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ENGINE GENERATOR SETS (EGS) Diesel And Propane Fueled 10 kW to 1500 kW

TABLE OF CONTENTS

SECTION	TITLE	PAGE
CHAPTER 1	**GENERAL INFORMATION**	
100.	Introduction	1
101.	Applicable Documents	4
102.	Engine Generator Parameter Schedules	6
103.	Quality Assurance And Certification	19
CHAPTER 2	**EQUIPMENT REQUIREMENTS**	
200.	Engine Generator System (EGS) Functional And Performance Characteristics	21
201.	General Requirements	21
202.	Prime Mover	24
203.	Alternator / Exciter Assembly	26
204.	Control And Indication Of Alternator / Prime Mover	27
205.	Automatic Transfer Switch (ATS) And Bypass Switch General Requirements	32
206.	Open Transition Transfer Switch (OTTS) Requirements	35
207.	Closed Transition Transfer Switch (CTTS) Requirements	37
208.	Integral Bypass And Isolation Switch Requirements	38
209	External Stand Alone Bypass Switch Requirements	39
210.	Residential Unit Automatic Transfer Switch and Bypass Switch Requirements	40
211.	Control And Indication Of Automatic Transfer Switch (ATS)	41
212.	Loadbank Assembly	45
213.	Remote Radiator Assembly	47
214.	Daytank Assembly	48
215.	Battery Charger	50
216.	Engine Starting Batteries	51
217.	Engine Exhaust	51

TABLE OF CONTENTS
Continuation

SECTION	TITLE	PAGE
CHAPTER 3	**ACCEPTANCE TESTING**	
300.	Test Procedures	53
301.	Fail-In Test	62
302.	Test Acceptance	62
CHAPTER 4	**PREPARATION FOR DELIVERY**	
400.	Cleaning	63
401.	Preservation	63

CHAPTER 1 GENERAL INFORMATION

ENGINE GENERATOR SETS

Diesel and Propane Fueled
10 Kw to 1500 Kw

100. INTRODUCTION

The contractor must provide Commercial Off The Shelf / Non-Developmental Items (COTS/ NDI) equipment that meets the EGS functional and performance characteristics set forth below. The Federal Aviation Administration (FAA) has a requirement to replace Engine Generator Systems (EGS) or various components of existing EGS currently in service nationwide. Additionally, there is a need to provide EGS for new facilities that will upgrade and modernize the National Airways System (NAS). The purpose of the EGS is to supply secondary electric power hereafter referred to as Standby Power, for the duration of any failure of the normal (Commercial) power supply. All equipment required to make-up the EGS must be designed and fabricated for the safe unattended operation as required in this document. The EGS will supply the equipment load from either a commercial source or from the engine generator by way of an automatic transfer switch. The commercial source will be connected to the normal side of the transfer equipment. Transfer between the two sources of power must be either by Open Transition Transfer Switch (OTTS) or a Closed Transition Transfer Switch, (CTTS). The generator must be connected through a main circuit breaker to the emergency side of the transfer equipment and to the loadbank. The common side of the transfer equipment will be connected to the equipment load. The automatic transfer equipment must be designed so that it will be impossible to back-feed the commercial power equipment from the generator in the event of normal source power failure; or, to back-feed the generator from the commercial source when the normal source is restored from the failed state. Additionally, at some sites the intended EGS will be tied to an Uninterruptable Power Source (UPS) which operates as a fail safe to the Load. The UPS is NOT part of this request. Unless otherwise specified on the order release, an **EGS must consist of the following items:**

1. **Prime Mover -** or engine, must consist of either a diesel engine or a spark ignited propane engine, and must include, but not be limited to, all ancillary devices such as the combustion air intake system, engine exhaust system, starting system, engine water pump, engine alternator, belts, hoses, electrical system, flywheel, the engine generator controller, governor control and actuator device, etc.

2. **Alternator/ Exciter Assembly -** or the generator assembly, must include but not be limited to all ancillary controls such as the voltage regulator, circuit breakers, electrical overload protection devices, conductor terminations, etc.

CHAPTER 1 GENERAL INFORMATION

100. INTRODUCTION (Continued)

3. **Automatic Transfer Switch (ATS) And Bypass Switch Assembly (BS) -** The ATS must include but not be limited to the actual transfer mechanism, and all monitoring, indication, and control devices necessary to perform the safe transfer of the facility power from the Normal (Commercial / Utility) Source to the Emergency (Engine-Generator) Source. Transfer Switches will be of the Open Transition Transfer Type (OTTS) and the Closed Transition Transfer (CTTS). Both type of these transfer switches will be made available with integral Bypass Switches included in the ATS enclosure and with external Bypass Switches physically separate from the ATS enclosures.

4. **Critical Support Equipment -** Any and all other critical support equipment or devices necessary to provide the Standby Power, such as the battery charger, engine cooling system, (rail mounted or remote radiator), and a daytank and daytank controls for diesel units.

5. **Loadbank Assembly –** Must be a resistive loadbank, either rail mounted or remote, and all required loadbank controls.

6. **Commercial Technical Documentation –** Each EGS unit will be supplied with 2 sets of hardcopy documentation as described below. All vendor supplied equipment manuals such as Parts Manuals, Wiring Diagrams, Operations and Service Manuals, etc., found to have errors, will be corrected and delivered to the FAA Engine Generator Program Office, within 90 days of notification of the vendor by the FAA of the specified errors. All document corrections will be provided at no cost to the FAA. The vendor shall supply to the FAA, 2 sets of hard copies of the corrected document for each unit purchased from the vendor from the beginning of the contract to the current date. For example, if an error is found in the engine generator wiring harness of the 125 kW diesel generator units, all applicable document furnished with the equipment will be corrected by the vendor. If 172 of these 125 kW units have been purchased on the contract, the vendor will supply the FAA Engine Generator Program Office with 344 hard copies of the corrected manuals within 90 days of the notification. For the purposes of this procurement, the term Commercial Technical Documentation includes, but is not limited to, the following items specific for the equipment:
   a. Technical Manuals for Installation, Operation and overhaul.
   b. Technical Data Sheets.
   c. Dimensional Drawing of the equipment.
   d. Item-specific Schematics and Wiring Diagrams (as appropriate).
   e. Generic site-wiring interconnect diagrams (as appropriate).
   f. Start-Up Procedure for Operational and Warranty Acceptance

   Parts Manuals - Origin Of Components - Parts Manuals shall contain the Company name of the actual manufacturer of the part as well as the manufactures part number. Examples of such items are belts, hoses, filters, relays, radiators, loadbanks, daytanks, and major external components such as water pumps, starters, alternators, injector pumps, etc.

CHAPTER 1 GENERAL INFORMATION

100. INTRODUCTION (Continued)

7. **Definition of Power Ratings -** Power Ratings and Industry Terminology. The following definitions are from the Electrical Generating Systems Association Standard 101P, Engine Driven Generating Sets. Stationary diesel-engine-driven electric generator sets are divided into the following four rating categories:

EMERGENCY STANDBY, LIMITED RUNNING TIME, PRIME POWER, and INDUSTRIAL.

"**Emergency Standby Rating** means the power that the generator set will deliver continuously under normal varying load factors for the duration of a power outage." It must be understood that this definition uses the term "normal varying load conditions". Most manufacturers use this terminology to indicate that their units typically are not rated for continuous operation at the nameplate rating, but rather that the units provided are rated for continuous operation at 70 to 80 percent of their nameplate rating, with periodic loading up to 100 percent of the nameplate rating for short (cyclical) periods during a power outage. When specifying a genset be sure to specify what the peak load is and how much is continuous.

"**Limited Running Time Rating** means the power that the generator set will deliver when used as a utility type power source, typically in load curtailment type service, for a limited number of hours, where there are non-varying load factors and/or constant dedicated loads."

"**Prime Power Rating** means the power that the generator set will deliver when used as a utility type power plant under normal varying load factors to run continuously. This rating requires a minimum momentary overload capability of 10 percent."

"**Industrial Rating** means the power that the generator set will deliver 24 hours per day when used as a utility type power plant where there are non-varying load factors and/or constant dedicated loads."

FAA Requirements are for Emergency Standby Rating and Prime Power Rating.

CHAPTER 1 GENERAL INFORMATION

101. APPLICABLE DOCUMENTS

1. The current issues of the following documents in effect on the date of the invitation for bids form a part of this specification and are applicable to the extent specified herein. In the event of conflict between the documents listed herein and the contents of this specification, the contents of this specification must be a superseding requirement. The following documents are referenced throughout this Standard and form a part of the specifications.

ANSI /IEEE C37.20	Switchgear
ANSI /IEEE C37.90	Standard for Relays and Relay Systems Associated with Electric Power Apparatus
ANSI C50 Standards	Rotating Electrical Machinery
ASTM-D-3951	Standard Practice for Commercial Packaging
CFR Title 40, Part 60	EPA Rules for Stationary Engines
EGSA-101P	Performance Standard for Engine Driven
FAA-STD-013	Quality Control Program Requirements
IEC 60947-6-1	Low-voltage Switchgear, Multifunction equipment; Automatic Transfer Switching Equipment
IEEE Standard 446	IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
ISO 9001	International Quality Standard Generators Sets
ISO 3046	Reciprocating Internal Combustion Engines – Performance
ISO 8528	Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets
NEMA MG-1	Motors and Generators
NEMA ICS 1	Industrial Controls and Systems: General Requirements
NEMA ICS 10	Industrial Controls and Systems: AC Transfer Switch Equipment
NEMA Std. ICS 10-1993	AC Automatic Transfer Switches
NFPA 30	Flammable and Combustible Liquids Code
NFPA 37	Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 54	National Fuel Gas Code
NFPA 58	Liquified Petroleum Gas Code
NFPA 70	National Electric Code (NEC)

CHAPTER 1 GENERAL INFORMATION

101. APPLICABLE DOCUMENTS (Continued)

NFPA 99	Standard for Health Care Facilities
NFPA 110	Standard for Emergency and Standby Power Systems
SAE J537	Storage Batteries
UL 142	Steel Above Ground Tanks for Flammable and Combustible Liquids
UL 508	Industrial Control Equipment
UL 1008	Transfer Switch Equipment

(European Standards – "European Committee for Standardization - CEN)

EN 55011:1991	Emission Standard – Group 1, Class A
EN 50082-2:1995	Generic Immunity Standard
EN 61000-4-2:1995	Electrostatic Discharge (ESD) Immunity
EN 50140:1993	Radiated Electro-Magnetic Field Immunity
EN 61000-4-4:1995	Electrical Fast Transient (EFT) Immunity
EN 61000-4-5:1995	Surge Transient Immunity
EN 61000-4-6:1996	Conducted Radio-Frequency Field Immunity

2. Copies of the foregoing documents may be obtained as follows:
   a. Information on obtaining copies of the National Electrical Code may be obtained from National Fire Protection Association, Battery March Park, Quincy, Massachusetts, 02269.
   b. Information on obtaining copies of USA Standards may be obtained from United States of America Standards Institute, 10 East 40th Street, New York, New York, 10016.
   c. Information on obtaining copies of NEMA Standards Publication may be obtained from National Electrical Manufacturer's Association, 2101 L Street, N.W., Washington, D.C. 20037.
   d. Information on obtaining copies of EGSA-101P may be obtained from Electrical Generating System Association, P.O. Box 9257, Coral Springs, Florida, telephone 303-755-2677.
   e. Information on obtaining copies of ISO 3046/1 and 8528 may be obtained from International Organization for Standardization, 3,rue de Varembe, 1211 Geneva 20, Switzerland; National:022/734 0150; International: +41 22 734 0150.
   f. Information on obtaining copies of the EN, European Standards can be found at the following web address; www.CEN.eu/CEN/Prodcut/Pages/default.aspx Then click on "Where to obtain CEN products?".

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE

1. LARGE DIESEL 300 kW and above

a. Power Rating	Emergency Standby Rating (see 100.7)
b. Overload Capacity	125% of Service Load for 2 hours
c. Power Factor	0.8 lagging
d. Engine-Generator Applications	stand-alone
e. Rated Speed	1800 rpm
f. Heat Exchanger Type	fin-tube (radiator)
g. Governor Type	Isochronous
h. Governor	Electronic
i. Governor Speed Adjustability	Manual adjustment by hand (Not computer software)
j. Frequency Bandwidth (steady state)	± 0.15 Hertz (0.25 %)
k. Voltage Regulation (No Load to Full Load) (Stand alone applications)	± 9.6 Volts at 480 Volts (2 %) ± 4.2 Volts at 208 Volts (2 %)
l. Voltage Bandwidth (steady state)	± 4.8 Volts at 480 Volts (1 %) ± 2.1 Volts at 208 Volts (1 %)
m. Frequency	60 Hz
n. Voltage	480/277 Volt, 3-Phase, 3-Wire 208/120 Volt, 3-Phase, 4-Wire 240/120 Volt, 1-Phase, 3 wire
o. Phases	3 Phase, Wye
p. Fault Current Capability	300% of Full Load current for 10 seconds with neutral solidly grounded.

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE (Continued)

1. LARGE DIESEL 300 kW and above (Continued)

q. Nonlinear Loads	> 25% of Unit Full Load Rating
r. Max Step Load Increase Unit Rating (at 0.8PF)	10 to 200 kW units 100 % of Full 201 to 1,200 kW units 50 % of Full Unit Rating
s. Transient Recovery Time	2 seconds with Step Load Increase (Voltage)
t. Transient Recovery Time	2 seconds with Step Load Increase (Frequency)
u. Maximum Voltage Deviation with Step Load Increase	5% of rated voltage
v. Maximum Frequency Deviation with Step Load Increase	2.5 percent of rated frequency
w. Max Step Load Decrease (without shutdown)	100 percent of Service Load at 0.8 PF
x. Max Time to Start and be Ready to Assume Load	15 seconds
y. Max Summer Indoor Temp (Prior to Genset Operation)	125 degrees Fahrenheit
z. Min Winter Indoor Temp (Prior to Genset Operation)	20 degrees Fahrenheit
aa. Installation Elevation	Sea level through 3000 feet
ab. Voltage THD at 50% load on loadbank	$\leq$ 5% THD
ac. Voltage THD at 100% load on loadbank	$\leq$ 5% THD

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE (Continued)

1. LARGE DIESEL 300 kW and above (Continued)

ad. Vendor to provide the following Generator Characteristics Parameters.

PARAMETER	DESCRIPTION	UNIT	VALUT
Kc	Short-circuit ratio		_____
Xd	D-Axis synchronous reactance (unsaturated)	pu	_____
X'd	D-Axis transient reactance (saturated)	pu	_____
X"d	D-Axis sub-transient reactance (saturated)	pu	_____
Xq	Q-Axis synchronous reactance (unsaturated)	pu	_____
X"q	Q-Axis sub-transient reactance (saturated)	pu	_____
X2	Negative-sequence reactance (saturated)	pu	_____
X0	Zero-sequence reactance (independent)	pu	_____
T'd	D-Axis transient time constant	ms	_____
T"d	D-Axis sub-transient time constant	ms	_____
T'do	D-Axis open-circuit time constant	ms	_____
Ta	Armature time constant	ms	_____
Tr	Voltage recovery time	ms	_____

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE

2. SMALL DIESEL 300 kW and Below

a. Power Rating	Emergency Standby Rating and Prime Power Rating (see 100.7)
b. Overload Capacity	125% of Service Load for 2 hours
c. Power Factor	0.8 lagging
d. Engine-Generator Applications	stand-alone
e. Rated Speed	1800 rpm
f. Heat Exchanger Type	fin-tube (radiator)
g. Governor Type	Isochronous
h. Governor	Electronic
i. Governor Speed Adjustability	Manual adjustment by hand (Not computer software)
j. Frequency Bandwidth (steady state)	± 0.15 Hertz (0.25 %)
k. Voltage Regulation (No Load to Full Load) (Stand alone applications)	± 9.6 Volts at 480 Volts (2 %) ± 4.2 Volts at 208 Volts (2 %)
l. Voltage Bandwidth (steady state)	± 4.8 Volts at 480 Volts (1 %) ± 2.1 Volts at 208 Volts (1 %)
m. Frequency	60 Hz
n. Voltage	480/277 Volt, 3-Phase, 3-Wire 208/120 Volt, 3-Phase, 4-Wire 240/120 Volt, 1-Phase, 3 wire
o. Phases	3 Phase, Wye
p. Fault Current Capability	300% of Full Load current for 10 seconds with neutral solidly grounded.

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE (Continued)

2. SMALL DIESEL 300 kW and Below (Continued)

q. Nonlinear Loads	> 25% of Unit Full Load Rating
r. Max Step Load Increase Unit Rating (at 0.8PF)	10 to 200 kW units 100 % of Full 201 to 1,200 kW units 50 % of Full Unit Rating
s. Transient Recovery Time	2 seconds with Step Load Increase (Voltage)
t. Transient Recovery Time	2 seconds with Step Load Increase (Frequency)
u. Maximum Voltage Deviation with Step Load Increase	5% of rated voltage
v. Maximum Frequency Deviation with Step Load Increase	2.5 percent of rated frequency
w. Max Step Load Decrease (without shutdown)	100 percent of Service Load at 0.8 PF
x. Max Time to Start and be Ready to Assume Load	15 seconds
y. Max Summer Indoor Temp (Prior to Genset Operation)	125 degrees Fahrenheit
z. Min Winter Indoor Temp (Prior to Genset Operation)	20 degrees Fahrenheit
aa. Installation Elevation	Sea level through 3000 feet
ab. Voltage THD at 50% load on loadbank	$\leq$ 5% THD
ac. Voltage THD at 100% load on loadbank	$\leq$ 5% THD

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE (Continued)

2. **SMALL DIESEL 300 kW and Below (Continued)**

ad. Vendor to provide the following Generator Characteristics Parameters.

PARAMETER	DESCRIPTION	UNIT	VALUT
Kc	Short-circuit ratio		_____
Xd	D-Axis synchronous reactance (unsaturated)	pu	_____
X'd	D-Axis transient reactance (saturated)	pu	_____
X"d	D-Axis sub-transient reactance (saturated)	pu	_____
Xq	Q-Axis synchronous reactance (unsaturated)	pu	_____
X"q	Q-Axis sub-transient reactance (saturated)	pu	_____
X2	Negative-sequence reactance (saturated)	pu	_____
X0	Zero-sequence reactance (independent)	pu	_____
T'd	D-Axis transient time constant	ms	_____
T"d	D-Axis sub-transient time constant	ms	_____
T'do	D-Axis open-circuit time constant	ms	_____
Ta	Armature time constant	ms	_____
Tr	Voltage recovery time	ms	_____

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE (Continued)

2. **SMALL DIESEL 300 kW and Below (Continued)**

ae. Prime Power Rated Engine Generator Fuel Consumption Characteristics. The Engine Fuel Consumption shall not exceed the following maximum limits based on the condition listed below.

Size Range Net kW	%of Rated Output Capacity	Fuel Usage Lbs./ kWH
5-250	75 and 100	0.600
	50	0643

Conditions:
a. Net kW of the Set corrected for engine auxiliaries that are electrically driven, where kW is electrical kilowatt hours.
b. 45 MJ/kg (19,350 Btu/pound) 19,350 Btu/pound high-heat value for fuel used.
c. Sea level operation.
d. Intake-air temperature not over 32 degrees C 90 degrees F.
e. Barometric pressure of intake air not less than 95.7 kPa 28-1/4 inches of mercury.

Fuel-Consumption Rebates:
Fuel consumption rebates shall be assessed for failure of engine generator set to meet guaranteed rates. If the guaranteed fuel-consumption rate for 100 percent rated output capacity is verified in the tests but the rates for 75 or 50 percent rated output capacity are not verified, the appropriate 75 or 50 percent rate differences shall be used in assessing the rebates. If more than one fuel consumption guarantee is not met, rebates shall be computed for 100, 75, and 50 percent rated output capacity, and the highest computed figure shall be used in assessing the rebates.
Rebate = H x C x D x N where:

H = Operating hours over a projected period of 15 years
C = Local fuel costs in dollars per pound
D = A - G
A = Measured fuel consumption in pounds per hour
G = kW x R = Guaranteed fuel consumption in pounds per hour
R = Fuel Usage LBS/kWH
N = Number of generator sets provided, equals 1. Each engine generator installation evaluated individually.

Adjust fuel costs to the heat value kJ/kg BTU/lb for the fuel used in the test (requires fuel laboratory test) rationed to the 45,000 kJ/kg 19,350 Btu/pound heat value used as the basis of the guarantee."

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE

3. PROPANE ENGINES

a. Power Rating	Emergency Standby Rating (see 100.7)
b. Overload Capacity	125% of Service Load for 2 hours
c. Power Factor	0.8 lagging
d. Engine-Generator Applications	stand-alone
e. Rated Speed	1800 rpm
f. Heat Exchanger Type	fin-tube (radiator)
g. Governor Type	Isochronous
h. Governor	Electronic
i. Governor Speed Adjustability	Manual adjustment by hand (Not computer software)
j. Frequency Bandwidth (steady state)	± 0.15 Hertz (0.25 %)
k. Voltage Regulation (No Load to Full Load) (Stand alone applications)	± 9.6 Volts at 480 Volts (2 %) ± 4.2 Volts at 208 Volts (2 %)
l. Voltage Bandwidth (steady state)	± 4.8 Volts at 480 Volts (1 %) ± 2.1 Volts at 208 Volts (1 %)
m. Frequency	60 Hz
n. Voltage	480/277 Volt, 3-Phase, 3-Wire 208/120 Volt, 3-Phase, 4-Wire 240/120 Volt, 1-Phase, 3 wire
o. Phases	3 Phase, Wye
p. Fault Current Capability	300% of Full Load current for 10 seconds with neutral solidly grounded.

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE (Continued)

3. **PROPANE ENGINES (Continued)**

q. Nonlinear Loads	> 25% of Unit Full Load Rating
r. Max Step Load Increase Unit Rating (at 0.8PF)	10 to 200 kW units 100 % of Full 201 to 1,200 kW units 50 % of Full Unit Rating
s. Transient Recovery Time	2 seconds with Step Load Increase (Voltage)
t. Transient Recovery Time	2 seconds with Step Load Increase (Frequency)
u. Maximum Voltage Deviation with Step Load Increase	5 % of rated voltage
v. Maximum Frequency Deviation with Step Load Increase	2.5 percent of rated frequency
w. Max Step Load Decrease (without shutdown)	100 percent of Service Load at 0.8 PF
x. Max Time to Start and be Ready to Assume Load	15 seconds
y. Max Summer Indoor Temp (Prior to Genset Operation)	125 degrees Fahrenheit
z. Min Winter Indoor Temp (Prior to Genset Operation)	20 degrees Fahrenheit
aa. Installation Elevation	Sea level through 3000 feet
ab. Voltage THD at 50% load on loadbank	$\leq$ 5% THD
ac. Voltage THD at 100% load on loadbank	$\leq$ 5% THD

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE (Continued)

3. **PROPANE ENGINES (Continued)**

ad. Vendor to provide the following Generator Characteristics Parameters.

PARAMETER	DESCRIPTION	UNIT	VALUT
Kc	Short-circuit ratio		_____
Xd	D-Axis synchronous reactance (unsaturated)	pu	_____
X'd	D-Axis transient reactance (saturated)	pu	_____
X"d	D-Axis sub-transient reactance (saturated)	pu	_____
Xq	Q-Axis synchronous reactance (unsaturated)	pu	_____
X"q	Q-Axis sub-transient reactance (saturated)	pu	_____
X2	Negative-sequence reactance (saturated)	pu	_____
X0	Zero-sequence reactance (independent)	pu	_____
T'd	D-Axis transient time constant	ms	_____
T"d	D-Axis sub-transient time constant	ms	_____
T'do	D-Axis open-circuit time constant	ms	_____
Ta	Armature time constant	ms	_____
Tr	Voltage recovery time	ms	_____

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE

4. AIR COOLED ENGINES

a. Power Rating	Emergency Standby Rating (see 100.7)
b. Overload Capacity	125% of Service Load for 2 hours
c. Power Factor	0.8 lagging
d. Engine-Generator Applications	stand-alone
e. Rated Speed	1800 rpm
f. Heat Exchanger Type	fin-type
g. Governor Type	Isochronous
h. Governor	Electronic
i. Governor Speed Adjustability	Manual adjustment by hand (Not computer software)
j. Frequency Bandwidth (steady state)	± 0.15 Hertz (0.25 %)
k. Voltage Regulation (No Load to Full Load) (Stand alone applications)	± 9.6 Volts at 480 Volts (2 %) ± 4.2 Volts at 208 Volts (2 %)
l. Voltage Bandwidth (steady state)	± 4.8 Volts at 480 Volts (1 %) ± 2.1 Volts at 208 Volts (1 %)
m. Frequency	60 Hz
n. Voltage	480/277 Volt, 3-Phase, 3-Wire 208/120 Volt, 3-Phase, 4-Wire 240/120 Volt, 1-Phase, 3 wire
o. Phases	3 Phase, Wye
p. Fault Current Capability	300% of Full Load current for 10 seconds with neutral solidly grounded.

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE (Continued)

4. **AIR COOLED ENGINES (Continued)**

q. Nonlinear Loads	> 25% of Unit Full Load Rating
r. Max Step Load Increase Unit Rating (at 0.8PF)	10 to 200 kW units 100 % of Full 201 to 1,200 kW units 50 % of Full Unit Rating
s. Transient Recovery Time	2 seconds with Step Load Increase (Voltage)
t. Transient Recovery Time	2 seconds with Step Load Increase (Frequency)
u. Maximum Voltage Deviation with Step Load Increase	5% of rated voltage
v. Maximum Frequency Deviation with Step Load Increase	2.5 percent of rated frequency
w. Max Step Load Decrease (without shutdown)	100 percent of Service Load at 0.8 PF
x. Max Time to Start and be Ready to Assume Load	15 seconds
y. Max Summer Indoor Temp (Prior to Genset Operation)	125 degrees Fahrenheit
z. Min Winter Indoor Temp (Prior to Genset Operation)	20 degrees Fahrenheit
aa. Installation Elevation	Sea level through 3000 feet
ab. Voltage THD at 50% load on loadbank	$\leq$ 5% THD
ac. Voltage THD at 100% load on loadbank	$\leq$ 5% THD

CHAPTER 1 GENERAL INFORMATION

102. ENGINE GENERATOR PARAMETER SCHEDULE (Continued)

4. **AIR COOLED ENGINES (Continued)**

ad. Vendor to provide the following Generator Characteristics Parameters.

PARAMETER	DESCRIPTION	UNIT	VALUT
Kc	Short-circuit ratio		_____
Xd	D-Axis synchronous reactance (unsaturated)	pu	_____
X'd	D-Axis transient reactance (saturated)	pu	_____
X"d	D-Axis sub-transient reactance (saturated)	pu	_____
Xq	Q-Axis synchronous reactance (unsaturated)	pu	_____
X"q	Q-Axis sub-transient reactance (saturated)	pu	_____
X2	Negative-sequence reactance (saturated)	pu	_____
X0	Zero-sequence reactance (independent)	pu	_____
T'd	D-Axis transient time constant	ms	_____
T"d	D-Axis sub-transient time constant	ms	_____
T'do	D-Axis open-circuit time constant	ms	_____
Ta	Armature time constant	ms	_____
Tr	Voltage recovery time	ms	_____

CHAPTER 1 GENERAL INFORMATION

103. QUALITY ASSURANCE AND CERTIFICATION

1. All equipment (100%) must be quality assurance tested prior to leaving the factory. After a 24 hour run-in period, all ATS, Engine-Generator and ancillary support equipment, must be fully tested to verify correct operation of transfer functions, interlock functions and all annunciations.

2. Upon request of the FAA, the Contractor must provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification must identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, must be included in the certification.

3. The ATS manufacturer must be certified to ISO 9001 International Quality Standard and the manufacturer must have third party certification verifying the quality assurance in design/ development, production, installation, and servicing in accordance with ISO 9001.

4. Reliability. The reliability of the system must be demonstrated with calculations, or statistical data or tests. In no case must the system MTBCF (Mean Time Between Critical Failure) fall below 2000 hours. Critical failures differ from failures in that the system is totally down with a critical failure. All solid state equipment including microprocessors must be specifically designed and fully tested for the application and must have a proven history of satisfactory performance in applications near identical to those specified. An operating engine generator system must successfully start 99.5 percent of the time or better.

5. Maintainability. Engines of the same model as the equipment furnished must have performed satisfactorily in an independent plant for a specified length of time so the manufacturer can certify that under the satisfactory maintenance program, the supplied engine will normally not need a major overhaul nor will a major expense be incurred until at the least 4,000 hours of operation. The top (minor) overhaul of the engine in no case must be required in less than 2000 hours of operation (Major overhaul would included re-boring, for units below 200 kW or cylinder liner replacement for units 200 kW and above, new piston, rings, crankshaft, camshaft and bearings, and minor overhaul would include a new camshaft, lifters, and valve grinding as required). Supply data on at least four installations for each engine size supplied verifying the 4,000 hour major overhaul period. EGS units specified may be subjected to extended periods of unattended operation.

CHAPTER 1 GENERAL INFORMATION

103. QUALITY ASSURANCE AND CERTIFICATION (Continued)

6. Mean Time Between Failures (MTBF). The Contractor must furnish to the FAA documentation showing the methods and testing used to develop the MTBF of the major components such as the ATS Controller, Engine Generator Controller, Alternator, ATS etc.. The MTBF must be indicated for each major component. To maximize MTBF, components must be tested and selected to satisfy specification requirements.

7. Mean Time To Repair (MTTR). The MTTR must be indicated for each lowest, replaceable (bolt-on or plug-in) component. To minimize MTTR, plug-in devices must be used and the system diagnosis and alarming must be extended to all key components. The engine generator system must have a MTTR of three hours with any single failure having a maximum repair time of 8 hours based on repair components being immediately available at the engine location.

CHAPTER 2 EQUIPMENT REQUIREMENTS

200. ENGINE GENERATOR SYSTEM (EGS) FUNCTIONAL AND PERFORMANCE CHARACTERISTICS

1. Equipment provided under this contract must, as a minimum, meet the requirements of ISO 8528 Class G3, NEMA MG1, NFPA 70, NFPA 110, and EGSA-101P Classification 1. In the event of a conflict between these documents and this specification, the more stringent requirement must apply. The contractor must provide personnel, material, services and facilities as required to produce, deliver, test, and support the EGS. The contractor must provide COTS/ NDI equipment that meets the EGS functional and performance characteristics set forth below.

201. GENERAL REQUIREMENTS

1. Safety. All components of the EGS must be in compliance with all OSHA safety standards both physically and electrically for protection of operating personnel.

2. All engine/ generator assemblies must provide a standby power rating in accordance with ISO-3046/1.

3. The engine/ generator assembly must be bedrail mounted with vibration absorbing mounting pads. This does not include earthquake (seismic) zone shock isolators. The bedrail skids must be of sufficient height to provide a minimum space of 8 inches of clearance from the lowest part of the engine oil pan to the floor, that facilitates oil pan removal from engine.

4. The automatic load transfer equipment must be the standard product by a manufacturer of automatic transfer equipment, complete with all controls and features as specified herein.

5. Engine rating. Engine net output, corresponding to the engine generator kW rating must be in accordance with ISO 3046/1 definitions and conditions. This rating must be for standby power at ISO 3046/1 conditions, barometric pressure 100 kpa (29.53 inches Hg), air temperature 30 degrees C (80.6 degrees F), relative humidity 60 percent. ISO 3046/1 overload power rating must be per Section 2.1, D (ISO 3046/1).

6. Overload power. The engine and generator must be capable of operating at 125 percent rated net output kW at sea level, for two hours at 125 degrees F ambient without signs of overload or exceeding temperature or frequency limitations as specified.

7. Speed and vibration. The EGS must be designed to operate continuously at 1800 RPM synchronous speed (see Section 203.6). The EGS must be free of critical flexural vibrations and dangerous torsional critical speeds between plus or minus 20 percent of synchronous speed. Dangerous critical speed is defined as a speed at which vibratory stresses in the shaft exceeds 5000 psi. At the discretion of the government, torsional vibration calculations may be subject to submission as part of the contract historical data. An overspeed safety device must be installed to stop the engine when the speed exceeds 120 percent of the synchronous speed.

CHAPTER 2 EQUIPMENT REQUIREMENTS

201. GENERAL REQUIREMENTS (Continued)

8. Environmental conditions. Within 15 seconds after commercial power is outside of acceptable parameters, the EGS must assume a facility's loads with the voltage, frequency and harmonic regulation specified, at indoor ambient temperatures between plus 20 degrees F (minus 6.6 degrees C) and 125 degrees F (52 degrees C) at 10 to 100 percent relative humidity, at altitudes up to 3,000-feet above sea level. Acceptance testing must be in accordance with Chapter 3 of this specification.

9. Air pollution controls. EGS must meet all national standards for emission controls in effect at the time of delivery. Documentation of these tests must be retained with the individual test records for each EGS. A record of this test must be included with each EGS as part of the historical data.

10. All components of the (EGS) shall be rated for 100% duty cycle.

11. Electromagnetic radiation. All electronic components must be shielded from all affects of EMI due to ignition noise, lightning and switching power supplies.

12. Vibration isolation. The total Engine Generator System (EGS), including the exhaust piping and accessory systems, must operate satisfactorily in a Seismic Zone 4 area. Isolation mounts may be either above or below the bedrail.

13. All terminal and connection points for a specific component of the EGS, made available for customer/FAA use, must have the same designation regardless of kW or ampacity rating. For example, if the terminal points for a set of auxiliary contacts on a 200 Ampere ATS are designated as TB1-1 and TB1-2, they must be designated as TB1-1 and TB1-2 on the 800 Ampere ATS also. This applies to E/G units, Loadbanks, Daytanks, etc.

14. Parallel Operation. Engine-generator Systems (EGS) specified for parallel operation shall be configured for automatic parallel operation. Each set shall be capable of parallel operation with one or more sets on an isolated bus.

15. Load Sharing. Engine-generator Systems (EGS) specified for parallel operation shall be configured to automatically load share with other sets by proportional loading. Proportional loading shall load each set to within 5 percent of its fair share. A set's fair share is its nameplate-rated capacity times the total load, divided by the sum of all nameplate-rated capacities of on-line sets. Load sharing shall incorporate both the real and reactive components of the load.

CHAPTER 2 EQUIPMENT REQUIREMENTS

201. GENERAL REQUIREMENTS (Continued)

16. Parallel Operation Of Multiple EGS Units On A Single Buss. Some FAA facilities will require the use of multiple Engine Generator Systems (EGS) connected to a single common buss. EGS units purchased for these applications shall be capable of providing Automatic Paralleling and Loading of Engine-Generator Systems (EGS). An automatic loading system shall be provided to load and unload engine-generator sets in the sequence indicated. The loading system shall monitor the system load and cause additional engine-generator sets to start, synchronize, and be connected in parallel with the system bus with increasing load. Actuation of the additional engine-generator set start logic shall occur when the load exceeds a percentage set-point of the operating set's rating for an adjustable period of 1 to 60 seconds. When the system load falls below the percentage set-point of the operating set's rating for an adjustable period of 1 to 60 seconds, the controller shall unload and disconnect engine-generator sets from the system, stopping each engine-generator set after cool-down. The device shall provide two adjustable set-point ranges from 50 to 100 percent. All set point adjustments must be manual adjustments made by hand or with the use of a screwdriver only. These adjustments will not require the use of software or a computer to perform changes to the settings.

17. Mobile Engine Generator Systems. Mobile units will meet all the requirements as specified in this document for Engine Generator Systems as well as meeting the current DOT requirements. Mobile units will be delivered road ready and tagable. Additionally, Mobile units will be self contained trailer mounted units and will be equipped with on board fuel cells appropriately sized to support a 72 hour run time at rated full load. A means of readily selecting the connection of the alternator windings, such as a rotary switch, from single phase to three phase and selecting 120/208V or 277/480V will be provided. The mobile engine-generator unit enclosure shall be corrosion resistant and fully weather resistant. The enclosure shall contain all set components and provide ventilation to permit operation at Service Load under secured conditions. Doors shall be provided for access to controls and equipment requiring periodic maintenance or adjustment. Removable panels shall be provided for access to components requiring periodic replacement. The enclosure shall be capable of being removed without disassembly of the engine-generator set or removal of components other than the exhaust system. The enclosure shall reduce the noise of the generator set to a noise level of below 85 dBA at 25 feet.

CHAPTER 2 EQUIPMENT REQUIREMENTS

202. PRIME MOVER

1. All engines must be rated in accordance with ISO-3046 requirements.

2. Engines provided must be certified for installation and operation by the Environmental Protection Agency (EPA). Where more stringent state or local emission requirements exist, engines must be factory adapted to meet these more stringent requirements.

3. Governor Control – Must be electronic with isochronous operation. The Air/Fuel Ratio control of the engine must be a closed loop system rather than an open loop system. These units must be self correcting for altitude and atmospheric conditions.

4. Prime Mover Speed Control - All EGS must be delivered with the generator frequency set to 60.1 Hertz. Speed adjustments must be a manual adjustment made by hand or with the use of a screwdriver only. It must not require software or a computer to make this adjustment.

5. All engines must be equipped with a means of draining the crankcase oil outside of the bedrail. The drain must located such that it will provide a minimum of 12” inches of clearance to the floor.

6. All engines will come equipped with dry-type Combustion Air Filter Assemblies with restriction indicators. Low noise air filter elements must be provided as available. Disposable cartridge air filter elements must be industry standard.

7. The engine's cooling system must be fitted with separate drain cocks for the radiator and engine block for servicing.

8. An electric water heater must be installed to supply heat to the engine jacket water. The body of the heater must be metallic not plastic. In an ambient temperature of 40 degrees F the heater must have sufficient capacity to raise the engine jacket water average temperature to 100 degrees within 2 hours, and after the temperature has stabilized, to maintain the average temperature between 100 degrees F and 105 degrees F. Maximum temperature in the immersion heater outlet must be 165 degrees F. The inlet and outlet of the immersion heater housing must be provided with lever handle ball type shutoff valves. Valve position must clearly indicate when the valves are opened or closed. A thermostat must be positioned in the engine block to maintain the engine block coolant temperature range as outlined above. The thermostat sensing element must be in direct contact with engine coolant. Thermostats with adjustable setting of the temperature must be provided with a locking means to prevent engine vibration from changing the setting.

9. For diesel fueled engines, a Primary and Secondary Fuel Filter must be provided as part of the engine assembly and must be equipped with fuel pressure gages on the supply and delivery side of each filter.

CHAPTER 2 EQUIPMENT REQUIREMENTS

202. PRIME MOVER (Continued)

10. Diesel fueled engines must be equipped with a Manual Fuel Filter Priming Pump.

11. For propane engines, the fuel delivery solenoid must be an energize-to-run (ETR).

12. Hoses and fittings. Throughout the coolant system, where flexible hoses are used, vendor must supply form fitting molded reinforced type hose secured with industry standard stainless steel worm screw clamps. Corrugated "universal" hoses are not acceptable.

13. Fuel lines connecting to the engine must be flexible.

14. Cranking and starting. Either intermittent or continuous cranking must be provided by a cranking control device. Continuous cranking must be limited to 60 seconds. Intermittent cranking must be adjustable to a fifteen second cranking on cycle followed by fifteen second cranking off cycle. Intermittent cranking must terminate in an overcrank lockout on failure of the engine to start after the third fifteen second crank on cycle. Overcrank cutout must require manual reset to clear.

15. For propane engines, the engine fuel system must be designed for propane vapor to be delivered at 7 inches to 14 inches of water column pressure at the inlet of the fuel solenoid valve.

16. Diesel fueled engines will be capable of operating with no more than a 50% load without wet stacking.

CHAPTER 2 EQUIPMENT REQUIREMENTS

203. ALTERNATOR/ EXCITER ASSEMBLY

1. The alternator must be rated for 60 Hertz service.

2. The alternator must be a brushless type. The exciter must have a permanent magnet generator type (PMG), and full wave rectifiers accessible for testing and replacement without disassembly of the generator or exciter. The exciter temperature rise, rating and insulation class must be the same as specified for the generator.

3. The alternator must be rated for standby service at the design load and with the voltage system applicable. The alternator must be large enough to start a motor of 25 percent of rated kW load consisting of NEMA Standard MG-1, Code G, 6.3 kVA/hp motors with no more than 2 percent voltage drop. The alternator must have a 125 percent net output kW (overload) capacity for two hours at 125 degrees F ambient and up to 3,000 feet altitude and must maintain the regulation and output requirements specified. The alternator must be capable of supplying 300 percent fault current for 10 seconds with neutral solidly grounded. The alternator must not sustain damage when operated at 125 percent of the rated speed.

4. The alternator must be synchronous type with 105 degrees C temperature rise by resistance over 40 degrees C ambient, NEMA MG-1, Class F insulation or better, fungus resistant, self-ventilated, drip-proof construction, meeting ANSI C50 Standards. The alternator must be protected from damage due to voltage spikes, transient or surges from external sources. The alternator rotor must have full amortisseurs windings.

5. Voltage Regulation and Stability. Voltage Regulators must be of a solid state design, adjustable, and must be fully input filtered, sensitive to 60 Hertz fundamental frequency only. The voltage regulation from no-load to full-load must not exceed $\pm$ 2% of the nominal system line-to-line voltage. The steady state stability (isochronous operation) from no-load to full-load must not exceed $\pm$ 1% of the nominal system line-to-line voltage. The voltage regulator must operate satisfactorily on unbalanced phase current loads not exceeding 25% of the alternator full load current rating. Regulator shall be configured for safe manual adjustment of the engine-generator voltage output without special tools, during operation, from 85 to 110 percent of the rated voltage over the steady state load range of 0 to 100 percent of rated output capacity. Regulation drift shall not exceed plus or minus 0.5 percent for an ambient temperature change of 20 degrees C 68 degrees F. Reactive droop compensation or reactive differential compensation shall load share the reactive load proportionally between sets during parallel operation. The voltage regulator shall have a maximum droop of 2 percent of rated voltage over a load range from 0 to 100 percent of rated output capacity and automatically maintain the generator output voltage within the specified operational bandwidth.

CHAPTER 2 EQUIPMENT REQUIREMENTS

203. ALTERNATOR/ EXCITER ASSEMBLY (Continued)

6. Frequency Regulation and Stability. The alternator frequency regulation must not vary more than ± 0.20 Hertz from no load to 110% full load. The steady state stability (isochronous operation) must not exceed ± 0.15 Hertz while serving the rated load, at indoor ambient temperatures between plus 20 degrees F (minus 6.6 degrees C) and 125 degrees F (52 degrees C) at 10 to 100 percent relative humidity, at altitudes up to 3,000-feet above sea level, and for any unbalanced phase load not exceeding 25 percent of alternator rating.

7. Single Phase units must be 12-lead re-connectable only and shall be configured to provide 120/240V.

8. Three phase units rated 400 kW and below, must be 12-lead re-connectable and be capable of being configured for 120/208V or 277/480V.

9. Three phase units rated more than 400 kW and less than or equal to 800 kW, must be 10-lead or 12 lead re-connectable and be capable of being configured for 120/208V or 277/480V.

10. Three phase units rated more than 800 kW must be 4-buss-bar or 12-lead re-connectable and be capable of being configured for 120/208V or 277/480V.

11. A load sensing device with the ability to shunt trip the loadbank circuit breaker in the event that the total load current applied to the alternator exceeds 110% for more than 10 seconds must be provided.

12. The alternator enclosure must allow for top and bottom entry of Load and Loadbank Conductors and all associated raceways (conduits) as required for these conductors.

13. Output Overcurrent Protection - Two independent circuit breakers, configured in parallel from the main alternator output, must be provided as part of the alternator assembly; one circuit breaker for the load and the other for the loadbank. The generator output circuit breaker and load bank circuit breaker are to be factory mounted and wired in the alternator enclosure. In the event of a fault or overload condition, the loadbank circuit must not cause the load circuit breaker to trip. These circuit breakers must be appropriately sized for the phase conductors as required by NFPA 70 (National Electric Code) for No More Than Three Current Carrying Conductors in a Raceway, Copper THHN type conductors with an ambient temperature ratings of 105°F-113°F to continuously carry the full output current rating of the alternator. The circuit breakers must be equipped with terminal lugs appropriately sized to accept the conductors as rated above. These circuit breakers must have voltage ratings equal to or greater than the output voltage of the alternator. The circuit breakers must provide electrical isolation in the “tripped” and “Off” positions, and must include “Shunt-Trip” elements with DC voltage rated coils to match the engine starting battery voltage. A single set of auxiliary contacts must be provided for each of the two circuit breakers.

CHAPTER 2 EQUIPMENT REQUIREMENTS

203. ALTERNATOR/ EXCITER ASSEMBLY (Continued)

14. Grounding Buss Bars - All alternators must be equipped with a copper grounding buss bars securely mounted on the inside of the alternator enclosure. All grounds are to terminate at this buss bar. The grounding buss bars must be sized as follows:
    a. Alternators rated 125 kW and below - ¼" X 4" X 10" as a minimum.
    b. Alternators rated above 125 kW - ¼ X 4" X 20" as a minimum.

CHAPTER 2 EQUIPMENT REQUIREMENTS

204. CONTROL AND INDICATION OF ALTERNATOR/ PRIME MOVER

The control and indication panel must meet the requirements of NFPA 110 level 1. The control and indication panel may use a common digital panel presentation with multiple selection features or independent analog gauges. The Prime Mover / Alternator Assembly must, as a minimum, include the following;

1. Controls

   Local (On the Alternator / Prime Mover Control Assembly)

   a. Alternator Voltage Adjustment – 85% to 110% of the nominal system line-to-line voltage. This adjustment must be a manual adjustment made by hand or with the use of a screwdriver only. It must not require software or a computer to make this adjustment.
   b. Alternator Frequency Adjustment - This adjustment must be a manual adjustment made by hand or with the use of a screwdriver only. It must not require software or a computer to make this adjustment.
   c. Engine Emergency Stop Switch (Push In Mushroom Button on Controller) Provide a manual OFF and ON switch with provision for locking in the OFF position to prevent manual or automatic cranking the engine starter. The switch must be located on the control panel and labeled Emergency Stop. A green indicator light must indicate the control is on and all safety circuits are normal.
   d. System Safety Lockout (Auto - Off/ Rest – Run)
   e. Panel Lamp Test Switch
   f. Parallel Operation Of Multiple EGS Units On A Single Buss. Some FAA facilities will require the use of multiple Engine Generator Systems (EGS) connected to a single common buss. EGS units purchased for these applications shall be capable of providing Automatic Paralleling and Loading of Engine-Generator Systems (EGS). An automatic loading system shall be provided to load and unload engine-generator sets in the sequence indicated. The loading system shall monitor the system load and cause additional engine-generator sets to start, synchronize, and be connected in parallel with the system bus with increasing load. Actuation of the additional engine-generator set start logic shall occur when the load exceeds a percentage set-point of the operating set's rating for an adjustable period of 1 to 60 seconds. When the system load falls below the percentage set-point of the operating set's rating for an adjustable period of 1 to 60 seconds, the controller shall unload and disconnect engine-generator sets from the system, stopping each engine-generator set after cool-down. The device shall provide two adjustable set-point ranges from 50 to 100 percent. All set point adjustments must be manual adjustments made by hand or with the use of a screwdriver only. These adjustments will not require the use of software or a computer to perform changes to the settings.

   Remote

   g. Engine Emergency Stop Switch (Personnel Safety Shutdown Switch located in room)
   h. Engine Start / Stop from ATS and/ or remote equipment

CHAPTER 2 EQUIPMENT REQUIREMENTS

204. CONTROL AND INDICATION OF ALTERNATOR/ PRIME MOVER (Continued)

2. Monitoring and Indications

Local (On the Alternator / Prime Mover Control Assembly)

a. Engine Coolant Temperature (°F ± 5% accuracy)
b. Engine Oil Pressure (PSI ± 5% accuracy)
c. Engine Run Time (Tenths of Hours)
d. Engine Manifold Pressure (turbo-charged units) gage may be mounted on the engine (PSI ± 5% accuracy).
e. Alternator AC Output Voltage, switchable for phase–to-phase and phase-to-neutral, switchable (AC Volts ± 2% accuracy)
f. Alternator Output Current switchable for each phase (Amperes ± 2% accuracy)
g. Engine System DC Voltage (DC Volts ± 2% accuracy)
h. Alternator Output Frequency (Hertz ± 0.5% accuracy)
i. Audible Safety Warning Device
j. Audible Safety Warning Device Silence Switch
k. Visual Safety Lockout Indication for each lockout condition (LED or lamps)
l. (2) Form A Engine Run Contacts
m. (2) Form B Engine Run Contacts
n. Synchronizing Panel. Engine-generator Systems (EGS) specified for parallel operation shall be configured with synchronizing panels and shall provide controls, gauges, meters, and displays to include but not limited to the following.

1. Frequency meters, dial type, with a range of 90 to 110 percent of rated frequency. Vibrating-reed type meters shall not be used. One shall monitor generator output frequency ("Generator Frequency Meter") and the other shall monitor the frequency of the parallel source ("Bus Frequency Meter").
2. Voltmeters, ac, dial type, 3-phase, with 4-position selector switch for the generator output ("Generator Volt Meter") and for the parallel power source ("Bus volt meter").
3. Automatic synchronizer.
4. Manual synchronizing controls.
5. Indicating lights for supplementary indication of synchronization.
6. Synchroscope.
7. Wattmeter, indicating

CHAPTER 2 EQUIPMENT REQUIREMENTS

204. CONTROL AND INDICATION OF ALTERNATOR/ PRIME MOVER (Continued)

Remote – RS-232 and RS-485 Communication Port Interface. A full duplex RS-485 interface must be installed in the ATS controller to enable serial communications. The controller must be capable of interfacing, through a serial communication module, with a network of engine controllers, locally (up to 4000 ft.) or remotely through serial communications. Standard software specific for the engine controller applications must be available by the manufacturer. This software must allow for the monitoring, control and setup of parameters. Remote monitoring must, as a minimum, include the following:

o. Engine Coolant Temperature (°F ± 5% accuracy)
p. Engine Oil Pressure (PSI ± 5% accuracy)
q. Safety Alarm - Engine Overcrank (cyclic us acceptable)
r. Safety Alarm - Engine Overspeed
s. Safety Alarm - Engine High Coolant Temperature
t. Safety Alarm - Engine Low Oil Pressure
u. Safety Alarm - Engine Low Coolant Level
v. Safety Alarm - Alternator Over Voltage
w. Safety Alarm - Over / Under Frequency
x. Engine Run Indication

3. Safety Shutdown Pre-alarm Warning Features, located on the Alternator / Prime Mover Assembly
   a. Engine High Coolant Temperature
   b. Engine Oil Pressure
   c. Engine Low Coolant Temperature

4. Safety Alarm Shutdown Controls, located on the Alternator / Prime Mover Assembly
   a. Engine Overcrank (cyclic is acceptable)
   b. Engine Overspeed
   c. Engine High Coolant Temperature
   d. Engine Low Oil Pressure
   e. Alternator Over Voltage
   f. Over / Under Frequency

CHAPTER 2 EQUIPMENT REQUIREMENTS

205. AUTOMATIC TRANSFER SWITCH AND BYPASS SWITCH ASSEMBLY GENERAL REQUIREMENTS

1. Transfer Switches as outlined here are to be used for emergency systems providing backup power for the safe operation of the National Airspace System (NAS). These systems will meet the current standards and requirements of the (NEC) article 517, 700 [3], 701, 702 and the NFPA 99 [4]. Additionally, all Transfer Switch designs must meet or exceed the requirements of codes and standards at the time of delivery. All switches will be continuously rated.

2. Automatic Transfer Switches will be required in the following configurations. Automatic Transfer Switches with Integral Manual Bypass Switches and with External stand-alone Manual Bypass Switches will be designated as follows;
   a. Open Transition Transfer Switch with Integral Bypass – OTTS / BS
   b. Open Transition Transfer Switch – OTTS (without Bypass)
   c. Closed Transition Transfer Switch with Integral Bypass – CTTS / BC
   d. Closed Transition Transfer Switch – CTTS (without Bypass)
   e. Bypass Switch – standalone, manually operated

3. All switches will be sized from 100 to 3000 amps.

4. All Automatic Transfer Switches must use only one type of main operator for ease of maintenance and commonality of parts.

5. Automatic Transfer – Time. The length of the transfer cycle must be no more than 15 seconds. A transfer cycle is defined as the time a Norman Source (Commercial) power out-of-tolerance condition is detected and the load is transferred to the Emergency Source (Engine-Generator) output. In the case where the generator was already running and supplying power to the load bank, the load bank must be automatically switched off.

6. Automatic Transfer - Engine Failure. In the event of a safety lock-out of the engine (engine failure) such as low oil pressure, high coolant temperature, overspeed or overcrank, retransfer to the commercial source must be immediate on availability. Any transfer delay timer must be bypassed under these conditions.

7. Automatic Transfer Switch Contacts. The Main Phase and Neutral Contacts of the switch must be electrically operated and mechanically held in place. The main contacts must be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life. The electrical operator must be a momentarily energized, single solenoid mechanism. Main contact operators which include overcurrent disconnect devices, linear motors or gears will not be accepted.

8. Automatic Transfer Switches and Bypass Switches will provide means of arc suppression to minimize arcing during the transferring of the load. Switches rated for 800 Amperes and above must have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contact.

CHAPTER 2 EQUIPMENT REQUIREMENTS

205. AUTOMATIC TRANSFER SWITCH AND BYPASS SWITCH ASSEMBLY GENERAL REQUIREMENTS (Continued)

9. Inspection of all Transfer Switch contacts must be possible from the front of the switch without disassembly of the operating linkages and without disconnection of power conductors. Switches rated 600 Amperes and higher must have front removable and replaceable contacts. All stationary and moveable contacts must be replaceable without removing power conductors and/ or bus bars. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.

10. All Automatic Transfer Switches must consist of an inherently double throw power transfer switch mechanism and controller to provide automatic operation. All automatic transfer switches and controllers must be the products of the same manufacture.

11. The Automatic Transfer Switch (ATS) Mean Time Between Failure (MTBF) must be greater than 300,000 hours of continuous operation without failure between 90% and 110% of the rated voltage and at the rated current. The Mean Time Between Failure test data will be provided as part of the Contractor submittal package.

12. The Automatic Transfer Switch and Bypass Switch enclosures must be Underwriters Laboratory (UL) listed and must as a minimum meet the requirements for a NEMA Type 1/ NEMA Type 3 enclosure. The Automatic Transfer Switch enclosure must allow for top entry of Normal (Commercial) Conductors, Emergency (Engine-Generator) Conductors, and the Load Conductors and all associated raceways (conduits) as required for these conductors.

13. Automatic Transfer Switches, weather of the OTTS or CTTS, single phase or three phase configuration, and all Bypass Switches, must be equipped with fully rated overlapping neutral transfer contacts. The neutrals of the normal and emergency power sources must be connected together only during the transfer and retransfer operation and remain connected together until power source contacts close on the source to which the transfer is being made. The overlapping neutral contact must not overlap for a period greater than 100 milliseconds. Neutral switching contacts that do not overlap are not acceptable.

14. All Automatic Transfer Switches, weather of the OTTS or CTTS, single phase or three phase configuration, and all Bypass Switches must be equipped with copper grounding buss bars securely mounted on the inside of the enclosures. The grounding buss bars must be sized as follows;
    a. ATS Rated 400 Amperes and below - ¼” X 4” X 10” as a minimum.
    b. ATS Rated above 400 Amperes - ¼ X 4” X 20” as a minimum.

CHAPTER 2 EQUIPMENT REQUIREMENTS

205. AUTOMATIC TRANSFER SWITCH AND BYPASS SWITCH ASSEMBLY GENERAL REQUIREMENTS (Continued)

15. Automatic Transfer switches will be provided with an optional “Preferred Source Switch”. This option will provide a selector switch, which, when operated, will allow either of the two power sources to operate as the preferred source. This selector switch will transfer all of the characteristics of the preferred source. This optional switch will be used in support of prime power sites that utilize two engine-generator sources and do not have a commercial power source available.

16. Automatic Transfer Switch and Bypass Switch manual operating handles must be marked to provide a clear explanation of the function. Handles must be permanently affixed and operable without opening the enclosure door. Designs requiring the insertion of a loose operating handle or requiring opening of the enclosure door to operate the switch are not acceptable.

CHAPTER 2 EQUIPMENT REQUIREMENTS

206. OPEN TRANSITION TRANSFER SWITCH (OTTS) REQUIREMENTS

1. Automatic load transfer from Normal Source (Commercial) power to the Emergency Source (Engine-Generator). When the Normal Source (Commercial) power fails as a result of an under/ over-voltage or under/ over-frequency out of tolerance condition, the transfer switch must automatically initiate a start command to the Emergency Source (Engine-Generator). Once the Emergency Source (Engine-Generator) has reach the acceptable voltage and frequency threshold limits set in the transfer switch, the switch will transfer the load to the engine generator. The transfer must not cause a loss of power to the load for longer than 1.0 second.

2. With both sources available, a failure of either source must cause the Open Transition Transfer Switch to transfer the load from the Normal Source (Commercial) to the Emergency Source (Engine-Generator) and visa-versa, with no more than a 1.0 second interruption in service to the connected load. When Emergency Source (Engine-Generator) power fails while supplying the equipment load, the retransfer must be automatically initiated by either the under/ over-voltage or under/ over-frequency relays (adjustable delays) which must cause the load to be retransferred as soon as the Normal Source (Commercial) power is available, i.e., voltage at least 95 percent of rating. When the Normal Source (Commercial) power is available, the retransfer must not be longer than 1.0 second from the time the Emergency Source (Engine-Generator) under / over-voltage or under/ over-frequency condition is detected until the load is on the Normal Source (Commercial) power. Retransfer must take place regardless of the way the load was transferred to generator, i.e., either manually or automatically initiated.

3. Restoration of Normal Source (Commercial) power. The transfer must take place only when the load is on the Emergency Source (Engine-Generator) as a result of an automatic transfer. When the Normal Source (Commercial) power has been restored and the equipment load is being supplied by the Emergency Source (Engine-Generator), retransfer must be automatically initiated. With the Normal Source (Commercial) power restored to the acceptable voltage and frequency threshold limits, the 0 to 30 minutes transfer delay timer (field adjustable), must be activated and the load must be automatically retransferred when the delay time setting has elapsed. Should the Normal Source (Commercial) power be restored intermittently for periods less than the setting of the transfer time delay, the delay must recycle and the load must continue to be supplied by the Emergency Source (Engine-Generator). After retransferring the load to commercial power the Emergency Source (Engine-Generator) set must be provided with a field adjustable time of 0 to 30 minute cool down period before it is automatically shut down. After a normal automatic transfer and shutdown, the engine generator unit must again be in normal standby status in all respects.

CHAPTER 2 EQUIPMENT REQUIREMENTS

206. OPEN TRANSITION TRANSFER SWITCH (OTTS) REQUIREMENTS (Continued)

4. Manually initiated automatic load transfer from the Normal Source (Commercial) power to the Emergency Source (Engine-Generator) and return. Transfer to the Emergency Source (Engine-Generator) must be initiated by actuating and holding the load test switch for 15 seconds or until the engine starts, attains rated output and transfers to the load. This is an open transition transfer. Transfer action must be controlled by a phase monitoring device to provide an in-phase open transition transfer. The load test run of the Emergency Source (Engine-Generator) must continue until the load test reset control switch is activated. Actuating the load test reset switch must terminate the load run, returning the Emergency Source (Engine-Generator) to normal standby status in all respects. The test circuit must be designed to immediately transfer back to the Normal Source (Commercial) power if the Emergency Source (Engine-Generator) output goes out of tolerance during the EGS load run.

CHAPTER 2 EQUIPMENT REQUIREMENTS

207. CLOSED TRANSITION TRANSFER SWITCH (CTTS) REQUIREMENTS

1. Automatic load transfer from Normal Source (Commercial) power to the Emergency Source (Engine-Generator). When the Normal Source (Commercial) power fails as a result of an under/ over-voltage or under/ over-frequency out of tolerance condition, the transfer switch must automatically initiate a start command to the Emergency Source (Engine-Generator). Once the Emergency Source (Engine-Generator) has reach the acceptable voltage and frequency threshold limits set in the transfer switch, the switch will transfer the load to the engine generator. The transfer must not cause a loss of power to the load.

2. Restoration of the Normal Source (Commercial) power. The transfer must operate without power interruption of power to the equipment load. Transfer must be initiated identical to the restoration of Normal Source (Commercial) power described above for the Open Transition Transfer Switch (ATS). The controls must be designed to permit this mode of operation only when both sources are available and within the set voltage and frequency threshold limits. Transfer must take place when the voltage differential is 5 percent or less, frequency differential is 0.2 Hz or less and when the phase angle differential is 5 degrees or less and approaching synchronism. The automatic synchronizer must function to aid in the transfer process. The retransfer time of 0 to 30 minutes must be nullified when the load is on the Emergency Source (Engine-Generator) as a result of a manually initiated transfer.

3. Manually initiated automatic load transfer from Normal Source (Commercial) power to the Emergency Source (Engine-Generator). Transition must take place without power interruption to the load. The operator must start the load transfer by actuating and holding the load test switch for 15 seconds (or until the EGS attains speed and stabilized). When the generator has stabilized a signal is developed within 1.5 seconds (0 to 3 seconds field adjustable period) and as soon as phase angle and voltages between the Emergency Source (Engine-Generator) and the Normal Source (Commercial) power permit as specified, the transfer will take place with no loss of power to the connected load. The test circuit must be designed to immediately transfer back to the Normal Source (Commercial) power if the Emergency Source (Engine-Generator) output goes out of tolerance during the EGS load run.

4. Manually initiated automatic load retransfer from the Emergency Source (Engin-Generator) to the Normal Source (Commercial) power. Transition must be without power interruption to the connected load. The operator will initiate the retransfer by actuating the load stop switch which must bypass the 0 to 30 minute retransfer delay. The events and requirements must be the same as specified for the automatically initiated retransfer with the Normal Source (Commercial) power available. After the normal automatic shutdown, the Emergency Source (Engine-Generator) must be in standby status in all respects.

5. Closed Transition Transfer Switches must be capable of transferring the load from the Normal Source (Commercial) to the Emergency Source (Engine Generator) and visa-versa, with no interruption in service to the connected load. Sensing and transfer control must be fully automatic and must be designed for safety of operation consistent with all known utility paralleling requirements.

CHAPTER 2 EQUIPMENT REQUIREMENTS

208. INTEGRAL BYPASS AND ISOLATION SWITCH ASSEMBLY

1. A two-way Bypass Isolation switch must provide manual bypass of the load to either the Normal or the Emergency Source and permit isolation of the Automatic Transfer Switch from all source and load power. All main contact of the Bypass Isolation Switch must be manually driven.

2. The only field installed power connections must be at the service and load terminal of the Bypass Isolation Switch. All control wiring must be provided with disconnect plugs.

3. Bypass to the load carrying source must be accomplished with no interruption of power to the load (make before break contacts). Designs which disconnect the load when bypassing are not acceptable. The Bypass handle must have three operating modes; Bypass to Normal, Automatic, and Bypass to Emergency.

4. The operating handle will be labeled “Bypass to Normal”, “Automatic”, and “Bypass to Emergency”.

5. The operating speed of the Bypass contacts must be the same as the associated Transfer Switch and must be independent of the speed at which the manual handle is operated. In the “Automatic mode of operation, the Bypass contact must be out of the power circuit so that they will not be subjected to fault current to which the system may be subjected.

6. The Isolation Switch handle must provide three operating modes: “Closed”, “Test”, and “Open”. The “Test” mode must permit testing of the entire Emergency power system, including the Automatic Transfer Switch with no interruption to the load. The “Open” mode must completely isolate the Automatic Transfer Switch from all source and load power. When in the “Open” position, it must be possible to completely withdraw the Automatic Transfer Switch mechanism from the enclosure for inspection or maintenance to conform to code requirements without removal of any power conductors or the use of tools.

7. When the Isolation Switch is in the “Test” or “Open” position, the Bypass Switch must function as a manual transfer switch.

8. Designs requiring operation of key interlocks for the Bypass Isolation or the ATS which cannot be completely withdrawn when isolated are not acceptable.

CHAPTER 2 EQUIPMENT REQUIREMENTS

209. EXTERNAL STAND ALONE BYPASS SWITCH (BS) ASSEMBLY

1. This switch is intended to be used, in certain situations up stream of the ATS. The function of this switch is to bypass the main transfer switch to the commercial power for maintenance purposes.

2. Bypass Switches will be equipped with mechanical and/ or electrical interlocks in such a manner as to prevent the simultaneous closing or paralleling of the Normal Source (Commercial) and Emergency Sources (Engine-Generator).

3. The Bypass Switch (BS) must provide a manual bypass of the load to either the Normal Source (Commercial) or the Emergency Source (Engine-Generator) and must permit isolation of the Automatic Transfer Switch from all source and load power. All main contacts of the Bypass Switch must be manually driven.

4. Bypass to the load carrying source must be accomplished with no interruption of power to the load (make before break contacts). Designs which disconnect the load when bypassing are not acceptable.

CHAPTER 2 EQUIPMENT REQUIREMENTS

210. RESIDINTIAL UNIT - AUTOMATIC TRANSFER SWITCH AND BYPASS SWITCH REQUIREMENTS

1. Small Residential Style Automatic Transfer Switch 100 – 400 amp.
   a. Switches will support small Engine Generator configurations in the 5kw to 25kw size.
   b. Two-pole, single phase open transition with solid neutral.
   c. Double throw inherently interlocked design.
   d. User friendly interface, with Led indicators, (example) source available, failure to transfer, auxiliary fault.
   e. Engine start contactor.
   f. Single phase voltage sensing on both sources.
   g. NEMA type 1 and NEMA type 2 enclosures.

CHAPTER 2 EQUIPMENT REQUIREMENTS

211. CONTROL AND INDICATION OF AUTOMATIC TRANSFER SWITCH (ATS)

1. The control and indication panel must meet the requirements of NFPA 110. The voltage sensing for both the Normal and Emergency Sources must be on all phases. The Frequency sensing may be on only one phase.

2. The control and indication of the Automatic Transfer Switch must be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.

3. A single microprocessor controller must provide twelve selectable nominal voltages for maximum application flexibility and minimal spare parts requirements. Voltage sensing must be true RMS type and must be accurate to ± 1% of the nominal voltage. The Frequency sensing must be accurate to ± 0.5%. The panel must be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.

4. The controller must be connected to the transfer switch by an interconnection wiring harness. The harness must include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic must be provided on multi-layer printed circuit boards. Interfacing relays must be industrial grand plug-in type with dust covers. The panel must be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance.

5. All customer connections must be wired to a common terminal block to simplify field wiring connections.

6. All standard and optional door-mounted switches and pilot light must be 16mm industrial grade type or equivalent for easy viewing and replacement.

7. The controller must meet or exceed the following requirements for Electromagnetic Compatibility (EMC);
   a. EN 55011:1991 Emission Standard – Group 1, Class A
   b. EN 50082-2:1995 Generic Immunity Standard
   c. EN 61000-4-2:1995 Electrostatic Discharge (ESD) Immunity
   d. EN 50140:1993 Radiated Electro-Magnetic Field Immunity
   e. EN 61000-4-4:1995 Electrical Fast Transient (EFT) Immunity
   f. EN 61000-4-5:1995 Surge Transient Immunity
   g. EN 61000-4-6:1996 Conducted Radio-Frequency Field Immunity

8. A Liquid Crystal Display (LCD) or equivalent type of display and keypad must be an integral part of the controller for viewing all available data and settings required for the operation control and monitoring of the ATS.

CHAPTER 2 EQUIPMENT REQUIREMENTS

211. CONTROL AND INDICATION OF AUTOMATIC TRANSFER SWITCH (ATS) (Continued)

9. The LCD display must include a “System Status” screen which must be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen must display a clear description of the active operating sequence and switch position. Controllers that require multiple screens to determine the system status or display “coded” system status messages, which must be explained by references in the operator’s manual, are not permissible.

10. Self Diagnostics – The controller must contain a diagnostic screen for the purposes of detecting system errors. This screen must provide information on the status input signals to the controller which may be preventing the load transfer commands from being completed.

11. Repetitive accuracy of all setting must be within ±0.5% over an operating temperature range of -20 to +60 degrees C.

12. The Voltage and Frequency setting must be field adjustable in increments of 1% of the system nominal value.

13. An In-Phase Monitor must be provided for both the OTTS and CTTS models. The monitor must control the transfer so that motor load inrush currents do not exceed the normal starting currents, and must not require external control of power sources.

14. Data Logging – The controller must have the ability to log data and to maintain the last 99 events, even in the event of a total power loss. The following events must be time and date stamped and maintained in a nonvolatile memory;
    a. Event Loggin
    b. Date and time and reason for transfer normal to emergency
    c. Date and time and reason for transfer emergency to normal
    d. Date and time and reason for engine start
    e. Date and time engine stopped
    f. Date and time emergency source available
    g. Date and time emergency source not available
    h. Total number of transfers
    i. Total number of transfers due to source failure
    j. Total number of days controller is energized
    k. Total number of hours both normal and emergency sources are available

CHAPTER 2 EQUIPMENT REQUIREMENTS

211. CONTROL AND INDICATION OF AUTOMATIC TRANSFER SWITCH (ATS) (Continued)

15. Controls – Adjustable, The ATS must, as a minimum, include the following;

Local

a. Engine Start Time Delay (0 to 10 Seconds)
b. Normal to Emergency Time Delay (0 to 30 Seconds)
c. Emergency to Normal Time Delay (0 to 30 minutes)
d. Normal Source Undervoltage Pickup Level (75% to 100% of Nominal)
e. Normal Source Undervoltage Dropout Level (70% to 98% of Nominal)
f. Normal Source Overvoltage Pickup Level (100% to 130% of Nominal)
g. Normal Source Overvoltage Dropout Level (105% to 135% of Nominal)
h. Emergency Source Undervoltage Pickup Level (75% to 100% of Nominal)
i. Emergency Source Underfrequency Pickup Level (85% to 100%)
j. Selectable Transfer Test – Front Panel Control
k. Extended Load Test (ELT) – Front Panel Control, Must cause the E/G to start and the ATS to transfer the load to the Emergency Source. The load will remain on the Emergency Source until the ELT switch is returned to the normal position. The ELT function will not prevent the ATS from returning the load to the Normal Source in the event that the Emergency Source fails. When activated this manual toggle switch will cause the E/G to start and the ATS to transfer the load to the E/G and remain there until the ELT is manually toggled back to the automatic mode. If the Engine fails for any reason the ATS will immediately acquire the alternate source if available. When toggled back to the automatic mode it will return the ATS to the automatic mode of operation after any appropriate timeouts. This switch is in addition to any other test capability the manufacturer has installed.
l. A Manual method must be provided to change the transfer switch position when the ATS is not under load or when the ATS is in the TEST position.
m. Commit/ No Commit to Transfer – Must provide the ability to select whether the load should be transferred to the Emergency Source if the Normal Source is restored before the E/G is ready to accept load.

Remote

n. Engine Start/ Stop Command (compatible with engine controls) and rated for 5 Amperes at 30 VDC
o. Start E/G and Transfer of ATS from the Normal Source to the Emergency Source. The load will remain on the Emergency Source until this signal is returned to the normal position. This function will not prevent the ATS from returning the load to the Normal Source in the event that the Emergency Source fails.

CHAPTER 2 EQUIPMENT REQUIREMENTS

211. CONTROL AND INDICATION OF AUTOMATIC TRANSFER SWITCH (ATS) (Continued)

16. Monitoring and Indications, The ATS must, as a minimum, include the following;

Local

a. Normal Source Available (Green Indication, 16mm Industrial Grade, Type 12) This indication must illuminate when the Source Voltage and Frequency satisfy the pick-up setting in the controller.
b. Emergency Source Available (Red Indication, 16mm Industrial Grade, Type 12) This indication must illuminate when the Source Voltage and Frequency satisfy the pick-up setting in the controller.
c. Load Connected to Normal Source (Green Indication, 16mm Industrial Grade, Type 12)
d. Load Connected to Emergency Source Red Indication, 16mm Industrial Grade, Type 12)
e. (4) Four independent sets of Form A, Transfer Switch Position Indication Auxiliary contacts must be provided for customer use, rated for 10 Amperes at 250 VAC
f. (4) Four independent sets of Form B, Transfer Switch Position Indication Auxiliary contacts must be provided for customer use, rated for 10 Amperes at 250 VAC
g. Metering must be provided for the monitoring of the Normal Source Voltage (allPhases), Normal Source Frequency, and the Load Current (all Phases)

Remote – RS-232 and RS-485 Communication Port Interface.

h. A full duplex RS-485 interface must be installed in the ATS controller to enable serial communications. The controller must be capable of interfacing, through a serial communication module, with a network of engine controllers, locally (up to 4000 ft.) or remotely through serial communications. Standard software specific for the engine controller applications must be available by the manufacture. This software must allow for the monitoring, control and setup of parameters. Remote monitoring must, as a minimum, include the following;
i. Commercial / Normal Source AC Voltage, for phase–to-phase and phase-to-neutral, (AC Volts $\pm$ 2% accuracy)
j. Generator / Emergency Source AC Voltage, for phase–to-phase and phase-to-neutral, (AC Volts $\pm$ 2% accuracy)
k. ATS Output, Load Current, for each phase (Amperes $\pm$ 2% accuracy)
l. ATS Position – Load on Normal Source or Load on Emergency Source

CHAPTER 2 EQUIPMENT REQUIREMENTS

212. LOADBANK ASSEMBLY

1. Loadbank. A forced air-cooled, resistive loadbank must be supplied, for permanent on-site installation, as a component of the EGS. The loadbank must be used for maintenance exercise and testing of the EGS. The loadbank must be designed for control by means of a separate panel. The loadbank housing must be comprised of the resistor bank section with cooling fan and the power control (contactors) section. Commercially available loadbanks must be subject to requirements of this section and approval by the government representative.

2. Installation. Standby power units with integral radiators must be provided with a duct type loadbank mounted on the engine radiator outer support frame. Units above 75 kW with and without remote radiators must be provided with remote loadbanks suitable for outdoor pad mounting.

3. Electrical connection. The loadbank voltage system must be same as the EGS. The power supply to the load elements must be obtained from the load side of the generator loadbank output circuit breaker.

4. Loadbank ratings
   a. Capacity: Minimum 80 percent of generator kW rating.
   b. Load Steps: Minimum of four equal steps.
   c. Voltage: Same as nameplate rating of generator.
   d. Frequency: 60 hertz.
   e. Temperature Rise: 60 degrees F maximum (with the forced air cooling).
   f. Time Rating: Continuous.

5. Operation. The system operator must be able to control the loadbank by way of control switches on the loadbank control panel (remotely mounted from loadbank) which must function to apply or remove load steps, either individually or in programmed blocks. The system operator must be able to monitor loadbank performance through indicator lights for operational mode, alarms, and load steps applied.

6. Loadbank design
   a. Enclosure. The loadbank enclosure must be NEMA Type 1 for indoor and NEMA type 3R corrosion resistant for outdoor. Enclosure must be designed for permanent installation. Enclosure must have removable side access panels. A perimeter flange must be provided for attachment of an air duct to radiator mounted loadbanks.

CHAPTER 2 EQUIPMENT REQUIREMENTS

212. LOADBANK ASSEMBLY (Continued)

b. Load elements. The resistor bank must be effectively separated from the power section. Each discrete single-phase resistor must be a rigid, continuously supported assembly of resistance wire on a ceramic clad stainless steel rod. Resistor elements which are not rigidly and continuously supported and which, when broken, can short to adjacent conductors or to ground, are not acceptable. All resistors elements must be readily serviceable.

c. Loadbank power section. The power section must include the controller (consisting of magnetic contactors, fuse blocks and terminal strips), overload/fault protection timers, and safeties. The short circuit protection must include one set of fuses for each of the load step sections. The fuses must be of the same interrupting rating as specified for the generator main circuit breaker, and must be coordinated to open on a fault before the generator main circuit breaker. Control components (contactors, terminal strips, etc) must be sub-panel mounted effectively separated and isolated with sheet metal from resistive power elements. Electrically-actuated and electrically-held magnetic contactors must be provided, one for each step.

d. Overheat protection. The loadbank must include a system to protect against over-temperature. A differential pressure switch which must function to protect against restricted airflow and fan failure must be provided. The system must be permissive, energize-to-run, fail-safe.

e. Wiring. The insulation of the loadbank power wiring must be rated 150 degrees C. The incoming power terminals must be 1000 amps per square inch of copper with silver plated connection pads. Control wiring termination must be provided with ring and tong lugs. Compression or set screw type terminals must be provided for power wiring. The wiring area must be adequately sized per NEC Article 373 - Cabinets and Cut Out Boxes.

f. Control power. Control circuits must operate at no more than 120 volts AC. All control circuits must be fused.

g. Loadbank control panel. The control panel must be a NEMA Type 1 wall mounting enclosure. To control the load steps, switches for each step must be provided. To permit application of a preset block load, a master load control switch must be provided. Indicator lights to show the load steps energized must be provided. A fan start/stop switch must be provided. Operational switches must include control-power on/off and indicator lights. Over-temperature shutdown protection indication must be provided.

CHAPTER 2 EQUIPMENT REQUIREMENTS

213. REMOTE RADIATOR ASSEMBLY

1. When required in the Contract Documentation and contract line item, units must be furnished with a remote, outdoor type, horizontal or vertical core radiator complete with fan and supporting structure ready for mounting on a concrete foundation. The top of the radiator core must be protected by a fabricated metal roof designed for a snow load of at least 20 pounds per square foot. Radiator core cooling section must be a self-supporting, self-contained assembly with brass tubes and copper fins designed to expand within its own frame independent of supporting structures.

2. The radiator provided must meet or exceed the engine manufacturers requirement to maintain the engine operating temperature within design limitations and overload condition requirements of Section 201.8.

3. The radiator housing, roof, supports, fan and guards must be made of corrosion-resistant metal. Hot dipped galvanized steel is acceptable. Structure must be designed for 120-MPH winds.

4. .The radiator must be furnished with an adequate capacity expansion overflow container or surge tank. This container must function in conjunction with the radiator cap to maintain normal liquid level within the radiator. The surge tank, sized for 10 percent of the cooling system volume, must be fabricated of copper or brass and include a sight gage, shut-off cock, drain fitting, pressure relief valve, and fill fitting. The total radiator/surge tank assembly must have a factory leak test at 25 psi and 300 degrees F. Core tanks and shrouds must be free of indentations or protrusions. The radiator input and output pipe must have flange connections. Flexible pipe sections must be provided for installation in each of the water lines to and from the radiator to isolate vibration and thermal expansion. The flange connections must include sealing gaskets or "o" rings, stainless steel bolts, nuts, and lock washers.

5. Exterior radiator fan. The fan motor must be Totally Enclosed Fan Cooled (TEFC), waterproof, suitable for use in the horizontal or vertical position. The fan must be guarded by a removable screen. A non-fusible, manual, lockable, horsepower rated disconnect switch in a NEMA type 4X enclosure, must be mounted on the supporting structure. The fan motor contactor must be controlled by a temperature sensor located in the engine coolant return path to the radiator. A grounding terminal must be provided on the supporting structure near the base.

CHAPTER 2 EQUIPMENT REQUIREMENTS

214. DAYTANK ASSEMBLY (Diesel Fuel Only)

1. Remotely located day tanks must have the capacity to provide adequate fuel supply to the engine during early start/run conditions and serve as an intermediate reservoir between the engine and fuel supply tank. The day tank must be constructed in accordance with the following standards;
   a. UL Standard UL-142
   b. NFPA 30 Flammable and Combustible Liquids Code
   c. NFPA 37 The Standard for Installation and use of Stationary Combustible Engine and Gas Turbines

2. The day tank must be made of heavy gauge steel construction, pressure tested from 3 to 5 psi for weld integrity, and must include a removable, non conductive top cover for indoor applications. The inside of the tank must be coated with an epoxy type rust inhibitor, the outside of the tank must be primed and finish painted.

3. The minimum allowable capacity of the tank must be sized to provide a minimum of four hours of EGS runtime at 100% load.

4. The input to the fuel supply pump must be equipped with an electrical solenoid operated shut-off valve, controlled by the day tank controller such that in its de-energized state, it will shut-off the supply of fuel to the day tank.

5. The tank must be provided with NPT fittings for; Engine Fuel Supply, Engine Fuel Return, Overflow, Normal Venting, an Inspection port for fuel level switches, and Emergency Vent sized as required by NFPA Code.

6. Tank Vent. The tank must be provided with an atmospheric (normal) vent cap with a screen and appropriately sized zinc-plated emergency vent cap.

7. Emergency Vent Cap. The Emergency Vent Release Device must be spring pressure operated. The opening pressure must be 0.5 psig (8 oz./ $in.^2$), the full opening pressure must be a maximum of 2.5 psig. The limits of the plug must be marked on the top of each vent. The vent device must meet UL 142 listing requirements for this application.

8. Supply Pump. The Fuel Supply Pump must be a bronze gear pump, capable of delivering fuel at a minimum rate required for proper EGS operation. The Fuel Supply Pump must be appropriately sized to provide a minimum of 17 feet of vertical lift at sea level. The 120 VAC single phase motor that drives the pump must be of sufficient horsepower to operate the pump.

CHAPTER 2 EQUIPMENT REQUIREMENTS

214. DAYTANK ASSEMBLY (Diesel Fuel Only) (Continued)

9. Reverse Pump. A Reverse Pump system must be provided to return fuel to the main tank in the event that the day tank level exceeds 110% of its normal capacity. Fuel Reverse Pump must be a bronze gear pump, and must be capable of returning fuel at a minimum rate of at least twice the rate of the Supply Pump. The 120 VAC single phase motor that drives the pump must be of sufficient horsepower to operate the pump.

10. Fuel Containment or Rupture Basin. The day tank must include a containment basin to prevent escape of fuel into the environment in the event of a tank rupture. The basin must be primed and finish painted. The rupture basin must consist of an open-top structure sized at a minimum holding capacity of 150% of the day tank capacity. A rupture basin leak detector switch must be wired into the day tank controller that will shut down the supply pump and motor in the event of a fuel leak into the containment basin.

11. Day Tank Controls. The following controls conditions must be provided for the operation of the day tank;
    a. ON / OFF Power Switch – Should completely remove power from the controller and the pump motor.
    b. Test – Test the controller panel indications and activate the fuel supply pump motor.

12. Alarm and Status Indications. The day tank controller must be capable of providing the following alarm and status indications listed below with a visual indication on the front of the controller and remotely by means of relays. Each alarm condition relay must provide one normally open and one normally closed set of contacts rated at 1 ampere, at 120 VAC or 24 VDC.
    a. High Fuel Level – Activates at 106% of normal fuel level with a two second change of state time delay
    b. Low Fuel Level – Activates at 62% of normal fuel level.
    c. Low Fuel Shutdown – Activates at 6% of normal fuel level.
    d. Fuel In Rupture Basin – Activates when fuel is detected in the rupture basin.
    e. Controller Failure – Activates when there is a fault in the day tank controller or any of the sensing devices that provide input to the controller.

CHAPTER 2 EQUIPMENT REQUIREMENTS

215. BATTERY CHARGER

1. The Battery Charger must be a stand alone wall mounted unit, properly ventilated, and of commercial heavy duty construction. The battery charger must be completely self contained, automatic, solid state and must operate in a float and equalizing charge mode.

2. The battery charger must be U.L. approved. The enclosure must be designed for remote mounting. Commercially available chargers must be subject to the requirements of this section and approved by the government representative. Engine driven charging systems are acceptable as a secondary charging means and must disconnect the primary charger during engine runs.

3. Equalization Charge. Equalization charge duration must be adjustable with automatic recovery to the float charge state. Equalizing must be automatic and initiated each time AC power is removed from the charger. The charger must be sized to bring batteries, after one full cycle crank, and while supplying the control power, back to full charge in 2 hours. The battery charger output equalizing voltage must be adjustable from +/- 5VDC of the nominal battery voltage.

4. Float Charge. Float charge current must be automatically controlled to maintain the batteries in a fully charged state. Chargers must be designed for constant voltage, current limiting to prevent gassing and overcharging. The battery charger output float voltage must be adjustable from +/- 5VDC of the nominal battery voltage.

5. The Battery Charger must be equipped with the following features;
   a. On-Off switch and LED/ Lamp indication of power status
   b. Input power must be 120 VAC or 240 VAC
   c. Output power must be 12 or 24 VDC, adjustable +/- 5 VDC.
   d. Automatic Float / Equalize Operation
   e. DC Output must be Ambient Temperature Compensated
   f. Terminal Blocks for AC Input and DC Output
   g. Fused Input and Output
   h. Reverse Polarity Protection
   i. DC Output Current Limiting
   j. DC Output Ammeter and Voltmeters (analog or digital)

CHAPTER 2 EQUIPMENT REQUIREMENTS

216. ENGINE STARTING BATTERIES

1. Cranking and starting. The engine starting batteries must be designed to overcome the starting torque and crank the engine at all ambient temperatures from 20 degrees F (minus 6.6 degrees C) to 125 degrees F (52 degrees C).

2. Battery Mounting Clearances – The battery mounting assembly may be located on the engine / generator bedrail assembly or may be a stand-alone battery shelf or stand. The engine starting battery(s) must be mounted as to satisfy one of the two following requirements;
   a. The positive battery post(s) must be located in such a manner that will allow a safe working clearance of the appropriate sized wrench for removal of the positive cable connector to negative grounded conductive components.
   b. An appropriate electrical insulating material must be installed on the negative grounded conductive components in such a manner that will allow a safe working clearance of the appropriate sized wrench for the removal of the positive cable connector to negative ground conductive components.

3. Batteries must be Commercial Heavy Duty type meeting the requirements of NFPA-110 and SAE Standard J-537.

4. Two 12-volt batteries must be used for 24-volt starting systems.

5. The batteries must be shipped dry; the Government will supply the electrolyte as needed.

6. The batteries will have a protective cover for safety purposes.

217. ENGINE EXHAUST

1. The Engine Exhaust System must have a Critical Grade Muffler with side in / end out connections. The muffler provided must having a chamber design with a silencing capability to bring all engine exhaust noise below 85 dBA at 25 feet.

2. A stainless steel flexible connection must be provided from the engine exhaust manifold to the rest of the exhaust system and must be fitted with a standard Schedule 40 flanged pipe fitting of the appropriate size with gasket. When provided, all elbows must have a radius greater than five times the exhaust diameter. Bolts and nuts for flanges must be stainless steel. Gaskets must be steel clad rated for 1400 degrees Fahrenheit.

3. Exhaust Manifold Insulator Blanket must be provided.

4. All hardware and mounting kit accessories to permit the complete field installation, exclusive of the exhaust piping and insulation, must be provided.

CHAPTER 3 ACCEPTANCE TESTING

300. FIRST ARTICLE TEST PROCEDURES

1. Test Plan. The contractor must submit for Government review and approval the inspection and test plan. The plan must, as a minimum, include all tests required by this specification. Approval is required prior to factory testing. The manufacturer's test manual and First Article Test instructions must be made available to Government. After the tests are completed, the test results must be certified, identified with the equipment serial number, and submitted to the Government representative for review and approval. The test reports must include certification that each item of equipment has been tested in strict accordance with all requirements of this specification and that the test report is true and accurate. The test report must also include the detailed test data including electronic copies of the Dranetz Power Quality Monitor files, temperature, and description of test equipment. Tests must be made with the same equipment, without maintenance or replacement of parts. Incomplete test data, evidence of inadequate testing, data indicating failure to meet performance requirements or subsequent failure to meet performance requirements must be cause for rejection of the equipment. See the Test Verification Requirements.

2. Responsibility for testing. The contractor must provide complete facilities, personnel, tools, fuel, oil, test equipment, electrical power, loads and all necessary devices to accomplish the inspection and tests specified. The Government will inspect the equipment at the contractor's plant. Perform the factory tests for the complete system with all components completely interconnected. Notify the Government of the time and date of the factory tests. The inspection and factory testing will be witnessed by the Government. All instruments, instrument transformers and other devices used in the test must be calibrated by a certified National Institute of Standards and Technology laboratory before the test is begun or within the last six months and must be described in the certified test report. Any changes in an approved type or model of equipment design or its component parts must invalidate test approval unless previously approved, in writing, by the Government.

3. First Article tests and evaluations. Qualification and Acceptance testing must be performed on the first equipment of each type specified by CLIN. Prior to test, perform an inspection which must include a complete and thorough check of the general design, principal dimensions, methods of assembly, and workmanship. The following First Article tests may be performed in any sequence except the twenty hour heat run test must be the last. Perform all inspections and First Article tests required by this specification. No adjustment, repair, substitution of parts or equipment is allowed between or during each phase of testing, once First Article testing has begun, without the express written permission of the Government.

CHAPTER 3 ACCEPTANCE TESTING

300. FIRST ARTICLE TEST PROCEDURES (Continued)

4. Unit operational test. Perform EGS start, load transfer and load step test for all automatic and manual operating and transfer modes specified. The test must be performed with all auxiliaries operational. All testing must be accomplished with contractor furnished test equipment. Initial load on the engine generator must be 100 percent rated load (resistive). The engine must be started by simulating power failure. The engine generator must not have been run for at least 24 hours. The test must start with commercial power supplying the load and with the engine and room at 100 degrees F or less.

5. Data Collection. Dranetz Power Quality Monitor recording equipment must be used to analyze and record voltage/frequency regulation and transient response conditions. The output voltage, frequency and power of the EGS must be recorded during initial load application and during load changes. Record the transient response of the EGS during testing. Record steady state run conditions, the time for the EGS unit to start, and the time required to transfer and assume the load. All data must be compared with the requirements specified in the documents as specified in Section 102. Unit performance must be as specified for all modes of operation. The test must be repeated when test results fail to meet essential parameters.

6. Cold operation test. A Dranetz Power Quality Monitor must be used to monitor the EGS during the actual start and run portions of this test. The entire EGS including the ATS, daytank, radiator and loadbank must be placed in a cold room at 15 degrees F for at least 12-hours prior to low temperature start and operation test. A suitable anti-freeze must be used in the cooling system with no lighter than SAE 20W oil in the engine crankcase. The immersion heater must be turned off. The immersion heater must be turned on when the coolant and the crankcase oil have leveled off at 20 degrees F or lower. When the temperature of the coolant in the head of the engine reaches 100 degrees F, (indicated by any one of the three thermometers attached to the engine head) the testing cranking and starting must be followed by a full rated load. After the set has started and picked up the load, the EGS must be run for a remainder of 15 minutes.

7. Output voltage waveform. The waveform of the generator output voltage must be viewed and recorded with a Dranetz Power Quality Monitor and the total harmonic distortion measured while operating at half load and full load with the loadbank. Recordings of the waveform must be made while serving the loadbank. Satisfactory operation will be with a voltage waveform meeting the 5% harmonic distortion specified.

8. Voltage and Frequency Pickup and Dropout sensing setpoints. By varying the engine voltage and speed while supplying rated kW to the test loadbank, the pickup and drop out value of all ATS voltage and frequency setpoints as well as the time delay settings must be measured and recorded.

CHAPTER 3 ACCEPTANCE TESTING

300. FIRST ARTICLE TEST PROCEDURES (Continued)

9. Battery charger test. Record the charging currents, voltage and the temperature rise. The functions of the tests must include:
   a. Charge rate at various states of battery discharge to determine that charger will deliver the charging requirements specified.
   b. An extended run at maximum current charger rate to determine temperature rise in the charger; (When temperature stops rising for 30 minutes in the chamber, the run may be terminated). Test: Equalizing charge, and Voltage sensors or relays and Overload protection.

10. Circuit breaker overload test. Overload must be applied with a resistive load bank, equally to all phases of generator up to the limit of the set's ability to maintain rated frequency and voltage. The generator circuit breaker must trip before the generator or exciter winding exceeds its permissible overload temperature rise. Satisfactory performance is defined as meeting the requirements of generator rating. The recorded values of the above tests must confirm the manufacturer's compliance with specification and alarm setting data.

11. Dielectric test. The alternator and exciter must withstand the high potential dielectric test described in NEMA MG-1, paragraph MG-1-22.51.

12. Test of Engine Safety Shutdown devices (NFPA 110 Safety Devices).
   a. Engine Water Temperature Shutdown. The engine water temperature must be caused to rise by operation of the engine, with radiator cooling air blocked, until the over-temperature device trips. The temperature of the water at the time of tripping must be recorded. The fan motor disconnect switch may be opened on remote radiator units for the test.
   b. Low Oil Pressure Safety Shutdown. A calibrated oil pressure gage must be connected to the engine oil pressure system just ahead of the low oil pressure protective device. With the engine running at no load, the oil pressure to the gage and the trip device must be lowered slowly until the trip device functions to stop the engine. The tripping pressure must be recorded.
   c. Test of Overspeed Safety control. The engine speed must be caused to rise above rated speed slowly until the overspeed device trips. Engine RPM must be recorded at the time of shutdown.
   d. Engine Overcrank Cutout. The overcrank cutout must be tested to confirm lock-out of the starting circuit in the specified time. Continuous cranking must terminate at 60 seconds duration. Intermittent cranking must terminate after four 15 second, crank, no crank periods.
   e. Over/under voltage cutout safety. Generator output must be manually raised and lowered to create an over and under voltage condition. The engine must shut down from both over and under voltage conditions.
   f. Over/under frequency cutout safety. The governor speed control must be raised and lowered to create an overspeed and under speed condition. The engine must shut down from both conditions.

CHAPTER 3 ACCEPTANCE TESTING

300. FIRST ARTICLE TEST PROCEDURES (Continued)

13. Immersion heater test. The immersion heater and the associated plumbing must be examined for compliance with the specified requirements. The immersion heater unit must be operated at rated voltage for a period of 5 consecutive days. A recording voltmeter must be connected to the heater element to record the cycling of the temperature control. The operation of the temperature control device must be positive with no evidence of flutter in turning the heater on and off. A thermocouple must be attached to the tubing (or a thermometer inserted into the coolant) to verify the maximum temperature in the immersion heater outlet. Thermometers must be attached to the front, rear, and top of the water-jacketed portion of the engine head. A maximum temperature differential of 15 degrees F must be allowed between any of the 3 engine thermometers. At the end of the test the system must be drained and the immersion heater elements removed and examined for hot spots due to steam pockets which may have been present in the element housing. Evidence of hot spots or signs of deterioration of the heater elements must be cause for rejection.

14. Twenty-Hour Heat Run and Frequency Dip Test as required by NFPA110.
    a. General. Remote Temperature Displays (RTD's), thermocouple (T/C's) or thermometers must be placed on the hot test available portion of the generator and the exciter, at the air intake to the generator, on either side of the engine, near the voltage regulator, near the governor control module, in the top radiator water hose and in the flow of the lubricate oil to the main bearings. Calibrated laboratory instruments must measure the generator output voltage, amperes, kilowatts, exciter and generator field volts and amperes. The instruments for recording the frequency, voltage and kilowatts must be connected to the output of the generator. A Dranetz Power Quality Monitor must be utilized to verify and record, the voltage and frequency variation during a 100 percent step load test. The 100 percent step load test must be performed a minimum of three times in order to collect sufficient data. When an outdoor radiator is used, at least two 90-degree elbows must be provided in each of the runs to and from the engine. Piping runs must be the maximum equivalent length recommended by the engine manufacturer. During the test run, all doors must be closed, all covers must be in place and no adjustments must be made to any controls. The following readings must be taken every hour (every half hour during the first four-hours of the test):
        1. All RTDs, thermocouple or thermometers
        2. All engine instruments
        3. All power and control panel instruments and alarms
        4. All Generator output volts, amperes, frequency and kilowatts

CHAPTER 3 ACCEPTANCE TESTING

300. FIRST ARTICLE TEST PROCEDURES (Continued)

b. Starting test. The EGS and ambient temperature at the start of the test must not be higher than 100 degrees F. Means must be provided to raise the ambient temperature to 120 degrees F during the first 4 hours of the run. The engine temperature must be determined by the temperature of the jacket water and crankcase oil. Commercial power must be connected. All timers must be set. The EGS must be started by simulating a failure of the commercial power, and 100 percent of the rated load using the test loadbank applied in one sudden step to the load terminals. From the moment of the simulated failure a Dranetz Power Quality Monitor must be utilized to verify and record, the voltage, current, and frequency variation during the entire test. The generator must meet the performance requirements as specified in the documents in Section 104.

c. Heat run test. The loadbank must be used for load tests in accordance with the following schedule. A Dranetz Power Quality Monitor must be utilized to verify and record, the voltage, current, and frequency variations during steady state and transient conditions such as sudden load changes. Test must be continuous. Failure of test subject to paragraph 301.

100% rated kW 1 hr.
10% rated kW 1 min.
50% rated kW 1 min.
100% rated kW 1 min.
10% rated kW 1 min.
50% rated kW 1 min.
100% rated kW 1 min. 110% rated kW 1 min.
50% rated kW 1 min.
110% rated kW 1 min.
80% rated kW at 0.8 lagging power factor 8 hrs.
10% rated kW 1 min
50% rated kW 1 min.
110% rated kW 1 min.
10% rated kW 1 min.
50% rated kW 1 min.
100% rated kW 4 hrs.
10% rated kW 1 min.
50% rated kW 4 hrs.
100% rated kW 1 min. 110% rated kW 2 hrs.
10% rated kW 11 min*

* At the end of the 11 minute 10 percent load, commercial power must be reapplied to the set to initiate the shutdown cycle.

CHAPTER 3 ACCEPTANCE TESTING

300. FIRST ARTICLE TEST PROCEDURES (Continued)

15. Reconnection test. Dual voltage sets must be reconnected to the alternate voltage and operated on the test loadbank for 15 minutes at 10 percent, 50 percent, 100 percent and 110 percent to determine that the voltage regulator, the governor, and all AC relays and timers are not overheating and operating satisfactorily.

16. Oil consumption test. The Contractor must reduce oil level to the add-oil-level-mark on the dip stick and the engine must continue to run at least 4 hours at full load without low oil pressure shutdown or damage to the engine.

17. Unbalanced load test. An unbalanced load test using the test loadbank must be run to verify that the engine generator set meets the requirements for steady state regulation, generator rating, automatic power transfer, and voltage regulation.

18. Vibration test. Visually inspect the assembled engine to insure that all pipes, conduits and supports and flexible connections are properly used and that the generator and base are totally free floating. Visually check to assure that all isolators are properly adjusted or sized for equal deflection. The displacement of the base must be measured with all vibration isolators properly adjusted and free floating. With the engine running at normal speed; completely block all engine vibration isolators and again measure the displacement of the base. The ratio of the displacement must be less than 10 percent. Certified vendor data showing the natural frequency of the vibration isolators provided and the engine weight imposed on each isolator furnished and verify that damping characteristics are as specified.

19. Miscellaneous testing. The following miscellaneous tests must demonstrate compliance with the performance requirements specified:
    a. Fuel shutoff
    b. Safety switch
    c. Overcrank failure alarm
    d. Alarms and indicators
    e. Test pushbuttons

20. Load bank test. An operational test must be conducted to demonstrate the performance specified for the load bank. The engine generator must be started and the load bank must be connected in steps of 25 percent, 50 percent, 75 percent, and 100 percent of the generator kW rating. The generator voltage, frequency and load bank temperature must be recorded, and compared with the specified values. The interlocks with the load transfer switch must be verified by simulating a commercial power failure while the generator feeds the load bank. The overheat protection must be tested by blocking the cooling of the resistor bank.

CHAPTER 3 ACCEPTANCE TESTING

300. FIRST ARTICLE TEST PROCEDURES (Continued)

21. Transfer Switch Test

a. Automatic Transfer Switch (ATS) independent laboratory test. The ATS must have been tested by a nationally recognized, independent test laboratory in accordance with ANSI/UL 1008. These tests are subject to Contracting Officers Representative (COR) approval and the COR reserves the right to witness all testing and review for approval the certified test report. Transfer Switches subject to these tests must not be acceptable for installation in production units. All testing of a given switch size must be continuous and complete using the same switch.

b. Withstand current test. Transfer Switches must be subjected to the following withstand currents:

SWITCH AMPERE SIZE	WITHSTAND CURRENT
100 - Ampere or less	5,000 Amperes
101 - 400 Amperes	10,000 Amperes
401 - Amperes and larger	20 times rated, but not less than 10,000 Amperes

Tests must be in accordance with ANSI/UL 1008, section 34, Withstand. The test current must be maintained for the time duration specified in sections 34.5 and 34.6. At the conclusion of the test, the switch must be capable of operation by its intended means. There must be no breakage of the switch base to the extent that the integrity of live parts is impaired. The door must be prevented from being blown open by its latch without bolt or lock installation.

c. Endurance test. The Endurance test must be in accordance with ANSI/UL 1008, paragraph 30.1 for total system load, motor load or electric discharge lamp control. All controls must be energized at full voltage during the endurance test and all auxiliary contacts must make and break normal currents. The Transfer Switch must be cycled through a test simulating normal source failure. An electrical or mechanical counter must be used to count the cycles of operation. There must be no arc-over at any time during the endurance test.

d. Temperature rise test. After the endurance test, and without any maintenance of the equipment, (same equipment as used for endurance test, paragraph 300.21.c.) including the contacts, temperature rise test must be made in accordance with ANSI/UL 1008, section 29. The Transfer Switch must be energized from the normal source at full name plate current rating. Every 30 minutes, temperature readings by thermocouple must be taken and recorded at the Transfer Switch main contacts until the temperature stabilizes. When 3 consecutive readings taken at 10-minute intervals show no increase in temperature, the temperature rise above ambient must not exceed the listing of table 29.1, section 29, ANSI/UL 1008.

e. CTTS contact overlap test. Test must be made to confirm the designed operation of the CTTS during the parallelled transfer period with commercial power demonstrating the no break to the load requirement.

CHAPTER 3 ACCEPTANCE TESTING

300. FIRST ARTICLE TEST PROCEDURES (Continued)

f. Calibration test. Three calibration tests must be made to determine the sensor settings and relays pickup and dropout voltage rates comply with the specified requirements. Tests must also be made to determine that values will not change more than plus or minus 2 percent over an ambient temperature range of minus 20 degrees C to plus 70 degrees C. Tests must be made at minus 20 degrees C, plus 25 degrees C and plus 70 degrees C.

g. Voltage withstand surge capability. The control modules or microprocessor controllers must be tested to demonstrate their ability to meet the voltage surge withstand test as specified in ANSI C37.90.1.

h. Impulse withstand voltage. The control modules or microprocessor controllers must be tested to demonstrate their ability to meet the impulse withstand voltage test specified in NEMA ICS 1 Section 109.

22. Quality conformance inspections (production tests). After the Government has given written approval of successful completion of the First Article tests, each of the following production tests must be performed on each First Article standby power unit:

a. Unit operational test
b. Output voltage waveform test
c. Overspeed safety control test
d. Pick up and drop out of voltage and frequency sensing device
e. Battery charger test
f. Circuit breaker overload test
g. Overtemperature, overcrank, overspeed and low oil pressure protective device
h. Reconnection test
i. Oil consumption test
j. Unbalanced load test
k. Vibration test
l. Miscellaneous test (Sec 300.19)
m. Load bank test
n. Four-hour test.

CHAPTER 3 ACCEPTANCE TESTING

300. FIRST ARTICLE TEST PROCEDURES (Continued)

23. Four-hour test. (The four hour test must be the last test.)
    a. A four hour test, using the loadbank with the EGS system at room ambient temperature, must be made by applying the following loads: Starting with an unloaded unit;
        1. 80% rated kW at 0.8 lagging power factor, 2 hours
        2. 10% rated kW, non-reactive 1 minute
        3. 50% rated kW, non-reactive 1 minute
        4. 110% rated kW, non-reactive 2 hours
        5. 10% rated kW, non-reactive 2 minute
    b. During the four hour test above, the voltage, frequency, and transient response must be monitored and recorded. The Dranetz Power Quality Monitor must be utilized to verify and record, the voltage and frequency variation during steady state and load conditions and must be retained with each EGS as historical test data. At each load step the following must be recorded every 15 minutes;
        1. Time
        2. Ambient air temperature; Kilowatt load
        3. AC voltage of generator (phase to phase)
        4. AC amperes of generator (line current to load)
        5. Frequency
        6. Exciter field voltage; Exciter field amperes
        7. Jacket water temperature from engine
        8. Lube oil temperature to engine
        9. Lube oil temperature from engine
        10. Generator winding temperature
        11. Lube oil pressure to engine
        12. Intake manifold pressure
        13. Crankcase pressure.
    c. Test and record all alarm and shutdown points. Verify that the steady state voltage regulation and the generator rating meet the requirements of this specification. Record the output voltage wave-form and the total harmonic distortion with the Dranetz Power Quality Monitor during the two long runs (1) 2 hours at 80% rated kW at 0.8 lagging power factor test and (2) 2 hours at 110% on the test loadbank.

CHAPTER 3 ACCEPTANCE TESTING

301. FIRST ARTICLE FAIL-IN TEST

1. Failure-In Test. Failure to meet the official First Article test, as specified, will require corrective action on the part of the contractor before resubmission for another official test. The following corrective actions are required and must be taken prior to continuation of First Article teats:
   a. The component which caused the failure must be isolated and tested to determine the cause of the failure. If the component is found to have been originally defective the component must be replaced with a new component of the same make and model.
   b. If the component became defective after the tests began, the use of the component must be reviewed for possible misapplication. If the application is determined to be correct the component must be replaced with a new component of the same make and model.
   c. If the replacement component fails or if the same component fails on either 3 sets or ten percent of the number of sets required by the solicitation, whichever is larger, the failed component must be replaced with a component of a different and more substantial design.
   d. Repeat of testing. During the First Article test cycle, the particular test during which the component failed must be repeated. Any previous test, successfully completed, utilizing the same component must be evaluated for repeat testing. Testing must be repeated where it can be deduced the component in question prevented an adequate or appropriate test.
   e. Furthermore, should the sets fail to meet a performance requirement in production testing, the failure must be treated the same as a failure in the First Article test.

302. FIRST ARTICLE TEST ACCEPTANCE

1. Acceptance. Acceptance for the purpose of this specification will be at the Contractor's plant prior to shipment. Acceptance must be by total system only. Shipment will be accomplished in accordance with the contract. Upon successful completion of all testing, special testing and production testing, (as defined in section 300 of this specification) the Government will issue written acceptance of each EGS total system. An EGS total system must consist of all items as listed in this specification, including accessory items such as battery charger, batteries, battery rack, muffler, loadbank, transfer switch, instruction books and any other items required by this specification.

CHAPTER 4 PREPARATION FOR DELIVERY

400. CLEANING

1. Cleaning. Prior to preservation and packing, all components of each EGS unit must be cleaned of all manufacturing debris, including metal chips and wire clippings.

401. PRESERVATION

1. Engine. Subsequent to all testing, the fuel, fuel filters, lube oil filters, and lubricating oil must be removed from the set. The filter housings must be thoroughly cleaned and new filters installed. The crankcase must be filled with new oil to a point where the oil level must be at the proper level on the dip stick. Each engine must then be run for a minimum of 5 minutes to ensure that the systems have been properly reassembled and are free from leaks. The following are minimum preservation requirements:
   a. With the fuel flow to the engine interrupted to prevent starting, the engine must be continuously cranked by the starter and suitable preservative oil sprayed into the engine air intake until fumes from the preservative oil show at the exhaust opening or for a period 20-seconds whichever occurs first.
   b. The fuel system must then be put back in operational condition. With the engine at rest, preservative oil must be sprayed into the exhaust manifold including the turbocharger if furnished, for a minimum of 15 seconds.
   c. All exposed unpainted ferrous metal surfaces except fan belt pulley or other similar surfaces must be covered with a thin coat of preservative lubricant. The immersion heater valves must be set in the open position and the electrical plugs disconnected from the receptacle and secured in such a manner to prevent damage during shipment.

2. Cooling system. The cooling system must be completely drained. All openings in the engine must be sealed with a suitable tape material to prevent entrance of moisture and insects.

3. Packing. All contactors and relays other than totally enclosed devices must be blocked and secured with twine or rubber band to prevent movement during shipment. Small delicate open type devices may be omitted. Self standing cabinets, such as the ATS, must have the doors secured by metal straps. Sufficient desiccant material must be provided to keep the air dry inside the package.

4. Pre-operation instructions. A water-resistant envelope must be attached to the front of the control panel containing pre-operation instructions. The instructions should give the necessary data for preparing the generator set for operation including all factory set points of adjustable devices. It must include such items as removing ties from the relays, clearing all openings of adhesive tape, cleaning relay contacts, filling radiator, crankcase, and adjusting fan belt. The envelope must be marked in large bold print "PRE-OPERATING INSTRUCTIONS."

CHAPTER 4 PREPARATION FOR DELIVERY

401. PRESERVATION (Continued)

5. Crating. Crate as required by Contract Documentation and the Statement of Work.

6. Marking. Marking must comply with the Contract Documentation and the Statement of Work.

7. Delivery, storage and handling. Packaging and preparation for shipment and storage must be in accordance with Contract Documentation and the Statement of Work Prior to packaging, clean and dry the units. Deliver products in undamaged condition with seals and labels intact and legible. Handle products in a manner to prevent damage.

8. Unpacking instructions. Where required, a step-by-step procedure for uncrating and unpacking each and every component of the EGS must be prepared and protected by enclosing in a water-resistant envelope clearly marked in large print "UNPACKING INSTRUCTIONS". The instructions must be attached in a conspicuous, protected place on the outside of the container. Included in the instructions must be any relevant precautionary information including the use of crowbars or other leverage tools and specific guidance in the proper method of moving heavy equipment assemblies using slings, skids, lifting eyes for lift truck, or other means. Particular attention must be given to the acceptability of using structural frame members in the moving process.