



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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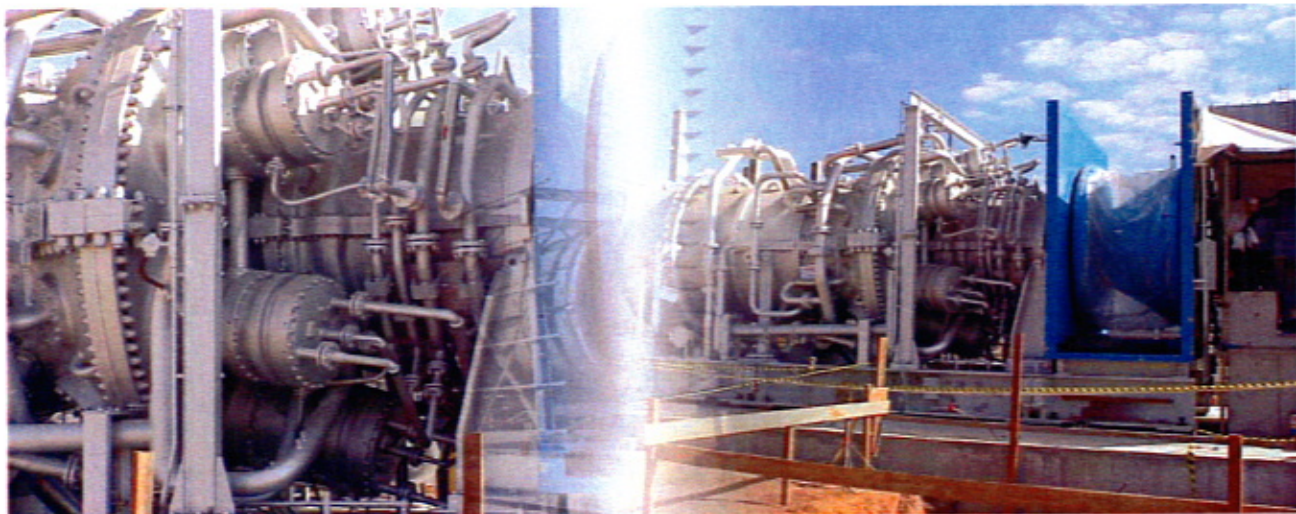
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Exhaust System Arrangement

- 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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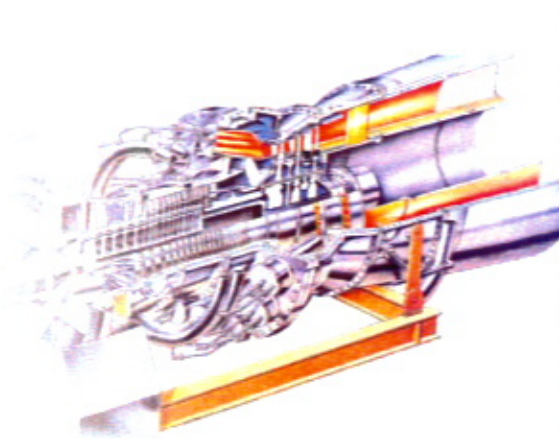
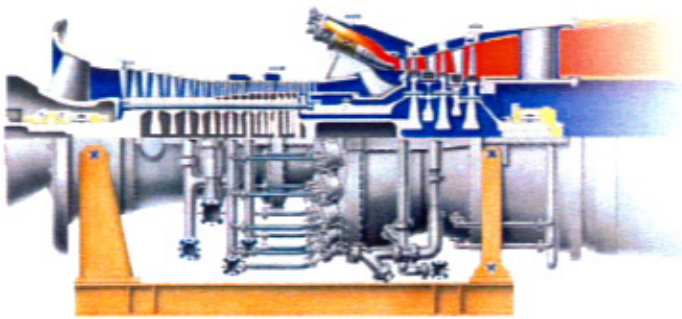
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7FA SCOPE OF SUPPLY

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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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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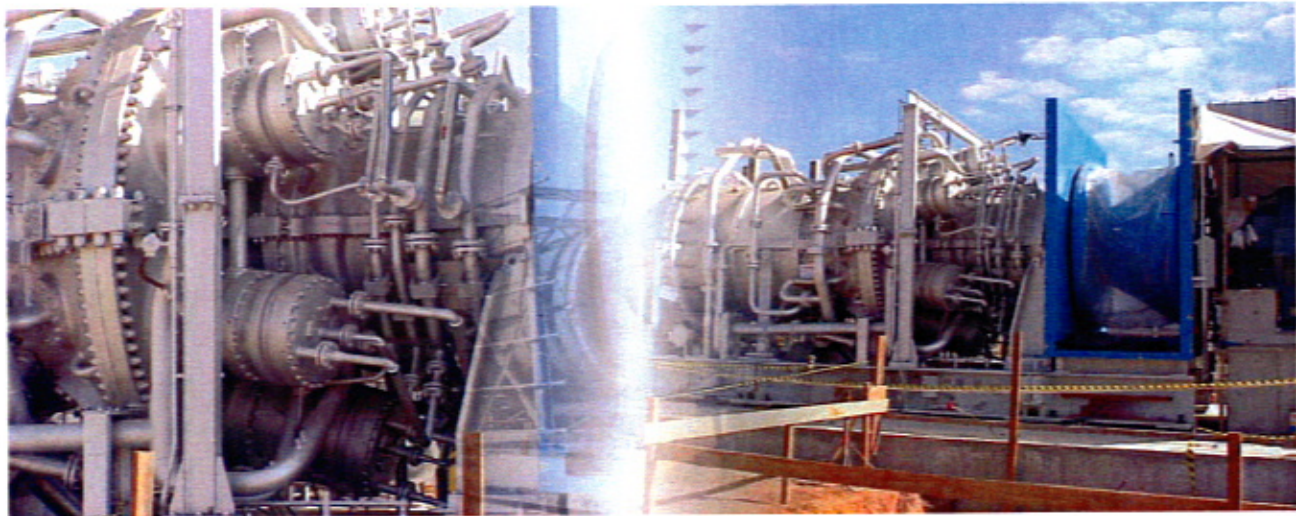
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7FA SCOPE OF SUPPLY

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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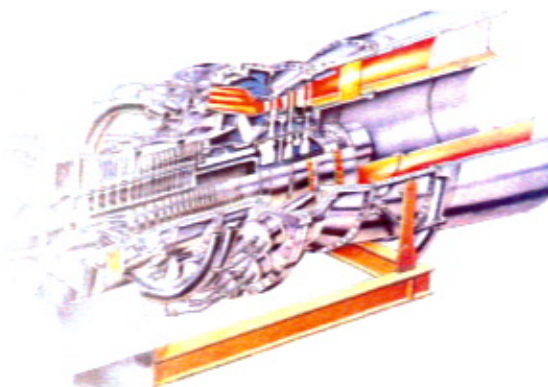
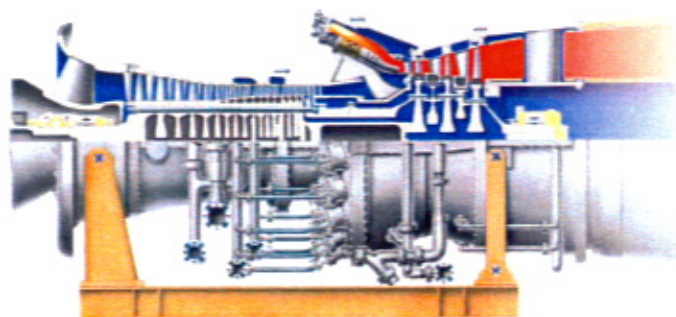
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7FA SCOPE OF SUPPLY

- 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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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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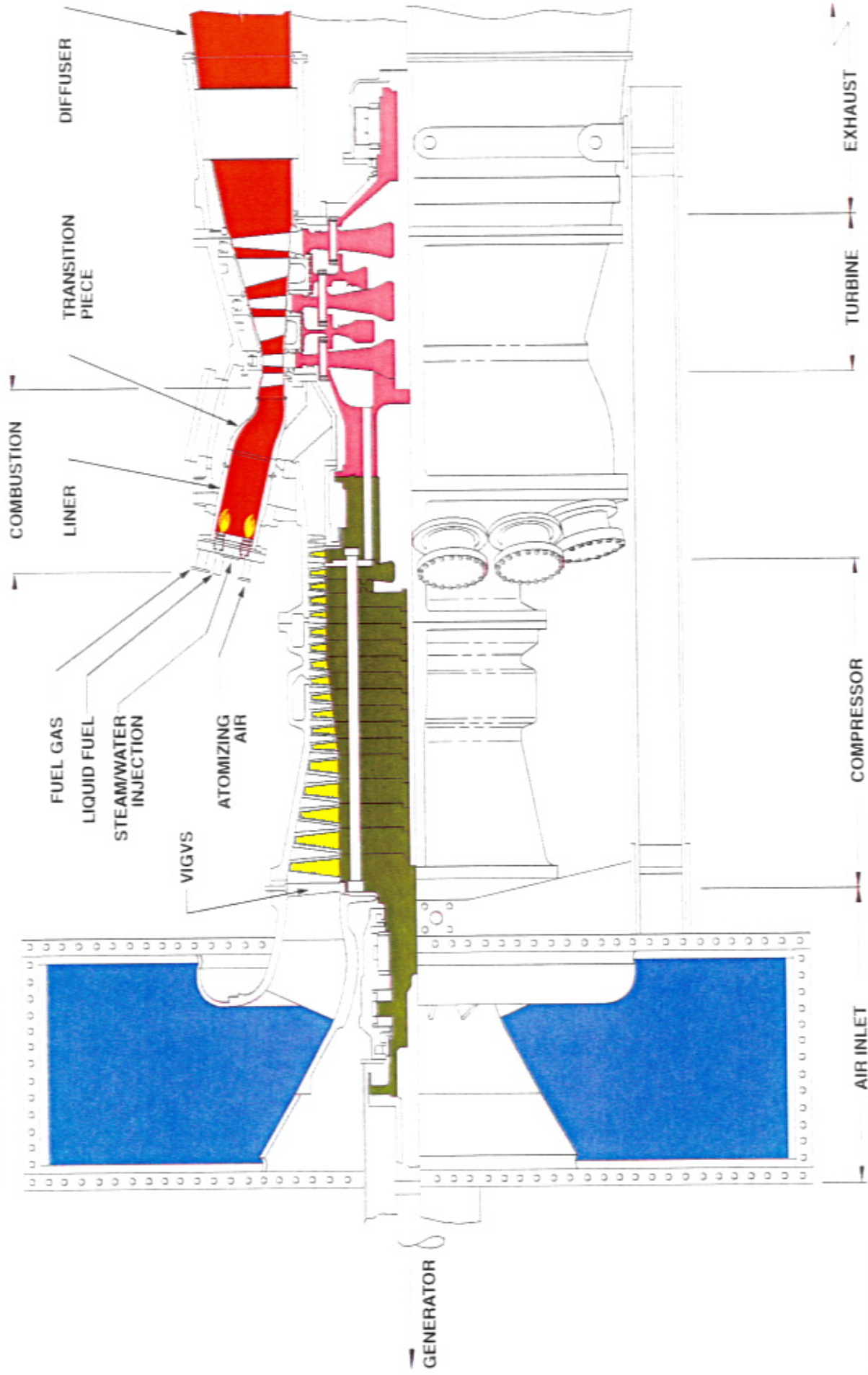
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MS7001FA **Gas Turbine Assembly** **Major Sections**





General Electric Model PG7241(FA) Gas Turbine

Estimated Performance - Configuration: DLN Combustor

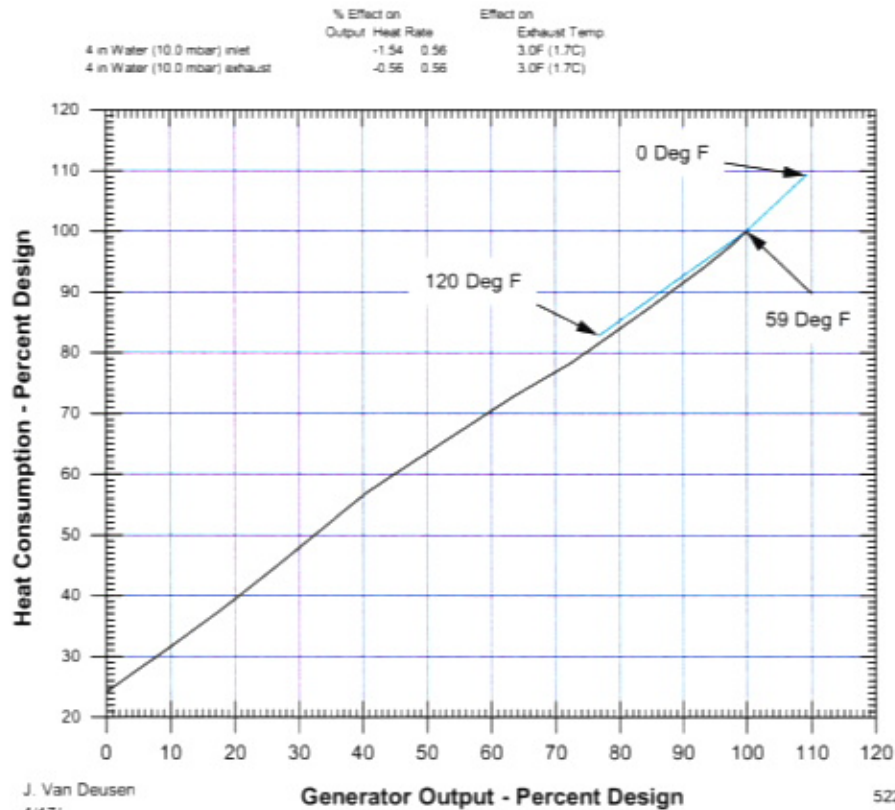
Compressor Inlet Conditions 59 F (15 C), 60% Relative Humidity

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 ⁶		1607.1 (1695.2)
Design Exhaust Flow	lb/h (kg/h)x10 ³		3542.0 (1607)
Exhaust Temperature	deg F (deg C)		1116 (602.2)
Load			Base

Notes

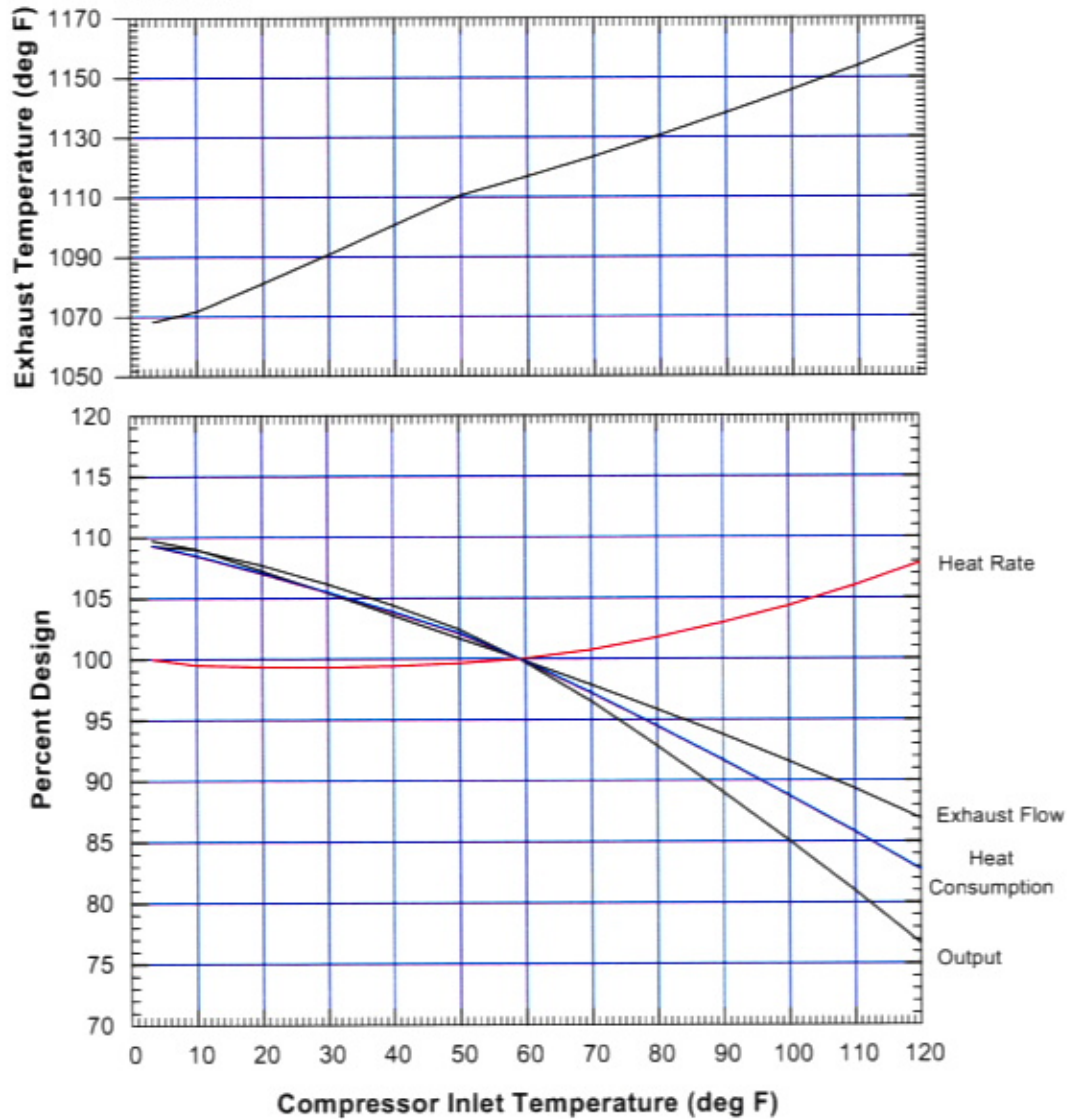
- Altitude correction on curve 416HA852 Rev A.
- Ambient temperature correction on curve 522HA852 Rev A.
- Effect of modulating IGV's on exhaust temperature and flow on curve 522HA853 Rev A.
- Humidity effects on curve 498HA697 Rev B - all performance calculated with a constant specific humidity of .0064 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 H₂O (8.33 mbar) inlet and 5.5 in H₂O (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

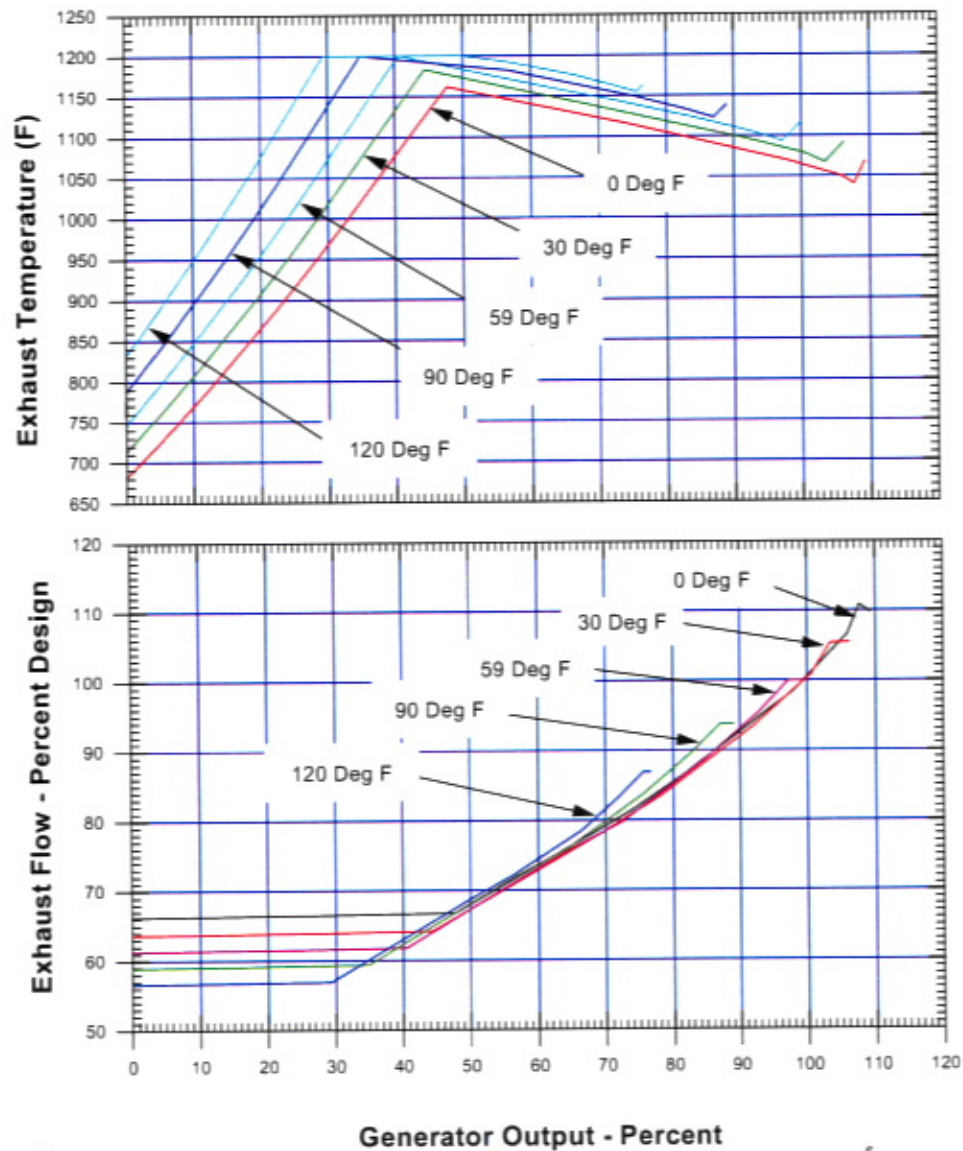
Fuel: Natural Gas
Design Values on Curve 522HA851 Rev A
DLN Combustor



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

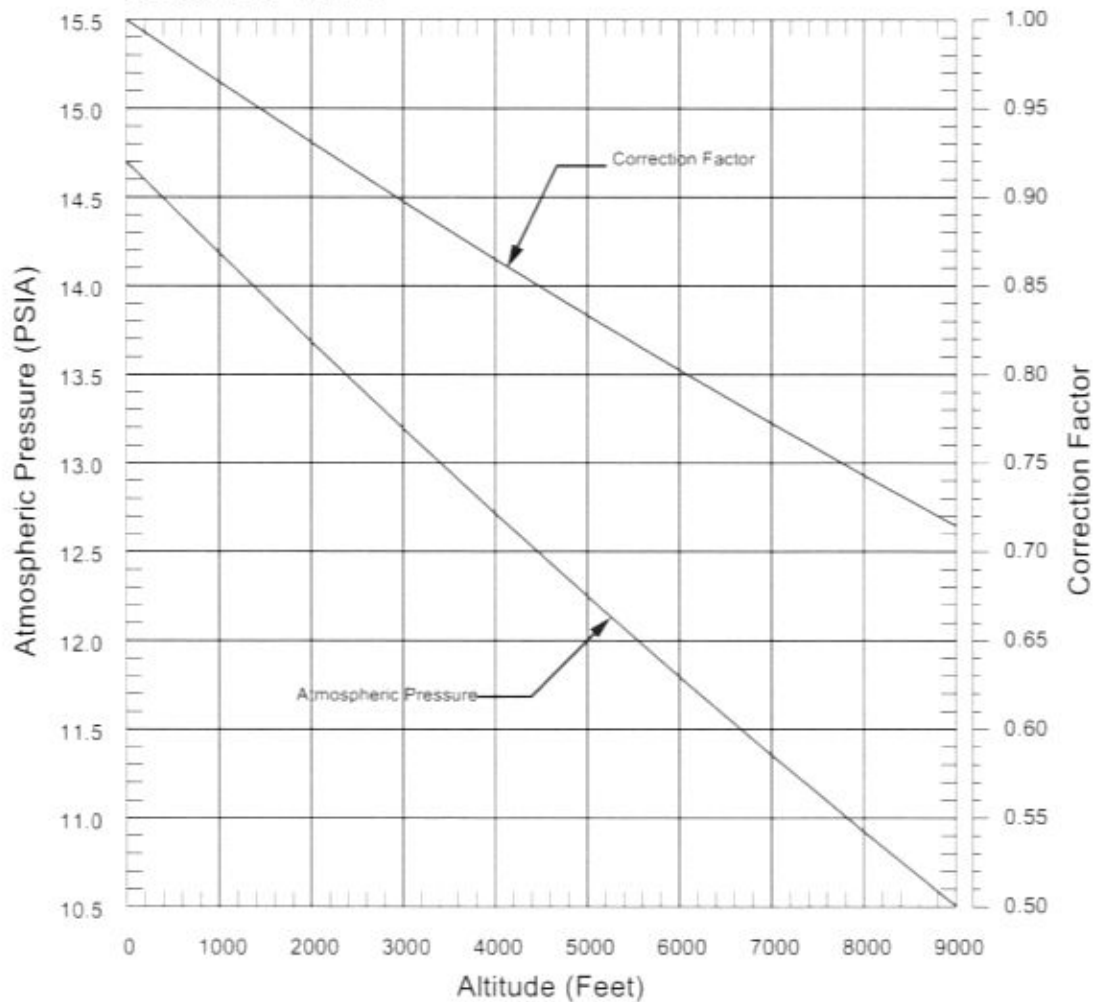


GENERAL ELECTRIC GAS TURBINE ALTITUDE CORRECTION CURVE

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 = $P_{\text{atm}}/14.7$

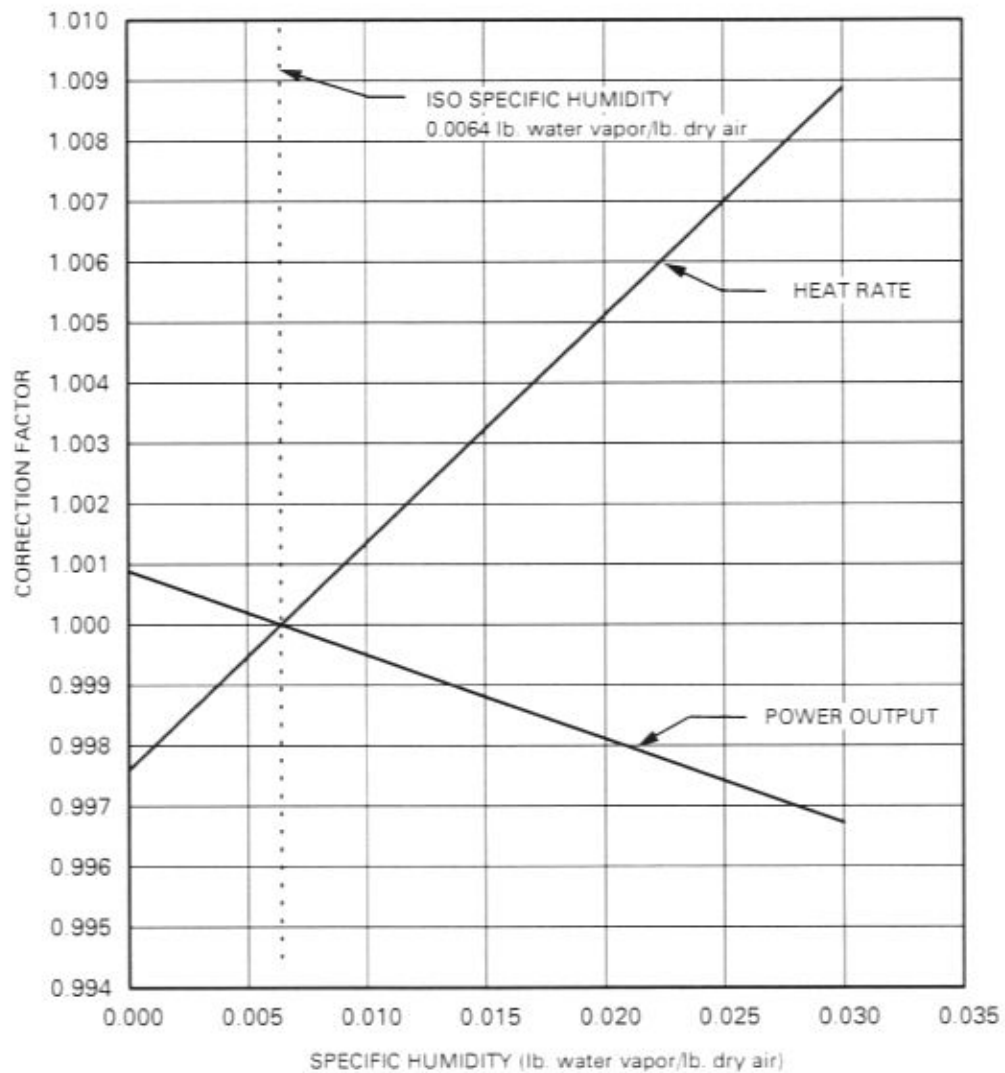


416HA6
Rev-B

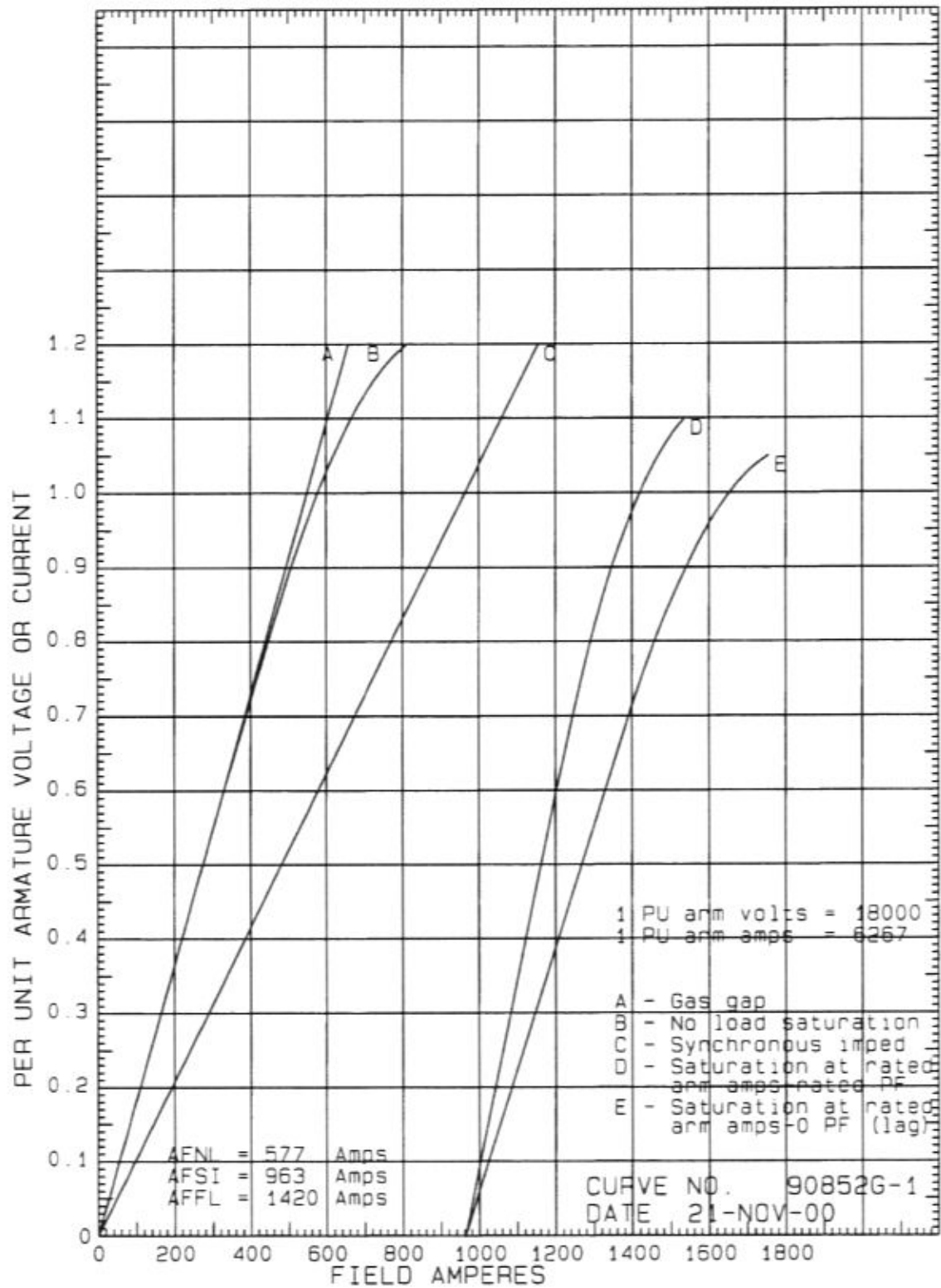
General Electric MS6001, MS7001 And MS9001 Gas Turbines

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

For Operation At Base Load On Exhaust
Temperature Control Curve

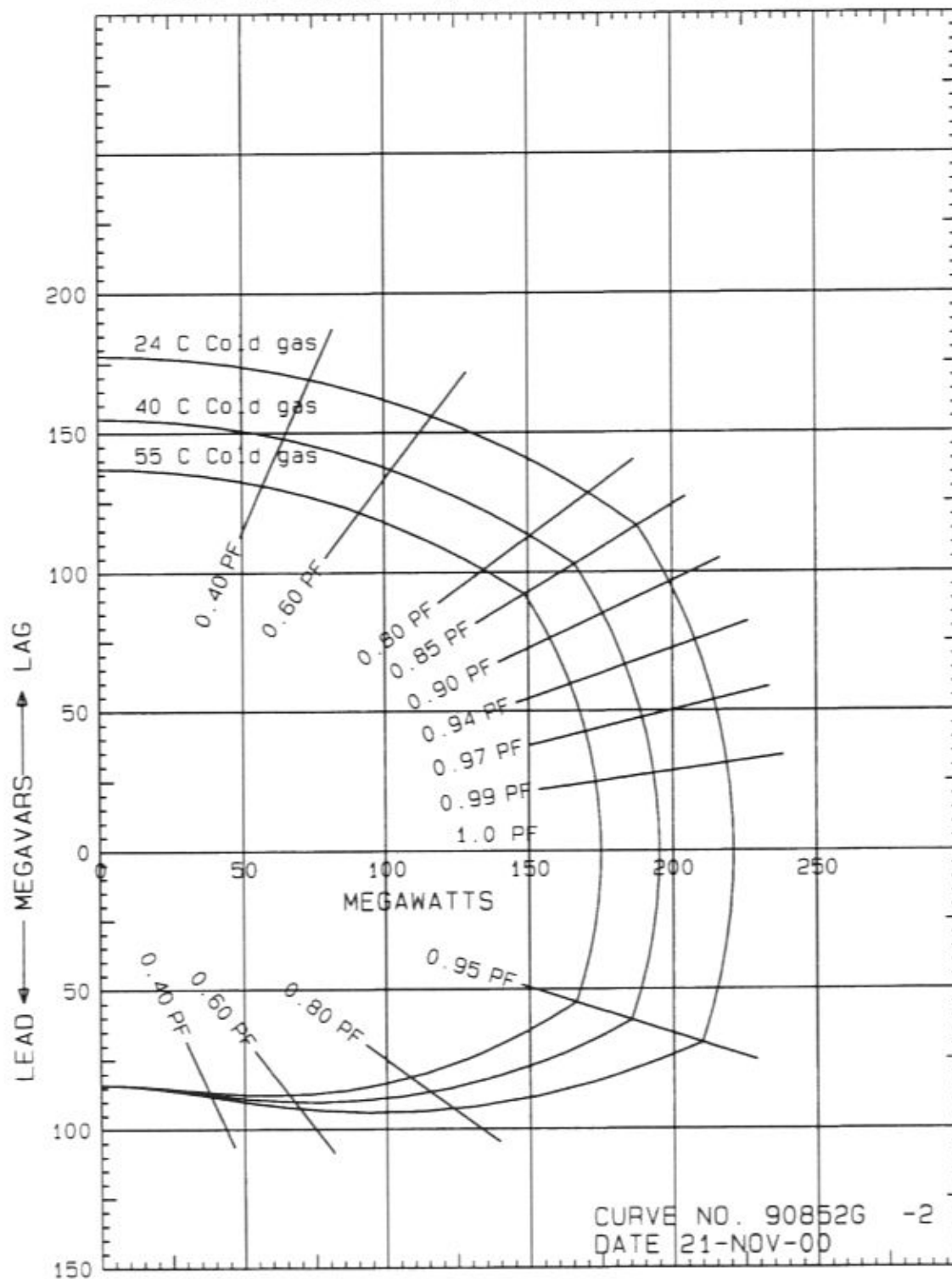


ESTIMATED SATURATION AND SYNCHRONOUS IMPEDANCE CURVES
 195400 KVA - 3600 RPM - 18000 VOLTS - 0.85 PF
 285 FLD VOLTS - 40 C COLD GAS - 30 PSIG H2



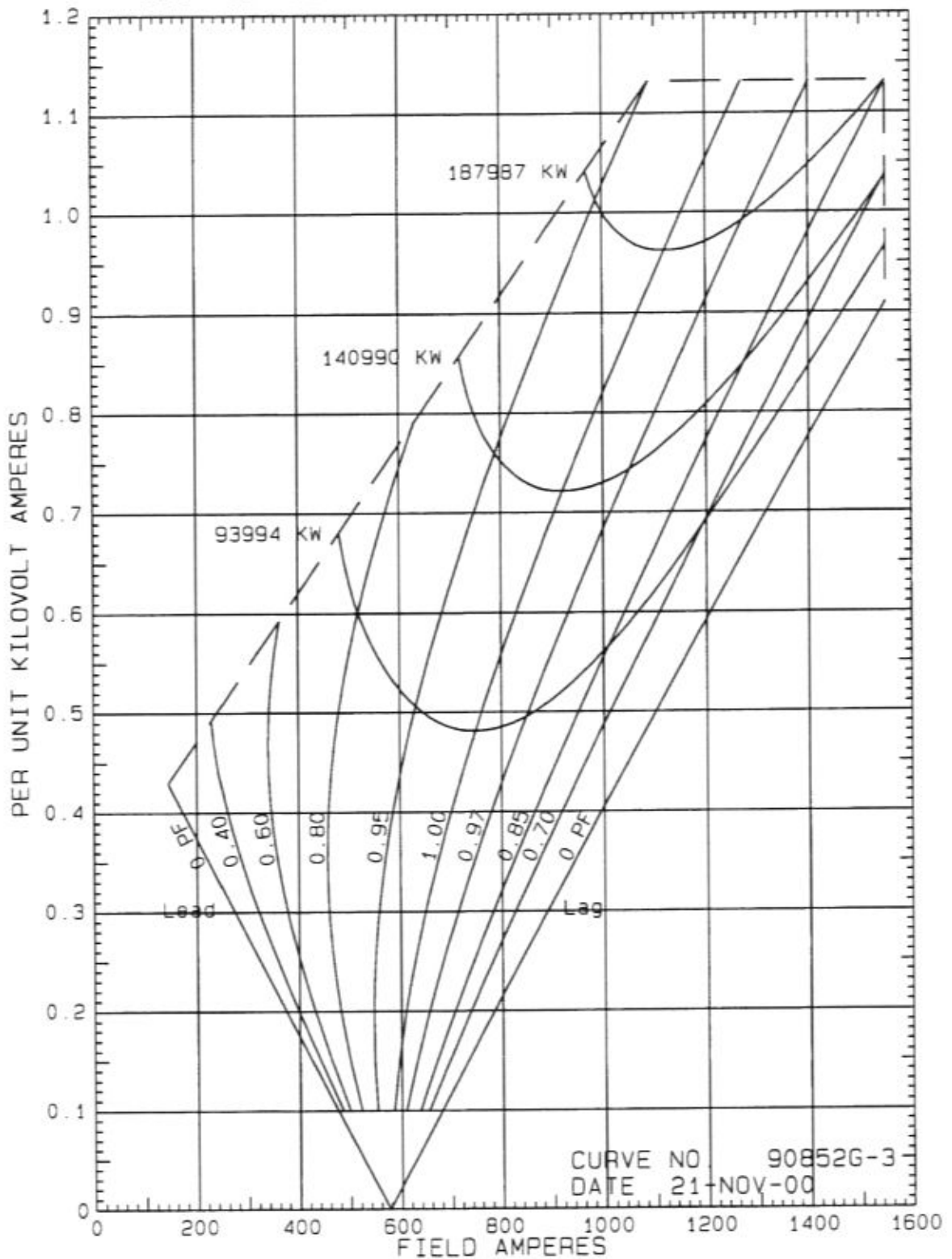
ESTIMATED REACTIVE CAPABILITY CURVES

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

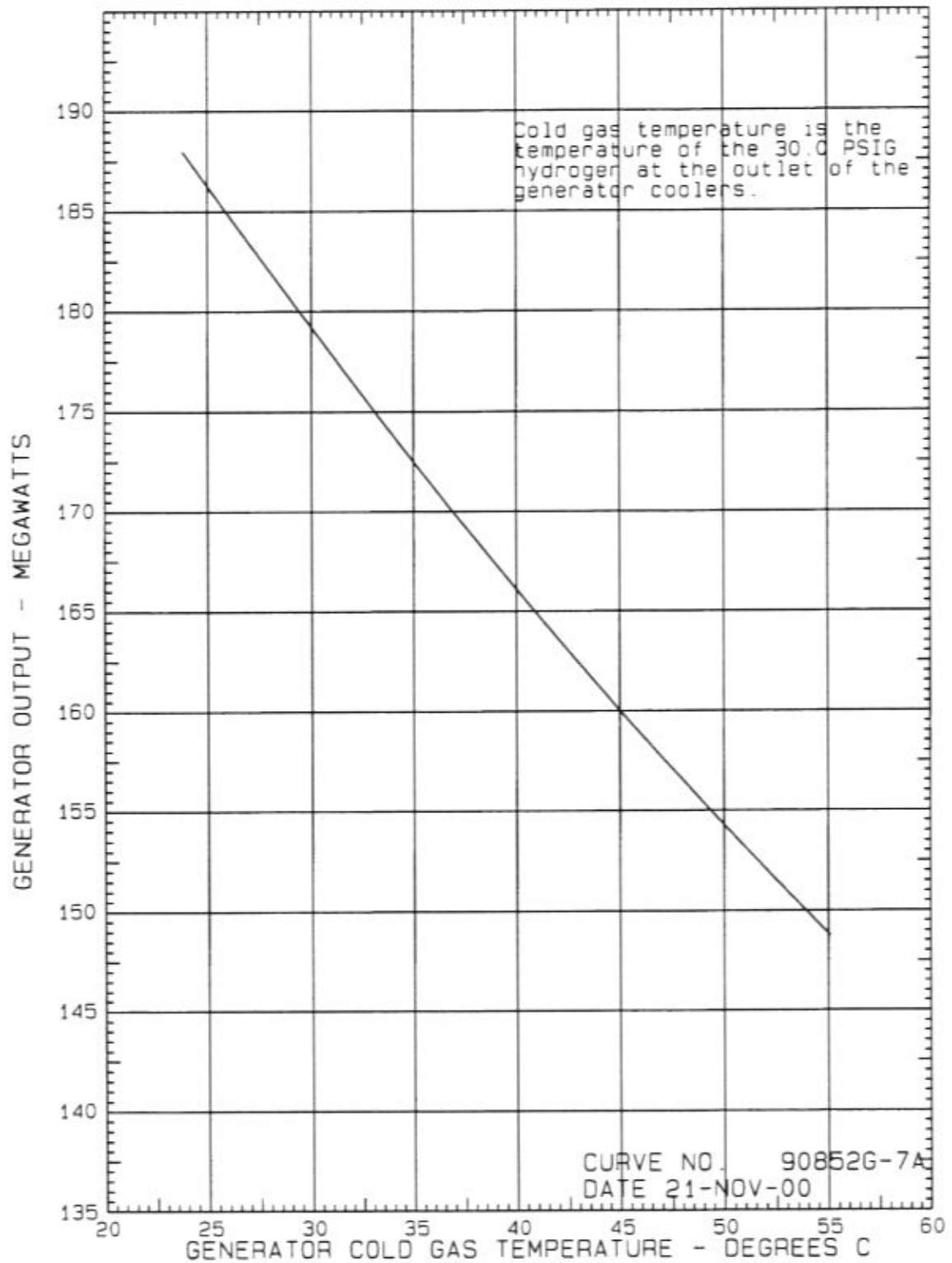


ESTIMATED EXCITATION V CURVES

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



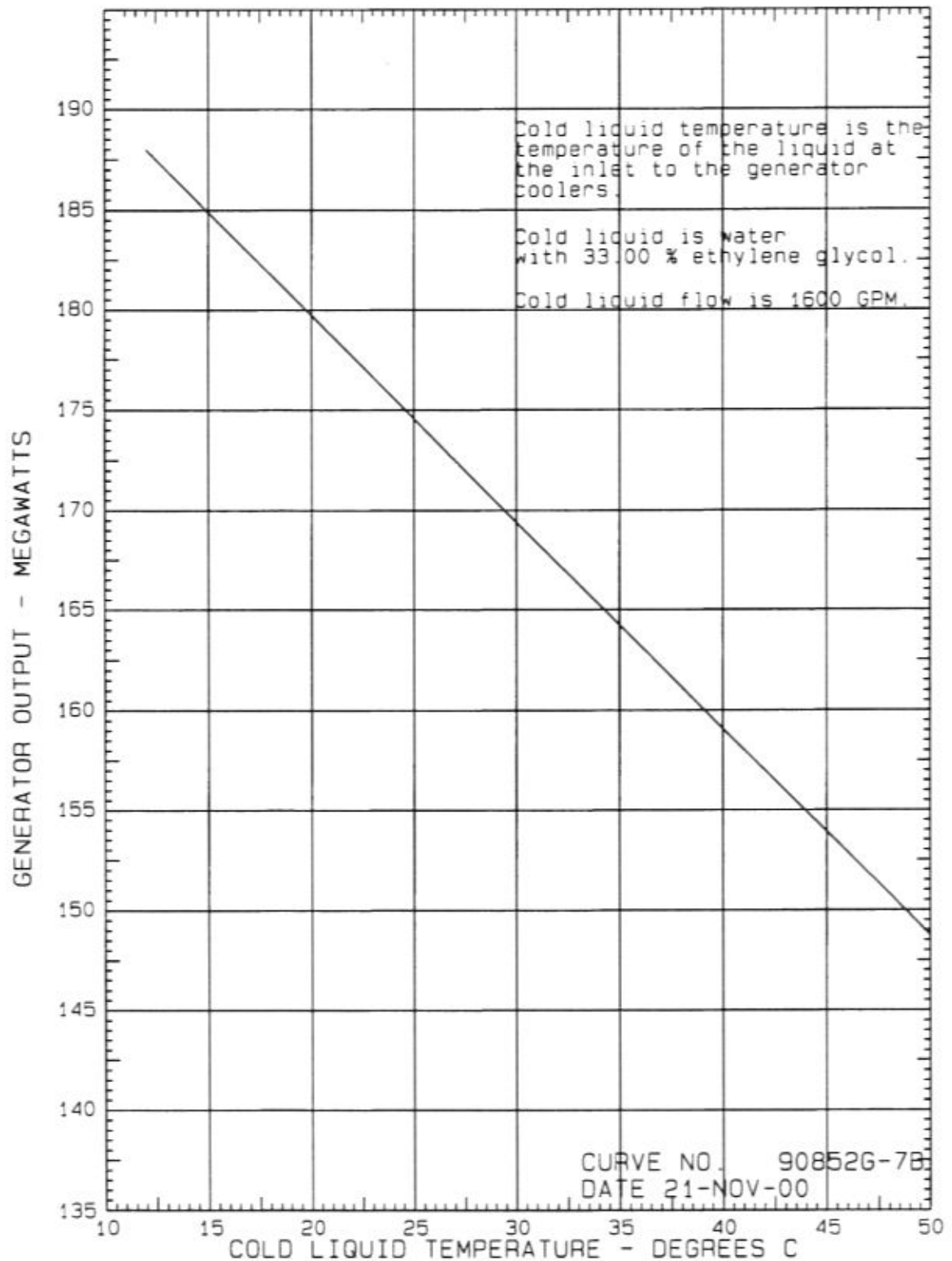
GENERATOR OUTPUT AS A FUNCTION OF COLD GAS TEMPERATURE
195400 KVA - 3600 RPM - 18000 VOLTS - 0.85 PF
285 FLD VOLTS - 40 C COLD GAS - 30 PSIG H2



GENERATOR OUTPUT AS A FUNCTION OF COLD LIQUID TEMPERATURE

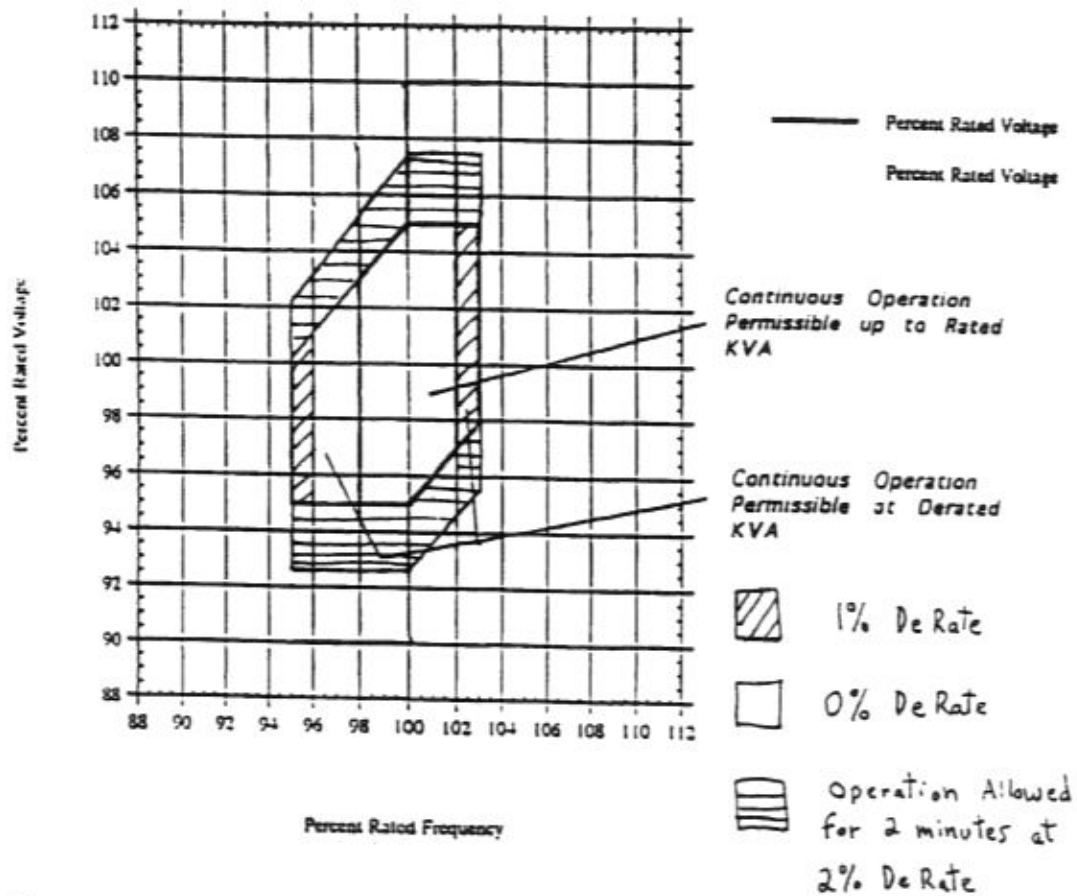
195400 KVA - 3600 RPM - 18000 VOLTS - 0.85 PF

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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