turbine Replacement- Proposed Design

	U1 Proposed Design Tests, Actual Cond Press,			U1 Proposed Des
	U1 92% HP	U1 92% HP	U1 92% HP	U1 92% HP
	VWO 6,750 kpph	VWO 6,900 kpph	VWO 6,975 kpph	VWO 7,100 kpph
Stage Bowl Flow				
HP 1st stg flow (lb/hr)	6,745,167	6,895,167	6,970,167	7,094,953
HP 2-5th stg flow (lb/hr)	6,673,102	6,823,102	6,898,101	7,019,684
HP 6-7th stg flow (lb/hr)	6,065,295	6,213,198	6,287,149	6,407,032
IP 8th stg flow (lb/hr)	5,440,262	5,576,177	5,644,312	5,694,166
IP 9-11th stg flow (lb/hr)	5,457,927	5,594,279	5,662,634	5,712,697
IP 12-14th stg flow (lb/hr)	5,198,294	5,325,950	5,389,914	5,436,715
LP 15th stg flow (lb/hr)	4,756,851	4,872,241	4,930,037	4,971,697
LP 16th stg flow (lb/hr)	4,619,791	4,730,801	4,786,389	4,826,339
LP 17-18th stg flow (lb/hr)	4,304,900	4,406,508	4,457,367	4,493,685
LPA 19th stg flow (lb/hr)	1,381,653	1,414,040	1,430,248	1,441,813
LPB 19th stg flow (lb/hr)	1,382,068	1,414,464	1,430,677	1,442,246
LPC 19th stg flow (lb/hr)	1,381,653	1,414,040	1,430,248	1,441,813
LPA 20th stg flow (lb/hr)	1,341,571	1,372,737	1,388,330	1,400,174
LPB 20th stg flow (lb/hr)	1,320,364	1,351,020	1,366,358	1,377,836
LPC 20th stg flow (lb/hr)	1,327,662	1,358,538	1,373,987	1,385,551
Stage Bowl Pressure				
HP 1st stg press (psia)	2339.83	2339.83	2339.83	2436.83
HP 2-5th stg press (psia)	1982.91	1982.91	1982.91	2065.11
HP 6-7th stg press (psia)	1133.09	1133.09	1133.09	1180.06
IP 8th stg press (psia)	544.29	557.71	564.43	569.35
IP 9-11th stg press (psia)	461.08	472.44	478.14	482.31
IP 12-14th stg press (psia)	254.93	261.09	264.18	266.44
LP 15th stg press (psia)	127.26	130.30	131.82	132.91
LP 16th stg press (psia)	66.86	68.44	69.23	69.79
LP 17-18th stg press (psia)	43.33	44.33	44.84	45.19
LPA 19th stg press (psia)	12.83	13.12	13.27	13.38
LPB 19th stg press (psia)	12.83	13.12	13.27	13.38
LPC 19th stg press (psia)	12.83	13.12	13.27	13.38
LPA 20th stg press (psia)	5.48	5.61	5.68	5.73
LPB 20th stg press (psia)	6.11	6.25	6.32	6.38
LPC 20th stg press (psia)	5.86	6.00	6.07	6.12
Stage Press Drop				
HP 1st stg press drop (psi)	356.92	356.92	356.92	371.72
HP 2-5th stg press drop (psi)	849.82	849.82	849.82	885.05
HP 6-7th stg press drop (psi)	542.19	527.69	520.39	561.96
IP 8th stg press drop (psi)	83.21	85.27	86.29	87.04
IP 9-11th stg press drop (psi)	206.15	211.35	213.96	215.87
IP 12-14th stg press drop (psi)	127.67	130.79	132.36	133.53
LP 15th stg press drop (psi)	60.40	61.86	62.59	63.12
LP 16th stg press drop (psi)	23.53	24.11	24.39	24.60
LP 17-18th stg press drop (psi)	30.50	31.21	31.57	31.81
LPA 19th stg press drop (psi)	7.35	7.51	7.59	7.65
LPB 19th stg press drop (psi)	6.72	6.87	6.95	7.00
LPC 19th stg press drop (psi)	6.97	7.12	7.20	7.26
LPA 20th stg press drop (psi)	3.58	3.66	3.71	3.72
LPB 20th stg press drop (psi)	4.69	4.80	4.86	4.89
LPC 20th stg press drop (psi)	4.53	4.65	4.71	4.73

IP7010418

High Pressure Turbine Replacement- Proposed Design

11/10/00	U2 Proposed Design Tests, Actual Cond Press			U2 Proposed Des
	U2 92% HP	U2 92% HP	U2 92% HP	U2 92% HP
	VWO 6,750 kpph	VWO 6,900 kpph	VWO 6,975 kpph	VWO 7,100 kpph
Gross Power (Mw)	960.7	979.6	989.1	1004.0
NTCHR (Btu/kwh)	7,637	7,644	7,647	7,630
Throttle flow (kpph)	**6,750**	**6,900**	**6,975**	**7,100**
Throttle press (psia)	2,412.2	2,412.2	2,412.2	2,487.2
Throttle temp (°F)	1,000	1,000	1,000	1,000
Hot Reheat temp (°F)	1,000	1,000	1,000	1,000
Reheater flow (kpph)	5,483.3	5,619.8	5,688.2	5,758.4
% Reheater press drop (%)	7	7	7	7
Reheater duty (MBtu/h)	1,162	1,175	1,181	1,216
High Pressure Turbine				
Efficiency (%)	92	92	92	92
Wheel power (Mw)	293.2	295.8	297.0	303.9
% Total Wheel power	30.1	29.8	29.6	29.9
Section press drop (psi)	1,722.2	1,707.1	1,699.5	1,764.5
1st stg shell press (psia)	1,933.8	1,933.8	1,933.8	1,993.9
1st stg press drop (psi)	406.1	406.1	406.1	418.7
4th stg ext press (psia)	1,092.5	1,092.5	1,092.5	1,126.5
4th stg ext enthalpy (Btu/lb)	1,366.6	1,366.6	1,366.6	1,364.5
Exhaust press (psia)	617.6	632.7	640.3	648.1
Exhaust enthalpy (Btu/lb)	1,305.4	1,307.8	1,309.0	1,305.3
Intermediat Pressure Turbine				
Efficiency (%)	91.51	91.50	91.53	91.57
Wheel power (Mw)	285.3	292.3	295.8	299.4
% Total Wheel power	29.3	29.4	29.5	29.4
8th stg bowl press (psia)	562.85	576.66	583.58	590.69
Section press drop (psi)	428.76	439.39	444.71	450.21
Exhaust press (psia)	134.09	137.3	138.9	140.48
Exhaust enthalpy (Btu/lb)	1,337.0	1,336.6	1,336.4	1,336.2
Low Pressure Turbines				
Wheel power (Mw)	395.2	404.8	409.6	414.2
% Total Wheel power	40.6	40.8	40.9	40.7
LPA exhaust press ("hg)	3.87	3.97	4.02	4.1
LPB exhaust press ("hg)	2.89	2.95	2.98	3.03
LPC exhaust press ("hg)	2.7	2.75	2.78	2.82

IP7010419

High Pressure Turbine Replacement- Proposed Design

11/10/00	U2 Proposed Design Tests, Actual Cond Press			U2 Proposed Des
	U2 92% HP	U2 92% HP	U2 92% HP	U2 92% HP
	VWO 6,750 kpph	VWO 6,900 kpph	VWO 6,975 kpph	VWO 7,100 kpph
Stage Bowl Flow				
HP 1st stg flow (lb/hr)	6,745,170	6,895,170	6,970,170	7,095,009
HP 2-5th stg flow (lb/hr)	6,670,921	6,820,920	6,895,920	7,018,286
HP 6-7th stg flow (lb/hr)	6,088,214	6,246,676	6,326,205	6,410,021
IP 8th stg flow (lb/hr)	5,485,891	5,622,347	5,690,761	5,761,059
IP 9-11th stg flow (lb/hr)	5,503,740	5,640,636	5,709,270	5,779,831
IP 12-14th stg flow (lb/hr)	5,245,250	5,373,467	5,437,717	5,503,726
LP 15th stg flow (lb/hr)	4,781,324	4,896,783	4,954,618	5,013,460
LP 16th stg flow (lb/hr)	4,638,685	4,749,598	4,805,140	4,861,555
LP 17-18th stg flow (lb/hr)	4,318,844	4,420,239	4,470,991	4,522,359
LPA 19th stg flow (lb/hr)	1,382,924	1,415,155	1,431,285	1,447,604
LPB 19th stg flow (lb/hr)	1,383,339	1,415,580	1,431,714	1,448,038
LPC 19th stg flow (lb/hr)	1,382,924	1,415,155	1,431,285	1,447,604
LPA 20th stg flow (lb/hr)	1,335,261	1,366,242	1,381,732	1,398,026
LPB 20th stg flow (lb/hr)	1,328,292	1,359,030	1,374,399	1,390,390
LPC 20th stg flow (lb/hr)	1,332,324	1,363,194	1,378,628	1,394,689
Stage Bowl Pressure				
HP 1st stg press (psia)	2339.83	2339.83	2339.83	2412.58
HP 2-5th stg press (psia)	1933.75	1933.75	1933.75	1993.87
HP 6-7th stg press (psia)	1092.51	1092.51	1092.51	1126.48
IP 8th stg press (psia)	562.85	576.66	583.58	590.69
IP 9-11th stg press (psia)	452.05	463.14	468.70	474.41
IP 12-14th stg press (psia)	254.12	260.23	263.30	266.44
LP 15th stg press (psia)	134.09	137.27	138.87	140.48
LP 16th stg press (psia)	67.36	68.94	69.73	70.54
LP 17-18th stg press (psia)	44.03	45.05	45.55	46.06
LPA 19th stg press (psia)	12.84	13.13	13.28	13.43
LPB 19th stg press (psia)	12.84	13.13	13.28	13.43
LPC 19th stg press (psia)	12.84	13.13	13.28	13.43
LPA 20th stg press (psia)	5.66	5.79	5.86	5.93
LPB 20th stg press (psia)	5.35	5.47	5.53	5.60
LPC 20th stg press (psia)	5.46	5.59	5.65	5.72
Stage Press Drop				
HP 1st stg press drop (psi)	406.08	406.08	406.08	418.71
HP 2-5th stg press drop (psi)	841.24	841.24	841.24	867.39
HP 6-7th stg press drop (psi)	474.91	459.81	452.21	478.38
IP 8th stg press drop (psi)	110.80	113.52	114.88	116.28
IP 9-11th stg press drop (psi)	197.93	202.91	205.40	207.97
IP 12-14th stg press drop (psi)	120.03	122.96	124.43	125.96
LP 15th stg press drop (psi)	66.73	68.33	69.14	69.94
LP 16th stg press drop (psi)	23.33	23.89	24.18	24.48
LP 17-18th stg press drop (psi)	31.19	31.92	32.27	32.63
LPA 19th stg press drop (psi)	7.18	7.34	7.42	7.50
LPB 19th stg press drop (psi)	7.49	7.66	7.75	7.83
LPC 19th stg press drop (psi)	7.38	7.54	7.63	7.71
LPA 20th stg press drop (psi)	3.76	3.84	3.88	3.92
LPB 20th stg press drop (psi)	3.93	4.02	4.07	4.11
LPC 20th stg press drop (psi)	4.13	4.24	4.28	4.33

IP7010420

High Pressure Turbine Repl 11/10/00

ign Tests, Actual Cond Press,

	U1 92 % HP VWO 910 MW	U1 92 % HP VWO 930 MW
Gross Power (Mw)	**910.0**	**930.0**
NTCHR (Btu/kwh)	7,865	7,874
Throttle flow (kpph)	6,585	6,750
Throttle press (psia)	2,412.2	2,412.2
Throttle temp (°F)	1,000	1,000
Hot Reheat temp (°F)	1,000	1,000
Reheater flow (kpph)	5,288.1	5,437.3
% Reheater press drop (%)	6	6
Reheater duty (MBtu/h)	1,162	1,178
<u>High Pressure Turbine</u>		
Efficiency (%)	92	92
Wheel power (Mw)	294.6	297.6
% Total Wheel power	31.9	31.6
Section press drop (psi)	1,765.0	1,749.0
1st stg shell press (psia)	1,982.9	1,982.9
1st stg press drop (psi)	356.9	356.9
4th stg ext press (psia)	1,133.1	1,133.1
4th stg ext enthalpy (Btu/lb)	1,371.0	1,370.9
Exhaust press (psia)	574.8	590.84
Exhaust enthalpy (Btu/lb)	1,298.5	1,301.2
<u>Intermediat Pressure Turbine</u>		
Efficiency (%)	91.19	91.19
Wheel power (Mw)	273.6	281.2
% Total Wheel power	29.7	29.8
8th stg bowl press (psia)	529.53	544.28
Section press drop (psi)	405.61	417.02
Exhaust press (psia)	123.92	127.3
Exhaust enthalpy (Btu/lb)	1,338.8	1,338.4
<u>Low Pressure Turbines</u>		
Wheel power (Mw)	354.2	363.8
% Total Wheel power	38.4	38.6
LPA exhaust press ("hg)	3.78	3.87
LPB exhaust press ("hg)	2.83	2.89
LPC exhaust press ("hg)	2.64	2.70

How are we going to test if unit can operate there?

U1 930
28

U2
28 960/(58) 930

IP7010421

High Pressure Turbine Repl 11/10/00

	ign Tests, Actual Cond Press,	
	U1 92 % HP	U1 92 % HP
	VWO 910 MW	VWO 930 MW
Stage Bowl Flow		
HP 1st stg flow (lb/hr)	6,579,683	6,744,998
HP 2-5th stg flow (lb/hr)	6,507,617	6,672,932
HP 6-7th stg flow (lb/hr)	5,902,124	6,065,128
IP 8th stg flow (lb/hr)	5,290,875	5,440,108
IP 9-11th stg flow (lb/hr)	5,308,060	5,457,773
IP 12-14th stg flow (lb/hr)	5,057,887	5,198,150
LP 15th stg flow (lb/hr)	4,629,856	4,756,720
LP 16th stg flow (lb/hr)	4,497,571	4,619,666
LP 17-18th stg flow (lb/hr)	4,192,956	4,304,784
LPA 19th stg flow (lb/hr)	1,345,973	1,381,617
LPB 19th stg flow (lb/hr)	1,346,377	1,382,031
LPC 19th stg flow (lb/hr)	1,345,973	1,381,617
LPA 20th stg flow (lb/hr)	1,307,409	1,341,541
LPB 20th stg flow (lb/hr)	1,286,760	1,320,334
LPC 20th stg flow (lb/hr)	1,293,817	1,327,632
Stage Bowl Pressure		
HP 1st stg press (psia)	2339.83	2339.83
HP 2-5th stg press (psia)	1982.91	1982.91
HP 6-7th stg press (psia)	1133.09	1133.09
IP 8th stg press (psia)	529.53	544.28
IP 9-11th stg press (psia)	448.58	461.07
IP 12-14th stg press (psia)	248.15	254.93
LP 15th stg press (psia)	123.92	127.26
LP 16th stg press (psia)	65.12	66.86
LP 17-18th stg press (psia)	42.23	43.33
LPA 19th stg press (psia)	12.51	12.83
LPB 19th stg press (psia)	12.51	12.83
LPC 19th stg press (psia)	12.51	12.83
LPA 20th stg press (psia)	5.34	5.48
LPB 20th stg press (psia)	5.95	6.11
LPC 20th stg press (psia)	5.71	5.86
Stage Press Drop		
HP 1st stg press drop (psi)	356.92	356.92
HP 2-5th stg press drop (psi)	849.82	849.82
HP 6-7th stg press drop (psi)	558.29	542.25
IP 8th stg press drop (psi)	80.95	83.21
IP 9-11th stg press drop (psi)	200.43	206.14
IP 12-14th stg press drop (psi)	124.23	127.67
LP 15th stg press drop (psi)	58.80	60.40
LP 16th stg press drop (psi)	22.89	23.53
LP 17-18th stg press drop (psi)	29.72	30.50
LPA 19th stg press drop (psi)	7.17	7.35
LPB 19th stg press drop (psi)	6.56	6.72
LPC 19th stg press drop (psi)	6.80	6.97
LPA 20th stg press drop (psi)	3.48	3.58
LPB 20th stg press drop (psi)	4.56	4.69
LPC 20th stg press drop (psi)	4.41	4.53

IP7010422

High Pressure Turbine Repl

11/10/00 ign Tests 11/10/00

	U2 92% HP VWO 910 MW	U2 92% HP VWO 930 MW
Gross Power (Mw)	**910.0**	**930.0**
NTCHR (Btu/kwh)	7,623	7,629
Throttle flow (kpph)	6,353	6,509
Throttle press (psia)	2,412.2	2,412.2
Throttle temp (°F)	1,000	1,000
Hot Reheat temp (°F)	1,000	1,000
Reheater flow (kpph)	5,124.5	5,265.4
% Reheater press drop (%)	7	7
Reheater duty (MBtu/h)	1,124	1,139
High Pressure Turbine		
Efficiency (%)	92	92
Wheel power (Mw)	285.7	288.8
% Total Wheel power	31.0	30.6
Section press drop (psi)	1,762.1	1,746.4
1st stg shell press (psia)	1,933.8	1,933.8
1st stg press drop (psi)	406.1	406.1
4th stg ext press (psia)	1,092.5	1,092.5
4th stg ext enthalpy (Btu/lb)	1,366.7	1,366.7
Exhaust press (psia)	577.7	593.4
Exhaust enthalpy (Btu/lb)	1,298.9	1,301.5
Intermediat Pressure Turbine		
Efficiency (%)	91.5	91.50
Wheel power (Mw)	266.9	274.1
% Total Wheel power	28.9	29.1
8th stg bowl press (psia)	526.52	540.79
Section press drop (psi)	401.45	411.79
Exhaust press (psia)	125.07	129.0
Exhaust enthalpy (Btu/lb)	1,338.0	1,337.6
Low Pressure Turbines		
Wheel power (Mw)	369.8	379.8
% Total Wheel power	40.1	40.3
LPA exhaust press ("hg)	3.64	3.73
LPB exhaust press ("hg)	2.74	2.80
LPC exhaust press ("hg)	2.56	2.62

IP7010423

High Pressure Turbine Repl

11/10/00 ign Tests 11/10/00

	U2 92% HP VWO 910 MW	U2 92% HP VWO 930 MW
Stage Bowl Flow		
HP 1st stg flow (lb/hr)	6,348,256	6,504,572
HP 2-5th stg flow (lb/hr)	6,274,008	6,430,324
HP 6-7th stg flow (lb/hr)	5,672,828	5,835,760
IP 8th stg flow (lb/hr)	5,127,271	5,268,111
IP 9-11th stg flow (lb/hr)	5,143,964	5,285,258
IP 12-14th stg flow (lb/hr)	4,907,866	5,040,440
LP 15th stg flow (lb/hr)	4,477,224	4,596,773
LP 16th stg flow (lb/hr)	4,346,368	4,461,319
LP 17-18th stg flow (lb/hr)	4,051,310	4,156,570
LPA 19th stg flow (lb/hr)	1,297,859	1,331,336
LPB 19th stg flow (lb/hr)	1,247,407	1,331,735
LPC 19th stg flow (lb/hr)	1,297,859	1,331,336
LPA 20th stg flow (lb/hr)	1,253,734	1,285,875
LPB 20th stg flow (lb/hr)	1,247,407	1,279,296
LPC 20th stg flow (lb/hr)	1,251,100	1,283,121
Stage Bowl Pressure		
HP 1st stg press (psia)	2339.83	2339.83
HP 2-5th stg press (psia)	1933.75	1933.75
HP 6-7th stg press (psia)	1092.51	1092.51
IP 8th stg press (psia)	526.52	540.79
IP 9-11th stg press (psia)	422.87	434.34
IP 12-14th stg press (psia)	238.02	244.35
LP 15th stg press (psia)	125.07	129.00
LP 16th stg press (psia)	63.18	64.83
LP 17-18th stg press (psia)	41.36	42.41
LPA 19th stg press (psia)	12.07	12.37
LPB 19th stg press (psia)	12.07	12.37
LPC 19th stg press (psia)	12.07	12.37
LPA 20th stg press (psia)	5.31	5.44
LPB 20th stg press (psia)	5.02	5.15
LPC 20th stg press (psia)	5.12	5.25
Stage Press Drop		
HP 1st stg press drop (psi)	406.08	406.08
HP 2-5th stg press drop (psi)	841.24	841.24
HP 6-7th stg press drop (psi)	514.81	499.11
IP 8th stg press drop (psi)	103.65	106.45
IP 9-11th stg press drop (psi)	184.85	189.99
IP 12-14th stg press drop (psi)	112.95	115.35
LP 15th stg press drop (psi)	61.89	64.17
LP 16th stg press drop (psi)	21.82	22.42
LP 17-18th stg press drop (psi)	29.29	30.04
LPA 19th stg press drop (psi)	6.76	6.93
LPB 19th stg press drop (psi)	7.05	7.22
LPC 19th stg press drop (psi)	6.95	7.12
LPA 20th stg press drop (psi)	3.52	3.61
LPB 20th stg press drop (psi)	3.67	3.77
LPC 20th stg press drop (psi)	3.86	3.96

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