

AMERICAN NATIONAL STANDARD

Procurement Standard for

Gas Turbine Preparation for Shipping and Installation

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FOREWORD

The purpose of the B133 standards is to provide criteria for the preparation of gas turbine procurement specifications. These standards will also be useful for response to such specifications.

The B133 standards provide essential information for the procurement of gas turbine power plants. They apply to open cycle, closed cycle, and semiclosed-cycle gas turbines with conventional combustion systems for industrial, marine, and electric power applications. Auxiliaries needed for proper operation are covered. Not included are gas turbines applied to earth moving machines, agricultural and industrial-type tractors, automobiles, trucks, buses, and aeropropulsion units.

For gas turbines using unconventional or special heat sources, such as: chemical processes, nuclear reactors, or furnaces for supercharged boilers, these standards may be used as a basis; but appropriate modifications may be necessary.

The intent of the B133 standards is to cover the normal requirement of the majority of applications, recognizing that economic trade-offs and reliability implications may differ in some applications. The user may desire to add, delete, or modify the requirements in this Standard to meet his specific needs, and he has the option of doing so in his own procurement specification.

The B133.11 Standard has been prepared to aid the user in drafting specifications applicable to his specific requirements, relative to shipping and installation.

Suggestions for improvement of this Standard will be welcome. They should be sent to The American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, N.Y. 10017.

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AMERICAN NATIONAL STANDARD

**PROCUREMENT STANDARD FOR GAS TURBINE PREPARATION
FOR SHIPPING AND INSTALLATION****1 SCOPE**

The intent of this Standard is to provide a review of shipping and installation items that should be considered in the preparation of procurement specifications.

The shipping sections of this Standard provide guidelines which the user may find helpful in preparing a specification applicable to his specific requirements.

In the preparation of the installation and start-up sections, it was found that there are a variety of suitable methods to achieve the same ultimate end, as employed by the various manufacturers. Because of this diversity, the user is advised to consult with the manufacturer on his use and interpretation of this Standard. This Standard should be useful in providing guidelines for items that should be included in the user's more detailed specifications, applicable to his specific requirements.

2 PRESERVATION**2.1 Duration of Treatment**

2.1.1 Domestic shipments shall be adequately preserved to withstand 3 months of combinations of outdoor storage and transit time. This shall not be construed to preclude planned inspections, renewal, or replacement of preservation materials required by these inspections.

2.1.2 Export shipments shall be adequately preserved to withstand 1 year of combinations of storage and transit time, except for air transportable items. Air transportable items shall comply with domestic preservation duration requirements as a minimum. This shall not be construed to preclude planned

inspection, renewal, or replacement of preservation materials required by these inspections.

2.1.3 Extended preplanned storage shall require additional or special consideration for selection of preservatives, inspection, and renewal of preservatives based upon type and duration of exposure and storage facilities available. Length of time in storage may be in excess of 1 year, or as agreed to by the manufacturer and user.

2.2 Types of Preservatives

2.2.1 Direct Application Types. Preservatives applied directly to metal surfaces (principally machined surfaces; i.e., paints, greases, sprays, cocooning) shall be selected to endure the climate and duration needs for the class of shipment planned. Surfaces treated directly with preservatives shall be protected from abrasion or other accidental impacts that could destroy, damage, or otherwise defeat the preservation treatment.

2.2.2 Area Treatment Types. Preservatives designed to treat large enclosed areas, i.e., vapor phase inhibitors, moisture controllers, either chemical or mechanical, and gases, shall be installed to prevent damage from the preservative itself in prolonged service exposures. Visual indicators shall be installed to facilitate verification of preservative adequacy, if applicable, to the type of preservative used. If required, renewal or servicing of the preservative shall be made possible without major disassembly of the packaging materials.

2.2.3 Additive Types. When preservatives are added to fluids for shipment and storage, (i.e., corrosion inhibitors, anti-freeze, or oils) placards shall

be installed, warning against operation of equipment without removal of the additives, as required. Also, placards shall indicate any personnel hazards relating to preservatives.

2.2.4 When mechanical or electrical devices are installed for preservation purposes (either in transit or energized after arrival at a storage site), they shall be clearly labeled with instructions for connections and service required during storage, as necessary.

3 BOXING

3.1 General Requirements

3.1.1 Materials selected shall be new, seasoned, and of sound quality.

3.1.2 Design and fabrication of boxes, crates, and skids shall be the responsibility of the manufacturer. For reference purposes, see "The Wood Crate Design Manual"(U.S. Dept. of Agriculture HPB No. 252), and Volume II, Defense Supply Agency Manual (4145.2-1967).

3.1.3 Ventilation and drainage systems shall be installed in boxes and crates when condensation, rains, or sea water may become trapped within the container.

3.1.4 Articles shall be installed in boxes, etc., so as to prevent damage from shifting, rubbing, or scraping, unless containerized shipment is used, in which case they may be secured in bins.

3.1.5 Boxes shall be filled to the maximum practical limit, but allowance shall be made for thermal expansion requirements, as applicable.

3.1.6 Preservation of articles for the control of rust and corrosion shall be performed, as required, in addition to boxing.

3.1.7 Stacking limitations, with arrows identifying right side up, shall be indicated on each box.

3.2 Placarding and Marking

3.2.1 Minimum marking requirements shall be exterior permanent legends in two locations on each box, affixed by stencil, paint, metal placard, etc.

3.2.2 Item identification, gross weight including crate, CG location, and lifting points, are minimum legends to be marked on each box.

3.2.3 Special preservation instructions or storage requirements shall be marked on the exterior of a box, if applicable.

3.2.4 Packing lists shall be inserted in waterproof envelopes and attached inside and outside the shippable item.

3.2.5 Sending and receiving addresses, routing, and any commercial papers shall be securely attached or marked on the exterior of each shippable item. Marking in two locations is recommended.

4 CLOSURES

4.1 Openings in equipment such as gas turbine inlets or exhausts, piping, vent lines, louvers, etc., shall be sealed via closures for protection against ingestion of moisture or foreign matter, and to retain internal preservatives installed before closure.

4.2 Closures shall be constructed of materials selected to withstand normal shock, vibration, weather hazards, and impact in transit.

4.3 Closures shall be secured via wiring, bolting, or fastening, with suitable hardware materials selected to withstand the anticipated exposure requirements. Such hardware shall be attached so that there is a minimal possibility of accidental ingestion into the machine during removal.

4.4 Closure materials shall themselves be treated or preserved to prevent condensation, local rusting, or the possibility of edge leakage of water, dust, sand, etc., into the item being protected.

4.5 Closures shall be marked or painted, if applicable, to identify them as removable temporary equipment.

4.6 If preservatives that are hazardous to personnel are installed within closures, they shall be marked with warning labels.

4.7 Closures shall be marked or noted with any applicable instructions for safe disposal of preservative materials.

4.8 If shipment out of bearings is required, the enclosure shall have adequately protected saddles to prevent shaft journal damage due to shipping.

5 SHIPPING ENVELOPE

5.1 The total dimensions of each item, including its packing materials and the dimensions added to the package due to placement on a truck bed, rail car bed, etc., shall be within the allowable limits for commercial transportation.

6 TRANSPORTATION

Domestic and overseas shipments require different considerations. There are, however, general considerations that apply to both types of shipment. These are as follows.

6.1 Items should be properly blocked and/or tied down on the rail car or truck. "No Humping" signs or other suitable markings should be displayed. Impact recorders may also be used to determine shock received from "humping" of rail cars.

6.2 The manufacturer should notify the user or his agent in advance, indicating such information as date of shipment, weight of package, dimension of package, routing, bill of lading, etc. There should be a clear understanding between the manufacturer and the user, relative to where this correspondence should be addressed.

7 RECEIVING INSPECTION, UNLOADING, AND STORAGE

7.1 Receiving Inspection

It is important that the installer, or other authorized receiver, carefully inspect the package before it is removed from the rail car or truck. This inspection should note any evidence of damage during transit, including "humping" of rail cars. Shock gages may be mounted on equipment subject to internal

damage, and should be inspected. Any such evidence should be carefully noted prior to signing for the shipment. Such damage should be documented, and the truck driver or railroad inspector should sign, acknowledging that the damaged condition exists. The user or his agent should then contact the manufacturer to determine whether additional checks are necessary, in order to verify the extent of the damage.

7.2 Unloading

The receiver should, where appropriate, request the manufacturer's representative to advise him, relative to proper lifting points, and special care to be exercised. OSHA regulations regarding materials handling and storage should be observed, relative to lifting devices and equipment. Prior to the arrival of the first piece of equipment, the receiver should determine the most expeditious route for moving the shipment from the rail siding to the storage area or ultimate site. The receiver should have preplanned the type of unloading equipment and necessary moving equipment to get the package to the plant site.

7.3 Storage

After unloading, the packages should be stored in such a way that deterioration will not take place prior to moving the equipment onto the foundation. Ducting, piping, and other components should not be set on the ground. They should be blocked up with suitable space under the surface facing the ground, so that adequate ventilation is available to prevent rusting. Covers should be checked periodically to ensure that all piping openings are properly covered to prevent the entrance of dirt, sand, or moisture. If heaters are specified by the manufacturer for such items as the turbine compartment, generator, or other components, these heaters should be energized as soon as the equipment arrives at the destination, and should be monitored periodically to ensure that they are in proper working order. Proper security should be exercised to prevent vandalism or theft. Tarpaulins or other suitable covering should be provided for piping and other equipment which is not stored inside a building or trailer. Tarpaulins should not be placed directly on material, and allowances should be made for free ventilation of air to prevent entrapment of moisture.

8 DEPRESERVING

Prior to initial operation of the gas turbine, the manufacturer's recommendations relative to depreserving should be carefully followed. Care should be taken to remove those types of preservatives mentioned in 2.2.2, and 2.2.3. All blanked off flanges for piping, ducting, or components should be removed.

9 INSTALLATION

The following items should be given consideration during the installation planning for the gas turbine power plant.

9.1 Foundations

The design, construction, and installation of the foundation may be the responsibility of either the user or the manufacturer.

9.1.1 If the foundation is the user's responsibility, the manufacturer should supply a manufacturer's nonstructural drawing of foundation requirements, approved for construction, showing location and size of foundation bolts, static, and dynamic loadings.

9.1.2 If the foundation is the manufacturer's responsibility, the user and the manufacturer should mutually agree to the following:

- (a) site preparation, such as access roads, material handling, and storage;
- (b) drainage;
- (c) soil loadings substantiated by test boring data, and including earthquake consideration;
- (d) construction utilities, such as electrical power, water, compressed air, etc.

9.2 Inlet and Exhaust Ducts

9.2.1 If inlet and exhaust ducts are user supplied, the manufacturer should review the design of the user's inlet and exhaust systems. The user should obtain the approval of the manufacturer for the compatibility of the inlet and exhaust systems with the gas turbine. Inlet and exhaust ducts should meet the allowable forces that can be imposed on the gas turbine, pressure drops, and thermal expansion requirements, as specified by the manufacturer. Refer to ANSI B133.8 for applicable sound requirements.

9.2.2 If inlet and exhaust ducts are manufacturer supplied, the manufacturer and user should agree to provisions for proper installation of the duct work.

9.3 Regenerator or Waste Heat Recovery Equipment

Regenerators for larger gas turbines are shipped separately and may require field assembly. The foundations for this equipment should be carefully reviewed with the manufacturer, so as to ensure adequate support, ventilation, and/or insulation to prevent severe thermal transients in the foundation. It is preferable to locate the regenerator as close to the gas turbine as is practical, to minimize thermal expansion of the hot gas ducting from the gas turbine to the regenerator.

Provision should be made and tests conducted for the regenerator high-pressure side leakage, prior to startup and at regular maintenance intervals.

9.4 Coupling to Driven Equipment

The coupling to driven equipment may be supplied by either the manufacturer or the user. When the driven equipment is not supplied by the manufacturer, the user should provide information describing shaft alignment changes resulting from temperature changes of the driven equipment as it is loaded, and to perform the necessary shaft-system structural and vibration analysis. In either case, installation and alignment of the coupling to the gas turbine should be approved and witnessed by the gas turbine manufacturer's representative, unless otherwise agreed to by the user and manufacturer. Coupling guards should be installed to insure personnel safety in these areas.

9.5 Connecting Piping or Tubing

Prior to installation, the user and manufacturer shall agree to location, size, and type of all field piping or tubing for field fabricated systems.

9.6 Lubricating Oil System

Gas turbines which have been factory assembled, flushed, and tested, and have only field fit-up welds, should require a minimum of flushing and cleaning at the time of installation.

Gas turbines requiring significant field piping fabrication and piping assemblies of intricate shapes

require a complete cleaning and flushing at installation. Field pipe fabrications of carbon steel should be pickled and protected from rusting. The flush is intended to reduce the solid contamination, and to remove light rust preventative oils.

A displacement flush may also be necessary. If the fluid used in the cleaning flush is not "compatible" with the operating turbine lubricant, or if the factory assembled gas turbine contains a rust preventative that is not compatible with the turbine lubricant, the displacement flush involves a circulation in the complete gas turbine and lubrication system for 24 hours of a charge of the lubricant (or a fluid completely compatible with it).

Consult the manufacturer for more specific recommendations, and see ASME Standard LOS-1M-1980 ASTM-ASME-NEMA, Recommended Practices for the Cleaning, Flushing, and Purification of Steam and Gas Turbine Lubrication Systems.

9.7 Fuel Oil System

During the installation of a gas turbine, the fuel oil system should be cleaned and flushed in a manner similar to that indicated for the lubricating oil piping. This piping is often coated, wrapped, or lined, in which case it cannot be pickled in the field. In this event, it is ordinarily brushed, blown out, and wiped clean, after which the completed system is rigorously flushed. Ordinarily, fuel oil is recirculated through filtering devices until all mill scale, welding slag, and other contaminants are removed from the piping.

9.8 Installation of Controls

The manufacturer should recommend the classification of cables and type of terminations to be used for connections between the gas turbine and control panels, in accordance with applicable codes and specifications. Proper spacing between circuits of different power levels is required, to avoid interferences and to insure proper operating of the gas turbine controls. The manufacturer should recommend the proper spacing required for the various classifications of cables. For direct burial of the cable, the responsibility for adhering to the manufacturer's instructions and for the mechanical and environmental locations remains with the user.

9.9 Calibration of Protective Relays

The protective relays provided by the manufacturer as a part of the gas turbine power plant control and protection system should be set in accordance with the manufacturer's instructions. For protective relays interfacing with the user's load system, such as the reverse power relay, the setting should be coordinated with the user. The user-provided protective relay system should also be coordinated between the user and the manufacturer.

9.10 Enclosure

If the gas turbine is to be enclosed in a building, either the user or the manufacturer may erect the structure. Should the user choose to erect the building, close coordination of the building design and the sequence of erection of the building and gas turbine shall be required. The manufacturer should supply dimensions of major pieces of equipment to allow the user to ensure adequate ventilation and accessibility for equipment placement. See B133.3, Section 13, Enclosures.

9.11 Interface Terminations

Drawings should be provided by the user so that the manufacturer can establish the optimum equipment layout and provide connecting means with these interface locations. The user and the manufacturer should accurately define the location and type of interface terminations required. Final approval of the manufacturer's suggested equipment layout, with respect to the overall site arrangement, should be obtained from the user.

9.12 Technical Direction of Installation

Technical direction service is engineering and technical guidance, advice, and counsel, based upon current engineering, manufacturing, installation, and operating practices for the manufacturer's equipment involved, with regard to work performed by others. The user should consult the manufacturer for specific details of this service.

9.13 Installation Schedule

It is recommended that the installer develop a detailed installation schedule, prior to the beginning of

the installation, which contains all key activities required for the installation. This schedule should become an important control and measurement tool during the installation, and will facilitate equipment shipment dates prior to the installation. A careful analysis should be made to see whether the planned shipment dates of all equipment to the site are compatible with the installation schedule.

10 PRESTART CHECKS

10.1 Subsystems Tests

The manufacturer may conduct subsystems tests on various assemblies prior to shipment. Copies of all such tests should be available to the installer as part of his prestart checks.

10.2 Alignment

The installer shall satisfy himself that the alignment of all drives mechanically connected to the gas turbine are within acceptable tolerances, as agreed to by the manufacturer and user. Special attention shall be paid to ease of rotation, rubbing noises, or any other indication of misalignment or binding. Visual inspection of all observable clearances should be made at this time. Thrust bearing clearances and rotor end float should be checked, in accordance with the manufacturer's instructions. Suitable data should be recorded by the installer.

10.3 Electrical and Mechanical Devices

The position and wiring of all electrical and mechanical devices, such as pumps, pressure, temperature and limit switches, speed and vibration transducers, as well as the proper rotation of electric motors shall be checked.

10.4 Lubricating Oil System

10.4.1 The system for conformance to drawings, pipe sizes, orifices, check valves, and field piping connections shall be checked, to the extent that is practical without disassembly.

10.4.2 Units that have been factory tested to establish with certainty the cleanliness of the complete lube oil system may require no further field clean-

ing or flushing, provided there has been no opportunity for the entry of foreign matter into the system, such as through disconnected pipes, openings for instrumentation, etc. The installer, however, must satisfy himself as to whether preservative coatings have been used internally, and whether they require flushing. If preservatives have been used, special care must be taken to clean them out, since foaming in the fresh charges of oil can occur.

10.5 Fuel Oil System

The fuel oil system should be cleaned in accordance with the manufacturer's instructions, and the system checked for conformance to drawings.

10.6 Cooling System for Lube Oil

Cooling systems may be shell and tube heat exchangers with a raw water supply, oil to air cooling through a radiator, or other combinations. The coolant side, liquid, air, or both, should be flushed out and the system checked for adequate flow.

10.7 Pressure Tests

All fluid systems should be operated at the maximum pressure likely to be encountered in service, and checked for leaks.

10.8 Pressure and Temperature Devices

10.8.1 Position and wiring shall be checked.

10.8.2 Pressure and temperature devices used only for indicating may be used without field calibration, unless they are believed to be in error.

10.8.3 Pressure and temperature devices used in the control of the machine, or for alarm or trip functions, should be calibrated, checked, and exercised for proper circuit function. Calibration records should be kept.

10.9 Starting System

The starting system shall be checked and exercised to the maximum extent possible without actually making a startup. The manufacturer's instructions should be followed.

10.10 Generator

The manufacturer's instruction book shall be consulted.

10.10.1 Check generator bearings to verify bearing installation, in accordance with drawing.

10.10.2 Check generator shaft to verify grounding brushes installed according to drawings.

10.10.3 Check ground detection system.

10.10.4 Check generator piping to see that it is in agreement with the drawings.

10.10.5 Megger the generator as recommended by the manufacturer, but with no less than 500V megger.

10.10.6 Hydrogen cooled generator subsystems should be checked as follows, in accordance with the manufacturer's instructions.

- (a) pressure and leak tests
- (b) purge cycle
- (c) hydrogen console
- (d) hydrogen dryer
- (e) hydrogen purity
- (f) seal oil system

10.10.7 Check phasing, including potential transformer on each side of the main breaker. Check all generator protective devices and circuits.

10.10.8 Check battery and charger.

10.10.9 Check generator protective relays, and remove all shipping materials from relay contacts.

10.10.10 Check battery connections and level of electrolyte in cells.

10.10.11 Check motor control center and other motor controls.

10.10.12 Check generator voltage regulator.

10.10.13 Check auxiliary power supply, including transformer. See ANSI C57.93 (oil), or C57.94 (dry type), for installation and maintenance procedures.

10.10.14 Check main generator switchgear or oil circuit breaker, per manufacturer's instruction book.

10.11.1 Controls. A checkout of all devices used for control of speed, load, fuel, and temperature should be made by, or under the direction of, the manufacturer's representative prior to start-up. Alarm and trip circuits and hardware should be included in this checkout, with particular attention being paid to those devices where malfunction would be a hazard to life or cause major damage to the installation. Where static checkout is unable to verify proper performance, such as overspeed trips, seismic vibration transducers, etc., every effort should be made to verify proper installation and the physical condition of the equipment. If a simulator is used, it shall be of the manufacturer's design, or approved by the manufacturer. The manufacturer's instructions and settings must be strictly adhered to.

10.11.2 Fire Extinguishing System. Check piping location of discharge nozzles. Verify that wiring is in accordance with the drawings. Check nozzle sizes. Check for correct temperature range on sensor. Perform vendor recommended tests of system.

10.11.3 Check fuel igniter for proper operation. Check flame monitor.

10.11.4 Verify proper installation and operation of all speed measuring equipment, plus speed sensitive settings of auxiliary devices.

10.11.5 Check settings of vibration monitoring, alarm, and trip systems and record.

10.11.6 Check settings of all level switches and controls.

10.11.7 Check operation of all recording equipment.

10.11.8 Check rotation of all auxiliary equipment.

10.11.9 Check all lube requirements, to assure that oil or grease is adequate.

10.11.10 Check vacuum system, where used, for proper settings.

10.11.11 Check ventilated spaces to ensure adequate circulation.

10.11.12 Check functioning of the manual emergency shutdown system.

10.11.13 Check cooling water anti-freeze, if applicable.

11.3 The manufacturer and the user should conduct an inspection of the installation to agree on its readiness for testing.

11 INITIAL STARTUP

11.1 The manufacturer should notify the user when he considers the installation to be suitable for its first startup. The manufacturer should outline the schedule of tests that he recommends.

11.2 Unless otherwise specified in the contract, the user will provide the initial fill for all systems, plus the consumables, as defined by the manufacturer.

12 PUNCH LIST

The punch list is a statement agreed to by the manufacturer and the user of work that is yet to be done, or material shortages or defects. The initial punch list may be drawn up by either the manufacturer or the user; however, the official punch list must be agreed to by both parties.

AMERICAN NATIONAL STANDARDS FOR GAS TURBINES

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