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Since 1922

State of Emissions

- New Regulations
- NOx Reduction Theory
- NOx Reduction Strategies

Seaworthy Systems, Inc.

- **Founded in 1973**
- **Principal Founders Came From P&W / TP&M**
- **Conducted Numerous Studies for the Maritime Administration Regarding Gas Turbine Installations**
- **Conducted Numerous Studies for Emissions Mitigation from Fossil Fuel Power Generation**

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Seaworthy Systems, Inc.

- **Developed HPWI Skid with PEPCO in 1995**
  - **> 60 systems in operation**
- **Specialty Fuel Filtration & Forwarding Systems for Gas Turbines**
- **Specialty Lube Oil Filtration System for Varnish removal (esp. applicable for Frame 5/7)**
- **Gas Turbine Inlet Air Fogging System**

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Regulations

OZONE TRANSPORT COMMISSION

Connecticut

Delaware

District of Columbia

Maine

Maryland

Massachusetts

New Hampshire

New Jersey

New York

Memorandum of Understanding Among the States of the Ozone Transport Commission Concerning the Incorporation of High Electrical Demand Day Emission Reduction Strategies into Ozone Attainment State Implementation Planning

Whereas the Ozone Transport Commission (OTC) was established under Sections 176A and 184 of the federal Clean Air Act (CAA) to ensure the development and implementation of regional strategies to reduce ground-level ozone to healthful levels; and

Whereas the adverse health effects of ground-level ozone are well documented, and in spite of significant reductions of ozone precursor emissions achieved to date as a result of our NOx MOU of 1994, the US Envi
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Therefore, be it **RESOLVED** that

The OTC States identified in the following table commit to pursue the following reductions in NOx emissions associated with HEDD units on high electrical demand days during the ozone season; such reductions to be achieved beginning with the 2009 ozone season or as soon as feasible thereafter, but no later than 2012:

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HEDD NOx Differential

STATE	Total NOx 6/4/2005	Total NOx 7/26/2005	Increased Tons of NOx	Percent Change
MD	84	218	134	160
NY	110	377	267	243
PA	233	404	171	73
CT	10	54	44	440
MA	47	74	27	57
DE	14	58	44	314
NJ	52	163	111	213
TOTAL	550	1348	798	145

Regulations

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Where docun emiss Enviro expec the ne cause region

Where have these polluti

State	NOx (tons per day)	Percent Reduction from HEDD Units
CT	11.7	25%
DE	7.3	20%
MD	23.5	32%
NJ	19.8	28%
NY	50.8	27%
PA	21.8	32%
Total	134.9	

Furthermore, that such reduction commitment will be included in each of the several states' 8-hour ozone attainment State Implementation Plan submissions to EPA due in June 2007; and

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Regulations

Model Rule for Additional
Nitrogen Oxides (NOx) Control Measures

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(2) For a simple cycle combustion turbine:

a. For a gas-fired turbine without oil back-up, 2.2 pounds of NOx per MWh (55 ppmvd, orrected to 15% O2);

For an oil-fired turbine, 3.0 pounds of NOx per MWh (75 ppmvd, corrected to 15% O2), and

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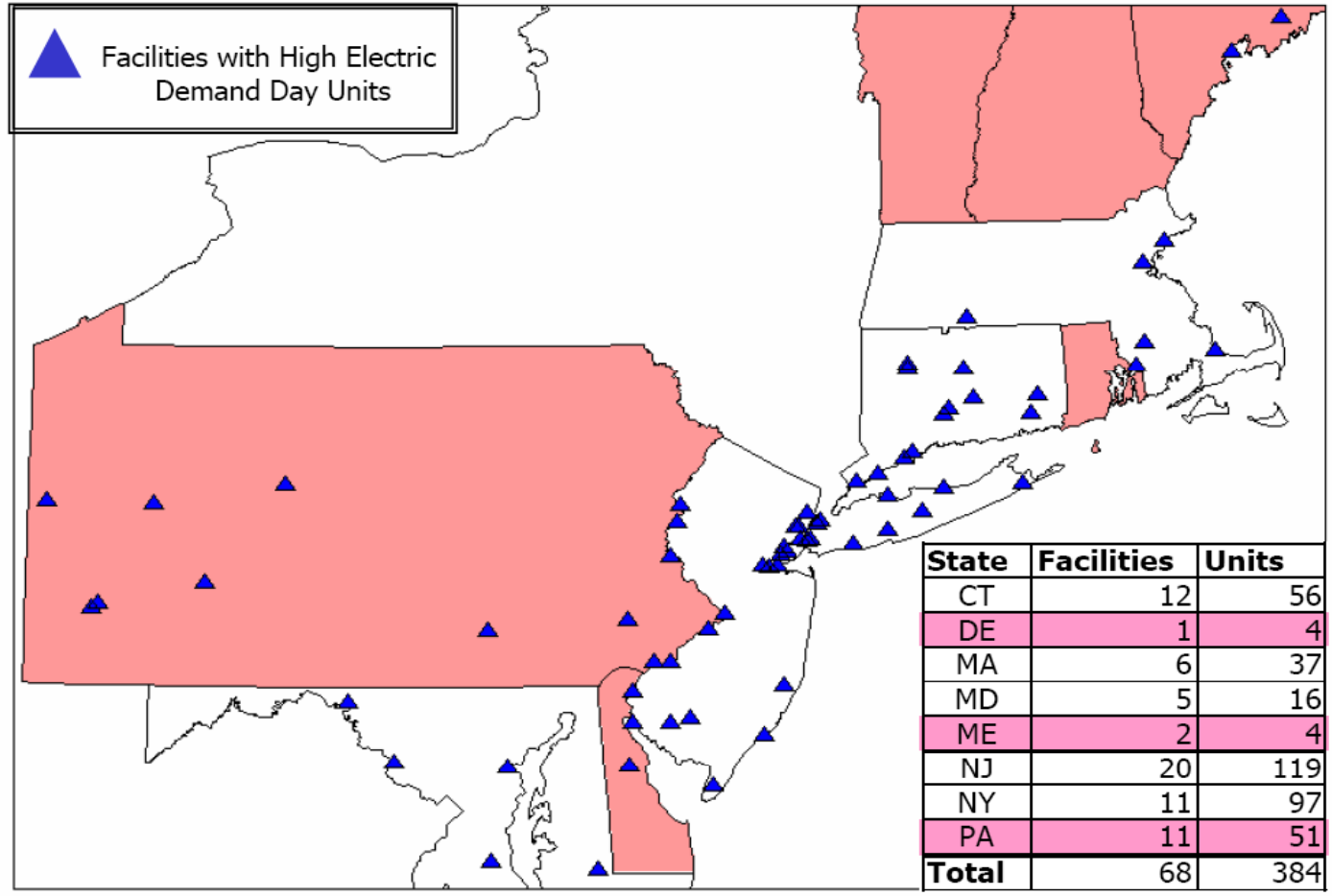
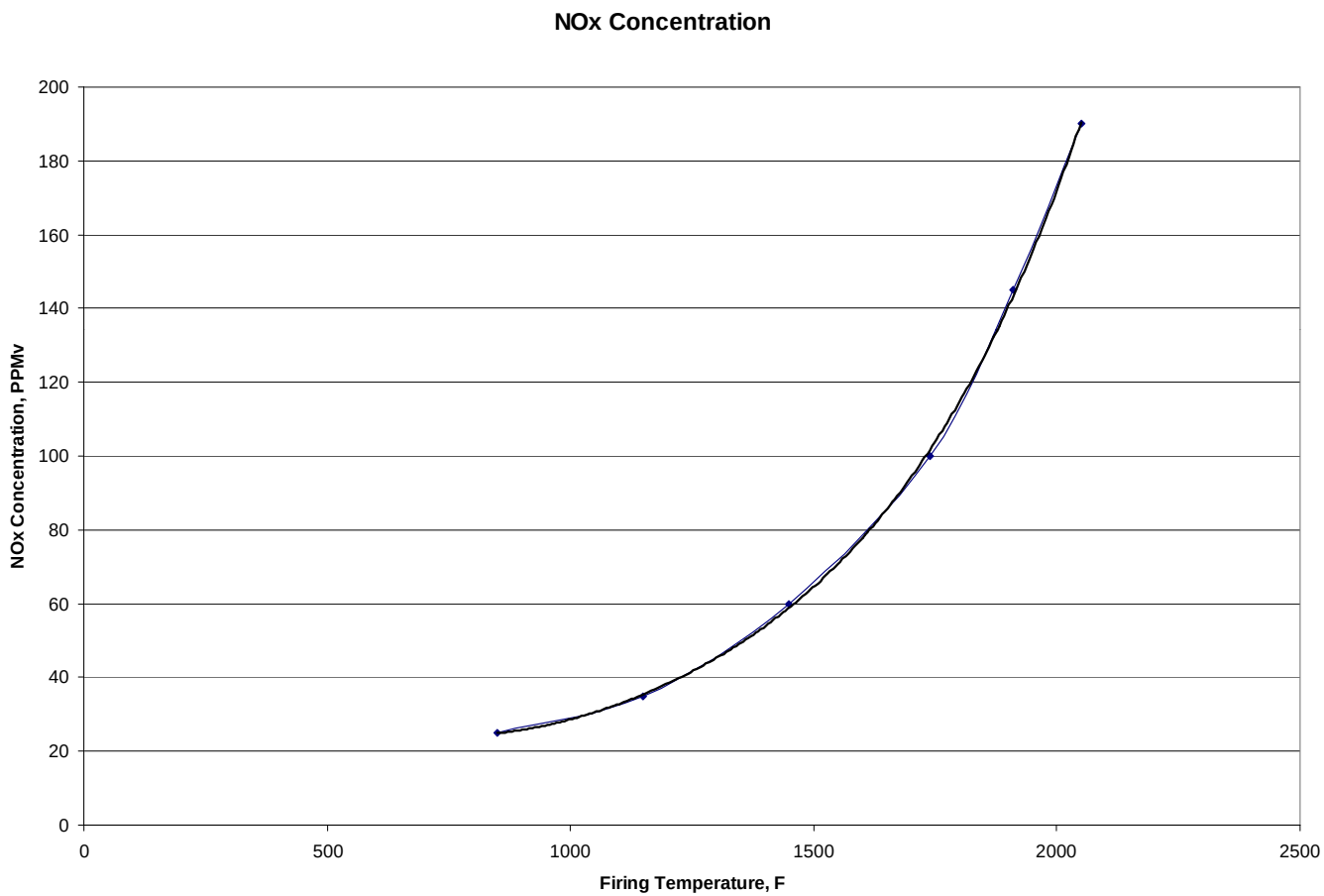
High Electric Demand Day Units



State	Facilities	Units
CT	12	56
DE	1	4
MA	6	37
MD	5	16
ME	2	4
NJ	20	119
NY	11	97
PA	11	51
Total	68	384

NOx Production vs. Firing Temp



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NOx Reduction Strategies

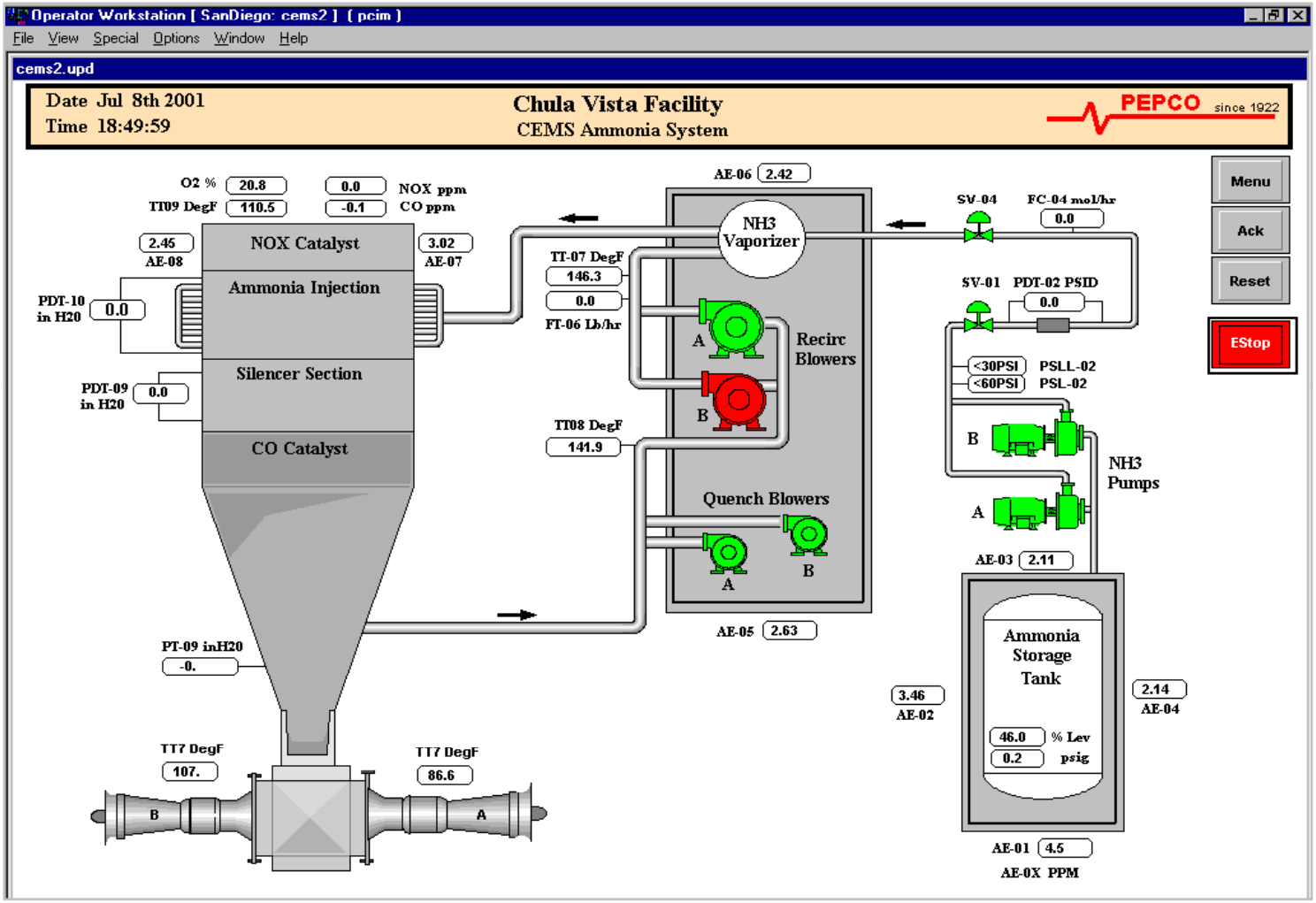
- Remove NOx from exhaust after production
- Reduce NOx production
- Combination of Removal & Reduction

NOx Removal

SCR System

- Uses Ammonia/Urea to remove NOx
- Pros
  - Can remove NOx to very low levels
  - Does NOT increase CO levels
- Cons
  - Very Large space requirements
  - Requires a separate Ammonia Delivery system
  - Requires an Ammonia/Urea Storage Tank
  - Requires Ammonia/Urea Resupply

SCR Screen



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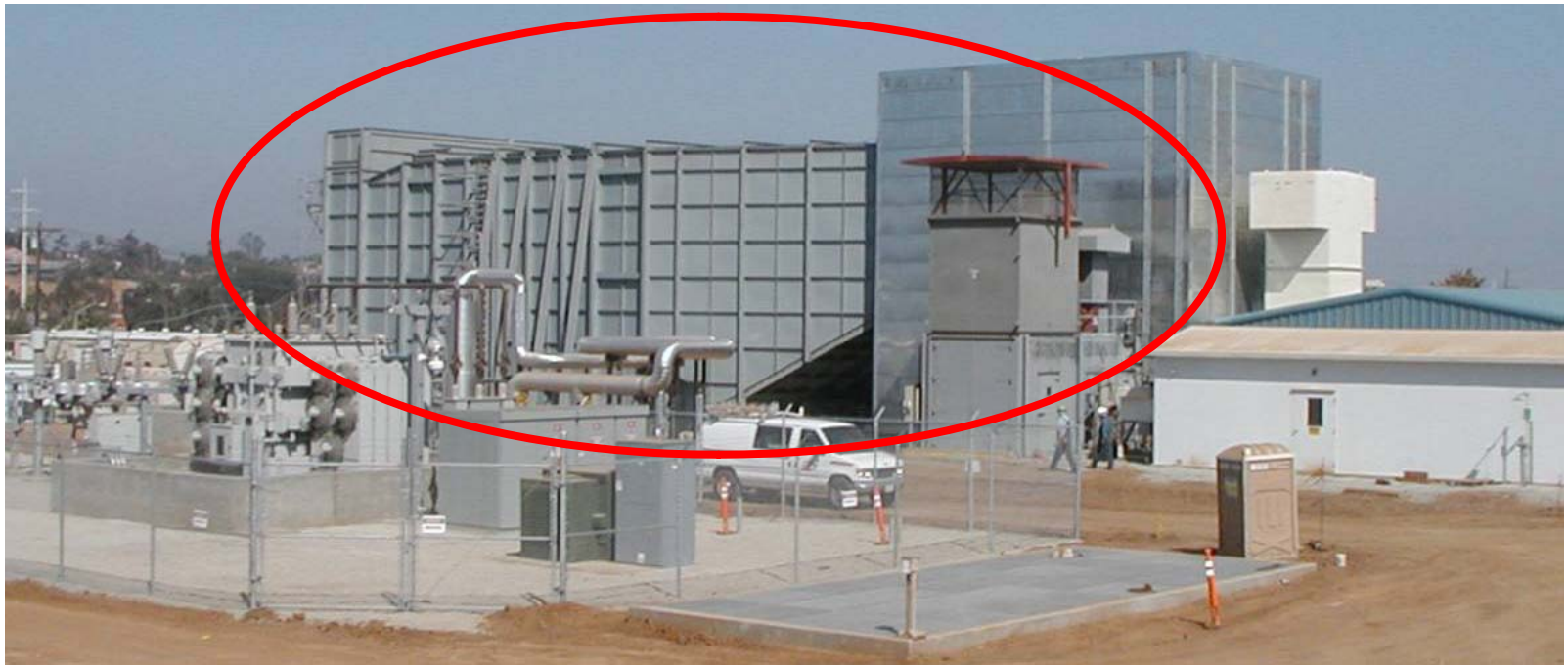
NOx Removal

SCR System Installation



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NOx Reduction

- Dry Low NOx (DLN)
  - No viable solution has yet been engineered for FT4s
- High Pressure Water Injection (HPWI)
  - Injects water into burner section to reduce peak combustion temperatures and reduce NOx

NOx Reduction

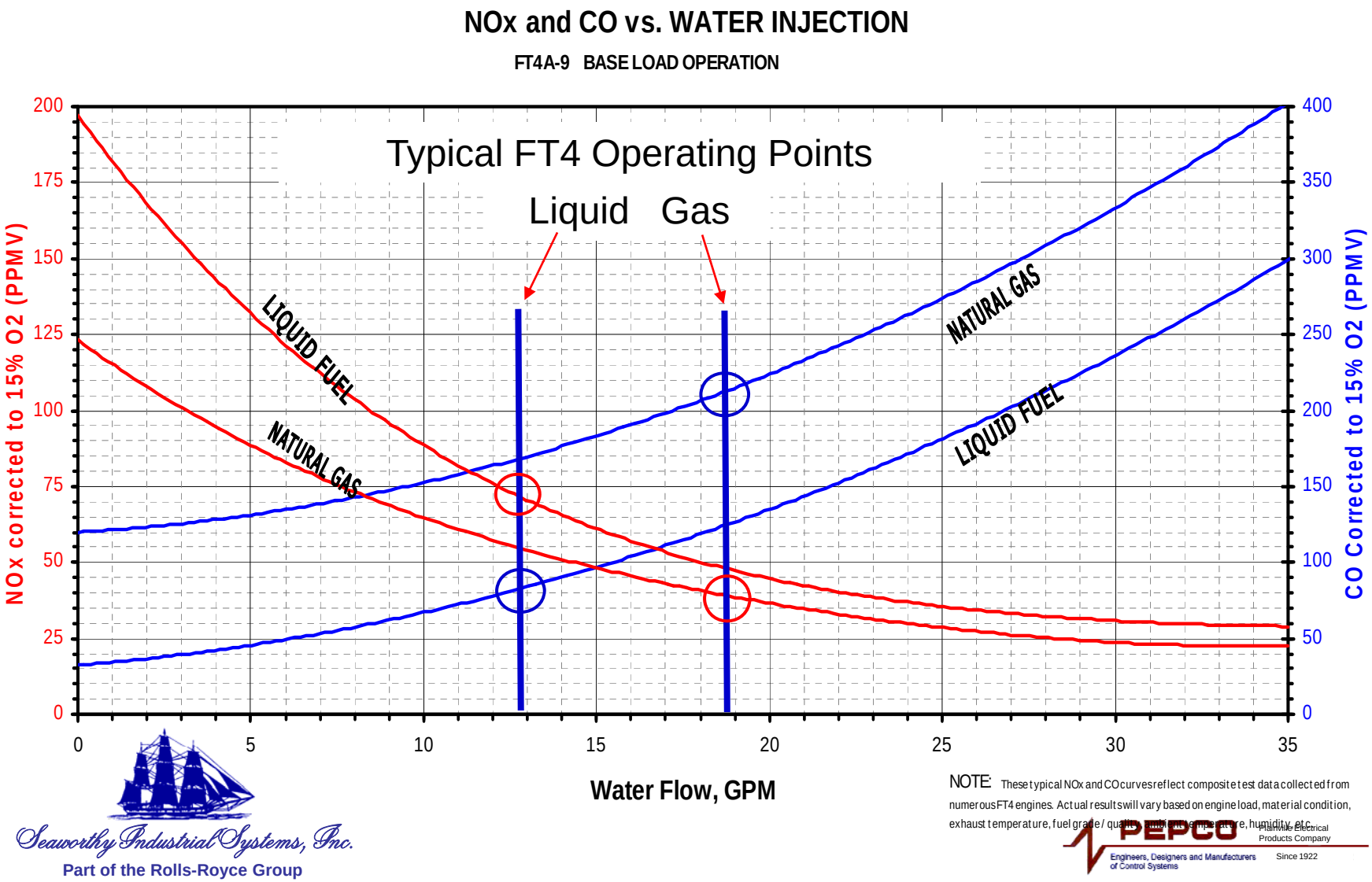
High Pressure Water Injection (HPWI)

- PROS
  - PROVEN technology
  - Simple Installation / packaged system
  - Small installation footprint
  - Low capital cost
  - Low Operations & Maintenance Costs
    - Only consumable is DI water and filters
  - Power increase (~7%) due to increased mass flow
  - Reduces **Opacity**

NOx Reduction

- High Pressure Water Injection (HPWI)
- CONS
  - Increases CO
    - *NOTE: CO for Liquid fuel w/ HPWI is < CO for Gas w/ No HPWI*
  - Need reliable source for DI water
    - Large Tank, or
    - Smaller tank and on-site DI Water Processing System
    - (Requires about 20 GPM per engine)
  - If you have a Gas only FT4, requires dual fuel manifolds
  - Water flow limited by fuel system nozzle capacity

NOx Reduction



NOTE: These typical NOx and CO curves reflect composite test data collected from numerous FT4 engines. Actual results will vary based on engine load, material condition, exhaust temperature, fuel grade / quality, [illegible] temperature, humidity, etc.

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Packaged HPWI System

I/O

I/O

480 VAC

125 VDC

Control Air

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Seaworthy/PEPCO Packaged HPWI

- Uses VFDs and Positive Displacement Pumps
  - Very fine water flow control
  - Smooth water flow change transitions
  - Lower pump discharge pressures
- Designed for minimal site interface requirements
- Interfaces with OEM and retrofitted control systems
- All wetted parts stainless steel
- Welded pipe & flange construction designed for strength & maintainability
- **100% factory tested – Typical Twin Pak commissioning one (1) day.**

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ROI (Return On Investment)

HPWI may pay for itself!

- Reserve Market Pricing (CT typical) of $14,000/MW/month
- Nominal 7% power increase on a 20MW unit is 1.4 MW
- Therefore, 1.4 MW x $14,000/MW/Mo x 12 mo = **$235,200 / year income**

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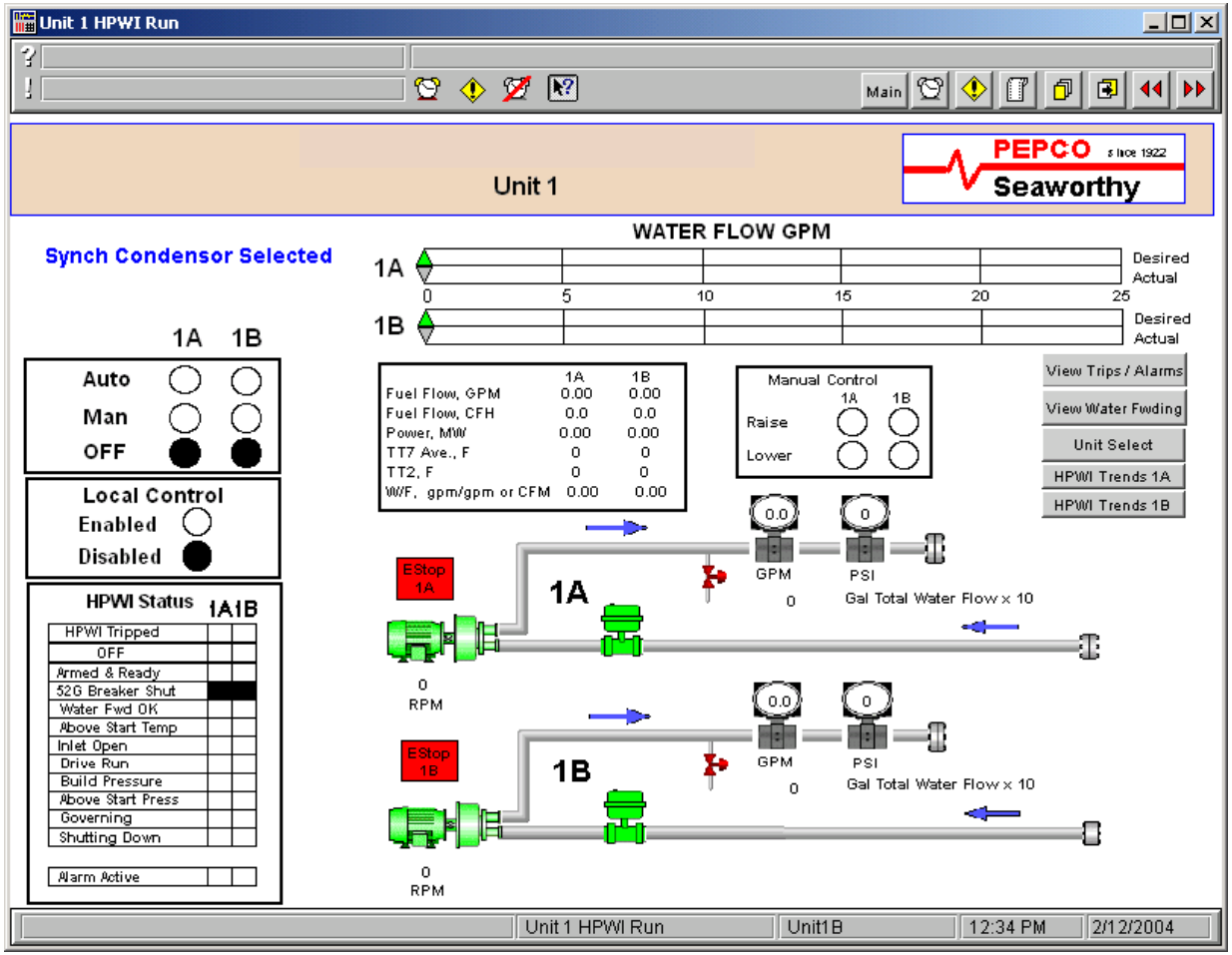
Main Screen



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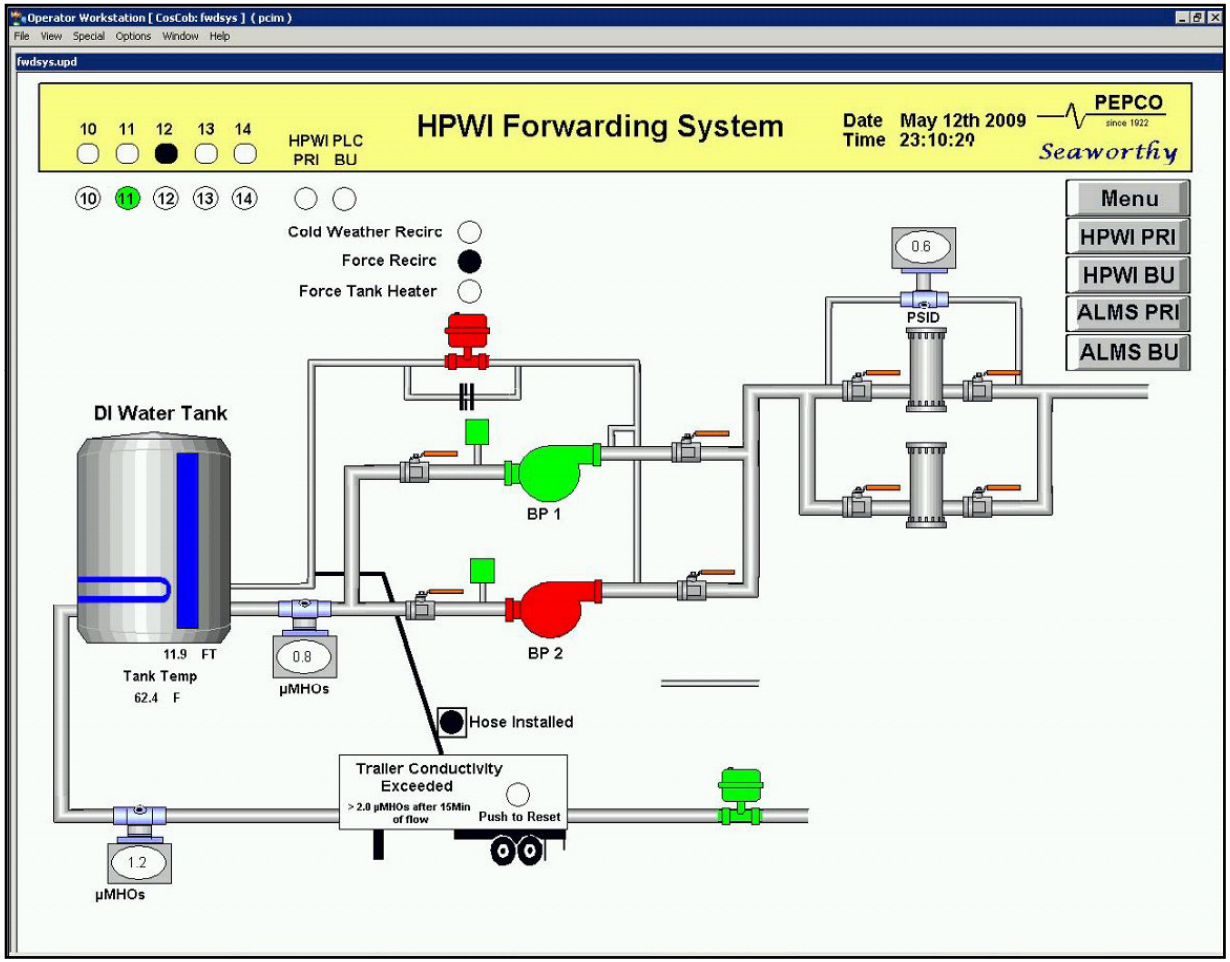
Water Forwarding



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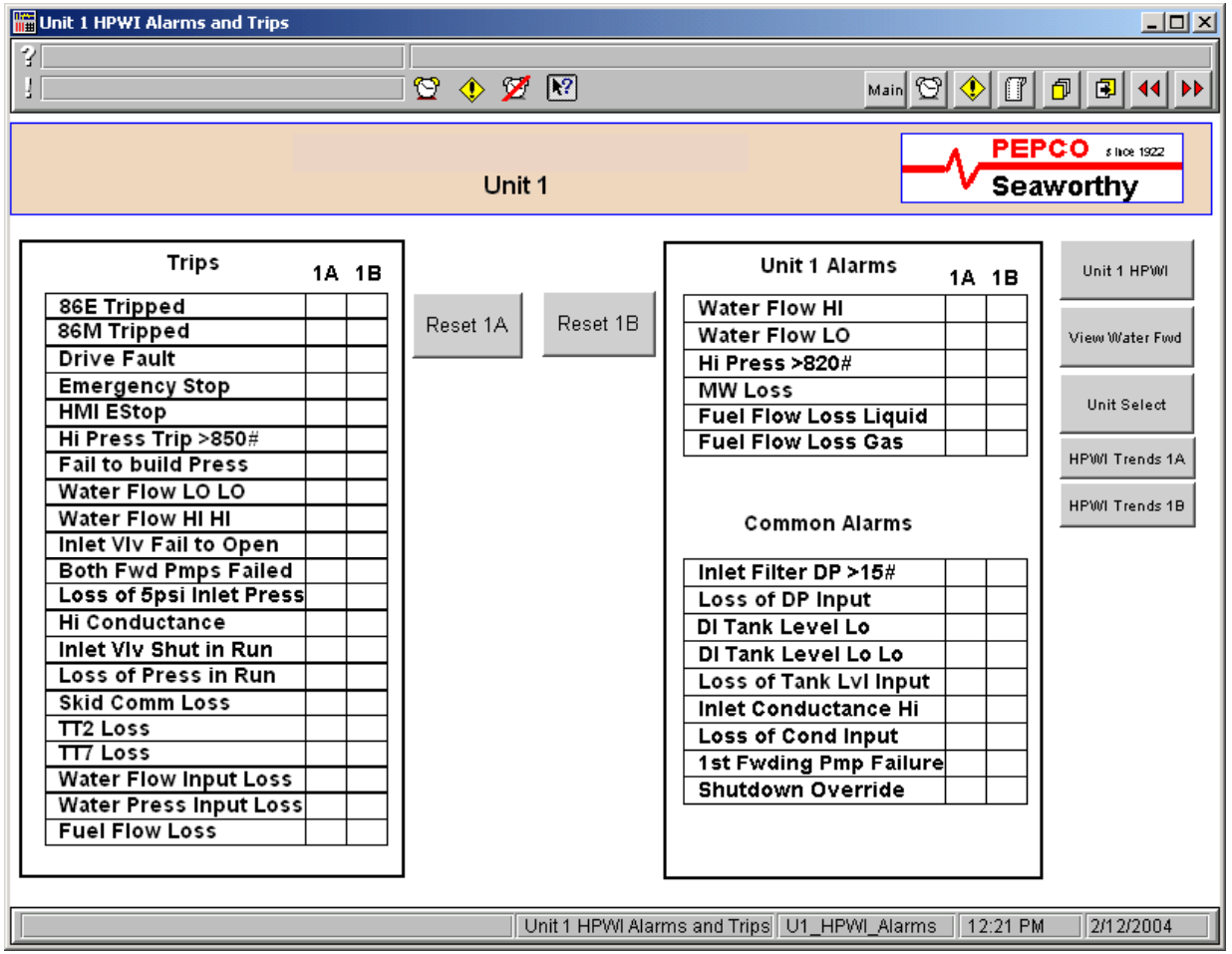
Alarms & Trips



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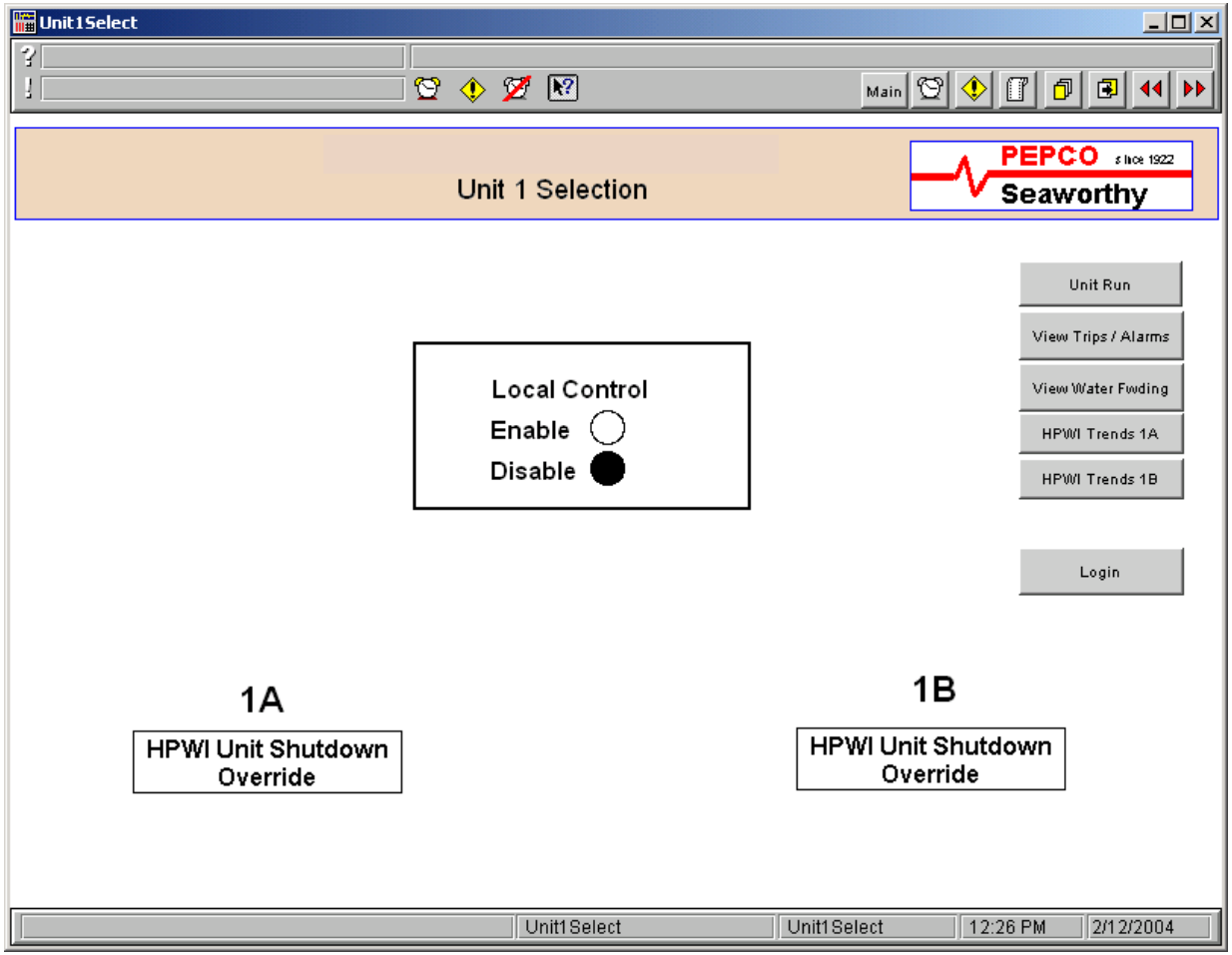
Shutdown Override



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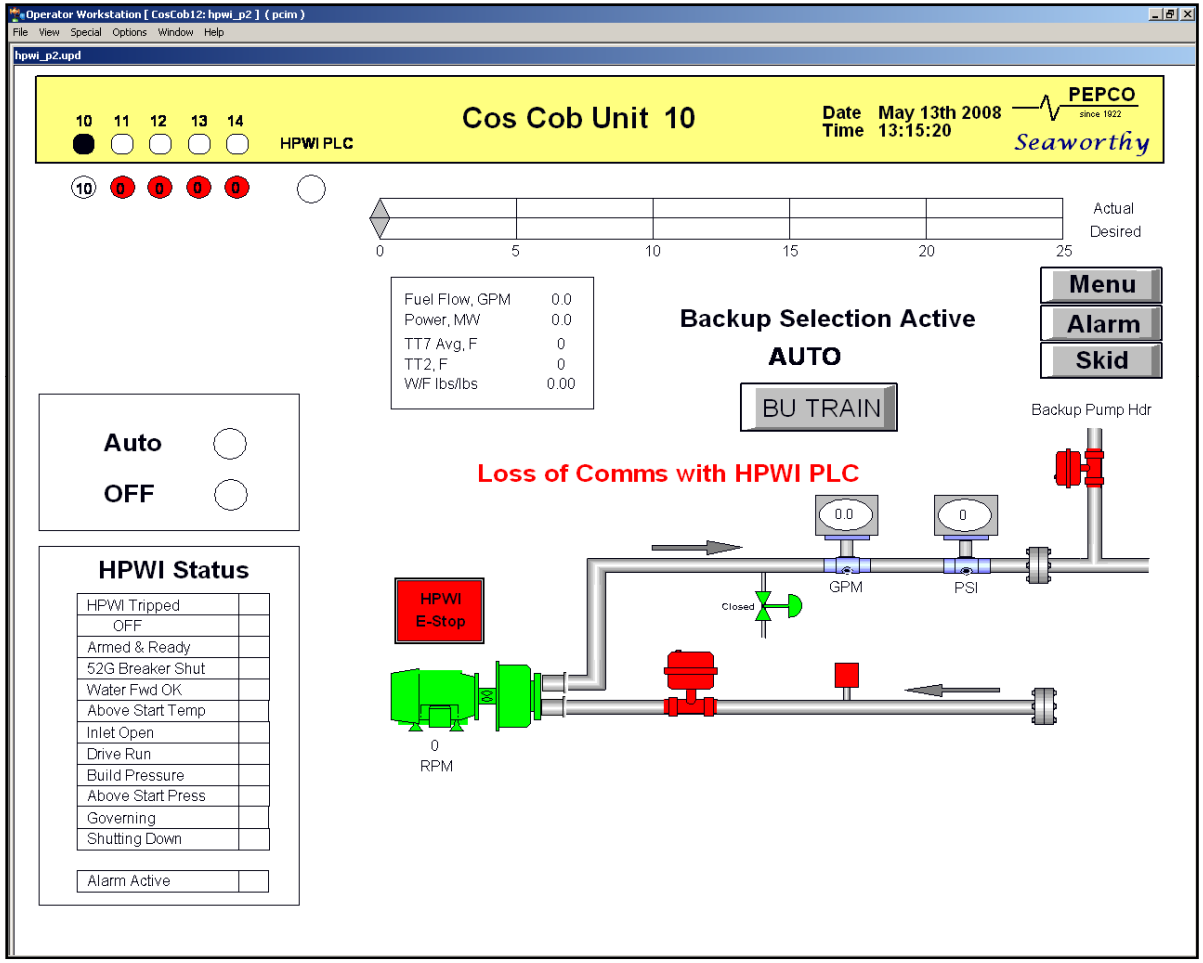
Redundant HPWI System



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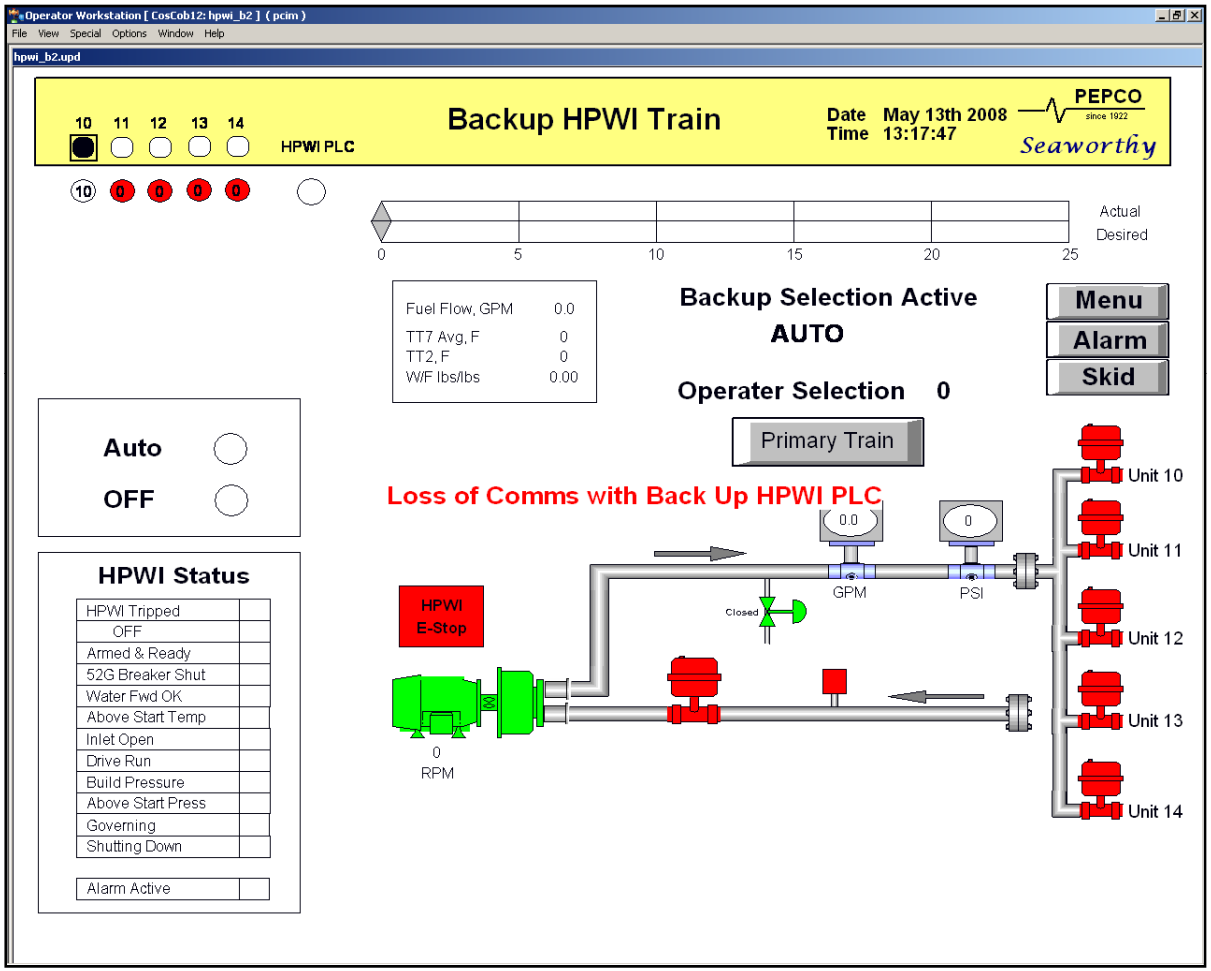

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Seaworthy/PEPCO Packaged HPWI

The Bottom Line

- Simple, very effective design
- Very Low maintenance
  - No mechanical throttling / no wear
  - Field proven Industrial components
- Cost effective

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Combination Removal/Reduction

Many SCR systems use a reduction technology, such as HPWI, to reduce the more expensive SCR requirements and reach lower emissions limits.

Contact Information:

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