



## 7FA SCOPE OF SUPPLY

### 1. GAS TURBINE SYSTEMS

#### Gas Turbine

- Base Mounted PG7241 (FA) 60 Hz gas turbine including:
  - Modulating IGV

#### Combustion System

- Dry Low NOx combustion system -With inlet heating
- Compressor inlet humidity sensor
- Compressor inlet temperature thermocouple

#### Fuel Systems

##### Gas Fuel System

- Natural gas only
- Stainless steel gas piping
- Orifice type gas flow measurement system
- Single gas strainer
- Gas fuel valves on accessory base
- Gas fuel temperature supplied per GEI-41040F-Heater by Owner
- Gas Fuel cleaning equipment (fuel gas scrubber) (duplex)

#### Lubricating and Hydraulic Systems Pumps

- AC Motor driven dual oil pumps
- AC Motor driven dual hydraulic pumps
- DC Motor driven, emergency lube oil pump
- AC/DC Motor driven auxiliary generator seal oil pump
- Dual pump for pressure lift journal bearings in:
  - Turbine
  - Generator
  - Generator seal oil pump

#### Filters and Coolers

- Dual lube oil system filters
- Dual hydraulic oil filters
- Dual lube oil coolers
  - Plate/Frame type with stainless steel plates
- ASME code stamp
  - Lube oil coolers
  - Lube oil filters

#### Lube Oil Piping

- 304L stainless steel lube oil feed pipe
- Carbon steel lube oil drain pipe
- Lube system valve stainless steel trim

#### Mist Elimination

- Lube vent demister

#### Oil Reservoir

- With heater for -20 deg. F

#### Instrumentation

- Pressure switches for lubrication and hydraulic oil filters

#### Inlet System

- Inlet system arrangement
  - Up and Forward inlet system arrangement
  - Inlet compartment supports straddle ductline
- Inlet Filtration
  - Two-stage static filter, prefilter and high efficiency filter
  - Standard filter media (low humidity, non-corrosive environments)
  - Weather protection on inlet filter compartment
  - Inlet system differential pressure indicator
  - Inlet system differential pressure alarm
  - Inlet filter compartment support steel (Seismic Zone 4A=120 mph wind speed)
- Inlet system atmospheric Protection
  - Zinc rich paint inside and outside of the inlet filter compartment
  - Zinc rich paint on inlet filter compartment support steel
  - Zinc rich paint inside and outside of inlet ducting with epoxy topcoat inside ducting
  - Galvanized inlet silencing perforated sheet
  - Zinc rich paint on inlet ducting support steel

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## 7FA EQUIPMENT OVERVIEW

### Gas Turbine

Feature Specification  
Primary Fuel Natural Gas  
Starting Means Static Start  
Air Filtration Two Stage Static  
Exhaust System Axial Exhaust  
Emissions Control Gas-Dry Low NOx  
Outdoor Enclosure Turbine and Accessory Compartments  
Off-Base Acoustic Enclosure Turbine and Accessory Compartments  
Off-Base Acoustic Enclosure Turbine Compartment

### Generator

Feature Specification  
Model 7FH2  
Cooling Hydrogen  
Frequency 60 Hz  
Power Factor (PF) 0.85 Lagging  
Power Factor (PF) Capability to .90 Leading @ ISO  
Conditions  
Terminal Voltage 18.0 kV  
Generator Excitation EX2000P-Static Bus Fed  
Outdoor Enclosure Load Compartment  
On-Base Lagging Accessory Base

### Control Systems

Feature Specification  
Turbine-Generator SPEEDTRONIC Mark VI

### G.E. SCOPE OF SUPPLY

1. Gas Turbine Systems
2. Generator
3. Gas Turbine-Generator Controls & Electric Auxiliaries
4. Services

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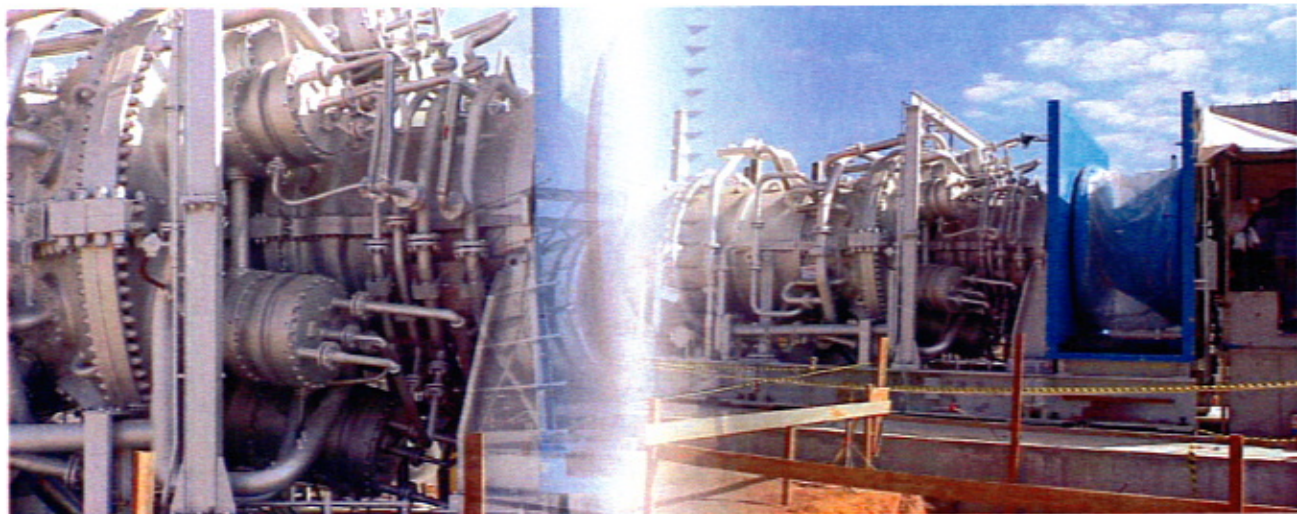
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## 7FA SCOPE OF SUPPLY

### Exhaust System Arrangement

- Exhaust diffuser with an axial exit
- Exhaust expansion joint
- Exhaust stack, if required, by Customer

### Couplings

- Rigid load coupling
- Load coupling guard

### Gas Turbine Packaging

- Lagging and enclosures
  - On-base accessory compartment lagging
  - Turbine and accessory compartment lagging
  - Load coupling compartment lagging
  - Off-base acoustic enclosure for turbine only
  - Off-base acoustic enclosure for turbine, accessory compartment and exhaust diffuser for 85A dBA
- Compartment ventilation, pressurization and beating
  - Dual turbine compartment vent fans
  - Dual accessory compartment lagging
  - Dual load compartment fan
  - Heated turbine and accessory compartments for humidity control
  - Dual vent fans for diffuser/exhaust area
- Plant Arrangement
  - Turbine designed for installation outdoors
  - Right hand accessory module
  - Unit walkways by customers, mounting pads by GE
- Turbine and accessory base painting
  - Standard primer
- UBC seismic zone #4
- Hazardous area classification
  - NEC Class 1, Group D, Division 2
  - Turbine compartment
  - Gas fuel compartment
- Special features
  - Dual (metric-English) indicators and gauges

### Fire Protection System

- Fire detection system
  - Turbine and accessory compartment
- Smoke detection system
  - Control cab/PEECC
- Compartment warning signs
- CO2 supply system
  - One low pressure CO2 tank per unit
  - Tank suitable for 0-120 deg. F (-18 to 49 deg. C)
- Fire protecting piping
- Hazardous atmosphere detectors in turbine and gas fuel compartments
- Hazardous atmosphere detector readout

### Starting Systems

- Static Start
  - Generator start with inverter/regulator
  - Static start isolation transformer
  - Oil filled
- Shared hardware for two units
  - Isolation transformer fed from auxiliary bus
  - Shared hardware across power blocks using cross ties
  - PLC based changeover panel
  - 12- pulse, water-cooled LCI
  - Single dc link reactor
  - Water to water heat exchanger, shipped loose
- Rotor turning systems
  - Turning gear and motor for rotor cool-down
  - Rotor indexing (borescope inspection)

### Miscellaneous Systems Special Systems

- Exhaust frame blowers on turbine compartment roof

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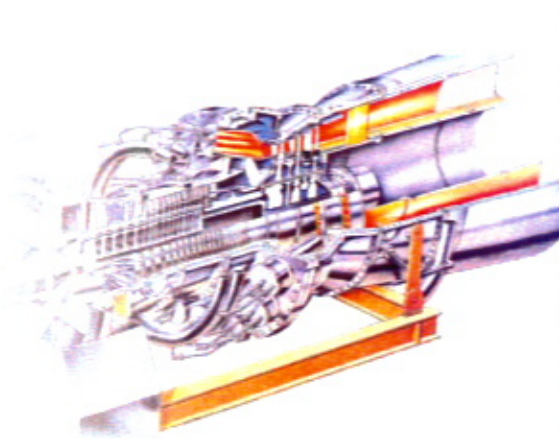
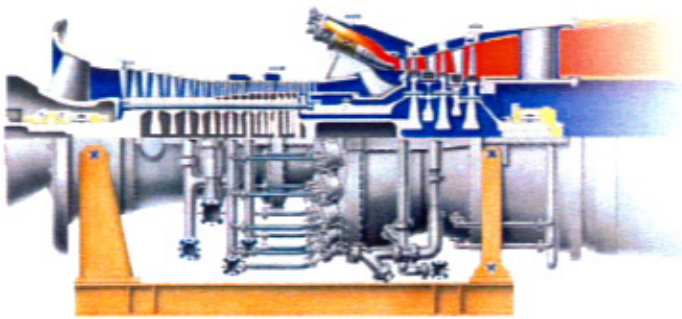
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## 7FA SCOPE OF SUPPLY

### 2. GENERATOR

#### General Information

- Hydrogen cooled generator with conventionally cooled armature
- Outdoor Installation
- 60 Hz generator frequency
- Generator voltage 18.0 kV
- 0.85 power factor (lagging)
- Capability to .90 power factor (leading) @ ISO conditions
- Class "F" armature and rotor insulation
- Class "B" temperature rise, armature and rotor winding
- Generator Bearings
  - End shield bearing support
  - Elliptical journal bearings
  - Rollout bearing capability without removing rotor
  - Insulated collector end bearing
  - Online bearing insulation check
  - Offline bearing insulation check with isolated rotor
- Monitoring Devices
  - Two BN3300 probes per bearing at 45 deg. Angle with monitors
  - Two (2) velocity vibration probes at turbine end, one (1) at collector end
  - Provisions for key phaser-generator
  - Provisions for permanent flux probe
  - Proximity vibration sensors
- Generator Field
  - Direct cooled field
  - Two-pole field
  - Finger type amortisseurs
  - Full-length coil slot amortisseurs

#### Generator Gas Coolers

- Coolers shipped installed
- Generator gas cooler configuration
  - Five (5) horizontally mounted simplex coolers

Cooler piping connections on the left side as viewed from collector end  
 ASME code stamp  
 Single wall cooler tubes  
 Victaulic cooler couplings  
 Plate fins  
 Cooling water manifold and isolation valves

- Generator gas cooling system characteristics
  - Coolant temperature -20 deg. F
  - TEMA Class C coolers
  - Generator capacity with one section out of service 80% with Class "F" rise
  - Maximum cooler pressure capability -125 psi
  - Fouling factor:.002
- Generator gas cooler construction materials
  - 90-10 copper-nickel tubes
  - Carbon steel tube sheets
  - Carbon steel waterbox and coupling flanges with epoxy coating
  - Aluminum cooler tube fins

#### Generator Lube Oil Systems and Equipment

- Bearing lube oil system
  - Generator lube oil system integral with turbine
  - Sight flow indicator
- Bearing lift oil system
  - Stainless steel lift oil piping and tubing
  - Lift oil supplied from turbine oil system
- Lube oil system piping materials
  - Stainless steel lube oil feed pipe
  - Carbon steel lube oil feed pipe
  - Welded oil piping
  - Flexible pipe as permitted by ANSI 31.3

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## 7FA SCOPE OF SUPPLY

### Generator Grounding Equipment

- Neutral grounding equipment
  - Neutral ground transformer and secondary resistor
  - Mounted in terminal enclosure
  - Motor operated neutral disconnected switch

### Generation Temperature Devices

- Stator winding temperature devices
  - 100 ohm platinum RTD's (resistance temperature detector)
  - Single element temperature sensors
  - Four (4) cold gas
  - Two (2) hot gas
  - GTG-2 (common cold gas)
- Bearing temperature devices
  - Chromel alumel (type K) thermocouples
  - Dual element temperature sensors
  - Two (2) bearing metal temperature sensors per bearing
- Collector temperature devices
  - 100 ohm platinum RTD's
  - Single element temperature sensors
  - Collector air inlet temperature sensors
  - Collector air outlet temperature sensor
- Lube oil system temperature devices
  - Chromel alumel (K) thermocouples
  - Dual element temperature sensors
  - One (1) bearing drain temperature sensor per drain

### Packaging, Enclosures and Compartment

- Paint and preservation
  - Standard alkyd beige primer
- Generator terminal enclosure (GTE)
- Line-side terminal enclosure
  - Terminal enclosure shipped separate
  - High voltage bushings shipped installed
  - Six (6) ambient air-cooled, high voltage bushings
  - Isolated phase bus duct connection
  - Phase sequence R-C-L when looking at enclosure terminals

Outgoing power connection on right side when viewed from collector end

Lighting arrestors  
Voltage transformers, fixed

- Current Transformers
  - Relaying Class C800
  - Metering Class- 0.3B- 1.8 (ANSI C57.13)
  - CT Ratio-800: 5A
  - Line CT's
  - CT16, CT17, CT18
  - CT19 for extension
  - CT19A and CT19C for EX2000
- Neutral Terminal enclosure
  - Integral with lines side terminal enclosure
  - Neutral tie
  - Neutral CT's
  - CT1, CT2, CT3
  - CT4, CT5, CT6
  - CT7, CT8, CT9
  - Top mounted
  - Forced ventilation
- Collector Compartment
  - Collector Compartment shipped separately
  - Outdoor
- Compartment Lighting and Outlets
  - AC Lighting
  - Collector Compartment
- Fountain Hardware
  - Generator Shims
  - Generator Alignment Key(s) – collector end
  - Generator Alignment Key(s) – turbine end
  - Generator Alignment Key(s) – axial

### Hydrogen Systems and Accessories

- Hydrogen Control Cabinet
  - NEMA 1 cabinet in collector compartment
  - Hydrogen Gas Manifolds
  - Auto purge gas purge control manifold
  - Hydrogen/CO2 control manifold in collector compartment

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## 7FA SCOPE OF SUPPLY

- Seal Oil System
  - Control unit mounted in collector compartment
  - Stainless steel seal oil feed pipe
  - Carbon steel seal oil drainpipe

### Electrical Equipment

- Motors
  - TEFC Motors
  - Coated with antifungal material for protection in tropical areas
  - High Ambient motor installation
  - Motor Heaters connected to AC power
  - Extra severe duty motors
  - Cast iron motor housing
- Heaters
  - Generator Stator Heaters
  - Generator Collector Heaters
  - Generator Terminal Enclosure Heaters

### Generator Excitation Systems, Static Components

- Static excitation with dual hot backup bridge

### Excitation Module Features

- Control/ Monitor/Display through TCP
  - Power Factor controller in turbine control system
  - Var controller in turbine control system
  - Selection of automatic or manual regulator
  - Voltage matching in turbine control system
  - Raise-lower of the active regulator setpoint
  - Enter setpoint command
  - Display field amps
  - Display field volts
  - Display transfer volts
  - Display field temperature
- 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)
- Offline/online over excitation protection (76EX)
- Loss of excitation protection (40EX)
- Bridge ac phase unbalance protection (47EX)
- Under excitation limiter (UEL)
- Generator over voltage protection (59EX)
- Generator field ground detector (64F)
- VT failure detector (VTFD) (60EX)
- Dual source internal bulk power supply
- Millivolt shunt for field
- Surge protection
  - VT disconnect and CT shorting switches
  - Two phase current sensing (CT's A, C)
  - Three phase voltage sensing
  - Single pole dc field contact/bridge
- Thyristor bridge circuit filtering
- Shaft voltage suppressor circuit (mounted in panel)
  - Field de-excitation circuit (with field discharge inductor)
  - 125 Vdc field flashing circuit (when required)
  - Bridge disconnect: ac no load
- Power system stabilizer

### Performance

- 2.0 Response and 160% VFFL (100 degree C) ceiling@ VT=1.0pu
- EX2000 ENCLOSURE LOCATION
- Installed in LCI/EX

### LCI Features

- LCI located in LCI/EX compartment
- LCI output isolation switch (89MD)
  - Located in LCI compartment
- LCI disconnect switch (89SS)
  - Located in generator terminal enclosure
- LCI fuse
  - Located in compartment with LCI

### PPT Features

- Freestanding oil filled PPT
- PPT fed from auxiliary bus

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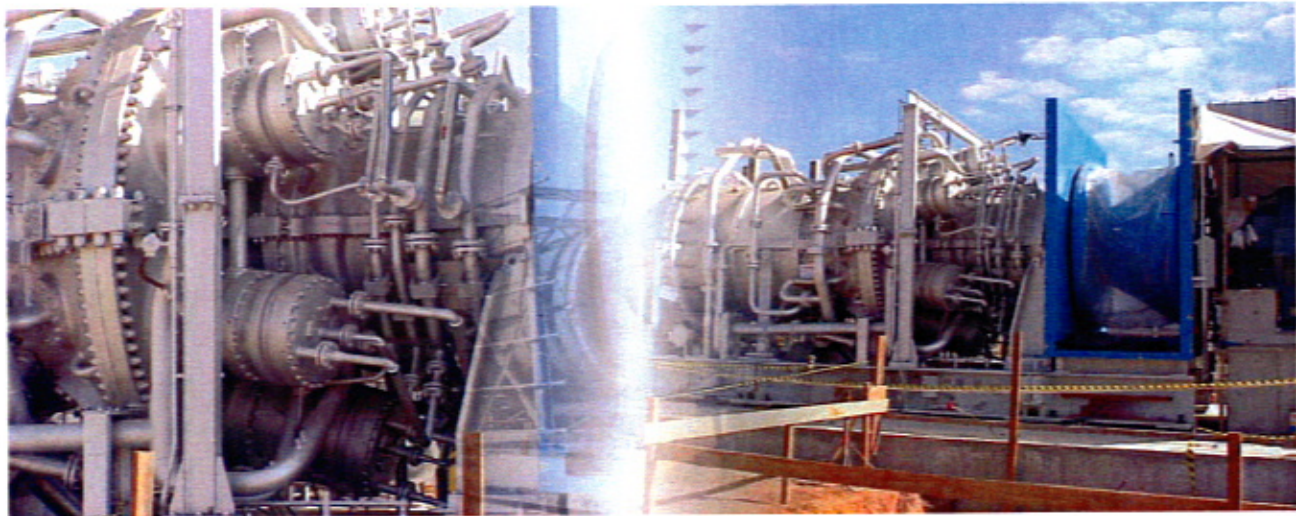
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## 7FA SCOPE OF SUPPLY

### 3. GAS TURBINE-GENERATOR CONTROLS & ELECTRIC AUXILIARIES

#### **Control Cab/Packaged Electric and Electronic Control Compartment (PEECC)**

- Control panels mounted on a common skid
- Weatherproof, climate control, base mounted enclosure
- Supplemental wall mounted air conditioner by General Electric
- Interconnection cables (hard wire) within enclosures by G. E.
- Interconnection cables (hard wire) between packages by Customer

#### **Gas Turbine Control System Panel Features**

- Triple modular redundant (TMR)
- Skid mounted control panels
- Auto/Manual synchronizing module with synchronizing check function
- Generator stator overtemperature alarm (49)
- Droop control
- Load limiter
- Purges cycle
- Customer alarm/trip contact for CRT display
- Additional customer input contacts
- Additional customer output to customer
- Provision for 8 selectable analog inputs from customer
- Provision for 8 selectable analog output from customer
- Wet low NOx data for EPA compliance
- Vibration alarm readout and trip
- Electrical overspeed protection
- Constant settable droop
- Power factor calculation and display
- Power factor control
- VAR Control
- Manual set point pre-selected load
- Mounted in PEECC

#### **Local Operator Station**

- Commercial grade personal computer
- Color Monitor  
Tabletop  
15-inch screen
- Mouse cursor control
- Table top AT 101 keyboard
- Printer  
24 pin dot matrix
- Display in English Language
- 50 foot of Arcnet cable between gas turbine control system panel and local operator interface <1> for indoor use
- RS232C two way serial link (MODBUS) via local <1>
- Power 120V ac 60 Hz
- Mounted in PEECC

#### **Rotor, Bearing and Performance Monitoring Systems Bentley Nevada 3500**

- Performance monitoring systems  
Performance monitoring sensors wired to gas turbine control system
- Vibration Sensors  
Velocity vibration sensors  
Proximity vibration sensors
- Bentley Nevada 3500 Monitor  
Relay outputs wired to gas turbine control panel
- Bearing Thermocouples  
Bearing Drain thermocouples  
Bearing metal thermocouples
- Borescope access holes

#### **Generator Control Panel Generator Control Panel Hardware**

- Mounted in PEECC
- Skid mounted with turbine panel

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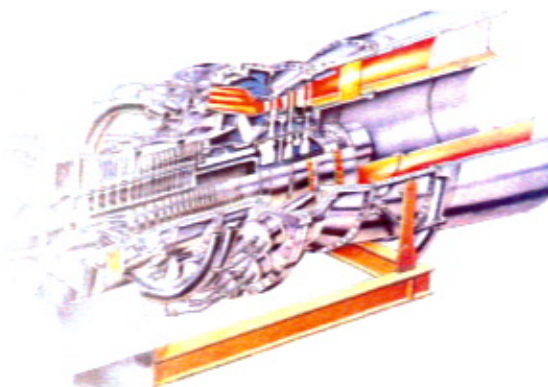
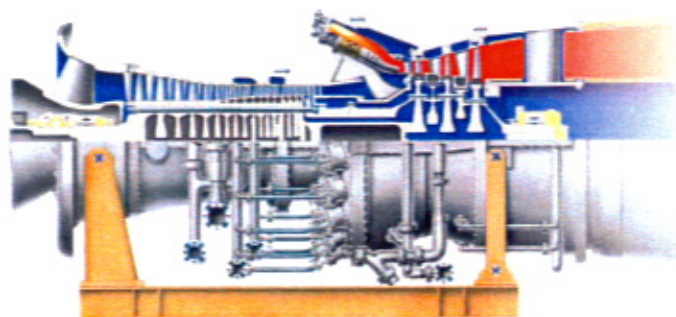
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## 7FA SCOPE OF SUPPLY

- DGP with test plugs
- DGP without Modbus communication interface
- DGP with communication interface
- DGP with oscillography capture
- DGP with printer port
- DGP with redundant internal power supply
- Generator breaker trip switch (52S/CS)
- Humidity sensor readout
- Bentley Nevada vibration monitor(s)

### Digital Generator Protection System (DGP)

- Generator overexcitation (24)
- Generator under voltage (27G)
- Reverse power/ anti-motoring (32-1)
- Loss of excitation (40-1,2)
- Current unbalance/negative phase sequence (46)
- System phase fault (51V)
- Generator overvoltage (59)
- Stator ground detection (64G1)/(59GN)
- Generator over frequency (810-1,2)
- Generator under frequency (81U-1,2)
- Generator differential (87G)
- Voltage transformer fuse failure (VTFF)

### Generator Protection Discrete Relays

- Synchronizing undervoltage relay (27BS-1,2)
- Voltage balance relay (60)
- Breaker or lockout trip coil monitor relay (74)
- DC tripping bus, blown fuse protection relay (74-2)
- Generator differential lockout relay

### Main Transformer Digital Protection

- SR 745 relay with two restraint windings (86T/87T)

### Main Transformer Discrete Relays

- Main transformer lockout relay (86T-1)

### Features Integrated into Gas Turbine Control System

- Gas turbine control system with speed matching, synchronization and check
- Manual synchronization displayed on gas turbine control system
- Auto/manual synchronizing module displayed on gas turbine system <1>
- Load control in gas turbine control system
- Temperature indication for generator RTD's

### Generator Control Panel Metering

- Generator digital multimeter
  - VM - Generator volts
  - AM - Generator Amps: Phase 1,2,3 and Neutral
  - MW - Generator Mega watts
  - MVAR - Generator Mega VAR's
  - FM - Generator frequency
  - MVA - Generator MVA
  - PF - Generator Power factor
  - MWH - Generator Megawatt Hours
  - MVAH - Generator MVA Hours

### Generator Control Panel Transducers

- Generator watt/VAR transducer 4-20 mA output for input to TCP (96GG1)
- Generator TCP/droop control transducer 4-20 mA output (96GW-1)
- Generator power factor transducer 4-20 mA output for customer (96GP-1)
- Generator VAR transducer 4-20 mA output for customer (96GR-1)

### Generator Protection

- Generator electrical protection equipment
- Ground brush rigging

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## 7FA SCOPE OF SUPPLY

### **Batteries and Accessories**

- Lead Acid Battery
- Single phase battery charger
- Battery and Charger mounted in the PEECC

### **Motor Control Center**

- MCC mounted in control cab/PEECC
- Tin-plated copper bus-work
- 42 kA bracing
- 480V 60 Hz auxiliary power

### **Motor Features**

- TEFC motors (200hp)
- Coated with anti-fungal material for protection in tropical areas
- High ambient motor insulation
- Energy saver motors
- Extra severe duty motors
  - Cast iron motor housing
  - All redundant motors to be lead/lag
  - Motor heaters
    - Rated 110/120 volts, 50/60 hertz
  - WP motors > 200 hp
    - Trunions for generator
    - On loan basis only
    - Jacking bolts for generator
    - Foundation/installation washer and shim packs
- Power Systems Studies
  - Provided by customer

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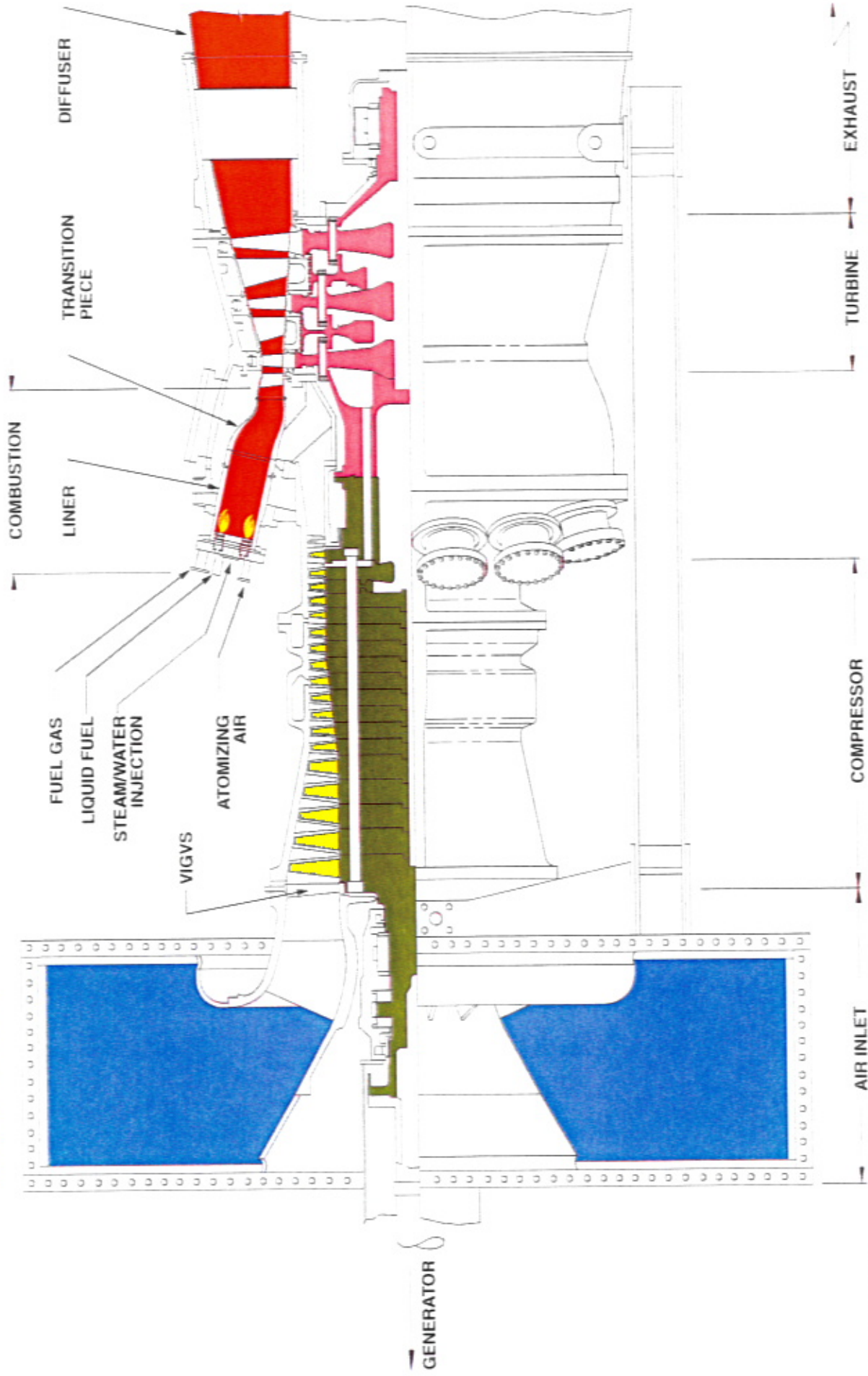
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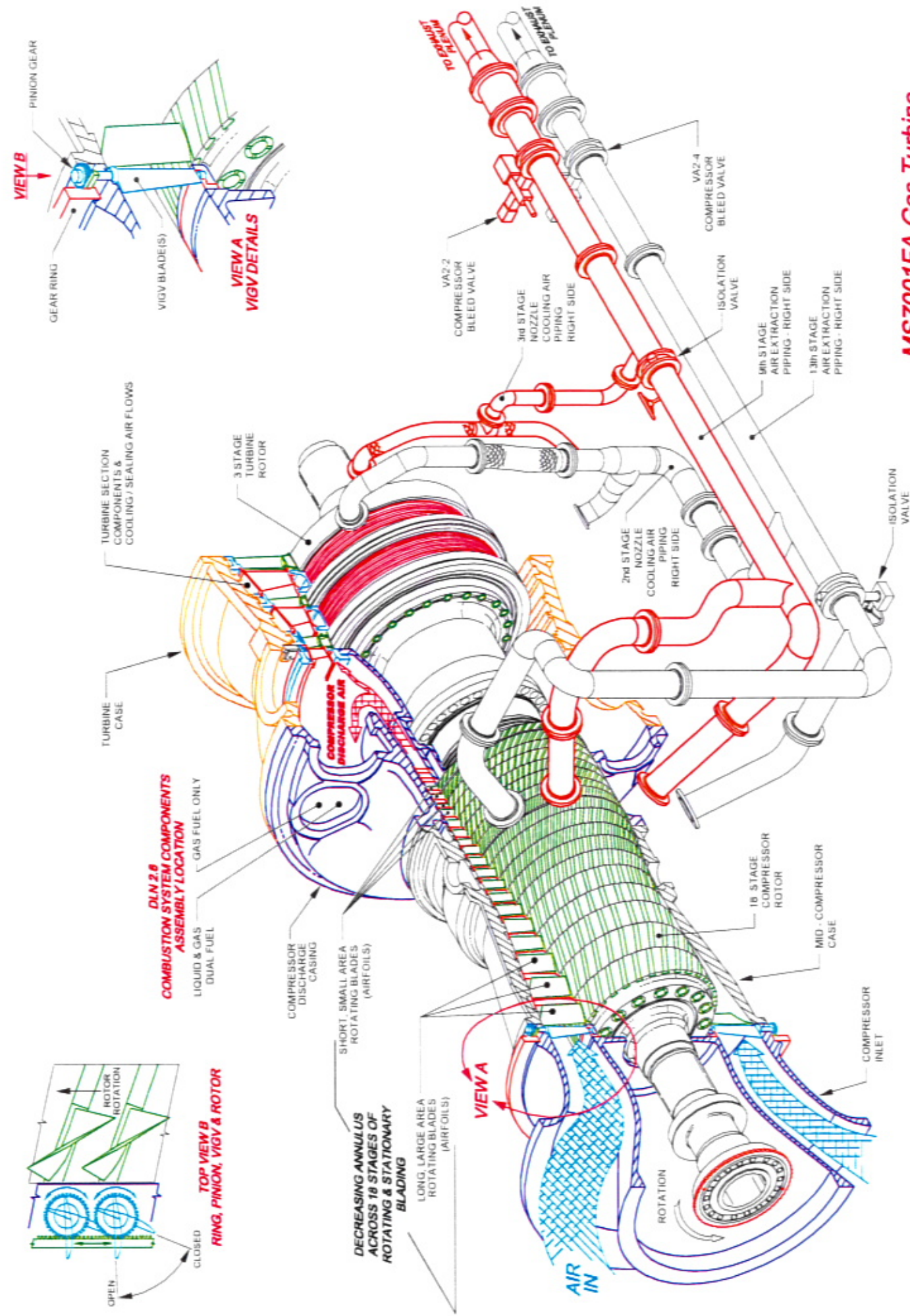
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# **MS7001FA** **Gas Turbine Assembly** **Major Sections**





# **MS7001FA Gas Turbine** **Construction & Operating Principles**

# General Electric Model PG7241(FA) Gas Turbine

Estimated Performance - Configuration: DLN Combustor

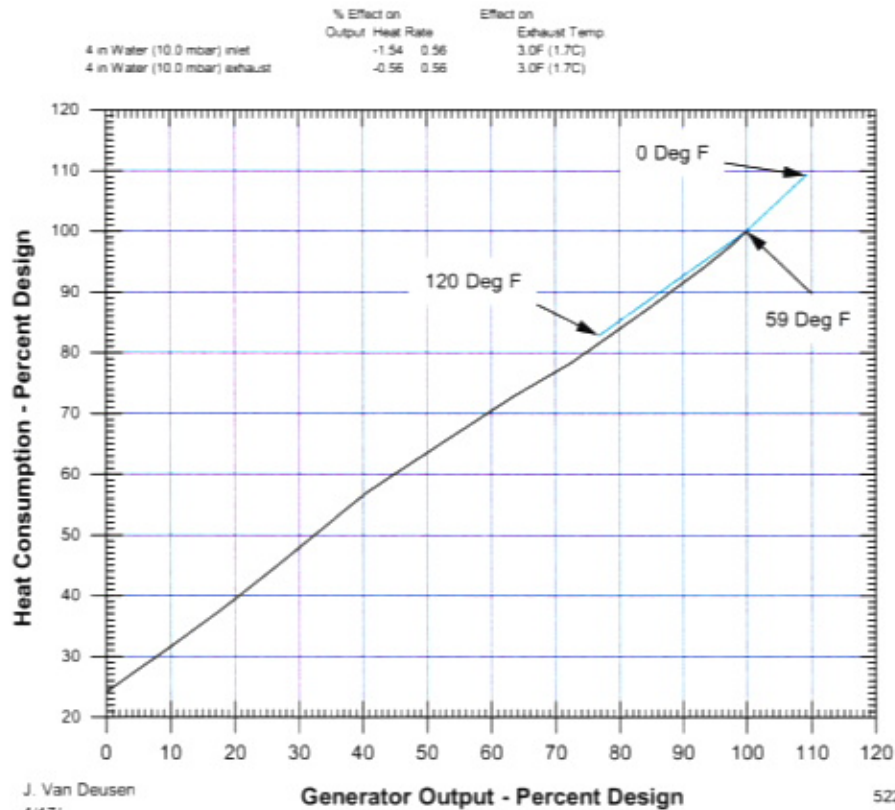
Compressor Inlet Conditions 59 F (15 C), 60% Relative Humidity

Atmospheric Pressure 14.7 psia (1.013 bar)

Fuel		Natural Gas
Design Output	kW	171700
Design Heat Rate (LHV)	Btu/kWh (kJ/kWh)	9360 (9870)
Design Heat Cons (LHV)	Btu/h (kJ/h)x10 <sup>6</sup>	1607.1 (1695.2)
Design Exhaust Flow	lb/h (kg/h)x10 <sup>3</sup>	3542.0 (1607)
Exhaust Temperature	deg F (deg C)	1116 (602.2)
Load		Base

## Notes

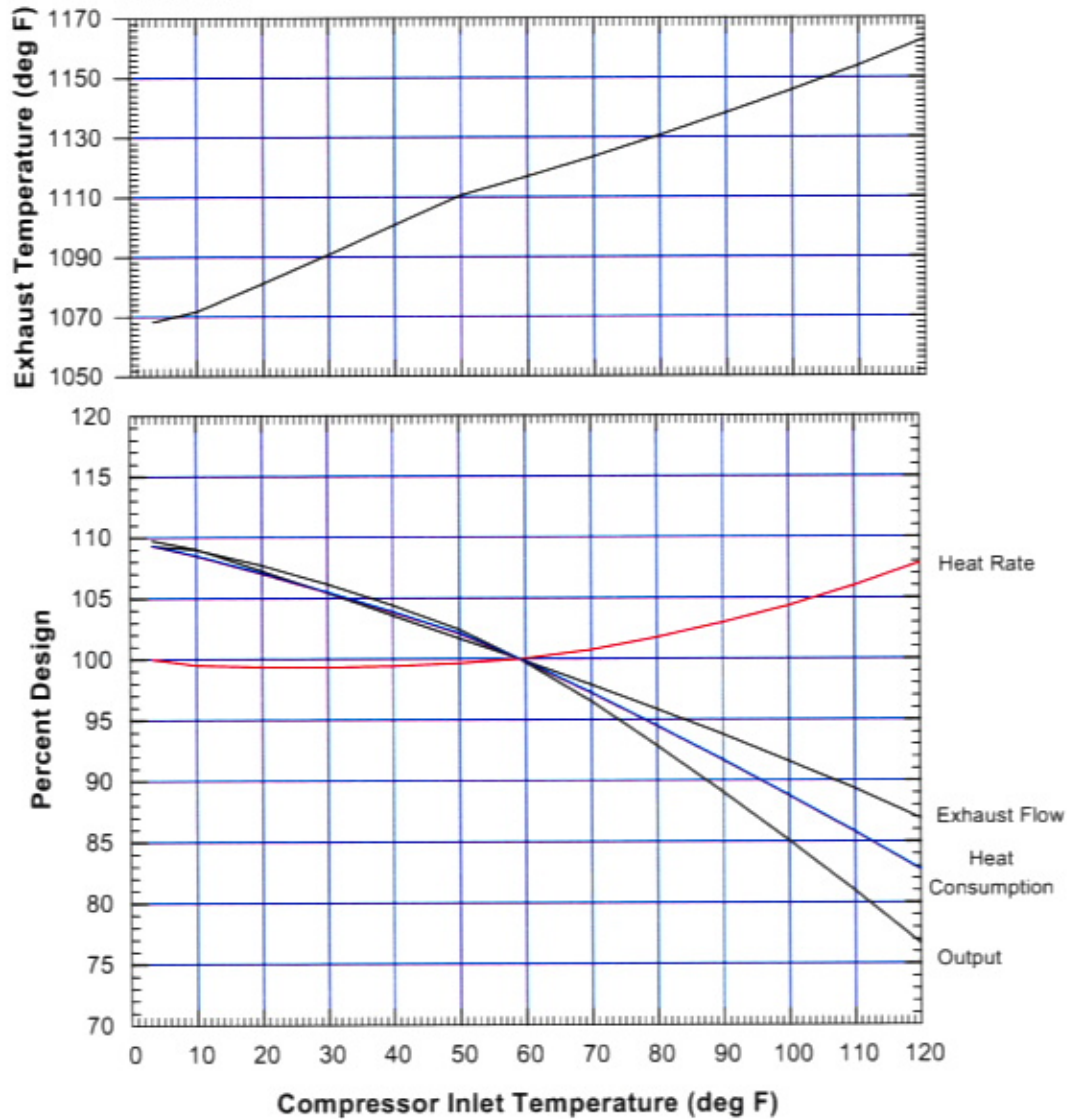
- Altitude correction on curve 416HA852 Rev A.
- Ambient temperature correction on curve 522HA852 Rev A.
- Effect of modulating IGV's on exhaust temperature and flow on curve 522HA853 Rev A.
- Humidity effects on curve 498HA697 Rev B - all performance calculated with a constant specific humidity of .0064 or less as not to exceed 100% relative humidity.
- Plant Performance is measured at the generator terminals and includes allowances for the effects of inlet bleed heating, excitation power, shaft driven auxiliaries, and 3.04 in H<sub>2</sub>O (8.33 mbar) inlet and 5.5 in H<sub>2</sub>O (13.70 mbar) exhaust pressure drops and a DLN Combustor.
- Additional inlet and exhaust pressure loss effects.



## GENERAL ELECTRIC MODEL PG7241(FA) GAS TURBINE

### Effect of Compressor Inlet Temperature on Output, Heat Rate, Heat Consumption, Exhaust Flow And Exhaust Temperature at Baseload

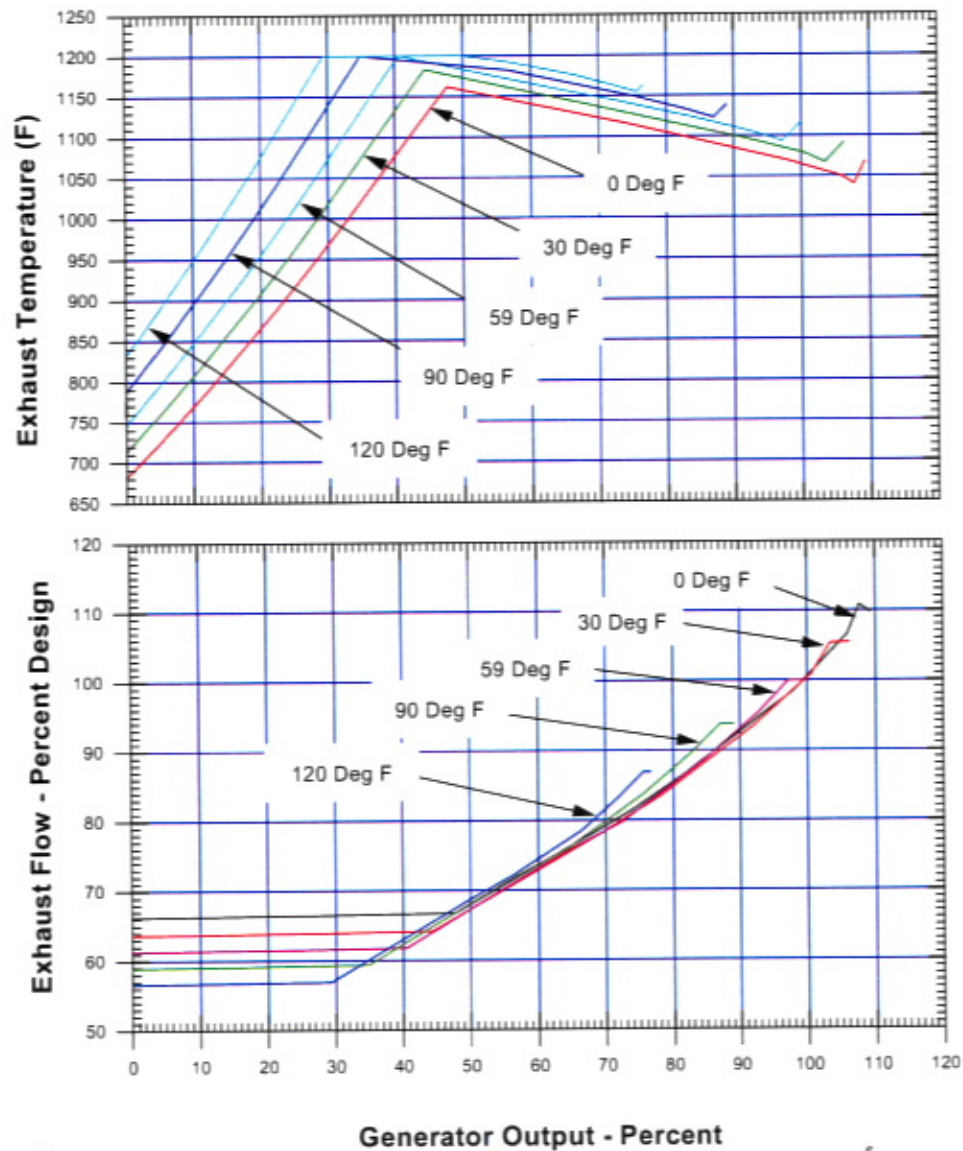
Fuel: Natural Gas  
Design Values on Curve 522HA851 Rev A  
DLN Combustor



## GENERAL ELECTRIC MODEL PG7241(FA) GAS TURBINE

### Effect of Inlet Guide Vane on Exhaust Flow and Temperature As a Function of Output and Compressor Inlet Temperature

Fuel: Natural Gas  
Design Values on Curve Rev A  
DLN Combustor

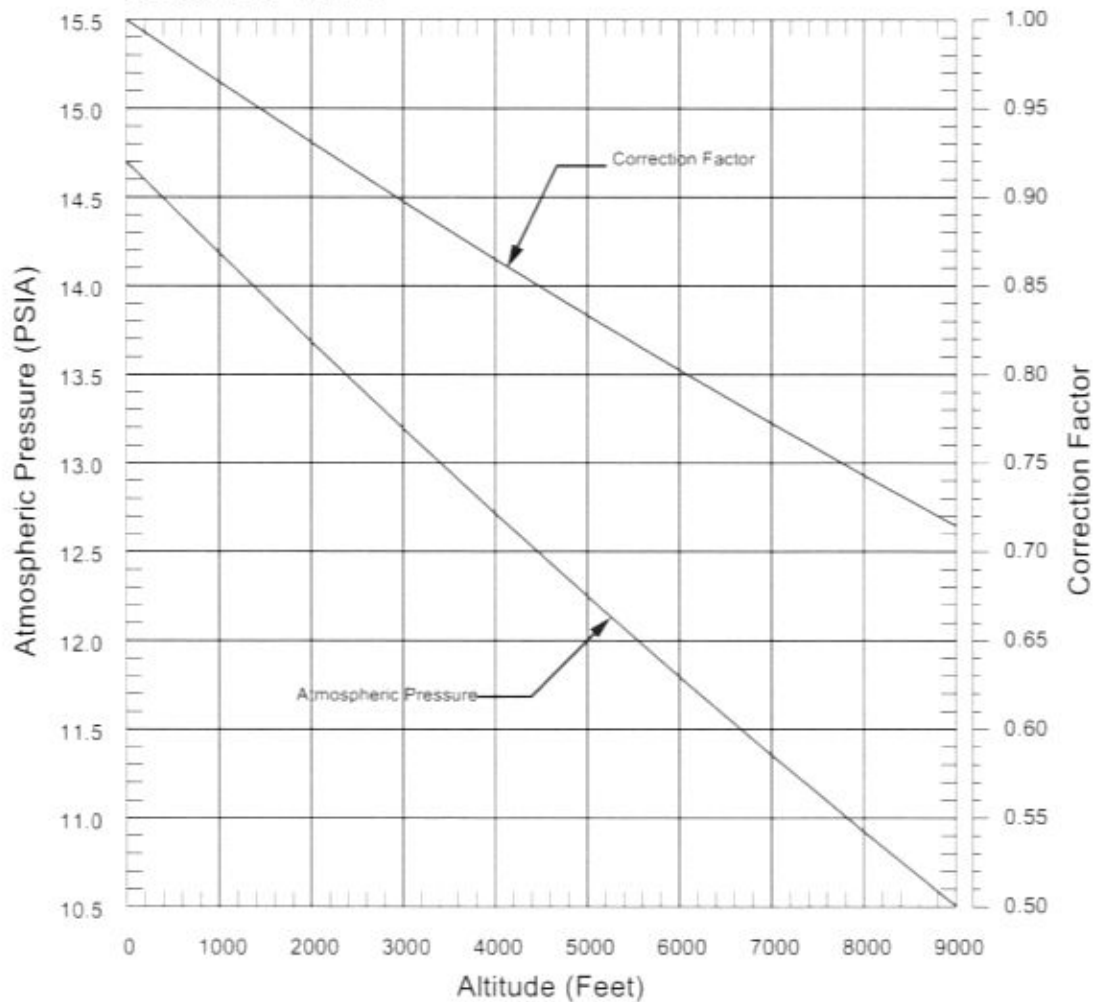


# GENERAL ELECTRIC GAS TURBINE ALTITUDE CORRECTION CURVE

ALTITUDE VS ATMOSPHERIC PRESSURE  
AND  
ALTITUDE VS CORRECTION FACTOR  
FOR GASTURBINE OUTPUT, FUEL CONSUMPTION, AND EXHAUST FLOW

## NOTES

- 1 Exhaust Temperature, Heat Rate, and Thermal Efficiency are not affected by altitude.
- 2 Correction Factor =  $P_{\text{atm}}/14.7$

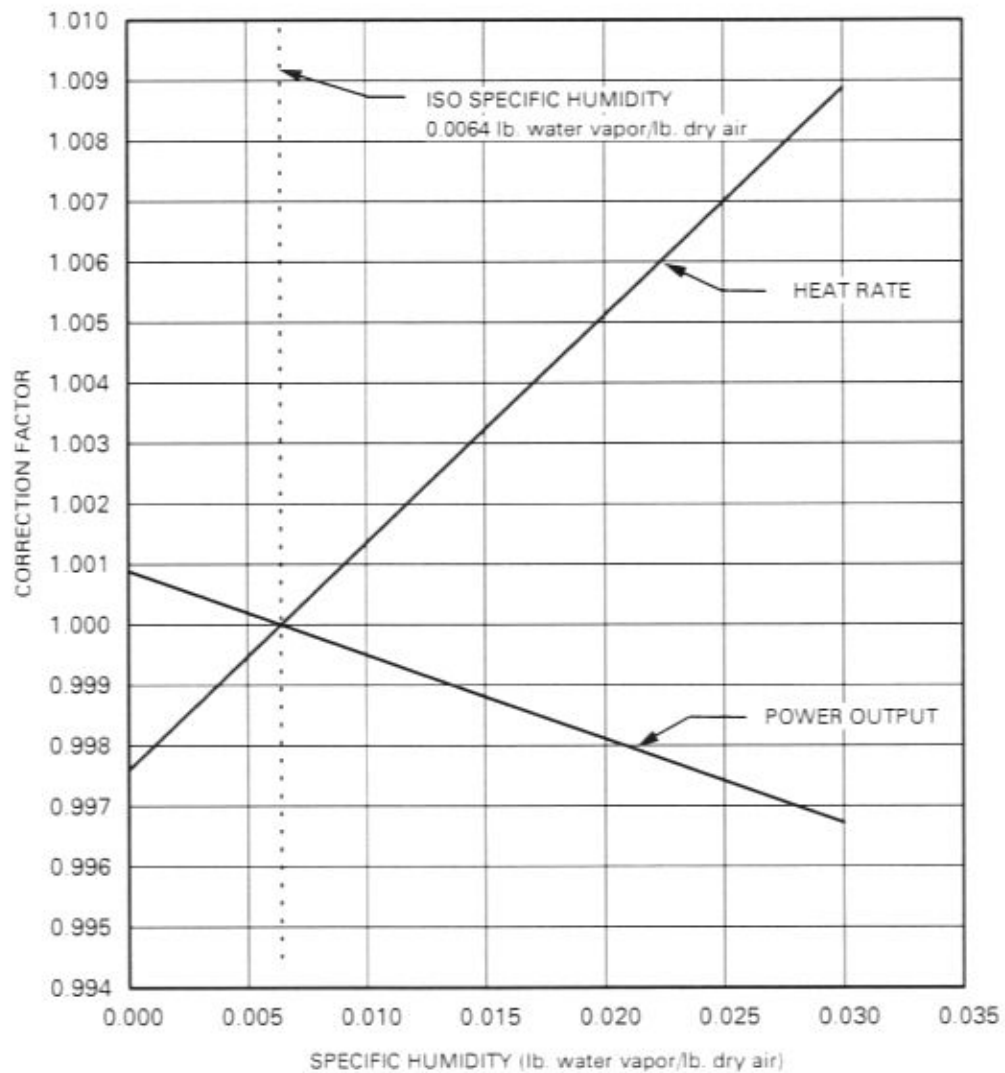


416HA6  
Rev-B

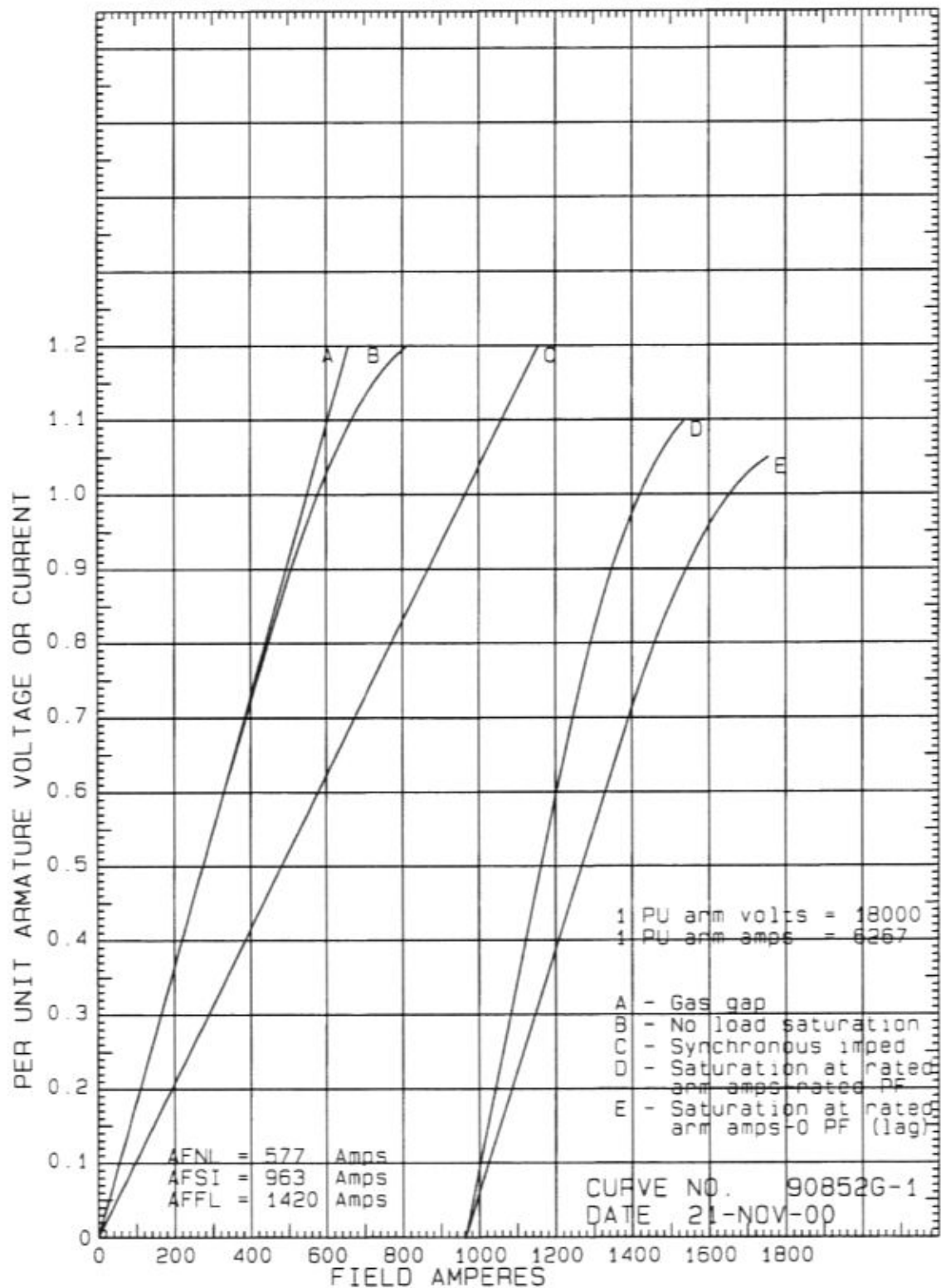
## General Electric MS6001, MS7001 And MS9001 Gas Turbines

Corrections To Output And Heat Rate  
For Non-Iso Specific Humidity Conditions

For Operation At Base Load On Exhaust  
Temperature Control Curve

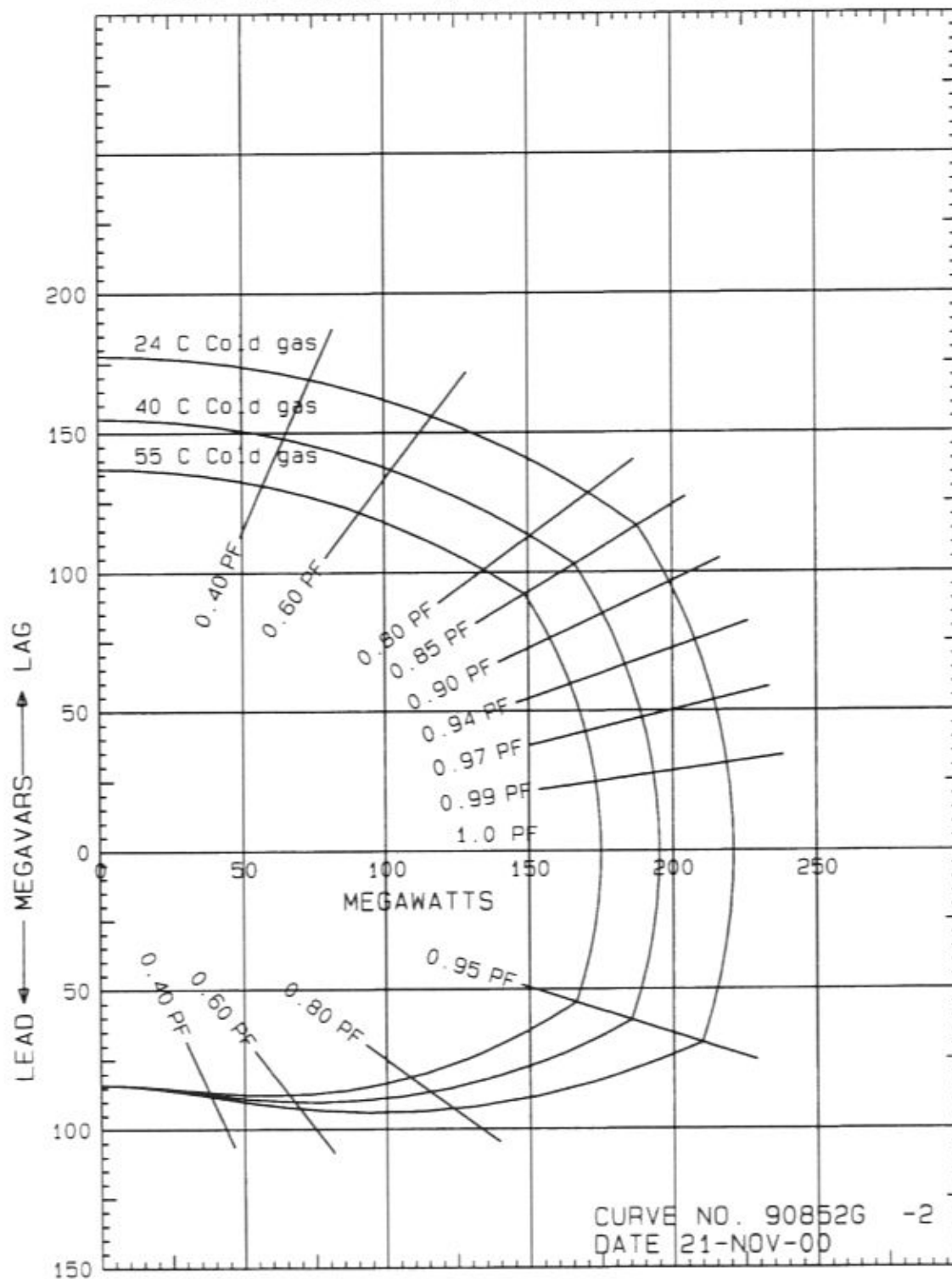


ESTIMATED SATURATION AND SYNCHRONOUS IMPEDANCE CURVES  
 195400 KVA - 3600 RPM - 18000 VOLTS - 0.85 PF  
 285 FLD VOLTS - 40 C COLD GAS - 30 PSIG H2



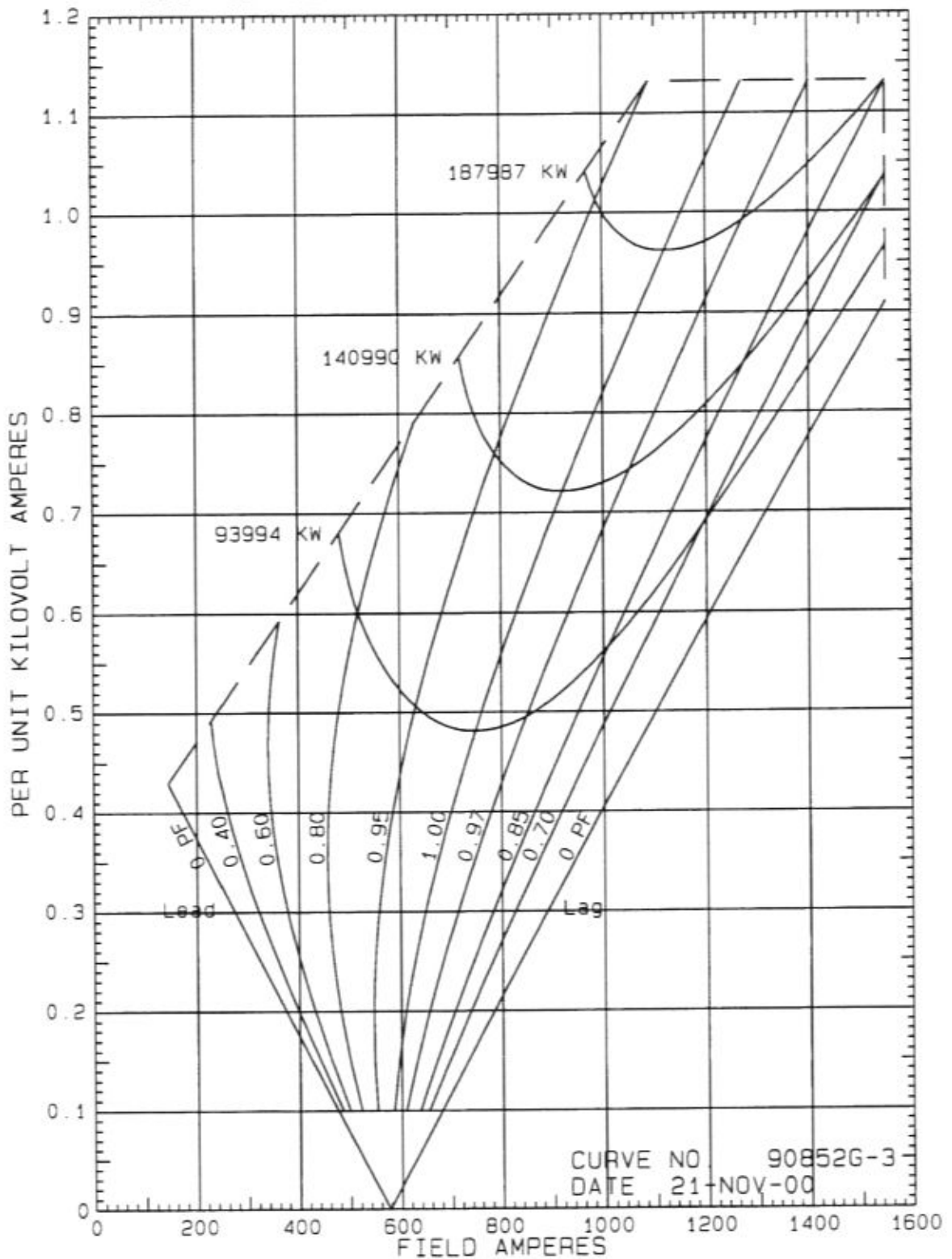
# ESTIMATED REACTIVE CAPABILITY CURVES

195400 KVA - 3600 RPM - 18000 VOLTS - 0.85 PF  
285 FLD VOLTS - 40 C COLD GAS - 30 PSIG H2

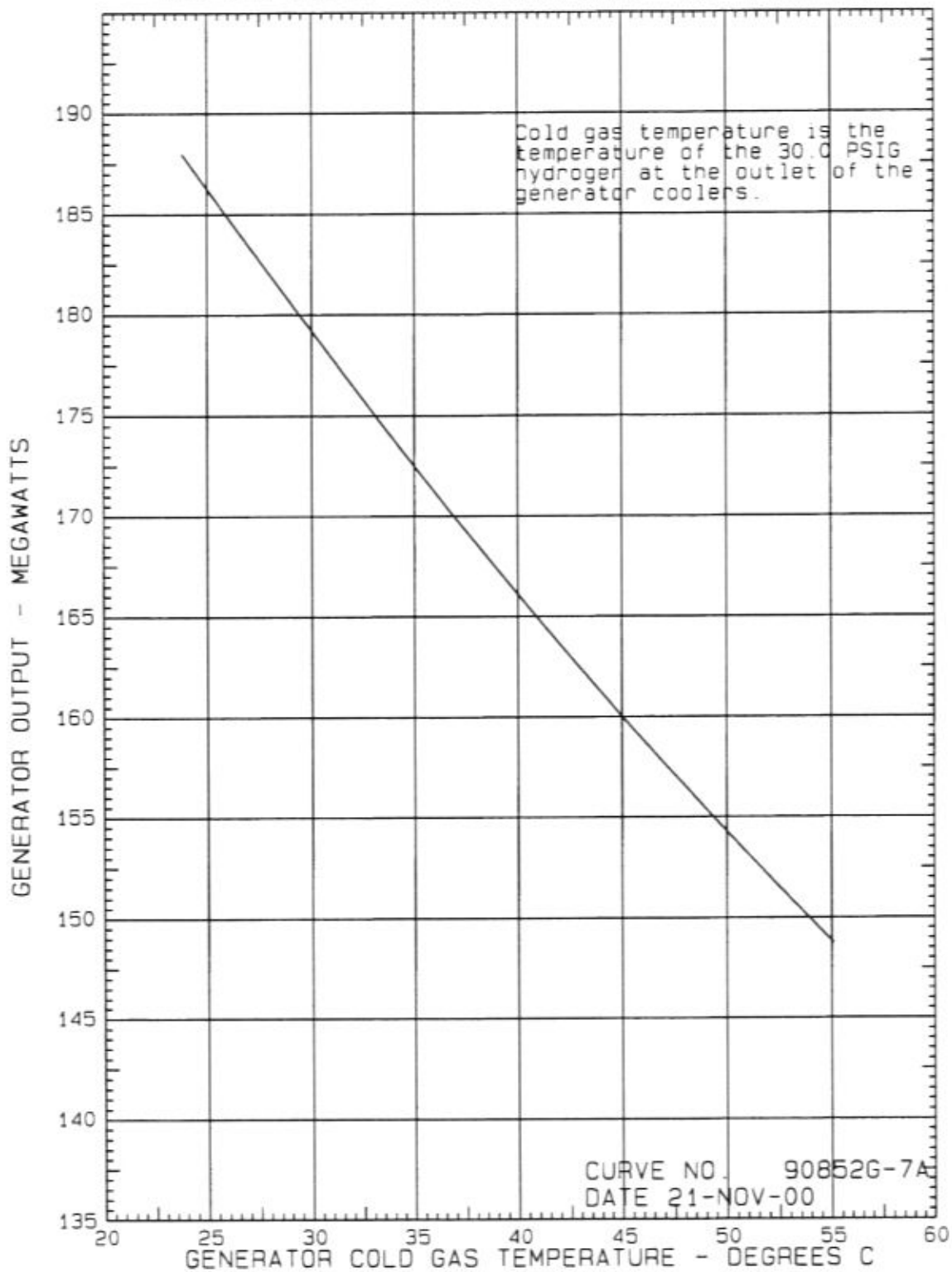


# ESTIMATED EXCITATION V CURVES

195400 KVA - 3600 RPM - 18000 VOLTS - 0.85 PF  
285 FLD VOLTS - 40 C COLD GAS - 30 PSIG H2



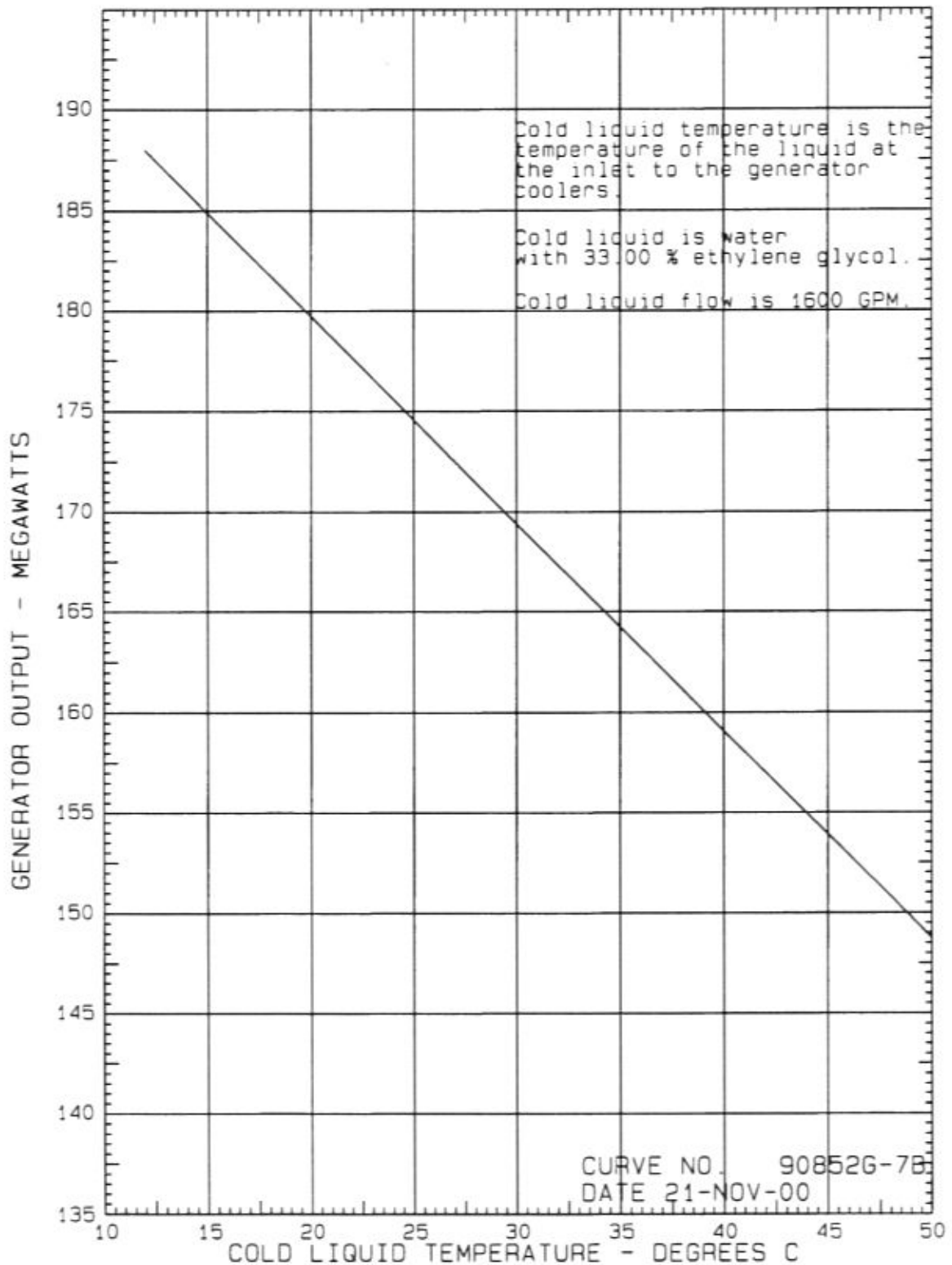
GENERATOR OUTPUT AS A FUNCTION OF COLD GAS TEMPERATURE  
195400 KVA - 3600 RPM - 18000 VOLTS - 0.85 PF  
285 FLD VOLTS - 40 C COLD GAS - 30 PSIG H2



# GENERATOR OUTPUT AS A FUNCTION OF COLD LIQUID TEMPERATURE

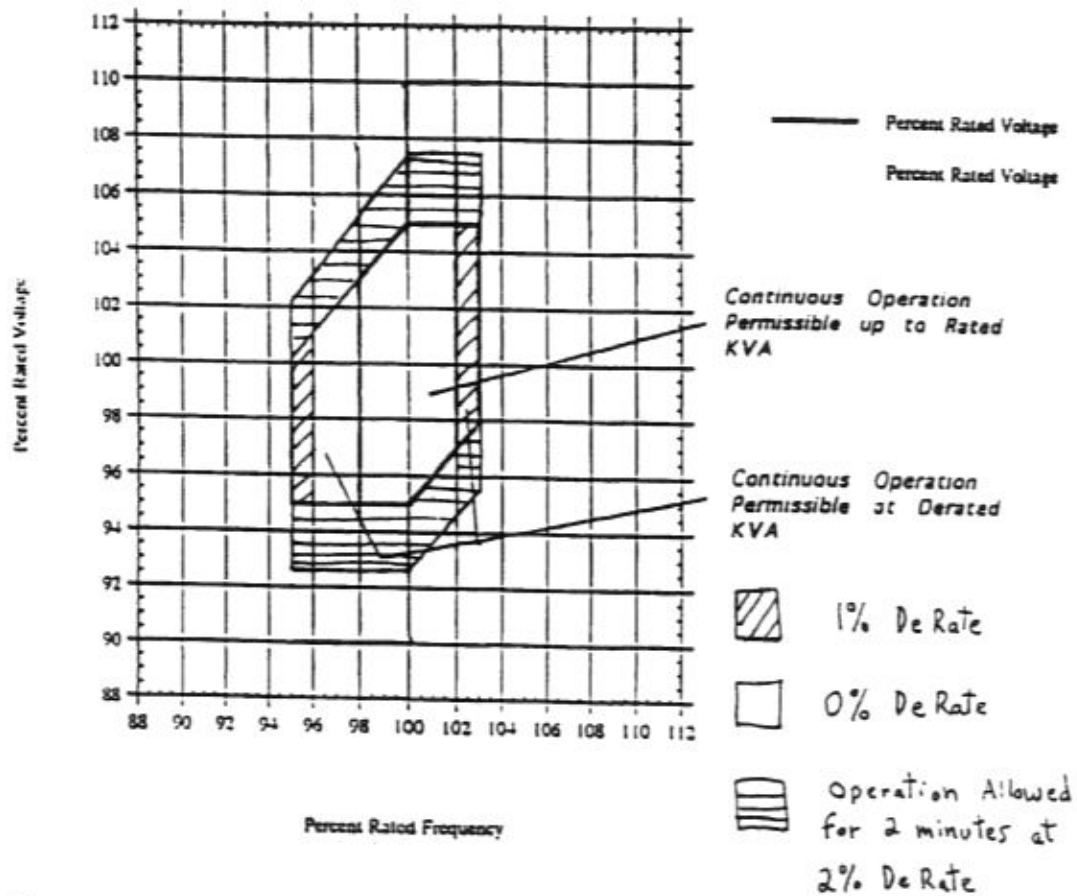
195400 KVA - 3600 RPM - 18000 VOLTS - 0.85 PF

285 FLD VOLTS - 40 C COLD GAS - 30 PSIG H2



# Voltage - Frequency Capability Curve

## Attachment A



### Notes:

1. Actual Over and Under Frequency may be Limited by Turbine.
2. Area Within Rated KVA Operation may Increase by 10°C.
3. Area Within Derated KVA Operation may Increase by 25°C with Loss of Life.

JHR 11/23/96

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