7. Exhibit D - Steam Turbine-Generator

Section

7.1 Major Equipment Description

7.1.1 Turbine

One (1) 3,600 RPM, reheat, double flow down exhaust, 40" inch last stage bucket, steam turbine designed for continuous operation at nominal inlet throttle steam conditions of 1905 psia, 1050°F, with 1050°F reheat temperature, exhausting to 1.5" HgA, will include:

- Forged steel rotor with integral wheel geometry
  - Mechanically attached, aerodynamic impulse type buckets
  - Shroud bands at bucket tips
  - Integral thrust runner and generator coupling
  - Designed for thermal cyclic operation
- Cast alloy steel casing construction
  - Casings split and machine ground at horizontal centerline (for easier maintenance)
- Fabricated steel exhaust casing
- Centerline supported diaphragms
  - Welded steel construction
  - Split and keyed at horizontal joint
  - Contains high performance nozzle profiles
  - Support of spring-backed interstage shaft packing
  - Contains radial spill strips, (as required)
  - Contains moisture removal devices in high moisture regions (ears, dams and orifices)
- Cast babbitt-on-steel journal bearing design
  - Replaceable without removing turbine casing upper half
  - Bently-Nevada® probe assemblies for vibration monitoring
- Front standard containing:
  - Pivoted shoe thrust bearing
  - Three axial position probes for thrust position monitoring

- Tilt pad journal bearing design with Bently-Nevada® vibration probes
- Speed pick-ups

• Two (2) combined GE inlet stop and control valves
  - Integral wire mesh strainers
  - Hard stem valve packing
  - Hydraulic actuator assemblies (including power cylinder, servo valve and feedback transducers)
  - Stop valve hydraulic line flushing valve
  - On-line test of valve stem freedom
  - Valve supports
  - Located off chest
  - Motor operated before and after seat drain valves
  - Blowdown cover/gasket, acid wash cover and seat blanking assembly

• Two (2) GE reheat valves
  - Integral wire mesh strainers
  - Hard stem valve packing
  - Hydraulic actuator assemblies (including power cylinder, servo valve and feedback transducers)
  - Motor operated before and after seat drain valves
  - Blowdown cover/gasket, acid wash cover and seat blanking assembly
  - On-line test of valve stem freedom
  - Valve supports

• Admission valves
  - High performance butterfly type
  - Hydraulic actuator assembly including power cylinder, servo valve and feedback transducers

• Two Exhaust casing blowout diaphragms, with two spares

• Carbon steel soleplates and stainless steel shims

• Lagging
  -
  - Specifications for piping thermal insulation
  - Reusable thermal insulation blankets for turbine HP/IP shell

- Preformed segmental insulation (calcium silicate) with AL jacket for main and reheat steam leads (pipe furnished between valves and turbine) and crossover pipe
- Appearance lagging/enclosure for HP/IP casings (outdoor installation)
- Acoustic treatment to lagging as required to meet site acoustic level requirements – 85 dba (near field)

- Exhaust hood spray control and manual bypass valve with stainless steel piping and nozzles inside hood
- Automatic steam seal regulators
  - Automatic dump and makeup valves
  - Handwheels on auto valves for emergency operation
  - Pneumatic controller
  - Individual pneumatic positioners
  - Filter/regulator on air supply
  - Locally mounted steam seal pressure and vacuum header pressure gauges
- Gland condenser
  - Shell and tube design
  - Stainless steel tubes
  - Redundant motor driven blowers with discharge check valves designed for 1 psig maximum discharge pressure
  - Designed for 125°F and 300 psig condensate temperature and pressure

7.1.1.1 Separate Lubrication and Hydraulic Oil Systems

7.1.1.1.1 Lubrication System

- Welded steel oil reservoir shipped fully assembled, wired and sealed after factory flushing, including:
  - Single AC motor-driven vapor extractor
  - Oil mist separator on vapor extractor suction
  - Bearing pressure regulator
  - Connections for oil supply to generator shaft seal system
  - Reservoir mounted Lube oil conditioner
  - Terminal strips for field wiring
  - Relief and access doors

— Connections for draining and cleaning
— Provisions for lifting fully assembled reservoir
— CO_2 connections
— 2" valved connections for buyer's temporary centrifuge system

- Two (2) full capacity AC motor-driven lube and seal oil pumps, including:
  — Inlet strainer baskets
  — Starting pressure switches
  — Service capability without draining reservoir
- DC motor-driven emergency lube oil pump including:
  — Inlet strainer basket
  — Starting pressure switch
  — Service capability without draining reservoir
  — DC motor starter
- DC motor-driven emergency seal oil pump including:
  — Inlet strainer basket
  — Starting pressure switch
  — Service capability without draining reservoir
  — DC motor starter
- Two (2) full capacity stainless steel plate and frame oil coolers
  — Mounted on end of reservoir
  — Designed for fresh cooling water with maximum conditions of 105°F and 150 psig.
  — Cooling water regulator sensor
  — Transfer valve
- Pump test system
- Control instrumentation console with manual pump test valves
- Tank mounted pressure coalescing oil conditioner for water removal
  — Removes up to 99.5% of free and emulsified water

7.1.1.1.2 Hydraulic Power Unit for Use with Fire Resistant Fluid

- Stainless steel reservoir with cleanout and drains
- Two (2) AC motor-driven, pressure-compensated variable displacement type pumps with automatic air bleed valve for starting, and relief valve for overpressure
- High-pressure filters after pump discharge
- Stainless steel interconnecting piping on reservoir
- Gas charged fluid accumulators
- Emergency trip system
  - — Two (2) normally energized DC trip devices (ETD's)
  - — Off-line testing capability of each ETD (generator breaker open)
- Manual hydraulic header bypass for cold start
- Pre-wired at the factory with all external connections (excluding motors) made to terminals or terminal boards
- Air dryer and reservoir vent (desiccant type)
- Heating and cooling system with thermostat to maintain fluid temperature, incorporating one (1) air/fluid heat exchangers
- Fluid conditioning unit including:
  - — Circulating pump
  - — Selexsorb filter and cartridge type polishing filter
  - — Connections for filling and draining the unit
- Instrument panel with test valves and gauges

7.1.2 AC Motor-Driven Turning Gear

- Engaging device for local manual engagement
- Engage and disengage limit switches
- Solenoid valve in air supply used for remote or automatic engagement
- Pressure switch interlock to prevent operation without adequate lube oil supply to bearings

- Hand crank provisions for emergency manual operation

7.1.3 Control System

7.1.3.1 GE Mark VI TMR (Triple Modular Redundant)

- Control functions
  - — Speed control
  - — Load/load limit (valve position)
  - — Load runback from external signal
  - — Inlet pressure control to maintain 1000 psig minimum
  - — Inlet pressure limiting
  - — Auto transfer between inlet pressure control and speed/load functions
  - — Remote speed raise/lower contact inputs
  - — Remote speed/load contact inputs
  - — Megawatt control
- Turbine Generator Protectives
  - — Speed, three (3) channels
  - — Emergency overspeed, three (3) channels with two-out-of-three voting logic
  - — Axial position alarm and trip, three channels
  - — Bearing vibration (Bently-Nevada®), "X" and "Y" directions
  - — Differential expansion alarm and trip
  - — Eccentricity
  - — Exhaust pressure, temperature
  - — Lube and control fluid pressure
  - — Lube and control fluid level
- On and off-line testing
  - — Primary overspeed
  - — Electrical trip devices
  - — Emergency overspeed
  - — Stop valves
- Monitoring of discrete contact and variable signals

- Automation of setpoints and ramps for speedset, load targets and ramp rates
- Operator control consists of: (Second operator control is optional)
  - — A personal computer
  - — Color graphics CRT, 19" table-top mounted
  - — Keyboard
  - — Mouse
  - — Trip and reset buttons
  - — Printer
- Additional "D" processor in auxiliary cabinet to obtain redundant data link with exciter (to be confirmed by Buyer)
- Redundant 115V or 230V AC primary power supplies
- NEMA 4X junction boxes

7.1.4 Generator — Hydrogen Cooled

- Model 324 - 18,000 volts, 60 Hz
- Outdoor installation
- Foundation hardware
  - — Carbon steel foundation plates and stainless steel shims
  - — Alignment keys
  - — Axial alignment block
- Line terminals and neutral terminals mounted at collector end of generator, leads down in lower frame extension (terminal box)
- 0.85 power factor (lagging)
- Generator rotation - clockwise (viewed from collector end of the generator)
- Coupling guard
- Proximity probes and proximeters
- Provisions for one (1) key phasor probe
- Permanently mounted flux probe (stator wedge)

- Stator winding with Class F insulation
- Cylindrical forged steel rotor with Class F insulation
- Class B temperature rise rotor/stator
- Conventional cooled stator
- Direct cooled rotor
  - Rotor balanced to ≤ two (2.0) mils (peak-to-peak @ 3600 rpm)
  - Ground brush rigging
- Generator terminal arrangement
  - Conventional cooled high voltage bushings (HVB)
  - Generator leads exit bottom
  - C800 CTs
  - Line leads outboard of neutral leads at collector end of generator
    - 914 mm (36 in.) centerline spacing for iso-phase bus connection
    - Phase sequence left-center-right (LCR) as viewed from collector end (CE)
- Generator frame prime painted
- Reach-in type collector housing
- Generator cooling system
  - Generator hydrogen coolers
    - Four (4) vertical single-pass coolers
    - 90-10 Cu-Ni tubes
    - Carbon steel tube sheets
    - ASME code stamp
    - Coolers shipped installed in generator
  - Hydrogen system
    - Remote mounted hydrogen control monitor
    - H_2 purity meters (one (1) collector end, one (1) turbine end)
    - Gas purge bottle manifold - shipped loose
    - Removable spool piece for H_2/CO_2 gas supply
    - H_2 core monitor suitable for outdoor installation (shipped loose)
    - Pyrolysate collector (shipped loose)

- H_2/CO_2 gas control valve assembly
-
- Portable CO2/H2 air analyzer

- Lubrication system integral with steam turbine lubrication system
  - Bearing Lube Oil
    - Low lube oil pressure switches
    - One (1) oil drain sight flow per bearing
    - Lube oil pressure valve and gauge
  - Lube oil piping for hydrogen cooled units (shipped loose)
    - Carbon steel piping from end shield to bearing drain enlargement
    - Loop seal
    - Bearing drain enlargement (BDE) - carbon steel
    - Carbon steel feed pipe and flange connections
    - Carbon steel drain pipe and flange connections
    - GTA weld of the root pass for lube oil feed and drain
  - Seal oil system
    - Seal oil control unit
  - Seal oil piping (shipped loose)
    - Stainless steel seal oil feed piping
    - Carbon steel seal oil drain piping
    - Seal drain enlargement - carbon steel
    - Seal drain enlargement liquid level detector
    - Carbon steel float trap
    - Float trap - carbon steel

- Bearings
  - Oil film bearings
  - End shield bearing supports
  - Roll out bearing capability without removing rotor
  - Bearing metal thermocouples - two (2) dual element
  - Bearing drain thermocouple - one (1) dual element

- Generator temperature monitoring devices
  - One (1) common cold gas RTD (hydrogen monitor)
  - Collector air inlet RTD

— Collector air outlet RTD
— Twelve (12) stator slot RTD's
— Eight (8) cold and hot gas path RTD's
— RTDs are 100 ohm platinum

- Generator collector ring assembly
  — Two (2) shrunk-on rings
  — Shaft mounted fan

- Reach-in type collector housing
  — Structural steel brush holder rigging base
  — AC lighting and convenience outlets

7.1.5 Generator Control Panel

7.1.5.1 Generator Control Panel Location

- Customer Control Room

7.1.5.2 Generator Control Panel Features

7.1.5.2.1 Generator Breaker Trip Switch (52g/cs)

7.1.5.2.2 Digital Generator Protection System (DGP)

- Redundant DGP (to be confirmed by Buyer)
- Generator differential (87G)
- Current unbalance (46)
- Loss of excitation (40)
- Reverse power (32)
- Stator ground detection (64G)
- Overexcitation (24)
- Overvoltage (59)
- Over frequency (81O)
- Under frequency (81U)

- System phase fault relay (51V)
- Generator differential lockout relay (86G-1)
- Undervoltage relay (27G)
- Voltage transformer fuse failure (VTFF)
- DCP powered from 2 sources allowing a back-up source of DC power for the DGP (second source by Buyer)

7.1.5.3 Generator Control Panel Discrete Relays

- Synchronizing Undervoltage relay (27BS-1,2)
- DC tripping bus, blown fuse protection (74)
- Distance relay (21) (LPSO)
- Breaker or lockout trip coil monitor (74)
- Reverse/Inadvertent energization protection (50RE/86RE)
- Breaker failure protection (50/62BF, 62BF)
- Out-of-step protection (78) (LPSO)

7.1.5.4 Generator Control Panel Instrumentation

— Generator multitransducer 4-20mA (96M)
  – Up to 10 customer outputs (VAR, WATTS etc)

- Generator digital multimeter
  - — VM - Generator Volts
  - — AM - Generator Amps: Phase 1,2,3 and Neutral
  - — MWATTS - Generator MegaWatts
  - — MVAR - Generator MegaVArs
  - — FM - Generator frequency
  - — MVA - Generator MVA
  - — PF - Generator Power Factor
  - — MWH - Generator MegaWatt-Hours
  - — MWVAH - Generator MVA Hours

- Bus digital multimeter
  - VM - Bus Volts:
  - PF - Bus Power Factor

7.1.5.5 Transformer Differential Protection

- SR 745 relay w/2 restraint
  - Transformer differential (87T)
  - Lockout relay (86T)

7.1.5.6 Integrated Into SPEEDTRONIC™ Mark VI

- SPEEDTRONIC Mark VI with speed matching, synch & check
- Manual sync displayed on SPEEDTRONIC Mark VI <HMI>
- Load control in SPEEDTRONIC Mark VI
- Temp indication-for generator RTD's
- Auto/manual synchronizing module displayed on SPEEDTRONIC Mark VI <HMI>
- Generator voltage matching (90VM)

7.1.6 Generator Excitation Systems

- Static auxiliary busfed, hot back-up bridge

7.1.6.1 Excitation Module Features

- Control/monitor/display through TCP
  - Voltage matching
  - VAR/PF Controller
  - Selection of automatic or manual regulator
  - Raise-lower of the active regulator setpoint
  - Enter setpoint command
  - Display field amps
  - Display field volts

™ A Trademark of the GE Company

- — Display transfer volts
- — Display field temperature (calculated)

- Built-in diagnostic display panel
  - — Automatic voltage regulator (AVR)
  - — Manual voltage regulator (FVR)
  - — Automatic and manual bi-directional tracking
  - — Reactive current compensation (RCC)
  - — Volts per hertz limiter (V/Hz LIM)
  - — Volts per hertz protection (24EX) (Backup to 24G)
  - — Over excitation limiter (OEL)
  - — Over excitation protection (76EX)
  - — Under excitation limiter (UEL)
  - — Generator field ground detector (64F)
  - — VT failure detector (PTFD) (60EX)
- Dual source internal bulk power supply
- Millivolt shunt for field
- Surge protection
  - — VT disconnect and CT shorting switches
  - — Two phase current sensing
  - — Three phase voltage sensing
  - — Single pole dc field contactor
- Thyristor bridge circuit filtering
- Shaft voltage suppresser circuit (mounted in panel)
  - — Field de-excitation circuit (with field discharge inductor)
  - — Bridge disconnect; ac no load
- Power system stabilizer
  - – PSS tuning study
  - – PSS field tuning

7.1.6.2 Performance

- 2.0 response ratio and 160% VFFL (100°C) ceiling @ Vt = 1.0pu

7.1.6.3 Enclosure Location

- Excitation compartment

7.1.6.4 Exciter Panel Construction

- NEMA-I enclosure
- Standard paint ANSI-70 light gray, interior and exterior

7.1.6.5 Excitation Transformer

- Oil filled-outdoor
- Fed from auxiliary bus

7.1.6.6 Special Tools

- One (1) set of eye bolts, balance weight kit, bolt heating device, tools to remove generator field, wrenches for turbine casing and stop valve head, slings and lifting beam for turbine rotor and casing.

7.2 Steam Turbine Mechanical Systems Description

7.2.1 Casing

Horizontally split, cast alloy steel symmetrical casing design incorporates free expansion of both rotating and stationary parts in all directions. The internal parts of the turbine are supported at the horizontal centerline of the unit. This allows expansion to be evenly distributed around the center of the unit where clearances are critical with respect to the rotor. During start-ups or rapid load swings, the casings are free to expand radially and axially while diaphragms remain concentric with the shaft at all times. The casing design incorporates minimum wall thickness with liberally designed fillets to reduce stress concentrations, and expedite starting and loading.

7.2.2 Diaphragms

The diaphragm assemblies are fabricated of semicircular flat plates with nozzle airfoils inserted between the inner and outer rings. The diaphragm rings are constructed of low-alloy steel suitable for the operating temperature, and the aerodynamically shaped nozzles are made of 12-chrome steels.

7.2.3 Rotor

The forged alloy steel rotor features rows of separate wheels that are an integral part of the shaft and are designed to carry the centrifugal load of the mechanically attached impulse type buckets. This design results in smaller shaft diameters and therefore decreases the sealing area of the inter-stage packing, which reduces leakage from the steam path and increases efficiency.

Integral wheel construction allows for thinner wheel thickness, which minimizes thermal stresses across the wheel and external dovetail. Fillet radii where the wheel meets the shaft are kept generous to reduce stress concentrations to the required low levels. By controlling the integral wheel thickness and shape, centrifugal stresses are kept at low levels. and starting and loading operations are expedited

Diameter changes in the shaft are kept small and gradual so that bending stresses are extremely low.

7.2.4 Buckets

The buckets are resistant to corrosion and erosion by steam. They are machined from bar stock or forgings, and are dovetailed to the wheel rims by a precision machine fit.

Metal shrouds are used to tie together the outer ends of the buckets. This improves efficiency and rotor dynamics.

The last stage bucket data will be dependent upon the site conditions, which to be decided later.

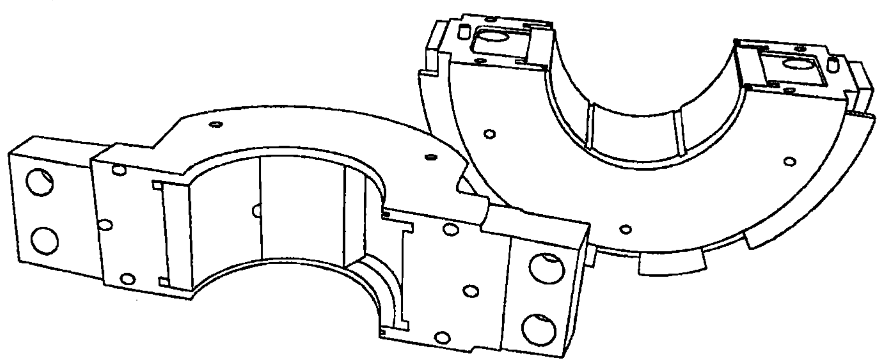
7.2.5 Labyrinth Shaft Packings

Spring-backed metallic labyrinth packings are used on both ends of the shaft and between the stages. Tooth design assures maximum protection against steam leakage and resultant energy waste.

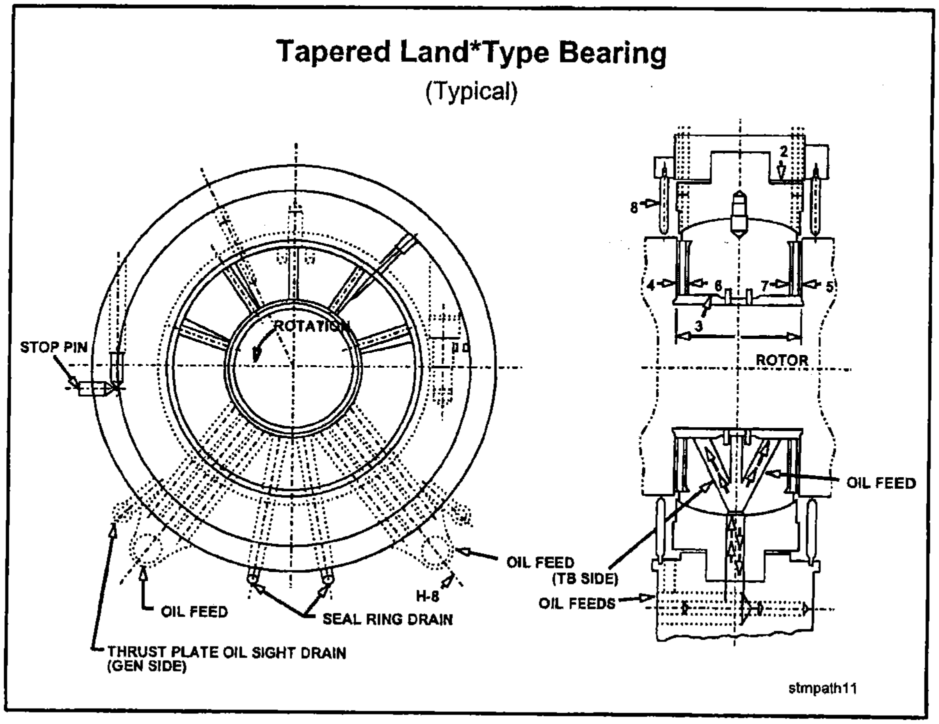
7.2.6 Thrust Bearing

A pivoted shoe thrust bearing is used to position the rotor axially in the casing and to absorb thrust loads generated during operation.

Tilting*Pad Journal Bearing
(typical)



stmpath7



7.2.7 Journal Bearings

Both tilting pad and elliptical journal bearings are employed. The journal bearings contain ports through which oil is supplied to the bearing. Oil flowing through the bearing absorbs heat from the journal as the shaft carries it over the upper half of the bearing. A portion of the oil is carried between the lower half of the bearing and the journal by rotation of the shaft. This forms a hydrodynamic oil film which supports the weight of the rotor and prevents any metal-to-metal contact. Instrumentation is provided to present vibration data to the operator.

The turbine rotor journal bearings are split horizontally, which allows the bearings to be removed without removing the casing upper halves.

7.2.8 Main Steam Valves

7.2.8.1 Combined Inlet Stop and Control Valve

Off-chest valves are made specifically for sliding pressure combined cycle applications. They contain in a common casing two (2) poppet type valves with independent actuators.

The control valve portion is normally fully open to provide minimum flow restriction. It can be used to control flow if the steam turbine is operated in a pressure control mode of operation or during start-up/shut-down transients. The valve is spring closed, and opened with a hydraulic actuator for throttling or full open positions. LVDT's, and servo valves are used for feedback and control. Closing of this valve is used as back-up protection to the stop valve. The stop valve portion of the combined stop valve/control valve (SV/CV) assembly is actuated independently of the control valve portion. It contains its own hydraulic actuator with a spring for closure. The stop valve is used to isolate the main steam inlet during emergency conditions.

Provisions are made for on-line periodic testing of both valve actuators and steam freedom. A steam strainer is provided to prevent material from entering the valve/turbine. The strainer has a coarse mesh wrapper for normal running and a fine mesh (start-up) screen.

7.2.8.2 Combined Reheat Valves

There are two combined reheat valves, one located on each side of the reheat turbine. Their primary purpose is to protect the unit from overspeed due to the energy stored in the reheater and reheat piping. Each combined reheat valve consists of a reheat stop valve, and intercept valve. The reheat stop and intercept valves have separate actuators and operate completely independently. As with the SV/CV, strainers are provided.

7.2.9 Steam Seal System

The steam sealing system comprises all valves, operators, gland steam condenser with a blower, and necessary instrumentation to allow fully automatic operation of the system by the turbine control room.

The steam-sealing system provides steam to and evacuates steam-air mixtures from the shaft packings in such a manner as to prevent steam escaping from the high-pressure and intermediate-pressure shaft packings and to prevent air from entering the low-pressure hoods along the shaft packings. The system allows full vacuum to be established in the main condenser even when the turbine is on turning gear.

The steam-air mixture in each packing's outboard annulus is exhausted by the action of a Gland Steam Condenser (GSC) blower. The steam is condensed in the condenser portion of the GSC and the condensate returned to the feedwater system via the main condenser. The air is exhausted to atmosphere. The coolant use by the GSD is condensate.

Temperature attemperation of the steam used for sealing the low-pressure hood seals is accomplished by routing the low pressure hood steam packing piping within the condenser neck. The cool low pressure turbine exhaust steam flowing around these pipes provides the required desuperheating without the danger of water being introduced into the low pressure packings. Adequate drainage provisions are made at system low points to ensure proper system drainage for all operating conditions. The system is provided with a relief valve to protect all system components including shaft packing casings from overpressure.

A steam seal can operate in two different modes. It can work either as a vacuum packing, which prevents air from leaking into the turbine, or as a pressure packing, which prevents the higher pressure steam from leaking out into the turbine room. When the turbine is on turning gear with vacuum pulled. all steam seals act as vacuum packings. As the unit is loaded, pressure in the HP and IP sections increases and the packings at the end of these sections change their function and become pressure packings.

All steam seal packings are designed to minimize steam leakage loss. Individual segmented spring-loaded packing rings are employed which permit the use of minimum radial clearance. This flexible packing ring design effectively resists long-term radial clearance growth due to possible rubbing during turbine startups. The packing tooth configuration is selected to minimize leakage flow consistent with the analysis of axial differential expansion.

The "high-low" packing design is most effective and is used in sections adjacent to the thrust bearing where axial differential expansions are relatively small. When expansions become too large, such as in the LP sections of the turbine, the use of non-interlocking teeth packings are more effective. In this case the rotor can be either smooth or can have slanted grooves to maximize the sealing effectiveness.

7.2.10 Lubrication System

A lubrication system is supplied to provide lubrication for turbine and generator bearings, and to provide seal oil to the generator shaft seals.

The turbine lubrication system is primarily comprised of a main oil reservoir which contains various pumps, coolers, regulators and other items required for a completely integrated lubrication system.

7.2.10.1 Oil Reservoir

A welded steel oil storage tank of sufficient capacity is provided to store all of the oil required by the pumping system including the flowback. The tank is located at an elevation below the turbine operating floor so the oil drainage from the main bearings is by gravity. The oil level in the tank provides adequate submergence of all pumps, which extend vertically down into the oil, and in addition results in a low recirculation rate. The low recirculation rate and minimum turbulence permit the returned oil to detrain air before being picked up by pump suction.

An AC motor-driven vapor extractor is provided to create negative pressure in the oil tank. This will eliminate leakage of oil mist into the turbine hall through the oil deflectors.

- Local pump test system (for all motor-driven pumps) including:
  - — Instrument panel, with 4-1/2 inch gauges, mounted on reservoir
  - — Test valves
  - — Pump discharge pressure gauges
  - — Shut-off valves for gauges
- Electrical enclosure including:
  - — Terminal strips, for Owner's connections
  - — Low oil level trip switch (DPDT)
  - — Low bearing pressure pre-alarm switch
  - — Low bearing pressure trip switch
  - — Low bearing pressure alarm switch
  - — Pump running pressure switches

7.2.10.2 Oil Pumps

Two (2) AC motor-driven, centrifugal-type oil pumps are arranged in parallel. If the operating pump fails, a drop in oil pressure will be sensed by a pressure switch which will provide a signal to start the alternate pump. A DC motor-driven emergency bearing oil pump and a DC motor-driven emergency seal oil pump are provided should both of the AC motor-driven pumps fail, in which case the oil pressure will drop to a lower level where the pressure switch will signal the DC pump to start.

All pumps are serviceable without draining the oil reservoir.

7.2.10.3 Oil Coolers

Two (2) 100%-capacity oil-to-water coolers are mounted at the end of the main oil tank to cool the oil before it is supplied to the turbine bearings. The coolers are ASME code stamped. The coolers are designed for fresh cooling water with maximum conditions of 105°F and 150 psig.

One (1) cooler is in use, with the second in reserve. This permits the removal of one cooler from service for repair or replacement without having to shut down the turbine.

- Local pump test system (for all motor-driven pumps) including:
  - — Instrument panel, with 4-1/2 inch gauges, mounted on reservoir
  - — Test valves
  - — Pump discharge pressure gauges
  - — Shut-off valves for gauges
- Electrical enclosure including:
  - — Terminal strips, for Owner's connections
  - — Low oil level trip switch (DPDT)
  - — Low bearing pressure pre-alarm switch
  - — Low bearing pressure trip switch
  - — Low bearing pressure alarm switch
  - — Pump running pressure switches

7.2.11 Hydraulic Power Unit

The hydraulic power unit supplies fire resistant fluid under pressure directly to the servo valves on the power actuators of the valve gear to open and close the steam valves, and indirectly to the stop valve through a series of trip devices.

7.2.11.1 Hydraulic Fluid Reservoir

The fluid reservoir is constructed entirely of stainless steel. Front and rear cover plates provide access to the reservoir for cleaning.

A desiccant-type air dryer on top of the reservoir removes moisture from air inside the reservoir as well as air breathed by the reservoir as the fluid level changes. Air is drawn through a filter and circulates through bags of desiccant in a perforated canister.

A heating/cooling circulating pump is used to add heat, when required, to maintain fluid temperature. An air/fluid heat exchanger is employed to cool the fluid. Its design insures that cooling water cannot contaminate the hydraulic fluid. The system operates automatically by a preset temperature controller which senses reservoir temperature.

Accumulators under the reservoir provide an immediate source of hydraulic fluid to satisfy large transient demands of valve actuators. The accumulators are pre-charged with nitrogen.

7.2.11.2 Pumping System

Two (2) AC motor-driven, variable displacement pumps with pressure compensators are used to operate the hydraulic power unit. The pressure compensator maintains the preset pressure throughout the delivery flow range. A relief valve on the pump discharge protects the system by bypassing pump output back to the reservoir.

A filter is provided downstream of pump discharge to assure system cleanliness.

7.2.11.3 Fluid Conditioning Unit

A fluid conditioning unit is provided to treat reservoir fluid by circulating the fluid from the reservoir, in a bypass loop through a Selexsorb® filter and cartridge type polishing filter. This system utilizes an AC motor-driven fixed displacement pump, and incorporates connections for filling and draining the unit.

7.2.12 Motors

TEFC enclosures are provided for integral HP motors where available. TENV enclosures are provided for fractional HP motors, and for integral HP motors if TEFC is not available.

- Class "F" insulation with Class "B" rises for AC motors
- Class "F" insulation for DC motors
- Dual voltage integral HP AC motors
- DC motors
- Oversize connection boxes

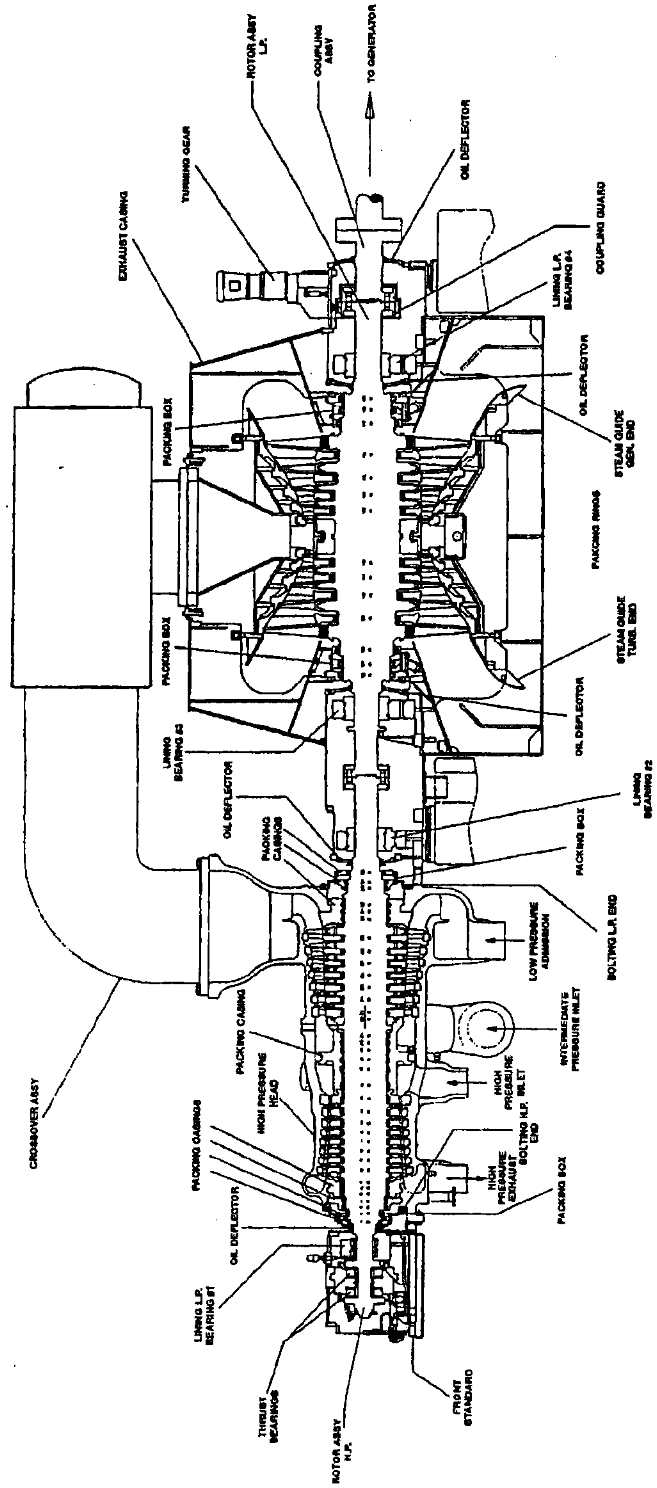
- Motor drain plugs (where available)
- Severe duty motors with 1.15 service factor
- Fungus resistant insulation

7.2.13 Turning Gear

A turning gear is provided to rotate the turbine-generator shaft slowly (approximately 3-5 rpm) during shutdown periods and in preparation for start-up. When a turbine is shut down, its internal elements continue to cool for many hours. To eliminate distortion that would be caused by allowing the rotor to remain stationary during the cool down period, the turning gear keeps the turbine and generator rotors revolving continuously until temperature change has stopped and the casing has become cool. Additionally, the turning gear can be used as a jacking device to turn the rotor small amounts for inspection.

The turning gear is driven by an AC motor, and power is transmitted to the turbine shaft through a reducing gear train. Lubrication for the turning gear is provided from the main lube oil system directly from the main bearing header. Valves are provided to admit oil to the turning gear. A pressure switch senses oil pressure within the turning gear and interlocks the turning gear motor starter circuit to prevent operation without adequate lube oil supply.

D–11
Reheat Double Flow Condensing
(typical)



stmturbar25
rev. 0 (294)

7.3 Generator Electrical Systems Description

7.3.1 Electrical Rating

The generator is designed to operate within Class "B" temperature rise limits, per IEC standards, throughout the allowable operating range. Insulation systems utilized throughout the machine are proven Class "F" materials.

7.3.2 Packaging

Buyer will assemble 324 Generator at site at its own cost. If requested by Buyer, Seller will provide up to 6 man-weeks of TA services free of cost for this purpose The generator is designed for ease of service and maintenance. The generator stator will receive a 150% pressure test and a 60 psig seal oil test will be performed to ensure seals are seated properly.

Field assembly will include but should be limited to the following:

— Loop seal between BDE and drain tank is shipped loose

— High voltage bushings

— Wiring from generator devices to customer supplied junction boxes

— Collector housing and brush rigging require some disassembly and alignment to the collector rings in the field

7.3.3 Frame Fabrication

The frame is a stiff structure, constructed to be a hydrogen vessel able to withstand in excess of 200PSI. It is a hard frame design with its four-nodal frequency significantly above 120Hz. The ventilation system is completely self contained, including the gas coolers within the structure. The gas-tight structure is constructed of welded steel plate, reinforced internally by radial web plates and axially by heavy wall pipes, bars and axial braces.

A series of floating support rings and core rings are welded to keybars which in turn support the core allowing the entire core to be spring mounted at twenty locations. This arrangement isolates the core vibration, resulting from the radial and tangential magnetic forces of the rotor, by damping the amplitude and reducing the transmissibility by 20:1. Excessive movement of the core, as may result from out of phase synchronization, is limited by the use of stop collars at certain circumferential locations around the frame. The clearance is designed to allow the spring action of the bar to be unrestricted during normal operation but to transmit the load of excessive movement through the structure prior to yielding of any of the components.

The stator frame is supported on feet attached to the side of the fabrication. All the weight of the unit and the operating loads is carried through the structure by the web plates and the wrapper to the feet. The machined portion of the feet is located 30 in. below the centerline of the unit.

7.3.4 Core

The core is laminated from grain oriented silicon steel to provide maximum flux density with minimum losses, thereby providing a compact electrical design. Laminations are coated on both sides to ensure electrical insulation and reduce the possibility of localized heating resulting from circulation currents.

The overall core is designed to have a natural frequency in excess of 170 hertz, well above the critical two-per-rev electromagnetic stimulus from the rotor. Numerous individual segments separated by radial ventilation ducts make up the axial length of the core. The ducts at the core ends are made of stainless steel to reduce heating from end fringing flux and the flanges are made of cast iron to minimize losses. To ensure compactness, the unit will receive periodic pressing during stacking and a final press in excess of 700 tons after stacking the core.

7.3.5 Rotor

The two pole design rotor is machined from a single high alloy steel forging with axial slots machined radially in the main body of the shaft. The axial vent slots machined directly into the main coil slot are narrower then the main slots and provide the direct radial cooling of the field copper.

The two retaining rings are of the body mounted design. The rings are made of 18 Mn - 18 Cr forged material which offers excellent protection against stress corrosion cracking.

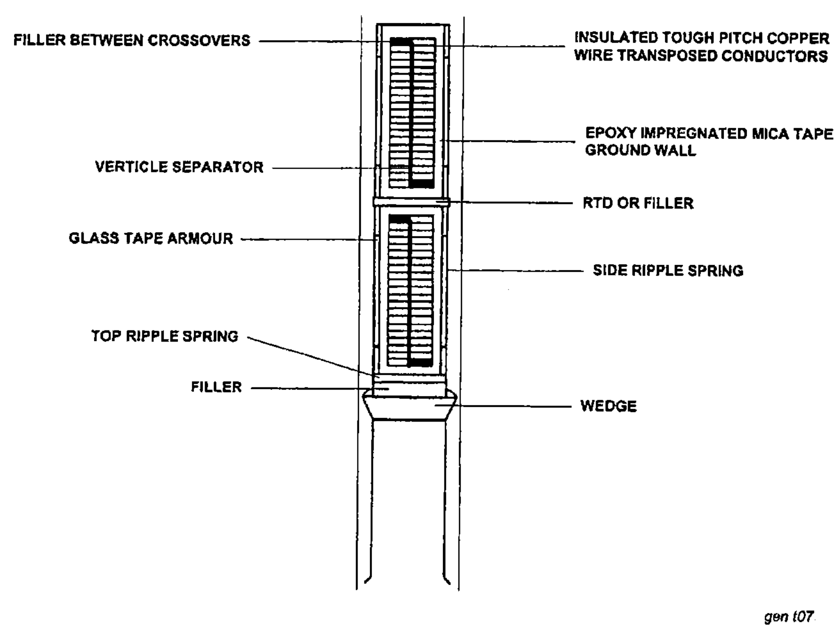
The coil wedges are segmented stainless steel with radial holes drilled in for ventilation passages.

7.3.6 Field Assembly

The field turns are made from high conductivity silver-bearing copper. Each turn has slots punched in the slot portion of the winding to provide direct cooling of the field. The end turns are of the same cross section as the slot portion. The entire coil is pre-assembled with square corner, overlapping brazed joints.

The slot armor is a Class "F" rigid epoxy glass design. An insulated cover is positioned on the bottom of each slot armor and on top of the subslot vent to provide the required creepage between the lower turn and the shaft. Epoxy glass insulation strips are used between each coil turn. A pre-molded polyester glass retaining ring insulation is utilized over the end windings and a partial amortisseur is assembled under the rings to form a low resistance circuit for eddy currents to flow. The rotor is designed to accommodate static start hardware utilizing full length slot amortisseurs.

Stator Slot Section
(Typical)



The collector assembly incorporates all the features of GE proven generator packages with slip on insulation over the shaft and under the rings. Collector rings use a radial stud design to provide electrical contact between the rings and the field leads. The rings are designed to handle the excitation requirements of the design.

7.3.7 End Shield/Bearing

The unit is equipped with end shields on each end, designed to support the rotor/bearings, to prevent gas from escaping, and to be able to withstand a hydrogen explosion in the unlikely event of such a mishap. In order to provide the required strength and stiffness, the end shields are constructed from steel plate and are reinforced. The split at the horizontal joint allows for ease of assembly and removal.

The center section of the end shields contains the bearings, oil deflectors and hydrogen seals.

A three section inner and a two section outer oil deflector is bolted into the end shield and provides sealing of the oil along the shaft. The deflectors are either fabricated or cast aluminum and incorporate the insert teeth design which are replaceable. All faces of the deflectors have "O" ring grooves to provide additional protection from oil leaks. All annular areas formed between the set of teeth are designed to provide minimum pressure drops and have oil gutters machined in to prevent oil from backdripping on the shaft.

The hydrogen seal casing and seals, which prevent hydrogen gas from escaping along the shaft, utilize steel babbitted rings. Pressurized oil for the seals is supplied from the main oil system header to the seal oil control unit where it is filtered and regulated.

The connection end bearing and hydrogen seals are insulated from the rotor to prevent direct electrical contact between the rotor and the end shield.

All exiting wiring from the temperature indication devices and the insulating test leads are brought out of the unit through gas tight conex type seals to prevent any chance of a hydrogen leak.

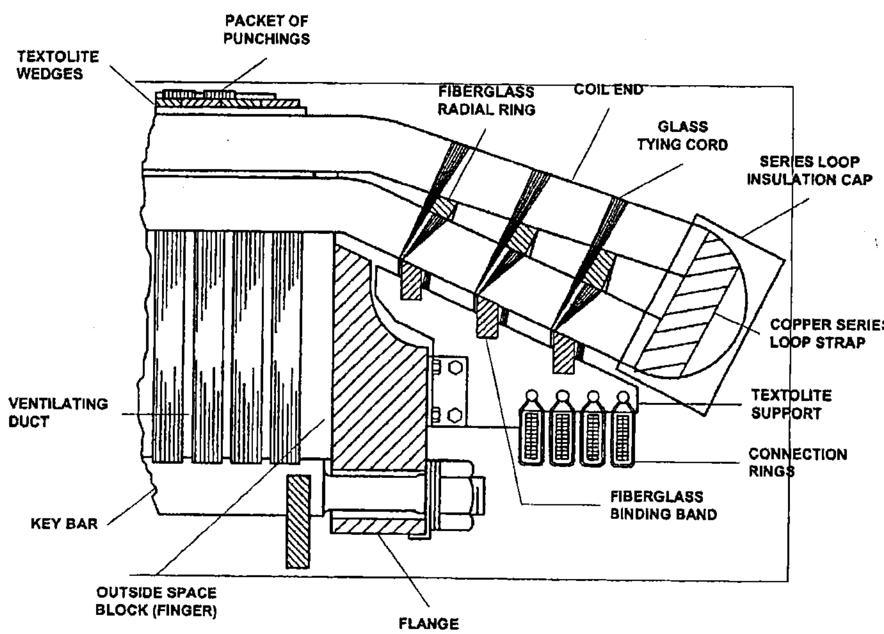
7.3.8 Winding

The armature winding is a three phase, two circuit design consisting of "Class F" insulated bars. The stator bar stator ground insulation is protected with a semi-conducting armor in the slot and GE's well proven voltage grading system on the end arms.

The ends of the bars are pre-cut and solidified prior to insulation to allow strap brazing connections on each end after the bars are assembled. A resin impregnated insulation cap is used to insulate the end turn connections.

The bars are secured in the slot with side ripple springs (SRS) to provide circumferential force and with a top ripple spring (TRS) for additional mechanical restraint in the radial direction. The end winding support structure consists of glass binding bands, radial rings, and the conformable resin-impregnated felt pads and glass roving to provide the rigid structure required for system electrical transients. Please see the stator end winding illustration provided below.

Stator End Winding Structure
(Typical)



7.3.9 Lead Connections

All the lead connection rings terminate at the top of the excitation end of the unit and the six high voltage bushings (HVBs) exit at the top of the frame.

The six high voltage bushings are made up of porcelain insulators containing silver plated, copper conductors which form a hydrogen tight seal. The bushings are assembled to non-magnetic terminal plates to minimize losses. Copper bus is assembled to the bushings within an enclosure. Customer connections are made beyond the customer supplied terminal enclosure and the specific mating arrangements will be provided within the enclosure, not inside the generator.

7.3.10 Hydrogen Cooling System

The generator is cooled by a recirculating hydrogen gas stream cooled by gas-to-water heat exchangers. Cold gas is forced by the generator fans into the gas gap, and also around the stator core. The stator is divided axially into sections by the web plates and outer wrapper so that in the center section cold gas is forced from the outside of the core toward the gap through the radial gas ducts, and in the end section it passes from the gas gap toward the outside of the core through the radial ducts. This arrangement results in substantially uniform cooling of the windings and core.

The rotor is cooled externally by the gas flowing along the gap over the rotor surface, and internally by the gas which passes over the rotor and windings, through the rotor ventilating slots, and radially outward to the gap through holes in the ventilating slot wedges.

After the gas has passed through the generator, it is directed to four vertically mounted gas-to-water heat exchangers. After the heat is removed, cold gas is returned to the rotor fans and recirculated.

7.3.11 Hydrogen Control Panel

To maintain hydrogen purity in the generator casing at approximately 98 percent, a small quantity of hydrogen is continuously scavenged from the seal drain enlargements and discharged to atmosphere. The function of the hydrogen control panel is to control the rate of scavenging and to analyze the purity of the hydrogen gas. The panel is divided into two compartments, the gas compartment and the electrical compartment, which are separated by a gas-tight partition.

7.3.11.1 Control Panel Functions

The GE hydrogen control panel is designed for use on hydrogen cooled generators with scavenging systems. The panel functions are described below:

— The hydrogen control panel allows manual control of the continuous scavenging rate, both turbine end and collector end, via metering valves.

— Hydrogen from the generator turbine end and generator collector end is continuously monitored for purity. At predetermined time intervals, the purity of the generator core gas is also checked. Two independent, switchable, triple range hydrogen purity analyzers are used, thus providing total redundancy, for two out of two voting. Each display and control panel will include three digital displays providing real time readout of gas purity, gas temperature and the status of the analyzers operating parameters. All information is provided to the station DCS via contact inputs and 4-20 milliamp analog signals.

— In the event that one of the analyzers detect a drop in purity, a confirmation by the other gas analyzer is performed. Time for the measurement, which requires reconfiguration of the valves, as well as the handling of possible disagreements in measurement results, is also negotiated between the analyzers.

— In the event that either analyzer indicates a low purity alarm, the rate of scavenging is increased automatically and an alarm is annunciated.

— All components used in the hydrogen control panel are specifically designed and / or third party approved for use in an Class I, Division I, Group B environment.

7.3.11.2 Control Panel Devices

7.3.11.2.1 Differential Pressure Gas Transmitter

The differential pressure gas transmitter measures the generator fan differential gas pressure. It provides a 4-20 mA DC signal proportional to differential gas pressure and includes a 316L stainless steel diaphragm all housed in a Factory Mutual approved explosion proof enclosure.

7.3.11.2.2 Differential Gas Pressure Gage

The differential gas pressure gage provides local indication of the generator fan differential gas pressure. The gage is flush mounted, waterproof, dual range and stainless steel movements.

7.3.11.2.3 Gas Pressure Transmitter

The gas pressure transmitter measures the generator core gas pressure or machine gas pressure as it is sometimes called. It provides a 4-20 mA DC signal proportional to gas pressure and includes a 316L stainless steel diaphragm all housed in a Factory Mutual approved explosion proof enclosure.

7.3.11.2.4 Gas Pressure Gage

The gas pressure gage provides local indication of the generator core gas pressure. The gage is flush mounted, water proof, dual range and stainless steel movements.

7.3.11.2.5 Total Gas Flowmeter

The total gas flowmeter provides local indication of the total flow of scavenged gas. The flowmeter is a flush mounted, in line, direct read flowmeter with stainless steel body.

7.3.11.2.6 Gas Analyzer Flowmeters (2)

Gas analyzer flowmeters provide local indication and control of the gas flow through each of the gas analyzers. Each flowmeter is a flush mounted, in line, direct read flowmeter with stainless steel body.

7.3.11.2.7 Gas Purifiers (3)

Gas purifiers remove oil, water and foreign particles from each of the gas sampling lines (turbine end, collector end and core gas).

7.3.11.2.8 Moisture Indicators (3)

Moisture indicators provide local indication relating to the operating condition of the gas purifiers in each of the gas sampling lines (turbine end, collector end and core gas).

7.3.11.2.9 Control Cabinet

The standard cabinet is NEMA 1 rated and fabricated from #10 standard gauge, sheet steel. Gas piping and electrical field connections can be located at either the top, bottom or rear of the cabinet per customer request.

7.3.11.2.10 Solenoid Valves

All solenoid valves have stainless steel bodies with class H temperature rated coils. The solenoids are also third party approved for use in a Class 1, Division 1, Group B environment.

7.3.11.2.11 Gas Analyzers

The gas purity analyzer utilizes the principle of fixed geometry diffused flow thermal conductivity to measure the purity of a known component of a binary gas mixture. Digital acquisition at the sensor level by precision components, rather than the previous Wheatstone bridge arrangement, increases measurement accuracy. A novel aspect of the analyzer is its ability to operate in a redundant configuration; the two, identical, microcontroller based subsystems which comprise the analyzer are interconnected by a communications channel to enable the analyzer to confirm an alarm condition, (i.e. two out of two voting). This communications channel also allows the analyzer to negotiate and report possible malfunctions in the measurement system.

A portable gas analyzer is used to supervise the purging operations. The gas analyzer operates on the principle of thermal conductivity to determine the amount of air in CO2, hydrogen in CO2, and hydrogen in the air. The analyzer consists of a power unit, detector unit, indicating instrument, and associated tubing.

7.3.11.3 Fault Detection and Reporting

Each subsystem within the analyzer is self-supervising and continuously checks itself for acceptable processor functioning, internal voltages, analog to digital conversion accuracy, integrity of cabling and relay operation. Any faults are immediately annunciated at the cabinet and a contact signal indicating analyzer trouble is opened. A faults log, which maintains a date/time stamp of detected failures can be viewed at any time. The analyzer can also execute detailed self-diagnostics.

7.3.12 Hydrogen Control Manifold

Hydrogen is admitted to the generator casing through the use of the hydrogen gas manifold. The following instrumentation is provided and is located in the collector compartment:

— Generator gas pressure gage

— High and low generator gas pressure switches

The H2 bottle manifold consists of two stages. A high pressure regulator reduces the bottle pressure for delivery into the control header, where a low pressure regulator maintains generator gas pressure. A bottle pressure gage and low bottle pressure switch are provided.

7.3.13 Carbon Dioxide Control Manifold

A carbon dioxide system is used for purging the generator casing of air before admitting hydrogen, and also to purge hydrogen before admitting air. The following instrumentation is provided:

— Purging control valve assembly

— Relief valve

Bottles of carbon dioxide are connected to the casing distribution pipe through a manifold which includes:

— Pressure gage with shut-off valve

— Mounting brackets

— Bottle connectors

7.3.14 Detraining System

The air-side seal oil and the generator bearing oil drain to a bearing drain enlargement mounted under the generator casing. This bearing drain enlargement is a detraining chamber and provides a large surface area for detraining the oil before it is returned to the main oil tank.

Two seal drain enlargements are provided for removing entrained hydrogen from the oil which drains from the hydrogen-side seal rings. They are drained through a common line to a float trap which then drains to the bearing drain enlargement for further detraining. A high liquid level alarm switch is provided to detect abnormal oil level in the seal drain enlargement.

Piping is factory fitted and the system is well-proven to assure that no hydrogen can enter into the oil system.

7.3.15 Collector Enclosure

An exciter-end enclosure is provided with the generator containing the following assemblies:

— Collector housing and brush rigging assembly

— Collector filters and silencers

The above hardware is positioned within the enclosure for easy maintenance access and lighting is provided for convenience. In addition, the enclosure is designed to be removable. All interconnecting piping and wiring are completed and terminated at convenient locations in the housing as well.

7.4 Generator Protection

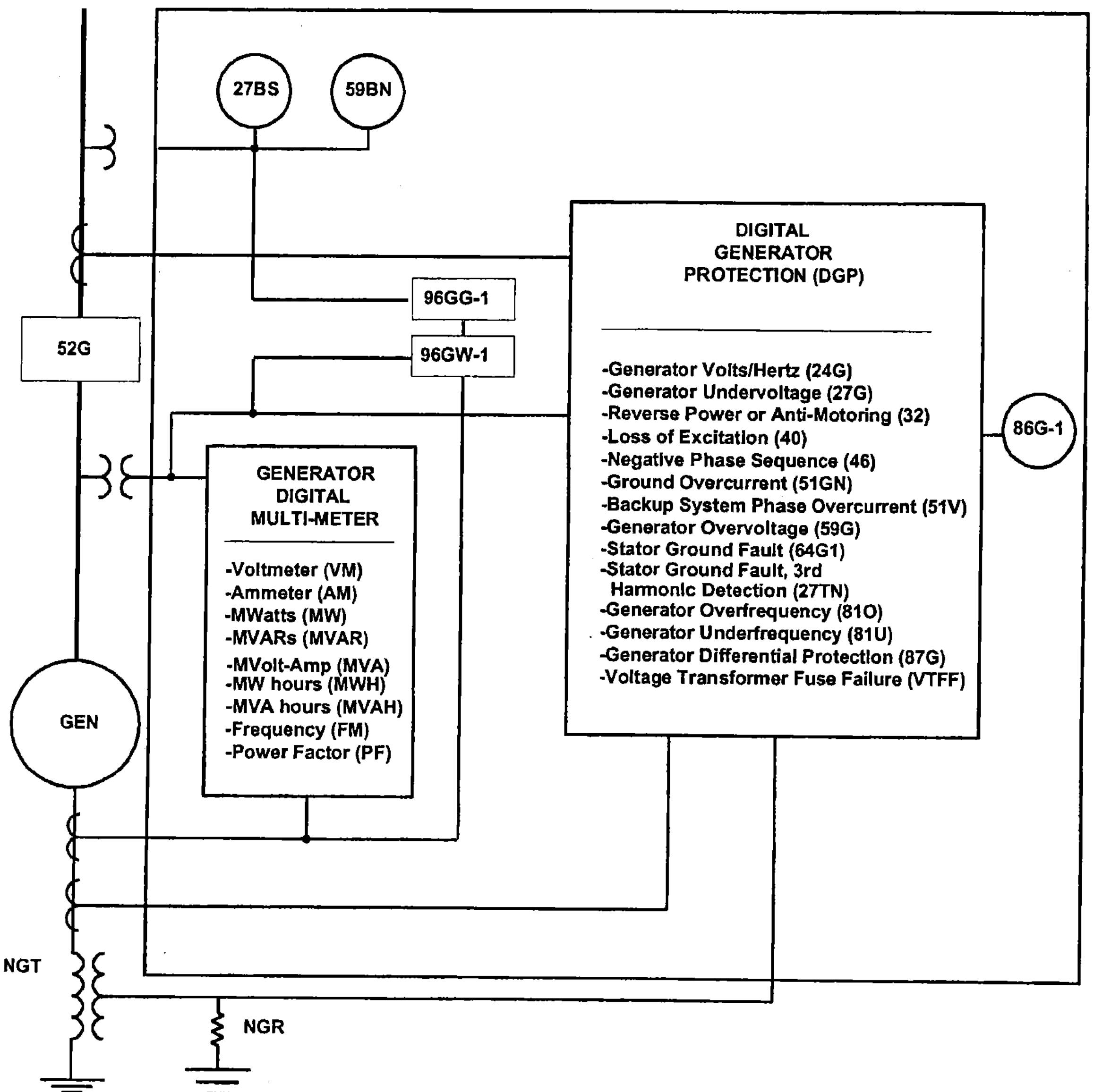
7.4.1 Generator Protection Panel

The current generator protection panel is the result of years of research to best meet our customers needs and to upgrade the generator protection panel to incorporate the latest in digital technology. The heart of the generator protection panel is the digital multifunction relay integration with the SPEEDTRONIC Mark VI turbine control panel.

The standard generator protection panel incorporates this features along with generator metering, Watt and Var transducers for turbine control, and bus ground detection. Pre-engineered protective modules such as generator step-up transformer protection and auxiliary transformer protection can be added to this standard generator protection panels design. The generator protective panel can also be customized to incorporate protective and monitoring features as required.

A simple one-line diagram of the standard generator protection panel is presented on the following page. This one-line is for illustration purposes only. For job specific details see the one-line diagram in the Equipment Drawings chapter of this proposal.

Standard Generator Panel
(Typical)



7.4.2 Generator Protection

The Digital Generator Protection is a compact, digital, multiprocessor, space saving, multifunction protection system. Its modular construction allows for easy maintenance. The Digital Generator Protection module provides a wide range of protection, monitoring, control and recording functions for ac generators. It can be used on generators driven by steam, gas and hydraulic turbines. Any size of generator can be protected with the Digital Generator Protection. A high degree of dependability and security is achieved by extensive self diagnostic routines and redundant power supplies.

The Digital Generator Protection provides the commonly used protective functions in one package. It has adaptive sampling frequency for better protection during startup. The Digital Generator Protection has eight configurable output relays, four trip and four alarm relays.

The Digital Generator Protection can record the last 100 sequence of events, 120 cycles of oscillography fault recording and the last 3 fault reports. These records and fault reports require connection to a local (customer supplied) PC for displaying of reports.

IRIG-B time synchronization capability is available as an option within the Digital Generator Protection Module. To take advantage of this feature, the customer must supply all external equipment.

A Man Machine Interface (MMI) with integral keypad, 16 character displays, and target LEDs allow easy local user interface for entering settings, display present values, view fault target information and access stored data. Some of the present values that can be displayed are amps, volts, Watts, Vars, power factor, negative sequence, third harmonic level.

A front 9 pin RS232 serial ports allow both local and remote computer access. Available options include, serial printer port supplied on the rear, and Sequential trip such as the 33ST function for steam turbines. It can be specified to operate with wye-wye or open-delta connected VTs and any phase rotation.

7.4.2.1 Generator Lockout Relay (86G-1)

Trips the generator breaker, the turbine, and the excitation system. This lockout is normally tripped by either one of the three functions 40, 87G or 59GN (64G1). The reasoning behind this is that if a loss of excitation, or differential, or stator ground fault occurs the structural integrity of the generator may have been compromised and continued operation will potentially lead to more devastating results. The turbine SPEEDTRONIC Mark VI logic monitors this lockout.

7.4.2.2 Breaker or Lockout Trip Coil Monitor (74)

Monitoring of trip coil circuit integrity is of sufficient concern to warrant the installation of an auxiliary relay and indicating lights for the lockout relays and generator breaker. A high impedance relay 74 is placed in series with the trip coil to be monitored. This relay drops out if either the power source fails (i.e.. a fuse blows) or circuit integrity to the trip coil is interrupted. A visual indication is also supplied via a white indication light mounted on the front of the generator protection panel. The contacts from the monitoring relay can go to either the Turbine control panel or customer DCS for alarm

7.4.2.3 Generator Breaker Control Switch With Status Lights (52G/CS)

The generator breaker control is through the SPEEDTRONIC Mark VI <HMI>. The 52G/CS function provides a way to manually open the generator breaker from the generator protection panel. This breaker control switch is for tripping only, the breaker can't be closed with it.

7.4.2.4 Breaker Dual Coil Cross Tripping (94BG)

The standard panel has the capability to take full advantage of redundant breaker trip coils when supplied on the breaker. To take full advantage of the redundant breaker coils (if supplied with the breaker) two separate dc sources feed the trip coil circuits. The separation of sources is normally via separate fusing. A high speed, low pickup voltage auxiliary relay 94GB is placed in parallel with each trip coil. Contacts from the relay in trip coil "A" circuit are used to cross trip coil "B" and vice versa.

7.4.2.5 Synchronizing Undervoltage Relays (27BS-1,2)

Undervoltage conditions can be present in a system due to faults to ground, sudden energization of a considerable load onto a loaded system, primary and backup regulator failure, and when running up or coasting to a stop. The 27BS-1, and 2 are used with the SPEEDTRONIC Mark VI synchronizing scheme to provide additional inputs to help determine whether the generator can be synchronized to a live or dead station bus. The SPEEDTRONIC Mark VI logic alarms when undervoltage conditions are present after the breaker has closed.

7.4.2.6 Generator Digital Meter (DMM)

This single meter provides the following functions:

1. VM - Generator Volts: 1-2, 2-3, 3-1
2. AM - Generator Amps: Phases 1,2,3 and Neutral
3. MWATTS - Generator MegaWatts
4. MVAR - Generator MegaVARs
5. FM - Generator frequency
6. MVA - Generator MVA
7. PF - Generator Power Factor
8. MWH - Generator MegaWatt-Hours
9. MVAH - Generator MVA Hours

7.4.2.7 Bus Ground Fault (59BN)

This protection scheme is designed to protect the system (station bus) from faults to ground. The synchronous generator is connected through a breaker to a step-up transformer. The low voltage side of this transformer is usually connected in a delta configuration. If one phase of the system should go to ground, virtually no fault current would flow. However, voltage reference in the delta connection will be fixed at the ground fault location causing the voltage vectors to be shifted. One set of PT's connected in a Wye - Broken Delta configuration, in conjunction with an overvoltage 59BN relay, are used to detect such a fault.

7.4.2.8 DC Blown Fuse Protection (74)

Each lockout tripping circuit is fused independently in the generator protection panel. If the fuse of a particular tripping bus is blown, the associated protective relays cannot trip the lockout relay. The intent of this function is to alert the operator when the dc voltage to the tripping bus is lost. This loss of dc can be a result of either a blown fuse or incoming dc source failure/low level.

7.4.3 SPEEDTRONIC Mark VI Integration

In addition to the relaying mounted in the generator protection panel, the SPEEDTRONIC Mark VI handles protection such as generator temperature protection (49), synchronizing check (25A), backup frequency and reverse power. Generator control and monitoring is primarily accomplished via the operator interface. The SPEEDTRONIC Mark VI handles manual and auto–synchronizing, speed raise/lower, voltage raise/lower, and generator breaker control. The operator interface also displays frequency and voltage for the generator and bus, breaker status, field current and voltage, along with the status of permissive.

7.4.4 Additional Protective Features

The following additional protective features are incorporated into a customized Generator Protective Panel. This panel will be larger than the standard generator panel.

7.4.4.1 System Backup Distance Protection (21)

The distance relays are typically used instead of overcurrent with voltage restraint when the lines leaving the station bus have distance or pilot relay protection schemes and the generator ties the station bus through a step-up transformer. The standard relay is an SLY three phase solid state relay. The 21Y is a delay relay which has two timing units and three targets. The time delay range is 0.03 - 99.0 seconds.

This protection scheme is designed to protect the generator from faults in the adjacent system which are not cleared by the first line relays. It is used in lieu of 51V (system phase fault over current relays with voltage restraint).

7.4.4.2 Reverse/Inadvertent Energization Protection (50RE/86RE)

This is also sometimes called: Accidental Energization, Back Energization. Prior to the generator achieving rated speed, the SPEEDTRONIC Mark VI arms/enables the trip circuit (using 14HS, i.e., 95% speed) of the overcurrent relay. A normally closed TMR contact is utilized in the SPEEDTRONIC Mark VI for maximum reliability both during normal operation and during shutdowns (i.e., SPEEDTRONIC Mark VI powered down). When the turbine is above 95% speed the SPEEDTRONIC Mark VI disarms the overcurrent relay trip circuit, allowing the unit to be synchronized.

An additional independent lockout 86RE is included to allow the 86G fuses to be removed while the unit is shut down. The trip contacts from the 86RE should trip customer upstream breakers since the generator breaker trip coil may be disabled (i.e., fuses removed during maintenance).

This protection scheme protects against inadvertent breaker closure while the unit is at standstill, running up or down in speed. One (1) three phase instantaneous overcurrent relay 50RE is supervised by frequency/turbine speed controlled outputs from the SPEEDTRONIC Mark VI.

7.4.4.3 Bus Digital Meter

This single meter provides the following functions:

1. VM - Bus primary volts : 1-2, 2-3, 3-1.
2. VMsec - Bus PT secondary volts: 1-2, 2-3, 3-1.
3. FM - Bus frequency.
4. This meter can be programmed on site for different CT and PT ratios.

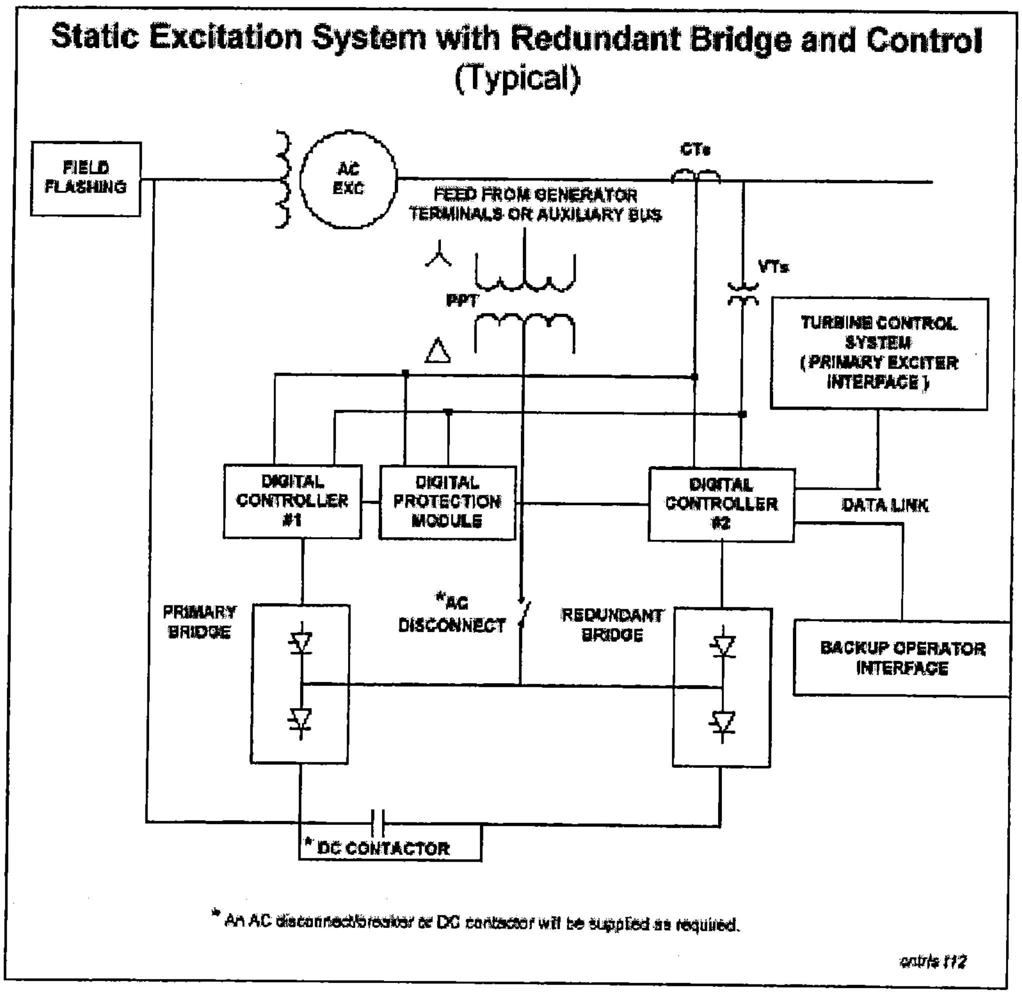
7.4.5 Electrical System Integration Study by Owner

All necessary studies and calculations required to integrate the generator panel into the electrical system, including short circuit, load flow, installation and protective device coordination studies are by Owner.

7.5 Digital Excitation System

7.5.1 Digital, Static Voltage Regulator for Bus Fed Excitation

The exciter is a digital, static, potential source excitation system. The system comes equipped with a full-wave thryristor bridge, which supplies excitation power to the rotating field winding of the main ac generator. In addition, all control and protective functions are implemented in the system software. Digital technology allows the exciter to maintain 99.98% availability. The following is a one-line diagram of the excitation system.



7.5.1.1 System Components

The exciter is comprised of the following four basic components as described below:

1. Power conversion module
2. Digital controller
3. Excitation transformer
4. Communication interface

7.5.1.1.1 Power Conversion Module

A three phase, full-wave thyristor bridge is the standard conversion module for the digital excitation system. The standard current capability of the bridge is 6% above the calculated rated full load field current of the generator.

The thyristor bridge assembly is forced air cooled. The cooling assemblies are all energized during normal operation. Thermostats are used to monitor the power conversion module temperature. An alarm is provided for a high temperature level and a trip is provided at a higher temperature level.

7.5.1.1.2 Excitation Transformer

The excitation transformer (power potential transformer) is separate from the exciter. The power to the transformer is obtained from a station auxiliary bus. The purpose of this transformer is to step the voltage down to the required level for the excitation system.

With the use of a regulator in the static exciter, it is not necessary to specify transformer full capacity taps above and below normal on the primary winding. The transformer rating is chosen so that the transformer can deliver the excitation required for the application at 110% rated generator terminal voltage on a continuous basis.

7.5.1.1.3 Digital Controller

The digital controller consists of several microprocessor I/O boards, and a power supply. Cell gating of the SCRs is controlled by one of the microprocessors. If redundant controls are provided, each controller section has its own power supply to ensure backup in the event of a power supply failure.

7.5.1.1.4 Communication Interface

The turbine control interface <HMI> is the primary interface with the exciter. Communication between the turbine control and exciter utilizes a single or redundant datalink. All exciter control logic and display data utilize this datalink. The exciter trip contact (94EX) is hardwired directly to the generator lockout relay and a single global alarm contact (30EX) is hardwired to the turbine control.

7.5.1.2 System Features

Following are descriptions of selected features of the exciter system. For a complete list of system features and accessories, please refer to the Scope of Supply section of the proposal.

7.5.1.2.1 Interface with the Gas Turbine Control System

The exciter is connected to the gas turbine control system through a digital datalink. This enables the gas turbine control system to provide a digital window into the exciter through which all pertinent variables can be monitored and controlled.

7.5.1.2.2 Protection Controller

The protection controller is separate from the main controller(s) and serves as a backup to the limiters located within the controller. The output of the protection controls transfer to backup control/bridge. The protection features provided are as follows:

— Volts/Hertz, dual level (24EX)

— Loss of excitation (40EX)

— Bridge ac phase unbalance (47EX)

— Generator overvoltage (59EX)

— Off/on-line overexcitation (76EX)

7.5.1.2.3 Spare Power Conversion Module as Redundant Bridge

A complete digital controller and rectifier bridge are provided as backup to the primary controller and bridge. If the protection module senses a condition that would normally initiate a trip signal, it will force a transfer to the redundant system before the trip contact is necessary. The transfer to the redundant system occurs with the generator on-line and does not affect generator output.

7.5.1.2.4 Power System Stabilizer (PSS)

The power system stabilizer function is incorporated into the exciter software. A signal representing the integral of accelerating power is introduced into the automatic voltage regulator algorithm to enable the generator to produce and transmit large power levels in a stable manner by reducing low frequency rotor oscillations

7.5.1.2.5 Enclosure

The exciter, located in a NEMA-1 stand-alone enclosure, contains the SCR power conversion module and regulator with all standard control and protection functions, plus auxiliary functions such as the de-excitation module and shaft voltage suppression circuit.

7.5.1.3 Related Services

7.5.1.3.1 Power System Stabilizer Tuning Study

GE provides engineering consulting services for tuning the power system stabilizer for optimal performance at the installation site. This includes studies to determine the optimum settings and producing computer models for use in transient stability analysis.

In order to complete the analyses described, GE typically requires data on the system strength at the HV bus (short circuit MVA) and data on the step-up transformer impedance. Copies of any pertinent interconnection specifications or performance requirements for the AVR/PSS should also be provided for use in determining the proper tuning.

7.6 Controls and Instrumentation

7.6.1 Control System

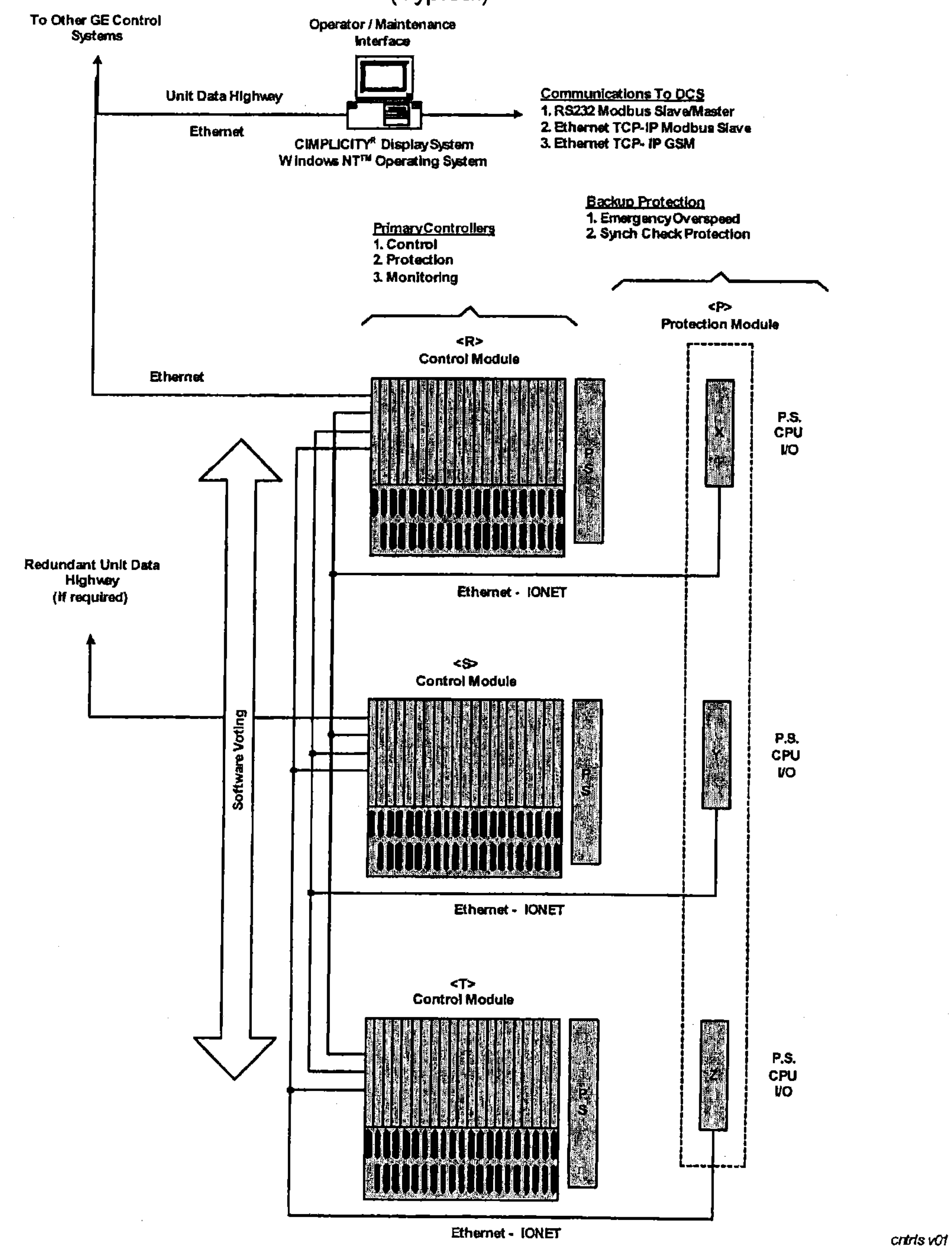
The steam turbine-generator control system, SPEEDTRONIC™ Mark VI, is a state-of-the-art Triple Modular Redundant (TMR) microprocessor control system with a heritage of over 40 years of successful turbine automation. The core of this system is the three separate but identical control modules <R>, <S>, and <T>. Each controller contains its own power supply, processor, communications, and I/O for all of the critical control, protection and sequencing of the gas turbine. Some backup protection devices interface with the <P> protection module which consists of triple redundant sections labeled <X>, <Y>, and <Z>. These sections provide independent backup protection for certain critical functions such as emergency overspeed protection and the phase-slip windows for synch check protection

The three control modules, <R>, <S>, and <T>, acquire data from triple–redundant sensors as well as from dual or single sensors. All critical sensors for control loops and trip protection are triple redundant. A major factor in the high reliability achieved by TMR control systems is due in considerable measure to the use of triple redundant sensors for all critical parameters.

7.6.1.1 Electronics

All of the micro-processor based electronics have a modular design for ease of maintenance. Each control module consists of a 21 slot VME type card rack with a processor card, communication card, and I/O cards. The I/O cards are connected to individual termination boards by computer type cables with 37 pin "D" type connectors. The termination boards have pluggable, barrier type termination blocks. Cards and termination boards can be arranged in various combinations and added in the field for future expansion. Ethernet based local area networks (LANs) are used to communicate between the control modules, the backup protection module, any expansion modules, and the operator interface. A real-time, multi-tasking operating system is provided with floating point data.

SPEEDTRONIC Mark VI Control Configuration
(Typical)



7.6.1.2 Shared Voting

An important part of the fault tolerant control architecture is the method of reliably "voting" the inputs and outputs without any single point failures. Each control module reads its inputs and exchanges the data with the other two control modules every time the application software is executed - 40ms.

The voted value of each contact input and the median value of each analog input is calculated within each control module and then used as the resultant control parameter for the application software. Diagnostic algorithms monitor these inputs and initiate a diagnostic alarm if any discrepancies are found between the three sets of inputs. In addition, a 1ms time stamp is assigned to each contact input to provide a built-in Sequence Of Events (SOE) monitor.

Redundant contact inputs for trip functions are connected to three separate termination points and then individually voted. This enables the control system to survive multiple failures of contact or analog inputs without causing an erroneous trip command as long as the failures are not from the same circuit.

An equally important part of the fault tolerance is the hardware voting of analog and contact outputs. Three coil servos on the valve actuators are separately driven from each control module, and the position feedback is provided with redundant LVDTs. Contact outputs to the hydraulic trip solenoids are voted with three magnetic relays on each side of the floating 125Vdc feeder to the solenoids.

7.6.1.3 PC Based Operator Interface

The operator interface consists of a PC with a GE Fanuc CIMPLICITYR graphics display system and a MicrosoftTM Windows NTTM operating system. A color monitor and keyboard are included. Client/server capability is inherent with Windows NTTM and redundant server configurations are supported for multi-unit applications.

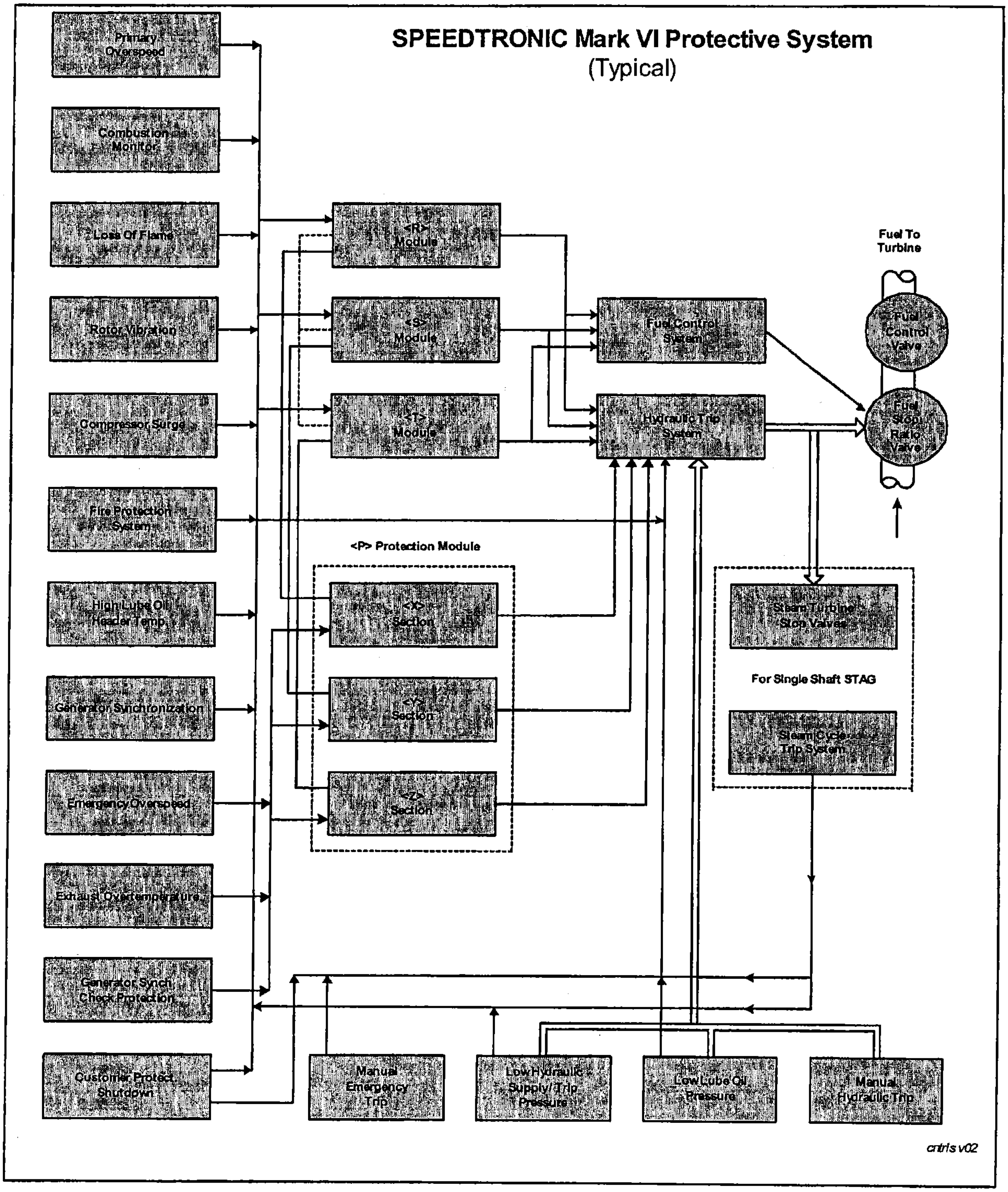
The PC can be used as either an operator interface or as a maintenance workstation with all operator control and monitoring coming from communication links with a plant distributed control system (DCS).

Remote access by the Human Machine Interface (HMI) is provided for monitoring and/or control.

7.6.1.4 Direct Sensor Interface

The input/output (I/O) is designed for direct interface to turbine and generator devices such as vibration sensors, flame sensors, LVDTs, magnetic speed pickups, thermocouples, and RTDs. Direct monitoring of these sensors eliminates the need for interposing instrumentation with its associated single point failures, reduces long term maintenance, and enables the SPEEDTRONIC Mark VI diagnostics to directly monitor the health of the sensors on the machinery. This data is then available to local operator/maintenance stations and to the plant digital control system via the optional communications links.

SPEEDTRONIC Mark VI Protective System
(Typical)



7.6.2 Scope of Control

The Mark VI Steam Control System provides complete monitoring control and protection for turbine-generator and specified auxiliary systems. The scope of control is broken down into three (3) sections: Control, Sequencing and Protection.

Control	Sequencing
Start-up control Speed/load setpoint and governor Generator excitation setpoints Synchronizing control (speed/ voltage matching)	Start-up, running and shutdown Alarm management Synchronizing Turning gear Event counters DCS interface, if applicable
Protection	
Overspeed — two (2) independent Thrust bearing wear Vibration Low lube oil press, high lube oil temp, etc.	

7.6.3 Steam Turbine-Generator Operating Modes

7.6.3.1 Starting/Shutdown

Automatic starting/shutdown is the normal method of operation. For starting, the speed ramp rates are calculated automatically while on turning gear. A start command initiates the start sequence which accelerates the turbine and can bring the unit to full load if automatic synchronization is preselected. Initial acceleration and loading rates are automatically adjusted based on calculated rotor stress and current differential expansion. Automatic synchronizing can be implemented with or without the automatic start sequence. Automatic operation of motor operated valves is implemented independent of the automatic start sequence.

Shutdown of the unit is initiated in a similar manner and will continue until the unit comes to a stop or is put on turning gear. The operator may select automatic engagement, which will put the unit on turning gear after a shutdown, without operator intervention, or the operator may select manual, which will require the operator to issue the engage command after the rotor has come to a stop.

All turbine applications can operate in the manual mode where speed, load, pressure and any other applicable targets or setpoints can be manually adjusted either locally from the operator interface or remotely from a DCS system. Manual operation of motor operated valves, sychronization and turning gear operation are also standard.

In automatic turbine start up (ATS) mode, the Mark VI uses algorithms to control acceleration and loading of steam turbine based on current and past steam and shell metal temperature. In the manual mode, the ATS algorithms will provide guidance for the operator.

7.6.3.2 Operation

The steam turbine-generator set can be operated in any one (1) of the following operating modes:

7.6.3.2.1 Speed Control

The Mark VI is configured for droop control.

7.6.3.2.2 Sliding Inlet Pressure (Inlet Pressure Control and Rate Sensitive Inlet Pressure Limiter)

This mode allows transient inlet pressure control while letting the pressure slide slowly to maintain open valves.

7.6.3.3 Protective Control/Monitoring Features

Described below are some of the steam turbine protective and monitoring systems for which the Mark VI control system maintains direct interface. The complete list of protective and monitoring systems is, of course, much more extensive.

7.6.3.3.1 Overspeed (Primary)

The median value of three (3) magnetic speed pickup inputs is used to trip if the speed exceeds the primary overspeed trip setpoint. Each speed input is wired individually (i.e., not in parallel) to the <R> <S> <T> controllers. A diagnostic alarm will occur if any of the three (3) signals diverge from the median.

7.6.3.3.2 Overspeed (Emergency)

Three (3) emergency overspeed pickups are monitored in the triple redundant redundant controller independent of the three (3) primary overspeed pickups which are monitored in the <R> <S> <T> for TMR controllers. A trip will occur if the median value of the three (3) speed signals exceeds the emergency overspeed setpoint. A diagnostic alarm will occur if any of the three (3) signals diverges from the median.

7.6.3.3.3 Vibration Proximitors

Direct 3-wire interface is supplied to Bently-Nevada® proximitors with 23VDC excitation. These proximity inputs measure the peak-to-peak radial displacement of the journal (i.e., the shaft motion in the bearing). This system uses a non-contacting probe(s) and proximitor(s) and results in alarm, trip and fault detection.

Two probes at each journal bearing is offered in this proposal.

7.6.3.3.4 Rotor Axial Position

Three probes are mounted in a bracket assembly off the thrust bearing casing to observe the motion of a collar on the turbine rotor. This system uses non-contacting probes and proximitors and results in thrust bearing wear alarm, trip and fault detection.

7.6.3.3.5 Shell Expansion

The shell is generally anchored or keyed to the foundation at its exhaust end and free to move or expand axially on its sliding or flex-leg mounted front end. This movement is monitored via an LVDT input to the turbine control so the operator can verify that the shell is not sticking, hanging up or moving in an unexpected manner as the temperature changes.

7.6.3.3.6 Differential Expansion

This system uses a non-contacting probe(s) and proximitor(s) and results in alarm, trip and fault detection for excessive expansion differential between the rotor and its casing.

7.6.3.3.7 **Rotor Eccentricity**

A probe is mounted some distance away from the bearing centerline and continuously updates the steam turbine control via a proximitor. The calculation of eccentricity is made while the turbine is on turning gear and calculated once per revolution as determined by a reference probe. Alarm and fault indications are provided.

7.6.3.3.8 **Shaft Voltage/Current Monitor**

Two pairs of brushes contact the turbine rotor. One set measures shaft voltage with respect to ground. The second set are connected to ground through a calibrated current shunt. Alarms are raised when either repetitive spikes in voltage or significant current are detected. Voltage spikes indicate problems with the grounding brushes, which can lead to bearing damage from electrical arc pitting. Excessive current can be caused by insulation breakdown of the collector end bearing or excessive moisture in the steam turbine.

7.6.3.4 Other Operating Features

7.6.3.4.1 **Manual Motor Operator Valve (MOV) Control**

Each motor operated valve can be manually opened, closed or placed in intermediate from the Mark VI operator interface. In addition, each MOV can be placed in manual or automatic control regardless of the operating mode of the control system. Commands to open or close a valve are latched in and alarmed if the valve does not reach its intended position in a predefined time — usually one (1) minute.

7.6.3.4.2 **Inlet Pressure Rate Limit**

This is a system where the inlet valves are closed if the inlet pressure begins to fall at a rate that exceeds a predefined level. It is always in service.

7.6.3.4.3 **Load Limit**

This function will limit the allowable load in the unit based on rated conditions to an operator defined percentage.

7.6.3.4.4 **Load Runback Signal From External Source**

Load/valve position is reduced at a preassigned rate to a designated level when a continuous contact closure is received from the external source.

7.6.3.4.5 Inlet Pressure Control

Inlet control valves are adjusted by the control system to hold inlet pressure to operator selected setpoint. Nominal minimum continuous operating pressure is 1000 pisg.

7.6.3.5 On-Line Testing

7.6.3.5.1 Primary Overspeed

The primary trip relays are bypassed, and the primary trip setpoint is lowered until the trip relays are de-energized. The trip is automatically reset when the test is complete.

7.6.3.5.2 Emergency Overspeed

The emergency trip relays are bypassed, and the emergency trip setpoint is lowered until the trip relays are de-energized. The trip is automatically reset when the test is over.

7.6.3.5.3 Electronic Trip System (ETD)

The ETD's are hydraulically locked out one at a time. A trip is initiated, and proximeter switches are monitored for the proper ETD response.

7.6.3.5.4 Stop Valve Movement

The main steam stop valve(s) are testable on-line to confirm the valves ability to function as required.

7.6.3.5.5 Shaft Voltage Monitor

DC signals are injected to test external circuit continuity, and AC signals are injected at the card inputs to test card circuitry and software.

7.6.3.6 Off-Line Testing

7.6.3.6.1 Electronic Trip Devices

Each ETD is manually tripped one at a time and verified for proper operation.

7.6.3.6.2 Primary Overspeed

An offset is added to the speed error causing the turbine speed to increase until a primary overspeed condition occurs.

7.6.3.6.3 Emergency Overspeed

The emergency overspeed setpoint is reduced below the primary setpoint and an offset is added to the speed error causing the turbine speed to increase until an emergency overspeed condition occurs.

7.6.4 Operator Interface

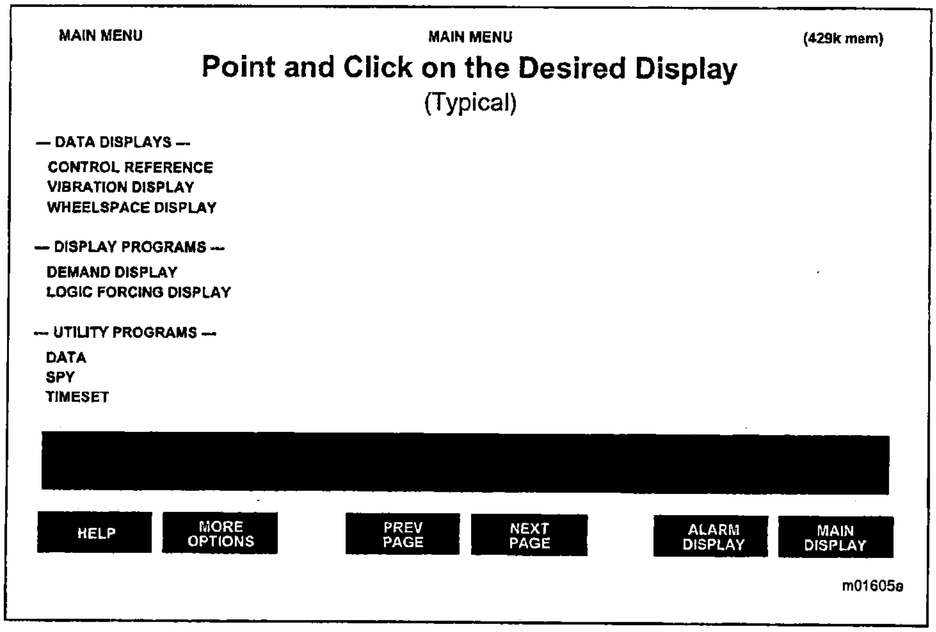
The standard operator interface is called an <HMI>. This is a PC workstation consisting of a CPU box, keyboard, color monitor, cursor positioning device, and dot matrix printer. This system provides both the operator interface function and provides the interface to the plant computer system (DCS) over an RS-232 data link using the MODBUS protocol.

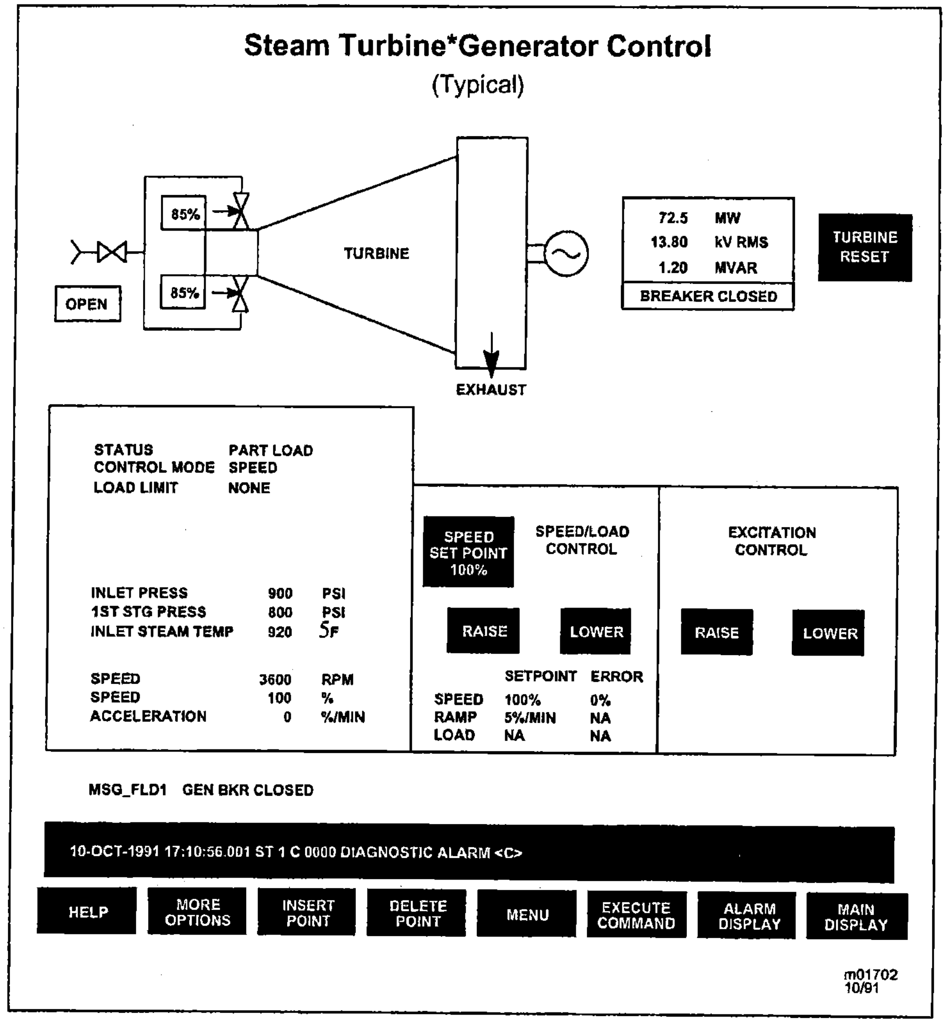
The <HMI> is supplied with 50 ft (15.2 m) of cable for flexible location near the Mark VI panel. The communications link provided allows for remote location of interface using up to 1500 ft (457 m) of cable without repeaters or 9600 ft (2926 m) using fiber optic link without repeaters.

A 19" monitor is offered in this proposal. The standard printer is a black and white dot matrix, which is the best type of printer available for the normal printing of alarms.

Two (2) out of the forty (40) available displays are shown on the attached page. The first screen is the main menu display. From the main menu all operation/maintenance and user defined screens can be reached. The screen is made up of three (3) major areas:

- List of available displays
- Alarm list (black band near bottom of screen)
- Function control keys (bottom of screen)


MAIN MENU
MAIN MENU
(429k mem)
Point and Click on the Desired Display
(Typical)
— DATA DISPLAYS —
CONTROL REFERENCE
VIBRATION DISPLAY
WHEELSPACE DISPLAY
— DISPLAY PROGRAMS —
DEMAND DISPLAY
LOGIC FORCING DISPLAY
— UTILITY PROGRAMS —
DATA
SPY
TIMESET
HELP
MORE OPTIONS
PREV PAGE
NEXT PAGE
ALARM DISPLAY
MAIN DISPLAY
m01605a



The second screen shown is a typical operating screen. Note the alarm list and function control key fields are also shown below the primary display field on this screen. Control target values are shown in the primary display field. Selecting and executing commands is very simple. For example, to reduce speed, you would move the cursor to the "Lower" speed target and click on it. Then before the control times out, you would move the cursor to the "Execute Command" target and click on it. The "Execute Command" step protects against accidental activation of the wrong command that might occur with a one (1) step (point/click) command.

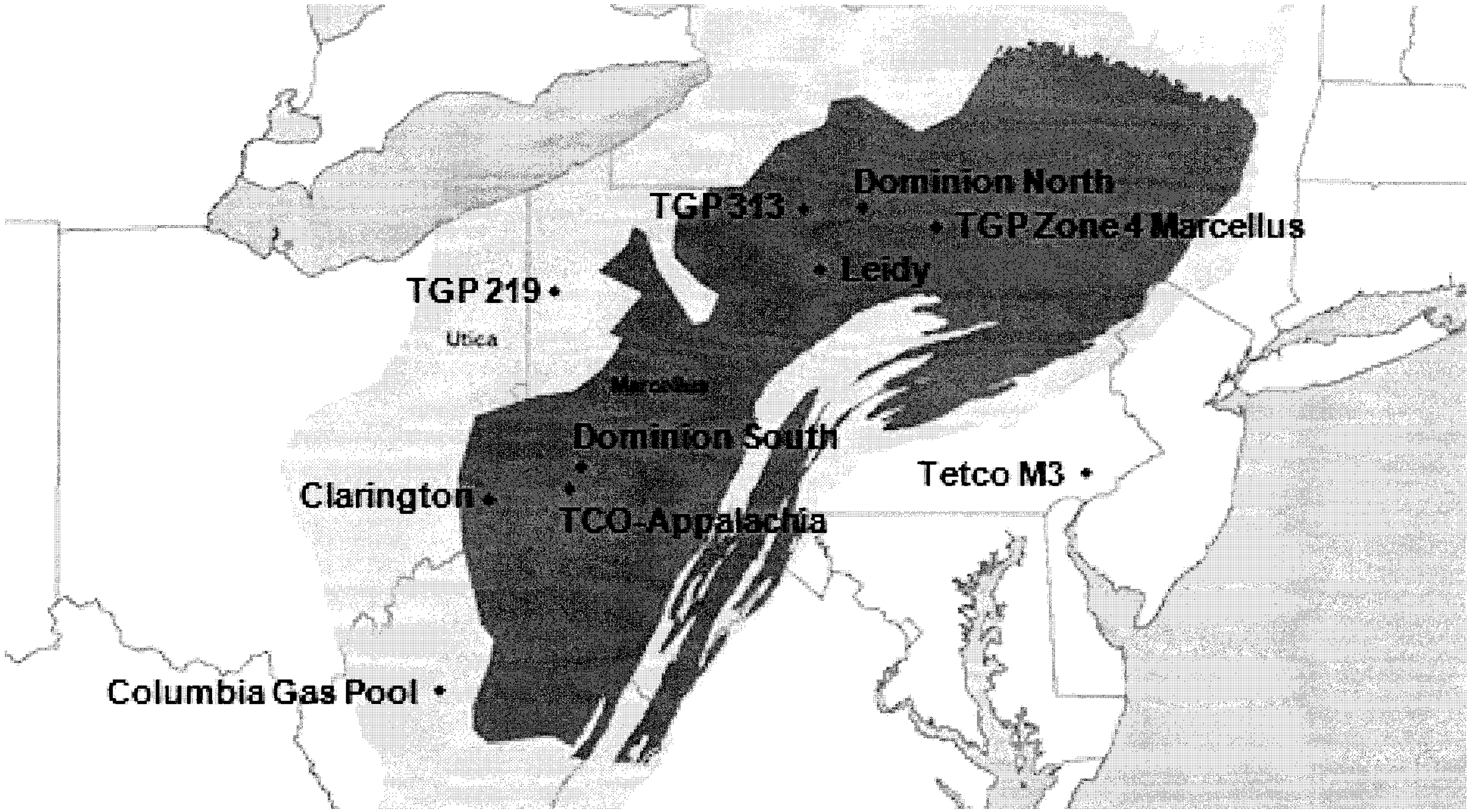
Interface display units can be either Metric or English. Standard operator display languages available are English, French, Spanish and German. Languages can be modified and points or signals renamed in the field.

7.6.5 Backup Interface

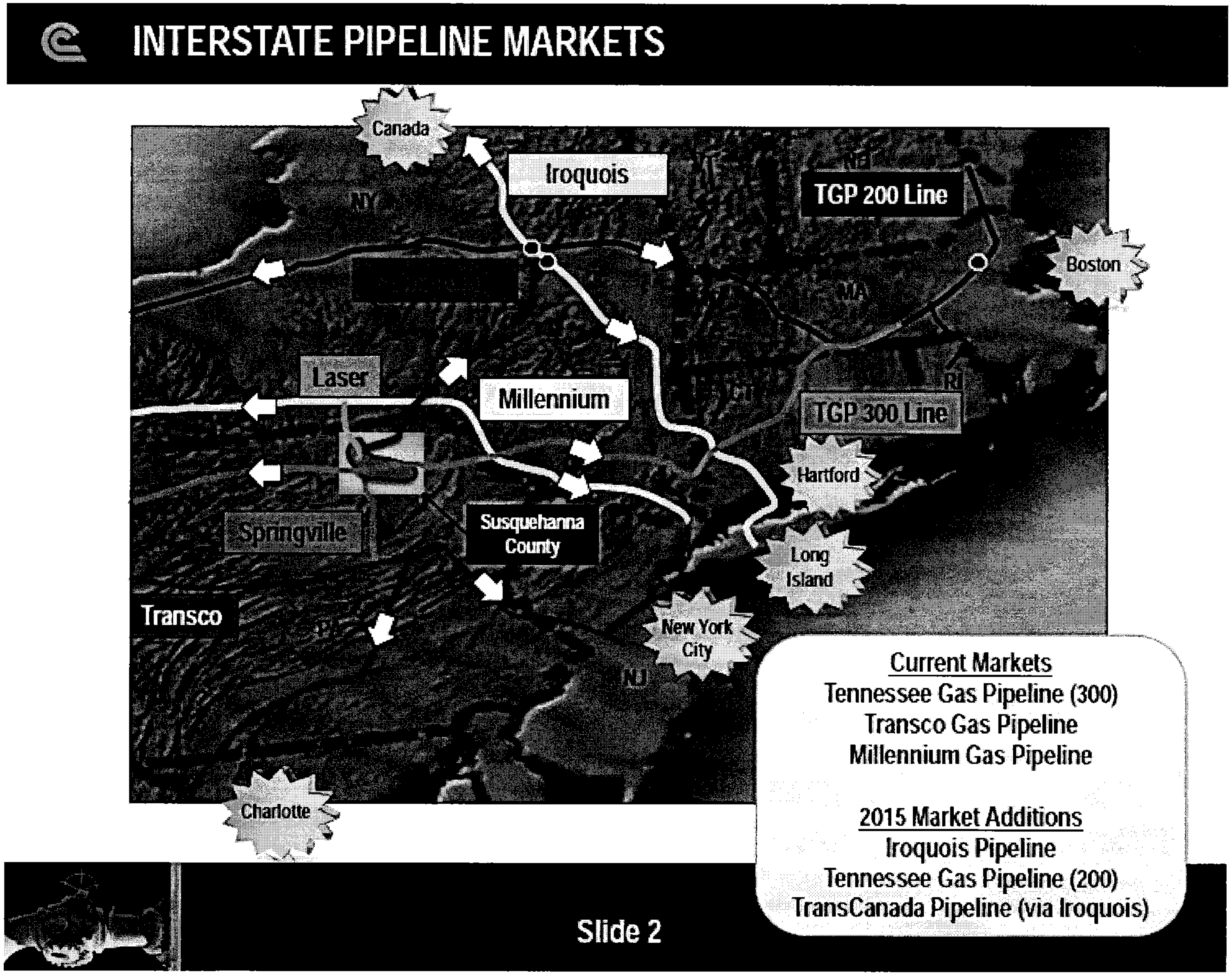
In the unusual event the operator interface becomes unavailable, a small backup interface is provided on the Mark VI cabinet door. It uses a liquid crystal display with two (2) lines of forty (40) characters per line to display key control parameters and alarms. The Mark VI accepts operator commands from this backup interface. A red shrouded, mushroom head, emergency stop pushbutton is located on the panel door.

Exhibit MDT-3

Marcellus area spot natural gas trading points

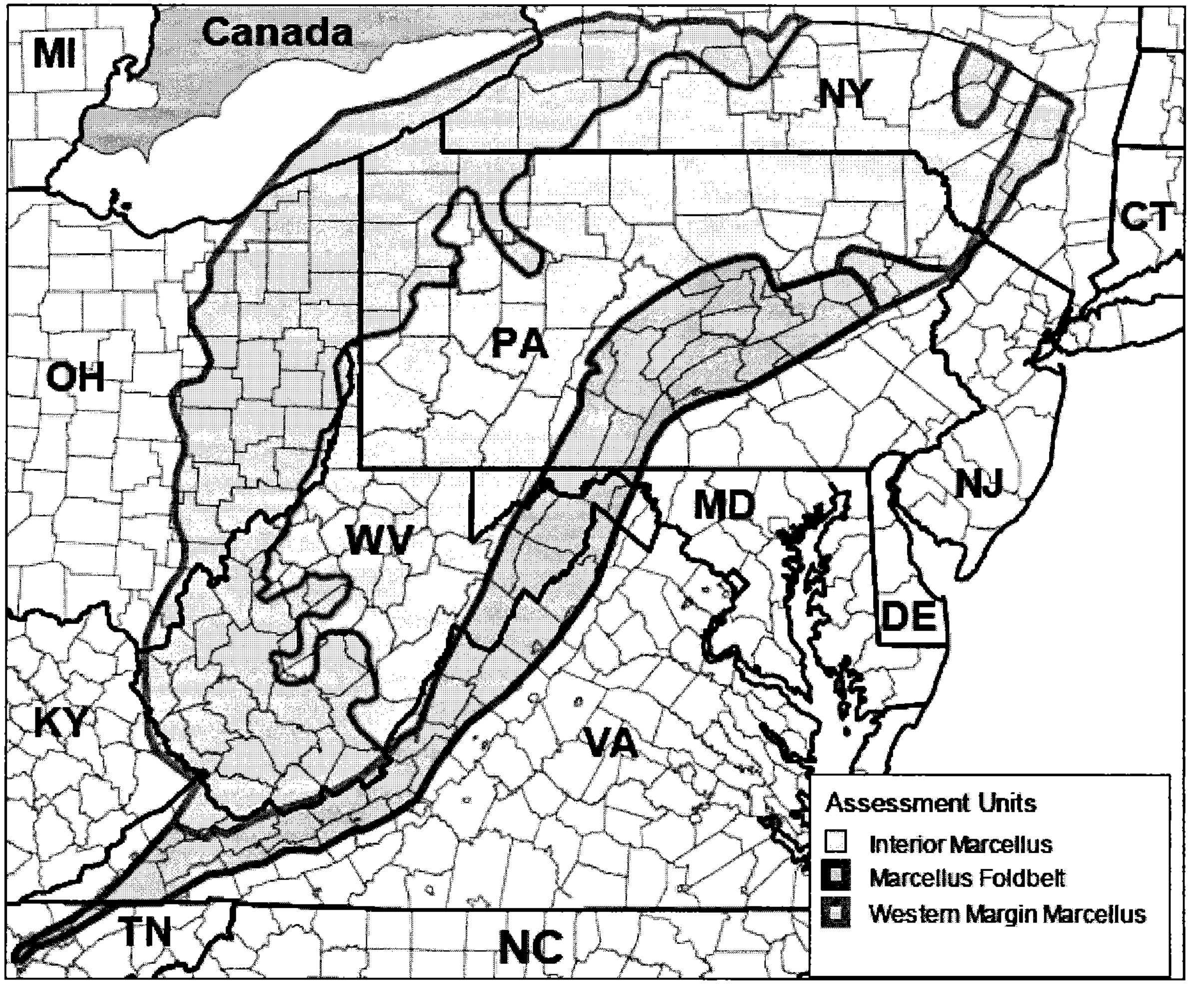


http://www.eia.gov/todayinenergy/detail.cfm?id=7230



http://www.cabotog.com/pdfs/Marcellus-Marketing-Supplementary-Materials.pdf

Figure 57. United States Geological Survey Marcellus Assessment Units



http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf

Table 15. Attributes of unproved technically recoverable resources for selected shale gas plays as of January 1, 2010

Basin/Play	Area (square miles)	Average well spacing (wells per square mile)	Percent of area untested	Percent of area with potential	Average EUR (billion cubic feet per well)	Number of potential wells	TRR (billion cubic feet)
Appalachian							
Marcellus	104,067	5	99	18	1.56	90,216	140,565
Utica	16,590	4	100	21	1.13	13,936	15,712
Arkoma							
Woodford	3,000	8	98	23	1.97	5,428	10,678
Fayetteville	5,853	8	93	23	1.30	10,181	13,240
Chattanooga	696	8	100	29	0.99	1,633	1,617
Caney	2,890	4	100	29	0.34	3,369	1,135
TX-LA-MS Salt							
Haynesville/Bossier	9,320	8	98	34	2.67	24,627	65,860
Western Gulf							
Eagle Ford	7,600	6	99	47	2.36	21,285	50,219
Pearsall	1,420	6	100	85	1.22	7,242	8,817
Anadarko							
Woodford	3,350	4	99	29	2.89	3,796	10,981
Total, selected shale gas plays						**181,714**	**318,825**
Total, all U.S. shale gas plays						**410,722**	**481,783**

http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf

Table 4. Principal shale gas plays: natural gas production and proved reserves, 2010-2011

trillion cubic feet

Basin	Shale Play	State(s)	2010 Production	2010 Reserves	2011 Production	2011 Reserves	Change 2011-2010 Production	Change 2011-2010 Reserves
Fort Worth	*Barnett*	TX	1.9	31.0	2.0	32.6	0.1	1.6
Appalachian	*Marcellus*	PA, WV, KY, TN, NY, OH	0.5	13.2	1.4	31.9	0.9	18.7
Texas-Louisiana Salt	*Haynesville/Bossier*	TX, LA	1.5	24.5	2.5	29.5	1.0	5.0
Arkoma	*Fayetteville*	AR	0.8	12.5	0.9	14.8	0.1	2.3
Anadarko	*Woodford*	TX, OK	0.4	9.7	0.5	10.8	0.1	1.1
Western Gulf	*Eagle Ford*	TX	0.1	2.5	0.4	8.4	0.3	5.9
Sub-total			**5.2**	**93.4**	**7.7**	**128.0**	**2.5**	**34.6**
Other shale gas plays			0.2	4.0	0.3	3.6	0.1	-0.4
All U.S. Shale Plays			**5.4**	**97.4**	**8.0**	**131.6**	**2.6**	**34.2**

Notes: Some columns may not add up to its subtotal because of independent rounding. Natural gas is wet after lease separation. The above table is based on shale gas proved reserves and production volumes reported and imputed from data on Form EIA-23. For certain reasons (e.g. incorrect or incomplete submissions, misidentification of shale versus non-shale reservoirs) the actual proved reserves and production of natural gas from shale plays may be higher or lower. The production estimates are offered only as an observed indicator of production trends and may differ from EIA production volumes listed elsewhere on the EIA web site.

Source: U.S. Energy Information Administration, EIA-23, "Annual Survey of Domestic Oil and Gas Reserves," 2010 and 2011 annual reports.

http://www.eia.gov/naturalgas/crudeoilreserves/

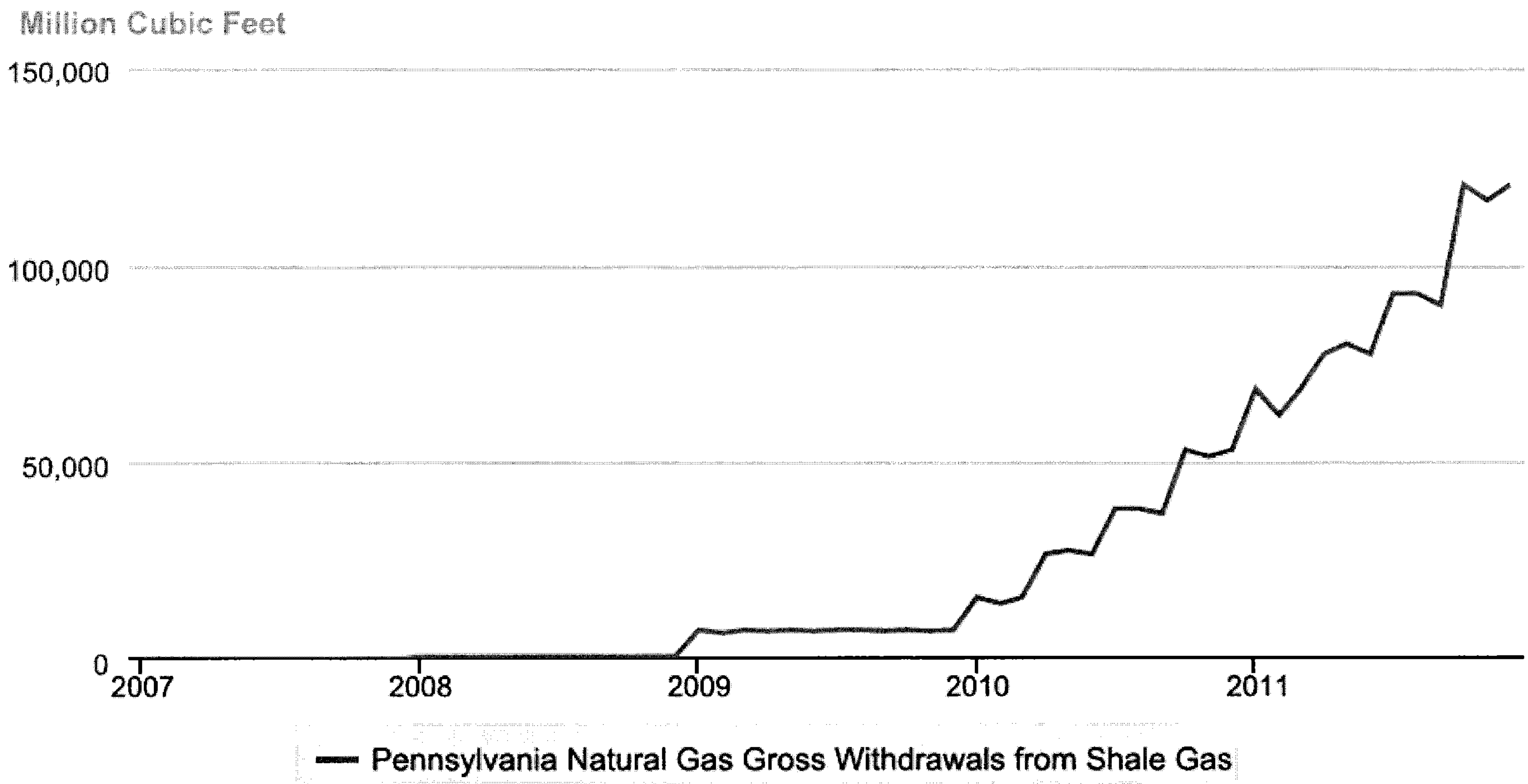
http://www.eia.gov/naturalgas/crudeoilreserves/pdf/table_4.pdf

Marcellus and Utica Gas Production

DRY GAS MAIN FORECAST*				
Date	Ohio	Pennsylvania	West Virginia	Total
Jan-06	193	564	579	1,336
Feb-06	191	566	596	1,353
Mar-06	200	573	582	1,355
Apr-12	192	5,753	1,301	7,246
May-12	202	5,968	1,419	7,589
Jun-12	212	6,109	1,438	7,759
Jul-12	209	6,295	1,369	7,874
Aug-12	200	6,433	1,477	8,111
Sep-12	202	6,742	1,526	8,469
Oct-12	195	6,978	1,582	8,755
Nov-12	195	7,352	1,598	9,145
Dec-12	188	7,673	1,565	9,426
Jan-13	187	7,890	1,578	9,655
Feb-13	190	8,127	1,549	9,865
Mar-13	187	8,198	1,645	10,030
Apr-13	193	8,593	1,708	10,494
May-13	196	8,985	1,881	11,062
Jun-13	198	9,270	2,042	11,510
Jul-13	200	9,634	2,096	11,930
Aug-13	300	9,856	2,201	12,357
Sep-13	400	9,947	2,245	12,592
Oct-13	400	10,054	2,290	12,744
Nov-13	500	10,186	2,336	13,022
Dec-13	500	10,355	2,383	13,238
Jan-14	500	10,530	2,430	13,460
Feb-14	500	10,655	2,479	13,634
Mar-14	600	10,752	2,528	13,881
Apr-14	700	10,860	2,579	14,139
May-14	800	10,985	2,631	14,416
Jun-14	800	11,106	2,683	14,589
Jul-14	800	11,214	2,737	14,750
Aug-14	900	11,319	2,774	14,993
Sep-14	935	11,436	2,779	15,150
Oct-14	995	11,560	2,784	15,339
Nov-14	1,033	11,668	2,789	15,489
Dec-14	1,071	11,760	2,793	15,625

* MCF/ a day

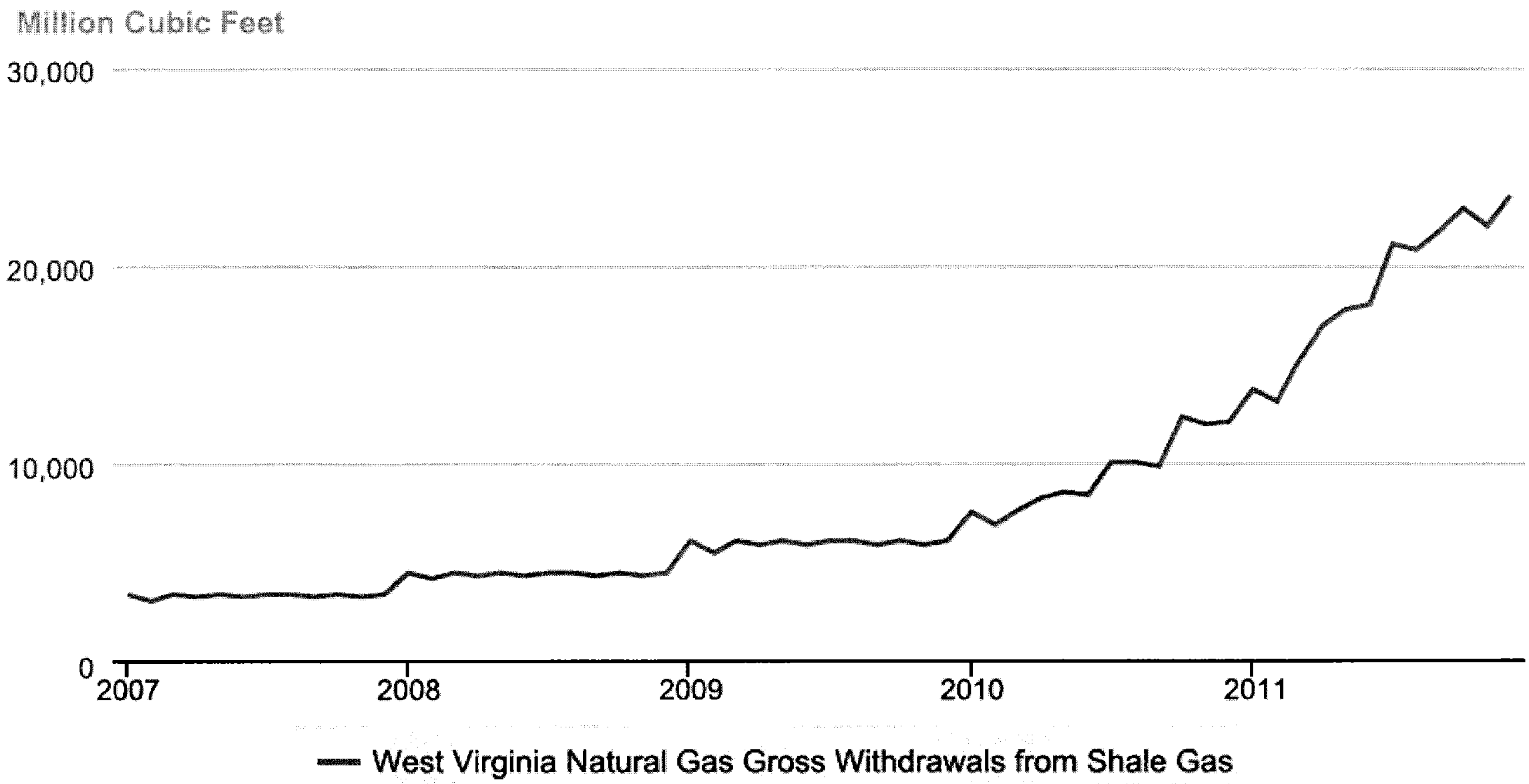
Pennsylvania Natural Gas Gross Withdrawals from Shale Gas



Source: U.S. Energy Information Administration

http://www.eia.gov/dnav/ng/hist/ngm_epg0_fgs_spa_mmcfm.htm

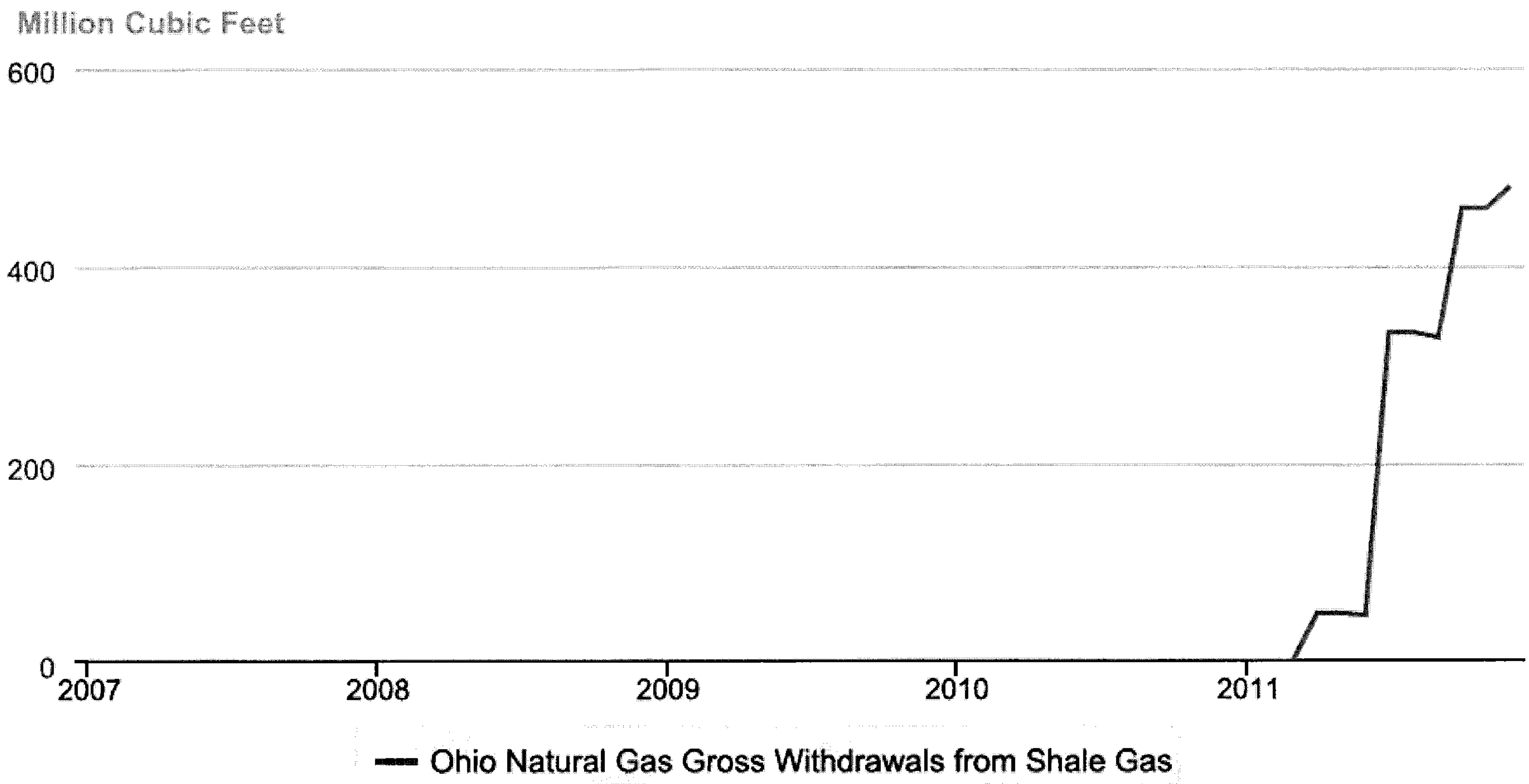
West Virginia Natural Gas Gross Withdrawals from Shale Gas



Source: U.S. Energy Information Administration

http://www.eia.gov/dnav/ng/ng_prod_sum_dcu_swv_m.htm

Ohio Natural Gas Gross Withdrawals from Shale Gas

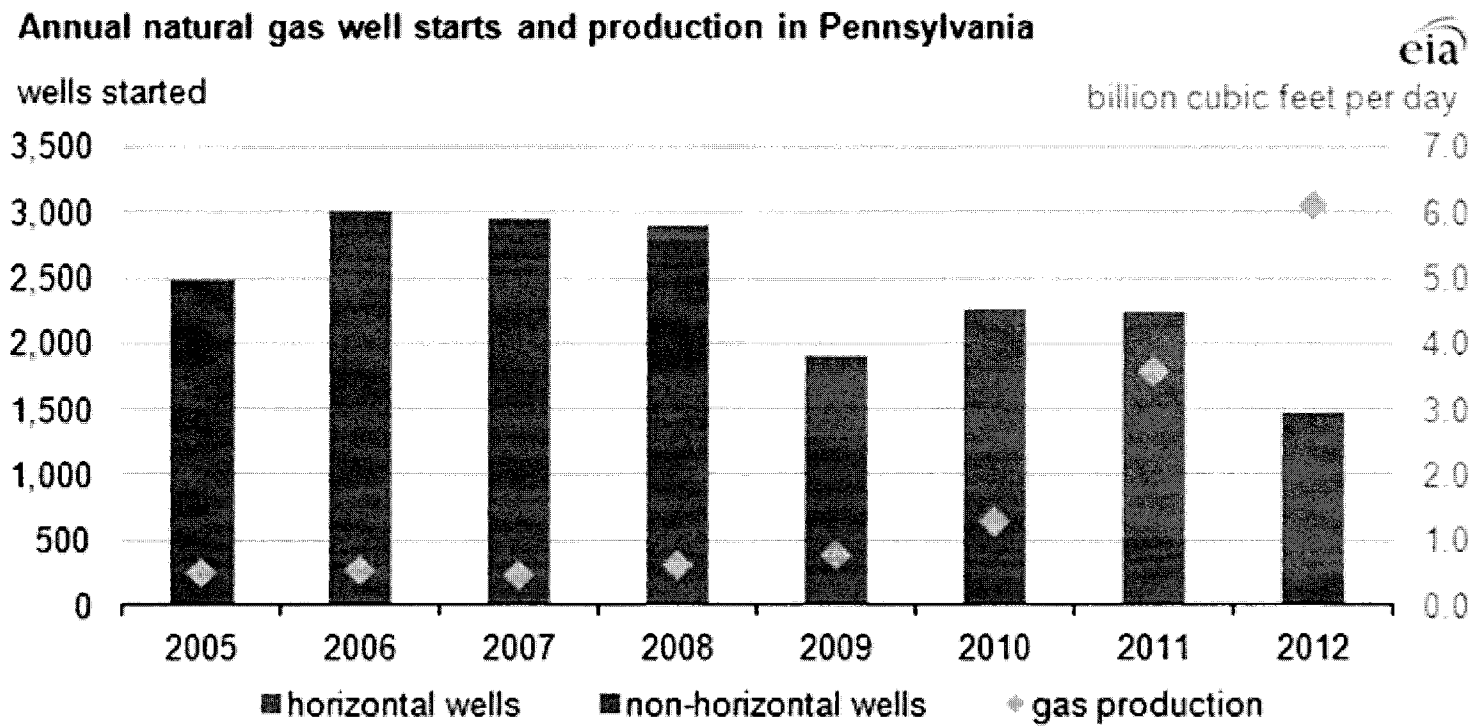


Source: U.S. Energy Information Administration

http://www.eia.gov/dnav/ng/hist/ngm_epg0_fgs_soh_mmcfm.htm

MARCH 21, 2013

Pennsylvania natural gas production rose 69% in 2012 despite reduced drilling activity

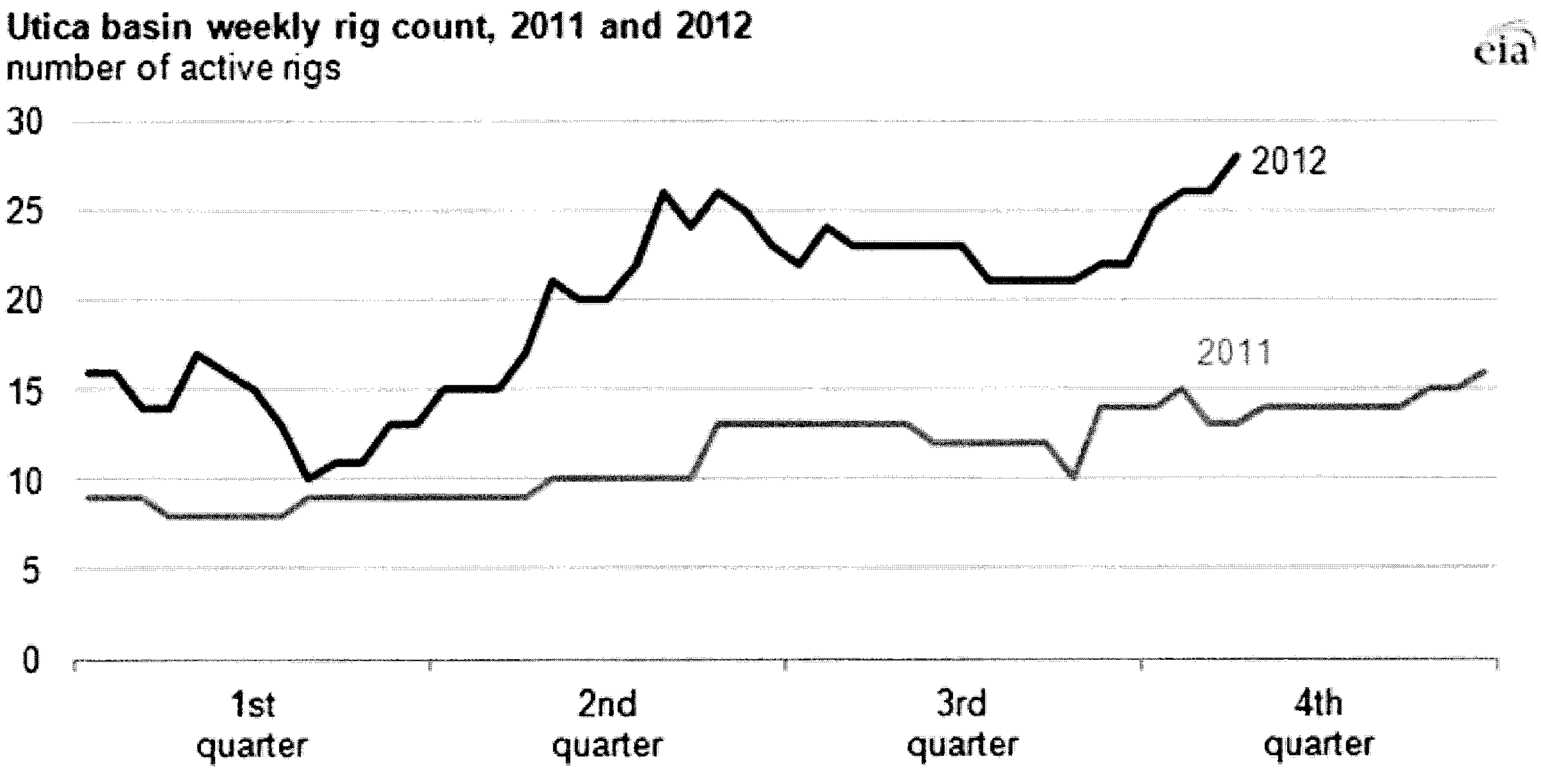


Source: Pennsylvania Department of Environmental Protection.
Note: New wells, or well starts, reflect the number of spudded wells, or wells that began drilling during the year. The figure above does not reflect the number of wells drilled, completed, or permitted.

http://www.eia.gov/todayinenergy/detail.cfm?id=10471

NOVEMBER 20, 2012

Rig count in Utica Shale doubles from year ago



Source: Baker Hughes, U.S. Rig Count Reports dataset

http://www.eia.gov/todayinenergy/detail.cfm?id=8850

2012 OHIO UTICA O&G PRODUCTION BY PRODUCER			
OWNER NAME	**OIL (BARRELS)**	**GAS (MCF)**	**# WELLS**
CHESAPEAKE ENERGY	372,212	10,092,701	53
GULFPORT ENERGY	63,167	767,129	8
ANADARKO	118,726	443,297	7
DEVON ENERGY	2,149	-	5
ANTERO RESOURCES	21,522	37,693	3
ENERVEST	32,546	160,209	3
HESS	560	922,979	2
CNX	10,015	9,986	1
HG ENERGY	-	232,847	1
PDC ENERGY	2,100	5,238	1
REX ENERGY	12,879	159,213	1
TOTAL	**635,876**	**12,831,292**	**85**

Source: Ohio Department of Natural Resources

http://oilandgas.ohiodnr.gov/shale

Utica Shale – Overview

Utica Shale Summary

- The Utica Shale has a recoverable potential of 1.3 billion to 5.5 billion barrels of oil and 3.8 to 15.7 trillion cubic feet of natural gas [1]
- Horizontal drilling, combined with multistage hydraulic fracturing to create permeable flow paths from wellbores into shale units, has unlocked the resource potential of the play
- The Point Pleasant formation, a submember of the lower part of the Utica interval, is the primary target of the play
  - The interval Gulfport targeted in the Point Pleasant is an interval greater than 100 feet thick, at a depth shallower than 9,500 feet but deeper than 7,500 feet, with an average TOC content greater than 2% located predominantly within the wet gas and volatile oil phases of the hydrocarbon system

Note: Images sourced from Ryder and others, 1998, modified from Wallace and Roen, 1989, industry data from peer company presentations, and internal company data

(1) Based on the estimates published by the Ohio Department of Natural Resources

GULFPORT ENERGY CORPORATION
WWW.GULFPORTENERGY.COM

http://ir.gulfportenergy.com/

USGS Releases First Assessment of Shale Gas Resources in the Utica Shale: 38 trillion cubic feet

Released: 10/4/2012 5:24:04 PM

Contact Information:
U.S. Department of the Interior, U.S. Geological Survey

The Utica Shale contains about 38 trillion cubic feet of undiscovered, technically recoverable natural gas (at the mean estimate) according to the first assessment of this continuous (unconventional) natural gas accumulation by the U. S. Geological Survey. The Utica Shale has a mean of 940 million barrels of unconventional oil resources and a mean of 208 million barrels of unconventional natural gas liquids.

The Utica Shale lies beneath the Marcellus Shale, and both are part of the Appalachian Basin, which is the longest-producing petroleum province in the United States. The Marcellus Shale, at 84 TCF of natural gas, is the largest unconventional gas basin USGS has assessed. This is followed closely by the Greater Green River Basin in southwestern Wyoming, which has 84 TCF of undiscovered natural gas, of which 82 TCF is continuous (tight gas).

"Understanding our domestic oil and gas resource potential is important, which is why we assess emerging plays like the Utica, as well as areas that have been in production for some time" said Brenda Pierce, USGS Energy Resources Program Coordinator. "Publicly available information about undiscovered oil and gas resources can aid policy makers and resource managers, and inform the debate about resource development."

The Utica Shale assessment covered areas in Maryland, New York, Ohio, Pennsylvania, Virginia, and West Virginia.

Some shale rock formations, like the Utica and Marcellus, can be source rocks – those formations from which hydrocarbons, such as oil and gas, originate. Conventional oil and gas resources gradually migrate away from the source rock into other formations and traps, whereas continuous resources, such as shale oil and shale gas, remain trapped within the original source rock.

These new estimates are for technically recoverable oil and gas resources, which are those quantities of oil and gas producible using currently available technology and industry practices, regardless of economic or accessibility considerations.

This USGS assessment is an estimate of continuous oil, gas, and natural gas liquid accumulations in the Upper Ordovician Utica Shale of the Appalachian Basin. The estimate of undiscovered oil ranges from 590 million barrels to 1.39 billion barrels (95 percent to 5 percent probability, respectively), natural gas ranges from 21 to 61 TCF (95 percent to 5 percent probability, respectively), and the estimate of natural gas liquids ranges from 4 to 16 million barrels (95 percent to 5 percent probability, respectively).

USGS is the only provider of publicly available estimates of undiscovered technically recoverable oil and gas resources of onshore lands and offshore state waters. The USGS Utica Shale assessment was undertaken as part of a nationwide project assessing domestic petroleum basins using standardized methodology and protocol.

The new assessment of the Utica Shale may be found online. To find out more about USGS energy assessments and other energy research, please visit the USGS Energy Resources Program website, sign up for our Newsletter, and follow us on Twitter.

http://www.usgs.gov/newsroom/article.asp?ID=3419&from=rss_home#.UHLZBFHh-So

Exhibit MDT-4
ORMET Power
Permitting Review

SCOPE OF WORK

Environmental permits required for the Project includes by is not limited to:

- Ohio Power Siting Board Permit
- Air Permits from Ohio EPA, Division of Air Quality, including a separate pre-construction NSR (PSD) permit and Title V operating permit, and a Phase II Acid Rain permit.
- Storm Water General Permit for construction activities associated with the project.
- National Pollutant Discharge Elimination System (NPDES) Permit from Ohio EPA Division of Surface Water: Permit for discharge of point source pollutants into waters of the State of Ohio.
- U.S. Army Corps of Engineers (USACE) permits under Section 404 of the Clean Water Act (CWA) related to the placement of dredge and fill material into waters of the U.S. and under Section 10 of the Rivers and Harbors Act of the 1899 (RHA) related to placement of a cooling water intake in the Ohio River.
- Section 401 of the CWA Water Quality Certification from the Ohio EPA Division of Surface Water related to the placement of dredge and fill material into waters of the U.S.
- Isolated wetlands permit from the Ohio EPA Division of Surface Water for the placement of dredged and fill material into isolated wetlands.
- Local/municipal and or county level permits and zoning, the types and duration of which would be determined as part of the planning/coordination activities discussed later in this letter.
- Civil Engineering (Phase I)

The Project will be designed in a manner to avoid and mitigate the impacts on any wetlands in sufficient detail that it can be used directly for the Section 404 Alternative Analysis. All natural, cultural, and wildlife impacts will be addressed in the siting study.

Exhibit MDT-5

CONFIDENTIAL

This document contains confidential and proprietary information and is being submitted under seal.