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NYSEG - SENECA COMPRESSED AIR ENERGY STORAGE PROJECT

Dresser Rand (Cycle 1) Generation and Compression Cycle Summary

Generation Cycle Data, 1 x 138 MW Air Expander

Item	Description	Max Generation	75% Load	50% Load	25% Load	10% Load	Remarks
1	Gross Power Output, kW	137,867	103,401	68,934	34,467	14,045	From Dresser Rand data dated 8/24/2011
2	Plant Auxiliary Power Requirements, kW	2,065	1,847	1,614	1,356	1,071	Incl. transformers, cooling tower, pumps, etc.
3	Net Power Output to Grid, kW	135,802	101,554	67,320	33,111	12,974	Power sent to grid.
4	Average Mass Flow Rate, lbs/hr	1,440,021	1,131,931	818,384	521,865	305,998	Between 1150 - 1500 psig Cavern pressure. Flowrate based on 92 deg F recuperator air inlet temperature.
5	Net Generation Specific Air Consumption, lbs/kW-hr	10.60	11.15	12.16	15.76	23.59	- Ditto -
6	Fuel Consumption HHV, MMBTU/hr	589	446	304	158	67	HHV/LHV Ratio = 1.109
7	Net Heat Rate, BTU/kW-hr - HHV	4,335	4,396	4,512	4,775	5,152	
8	Total Hours of Generation	12.36	15.73	21.75	34.11	58.17	Time until cavern is depleted for the given generation.
9	Net Energy Ratio @ 45 deg F Ambient	0.77	0.81	0.88	1.15	1.72	
10	Net Energy Ratio @ -2 deg F Ambient	0.72	0.76	0.83	1.08	1.61	
11	Net Energy Ratio @ 87 deg F Ambient	0.82	0.86	0.94	1.22	1.82	Based on 170 MW Compression
12	**Total Usable Air Storage in Cavern @ 1500 psig, lbs**	**17,800,000**					Usable air mass between 1500 and 1150 psig (125 to 85 deg F respectively).
13	Emissions (after control)						
	NOx, lbs/hr	4.66	3.69	2.69	1.73	1.14	From DR document StartupEmissions-10MinStart 5-25-11. Corrected to 2 ppmvd. 10% Load lbs/hr values estimated from 25% load values.
	NOx, lbs/MW-hr (Net)	0.034	0.036	0.040	0.052	0.088	
	CO_2, lbs/hr	73,715	55,877	37,962	19,696	9,153	From DR document, Gen Performance Tab. 5-20-2011. 10% Load lbs/hr values prorated from 25% load values.
	CO_2, lbs/MW-hr (Net)	543	550	564	595	705	
14	Additional Consumption Rates						
	19% Aqueous NH3, lbs/hr	290	228	166	106	69	2 ppmVd@15% O2 NOx at Stack, 5 ppm NH3 slip. NH3 lbs/hr values prorated from 25% load.
	19% Aqueous NH3, lbs/MW-hr	2.13	2.25	2.47	3.20	5.32	
	Demin Water, lbs/hr	10,127	7,677	5,224	2,718	0	From Dresser Rand data dated 8/24/2011
	Demin Water, lbs/MW-hr	74.57	75.60	77.59	82.09	0	

Compression Cycle Data

Item	Description	45 deg F, 60% RH		-2 deg F, 60% RH	87 deg F, 46% RH	Remarks
		110 MW Compression	170 MW Compression	170 MW Compression	170 MW Compression	
1	Compression Power, kW	110,000	168,202	168,000	168,000	From Dresser Rand Proposal, 1 x40%, 1 x 60% compressors
2	Plant Auxiliary Power Requirements, kW	2,033	2,890	2,683	3,303	Incl. transformers, cooling tower, pumps, etc.
3	Total Power Required, kW	112,033	171,092	170,683	171,303	Total power required from grid for compression cycle.
4	Average Mass Flow Rate, lbs/hr	1,549,296	2,350,656	2,499,552	2,217,600	Between 1150 - 1500 psig Cavern pressure. Flow adjusted for average and low ambient from 87 deg F ambient data.
5	Average Net Compression Specific Air Consumption, lbs/kW-hr	13.83	13.74	14.64	12.95	- Ditto -
6	Total Hours of Compression	11.49	7.57	7.12	8.03	Time required to bring cavern from 1150 to 1500 psig.

Notes:

1. Plant load percentage based on Max Generation as 100% Load Point.
2. Minimum air expander load is 10% for emission compliance based on Dresser Rand email dated 10/3/2011.
3. Compression flow rates estimated from 87 deg F ambient temperature data.
4. All generation data is valid for all ambient conditions unless specified otherwise, and a recuperator inlet air temperature of 92 deg F.

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NYSEG - SENECA COMPRESSED AIR ENERGY STORGE PROJECT

Dresser Rand (Cycle 1A-210 MW Option) Generation and Compression Cycle Summary

Generation Cycle Data, 2 x 105 MW Air Expander Trains (One HP and LP Expander per Train)

		DUAL TRAIN OPERATION					SINGLE TRAIN OPERATION			
Item	Description	Max Generation	75% Load	50% Load	25% Load	Min Load (16%)	50% Load	25% Load	Min Load (8%)	Remarks
1	Air Expander Power Output, each, kW	106,450	79,838	53,225	26,613	16,254	106,450	53,225	16,254	From Dresser Rand data dated 10/21/2011
2	Air Expanders Operating	2	2	2	2	2	1	1	1	
3	Gross Plant Power Output, kW	212,900	159,675	106,450	53,225	32,508	106,450	53,225	16,254	From Dresser Rand data dated 10/21/2011
4	Plant Auxiliary Power Requirements, kW	2,956	2,645	2,313	1,943	1,793	2,292	1,939	1,641	Incl. transformers, cooling tower, pumps, etc.
5	**Net Plant Power Output to Grid, kW**	**209,944**	**157,030**	**104,137**	**51,282**	**30,715**	104,158	51,286	14,613	Power sent to grid.
6	Total Average Mass Flow Rate, lbs/hr	2,226,295	1,757,543	1,321,896	856,923	633,613	1,113,148	660,948	316,807	Between 1150 - 1500 psig Cavern pressure. Flowrate based on 100 deg F recuperator inlet air temperature.
7	Net Generation Specific Air Consumption, lbs/kW-hr	10.60	11.19	12.69	16.71	20.63	11	13	22	- Ditto -
8	Total Fuel Consumption HHV, MMBTU/hr	919	699	475	241	153	459	238	76	HHV/LHV Ratio = 1.109
9	Net Heat Rate, BTU/kW-hr - HHV	4,376	4,450	4,565	4,692	4,968	4,410	4,635	5,221	
10	Total Hours of Generation	8.00	10.13	13.47	20.77	28.09	16	27	56	Time until cavern is depleted for the given generation.
11	Net Energy Ratio @ 45 deg F Ambient (1 x 170 MW Compressor)	0.75	0.79	0.90	1.18	1.45	1	1	2	
12	**Total Usable Air Storage in Cavern @ 1500 psig, lbs**	**17,800,000**								Usable air mass between 1500 and 1150 psig (125 to 85 deg F respectively).
13	Total Emissions (after control)									
	NOx, lbs/hr	7.30	5.76	4.32	2.79	2.16	4	2	1	From DR provided data
	NOx, lbs/MW-hr (Net)	0.035	0.037	0.042	0.054	0.070	0	0	0	Calculated
	CO_2, lbs/hr	108,860	82,799	56,335	28,514	18,082	54,430	28,167	9,041	Calculated, Assumed pure CH4, Fuel LHV: 20,949 BTU/lb
	CO_2, lbs/MW-hr (Net)	519	527	541	556	589	523	549	619	
14	Additional Consumption Rates									
	19% Aqueous NH3, lbs/hr	453	357	268	245	157	226	134	79	2 ppmVd@15% O2 NOx at Stack, 5 ppm NH3 slip. NH3 lbs/hr values provided by DR.
	19% Aqueous NH3, lbs/MW-hr	2.16	2.27	2.57	4.77	5.13	2	3	5	
	Demin Water, lbs/hr	15,444	11,750	8,179	0	0	7,534	3,900	0	From Dresser Rand data dated 10/21/2011
	Demin Water, lbs/MW-hr	73.56	74.83	78.54	0.00	0.00	72.33	76.04	0.00	

Compression Cycle Data

Item	Description	45 deg F, 60% RH, 170 MW Total Compression		Remarks
		2 x 50% Compressors	1 x 100% Compressor	
1	Number of Operating Compressors	2.00	1	
2	Compressor Size, each, kW	85000.00	170,000	Nominal Compressor(s) Size
3	Total Compression Power, kW	168000.00	168,300	From Dresser Rand Proposal
4	Plant Auxiliary Power Requirements, kW	2890.00	3,060	Incl. transformers, cooling tower, pumps, etc.
5	Total Power Required, kW	170890.00	171,360	Total power required from grid for compression cycle.
6	Total Average Mass Flow Rate, lbs/hr	2294756.00	2,430,000	Between 1150 - 1500 psig Cavern pressure.
7	Average Net Compression Specific Air Consumption, lbs/kW-hr	13.43	14.18	- Ditto -
8	Total Hours of Compression	7.76	7.33	Time required to bring cavern from 1150 to 1500 psig.

Notes:

1. Plant load percentage based on Max Generation as 100% Load Point.
2. Compression flow rates provided by Dresser Rand.
3. All generation data is valid for all ambient conditions unless specified otherwise, and a recuperator inlet air temperature of 100 deg F.
4. Min Load points are within emission compliance based on Dresser Rand email dated 10/3/2011.
5. All strikethrough data not updated from Rev A.

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NYSEG - SENECA COMPRESSED AIR ENERGY STORAGE PROJECT

Energy Storage and Power (Cycle 2) Generation and Compression Cycle Summary

Generation Cycle Data, 45 deg F, 60% RH

Item	Description	210 MW (100% Load)	75% Load	50% Load	25% Load	Remarks
1	Gross Power Output, kW	212,092	159,353	106,354	53,940	Data based on ESP Cycle parameters
2	Plant Auxiliary Power Requirements, kW	2,225	1,940	1,635	1,296	Incl. transformers, cooling tower, pumps, etc.
3	Net Power Output to Grid, kW	209,867	157,413	104,719	52,644	Power sent to grid.
4	Average Mass Flow Rate, lbs/hr	2,125,800	1,631,880	936,000	187,200	Between 1150 - 1500 psig Cavern pressure.
5	Net Generation Specific Air Consumption, lbs/kW-hr	10.13	10.37	8.94	3.56	- Ditto -
6	Fuel Consumption HHV, MMBTU/hr	895	699	647	647	HHV/LHV Ratio = 1.109
7	Net Heat Rate, BTU/kW-hr - HHV	4,267	4,439	6,181	12,294	
8	Total Hours of Generation	8.37	10.91	19.02	95.09	Time until cavern is depleted for the given generation.
9	Net Energy Ratio	0.74	0.75	0.65	0.26	Based on 170 MW Compression
10	**Total Usable Air Storage in Cavern @ 1500 psig, lbs**	**17,800,000**				Usable air mass between 1500 and 1150 psig (125 to 85 deg F respectively).
11	Emissions (after control)					
	NOx, lbs/hr	6.48	5.05	4.68	4.68	Calculated from GE provided emission rates.
	NOx, lbs/MW-hr (Net)	0.031	0.032	0.045	0.089	
	CO_2, lbs/hr	103,840	81,039	75,065	75,065	
	CO_2, lbs/MW-hr (Net)	495	515	717	1,426	
12	Additional Consumption Rates					
	19% Aqueous NH3, lbs/hr	90	70	65	65	Based on 2 ppmVd@15% O2 NOx at Stack
	19% Aqueous NH3, lbs/MW-hr	0.43	0.45	0.62	1.24	
	Demin Water, lbs/hr	0	0	0	0	N/A for CAES 2 Plant
	Demin Water, lbs/MW-hr	0.00	0.00	0.00	0.00	

Compression Cycle Data

Item	Description	145 MW Compression	170 MW Compression	Remarks
1	Compression Power, kW	145,000	168,000	From Man Turbo Proposal
2	Plant Auxiliary Power Requirements, kW	2,544	2,890	Incl. transformers, cooling tower, pumps, etc.
3	Total Power Required, kW	147,544	170,890	Total power required from grid for compression cycle.
4	Average Mass Flow Rate, lbs/hr	2,061,000	2,350,800	Between 1150 - 1500 psig Cavern pressure. Based on 45 deg F ambient air. Flow based on Man Turbo charts.
5	Average Net Compression Specific Air Consumption, lbs/kW-hr	13.97	13.76	- Ditto -
6	Total Hours of Compression	8.64	7.57	Time required to bring cavern from 1150 to 1500 psig.

Notes:

1. Plant load percentage based on 210 MW as 100% Load Point. Maximum theoretical net generation is 227 MW.
2. Minimum gas turbine load is 50% for emission compliance,
3. Operation of plant load below 40% may be undesirable due to the following reasons. Man Turbo needs to verify minimum feasible operating load.
    a. Both the gas/air temperatures across the recuperator increases significantly due to less heat extracted from gas turbine exhaust.
    b. The high gas side temperature may negatively impact the design, operation and life of the recuperator and catalysts.
4. All data is valid for 45 deg F ambient temperature and 60% RH
5. Data based on air expander inlet pressure of 1085 psia, and recuperator air inlet temperature of 100 deg F. Air expander assumed to operate on nozzle control.

NYSEG - SENECA COMPRESSED AIR ENERGY STORAGE PROJECT

Energy Storage and Power (Cycle 2) Generation and Compression Cycle Summary

Generation Cycle Data, 87 deg F, 46% RH

Item	Description	210 MW (100% Load)	75% Load	50% Load	25% Load	Remarks
1	Gross Power Output, kW	212,159	159,327	106,749	53,636	Data based on ESP Cycle parameters
2	Plant Auxiliary Power Requirements, kW	2,225	1,940	1,635	1,296	Incl. transformers, cooling tower, pumps, etc.
3	Net Power Output to Grid, kW	209,934	157,387	105,114	52,340	Power sent to grid.
4	Average Mass Flow Rate, lbs/hr	2,171,520	1,605,600	871,200	111,600	Between 1150 - 1500 psig Cavern pressure.
5	Net Generation Specific Air Consumption, lbs/kW-hr	10.34	10.20	8.29	2.13	- Ditto -
6	Fuel Consumption HHV, MMBTU/hr	872	687	672	672	HHV/LHV Ratio = 1.109
7	Net Heat Rate, BTU/kW-hr - HHV	4,152	4,368	6,390	12,832	
8	Total Hours of Generation	8.20	11.09	20.43	159.50	Time until cavern is depleted for the given generation.
9	Net Energy Ratio	0.78	0.77	0.63	0.16	Based on 170 MW Compression
10	**Total Usable Air Storage in Cavern @ 1500 psig, lbs**	**17,800,000**				Usable air mass between 1500 and 1150 psig (125 to 85 deg F respectively).
11	Emissions (after control)					
	NOx, lbs/hr	6.30	4.98	4.86	4.86	Calculated from GE provided emission rates.
	NOx, lbs/MW-hr (Net)	0.030	0.032	0.046	0.093	
	CO_2, lbs/hr	101,123	79,718	77,870	77,870	
	CO_2, lbs/MW-hr (Net)	482	507	741	1,488	
12	Additional Consumption Rates					
	19% Aqueous NH3, lbs/hr	88	69	68	68	Based on 2 ppmVd@15% O2 NOx at Stack
	19% Aqueous NH3, lbs/MW-hr	0.42	0.44	0.64	1.29	
	Demin Water, lbs/hr	0	0	0	0	N/A for CAES 2 Plant
	Demin Water, lbs/MW-hr	0.00	0.00	0.00	0.00	

Compression Cycle Data

Item	Description	145 MW Compression	170 MW Compression	Remarks
1	Compression Power, kW	145,000	168,000	From Man Turbo Proposal
2	Plant Auxiliary Power Requirements, kW	2,909	3,303	Incl. transformers, cooling tower, pumps, etc.
3	Total Power Required, kW	147,909	171,303	Total power required from grid for compression cycle.
4	Average Mass Flow Rate, lbs/hr	1,990,800	2,268,000	Between 1150 - 1500 psig Cavern pressure. Based on 87 deg F ambient air. Flow based on Man Turbo charts.
5	Average Net Compression Specific Air Consumption, lbs/kW-hr	13.46	13.24	- Ditto -
6	Total Hours of Compression	8.94	7.85	Time required to bring cavern from 1150 to 1500 psig.

Notes:

1. Plant load percentage based on 210 MW as 100% Load Point.
2. Minimum gas turbine load is 65% for emission compliance.
3. Operation of plant load below 40% may be undesirable due to the following reasons. Man Turbo needs to verify minimum feasible operating load.
   a. Both the gas/air temperatures across the recuperator increases significantly due to less heat extracted from gas turbine exhaust.
   b. The high gas side temperature may negatively impact the design, operation and life of the recuperator and catalysts.
4. All data is valid for 87 deg F ambient temperature and 46% RH
5. Data based on air expander inlet pressure of 1085 psia, and recuperator air inlet temperature of 100 deg F. Air expander assumed to operate on nozzle control.

NYSEG - SENECA COMPRESSED AIR ENERGY STORAGE PROJECT

Energy Storage and Power (Cycle 2) Generation and Compression Cycle Summary

Generation Cycle Data, -2 deg F, 50% RH

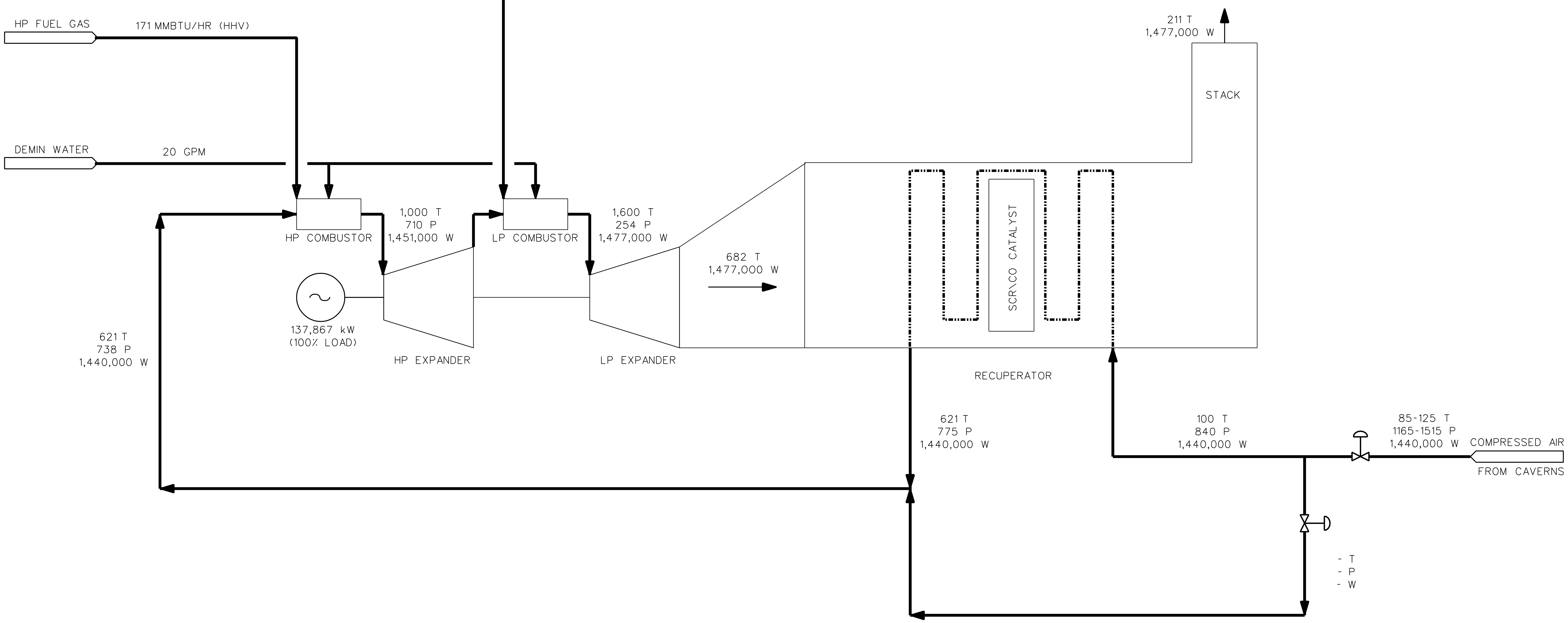
Item	Description	210 MW (100% Load)	75% Load	50% Load	25% Load	Remarks
1	Gross Power Output, kW	212,110	159,485	106,353	53,874	Data based on ESP Cycle parameters
2	Plant Auxiliary Power Requirements, kW	2,225	1,940	1,635	1,296	Incl. transformers, cooling tower, pumps, etc.
3	Net Power Output to Grid, kW	209,885	157,545	104,718	52,578	Power sent to grid.
4	Average Mass Flow Rate, lbs/hr	2,128,680	1,641,240	864,000	108,000	Between 1150 - 1500 psig Cavern pressure.
5	Net Generation Specific Air Consumption, lbs/kW-hr	10.14	10.42	8.25	2.05	- Ditto -
6	Fuel Consumption HHV, MMBTU/hr	920	719	704	704	HHV/LHV Ratio = 1.109
7	Net Heat Rate, BTU/kW-hr - HHV	4,383	4,564	6,722	13,388	
8	Total Hours of Generation	8.36	10.85	20.60	164.81	Time until cavern is depleted for the given generation.
9	Net Energy Ratio	0.70	0.72	0.57	0.14	Based on 170 MW Compression
10	**Total Usable Air Storage in Cavern @ 1500 psig, lbs**	**17,800,000**				Usable air mass between 1500 and 1150 psig (125 to 85 deg F respectively).
11	Emissions (after control)					
	NOx, lbs/hr	6.65	5.20	5.09	5.09	Calculated from GE provided emission rates.
	NOx, lbs/MW-hr (Net)	0.032	0.033	0.049	0.097	
	CO_2, lbs/hr	106,645	83,384	81,604	81,604	
	CO_2, lbs/MW-hr (Net)	508	529	779	1,552	
12	Additional Consumption Rates					
	19% Aqueous NH3, lbs/hr	93	73	71	71	Based on 2 ppmVd@15% O2 NOx at Stack
	19% Aqueous NH3, lbs/MW-hr	0.44	0.46	0.68	1.35	
	Demin Water, lbs/hr	0	0	0	0	N/A for CAES 2 Plant
	Demin Water, lbs/MW-hr	0.00	0.00	0.00	0.00	

Compression Cycle Data

Item	Description	145 MW Compression	170 MW Compression	Remarks
1	Compression Power, kW	145,000	168,000	From Man Turbo Proposal
2	Plant Auxiliary Power Requirements, kW	2,362	2,683	Incl. transformers, cooling tower, pumps, etc.
3	Total Power Required, kW	147,362	170,683	Total power required from grid for compression cycle.
4	Average Mass Flow Rate, lbs/hr	2,158,842	2,462,400	Between 1150 - 1500 psig Cavern pressure. Flow rate estimated from Man Turbo provided data.
5	Average Net Compression Specific Air Consumption, lbs/kW-hr	14.65	14.43	- Ditto -
6	Total Hours of Compression	8.25	7.23	Time required to bring cavern from 1150 to 1500 psig.

Notes:

1. Plant load percentage based on 210 MW as 100% Load Point.
2. Minimum gas turbine load is 50% for emission compliance.
3. Operation of plant load below 40% may be undesirable due to the following reasons. Man Turbo needs to verify minimum feasible operating load.
   a. Both the gas/air temperatures across the recuperator increases significantly due to less heat extracted from gas turbine exhaust.
   b. The high gas side temperature may negatively impact the design, operation and life of the recuperator and catalysts.
4. All data is valid for -2 deg F ambient temperature and 50% RH. Compression flow rates estimated from MDT data supplied for other ambient temperatures.
5. Data based on air expander inlet pressure of 1085 psia, and recuperator air inlet temperature of 100 deg F. Air expander assumed to operate on nozzle control.



FOR HEAT AND MASS BALANCE PURPOSES ONLY

NOTES:

1. FOR MORE PERFORMANCE DETAILS SEE CYCLE 1 PERFORMANCE SUMMARY (CAES-1-LI-021-0006).
2. HEAT BALANCE DIAGRAM ONLY. VALVES AND LINES SHOWN ARE NOT NECESSARILY INDICATIVE OF DESIGN.
3. AVERAGE RECUPERATOR AIR INLET TEMP ASSUMED IS 100°F.
4. NOT USED
5. PERFORMANCE IS BASED ON NEW AND CLEAN CONDITION.

LEGEND

T	TEMPERATURE, F
P	PRESSURE, PSIA
W	MASS FLOW, LBS/HR
KWe	POWER, KILOWATTS ELECTRICAL

SYSTEM PERFORMANCE SUMMARY

AMBIENT TEMPERATURE:	45° F
RELATIVE HUMIDITY:	60%
SITE ELEVATION:	1,000 FT
GROSS POWER:	137,867 KW
AUX POWER:	2,065 KW
NET POWER:	135,802 KW
NET HEAT RATE HHV:	4,335 BTU/KW-HR
NET SP. AIR CONSUMP.:	10.60 LBS/KW-HR

REV	DATE	DESCRIPTION	DRAWN	CHECKED	LEAD DESIGNER	ENGINEER/TECH. SPEC.	LEAD DISC ENGINEER	PROJ ENGR MANAGER	PROJECT MANAGER
A	06 04 12	ISSUED FOR REVIEW AND COMMENT	JEV	KM	JEV	PMP	HGE		MH

PRELIMINARY STATUS DATE — REPRESENTS GENERAL DESIGN CONCEPTS BASED ON ASSUMPTIONS. REVIEWED NOT CHECKED.
LDE

APPROVED STATUS DATE — REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS.
LDE

ORIGINATING PERSONNEL

DRAWN BY: JEV
CHECKED BY: K. MUKHERJEE
LEAD DESIGNER: J.E. VEEN
ENGINEER/TECH SPECIALIST: P. PHIAMBOLIS
PROJECT ENGINEERING MANAGER:
PROJECT MANAGER: M. HOLDRIDGE

PROFESSIONAL ENGINEER'S SEAL

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF
PE: ____________ STATE: ________
LIC. NO.: __________ DATE: ________

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resources & energy

CLIENT/PROJECT TITLE
NYSEG
SENECA COMPRESSED AIR ENERGY STORAGE (CAES) PROJECT

HEAT AND MASS BALANCE DIAGRAM
CYCLE #1, AVERAGE AMBIENT OPERATION
45°F, 60% RH, 135 MW NET OUTPUT

SCALE: NONE
DRAWING SIZE: ARCH D (36" x 24")
WORLEYPARSONS DWG. NO.: CAES-1-HT-021-0159
REV: A

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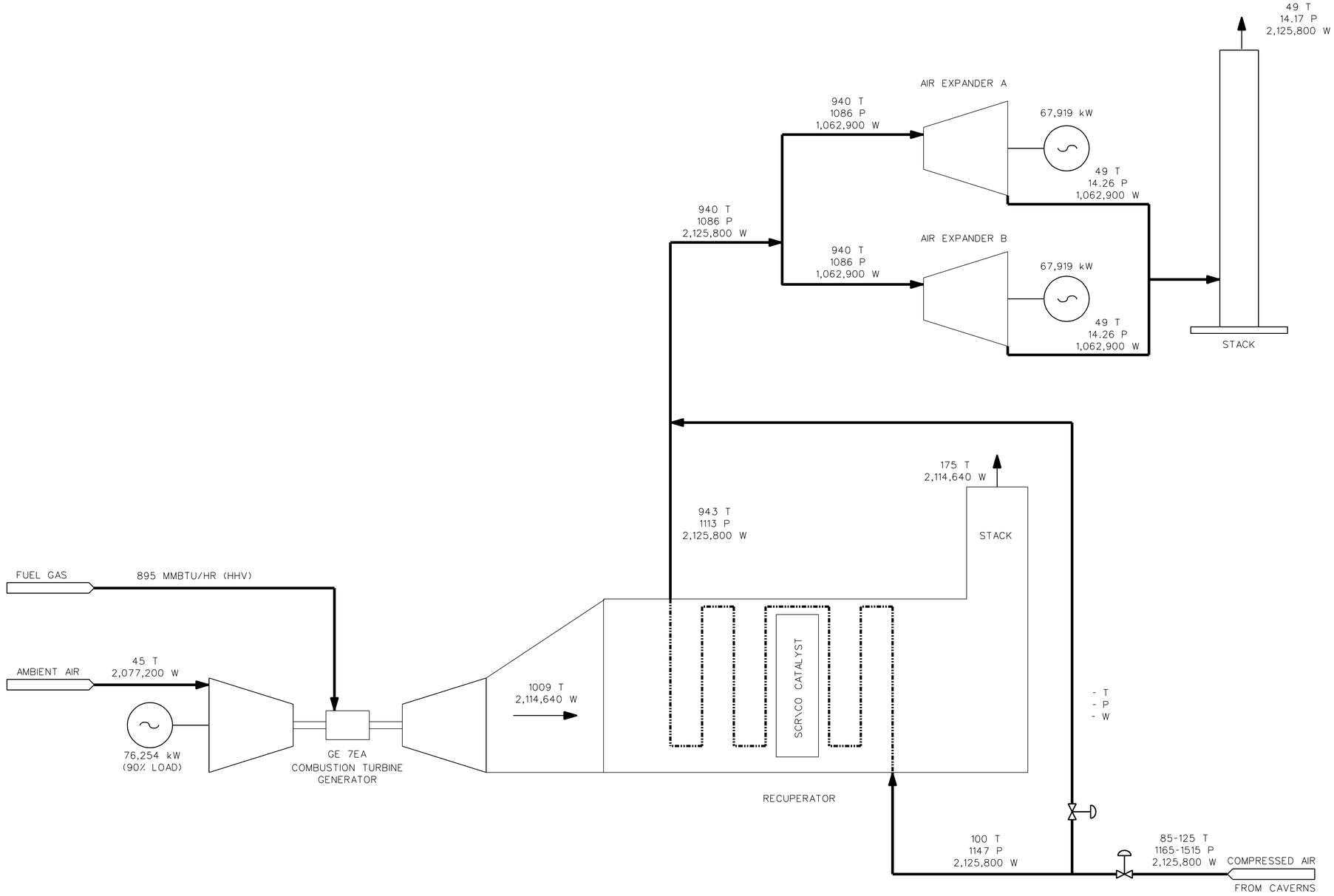
6/4/2012 11:27:33 AM



FOR HEAT AND MASS BALANCE PURPOSES ONLY

NOTES:

1. FOR MORE PERFORMANCE DETAILS SEE CYCLE 2 PERFORMANCE SUMMARY (CAES-1-LI-021-0007).
2. HEAT BALANCE DIAGRAM ONLY. VALVES AND LINES SHOWN ARE NOT NECESSARILY INDICATIVE OF DESIGN.
3. AVERAGE RECUPERATOR AIR INLET TEMP ASSUMED IS 100°F.
4. CTG IS OPERATRED AT PART LOAD TO STAY WITHIN THE MAXIMUM GRID CAPACITY OF 210 MW.
5. PERFORMANCE IS BASED ON NEW AND CLEAN CONDITION.

LEGEND

T	TEMPERATURE, F
P	PRESSURE, PSIA
W	MASS FLOW, LBS/HR
KWe	POWER, KILOWATTS ELECTRICAL

SYSTEM PERFORMANCE SUMMARY

AMBIENT TEMPERATURE:	45° F
RELATIVE HUMIDITY:	60%
SITE ELEVATION:	1,000 FT
GROSS POWER:	212,092 KW
AUX POWER:	2,225 KW
NET POWER:	209,867 KW
NET HEAT RATE HHV:	4,267 BTU/KW-HR
NET SP. AIR CONSUMP.:	10.13 LBS/KW-HR

REV	DATE	DESCRIPTION	DRAWN	CHECKED	LEAD DESIGNER	ENGINEER/ TECH. SPEC.	LEAD ENGINEER	PROJ. ENGR. MANAGER	PROJECT MANAGER
A	10.26.11	ISSUED FOR REVIEW AND COMMENT	TWB	KM		PMP	HGE		MH

PRELIMINARY STATUS — DATE — LDE — REPRESENTS GENERAL DESIGN CONCEPTS BASED ON ASSUMPTIONS. REVIEWED NOT CHECKED.

APPROVED STATUS — DATE — LDE — REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS.

ORIGINATING PERSONNEL	
DRAWN BY	TWB
CHECKED BY	K. MUKHERJEE
LEAD DESIGNER	
ENGINEER/TECH SPECIALIST	P. PHIAMBOLIS
PROJECT ENGINEERING MANAGER	
PROJECT MANAGER	M. HOLDRIDGE

PROFESSIONAL ENGINEER'S SEAL

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF
REV. ____ STATE ____
LIC. NO. ____ DATE ____

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CLIENT/PROJECT TITLE

NYSEG
SENECA COMPRESSED AIR ENERGY STORAGE (CAES) PROJECT

HEAT AND MASS BALANCE DIAGRAM
CYCLE #2, AVERAGE AMBIENT OPERATION
45°F, 60% RH, 210 MW NET OUTPUT

SCALE	DRAWING SIZE
NONE	ARCH D (36" x 24")

WORLEYPARSONS DWG. NO.	REV
CAES-1-HT-021-0259	A

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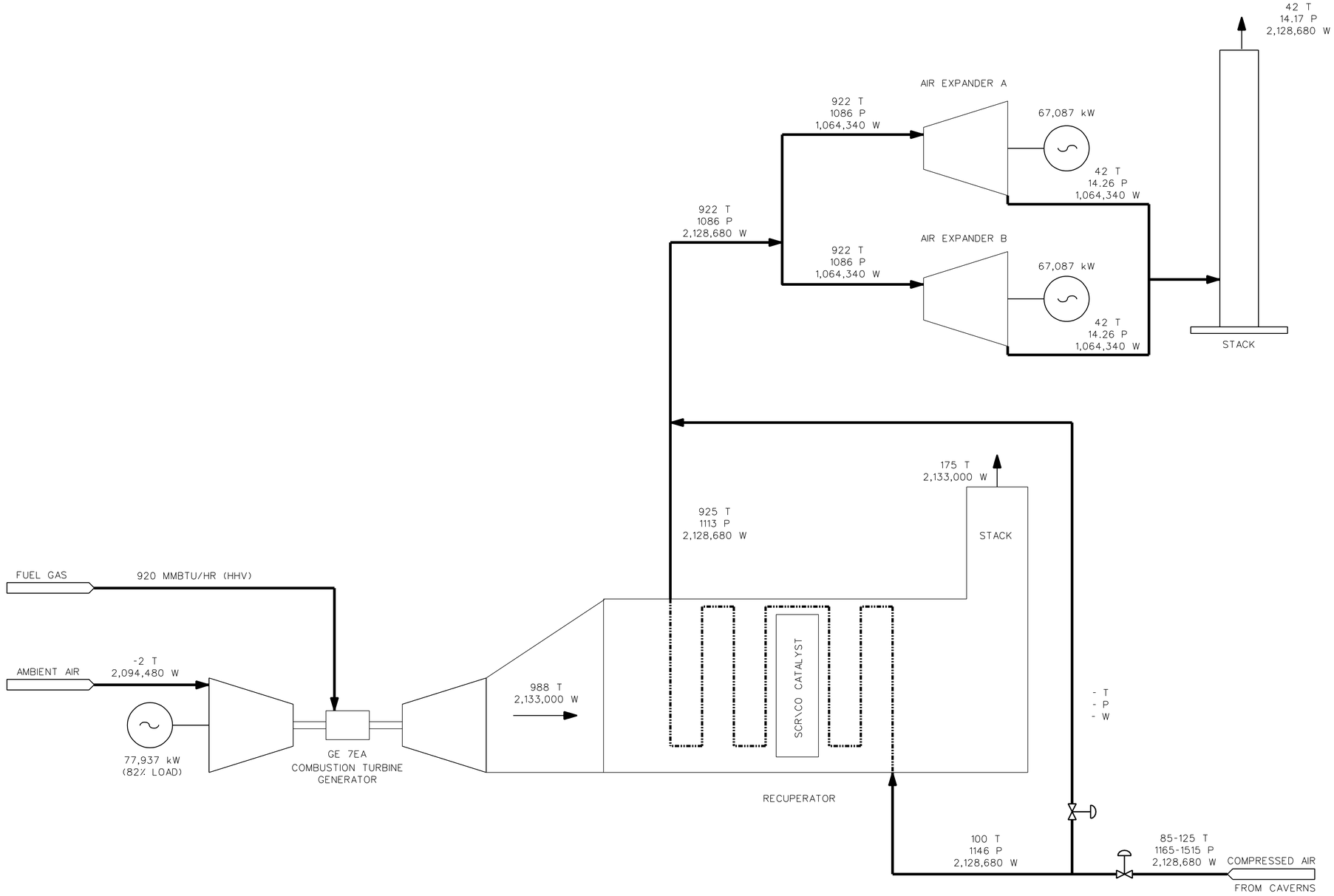

FOR HEAT AND MASS BALANCE PURPOSES ONLY

NOTES:

1. FOR MORE PERFORMANCE DETAILS SEE CYCLE 2 PERFORMANCE SUMMARY (CAES-1-LI-021-0007).
2. HEAT BALANCE DIAGRAM ONLY. VALVES AND LINES SHOWN ARE NOT NECESSARILY INDICATIVE OF DESIGN.
3. AVERAGE RECUPERATOR AIR INLET TEMP ASSUMED IS 100°F.
4. CTG IS OPERATRED AT PART LOAD TO STAY WITHIN THE MAXIMUM GRID CAPACITY OF 210 MW.
5. PERFORMANCE IS BASED ON NEW AND CLEAN CONDITION.

LEGEND

T	TEMPERATURE, F
P	PRESSURE, PSIA
W	MASS FLOW, LBS/HR
KWe	POWER, KILOWATTS ELECTRICAL

SYSTEM PERFORMANCE SUMMARY

AMBIENT TEMPERATURE:	-2° F
RELATIVE HUMIDITY:	50%
SITE ELEVATION:	1,000 FT
GROSS POWER:	212,110 KW
AUX POWER:	2,225 KW
NET POWER:	209,885 KW
NET HEAT RATE HHV:	4,383 BTU/KW-HR
NET SP. AIR CONSUMP.:	10.14 LBS/KW-HR

REV	DATE	DESCRIPTION	DRAWN	CHECKED	LEAD DESIGNER	ENGINEER/ TECH. SPEC.	LEAD ENGINEER	PROJ. ENGR. MANAGER	PROJECT MANAGER
A	10.26.11	ISSUED FOR REVIEW AND COMMENT	TWB	KM		PMP	HGE		MH

PRELIMINARY STATUS — DATE — LDE
REPRESENTS GENERAL DESIGN CONCEPTS BASED ON ASSUMPTIONS. REVIEWED NOT CHECKED.

APPROVED STATUS — DATE — LDE
REPRESENTS REVIEWED AND APPROVED DESIGN, ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS.

ORIGINATING PERSONNEL	
DRAWN BY	TWB
CHECKED BY	K. MUKHERJEE
LEAD DESIGNER	
ENGINEER/TECH SPECIALIST	P. PHIAMBOLIS
PROJECT ENGINEERING MANAGER	
PROJECT MANAGER	M. HOLDRIDGE

PROFESSIONAL ENGINEER'S SEAL

OneWay to zero harm

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF
REV. ____ STATE ____
LIC. NO. ____ DATE ____

WorleyParsons
resources & energy

CLIENT/PROJECT TITLE

NYSEG
SENECA COMPRESSED AIR ENERGY STORAGE (CAES) PROJECT

HEAT AND MASS BALANCE DIAGRAM
CYCLE #2, LOW AMBIENT OPERATION
-2°F, 50% RH, 210 MW NET OUTPUT

SCALE	DRAWING SIZE
NONE	ARCH D (36" x 24")

WORLEYPARSONS DWG. NO.	REV
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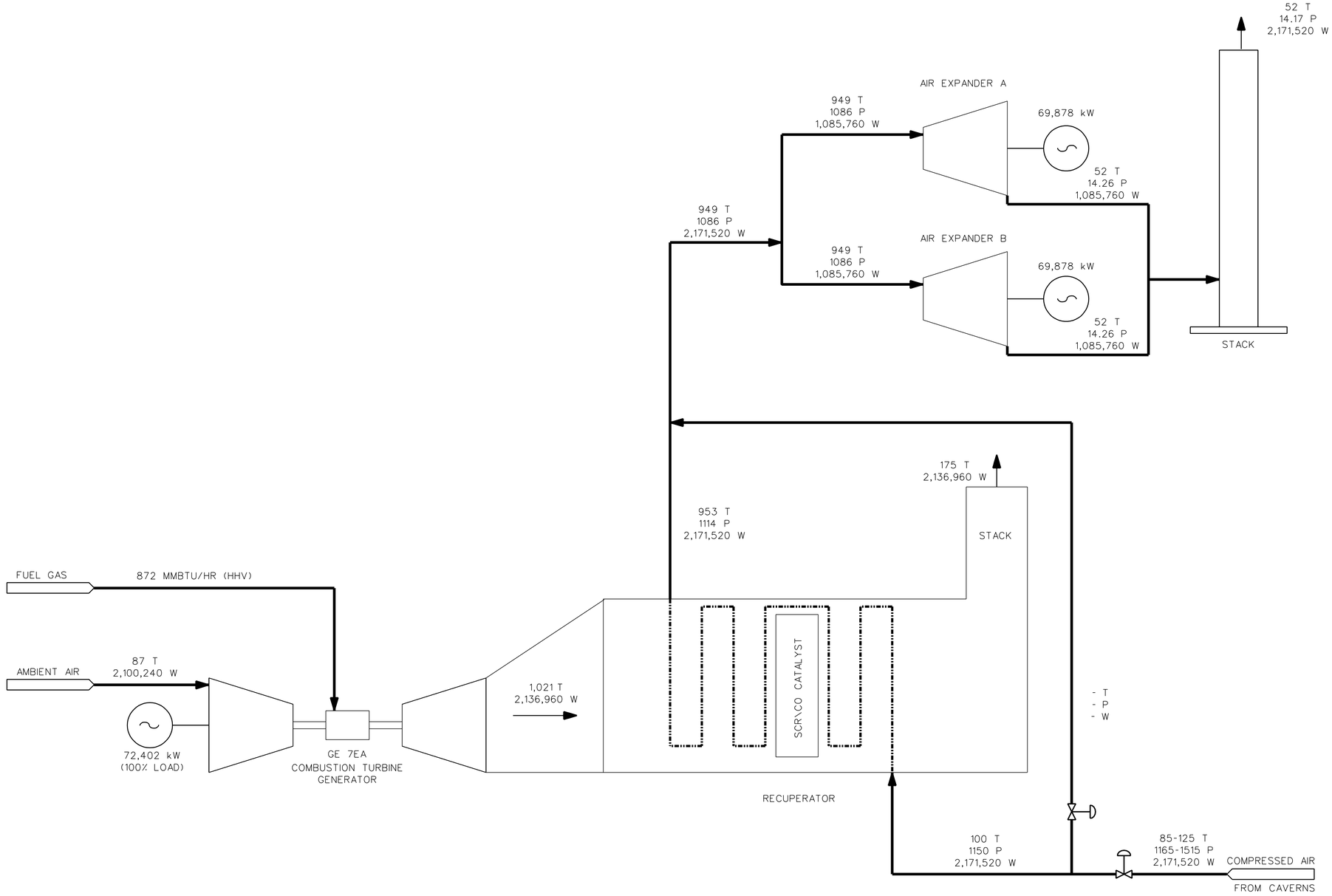

FOR HEAT AND MASS BALANCE PURPOSES ONLY

NOTES:

1. FOR MORE PERFORMANCE DETAILS SEE CYCLE 2 PERFORMANCE SUMMARY (CAES-1-LI-021-0007).
2. HEAT BALANCE DIAGRAM ONLY. VALVES AND LINES SHOWN ARE NOT NECESSARILY INDICATIVE OF DESIGN.
3. AVERAGE RECUPERATOR AIR INLET TEMP ASSUMED IS 100°F.
4. CTG IS OPERATRED AT PART LOAD TO STAY WITHIN THE MAXIMUM GRID CAPACITY OF 210 MW.
5. PERFORMANCE IS BASED ON NEW AND CLEAN CONDITION.

LEGEND

T	TEMPERATURE, F
P	PRESSURE, PSIA
W	MASS FLOW, LBS/HR
KWe	POWER, KILOWATTS ELECTRICAL

SYSTEM PERFORMANCE SUMMARY

AMBIENT TEMPERATURE:	87° F
RELATIVE HUMIDITY:	46%
SITE ELEVATION:	1,000 FT
GROSS POWER:	212,159 KW
AUX POWER:	2,225 KW
NET POWER:	209,934 KW
NET HEAT RATE HHV:	4,152 BTU/KW-HR
NET SP. AIR CONSUMP.:	10.34 LBS/KW-HR

REV	DATE	DESCRIPTION	DRAWN	CHECKED	LEAD DESIGNER	ENGINEER/ TECH. SPEC.	LEAD ENGINEER	PROJ. ENGR. MANAGER	PROJECT MANAGER
A	10.26.11	ISSUED FOR REVIEW AND COMMENT	TWB	KM		PMP	HGE		MH

PRELIMINARY STATUS — DATE — LDE — REPRESENTS GENERAL DESIGN CONCEPTS BASED ON ASSUMPTIONS. REVIEWED NOT CHECKED.

APPROVED STATUS — DATE — LDE — REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS.

ORIGINATING PERSONNEL	PROFESSIONAL ENGINEER'S SEAL
DRAWN BY: TWB	
CHECKED BY: K. MUKHERJEE	
LEAD DESIGNER:	
ENGINEER/TECH SPECIALIST: P. PHIAMBOLIS	
PROJECT ENGINEERING MANAGER:	
PROJECT MANAGER: M. HOLDRIDGE	

OneWay to zero harm

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF
REV. _____ STATE _____
LIC. NO. _____ DATE _____

WorleyParsons
resources & energy

CLIENT/PROJECT TITLE

NYSEG
SENECA COMPRESSED AIR ENERGY STORAGE (CAES) PROJECT

HEAT AND MASS BALANCE DIAGRAM
CYCLE #2, HIGH AMBIENT OPERATION
87°F, 46% RH, 210 MW NET OUTPUT

SCALE	DRAWING SIZE
NONE	ARCH D (36" x 24")

WORLEYPARSONS DWG. NO.	REV
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