electric Power Systems inc.
Consulting Engineers

Wind-Diesel SCADA System

A Discussion of the Kotzebue Electric SCADA System

April 25, 2008

Goals:

1. Maximize wind resource
2. Automatically commit/dispatch generation
3. Support Ancillary Systems
   - Fuel Tankage
   - Radiators - JW and AC
   - Provide heat energy for the City water system
4. Flexibility to accommodate tuning and future upgrades
5. Open hardware architecture/industry standard devices
6. KEA owned software
7. Improved data gathering, handling and retention
8. Clear upgrade paths – large installed base of hw/sw
9. Ease of operation

Maximize Wind Resources:

Dispatch wind as available
Turbine status shown at main power plant on HMI
Available/Non-Available Turbines
Wind speed, real power and status for individual turbines
Net WF real and reactive power also displayed

System | Wind | Ancillary | Fuel | Kwh Meter | Hour Meter | Gen Detail | Wt Detail | Comms | Trends | Alarms | Menu

Wind Overview

	Wind Avg	kW
WT 03	6.7	22.9
WT 02	6.3	20.6
WT 01	6.3	17.8
WT 07	7.5	0.0
WT 06	0.0	21.8
WT 05	6.4	18.8
WT 10	6.7	24.8
WT 09	6.7	27.0
WT 08	6.5	27.7
WT 11	7.6	0.2
WT 14	9.77	0.0
WT 04	0.0	21.9
WT 12	6.2	18.3
WT 13	0.0*	0.0*
WT 15	7.2	17.4
WT 16	8.1	0.0
WT 17	0.0*	0.0*

Feeder 4

WIND KW
236

WIND KVAR
-94

Log On

Log Off

01/30/2007 14:08:07

System | Wind | Ancillary | Fuel | Kwh Meter | Hour Meter | Gen Detail | Wt Detail | Comms | Trends | Alarms | Menu

WT-01 | WT-02 | WT-03 | WT-04 | WT-05 | WT-06 | WT-07 | WT-08 | WT-09 | WT-10 | WT-11 | WT-12 | WT-13 | WT-14 | WT-15 | WT-16 | WT-17 | Wind Turbine

Wind Turbine Detail WT01

Current	Actual
A Phase	55 Amps
B Phase	49 Amps
C Phase	55 Amps

Potential	Actual
A Phase	277 V
B Phase	278 V
C Phase	277 V

Real Power	Actual
A Phase	13.3 KW
B Phase	13.3 KW
C Phase	14.2 KW
3 Phase	41.0 KW
Average	38.7 KW
Peak	90.0 KW

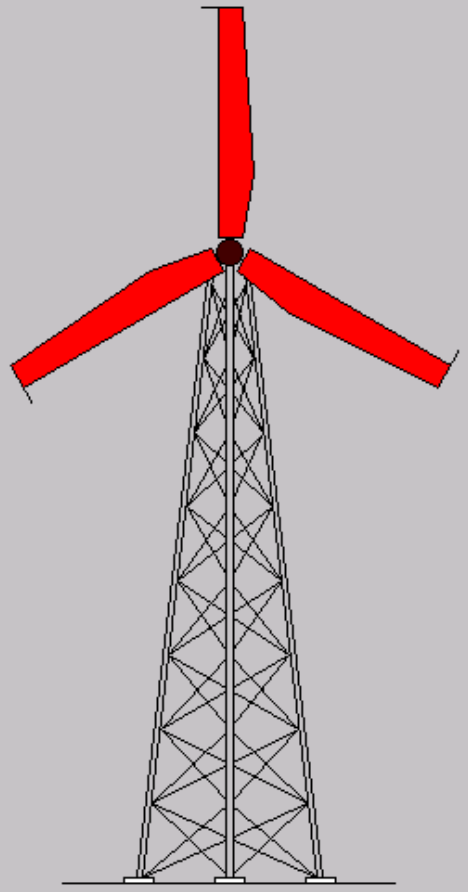
Status	Actual
System State	Production
System Error State	System Ok
System Mode	Automatic

Wind	Actual
Wind Speed	8.6 m/s
Wind Speed Avg	8.5 m/s
Wind Speed Peak	28.1 m/s

Frequency	Actual
A-B	60.04 Hz

Miscellaneous	Actual
Generator 1 RPM	1810 RPM
Generator 2 RPM	1810 RPM
Total kWH	817 kWH
Energy Hour	2200 kWH

Clock	Actual
Time	15:56:25
Date	01/31/07



Log On

Log Off

01/30/2007 14:54:32

System | Wind | Ancillary | Fuel | Kwh Meter | Hour Meter | Gen Detail | Wt Detail | Comms | Trends | Alarms | Menu

WT-01 | WT-02 | WT-03 | WT-04 | WT-05 | WT-06 | WT-07 | WT-08 | WT-09 | WT-10 | WT-11 | WT-12 | WT-13 | WT-14 | WT-15 | WT-16 | WT-17 | Wind Turbine

Wind Turbine Detail WT14

Wind	Actual
Wind Speed 1-Sec Avg	10.43 m/s

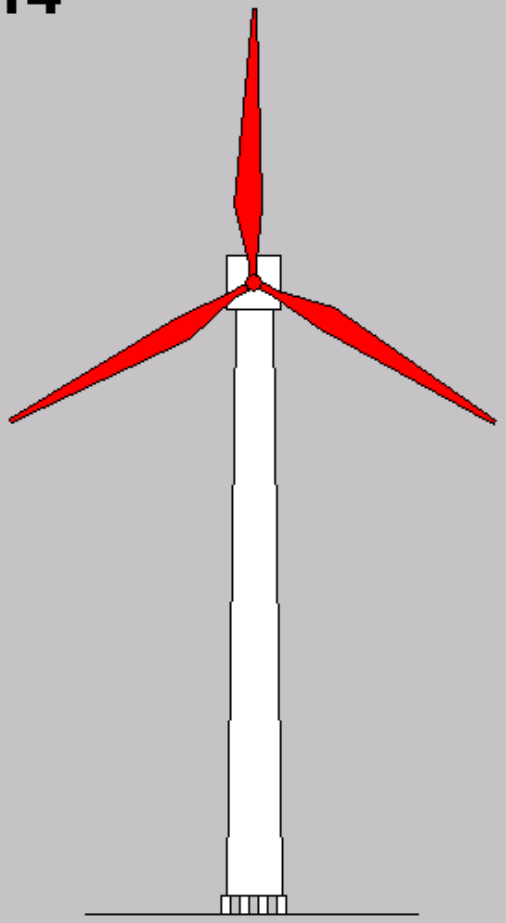
Real Power	Actual
3 Phase	110.1 KW

Miscellaneous	Actual
Rotor RPM	59 RPM
Total kWH	4086754 kWH

Temperature	Actual
Generator Stator A	168 deg C

Status	Actual
System State	Online
Up Tower Service Switch	Off
Down Tower Service Switch	Off

Alarms	
Error State 1	Overspeed Shutdown
Error State 2	
Error State 3	Normal Shutdown
Error State 4	Circuit Brkr 21 Open (Nacelle 480 V)
Error State 5	Circuit Brkr 31 Open (Nacelle 120 V)
Error State 6	To Enter Service Set Brake



Log On

Log Off

01/30/2007 15:05:16

Automatically commit/dispatch generation:

- Maximize wind resource (negative load)
- Commit diesel based on residual load on system
- Allow for operator selection of reserves, unit availability

Demand Control

Enabled

ur Step	4
W Capacity Online	3710
W Load	2601
W Reserve	1109

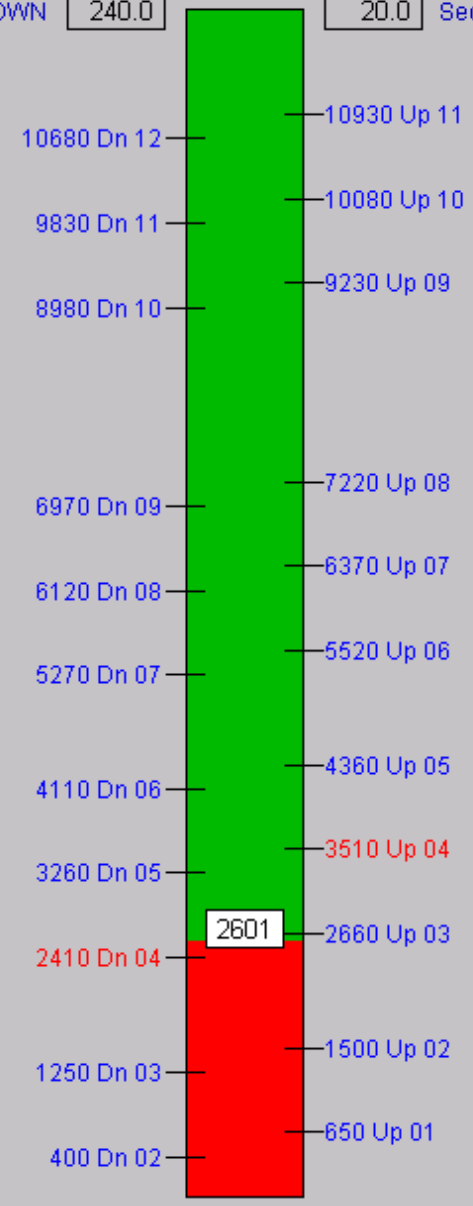
	1	2
Req	●	●
Avail	●	●
Not Rmt	○	○
Lockout	○	○

Step DOWN Res Setpt	250
Step DOWN Delay	240.0
Secs until Step DOWN	240.0

200	Step UP Res Se
20.0	Step UP Delay
20.0	Secs until Step U

tep #	Qty 01	Qty 02	Qty 03	Qty 04	Qty 05	Qty 06	Qty 07	Qty 08	Qty 09	Qty 10
0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
1	3	3	0	0	0	0	0	0	0	0
0	2	3	0	0	0	0	0	0	0	0
	1	3	0	0	0	0	0	0	0	0
	2	2	0	0	0	0	0	0	0	0
	1	2	0	0	0	0	0	0	0	0
	0	2	0	0	0	0	0	0	0	0
	2	1	0	0	0	0	0	0	0	0
	1	1	0	0	0	0	0	0	0	0
	0	1	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0

nit Size	01	02	03	04	05	06	07	08	09	10
nit Rating	850	2860	0	0	0	0	0	0	0	0
ty of Size	3	3	0	0	0	0	0	0	0	0
ead of Size	1	3	0	0	0	0	0	0	0	0



Log On

System | Wind | Ancillary | Fuel | Kwh Meter | Hour Meter | Gen Detail | Wt Detail | Comms | Trends | Alarms | Menu

System Overview

SYSTEM KW	SYSTEM KVAR	SYSTEM VOLTS
3076	942	12634

Old Plant — Station Service — New Plant

Demand Control: ENABLED

	CAT	EMD
Lead Unit	12	15
2nd Unit	7	10
3rd Unit	11	14

Seconds Until Step DOWN	240.0
Seconds Until Step UP	20.0

Tiebreaker

	GEN 12	GEN 11	GEN 07	GEN 14	GEN 15	GEN 10
Remote	Remote	Remote	Remote	Remote	Remote	Remote
	Remote Isoch	Off Isoch	Off Isoch	Remote Isoch	Remote Isoch	Remote Isoch
kW Setpt	679	200	200	400	2409	400
kW	679	0	0	0	2409	0
Kvar	183	0	0	0	764	0
Volts	4228	0	0	0	4227	0
Pf	0.965	0.000	0.000	0.000	0.954	0.000
Freq	59.99	0.00	0.00	0.00	59.99	0.00

Feeder 1 | Feeder 2 | Feeder 3 | Feeder 4 Wind Site

Cold Load Pickup: DISABLED

	TOTAL DIESEL	TOTAL WIND
kW	3088	-12
Kvar	947	-5

02/21/07	16:19:30	GEN07 - CONTROL SWT NOT IN REMOTE
02/21/07	16:19:30	GEN07 - STARTING AIR PSI LO ALM ANALOG
02/21/07	16:19:30	GEN11 - CONTROL SWT NOT IN REMOTE
02/21/07	16:19:30	GEN11 - STARTING AIR PSI LO ALM ANALOG

Log On | Log Off

02/21/2007 16:19:46

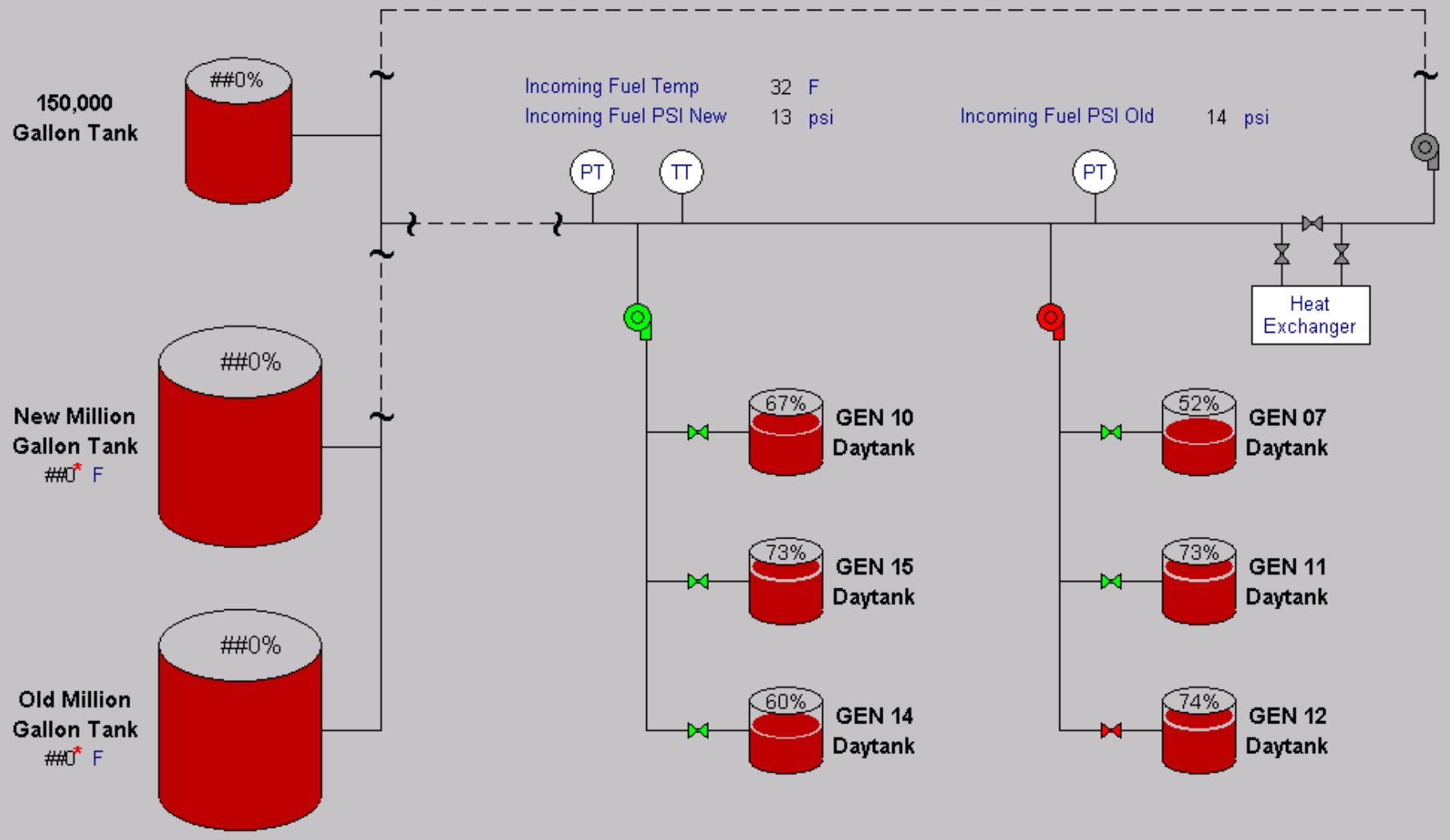
Ancillary Systems:

Fuel Tankage
Radiators - JW and AC

Provide heat energy for the City water system

System | Wind | Ancillary | Fuel | Kwh Meter | Hour Meter | Gen Detail | Wt Detail | Comms | Trends | Alarms | Menu

FUEL SYSTEM



02/21/07	11:46:00	GEN07 - CONTROL SWT NOT IN REMOTE
02/21/07	11:46:00	GEN07 - STARTING AIR PSI LO ALM ANALOG
02/21/07	11:46:00	GEN11 - CONTROL SWT NOT IN REMOTE
02/21/07	11:46:00	GEN11 - STARTING AIR PSI LO ALM ANALOG

Log On

Log Off

02/21/2007 11:51:03

System | Wind | Ancillary | Fuel | Kwh Meter | Hour Meter | Gen Detail | Wt Detail | Comms | Trends | Alarms | Menu

ANCILLARY SYSTEMS

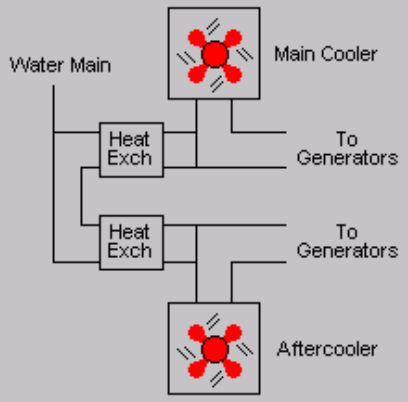
City Water Waste Heat System

Main Cooler

VFD Setpoint Temp	63	F
VFD Speed	6	%
VFD Mode	Auto	
HOA	Auto	
Glycol Heat Ex Inlet Temp	168	F
Glycol Heat Ex Outlet Temp	67	F

Aftercooler

AC VFD Setpoint Temp	0	F
AC VFD Speed	25	%
AC VFD Mode	Manual	
AC HOA	Auto	
AC Heat Exch Outlet Temp	62	F
Glycol Heat Ex Inlet Temp	93	F
Glycol Heat Ex Outlet Temp	72	F



BTU Meter

Flow Rate	203	GPM
Energy Rate	1319	kBTU/HR
Transferred Heat	77760	100kBTU
Inlet Temp	51	F
Heat Exch Outlet Temp	63	F

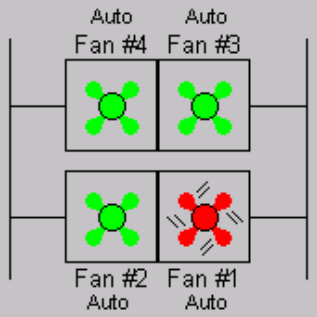
Battery System

125VDC Old Plant	131	V
125VDC New Plant	126	V
125VDC Sub	131	V

Jacket Water/Radiator System

Radiator Return Temp A	168	F
Radiator Return Temp B	168	F
Cooling Setpoint Temp	168	F
Cooling Percent Utilized	5	%
VFD Speed Percentage	21	%

Fan #	Priority	HOA Mode	Starts
1		Remote	657
2	2	Remote	20
3	3	Remote	4
4	1	Remote	39



System Control

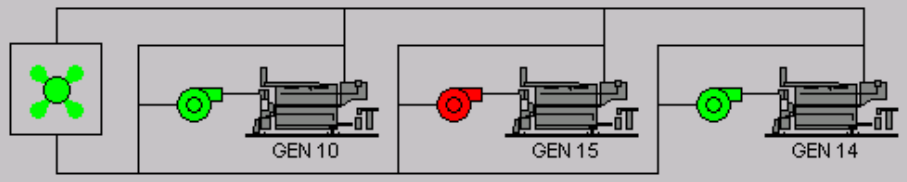
Plant Heat

Plant Heat Loop	9	PSI
Plant Heat Temp Inlet	171	F
Plant Heat Temp Outlet	167	F

Aftercooler System

Radiator Outlet Temp	89	F
Radiator Inlet Temp	94	F
VFD Setpoint Temp	95	F
VFD Speed	0	%
VFD Mode	Auto	
HOA	Auto	

Gen 10 Outlet Temp	69	F
Gen 10 Inlet Temp	55	F
Gen 15 Outlet Temp	95	F
Gen 15 Inlet Temp	82	F
Gen 14 Outlet Temp	58	F
Gen 14 Inlet Temp	64	F



02/21/07	11:46:00	GEN07 - CONTROL SWT NOT IN REMOTE
02/21/07	11:46:00	GEN07 - STARTING AIR PSI LO ALM ANALOG
02/21/07	11:46:00	GEN11 - CONTROL SWT NOT IN REMOTE
02/21/07	11:46:00	GEN11 - STARTING AIR PSI LO ALM ANALOG

Log On

Log Off

02/21/2007 11:47:32

Flexible to accommodate tuning and future upgrades:

- Fully documented, both in code and in manuals
- Tuning screens/tools included in application
- Modular, to allow for incremental improvements/upgrades
- Industry standard hw/sw, for long term maintainability

System | Wind | Ancillary | Fuel | Kwh Meter | Hour Meter | Gen Detail | Wt Detail | Comms | Trends | Alarms | Menu

GEN07 | GEN11 | GEN12 | GEN10 | GEN14 | GEN15

Miscellaneous

Health Counter (Clock Seconds)	50
Global Switch Debounce Delay	2.0
Breaker fail to sync delay	300.0
Maint Interval hrs	250
Voltage Step Pulse Width	0.1
Readable Cyl Temp Range	1 - 2000
Baseload kW Setpt Range	200 - 800
Baseload kW Step Size	50

Off | Lcl/Run | BD | Rem

Control Swt

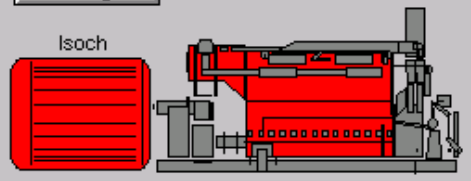
kW Setpt	527
kW	527
Amps	79
Volts	4235
Kvar	249
Pf	0.906
Freq	59.99

Lcl | Rem

Switchgear

Auto Sync	Enabled
Rated Speed Request	On

Isoch

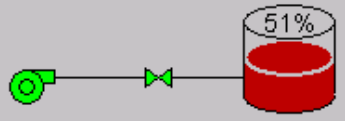


Crank Configuration

Flywheel # Teeth	183
Prelube Secs	0.0
Prelube Remain	0.0
Crank Cutoff RPM	200
Crank Time in Secs	45.0
Secs Between Cranks	10.0
Max Crank Attempts	1
Actual Crank Attempts	0
Oil Warmup Temp	160
Max Warmup Secs	60.0
Warmup Remain	0.0
Rated Cooldown Secs	60.0
Rated Cooldown Remain	60.0
Idle Cooldown Secs	60.0
Idle Cooldown Remain	60.0
Postlube Secs	0.0
Postlube Remain	0.0

Fuel Cooler Fan

Daytank Pump Overrun Delay	480.0
Fuel Daytank Pump Stop Level	75
Fuel Daytank Pump Start Level	50



Alarm Configuration

	Cur	Mask	Lo S/D	Lo Stp	Lo Alm	Hi Alm	Hi Stp	Hi S/D
Coolant Flow Switch Delays		20.0	0.0	0.0	0.0			
Generator RPM	1799					1850	1860	1920
2 L Air Filter Diff In/H2O R	0					15	17	19
Air Starter Psi	166				100			
Crankcase Psi	0					0	0	0
After Cooler Coolant Flow	0		0	0	0			
% Coolant Level	0		0	0	0			
Coolant Psi	47	50.0	15	20	25			
155 In Coolant Temp Out	173	10.0	0	0	100	195	203	210
Fuel Filter Diff Psi	0					0	0	0
% Fuel Daytank Level	51		10	20	45	80	85	0
Fuel Psi	69	60.0	30	40	45	75	90	0
Oil Filter Diff Psi	0					0	0	0
Oil Level	0		0	0	0	0	0	0
Idle Oil Psi	59	90.0	18	25	30			
Rated Oil Psi	59	30.0	30	35	40	95	0	0
195 In Oil Temp Out	0		0	0	110	225	230	235
Turbo Oil Psi	0	0.0	0	0	0			
0 L Turbo Outlet EGT R	0					0	0	0
After Turbo Air Psi	0	12.0				20		
After Turbo Air Temp	174					200	230	0
Vibration	0.00					0.00	0.00	0.00
Rear Bearing Temp	108					140	160	175
Hottest Stator Temp	0					0	0	0
Turbo Oil Temp	0					0	0	0
Coolest Cyl Temp 12	953		0	250	350			
Hottest Cyl Temp 10	1017					1120	1150	0
Cyl Temp Diff Temp	64	240.0				175	200	0

Coolant flow switch statistics

Max Time to Enable	2.0	(Set Mask based on this)
Max Offtime After Enabled	2.0	(Set Alarm delays based on this)

GEN12

Ver 1.0

Alarms

Log On

Log Off

01/30/2007 14:50:50

electric Power Systems inc.
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Open Architecture/Industry standard parts:

- Again, fully documented, both in code and in manuals
- GE 90-30 PLC's
- Wonderware/InTouch HMI
- Canary Labs Trending
- KEPWare OPC Server
- SEL relays
- EPM6000 Meters
- Not single vendor

System | Wind | Ancillary | Fuel | Kwh Meter | Hour Meter | Gen Detail | Wt Detail | Comms | Trends | Alarms | Menu

GEN07 | GEN11 | GEN12 | GEN10 | GEN14 | GEN15

SEL300G Detail GEN15

Current	Actual
A Phase	361 Amps
B Phase	338 Amps
C Phase	329 Amps

Real Power	Actual
3 Phase	2.4 MW

Real Power	Actual
3 Phase	5 MWH

Potential	Actual
A Phase	2.5 KV
B Phase	2.5 KV
C Phase	2.5 KV
Sync	2.5 KV
DC	127 V

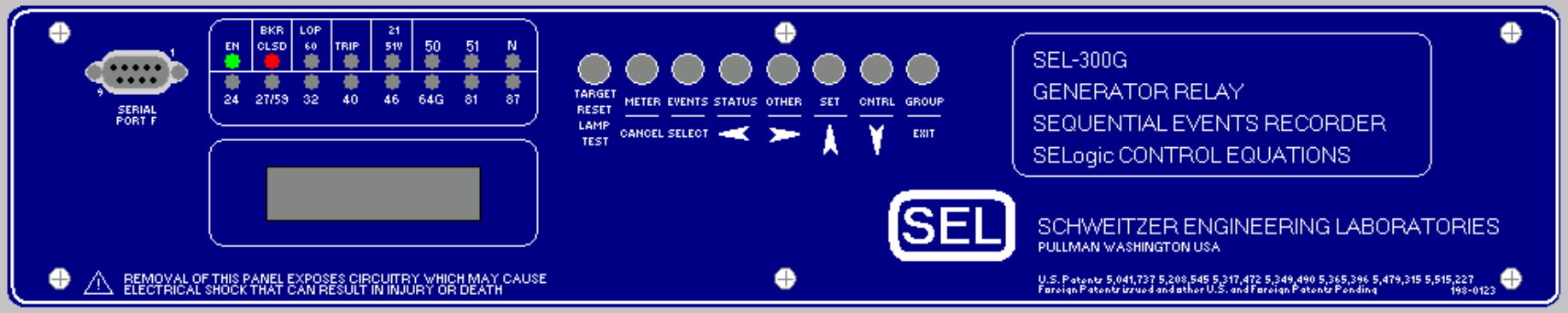
Reactive Power	Actual
3 Phase	0.9 MVAR

Reactive Power	Actual
3 Phase	23 MVARH

Frequency	Actual
A-B	60.04 Hz

Power Factor	Actual
3 Phase	0.94 Lag

Real Time Clock	Actual
Date	02/21/2007
Time	16:06:12



Ver 1.0

02/21/07	15:08:32	GEN11 - CONTROL SW'T NOT IN REMOTE
02/21/07	15:08:32	GEN11 - STARTING AIR PSI LO ALM ANALOG
02/21/07	15:08:32	GEN07 - CONTROL SW'T NOT IN REMOTE
02/21/07	15:08:32	GEN07 - STARTING AIR PSI LO ALM ANALOG

Log On

Log Off

02/21/2007 15:08:50

System | Wind | Ancillary | Fuel | Kwh Meter | Hour Meter | Gen Detail | Wt Detail | Comms | Trends | Alarms | Menu

GEN07 | GEN11 | GEN12 | GEN10 | GEN14 | GEN15 | FDR1 | FDR2 | FDR3 | FDR4 | WIND | STA-OLD | STA-NEW

EPM 6000

GEN15

Current	Actual
A Phase	387.5 Amps
B Phase	371.1 Amps
C Phase	361.0 Amps

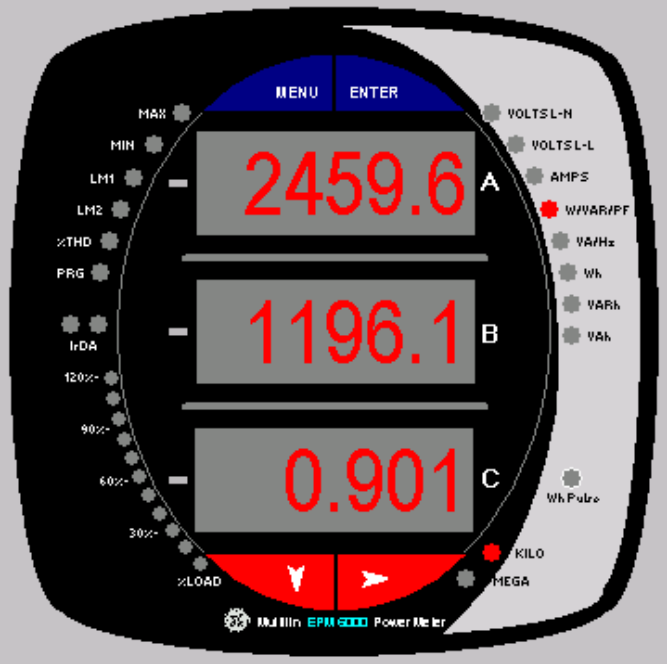
Frequency	Actual
Sys Freq	59.99 Hz

Health Status	
Health Counter	34944

Potential	Actual
A-N	2432 Volts
B-N	2424 Volts
C-N	2447 Volts
A-B	4203 Volts
B-C	4216 Volts
C-A	4223 Volts

Power	Actual
Real 3 Phase	2459.6 kWatts
Reactive 3 Phase	1196.1 kVars
Apparent 3 Phase	2735.0 kVA
Power Factor	0.901 (Pos = Lag)

Meter	Actual
Received kWh	-1 kWh
Delivered kWh	2666711 kWh
Net kWh	2666710 kWh
Total kWh	2666712 kWh
Positive kVARh	1056821 kVARh
Negative kVARh	-108 kVARh
Net kVARh	1056713 kVARh
Total kVARh	1056929 kVARh



01/31/07 14:12:34 GEN14 - SWGR LR SWT IN LOCAL

Log On

Log Off

01/31/2007 14:13:49

KEA Owned Software:

- Development tools
  Cimplicity ME, InTouch, Canary Labs, KEPWare
- Custom applications developed by EPS
- Relay settings, governors, regulators, etc.

Non-proprietary

Improve data gathering, handling and retention:

- Canary Labs
- Excel Exports
- Predefined reports
- Alarms

System | Wind | Ancillary | Fuel | Kwh Meter | Hour Meter | Gen Detail | Wt Detail | Comms | Trends | Alarms | Menu

System | Diesel | Emd's | Cat's | Wind/Ancillary | USER-1 | USER-2

OVERVIEW

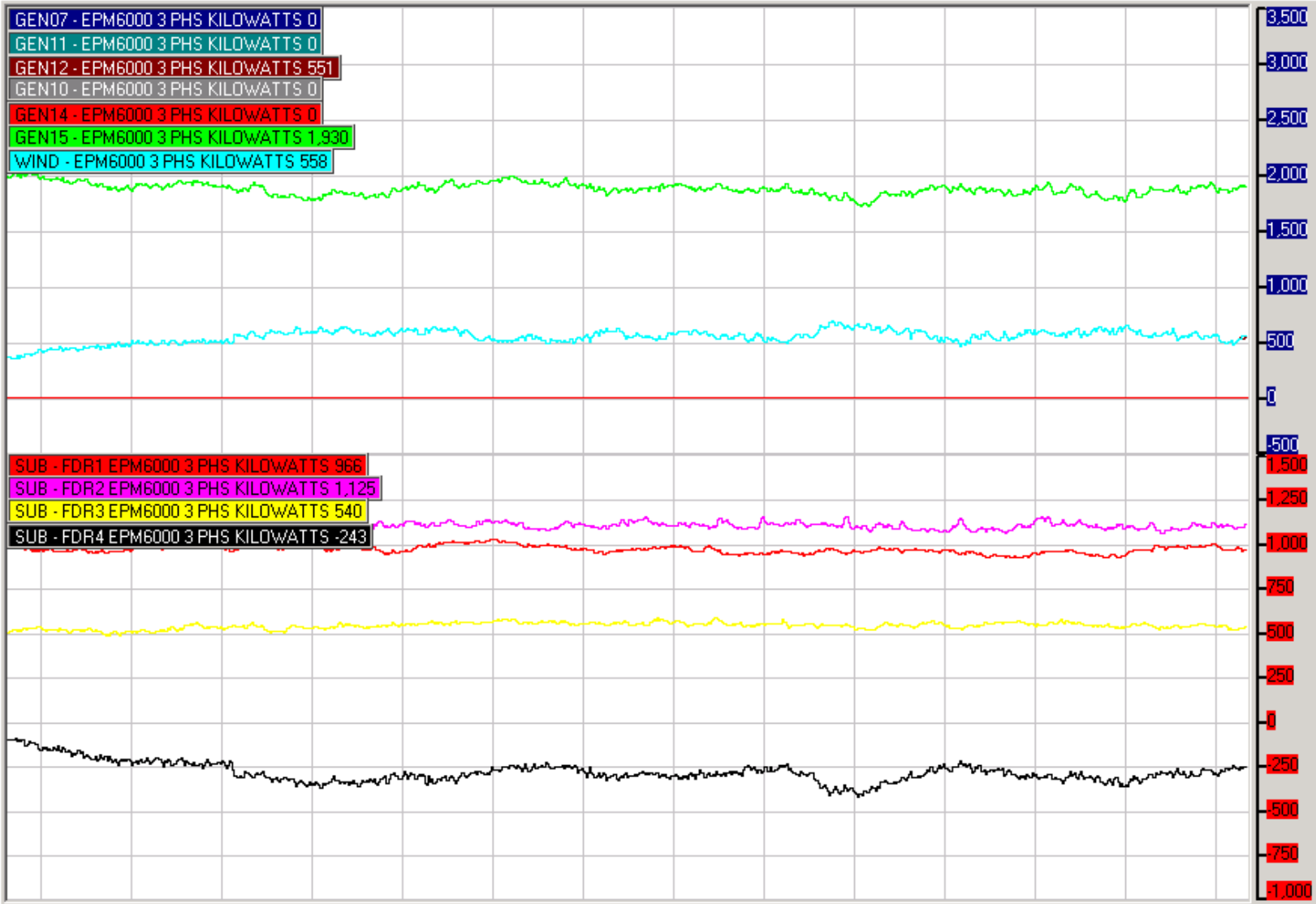
KW

KVAR

AMPS

VOLTS

FREQ



PRINT TREND

Ver. 04

Log On

Log Off

01/30/2007 15:20:37

Unit Hours Metering

Location/Unit	Current Values				End of Day			End of Month		End of Year
	Accumulated Time	Day to Date	Month to Date	Year to Date	Day to Date	Month to Date	Year to Date	Month to Date	Year to Date	Year to Date
Gen 07 Running	51980:19:19	0	226	226	16	226	226	154	443	443
Gen 07 Online	51977:36:10	0	224	224	15	224	224	153	430	430
Gen 11 Running	26165:39:41	0	214	214	0	214	214	157	433	433
Gen 11 Online	26162:44:09	0	212	212	0	212	212	156	427	427
Gen 12 Running	22738:08:45	6	7	7	0	1	1	71	221	221
Gen 12 Online	22737:07:55	6	6	6	0	0	0	71	216	216
Gen 10 Running	43236:24:15	0	114	114	0	114	114	403	703	703
Gen 10 Online	43235:51:26	0	113	113	0	113	113	403	701	701
Gen 14 Running	55671:37:01	0	13	13	0	13	13	196	863	863
Gen 14 Online	55670:55:34	0	12	12	0	12	12	195	859	859
Gen 15 Running	1586:58:38	14	585	585	24	571	571	174	576	576
Gen 15 Online	1586:00:26	15	586	586	24	571	571	173	574	574
MC/Fan 1	2107:56:45	6	437	437	22	431	431	636	1670	1670
MC/Fan 2	1:01:12	0	1	1	0	1	1	0	0	0
MC/Fan 3	2:10:29	0	0	0	0	0	0	0	2	2
MC/Fan 4	112:44:20	0	0	0	0	0	0	0	112	112
MC/No Fan	404:45:29	8	273	273	2	265	265	108	131	131

System | Wind | Ancillary | Fuel | Kwh Meter | Hour Meter | Gen Detail | Wt Detail | Comms | Trends | Alarms | Menu

Cur By Pri | Cur By Tim | Historical | Events

Priority 1 Alarms

Date	Time	Comment	Name

Priority 2 Alarms

Date	Time	Comment	Name

Priority 3 Alarms

Date	Time	Comment	Name
02/01/07	14:39:10	HMI - WT02 PLC COMMUNICATION FAILURE	HMI-WT02-COMM-FAIL
02/01/07	14:39:10	HMI - WT05 PLC COMMUNICATION FAILURE	HMI-WT05-COMM-FAIL
02/01/07	14:39:10	HMI - WT04 PLC COMMUNICATION FAILURE	HMI-WT04-COMM-FAIL
02/01/07	14:39:10	HMI - WT06 PLC COMMUNICATION FAILURE	HMI-WT06-COMM-FAIL
02/01/07	14:39:10	HMI - WT07 PLC COMMUNICATION FAILURE	HMI-WT07-COMM-FAIL
02/01/07	14:39:10	HMI - WT09 PLC COMMUNICATION FAILURE	HMI-WT09-COMM-FAIL
02/01/07	14:39:10	HMI - WT08 PLC COMMUNICATION FAILURE	HMI-WT08-COMM-FAIL
02/01/07	14:39:10	HMI - WT11 PLC COMMUNICATION FAILURE	HMI-WT11-COMM-FAIL
02/01/07	14:39:10	HMI - WT10 PLC COMMUNICATION FAILURE	HMI-WT10-COMM-FAIL
02/01/07	14:39:10	HMI - WT15 PLC COMMUNICATION FAILURE	HMI-WT15-COMM-FAIL
02/01/07	14:39:10	HMI - WT12 PLC COMMUNICATION FAILURE	HMI-WT12-COMM-FAIL
02/01/07	14:39:10	HMI - WT16 PLC COMMUNICATION FAILURE	HMI-WT16-COMM-FAIL

02/01/07	14:39:10	HMI - WT10 PLC COMMUNICATION FAILURE
02/01/07	14:39:10	HMI - WT15 PLC COMMUNICATION FAILURE
02/01/07	14:39:10	HMI - WT12 PLC COMMUNICATION FAILURE
02/01/07	14:39:10	HMI - WT16 PLC COMMUNICATION FAILURE

Log On

Log Off

02/01/2007 14:51:48

Clear Upgrade Paths:

- Regular software upgrades and maintenance contracts
- Hardware upgrades (Series1 -> 90-30 ->RX3i)

Could use GE, AB, etc., per Owners preference

Ease of Operation:

- Intuitive HMI
- Two Step Control Actuation (SBO)
- Operator Training Available (should be part of contract)

Multi Vendor:

- No need to single source controls or switchgear
- Vendors can be selected on merit, price, etc.
- EPS has a “relationship” with 6 switchgear vendors that can complete similar work, as well as EPS’ own panel shop

Open Discussion