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Sedalia, Missouri 65301

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October 13, 2008

John R. Demaree
Marson Energy
1312 Laurel Lake Road
Brackney, Pa 18812

Attn: Mr. Demaree

Subject: Budgetary Proposal for Equipment & EPC

Dear Sir:

ProEnergy EPC Services (ProEnergy) proposes to provide engineering, design, procurement and material including (2) Refurbished Pratt & Whitney FT-4 Twin Pacs Gas Turbine Generators sets complete with Balance of Plant equipment.

The attached Technical Proposal is in response with your request. It describes what will be supplied by ProEnergy. Our overall objective of is to provide equipment and associated engineering for our equipment provided and to optimize the use of available local labor, material and construction equipment. ProEnergy will also provide Technical Proposal drawings, Process Flow Diagrams and Electrical One Lines, will also provide guidance in the required mechanical pipe, valves and fittings and electrical wire, cable and cable tray required for the project.

ProEnergy has the ability to deliver the major equipment to the US Port within (4) months from date of contract and receipt of down payment. During this time we can perform engineering and prepare the site and foundations for the equipment once it arrives. The facility should be operational within Two months after delivery to site.

Performance

The performance is based on the site conditions and will be included in the Performance Tab of the Technical Proposal. (As soon as we receive the site conditions). Performance correction curves will be also included.

Price

Equipment

Two (2) refurbished 52MW (ISO) FT-4 Pratt & Whitney Gas Turbine Generators
(Single fuel) P&W Gas Turbines

EPC

- Major Equipment (not inclusive):
 - Plant DCS System
 - Oil/Water Separator
 - Switchgear Building
 - Control Room Building
 - Instrument Air Compressor
- Engineering, Design, Procurement, Construction Management (project management, safety – QA/QC, scheduling), Subcontracting for local equipment rental, civil, mechanical and electrical labor and material, commissioning, training,, start-up, and testing.
- Schedule: Commercial Operation Date (“COD”) is estimated to be 5-7 months from contract execution.
- **Pricing: for all of the above: \$49,750,000.00 (US Dollars)**

Terms of Payment EPC-EQUIPMENT

First Payment	Due at Contract Signing to Secure Major Equip	(70%)
Second Payment	Due When BOP Equipment at US Port	(10%)
Third Payment	Due When GT on Pad at Site	(2.5%)
Fourth Payment	Due When GSU on Pad at Site	(5.0%)
Fifth Payment	Due Upon Mechanical Completion	(2.5%)
Sixth Payment	Due Upon 1st Fire of	(2.5%)
Seventh Payment	Due Upon Readiness to Export Power	(5.0%)
Final Payment	Due Upon Final Completion of Plant	(2.5%)

Taxes/Duties/Bank Expenses

All taxes, VAT, custom duties, and bank expenses due are for the purchaser's account.

Proposal Validity

This budgetary proposal is valid for thirty (30) days. The equipment described herein is subject to prior sale.

Delivery

Proposed delivery for Two (2) Refurbished Pratt & Whitney Twin Pac, single fueled, simple cycle Gas Turbine Generator Package and associated skids is 4 to 6 months from contract signing.

Terms and Conditions

This proposal is based on PES standard Terms and Conditions.

All Equipment is subject to previous sale

Confidentiality

This Proposal is submitted in confidence for evaluation by Buyer. Its contents are proprietary to Seller. By taking receipt of this Proposal, Buyer agrees not to reveal its contents in whole or in part beyond those persons in its own organization necessary to properly evaluate this Proposal or to perform any resulting contract. Buyer shall not reveal the contents of this Proposal to a third party or make copies of this Proposal without the prior written consent of Seller. Buyer shall return this entire Proposal to the undersigned, if Buyer does not accept this Proposal.

We sincerely appreciate this opportunity to provide you with this offer and are willing to discuss any issues and resolve them on a mutually acceptable basis as you progress through your overall proposal preparation.



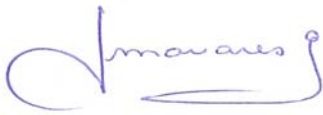
2031 Adams Road
Spartanburg, Missouri 65301
tel 860.829.5100
fax 860.829.1180

Give me a call should you have any questions.

We look forward to meeting you to determine what refinements are necessary to move this to the next stage.

Sincerely,

ProEnergy EPC Services, LLC



Joaquin S. Mavares
Director International Sales

ESTIMATED EMISSIONS

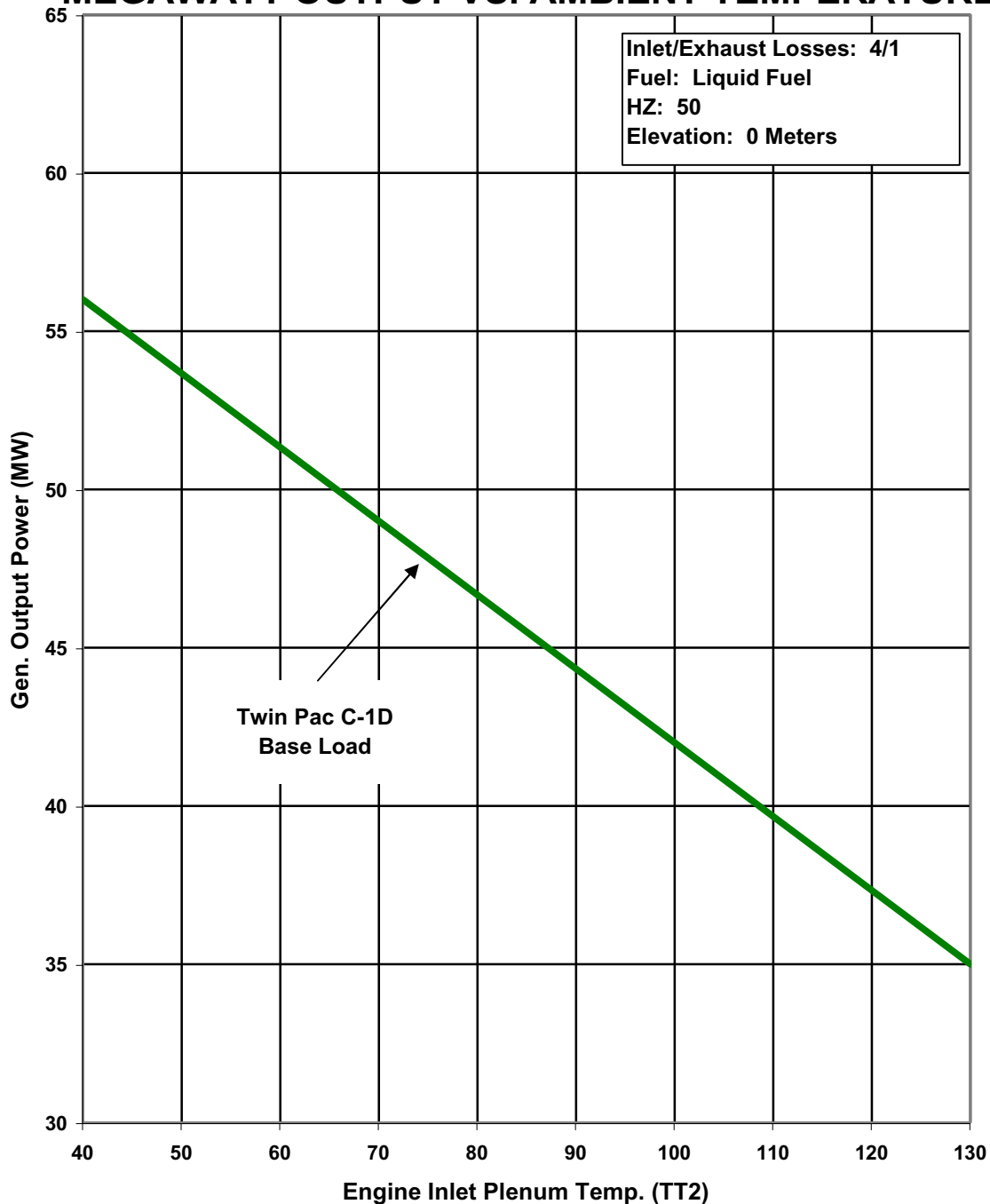
FT8

	<u>Natural Gas</u>		<u>Liquid Fuel</u>	
	<u>No. Inj.</u>	<u>H2O Inj.</u>	<u>No Inj.</u>	<u>H2O Inj.</u>
NOx, ppm	220	42/25	385	42
CO, ppm	10	25/50	15	20

FT4

	<u>Natural Gas</u>		<u>Liquid Fuel</u>	
	<u>No. Inj.</u>	<u>H2O Inj.</u>	<u>No Inj.</u>	<u>H2O Inj.</u>
NOx, ppm	100-135	35-40	190-250	42-47
CO, ppm	80-130	220-300	30-85	140-300

TWIN PAC C-1D
ESTIMATED POWER OUTPUT
MEGAWATT OUTPUT VS. AMBIENT TEMPERATURE



TURBO POWER AND MARINE SYSTEMS, INC.

TP4-2 (C-1D) Gas Turbine Twin Pac

Estimated Heat Rate vs. Megawatt Output

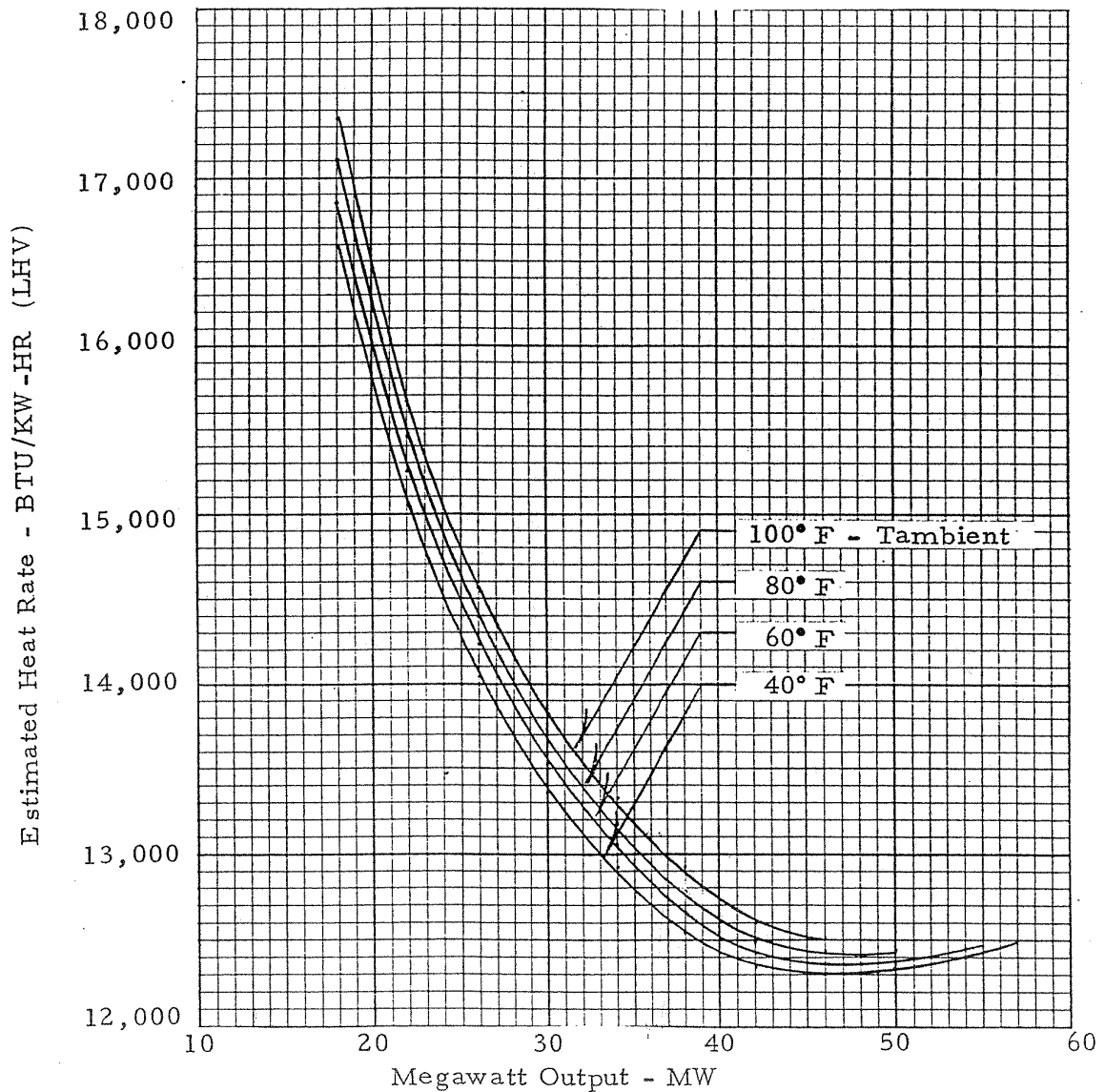
5.5"H₂O Inlet Duct Pressure Loss

1.0"H₂O Exhaust Duct Pressure Loss

Sea Level

50 Hz.

Transformer Not Included



TURBO POWER AND MARINE SYSTEMS, INC.

TPA-2 (C-1D) GAS TURBINE TWIN PAC

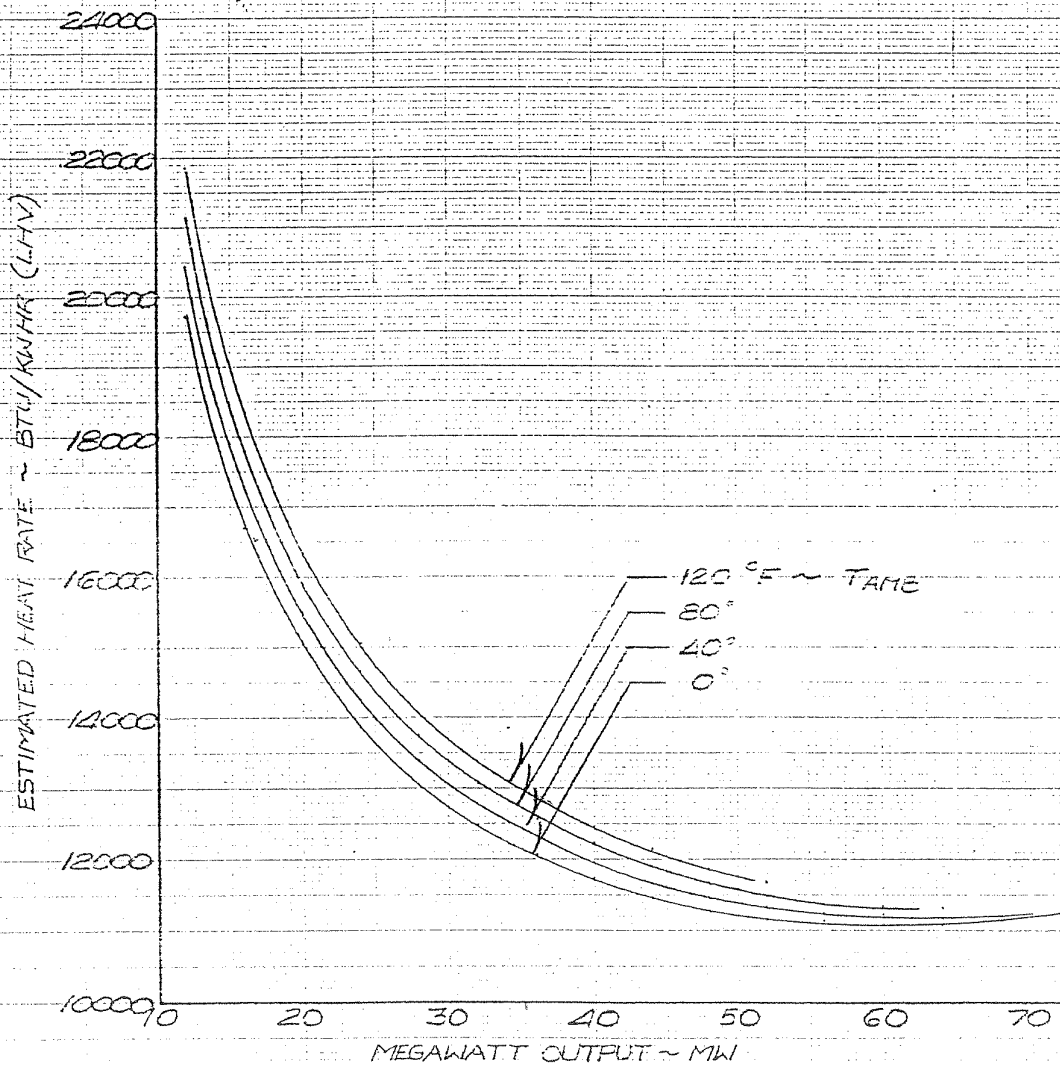
ESTIMATED HEAT RATE VS MEGAWATT OUTPUT

3" H₂O INLET DUCT PRESSURE LOSS

1" H₂O EXHAUST DUCT PRESSURE LOSS

SEA LEVEL

N₃ = 3600 RPM



TURBO POWER AND MARINE SYSTEMS, INC.

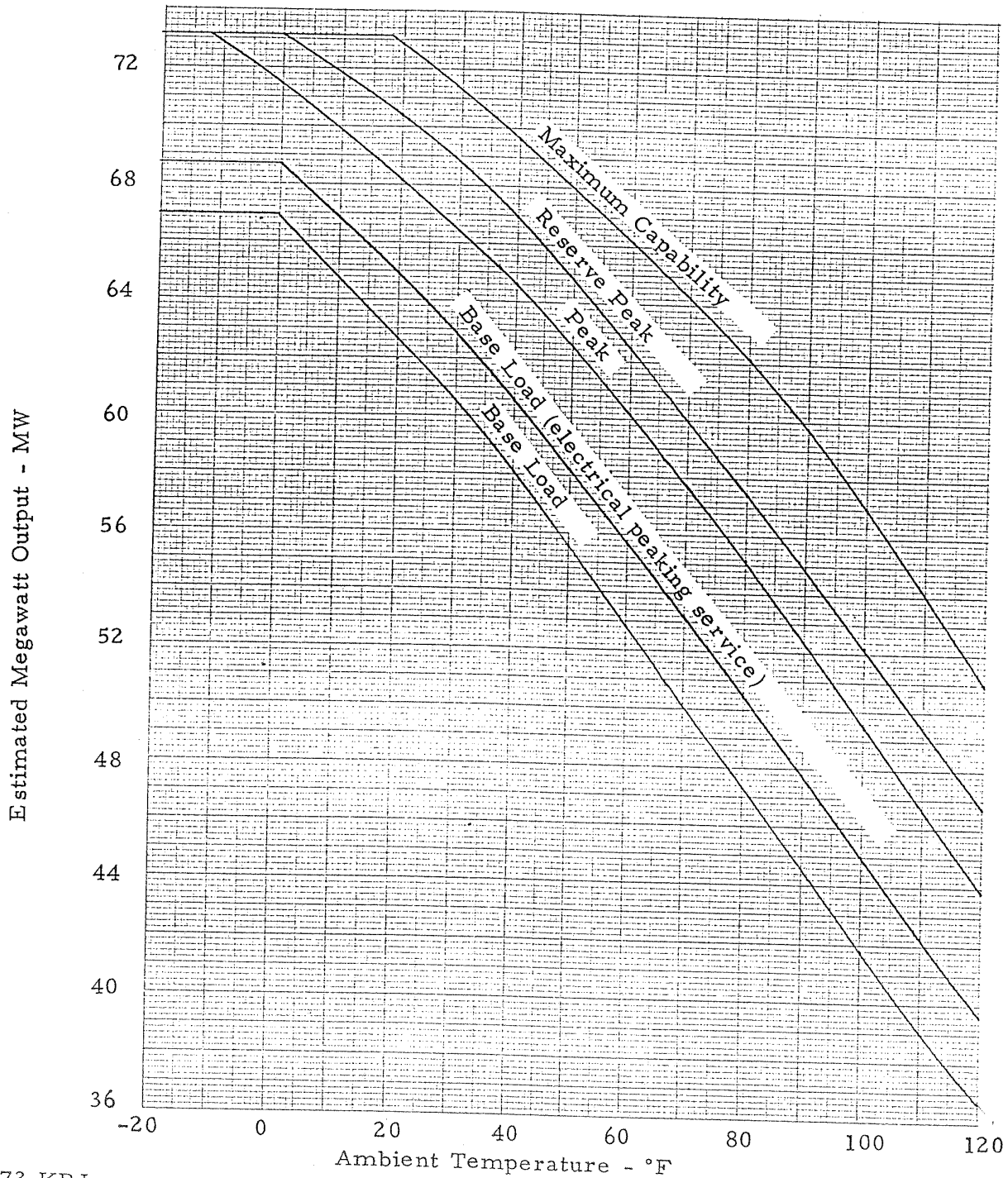
TP4-2 (FT4C-1D) Gas Turbine Twin Pac

Estimated Megawatt Output vs. Ambient Temperature

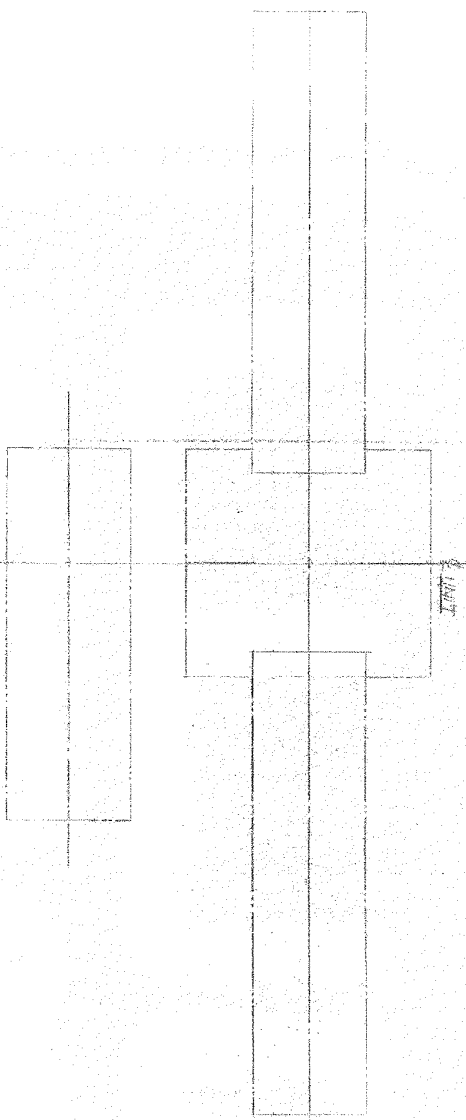
3" H₂O Inlet Duct Pressure Loss
1" H₂O Exhaust Duct Pressure Loss

Sea Level

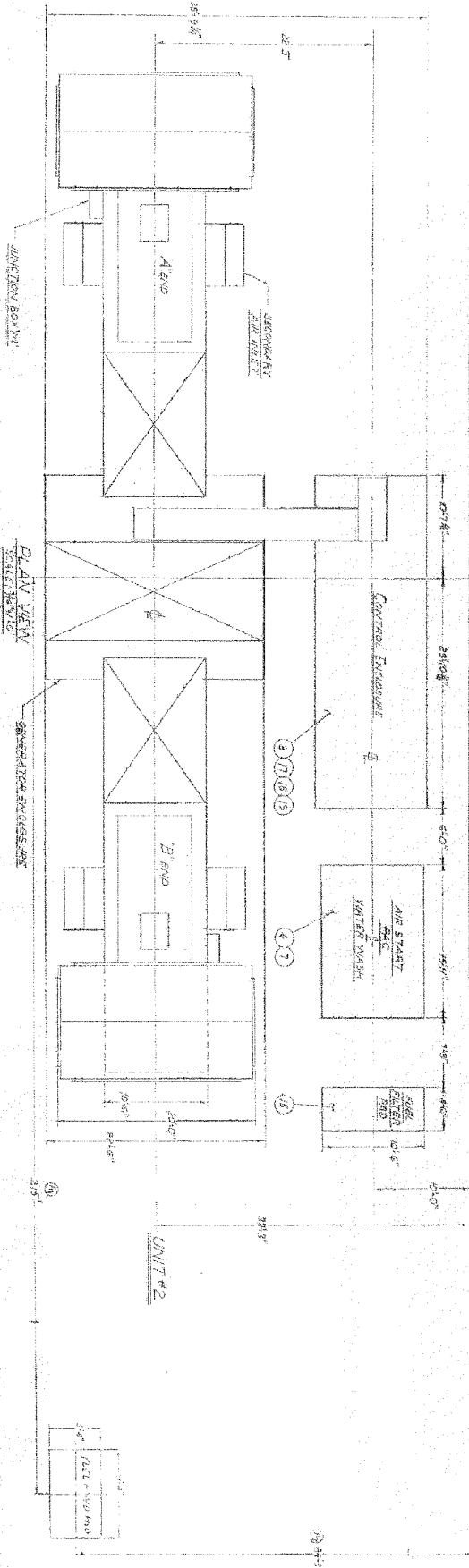
N₃ = 3,600 RPM



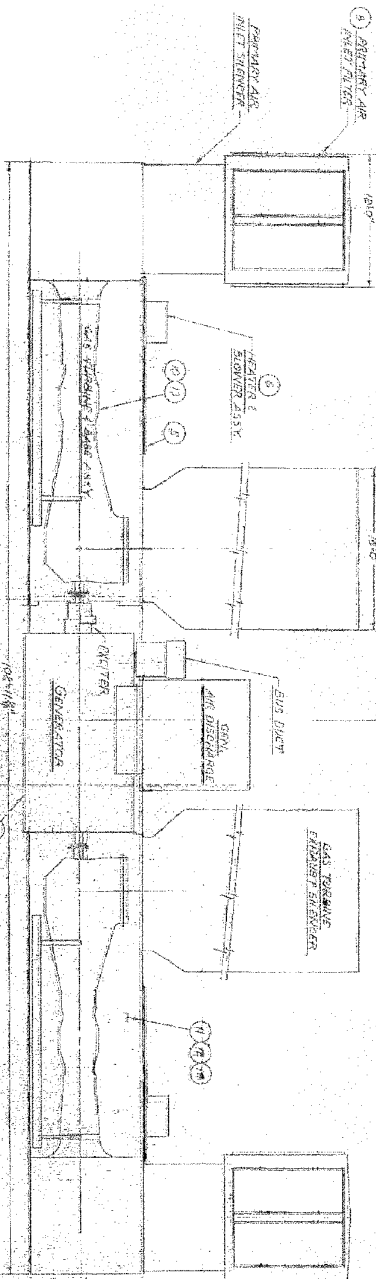
DATE	BY	TIME	REMARKS
		10	1. DECONTAMINATED AIRPORT ROADS 2. 1000' WEST DASH LINE WAS REACHED. ACCORD WITH SECTION 10.000. A 3. 1000' WEST LINE WAS REACHED. 4. 1000' WEST LINE WAS REACHED.



UNIT 1: INTRODUCTION



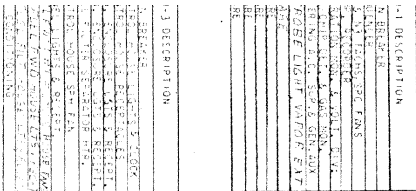
CONFIDENTIAL



PLAN 1151
324651 7/15/60

NOTES:
1. SUPPLEMENTAL NOTATION IS GIVEN IN COUNTER-EXAMPLES
WHEN FROM THE EXISTENCE
2. THE EXISTENCE OF THE METHOD ON THE PARTS
IS THE CRUCIAL POINT
3. THE FIRST PART OF THE COUNTER-EXAMPLES


[illegible]




QCT	QCT DESCRIPTION
1	1.01. 0000-0000
2	1.02. 0000-0000
3	1.03. 0000-0000
4	1.04. 0000-0000
5	1.05. 0000-0000
6	1.06. 0000-0000
7	1.07. 0000-0000
8	1.08. 0000-0000
9	1.09. 0000-0000
10	1.10. 0000-0000
11	1.11. 0000-0000
12	1.12. 0000-0000

[illegible]

21

 Electric Machines
MILWAUKEE, WIS.

Electric Machines
MINI-EXPOS

 Pratt & Whitney A United Technologies Company Pratt & Whitney Power Systems, Inc.	PWPS SPECIFICATION RELEASED	FR-1	REV D	SHEET 1 OF 6
		ISSUED BY : P. Lavendier		DATE: 8/18/95
		REVISE BY : D. Tougas		DATE: 7/8/03
		REFERENCE :		REV:

GAS TURBINE LIQUID DISTILLATE FUEL REQUIREMENTS

GENERAL

This document provides the requirements and general guidelines for light and medium hydrocarbon liquid distillate fuels which can be burned satisfactorily in PWPS/P&W aeroderivative industrial gas turbines.

Industrial gas turbines are capable of burning a variety of liquid fuels providing they have appropriate fuel delivery, injection and combustion systems for each class of fuel. Distillate liquid fuels are complex hydrocarbon mixtures processed from a wide variety of basic crude oil stocks, and have a broad range of property values. In some cases, such as gasoline, the hydrocarbon fraction may undergo further processing and acquire additives or, as with naphtha, may be offered for use in the as-distilled form.


This document recognizes three general categories of distillate fuels as defined by ANSI/ASME B 133.7M which may be employed in properly configured PWPS/P&W gas turbines. Category a is No. 0-GT fuels such as light naphtha, gasoline, and JP-4/ Jet B fuels which are highly volatile and require special handling and fuel system design. Categories b and c are No. 1-GT and No. 2-GT such as light to medium kerosene and diesel fuels which can be burned in the standard gas turbine, providing all fuel properties specified in the following Table 1 are met. Fuel treatment or conditioning, including heating, may be necessary to satisfy these requirements. Residual, ash bearing fuels, and blends of distillate and residual fuels are not suitable for aeroderivative gas turbines.

Industrial fuels may be obtained from a large number of producers with a broad range of properties. Contamination in transport and deterioration in storage are common problems. Poor and contaminated fuels greatly affect the performance and durability of gas turbines. Therefore, it is imperative for the gas turbine user to install a proper fuel system design and institute an effective fuel quality management program to insure and maintain clean, high quality fuels.

GUIDELINES FOR EFFECTIVE FUEL QUALITY MANAGEMENT

The fuel management system should be designed and in place prior to the site start-up. The following considerations should be addressed:

- 1) The fuel type is generally chosen on the basis of cost and availability, however, the effects of fuel on gas turbine operation and life cycle economics should be considered. Normally, high viscosity fuels such as heavy diesel are less expensive initially, but usually impact engine life and increase overall life cycle costs. Some fuels can be made usable through treatment and/or conditioning, and the cost of these processes should be factored into the overall economics. Possible treatment processes are water wash, heating, filtration, and centrifuge or cyclone separation.
- 2) The transport path between the fuel producing location and the customer's unloading/ storage area should be analyzed for possible contamination potential. Dedicated transport containers are highly

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		ISSUED BY : P. Lavendier	DATE: 8/18/95	
		REVISE BY : D. Tougas	DATE: 7/8/03	
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GAS TURBINE LIQUID DISTILLATE FUEL REQUIREMENTS


recommended.

- 3) The fuel storage equipment should be properly designed and sized and should be free of any contaminating or corrosive materials. Fuel storage time versus tank capacity should be balanced. Sufficient time should be allowed for incoming fuel to settle. The fuel for the gas turbine should not be removed from the bottom of the tanks, so as to avoid picking up heavy bottom ends. Tanks should be regularly drained from the bottom to remove the sediment.
- 4) The on-site conditioning and treatment systems should clean the impurities from the fuel and maintain high quality as it forwards the fuel to the gas turbine. The design should consider the quantity, placement and filtration efficiency of the filters.
- 5) The requirement for fuel preheating, if necessary, should be considered. Preheating is required for viscosity enhancement of heavy fuels and wax removal from high cloud point (waxy) fuels.
- 6) Safety requirements should be considered in the initial design phase, particularly if the fuel is one of the highly volatile Category a type fuels.
- 7) Contaminants brought in with the incoming gas turbine airflow should be considered. Proper air filtration is required. It is the normal practice to subtract the incoming air contaminants from the allowable fuel contaminant limit through a formula given in Note 7 of Table 1.

The operators of PWPS/P&W equipment must comply with all aspects of this specification, and ensure compliance by regularly taking and analyzing liquid fuel samples. Contaminants not normally present in the fuel at the production site may be introduced as a result of contact with sea water, other fuels, or insufficiently cleaned equipment during the transportation, handling and storage phases. If the fuel arriving at the user location falls out of compliance with the specification, and can not be made compliant by treatment, then the fuel supplier should be contacted immediately for a corrective action. Even a short period of operation with fuel of excess contaminants (salts, trace metals, particulates, wax. etc.) could seriously impact the gas turbine life and performance.

To further insure high quality fuel and continuous compliance, a regular maintenance program must be adopted for all on-site fuel handling, storage, conditioning and treatment systems. Regular replacement of filter elements, periodic draining of water, removal of sediments from the tanks, lines and sumps, and replacement of treatment fluids, etc., should be planned for and implemented.

PWPS/P&W requests review of the customer's final overall fuel management system design. PWPS bulletin no. 97M01 entitled "Distillate Fuel System Recommendations" is available for further details on implementing a quality fuel system. Additional guidance can be obtained by contacting your PWPS/P&W Marketing representative.

 Pratt & Whitney A United Technologies Company Pratt & Whitney Power Systems, Inc.	PWPS SPECIFICATION RELEASED	FR-1	REV D	SHEET 3 OF 6
		ISSUED BY : P. Lavendier	DATE: 8/18/95	
		REVISE BY : D. Tougas	DATE: 7/8/03	
		REFERENCE :	REV:	

GAS TURBINE LIQUID DISTILLATE FUEL REQUIREMENTS


RECOMMENDED DISTILLATE FUELS

The following liquid distillate fuels can be used in the gas turbine, if the fuel property requirements listed in Table 1 are met for the fuel delivered to the inlet of gas turbine.

Category a (No. 0-GT): Naphtha Fuels, Unleaded gasoline types, wide-cut fuels of the JP-4 (MIL-T-5624), and Jet B (ASTM D 1655) types - SEE NOTE 3

Category b (No. 1-GT): Kerosene or other distillates of the JP-5 (MIL-T-5624); Jet A and A-1 (ASTM D1655); No. 1-D diesel fuel (ASTM D975); No. 1 fuel oil (ASTM D 396); and No. 1 GT gas turbine fuel oil (ASTM D2880) types.


Category c (No. 2-GT): Distillates of the No. 2 diesel fuel (ASTM D975) No. 2 fuel oil (ASTM D 396), No. 2 GT gas turbine, and marine diesel (MIL-F-16884) types.

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		ISSUED BY : P. Lavendier		DATE: 8/18/95
		REVISE BY : D. Tougas		DATE: 7/8/03
		REFERENCE :		REV:

GAS TURBINE LIQUID DISTILLATE FUEL REQUIREMENTS

TABLE 1: GAS TURBINE LIQUID FUEL PROPERTY REQUIREMENTS

Property	Limit	NOTE(S)	Test Method (Note 1)
Viscosity - cSt: Max. (for category a, b, and c)	6.0 max. for starting, 12.0 max. for operation	2	ASTM D445
Min. at 100 °F (37.8°C) (for category a)	0.5 min.	3	ASTM D445
Min. at 100 °F (37.8°C) (for category b&c)	1.0 min		ASTM D445
Combined Free Water and Sediment, vol. %	0.1 max.	4	ASTM D2709
Particle Contamination, mg/gal.	10.0 max.		ASTM D2276 or ASTM D5452
Particle Size - microns (micrometer)	20 max	13	
Hydrogen - % by weight	12.4 min	5	ASTM D1018
Metal Contaminants - ppm by wt.			ASTM D3605
Vanadium (V)	0.2 max.	6 & 7	
Sodium (Na) + Potassium (K)	0.2 max.	6 & 7	
Calcium (Ca)	2.0 max.	6 & 7	
Lead (Pb)	0.1 max.	6 & 7	
Copper (Cu)	0.02 max.	6 & 7	
Copper corrosion	No.1 max.	8	ASTM D130
Fuel Category a (only)			
Flash Point, °F (°C)	To be reported	9	ASTM D93
Reid Vapor Pressure, psi or	12.5 max.		ASTM D323
Vapor Pressure by Mini- method, psi	12.5 max.		ASTM D5191
Fuel Category b and c (only)			
Flash Point, °F (°C)	100 °F (37.7°C) or local regulatory limit	10	ASTM D93
Cloud Point, °F (°C)	25 °F (14°C) below GT inlet fuel temp.		ASTM D2500
Carbon Residue (on 10% bottoms), %	0.25 max.		ASTM D524
Sulfur, % by mass	1.3	11, 12	ASTM D4294
Ash, % by mass	0.005 max.		ASTM D482
Net Heating Value, Btu/lb (kcal/kg)	To be reported		ASTM D4809
Specific Gravity	To be reported		ASTM D1298

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		REVISE BY : D. Tougas	DATE: 7/8/03	
		REFERENCE :	REV:	

GAS TURBINE LIQUID DISTILLATE FUEL REQUIREMENTS

NOTES TO REQUIREMENTS (TABLE 1)

NOTE 1

The most recent revision of the ASTM test method should be used insofar as practicable. An equivalent test method may be used in lieu of ASTM test method, if approved by PWPS/P&W.

NOTE 2

Maximum fuel viscosity at gas turbine fuel pump inlet shall be 6.0 cSt for starting and 12.0 cSt during operation. Fuel may be heated, to a maximum of 160 deg F (71C), to meet this requirement.

NOTE 3

In order to operate FT8 with Category a fuels, such as naphtha, specially designed PWPS/P&W fuel system components are required.

NOTE 4

The fuel delivered to the inlet of the gas turbine is to have a sediment level less than 10 mg./gallon of fuel. However, for practical extended fuel filter life, the fuel should have lower sediment levels

NOTE 5

Minimum hydrogen percentage by weight is 12.4; however, for optimum combustion, higher hydrogen percentage is recommended.

NOTE 6

To achieve the level of sensitivity required for the detection of some of these metals, the furnace atomic absorption method may be necessary. Since some trace metals can have harmful effects on gas turbine operation, it is necessary to impose limitations. Higher levels of Table 1 metallic levels, even for short period, will increase the gas turbine maintenance costs.


NOTE 7

Limits of metal contaminants in Table 1 assume no contaminants in the inlet air or injected water. For operation with contaminants in the inlet air or injected water, the maximum allowable limit of any particular contaminant in the fuel must be reduced according to the following formula:

$$Af = Lf - [C_{air} \times (\text{air/fuel weight ratio})] - [C_{water} \times (\text{water/fuel weight ratio})]$$

where,

Af	= Maximum allowable contaminant in the fuel, ppm by wt.
Lf	= Contaminant Limit as called out in Table 1, for example 0.2 for (Na+K)
C _{air}	= Contaminant in inlet air, ppm by wt.
C _{water}	= Contaminant in injection and/or evaporative cooling water, ppm by wt.

 Pratt & Whitney A United Technologies Company Pratt & Whitney Power Systems, Inc.	PWPS SPECIFICATION RELEASED	FR-1	REV D	SHEET 6 OF 6
		ISSUED BY : P. Lavendier	DATE: 8/18/95	
		REVISE BY : D. Tougas	DATE: 7/8/03	
		REFERENCE :	REV:	

GAS TURBINE LIQUID DISTILLATE FUEL REQUIREMENTS

NOTE 8

Copper corrosion test conditions are 2 hours at 212 deg F (100 deg C).

NOTE 9

No flash point limitation is specified; however, local regulatory limits and safety regulations must be met.

NOTE 10

The cloud point shall be at least 25 degrees F below the anticipated gas turbine fuel inlet temperature. To meet this requirement, additional fuel heating, to a maximum of 160 degrees F (71C), may be needed.

NOTE 11

Sulfur content limits Below 1.3% WT. are imposed when:


- a) The local regulatory limits of sulfur oxides exhaust emissions are exceeded; then the fuel sulfur content must be reduced until the local regulatory limits are satisfied. For instance, the USA EPA limits fuel Sulphur content to 0.8% for SO₂ emissions control, but local codes vary widely.
- b) If exhaust heat recovery equipment is employed; then the equipment manufacturer's limit may apply.

NOTE 12

High sulfur fuels will impact hot section repair interval dependent on the amount of alkalai metals present. The combination of high sulfur and high alkalais must be avoided.


NOTE 13

Maximum particle size to be controlled by filtration with a β_{20} ratio of 200.

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		ISSUED BY: P. Lavendier		DATE: 8/28/95
		REVISE BY: D. Tougas		DATE: 7/8/03
		REFERENCE :		REV:

GAS TURBINE LIQUID DISTILLATE FUEL REQUIREMENTS

REV LET	SHEETS AFFECTED	SHEETS ADDED	DESCRIPTION	REV BY & DATE	APPVD & DATE
A	1-4		1) Added 1.7 cs lower limit of viscosity 2) Changed NA + K limit to 0.2 ppm 3) Added sulfur limit to 1.3% max. 4) Changed format to FrameMaker 5) Revised verbiage to put more stringent requirements for fuel management 6) Updated test procedures to current standard	P. Lavendier 8/18/95 EC#8352	
B			Completely re-written and updated to allow the use of Naptha Fuels, lower min viscosities. Max allowable fuel viscosities were changed to be based on actual operating temperatures, rather than a fixed temperature.	EC#9025 T. Fox/D. Dalal 2/11/98	
C	All		Updated Logo to new PWPS Logo. Updated all TPM references to PWPS references.	EC#9925 L. DiSalvo 7/23/01	
D	4		1) Changed Free Water to Combined Free water and sediment. changed limit to 0.1% max by volume. Changed Test Method to ASTM D2709. 2) Changed sediment to Particulate Contamination. Removed metric unit (mg/l) (2.7) from Limit. Changed test method to ASTM D2276 or D5452.	EC#10620 D. Tougas 7/8/03	
	4		3) Added Note 13 to Particle size		
	5 & 6		4) Removed Test Method IP288. 5) Added Test Method ASTM 4809 to Net Heating Valve. 6) Made various typographical changes. Added Note 13 regarding filtering.		

 Pratt & Whitney A United Technologies Company Pratt & Whitney Power Systems, Inc.	PWPS SPECIFICATION RELEASED	FR-2	REV D	SHEET 1 OF 6
		ISSUED BY : P. Lavendier		DATE: 7/1/85
		REVISE BY : L. DiSalvo/J. Kennedy		DATE: 7/23/01
		REFERENCE :		REV:

GAS TURBINE NATURAL GAS FUEL REQUIREMENTS

GENERAL

This document provides the requirements and application guidelines for natural gas fuels which can be fired satisfactorily in PWPS/P&W gas turbines without fuel system modification.

The term gas fuel can refer to a range of fuels which are normally in the gas state in gas turbine operational use. These range from low BTU content types such as coke oven gas to high BTU types such as propane. Because of the wide variation of gas fuels in ignition and combustion properties, as well as volume throughput requirements, their combustor and fuel delivery systems may differ widely. The fuel specification must be matched to the gas generator design.

The most common gas fuels used are those of the natural gas family. For satisfactory use in gas turbines, these fuels must meet minimum specifications so as to avoid combustion and fuel system problems, as well as hot section corrosive damage.

In addition to reviewing the composition and contaminants of the gas fuels being considered for use, the customer is urged to institute good fuel management, handling and treatment systems. A fuel that might not meet the requirements at the engine fuel inlet location may be treated prior to that location.


Present gas turbine combustion systems are comprised of conventional types which may or may not employ water injection to reduce oxides of nitrogen (NOx) emission, or Dry Low NOx (DLN) types which control NOx emissions without water. The latter are more sensitive to certain fuel properties than conventional systems and therefore have more stringent limits on some properties, as noted in the following specification.

GUIDELINES FOR EFFECTIVE FUEL MANAGEMENT

The first step in designing an effective fuel management system is to identify the composition and contaminants in the gaseous fuels being considered for use in PWPS/P&W aeroderivative gas turbines. The gas analysis performed to analyze the gas composition and contaminants should include, as a minimum, all properties listed in Table 1. Clean, dry fuel is required for safe and durable operation of a gas turbine.

The minimum and maximum limits of gas fuel supply temperature are listed in Table 1. The gas supply to the site should be evaluated to prevent any liquid from accumulating in the off site piping and then flooding the site fuel systems with large volume of liquids.

In reviewing the gas composition, the presence of corrosion-producing substances such as alkali metals (sodium, potassium, etc.), sulfur compounds, etc. should be noted so that proper precautions can be taken to minimize gas turbine and/or fuel system corrosion. When exhaust recovery equipment is utilized, there will be further requirements for fuel sulfur limit to minimize corrosion of the cold end surfaces.

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		ISSUED BY : P. Lavendier		DATE: 7/1/85
		REVISE BY : L. DiSalvo/J. Kennedy		DATE: 7/23/01
		REFERENCE :		REV:

GAS TURBINE NATURAL GAS FUEL REQUIREMENTS

The contaminants in natural gas are normally introduced as a result of production and transportation processes. These contaminants may include tar, resins, water, salt water, rust (iron oxide), sand, lubricating oil, crude oil, gas hydrates, ice, construction debris, etc. Widely distributed gaseous fuels such as natural gas are usually cleaned prior to distribution. Water with its associated pipeline corrosion and condensate are probably the largest contaminants occurring in the gas distribution systems.

The design of an adequate fuel handling/treatment system is based on the actual gas composition and the contaminants present in the gas fuel delivered to the site. The following considerations should be addressed in the design of an effective gas fuel management system:


- Pressure reducing station
- Type of filtration systems such as inertial separators (scrubbers), gas separator, coalescing filter, or filter separator to remove liquid and/or solid contaminants
- Fuel handling system materials that are compatible with the gaseous fuel properties
- Fuel heating to raise the temperature of the gas sufficiently above the hydrocarbon and moisture dew points
- Safety precautions for handling the fuel

To protect the power plant equipment, a fuel testing program to periodically measure contaminant removal from the fuel and perform maintenance on the fuel filtration system is recommended. This is an important step in ensuring that the proper quality fuel is provided to the gas turbine.

PWPS/P&W fuel requirements of Table 1 are the allowable limits of fuel properties. The operators of the PWPS/P&W equipment must comply with all aspects of this specification, and confirm compliance through analysis of gas fuel samples taken regularly. Additional detailed guidance can be obtained through a PWPS/P&W representative.

OTHER GASEOUS FUELS


The standard model gas turbine is optimized to operate on gaseous fuels within this specification. The gas turbine has the basic capability of operating on a range of fuels outside of this specification, but may require modifications to fit the specific application. Such modifications could include fuel system component re-sizing, additional safety equipment, fuel pre-heating or gasification equipment, and engine controls adjustment. To judge the suitability of other gaseous fuels for a given application, please contact the PWPS/P&W Marketing Department.

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		ISSUED BY : P. Lavendier		DATE: 7/1/85
		REVISE BY : L. DiSalvo/J. Kennedy		DATE: 7/23/01
		REFERENCE :		REV:

GAS TURBINE NATURAL GAS FUEL REQUIREMENTS

TABLE 1: GAS TURBINE GASEOUS FUEL REQUIREMENTS

Property	COMBUSTOR TYPE		NOTE(S)	Test Method (Note 1)
	A	B		
	Conventional	DLN		
Lower Heating Value (LHV) BTU/SCF (MJ/m ³)	800-1200 (30 - 45)	800-1200 (30 - 45)	2	ASTM D3588
Wobbe Index, BTU/SCF (MJ/m ³)	1040-1350 (39 - 50)	1040-1350 (39 - 50)	2, 3	ASTM D3588
Hydrogen Gas (H ₂) Content, % Vol. Max	Note 4	1.0	5	ASTM D1945
Carbon Monoxide (CO) Content,% Vol	Note 6	Note 6	6	ASTM D1946
Total Particulate, PPM WT. MAX.	30	30	5, 7, 10	ASTM D2009
Max Particle Size, Microns (Micrometre)	10	10	-	ASTM D2009
Max Gas Supply Temp, °F (°C)	300 (149)	300 (149)	5	-
Min. Gas Supply Temp, °F (°C)	32 (0)	32 (0)	5	-
Min Gas Fuel Superheat Above Hydrocarbon Dew Pt, °F (°C)	+28 (+16)	+50 (+28) Note 13	5	-
Min Gas Fuel Superheat Above Moisture Dew Pt, °F (°C)	+28 (+16)	+50 (+28)	5	-
Total Sulfur Content,% Wt Max	Note 8	Note 8	5, 10, 8	ASTM D1072 or ASTM D3246
Total Metals, PPM Wt, Max Sodium + Potassium	0.2	0.2	5, 10	ASTM D3605
Water Content	Note 10	Note 10	5, 11	ASTM D1142
Flammability Ratio (UFL/LFL), MIN	Not Applicable	2.2	12	

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GAS TURBINE NATURAL GAS FUEL REQUIREMENTS

NOTES TO REQUIREMENTS (TABLE 1)

NOTE 1

The most recent revision of the ASTM test method should be used insofar as practicable. Equivalent test method may be used in lieu of ASTM test method if approved by PWPS/P&W.

NOTE 2

At standard conditions of 60° F (15.6° C) 1 atm (101.3 KPa).

NOTE 3

Wobbe Index = $LHV/SQRT(S.G. \cdot (T_{gf}+460)/520)$ OR Wobbe Index = $LHV/SQRT(S.G. \cdot (T_{gc}+273)/288.6)$
(corr. to 60° F) (corr. to 15.6° C)

Where:

T_{gf} = inlet gas temperature, °F
S.G = specific gravity relative to air
LHV in BTU / SCF

Where:

T_{gc} = inlet gas temperature, °C
S.G = specific gravity relative to air
LHV in MJ/m³ (note 2)

NOTE 4

Hydrogen content up to 4% vol. may be used. Higher amounts of hydrogen content can be used but should be approved by PWPS/P&W and must satisfy all applicable safety codes for the fuel system.

NOTE 5

At the inlet to the gas turbine fuel plate or at gas turbine enclosure interface, if the enclosure is provided by PWPS.

NOTE 6


Fuel CO content will increase CO output, thus CO fuel content may require control to meet guarantee exhaust emissions levels.

NOTE 7

Particulates are composed of any solids in the gas fuel stream, including sand, rust, clay, coke, tar, iron sulfide, etc.

NOTE 8

Total sulfur includes hydrogen sulfide (H₂S), mercaptans, carbon disulfide(CS₂), carbonyl sulfide(COS), thiopene, sulfur oxides, etc.

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GAS TURBINE NATURAL GAS FUEL REQUIREMENTS

NOTE 9

Limits on fuel sulfur are imposed when:

- a) The local regulatory limits of sulfur oxides exhaust emissions are exceeded, then the fuel sulfur content must be reduced until the local regulatory limits are satisfied.
- b) When exhaust heat recovery equipment is employed, the equipment manufacturer's limits will apply.

NOTE 10

The allowable gas fuel contaminants shall be debited by the amounts of that contaminants entering with the inlet airflow (type A&B combustor) and water injection flow (type A combustor):

Allowable fuel limit = Overall limit - (Air/Fuel x Inlet Air Level) -(Water/Fuel x Water Level)

NOTE 11

Gas Hydrates are not allowed, therefore water content should be below the concentration which would allow gas hydrates to form at the operating temperature and pressure. Fuel heating is allowed to bring gas fuel temperature above the moisture saturation (dew) point.

NOTE 12

Flammability limits at 1 atm (101.3 KPa) and 77 Deg. F (25 Deg. C).

NOTE 13

FOR DRY LOW NO_x (DLN) COMBUSTORS ONLY:

- Hydrocarbon dew points are to be evaluated from ambient pressure up to the maximum gas turbine inlet pressure
- Dew points will be based on extended analysis to C14 level according to method of GPA 2286-95.
- Gas samples shall be taken per method of GPA 2166-86.
- Concentrations should be determined to an accuracy of 10 PPM or less.
- The maximum expected dew point line during the operating period, must be used to establish the minimum required fuel temperature at the gas turbine inlet



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PWPS

SPECIFICATION

RELEASED

FR-2

REV D

SHEET 1A
OF 1

ISSUED BY : P. Lavendier

DATE: 7/1/85

REVISE BY : L. DiSalvo/J. Kennedy

DATE: 7/23/01

REFERENCE :

REV:

GAS TURBINE NATURAL GAS FUEL REQUIREMENTS

REV LET	SHEETS AFFECTED	SHEETS ADDED	DESCRIPTION	REV BY & DATE	APPVD & DATE
A	All	3 & 4	Specification completely re-written incorporating Gas Turbine Gaseous Fuel Requirements for "Dry Low Nox". Title was "Gas Turbine Gaseous Fuel Requirements". Proprietary box was removed.	EC#8975 D. J. Dalal 10/28/97	
B	All	5	In table sht 3 deleted "absolute" in max. particle size Changed MJ/nm3 to MJ/m3	EC#9012 D.J. Dalal/T. Fox 12/22/97	
C	3 5		In table sht 3, added note 13 in column B Added note 13 requirements for H/C dew point.	EC#9077 T. Fox 8/20/98	
D	All 3		Updated Logo to new PWPS Logo. Updated all TPM references to PWPS references. In Table1: 1. Change test method for CO from ASTM D2099 to ASTM D1946. 2. Added ASTM D3246 as an alternate test method for total sulfur content.	EC#9925 L. DiSalvo J. Kennedy 7/23/01	