GE Power Systems
Gas Turbine

Inspection and Maintenance Instructions For MS-7001FA+ and MS-7001FA+e Fuel Gas Only Gas Turbines With Dry Low NOx

GEK 107492
Rev. 0

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NEW FORMAT

The Combustion Inspection, Hot Gas Path Inspection and Major Inspection sections of this manual have been formatted to separate the Disassembly, Inspection, and Reassembly Operations for each inspection. The figure numbers and page numbers have also been revised to follow this format.

A “D” preceding a figure or page number is used for the Disassembly section, an “I” is used for the Inspection section, an “R” is used for the Reassembly section, and an “SC” is used for the Startup Checks section.

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Inspection and Maintenance Instructions

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NOTES, CAUTIONS AND WARNINGS

Notes, Cautions and Warnings will be found throughout this Maintenance Publication. It is important that the significance of each is thoroughly understood by personnel using these Maintenance Procedures. Their definitions are as follows:

Note: Highlights an essential element of a procedure to assure correctness.

CAUTION

Indicates a procedure or practice, which if not strictly observed, could result in damage or destruction of equipment.

WARNING

Indicates a procedure or practice, which could result in injury to personnel or loss of life if not followed correctly.

SAFETY

This publication is designed to provide safe procedures and processes for accomplishing the maintenance instructions described herein. It is important, therefore, that the warnings, cautions, and notes in these procedures be thoroughly understood and observed by the personnel performing maintenance. Changes or additions deemed necessary for proper maintenance and/or suggested safety improvements should be submitted to:

Manager: Technical Communications and Publishing
GE Company
Building 53, Room 229
1 River Road
Schenectady, New York 12345

Note: All dimensions called for throughout the maintenance publication are in S.A.E. units first, followed by metric (where applicable) in brackets [ ].

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INTRODUCTION

Introduction

GENERAL

Operation of the combustion gas turbine, as of any rotating power equipment, must include a planned program of periodic inspection, with accompanying repair and replacement of parts as necessary, to ensure the maximum availability and reliability of the unit.

The object of this Maintenance Section is threefold:

1. To aid the user in becoming familiar with the unit by separating the inspections according to specific systems and, where appropriate, describing briefly the reason for the inspection and the action to be taken.

2. To identify those components and parts that should be periodically examined between the initial start-up tests and the designated inspection.

3. Inspection intervals herein are based on engineering judgment and experience gained with gas turbine units. The actual time interval established for any particular gas turbine should be based on the user's operating experience and on ambient conditions, such as humidity, dust, and corrosive atmosphere.

Prior to scheduled inspections or taking operating data, clean the compressor per the gas turbine compressor cleaning procedure in the Water Wash/Cleaning Tab in this service manual. Before and after any inspection a complete set of operating data including vibration readings should be taken and recorded for reference. A record of the inspections made, and the maintenance work performed, will be most valuable in helping to establish a good maintenance program for the gas turbine unit(s). It is expected that the maintenance program will start with minor work, and increase in magnitude over a period of time to a major overhaul, and then repeat the cycle. The performance of inspections can be optimized to reduce unit outage time and maintenance cost for a particular mode of operation, and still maintain maximum availability and reliability of the unit.

OPERATING FACTORS AFFECTING MAINTENANCE

Note: The effect of maintenance factors for fuel, starts and load duty are cumulative if all the above factors are present. It should also be understood that as the maintenance factor increases the time between inspections and components repairs decreases and it is possible that component replacement frequency will increase.

The factors having the greatest influence on the life of parts for any given machine are shown in Figure 1-1.

Fuel

The effect of the type of fuel on parts life is associated with the radiant energy in the combustion process and the ability to atomize the various liquid fuels. Therefore, natural gas, which does not require atomization, has the lowest level of radiant energy and will produce the longest life of parts.

Natural gas has been the traditional fuel for use with gas turbines. Due to the need to back up an interruptible gas supply many gas turbines are dual fuel with a distillate fuel oil used as the alternate fuel.

Contaminants in the fuel also affect maintenance intervals. This is particularly true for liquid fuels in which dirt results in accelerated replacement of pumps, metering elements, and fuel nozzles. Contaminants in fuel gas can erode or corrode control valves and fuel nozzles.

Starting Frequency

Each stop and start of a gas turbine subjects the hot gas path to significant thermal cycles. Control systems are designed and adjusted to minimize this effect. However, a gas turbine with frequent starting and stopping requirements will demonstrate parts lives that are shorter than those for a similar unit in continuous-duty service. See Figure 1-3.

Load Cycle

The load cycle of the gas turbine, up to its continuous rating, will have little effect on parts lives, provided it does not require frequent and rapid load changes.

Environment

The condition of the inlet air to the gas turbine can have a significant effect on maintenance costs and intervals if it is either abrasive or corrosive. If abrasives are in the inlet air (e.g., as from sand storms), careful attention should be paid to inlet filtering in order to minimize this effect.

If the gas turbine is to be operated in a corrosive atmosphere (for example, one with salts), careful attention should be paid to the location of the inlet air arrangement and the application of correct materials and protective coatings. It is essential during the planning stages of an application to recognize any abrasive or corrosive contaminants and to take the necessary steps to minimize them. Contaminants in the fuel and air are additive. Refer to the liquid fuel specifications.

MAINTENANCE PRACTICES

Parts condition information is based on estimates only, and will vary with machines and specific operating conditions. However, estimates are based on previous experience and can be very useful in planning a maintenance program. As actual operating data is accumulated on a specific application, adjustments of inspection cycles should be the next step in a well-planned program.

Initial inspection planning can be based on the combustion inspection schedule, hot gas path inspection schedule, and major inspection schedule tailored to your unit and estimated outage requirements listed in Figure 1-4.

It must be recognized that the foregoing estimated outage requirements can be used for estimating maintenance cycles, however, these numbers will vary depending upon the many factors which establish the operating conditions for a specific installation. The inspection cycles will vary depending upon fuel, duty cycle and maintenance philosophy of the owner. The inspection manhours will vary depending upon preplanning, availability of parts, productivity, weather conditions, union regulations, supervision, etc.

Precise estimates of the outage duration resource requirements and costs associated with the inspection of a specific installation may be obtained from your GE Company Apparatus and Engineering Services Operation Representative.

Good maintenance planning for minimum down-time requires the availability of replacement parts, either new or previously repaired, that can be exchanged with existing parts. The exchanged parts can then be repaired without extending the down-time.

To ensure optimum performance of the gas turbine, the minimum stock of spare parts should be able to support the service inspection. A predetermined central location can stock spare parts that are adequate for hot gas path inspection. Many gas turbine plants stock capital spare parts on-site, recognizing that this parts availability minimizes the turn-around time required for major overhauls.

The planned maintenance program anticipates the needs of the equipment and is tailored to meet the requirements of the system for utilization, reliability, and cost.

TYPES OF INSPECTIONS

The types of inspections covered in this publication may be broadly classified in terms of unit “running” and unit “shutdown” inspections. The running inspection is performed during start-up and while the unit is operating. This inspection indicates the general condition of the gas turbine unit and its associated equipment. The shutdown inspection is performed while the unit is at a standstill. The shutdown inspections include “Combustion,” “Hot Gas Path,” and “Major” inspections. These latter inspections require disassembly of the turbine in varying degrees. See Figure 1-5.

Turbine starting reliability can be aided by conducting a “standby” inspection while the unit is shut down. Routine servicing of the battery system, changing of filters, checking oil and water levels, cleaning relays, checking device settings and calibrations, lubrication and other general preventative maintenance can be performed in off-peak hours without interrupting the availability of the turbine. Certain designated accessories in need of repair or replacement may be returned to the factory on either a repair and return basis or an exchange basis.

GE Company Field Service Representatives are available to provide technical direction or consultation for repair and replacement.

Periodic test runs are also an essential part of a good maintenance program. It is highly recommended that the unit be operated at load for at least 1 hour bi-monthly, and data recorded. It is recommended that gas turbines on extended shutdown (three weeks or more) should be operated on turning gear or ratchet for one hour each day to prevent the buildup of corrosive deposits in the turbine wheel dovetails *or* the gas turbine should be operated at full speed, no load for one hour per week to dry the turbine out and thereby prevent moisture condensation in the turbine dovetail crevices.

Special inspections such as borescope and eddy current probe, can be used to further plan periodic maintenance without interrupting availability. It is also recommended that visual inspections be performed whenever there is personnel at the unit.

Combustion Inspection

A brief shutdown inspection is required to change out fuel nozzles and to check the combustion liners transition pieces and crossfire tubes. These parts require the most frequent attention, as continued operation with a deteriorated combustion system can result in much shortened life of the downstream parts, such as turbine nozzles and buckets. It is also inherent in the gas turbine design that these parts are the first to require repair or replacement. Therefore, the importance of this inspection in the maintenance program must be emphasized.

Figure 1-5 shows these components in relationship to one another.

A visual inspection of the leading edge of the first-stage turbine nozzle partitions and buckets should be made during the combustion inspection to note any wear or deterioration of these parts. This inspection will help to establish the schedule for the Hot Gas Path inspection.

The combustion liners, transition pieces, crossfire tubes, and fuel nozzles should be removed and replaced with new or repaired liners, transition pieces, crossfire tubes and new or cleaned fuel nozzles. This procedure reduces downtime to a minimum and the removed liners, transition pieces, crossfire tubes, and fuel nozzles can be cleaned, inspected and repaired later when it is more convenient.

After the combustion inspection is completed and the turbine has been returned to service, the removed liners, and transition pieces can be bench inspected and repaired if necessary, by competent service personnel, or off-site at a qualified service facility. Off-site cleaning inspection, and repair of the liners and transition pieces is recommended, since this activity can best be performed where specialized equipment and fixtures are available.

The removed fuel nozzles can be cleaned and calibrated on site. Fuel nozzles should be stored in sets for use at the next inspection.

Hot Gas Path Inspection

The Hot Gas Path inspection includes the Combustion Inspection just described and, in addition, a detailed inspection of the turbine nozzles and turbine buckets. To perform this inspection, the top half of the turbine case (shell), and the first-stage nozzle must be removed. The second-stage nozzle, the third-stage nozzle, and the turbine buckets will be inspected visually while still in place in the unit. A complete set of turbine clearances should also be taken during any inspection of the hot gas path. Figure 1-5 shows the components involved in the hot gas path inspection.

As with the combustion inspection, it is recommended that replacement combustion liners, fuel nozzles and transition pieces be available for installation at the conclusion of the visual inspection. The removed parts can then be inspected at a qualified service facility and returned to stock for use during the next inspection. It is also recommended that the Hot Gas Path inspection be conducted under the technical direction of the GE Company Field Service Representative for accurate analysis of inspection data and most effective use of outage time.

Major Inspection

The Major Inspection involves inspection of all of the major "flange-to-flange" components of the gas turbine which are subject to wear during normal turbine operation. This inspection includes elements of the Combustion and Hot Gas Path inspections. In addition, casings are inspected for cracks and erosion, rotor and stator blades are to be checked for tip clearance, rubs, bowing, cracking, and warpages. Shrouds are checked for clearance, erosion, rubbing and build-up. Seals and hook fits of nozzles and diaphragms are inspected for rubs, erosion, fretting or thermal deterioration. The compressor and inlet are inspected for fouling, erosion, corrosion, and leakage. Bearings and seals are inspected for clearance and wear. All clearances are checked against their original values.

INSPECTION INTERVALS

It is important to develop a schedule of inspection intervals and maintenance procedures based on the utilization of the equipment and the experience accumulated during its operation. A schedule developed in this manner will result in minimum downtime and lowest overall maintenance costs.

Contact your GE Company representative for these intervals.

SPECIAL INSPECTIONS

Variable Inlet Guide Vanes Bushing Inspection

GE recommends the following procedure for inspection of inlet guide vanes for bushing wear:

Caution should be exercised to ensure that the inlet guide vane controls have been rendered inoperable during measurement and inspection. Failure to do so could result in injury to personnel.

With the gas turbine shut-down and the inlet guide vanes secured in the normally open position for loaded operation (84 degrees in most instances), use a dial indicator to measure motion normal to the vane chord. Position the indicator to read as close to the vane inner button as possible, then deflect the vane to both sides of the bushing clearance and record the full dial indicator reading. It is important to note that any residue in the clearance area be removed prior to measuring bushing clearances with the dial indicator.

Variable inlet guide vanes should be inspected for bushing wear according to a schedule as listed in Table 1-1. Special attention should be paid to the clearance limits as defined in the table. If any clearance measured is equal to or greater than that in the table, immediate action should be taken to replace the bushing(s).

On units fitted with chemloy bushings (GE drawing numbers 315A9681 and 339A9913) that do not exceed the wear limits specified, verify that the bushings are not loose in the inner segment holes. If bushings are loose or free to turn, re-stake the segments to tighten the bushing fit. Do not overstake, the inlet guide vanes should be free to actuate.

Customers should contact their local GE Power Generation Field Office for assistance in implementing these new inspection procedures and ordering the new design bushings as necessary.

Table 1-1. VIGV Bushing Inspection Schedule

Frame Size	VIGV	Bushing	Clearance Limits for Bushing Changeout (≥ inches)	Inspection Interval (Hours)
MS5001, 5002, 6001	403 Stainless Steel	158A7888, P004,5,6	0.050	5,000
MS5001, 5002, 6001	403 Stainless Steel	315A9681 or 339A9913	0.050	8,000
MS5001, 5002, 6001	GTD 450	315A9681 or 339A9913	0.075	16,000
MS7001, 9001	403 Stainless Steel 403 Stainless Steel GTD 450	158A7888 315A9681 (or 339A9913) 315A9681 or 339A9913	0.070 0.070 0.100	8,000 8,000 16,000

PARTS

GE Power Systems maintains a large volume of replacement parts to cover the requirements of gas turbine owners. The parts protection system is designed for rapid response; however, there are periods of heavy demand where certain parts may not be readily available for planned inspections.

It is strongly recommended that high probability parts be available on site prior to the start of inspections.

Spare and Renewal Parts sales personnel have responsibility for customer contact, to advise scheduling of maintenance parts and identify additional parts needs. Local Spare and Renewal Parts sales personnel can present operations spare parts recommendations and factor individual needs into gas turbine maintenance philosophy as well as to provide for planned maintenance parts, including time tables and making suitable recommendations concerning design improvements and modifications to improve reliability, maintainability or reduce operating cost. In addition gas turbine parts programs such as interchangeability, exchange plan, warehousing program, and repair and return policy can be identified.

- **Type of Fuel**
- **Starting Frequency**
- **Load Cycle**
- **Water or Steam Injection**
- **Environment**
- **Maintenance Practices**

Figure 1-1. Maintenance Factors.

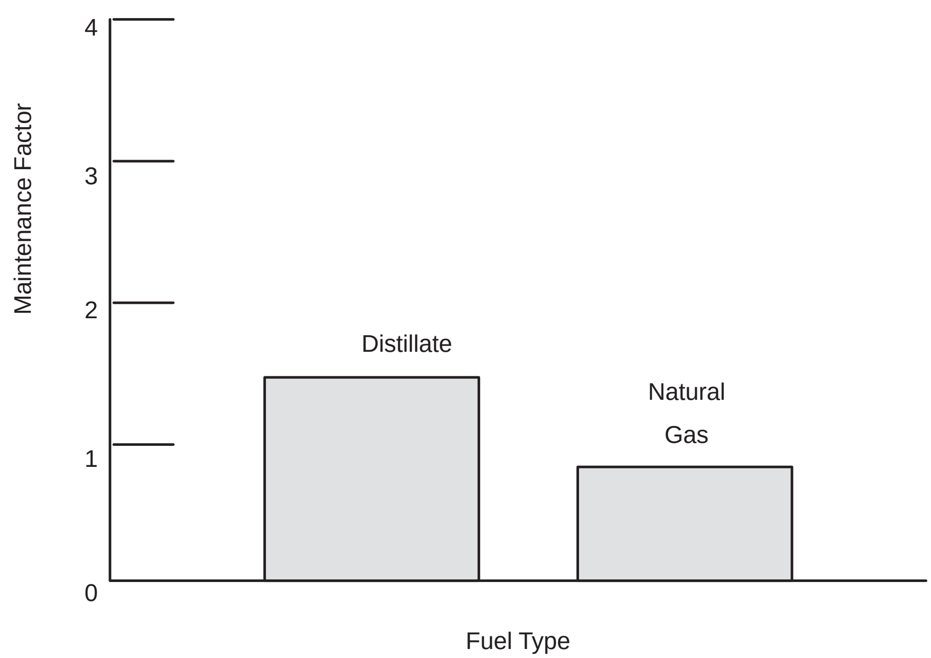


Figure 1-2. Effect of Fuel.

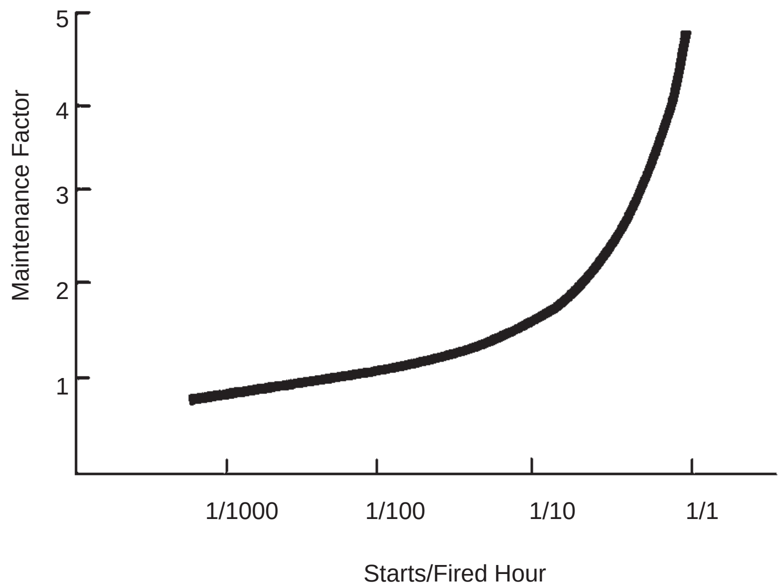


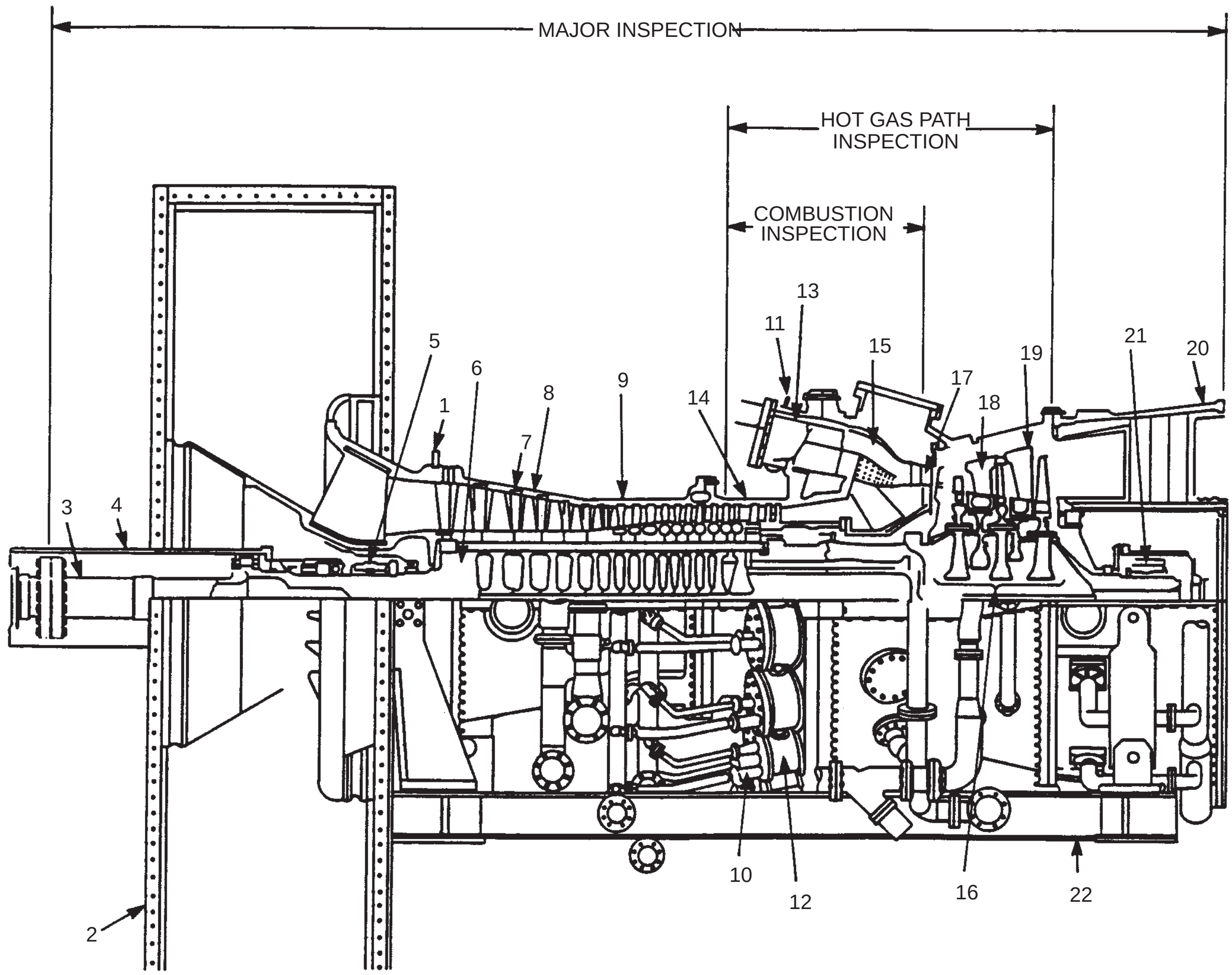
Figure 1-3. Effect of Starts.

TYPE OF INSPECTION	8-HOUR SHIFTS
Combustion	10
Hot Gas Path	22
Major	46

Assumptions

- No Repair Time — Replacement Only
- All Parts Available
- All Necessary Tools Available
- Crew with Average Trade Skill
- Flange-to-Flange *Turbine Only*
- Inspection Has Been Pre-Planned

Figure 1-4. Maintenance Inspections — Model Series 7001FA Estimated Outage Requirements



1 Variable IGV Arrangement
2 Inlet Plenum Assembly Output
3 Coupling
4 Output Coupling Guard Assembly
5 Compressor Inlet and No. 1 Bearing Case Assembly
6 Compressor Rotor Assembly
7 Compressor Stator Vane Arrangement
8,9 Mid Compressor Case Assembly
10 Fuel Nozzle Assembly
11 Spark Plug Assembly
12 Combustion Chamber Arrangement
13 Combustion Cap and Liner Assembly
14 Compressor Discharge Case Assembly
15 Combustion Transition Piece
16 Turbine Rotor Assembly
17 First Stage Nozzle Arrangement
18 Second Stage Nozzle Arrangement
19 Third Stage Nozzle Arrangement
20 Exhaust Frame Assembly
21 Number 2 Bearing Assembly
22 Turbine Base

Figure 1-5. Types of Shutdown Inspections.

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STANDARD PRACTICES

Standard Practices

GENERAL

At all times when performing work on a GE Gas Turbine the following general practices should be observed:

1. Keep complete records.
2. Remove and tag out electrical power from all systems/circuits upon which work is to be performed.
3. Disable unit's fire protection system and provide an alternate means of fire protection while this system is disabled.

****WARNING****

Fire suppressant, in a concentration sufficient to extinguish fire, creates an atmosphere that will *not* support life. It is extremely hazardous to enter the compartment after the CO_2 system has discharged. Anyone rendered unconscious by fire suppressant should be rescued as quickly as possible and revived immediately with artificial respiration or by mouth-to-mouth resuscitation. The extent and type of safeguards and personnel warnings that may be necessary must be designed to meet the particular requirements of each situation. It is recommended that personnel be adequately trained to cope with such an emergency.

4. Purge the turbine of potentially hazardous fumes, before opening casings, by operating the unit at crank for 5 minutes, with all fuel shut off and purged. Use extreme care to isolate and vent gas fuel systems.
5. Clean all removed parts, and fasteners and store in separate containers, tagged to simplify reassembly. (See Gas Turbine Cleaning in this section for cleaning methods.)

6. Use penetrating oil prior to bolt removal. (Refer to recommended solvents, sealers, cleaners, etc. in this section for listing of acceptable penetrating oils.)

7. Protect all casing flanges from rust and mechanical damage after removal. Grease, layout dye or commercial rust inhibitors will retard flange rusting and plywood, masonite, or equal will prevent mechanical damage.

8. Deburr mating surfaces and eliminate flange face high spots before assembling any casings. Carborundum stones and flat mill files are effective for these tasks.

9. Cover all open pipe and tubing. Do not stuff rags in pipes. Sheet metal or plywood are effective covers for large pipes and duct tape will protect tubing.

10. Never use pipe wrenches or pliers on tube fittings.

11. Do Not Reuse Gaskets — unless specifically instructed to do so in the procedures.

12. Do not reuse lockplates internal to the unit or those noted with a double asterisk (**).

13. Match mark piping, fuel nozzles, couplings and casings to assist in proper orientation during reassembly.

14. Do not mark on any combustion system or turbine components with any compounds containing lead. Carters Marks-A-Lot, black or blue, Dixon Company black or blue, Everhard Faber #7500 Water Color, black, Dykem Company dark blue, Dykem DSL, light blue, Dykem DMP, high spot blue, Dykem 107, Joseph Dixon lead free yellow lumber crayons, Wallace Pencil Company #800 black marker, Machine Manufacturing Company Marco S-1141 black and Marco S-1141 white are recommended and approved markers. Nickel base alloys are subject to attack when heated in the presence of sulfur, lead and other metals. These materials can cause embrittlement and cracking at elevated temperatures. Some common sources of these compounds are paint, markers and machining oil. Use of tags wired to the parts (avoid aluminum or other low melting point alloys), and markers certified free of injurious materials can eliminate this source of contamination.

15. Observe the following general precautions when the unit is undergoing major inspection, maintenance checks and taking clearance readings.

    a. Axial readings must be taken with the rotor positioned in contact with the active face of the thrust bearing. Any pressure applied in moving the rotor should be released prior to taking rotor position or clearance measurements.

    b. Parallel bars and feeler stock, when used with proper attention to detail, provide good measurements. In order to obtain proper measurement accuracy, the total thickness of the parallel bar and feeler stock must be measured with a micrometer.

    c. Snap gauges may be used to obtain measurements when proper attention is applied to the gauge orientation. Snap gauges used on bevel surfaces will result in inaccurate readings.

    d. The use of taper gauges is not recommended because the pointed end of the gauge often “bottoms” on an internal curved surface before an accurate reading can be obtained. This gauge should not be used to take radial clearances.

e. Never rotate the unit rotor when the unit is undergoing inspection and maintenance checks without adhering to the below listed precautions.

(1) Thrust bearing must be fully assembled in unit.

(2) Lubricant from unit lube system should be applied to journals.

(3) Check close clearance areas for potential interference and foreign object damage.

(4) Warn personnel working on unit.

16. To properly tighten new Swagelock stop-collar fittings, snug the nut by hand after cleaning threads. Then tighten the nut until the stop-collar just stops turning.

17. Anti-Seize Compound

a. Anti-seize compound shall be applied on all rotor and stator bolting threads, dowels, rabbets and sliding fits (internal and external).

External bolting threads for mounting associated equipment, pipe flanges, ductwork etc. Also apply on vertical flange faces of the top halves of outer casings that may be subject to removal for maintenance.

Note: This usage must be restricted to a thin film such that the compound is not forced into the inner gas path. Should this occur, it must where possible, be carefully removed.

b. Do not apply anti-seize compound to pipe threads or bolting threads internal to oil or water tanks.

18. Sealing Compound

a. Loctite Pipe Sealant with Teflon should be used on all pipe thread joints. The pipe thread must be clean and free of foreign material before applying the sealant. Follow instructions on container.

b. Loctite Pipe Sealant with Teflon is to be used on all threaded connections to cast iron castings, after control filters, and in areas over 500°F.

Apply to the male threads so that the first thread is free of any compound.

When a fitting is removed, the female threads shall be cleaned to remove all loose particles of compound.

19. Joint Compound

a. Joint compound shall not be used on machined joints except as follows:

(1) For compressor and turbine casings apply Perfect Seal only on the surface of horizontal joint and only for a distance of one (1) inch on both sides of the four (4) way joint. The Perfect Seal *shall not be applied* on the surface of the vertical joint.

(2) Instant Seal Locktite Plastic Gasket shall be used on all bolted *oil* to *air* joints (vertical and horizontal) that are not gasketed and on plug openings. This includes, but is not limited to, bearing housings, continuously lubricated coupling guards and stationary oil seals.

Instant Seal Locktite Plastic Gasket *shall not be used* on vertical joints of non-bolted stationary oil seals.

b. Joint compound shall not be used on sheet metal joints except as follows:

(1) Gasket tape used between exhaust skin, or plenum joints shall be coated on both sides with perfect seal.

(2) Silicone rubber adhesive sealant shall be used between non-gasketed joints of inlet hoods or plenums. It shall be applied as a continuous bead of minimum of 0.25 wide and shall be tangent to the outboard edges of the flange bolt holes.

20. Piping Flanges

a. Pipe flanges must not be forced into alignment. If flanges cannot be brought to within 1/8 in. of parallel by hand, the piping should be reformed or replaced. When the flanges are parallel with a new gasket in place, insert the bolts by hand. Do not pry on the flanges. Use anti-seize compound on the bolts. Tighten the bolts in three stages on alternately opposite bolts.

21. Bolt and Stud Torquing

a. Before torquing, remove foreign matter from bolt, nut and bolting surfaces.

b. Apply anti-seize compound to bolt and nut threads and bearing surfaces.

c. Tighten bolt/or nut to be sure threads are free, then back off until free from surface. Snug against surface and torque to values shown on drawing 248A4158, which is located in the Gas Turbine Maintenance tab of the Service Manual.

d. When using impact wrenches, torque to values on drawing 248A4158. Item 21-c. above does not apply to impact wrenching.

22. Classification of Joints

a. All classes of joints (oil tight, air tight and for frame rigidity) with metal to metal contact shall have their bolt or stud elongation determined by micrometer measurements, torque wrench or by head rotation. See drawing 248A4158, which is located in the Gas Turbine Maintenance tab of the Service Manual.

b. All gasket joints shall have their bolt and stud elongation determined by micrometer measurements or torque wrench. See drawing 248A4158, which is located in the Gas Turbine Maintenance tab of the Service Manual.

c. To insure air tight joints there must be a 50% contact over the critical area. Burrs and high spots must be removed before assembly.

d. To insure an oil tight joint, a line of continuous contact, with 0.25 in. minimum width, must be maintained, in addition to 50% contact over the critical area. The 50% contact must be equally distributed over the critical area. See Figure 2–1.

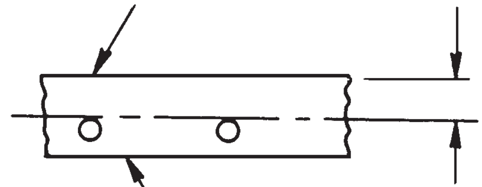

Figure 2-1. Typical Flange Joint Makeup

RECOMMENDED SOLVENTS, SEALANTS AND CLEANERS

****WARNING****

Most solvents, sealants and cleaners are flammable at elevated temperatures. Read and observe manufacturer's precautions on substance. Do not substitute gasoline or unknown substances for the following recommended items.

GE Company normally supplies lubricants, solvents, and sealants as part of the loose parts for turbine installation. The listing below includes special items recommended for use during maintenance operations. All may be procured locally or from the manufacturer.

NAME	DESCRIPTION OR APPLICATION	REFERENCE
Dux Seal	Non-hardening adhesive plastic compound.	158A2557P1
Petrolatum	Used on compartment door gaskets to prevent sticking.	118A449P4 Atlantic Richfield, Gulf Oil, Humble Oil or equivalent.
RTV102 Adhesive	Silicone rubber sealant white paste.	GE Co.
RTV106 Adhesive	Silicone rubber sealant. Good for high temperature areas red paste.	GE Co.
Locktite Pipe Sealant with Teflon	Used on all pipe thread joints.	118D5700
Locktite Plastic Gasket #47	Oil to air sealing joints.	226A1482P1

NAME	DESCRIPTION OR APPLICATION	REFERENCE
Never Seeze	Bolting antiseize compound, low temp.	248A5801
Perfect Seal	Gasket sealing compound.	K9692676
Contact Cement	Exhaust system.	226A2449
Rubber Cement	Heat exchanger head gaskets.	248A5557P1
Paint	High temperature aluminum silicone.	262A3194P1
Paint	Rust inhibitive beige primer. Water reducible	262A3195P1
Thinner 1500 Alkyd Resin 05B7A	High temperature aluminum paint.	GE Co.
Thinner Carboline 33	Exhaust system paint thinner for CarboZinc 11 Grey.	Carboline Co. 32 Hanley Ct. St. Louis, Mo. 63122
Primer Carbo Zinc Grey	Exhaust system paint.	Carboline Co. 32 Hanley Ct. St. Louis, Mo. 63122
Galvanizing Paint	Unit walkways.	211A8426
Uniroyal Industrial Adhesive Rubber Cement #6128	Apply on heat exchanger head gaskets.	248A5557P1
Sealing Fiber Adaco	Sealing fiber for use in electrical conduits.	256A1201P4
Adaco #1 Sealing Compound	Sealing compound for use in electrical conduits.	256A1200P4
Adhesives	Quick setting type suitable for outdoor environments.	158A7228P1
3M2121 Strip Caulk	Unit lagging, soft, nonhardening sealer.	156A1563P2 or P1
Moreland Chemical Co. Sodium Silicote Adhesive	Heavy grade adhesive paste.	239A5612P19
Vimasco 136	Canvas lagging adhesive.	248A5660P1
Zyglo ZL22	Fluorescent penetrant, for crack check.	From Magnaflux Corporation (Chicago, Ill.)
Plus Gas Formula “A” Dismantling Fluid	Penetrating oil.	From Dockrell Agencies (Scarborough, Ontario — Canada)

NAME	DESCRIPTION OR APPLICATION	REFERENCE
WD-40	Penetrating oil.	WD-40 Company 1061 Cudahy Place San Diego, CA 92116
Kano “Kroil”	Penetrating oil.	From KANO Laboratories, Inc. (Nashville, Tenn.)
Stoddard Solvent	Cleaning solvent (petroleum spirits).	Standard Oil of Ohio Cleveland, OH 44115
Exxon Varsol I	Cleaning solvent (petroleum spirits).	Exxon Company Pelham, NY 10803
Exxon Varsol 18	Cleaning solvent (petroleum spirits).	Exxon Company Pelham, NY 10803
Boron Fast Dry 3137	Cleaning solvent (petroleum spirits).	Standard Oil of Ohio Cleveland, OH 44115
Multicleaner No. 44	Cleaning solvent (petroleum spirits).	Eastern Chemicals Co., Albany, NY
Turco Cold Spray	Rust Inhibitor.	Turco Products Co. Patterson, NJ
Victaulic Lubricant (Soap Base)	Used to lubricate Dresser type coupling pipe ends and rubber seal lips inside and outside diameters.	Victaulic Co. of America 3100 Hamilton Blvd. South Plainfield, NJ 07080
Heat Transfer Compound, Grade Z-80	Used in VTR temperature regulating valve wells.	235A6987

Anti-Seize Compound, High Temperature

GE Company Design Engineering and Materials Engineering has evaluated Fel-Pro C-102, Nickel-Ease, N5000 (Fel Pro products) and Teutonic Power Tool’s 0505 as acceptable anti-seize compounds. Although the four compounds listed above are recommended, use of any other anti-seize compounds is acceptable provided they meet the guidelines given in Table 2-1.

A number of other commercially available compounds have been considered as replacements. However, many have low melting point elements such as aluminum, copper, or cadmium added in quantities that are detrimental to the mechanical properties of nickel and cobalt based alloys used in gas turbine parts (Reference 1). Therefore, the use of anti-seize compounds that contain any of these added low melting point elements is not recommended.

Table 2-1. Anti-Seize Chemical Constituent Guidelines

Element	Maximum Contents
Lead	25 ppm
Aluminum, Cadmium, Tin, Zinc, Silver, Tellurium, Selenium, Antimony, Bismuth, Mercury, Copper (present in the metallic state, not as oxides or other compounds)	300 ppm total; 100 ppm individual

LUBRICATION GUIDANCE

Lubrication frequency will vary, depending on turbine operating hours and ambient temperature. It is therefore suggested that the purchaser keep records of lubrication intervals to determine variances between periods listed on the chart and those scheduled for a specific installation. Refer to vendor supplied component instruction included in the System Description sections for maintenance lubrication requirements.

The lubricants listed do not exclude comparable products from other oil companies. Should the purchaser wish to use an alternate lubricant not mentioned, or recommended by the component manufacturer, approval must be requested from the component manufacturer, not the GE Company. The use of lubricant grades other than those recommended, should be first approved by the GE Company.

****WARNING****

> **Motor shaft *must* be stationary when relubricating.**

CAUTION

> Bearing and grease must be kept free of dirt.

GAS TURBINE COMPRESSOR CLEANING

See cleaning instructions included in Water Wash System Tab.

CAUTION

> Gas turbines operating with Dry Low Nox Combustion Systems should *not* use solid compounds for compressor cleaning.

TOOLS AND EQUIPMENT

The tools and equipment required to disassemble the gas turbine and repair it if necessary are listed below. The list of tools represent the typical quantities and kinds of tools that could be required for worst-case conditions. The list may be modified as dictated by availability. The special tools required are provided by the GE Company and are itemized in a tool list in the Parts Volume of this Service Manual.

Standard Tools

Hydraulic Torque Wrench (Plarod Torquing System or equivalent)

Socket Sets
(1) 1-inch drive
(1) 3/4-inch drive
(2) 1/2-inch drive
(2) 3/8-inch drive

Socket Set (12 Point)
(2) 1/2-inch drive sockets 1 inch
(2) 1/2-inch drive sockets 1 1/8 inch
(2) 1-inch drive sockets 1 1/2 inch
(2) 1-inch drive sockets 1 7/8 inch
(2) 1-inch drive sockets 2 1/4 inch

1 set box wrenches — open end — to 2 inches

1 set box wrenches 12 point 1 1/8 inch to 2 1/4 inch

Slugging wrenches 2 each — 1 1/2, 1 7/8, 2 1/4 inches

Slugging wrenches 12 point 1 1/2, 1 7/8, 2 1/4 inches

Miscellaneous
(2) 6-inch adjustable wrenches
(2) 8-inch adjustable wrenches
(2) 10-inch adjustable wrenches
(2) 12-inch adjustable wrenches
(1) 16-inch adjustable wrench
(2) 8-inch pipe wrenches
(2) 12-inch pipe wrenches
(2) 16-inch pipe wrenches

2 sets Allen wrenches to 1 inch

1 set straight Allen wrenches to 1 inch

Miscellaneous screwdrivers, pliers, wire cutters, chisels, files, punches, snap-ring pliers

Torque wrenches 0–100, 0–300, 0–600 foot-pounds.

Hammers
(2) 1-pound ball-peen
(2) 2 1/2-pound ball-peen

(1) 7-pound sledge
(1) 14-pound sledge

Mallet — plastic, rawhide

Pry bars
(2) 18-inch foot bars
(2) 6-foot pry bars

Carpenter’s level

Wood saw

2 Hacksaws with extra blades

Portapower — hydraulic jack set

(1) 10-foot measuring tape

Hand stones
4 coarse
4 fine

1 set of easy out (screw extractors)

1 set of taps and dies to 1 1/2 inches (1, 1-1/4, 1-1/2 x 8 thd)

Impact wrenches
(1) 1/2-inch drive with sockets
(2) 3/4-inch drive with sockets
(1) 1-inch drive with sockets

Electric or air drill with chuck to 1/2 inch with bits

(4) 50–foot air hoses with 1/2-inch “whips”

Air grinder with grinding wheels

Dial indicators
(1) Starrett “Last Word”
(1) Starrett Universal
(2) 0- to 1-inch indicator plus magnetic bases, arms and swivels

Micrometers
(1) 0–1 outside
(1) 0–8 outside (set)
(1) 2–8 inside (set)
(1) 0–6 depth

Feeler gauges
1 set 0.0015 to 0.030 12 inches long
2 sets 0.0015 to 0.030 4–6 inches long

1 Machinist’s level

1 Telescope gauge set

(1) 12-inch and (1) 18-inch machinist's scale

Mobile crane
50 tons at 25 feet radius — 45 feet high (71F unit RTR)
10 tons at 25 feet radius — 45 feet high from ground
(U.H. turbine casing)

Helicoil insertion tools

Engine-driven air compressor
90 psi with sufficient volume to drive impact wrenches

Oxyacetylene cutting outfit

Engine-driven welder

Chain hoists
(1) 10 ton
(1) 8 ton
(1) 3 ton

Comealong
(2) 1/2 ton
(2) 1-1/2 ton
(2) 3-1/2 ton

Eyebolts
(8) 1/2-13 shouldered
(8) 5/8-11 shouldered
(8) 3/4-10 shouldered
(4) 1-8 shouldered
(2) 1-1/2 — 6 shouldered

Eyebolts, special
(4) 1/2 - 13 x 12 inches
(4) 5/8 - 11 x 12 inches

Shackles
(4) 3/16- inch pin
(4) 1/4-inch pin
(4) 3/8-inch pin
(4) 1/2-inch pin
(4) 3/4-inch pin

Slings — cables
(4) 3/8 x 12 feet
(4) 1/2 x 12 feet
(2) 3/4 x 30 feet
(2) 3/4 x 3 feet

Screw jacks (as required) 25-ton minimum capacity.

Wood blocking
- 10 pieces 2 × 4 × 6 ft
- 10 pieces 4 × 4 × 6 ft

Rope
- 100 ft of $^{1}/_{2}$ in. diameter
- 100 ft of $^{3}/_{4}$ in. diameter

Expendables — See Recommended Solvents, Sealants, Cleaners, etc., in this section.
- 10 lb anti-seize
- 13 cans joint compound
- 3 rolls masking tape
- 6 rolls duct tape
- 14 marking pens, lead and sulfur free (Carter's Marks-A-Lot or equivalent)— see Standard Practices General Section.
- 100 wiping cloths
- 2 tubes Teflon thread sealant (liquid)
- Barrel of solvent
- Weather stripping glue

Miscellaneous items
- 100 ft work lights
- Fire extinguishers
- 100 ft extension cords
- Tote boxes
- Ladders
- Tie-on tags
- Gloves
- Tape writer
- Nitrogen cylinder, regulator, gauge and hoses

Special Tools — Typical For Gas Turbine (Model FA)

Note: Refer to the Tool Lists, line items A033 and 0104, in the parts volumes of the Service Manual for list of tools furnished for your unit(s).

The following Spare Parts Lists are Applicable to the MS7001FA+e Gas Only Units.

Note: Contact your local GE Service Representative for Information on the MS7001FA+ gas only units.

1.0 General Information

Combustion Inspection Consumable Items

This list includes parts such as bolts, nuts, gaskets, etc. that should be on hand to complete a Combustion Inspection. Typical parts included are fuel nozzles, combustion chambers, transition piece hardware, flame detectors, spark plugs, appropriate piping arrangements, and a visual inspection of the first stage nozzle.

Combustion Inspection Capital Items

This list includes items which should be on hand for each combustion inspection. The components in this list can be used to replace original parts (which may require wear repair) and help minimize outage time. Typical parts included are fuel nozzle tips or assemblies, combustion transition pieces, and combustion liners.

Hot Gas Path Inspection Items

This list includes those parts required in addition to the Combustion Inspection Consumable Items to perform a Hot Gas Path Inspection. Typical parts included are combustion casing, cooling and sealing air piping, first stage nozzle and support ring, bolt and dowel arrangement, enclosure assembly, and the exhaust plenum assembly

Major Inspection Items

This list includes those parts required in addition to the Combustion and Hot Gas Path Inspection Consumables to perform a Major Inspection. Typical parts included are bearing liners, consumables for the exhaust frame, compressor discharge case, inlet plenum and inlet duct arrangement and generator disassembly.

Capital Items

This list includes those items which are normally repaired/replaced in conjunction with the Hot Gas Path or Major Inspection. Typical parts included are inlet guide vanes, compressor stator and rotor blades, first, second and third stage buckets and nozzles, and the accessory and load couplings.

Ordering Parts

Spare and renewal parts orders for GE turbine parts should be placed with your GE Company Energy Services office. When ordering parts for the turbine or associated equipment, refer to instructions provided in the Parts Volume of your Service Manual.

GT Combustion Inspection Consumables

CATALOG NUMBER	PART DESCRIPTION	QTY
G070107	"CHAMBER ARR, CROSSFIRE TUBE,RETNR"	28
G07010A	"CHAMBER ARR, FLOW SLEEVE, BOLT"	56
G07010V	"CHAMBER ARR, SPARK PLUG, GASKET"	3
G07010Y	"CHAMBER ARR, FLAME DETECTOR, GASKET"	4
G0701101	"CHAMBER ARR, FLOW SLEEVE, STOP/SHIM"	42
G07011A	"CHAMBER ARR, FLAME DTCTR, MNTNG BLT"	4
G07012G	"CHAMBER ARR, FLOW SLEEVE, MNTNG SCR"	12
G07012G	"CHAMBER ARR, FLOW SLEEVE, MNTNG SCR"	12
G070174	"CHAMBER ARR, XFIRE ASSY,PKG RNG"	56
G07018V	"CHAMBER ARR,FUEL NOZZ,MTNG BLT,SHRT"	1
G070191	"CHAMBER ARR, COMB CASE AFT,BOLT"	70
G0701A7	"CHAMBER ARR, SPRK PLG CVR MTNG,SCRW"	2
G0701C4	"CHAMBER ARR, TRNS PC,RING–SEAL"	14
G0701EM	"CHAMBER ARR, XFIRE TUBE RTNR,BOLT"	34
G0701G4	"CHAMBER ARR, SPARK PLUG,WASHER"	8
G0701G5	"CHAMBER ARR, FLAME DET MTG, WASHER"	20
G071701	"TRNS PC ARR,FWD MNT SPPRT,BULL HORN"	14
G07170D	"TRNS PC, FWD MNT SPRT BLT (HRN/BLK)"	28
G07170G	"TRNS PC ARR, FWD MNT SPPRT LCKPLT"	14
G07170J	"TRNS PC, FWD MNT SPRT BLT (BLK/CSG)"	28
G071719	"TRNS PC ARR, SEAL,SIDE"	14
G071727	"TRNS PC ARR, FWD MNT SPRT LKPLT"	14
G07191J	"CASE ARR, COMB–OTR, BOLT, AFT MOUNT"	93
G07191M	"CASE ARR, COMB–OTR, GASKET–AFT"	14
G071944	"CSE, CMB–OTR, INSERT FWD CSNG FLNG"	105
G071946	"CSE, CMB–OTR, PIN, COMB CSG\O WRAP"	7
G071947	"CSE, CMB–OTR, INSERT XFIRE TUBE FLG"	42
G092404	"PP AR, AIR EXTR,GSKT,AIR EXTR VLV"	16
G09242D	"PP AR, AIR EXTR, MANIFOLD"	5
G09242G	"PP AR, AIR EXTR, NZL/A.A.CONN"	14
G09242P	"PP AR, AIR EXTR, BOLT, MNFLD FLNG"	10
G09242Y	"PP AR, AIR EXTR, BOLT, PIGTAIL"	45
G09243434	"PP, AIR EXTR, GASKET, SPIRAL–WOUND"	42
G092437	"PP AR, AIR EXTR, BOLT,NZL/PGTL PIPE"	4
G09246559	"PP, AIR EXTR, NUT, SELF–LOCKING"	48
G09246562	"PP, AIR EXTR, NUT, SELF–LOCKING"	84
G096207	"PP ARR, GAS TRBN, GSKT, PGTL/ MNFLD"	2
G096207	"PP ARR, GAS TRBN, GSKT, PGTL/ MNFLD"	2

G09620A	"PP ARR, GAS TRBN, GSKT, MNFLD & PRG"	2
G09620A	"PP ARR, GAS TRBN, GSKT, MNFLD & PRG"	2
G096217	"PP ARR, GAS TRBN, BOLT FUEL NOZ"	8
G096217	"PP ARR, GAS TRBN, BOLT FUEL NOZ"	5
G09621J	"PP ARR, GAS–TRBN, BOLT PIGTAIL"	12
G09621J	"PP ARR, GAS–TRBN, BOLT PIGTAIL"	20
G09621S	"PP ARR, GAS TRBN, BOLT, MNFLD FLNG"	4
G09621S	"PP ARR, GAS TRBN, BOLT, MNFLD FLNG"	4
G09622P	"PP ARR, GAS TRBN, BOLT, SPPRT CHNL"	7
G09622S	"PP ARR, GAS TRBN, NUT, SPPRT CHNL"	5
G09623432	"PP ARR, GAS TRBN, GASKET"	10
G09623432	"PP ARR, GAS TRBN, GASKET"	18
G09626027	"PP ARR, FUEL GAS, BOLT"	2
G09626030	"PP ARR,GAS TRBN,BOLT HX HD"	34
G09626559	"PP ARR, GAS TRBN, NUT,SELF–LOCKING"	12
G09626559	"PP ARR, GAS TRBN, NUT,SELF–LOCKING"	24
G09626J	"PP ARR, GAS, PRM MNFLD, BOLT"	8
G09626J	"PP ARR, GAS, PRM MNFLD, BOLT"	15
G096274	"PP ARR, GAS, SCN MNFLD/NOZZ, GASKET"	42
G096278	"PP ARR, GAS, SCN, PIGTAIL, NUT–LOCK"	20
G096278	"PP ARR, GAS, SCN, PIGTAIL, NUT–LOCK"	56
G09627J	"PP ARR, GAS, SCN MNFLD, BOLT"	13
G0962D3	"PP ARR, GAS, QTN, PIGTAIL, GASKET"	10
G0962D3	"PP ARR, GAS, QTN, PIGTAIL, GASKET"	4
G09693435	"PP, BSE INTCN, GASKET, SPIRAL–WOUND"	9
G09696051	"PP, BSE INTCN, BOLT, HEX HEAD"	10
G09696559	"PP, BSE INTCN, NUT, SELF–LOCKING"	28
G112100	"DTCTR, FLME (28FD), ASSEMBLY"	4
G12140A	"SPRK PLG ASM, LOCKWASHER"	8
G12140J	"SPRK PLG ASM, GASKET"	4
G121431	"SPRK PLG, BALL JOINT, IGNITER"	2

GT Combustion Inspection Capitals

CATALOG NUMBER	PART DESCRIPTION	QTY
G051202	"FUEL NOZZLE ASSY, GAS FUEL"	14
G07016S	"CHAMBER ARR, XFIRE–MALE,TUBE"	14
G07016V	"CHAMBER ARR, XFIRE OUTER,TUBE"	14
G07016Y	"CHAMBER ARR, XFIRE–FEMALE,TUBE"	14
G070200	"TRANS PC ASM, COMB, ASSEMBLY"	14
G070301	LINER ARRANGEMENT	1
G072200	"DRY LOW NOX, CAP ASSEMBLY"	14

GT Hot Gas Path Inspection

CATALOG NUMBER	PART DESCRIPTION	QTY
G0705ME	"CASE ARR, TURB, GSKT, ACCESS COVER"	4
G0705MH	"CASE ARR, TURB, BLT, ACCESS CVR–SML"	26

G0705MJ	"CASE ARR, TURB, GSKT, ACCSS CVR–SML"	4
G0705N1	"CASE ARR, TURB, BOLT, ALY STL 12 PT"	7
G0705N4	"CASE ARR, TURB, NUT, 12 POINT NUT"	7
G09090V	"PP ARR,C&SA, BLT, CMP BLD MNFLD"	4
G09093324	"PP ARR C&SA, PLATE,LOCKING,NUT&BOLT"	32
G09093325	"PP ARR C&SA, PLATE,LOCKING,NUT&BOLT"	96
G09093415	"PP ARR C&SA, GASKET,SPIRAL–WOUND"	8
G09093417	"PP ARR C&SA, GASKET,SPIRAL–WOUND"	8
G09093418	"PP ARR C&SA, GASKET,SPIRAL–WOUND"	38
G09093419	"PP ARR C&SA, GASKET,SPIRAL–WOUND"	8
G09093435	"PP ARR C&SA, GASKET,SPIRAL–WOUND"	4
G09096025	"PP ARR C&SA, BOLT,HEX HEAD"	1
G09096026	"PP ARR C&SA, BOLT,HEX HEAD"	7
G09096029	"PP ARR C&SA, BOLT,HEX HEAD"	13
G09096030	"PP ARR C&SA, BOLT,HEX HEAD"	7
G09096044	"PP ARR C&SA, BOLT,HEX HEAD"	7
G09096045	"PP ARR C&SA, BOLT,HEX HEAD"	13
G09096050	"PP ARR C&SA, BOLT,HEX HEAD"	23
G09096064	"PP ARR C&SA, BOLT,HEX HEAD"	20
G09096101	"PP ARR C&SA, BOLT,HEX HEAD"	11
G09096557	"PP ARR C&SA, NUT,SELF–LOCKING"	1
G09096558	"PP ARR C&SA, NUT,SELF–LOCKING"	10
G09096559	"PP ARR C&SA, NUT,SELF–LOCKING"	42
G09096562	"PP ARR C&SA, NUT,SELF–LOCKING"	29
G09097V	"PP ARR C&SA, BOLT, 9TH STG BFLY VLV"	10
G09152T	"PP AR, CLNG WTR, FLX HS, BS/MNFLD"	2
G09152V	"PP ARR, CLNG WTR, GASKET, HS/MNFLD"	6
G130551	"TRBN RTR, STG 1, BUCKET LOCKWIRE"	1
G130552	"TRBN RTR, STG 2, BUCKET LOCKWIRE"	1
G130553	"TRBN RTR, STG 3, BUCKET LOCKWIRE"	1
G14011G	"NOZZ 1ST–STG, HOR HLD DWN CLMP BOLT"	1
G14011J	"NOZZ 1ST–STG, HOR HLD DWN CLMP LKPL"	4
G14013R	"NOZZ 1ST–STG, BOLT, CLMP OTR SPPRT"	8
G14013X	"NOZZ 1ST–STG, LKPLT, CLMP OTR SPPRT"	2
G14014G	"NOZZ 1ST–STG, RTNG RING BOLT"	1
G14014J	"NOZZ 1ST–STG, RTG RNG WIR–LK INSERT"	42
G14014M	"NOZZ 1ST–STG, RTG RG WIR–LK BLT INS"	1
G140154	"NOZZ 1ST–STG, BOLT, KEY, LOCTNG"	2
G140157	"NOZZ 1ST–STG, LCKPLT, KEY, LOCTNG"	2
G14030D	"SPPRT RNG, 1ST–STG, RNG MNT BOLT"	1
G16045Y07	"B&D ARR, STUD, DSCH CS/TRB SHL–JNT"	1
G1604XI	"BLT & DWL (B &D) ARR, WASHER"	36

GT Major Inspection

CATALOG NUMBER	PART DESCRIPTION	QTY
G07066G	"EXHST FRM, INSERT OUTER CASING"	96
G080104	"CASE–CPR INLT&1BRG,STAT OIL SEAL"	1

G080107	"CASE–CPR INLT&1BRG,LINER ASSEMBLY"	1
G08010D	"CASE–CPR INLT&1BRG,AIR DEFLECTOR"	1
G08013P	"CASE–CPR INLT&1BRG,OIL SEAL – AFT"	1
G08013R	"CSE–CPR INLT&1BRG,OIL SEAL –INR AFT"	1
G080151	"CSE–CPR INLT&1BRG, SEAL THR BRG–FWD"	1
G080154	"CSE–CPR INLT&1BRG, SEAL THR BRG–AFT"	1
G080201	"CMP CASE–FWD, HOR JOINT BOLT"	2
G080205	"CMP CASE–FWD, HOR JNT STUD –BDY BND"	1
G08050Y	"CASE–CPRSR DISCH,INNER CASE SCREW"	3
G08120V	"CASE, INLET BRG #1, BOLT"	1
G081214	"CASE, INLET BRG #1, BOLT"	3
G081270	"CASE, INLET BRG #1, HARDWARE KIT"	1
G081271	"CASE, INLET BRG #1, BOLT"	9
G081277	"CASE, INLET BRG #1, STUD–BB"	1
G08127G	"CASE, INLET BRG #1, PIN"	2
G08127M	"CASE, INLET BRG #1, INSERT"	9
G08127P	"CASE, INLET BRG #1, INSERT"	1
G081281	"CASE, INLET BRG #1, INSERT"	2
G081284	"CASE, INLET BRG #1, INSERT"	3
G08128J	"CASE, INLET BRG #1, PIN"	1
G090541	"PP LO FD&DRN, GSKT, BRG1 DRN PIPE"	2
G090544	"PP LO FD&DRN, BOLT, BRG1 DRN PIPE"	3
G090548	"PP LO FD&DR, LKWSHR, BRNG1 DRN PIPE"	12
G09057A	"PP LO FD&DR, LKWSHR, BRNG1 FD PIPE"	16
G09057D	"PP LO FD&DR, O RING, BRNG1 FD PIPE"	4
G09057G	"PP LO FD&DR, SCREW, BRNG1 FD PIPE"	4
G09058D	"PP LO FD&DR, O RING, BRNG1 LIFT OIL"	6
G09058G	"PP LO FD&DR, SCREW, BRNG1 LIFT OIL"	5
G09242S	"PP AR, AIR EXTR, BOLT, CS EXTR FLNG"	7
G09242V	"PP AR, AIR EXTR, CS EXTR FLANGE"	6
G095301	"PPNG ARR,GSKT,HRZNTL JT WTR WSHMFD"	6
G097201	"PPG ARR, EX FR CLG, LKPL, CSNG FLNG"	64
G09720J	"PPG ARR, EX FR CLG, BOLT, CSNG FLNG"	13
G09721A	"PPG ARR,EX FR CLG,BOLT–U,MNFLD/BRKT"	1
G097227	"PP AR, EX FR CLG, GSKT, FLX HSE"	16
G09722A	"PP AR, EX FR CLG, BLT, FL HSE/MNFLD"	13
G09722J	"PP AR, EX FR CLG, BOLT, MNFLD FLNG"	15
G09723419	"PPG ARR, EX FRM, GASKET"	1
G09723420	"PPG ARR, EX FRM, GASKET"	6
G09724908	"PPG ARR, EX FR CLG, FLNG, PIPE–SLIP"	1
G09726007	"PPG ARR, EX FRM, BOLT"	2
G09726063	"PPG ARR, EX FRM, BOLT"	5
G0972626114	"PPG ARR,EX FR CLG, BOLT–U"	1
G09726557	"PPG ARR, EX FRM, NUT"	4
G09726558	"PPG ARR, EX FRM, NUT"	13
G09726562	"PPG ARR, EX FRM, NUT"	17
G09726614	"PPG ARR, EX FRM, WASHER, PLAIN"	2
G13052V	"ROTOR, TRBN, SHFT, WHL–AFT,PLT–RET"	1
G13052Y	"ROTOR, TRBN, SHFT, WHL–AFT,PLT–LKG"	6

G130531	"ROTOR, TRBN, SHFT, WHL–AFT,PLT–BLT"	12
G131111	"GRD CPL–OUTPT, BOLT, HEX HEAD"	8
G131114	"GRD CPL–OUTPT, BOLT, HEX HEAD"	2
G131115	"GRD CPL–OUTPT, NUT"	2
G14026Z	"NOZZ STG–2, DIAPH AIR INJ SET–SCREW"	10
G140317	"SPPRT RNG, 1ST–STG, SCRW–HOR JNT"	6
G14031G	"SPPRT RNG, 1ST–STG, INSRT–H JNT SCR"	2
G150201	"BRNG ASM,NO 2, LINER ASSEMBLY"	1
G15022D	"BRNG ASM,NO 2, STRAP MTG LCK PLT"	2
G15024S	"BRNG ASM,NO 2, SHIM–HOR LCK PLT"	2
G15026G	"BRNG ASM,NO 2, DEFLECTOR, FWD"	1
G150701	"BRNG ARR, THRST–HP, SHIM (LOADED)"	1
G150707	"BRNG ARR, THRST–HP, BRNG (LOADED)"	1
G15070A	"BRNG ARR, THRST–HP, BRNG (UNLOADED)"	1
G15070D	"BRNG ARR, THRST–HP, SHIM (UNLOADED)"	1
G160401	"B&D ARR, BOLT, INLT/CMP CSNG"	12
G160404	"B & D ARR, DWL, INLET/FWD CMP CSNG"	2
G160407	"B & D ARR, BLT, FWD/AFT CMP CASE"	4
G16040F	"B&D, BLT,AFT CMP CSE/DSCH CSE, SHRT"	1
G1604B1	"B&D ARR,BOLT,EXH FRME/EXH PLNM ASM"	18
G1604B4	"B&D ARR,GSKT,EXH FRME/EXH PLNM ASM"	1
G1604CY	"B&D ARR,BOLT,EXH FRAME/BRG HSG"	2
G1604DG	"B&D ARR,SHIM,HP OSPD TRIP"	1

GT Turbine Capitals

CATALOG NUMBER	PART DESCRIPTION	QTY
G070504	"CASE ARR, TURB, STG 1 SHROUD RNG ASM"	1
G070507	"CASE ARR, TURB, STG 2 SHROUD RNG ASM"	1
G07050A	"CASE ARR, TURB, STG 3 SHROUD RNG ASM"	1
G130101	"CMPRSR STATR, BLD–IGV"	64
G13014X	"CMPRSR STATR, VANE ARR, KIT –BLADES"	1
G13032S	"CMPRSR RTR, BLADE KIT"	1
G13052J	"ROTOR, TRBN, BUCKET KIT – 1ST STG"	1
G13052M	"ROTOR, TRBN, BUCKET KIT – 2ND STG"	1
G13052P	"ROTOR, TRBN, BUCKET KIT – 3RD STG"	1
G140100	"NOZZ 1ST–STG, ASSEMBLY"	1
G140200	"NOZZ 2ND STG, ASSEMBLY"	1
G140300	"SPPRT RNG, 1ST–STG ASSEMBLY"	1
G140900	"NOZZLE 3RD STG, ASSEMBLY"	1

INSERT

TAB

Auxiliary & Controls Systems Maintenance

Auxiliary and Controls Systems Maintenance

CONTENTS (PERIODIC INSPECTION SCHEDULE)

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Auxiliary and Controls Systems Maintenance

GENERAL

The maintenance procedures recommended in this section apply to a typical package power plant installation and do not pertain to any particular plant equipment model.

This section is subdivided into two subsections: the Periodic Inspection Schedule followed by Inspection and Maintenance Procedures. Although the subjects in each follow the same general order, not every item listed in the Inspection Schedule is mentioned in the Maintenance Procedures. Only those items which require special care, or which are not covered by manufacturer's instructions, are covered in the text portion.

Standard maintenance items, such as gauges, switches, valves, filters, etc., have been grouped under one heading in each subsection. Following this, the items have been grouped by system and major equipment categories.

In the Periodic Inspection Schedule, the "Inspect" column lists all the systems, components and devices on the gas turbine and generator that require inspection. In the "What to Inspect For" column, particular points of each item of inspection are listed as possible defective conditions that should be looked for and corrected.

For temperature and pressure settings, flow rates, calibration data, etc., plus detailed information on the inspection and maintenance of any device listed herein, the reader should also refer to the following documents in this Service Manual:

1. Schematic Piping Diagram
2. Diagram Device Summary
3. Control Specifications
4. Equipment Publications

The "Inspection Frequencies and Turbine Status" column specifies, by means of abbreviations, how often a device or assembly should be inspected and whether or not the turbine can be operating at the time of inspection. The left-hand letter(s) designate the frequency and the right specifies the turbine status. Following is a list of abbreviations used:

D —	Daily Inspection
W —	Weekly Inspection
M —	Monthly Inspection
Q —	Quarterly Inspection
SA —	Semiannual Inspection
CI —	Combustion Inspection
A —	Annual Inspection
HGP —	Hot Gas Path Inspection
Maj —	Major Overhaul Inspection
Yrs. —	Years
O —	Turbine Operating
S —	Turbine Shutdown

The recommended inspection frequencies and turbine statuses, specified in this column, are representative of an average power plant installation and include both peaking and continuous operating stations. They are not intended to cover all variations of equipment supplied and may depend upon station environment. (In some cases, a shutdown may be recommended solely as a precaution against possible injury to maintenance personnel, because the location of the component or device is in a hazardous area.)

The "Reference" column, in the Inspection Schedule, refers to those pages in the text which provide detailed inspection information on the device, assembly, or system under inspection. This column also refers to publications, issued by the GE Company which supplement the information in the text. These publications can be found under the system tabs in the Service Manual.

It is our intent that these instructions, with the help of a GE Field Service Representative, be used as an aid in the preparation of an individual maintenance program for each purchaser.

PERIODIC INSPECTION SCHEDULE

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
STANDARD MAINTENANCE ITEMS			
INSTRUMENTATION			
Pressure Switches and Gauges			IMP–1
	Damage	D — O	
	Reading in Error	D — O	
	Calibration	A — S	
Thermometers (Dial Type)			IMP–1
	Damage	D — O	
	Reading in Error	D — O	
	Calibration	A — S	
Flowmeters			IMP–1
	Leaking Seams and Joints	D — O	
	Calibration	A — S	

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
Vibration Detectors			IMP–2
	Stable Reading	D — O	
	Mounting Secure	A — S	
Liquid Level Indicators			IMP–2
	Reading in Error	D — O	
	High and Low Actuation Point	A — S	
Panel Meters			IMP–2
	Damage	D — O	
	Zero Reading	M — S	
	Calibration	A — S	
CONTROL DEVICES			
Temperature Switches			IMP–2
	Calibration Pickup and Dropout Setting	A — S	
Thermostats			IMP–2
	Calibration Setting	A — S	
Pressure Regulating Valves (VPR’s)			IMP–2
	Packing Leakage	M — O	
	Incorrect Setting	D — O	
Temperature Regulating Valves (VTR’s)			IMP–3
	Packing Leakage	M — O	
	Incorrect Setting	D — O	
HYDRAULIC/MECHANICAL EQUIPMENT			
Relief Valves			IMP–4
	Chattering and Leakage	M — O	
	Settings	A — S	
Solenoid Valves			IMP–4
	Leakage	M — O	
	Proper Operation	A — S	
Servovalves			IMP–4
	Verify proper torque (17–19 inch pounds)	A — S	
Orifices			IMP–5
	Erosion or Corrosion	A — S	
	Plugging, Orifice Deterioration	A — S	
	Sharp Edges or Irregular Chamfer	A — S	
Check Valves			IMP–5
	Leakage	SA — S	
	Corrosion	3 Yrs. — S	

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
Strainers,	Dirt, Scale	SA — S	
Filters, Lube and Fuel			IMP–5
	15 psi (1.03 bars) Maximum P	D — O	
	Leaking Seams and Joints	M — O	
	Dirty Element	SA — S or As Required	
Hydraulic Supply Filter			IMP–5
	60 psi (4.14 bars) Maximum P	D — O	
	Leaking Seams and Joints	M — O	
	Dirty Element	SA — S	
Air Filters			IMP–6
(Air Extraction Valve)	Moisture Accumulation	M — O	
	Dirty Filter	SA — S	
HEATING COOLING AND VENTILATION			
Air Conditioners			IMP–6
	Dirty Filter	W — O/S	
	Improper Thermostat Setting	W — O/S	
	Dirty Condenser Coil	A — O/S	
Space Heaters			IMP–6
	Improper Operation	A — O	
	Dirty Heating Elements, Blades and Louvers	A — S	
	Improper Thermostat Setting	A — O	
Accessory and Turbine			IMP–6
Compartment Vent Fans	Excessive Fan Wheel Wear	A — S	
	Vibration	A — O	
	Cleanliness	A — S	
	Mounting Security of Hardware etc.	A — S	
MOTORS, MOTORS AND PUMP COUPLINGS			
Motors			IMP–6
	Excessive Vibration	A — O	
	Dirty Louvers and Screens	A — O	
	Loose Mounting Bolts and Electrical Connections	A — S	
	Dirty Windings, Collector Rings, Commutator, Brush Rigging	A — S	
	Brush Condition	A — S	

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
Motor and Pump Couplings			IMP–7
	Loose Bolts and Grease Plugs	A — S	
	Evidence of Wear	A — S	
UNIT PIPING SYSTEMS			
(Fuel, Oil, Air, Water) Piping and Valves			IMP–7
	Leakage	D — O	
	Loose Hardware, Hangers and Clamps	M — O	
	Broken Supports	M — O	
	Vibration	M — O	
	Improper Valve Operation	M — O	
	Loose Valve Packing	M — O	
SYSTEMS MAINTENANCE ITEMS			
LUBE SYSTEM			
Lube Oil Pumps			IMP–7
	Excessive Noise	M — O	
	Wear Ring Clearance	Maj — S	
	Thrust Bearing Wear	Maj — S	
	Bearing Seal Wear	Maj — S	
Lube Oil Tank			IMP–7
	Peeling Paint	A — S	
	Loose Hardware, Fittings on Internal Piping and Tubing	Maj — S	
	Loose or Missing Hardware on Pipe Hangers and Clamps	Maj — S	
	Loose Hardware at Pump Intakes	Maj — S	
	Presence of Sludge and Unusual Foreign Matter in Bottom of Tank	Maj — S	
Lube Oil Properties			IMP–7
	Irregular Physical Properties of Lubricant Sample Taken from Tanks and Presence of Contaminants	M — S/O	
Heat Exchangers			IMP–7
	Improper Operation	M — O	
	Leakage	M — O	
	Contaminated Water	M — O	
	Plugging of Leaking Tubes	3 Yrs. — S	
Lube Oil Immersion Heaters			IMP–8
	Improper Operation	M — O	

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
Mist Eliminator (If Applicable)			IMP–8
	Excessive Pressure Drop Across Unit	M — O	
	Oil Vapor Leakage	M — O	
	Dirty Filter Element	M — O	
	Condition of Filter Element Fiber Bed	M — O	
Mist Eliminator Fan (If Applicable)			IMP–8
	Dirty Fan Housing	M — O	
	Loose Mounting Bolts	M — O	
	Excessive Vibration Noise	M — O	
Pipe Couplings			IMP–9
	Oil Leakage/Hardware Security	D — O	
	Seal Brittleness	A — S	
WATER SYSTEM (if applicable)			
Cooling System Checks			IMP–9
	System Fouled with Contaminants	Maj — S	
	Improper Water Flow	Maj — O	
	Incorrect Flow Versus Pressure Drop	Maj — S	
Water Tank			IMP–10
	Evidence of Tank Leakage	A — S	
	Improper Pressure Cap Setting	3 Yrs. — S	
	Poor Condition of Cap Gasket and Gasket Surface	M — O	
	Damaged Filler Neck	A — S	
	Dirt Inside Tank	A — S	
	Corrosion Inhibition	Q — S (Or Every Water Addition)	
Radiator Header Assemblies			IMP–8
	Leaking Seams and Joints	M — O	
	Corrosion and Erosion of Fins and Tubes	M — O	
	Damaged Parts	M — O	
	Cleanliness	A — S	
Anti-Freeze Protection			
	Improper Concentration	A — S	

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
Cooling Water Radiator Fan Module	Dirty Wheel Housing, Ducts and Screens	A — S	IMP–10
	Excessive Vibration Noise	A — O	
	Damaged Blades	A — S	
	Loose Mounting Bolts	A — S	
	Air Flow Obstructed	A — S	
	Rust, Corrosion and Peeling	A — S	
Cooling Water Pump			IMP–11
	Leakage Shaft Seal	M — O	
	Dirty Shaft Seal Cooling Water Line and Filter Element	A — S	
	Excessive Wear Ring Clearance	Maj — S	
	Excessive Mechanical Seal Wear	Maj — S	
FUEL GAS SYSTEM			
Gas Control Valve			IMP–11
	Gas Leakage at Stem, Packing Leak Off or Vent	M — O	
	Hydraulic Cylinder Rod Seal Leakage	M — O	
	Rough Operation	SA — S	
	Improper Operation of Trip Relay	SA — S	
	Damage Control Surfaces of Valve Plug and Seat	Maj — S	
	Trip Action with Loss of Hydraulic Trip Oil	SA — S	
SPEEDTRONIC Control Loop			Control Specification, Control Specification–Operating Instructions and Sequences and Control Specification–Control System Adjustments
	Valve Unstable, Slow Movement, Stroke Out of Specification, P2 in Error	D — O	
	Calibration, FCR Versus Stroke, Gas Control Valve	A — S	
	Speed Versus P2 Speed Ratio Valve, P2 Transducer Calibration, LVDTs Calibration	A — S	
	Electronic Trip action of 20FG and 20 HD	SA — S	
	Check 20FG for Proper Null Bias	SA — S	

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
HIGH PRESSURE CONTROL OIL SYSTEM HYDRAULIC SUPPLY			
Main Hydraulic Supply Pump			IMP–12
	Excessive Vibration or Unusual Noise	M — O	
	Improper Discharge Pressure	D — O	
	Relief Valve Leaking	A — O	
	Leakage at Shaft and Mounting Flanges	M — O	
Auxiliary Hydraulic Supply Pump			IMP–12
	Low Discharge Pressure	A — S	
	Leakage Around Shaft and Mounting Flanges	M — O	
	Excessive Vibration or Unusual Noise	M — O	
Hydraulic Supply Manifold			IMP–12
	Connections Loose or Leaking	A — S	
Air Bleed Valves			IMP–12
	Improper Air Bleed Valve Operation	A — S	
Accumulator			IMP–12
	Pre-charge Pressure	A — S	
	Accumulator Safety Disc	A — S	
Hydraulic System Piping			
	Leaking Pipe Connections		
	(All Other Units)	HGP — S	
INLET GUIDE VANE CONTROL SYSTEM			
Operation and Calibration			Control Specification, Control Specification–Operating Instructions and Sequences and Control Specification–Control System Adjustments
	Inlet Guide Vanes Proper Operation	D — O	
	Calibration	A — S	
	20TV Trip Servo Valve for Proper Operation	A — S	
	Check Trip Action of Inlet Guide Vanes with Loss of Hydraulic Trip Oil	SA — S	
	Check Operation and Sequencing of Compressor Bleed Valves	SA — S	
	Leakage in the System	M — O	

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
COOLING AND SEALING AIR SYSTEM			
Piping			IMP–13
	Orifice Plates	A — S	
	Orifice Unions	A — S	
	Leakage	D — O	
	Loose Hardware, Hangers and Clamps	M — O	
	Vibration	M — O	
Compressor Bleed Valve			IMP–13
	Sluggish Movement Open/Close	SA — S	
	Leakage	M — O	
Compressor Discharge Pressure Transmitter	Calibration	A — S	IMP–13
STARTING SYSTEM			
Starting (if applicable)			
	See Vendor’s Preventive Maintenance Procedure in Starting System Tab	90 Starts or Once per Year	
Starting Motor			IMP–13
	See Vendor’s Preventive Maintenance Procedure in Starting System Tab		
Starting Clutch			IMP–13
	Improper Clearance of Clutch Jaws at Engaged and Disengaged Positions	SA — S	
	Improper Operation of Limit Switch	SA — S	
	Worn Clutch Jaws	A — S	
Torque Converter			IMP–14
	External Oil Leaks at Shaft Seals, Bolted Flanges, Cover Plates	D — O	
Tubing Connections and Hydraulic Hoses	Leakage, Wear, Chafing and Abrasions	Q — O	
Ratchet System			IMP–14
	Oil Leakage	D — O	
	Dirt in Commutator	A — S	
	Faulty Pump	A — S	
FIRE PROTECTION SYSTEM			
System Package Lagging			IMP–14
	Leakage at Lagging	A — S	
	Open Joints Between Bases, Roof Joints and Door Fits	A — S	
	Pilot Operated Cylinders Show Improper Pressure at Gauges	A — S	

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
High Pressure System			IMP–15
	Ventilation Dampers Operate Freely and are not Obstructed	A — S	
High Pressure Storage Cylinders	Loss of Cylinder Weight	SA — S	IMP–15
Fire Detectors			IMP–15
	Improper Operation	A — S	
High Pressure System Solenoid Pilot Valve and "Puff" Tests			IMP–16
	Verification of Proper Operation of System	A — S	
	Ventilation Dampers Operate Freely and are not Obstructed	A — S	
Low Pressure (if applicable) CO_2 System Electric Release and "Puff" Tests			IMP–16
	Verification of Proper Operation of System	A — S	
	Ventilation Dampers Operate Freely and are not Obstructed	A — S	
SPEEDTRONIC CONTROL SYSTEMS (Refer to Control Systems Tab in the Operators Manual)			
	Control Specifications, Control System Settings		
	Control Specification – Control System Adjustments		
WATER INJECTION SYSTEM (if applicable)			
Systems Maintenance			Control Specifications Water Injection System Section
	Calibration Electronic Circuits	A — S	
	Calibration of Control Valve Circuits	A — S	
	Calibration of Flowmeter Circuits	A — S	
	Check Flowmeter Accuracy	3 Yrs. — S	
	Check Control Valve for Leakage	A — S	
	Check Stop Valve Operation	A — S	
	Check Stop Valve for Leakage	A — S	
	Check Forwarding Pump Oil Level	M — O	
	Check that Water Flow is per Control Specifications	D — O	
	Check Accumulator Pre-charge	A — S	
	Check Water Spray Nozzles — for Plugging and Spray Pattern	A — S	

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
STATION AUXILIARIES AND SERVICE			
Battery			IMP–22
	Improper Specific Gravity at Pilot Cell	M — S	
	Low Electrolyte Level at Pilot Cell	M — S	
	Loose and Dirty Connections	M — S	
	Damaged Containers and Cell Covers	M — S	
	Faulty Sealing or Missing Vent Plugs	M — S	
	Improper Specific Gravity and Low Electrolyte at any One Cell	A — S	
Battery Charger			IMP–22
	Dirty Charger	A — S	
	Voltmeter Out of Calibration	SA — S	
	Faulty Capacitors and Diodes	A — S	
MOTOR CONTROL CENTER			
Indicating Lamps			IMP–22
	Burned Out Lamps	M — O/S	
	Improper Operating Lighting Sequence	M — O/S	
Main Bus Insulators			
	Dirty Bus Insulators and Barriers	A — S	
Main Vertical Bus Joints and Main Bus Supports	Loose Connections	A — S	
Magnetic Contactors and Starters			IMP–23
	Dirty Contactors and Starters	A — S	
	Loose Connections	A — S	
	Contacts Welded Together, Worn and Arcing	A — S	
Magnetic Relays			IMP–23
	Dirt, Dust, Oil, Grease	A — S	
General Purpose Contactors			IMP–23
	Damaged Arc Chute	A — S	
	Improper Arcing Horn Clearances	A — S	
	Improper Armature Spring Adjustment	A — S	
	Weak Contact Pressure	A — S	
	Loose Screws, Nuts and Bolts	A — S	
General			
	Improper Closing and Latching of Control Panel Doors	A — S	
	Nameplates Missing	A — S	
	Cleanliness of Panel	A — S	

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
Starting Motor Limitamp Contactor (If Applicable)			IMP–23
	Loose Screws, Nuts and Bolts	A — S	
	Loose Electrical Interlocks	A — S	
	Contacts, General Condition	A — S	
	DC Magnet Assembly Alignment per Specs.	A — S	
	Collars on Each Side of Movable Power Tips for Proper Fit and Alignment	A — S	
	Accumulation of Dust, Dirt and Foreign Material on Contactor and Arc Chutes	A — S	
GENERATOR			
	For Inspection and Maintenance Procedures on the generator and its associated equipment, refer to the Generator Maintenance Section of the Service Manual.		
COLLECTOR COMPARTMENTS (if applicable)			
Fiberglass Expansion Joints	Loose Joints	M — O	IMP–23
	Accumulation of Dust and Dirt	M — S	
	Clogged Cooling Air Discharge Vents	M — O	
Generator Ends and Compartment Interfaces	Seals Damaged, or Not Watertight	M — O	
Collector Compartment Air Filters	Dirty Filters	A — S	
INLET SYSTEMS (TURBINE)			
Inlet Screen			IMP–24
	Obstructions	M — O	
Bypass Door			IMP–24
	Proper Seal	M — O	
	Limit Switch Operation	A — S	
Inlet Compartment Inlet Ductwork and Silencers			IMP–24
	Sealing	A — S	
	Cleanliness	A — S	
	Entrapped Material	A — S	
Inlet Guide Vanes			IMP–25
	Corrosion Pitting	A — S	
Moisture Separators (if applicable)			IMP–25
	Cleanliness of Media Section	M — O	
	Build Up on Blades	A — S	

Inspection	What to Inspect for	Inspection Frequency and Turbine Status	Document or Page Reference
Inlet Filtration System	Refer to the Maintenance Section of the Manufacturer's Operation and Maintenance Manual contained in Volume II.		
Evaporative Cooler (if applicable)			IMP–25
	Lubricate Motor	A — O	
	Tanks for Debris	A — S	
	Media Buildup	A — S	
	Nozzles Plugging	M — O	
	Spray Pattern	A — S	
	Clean Tank	A — S	
Water Flow Adjustment			IMP–25
	Proper Water Flow Media Wetness	D — O	
Pump Operation			IMP–25
	Secure Prior to Unit Shutdown	D — O	

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Inspection and Maintenance Procedures

CONTENTS

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Inspection and Maintenance Procedures

STANDARD MAINTENANCE ITEMS

Pressure Switches and Gauges

The setting of pressure switches and calibration of the gauges can be checked with a dead weight tester, a regulated source of clean, dry, compressed air or a nitrogen cylinder and a calibrated pressure gauge. The use of air pressure is generally more convenient and is recommended whenever the air pressure is sufficient to check the specified switch setting and gauge calibration. To avoid the possibility of oil contamination, it is preferable that air actuated switches and gauges not be tested with the dead weight tester.

CAUTION

Pressure gauges on heavy fuel lines have a medium-separation diaphragm to keep heavy fuel from solidifying in the sensing line. Removal of the pressure switch and loss of the fluid will damage the diaphragm or allow air into the system. Both events will cause the gauge or switch to read incorrectly.

Thermometers (Dial Type)

To calibrate a dial-type stem thermometer, immerse the sensor a minimum of two inches (5 cm) in an agitated bath maintained at a temperature between 1/2 and 3/4 of its full-scale reading or near the maximum temperature normally registered by that particular thermometer, if known. By means of an external adjusting screw, rotate the thermometer dial face until the pointer registers the correct temperature. The bath temperature must be monitored by a thermal sensing device known to be accurate.

Flowmeter

The ± 1.5% accuracy of the flowmeter should be checked and calibrated by the manufacturer or a qualified facility.

Vibration Detectors

Monitor the vibration levels during operating. Insure each vibration detector is functional. Vibration levels may be monitored directly on the turbine panel.

Physically check the mounting security of each vibration detector and detector leads.

Refer to the Control Specifications and Control Specifications — Control System Adjustments for complete operational checks.

Liquid Level Indicators

When the tank is drained of liquid, check that the linkages are free from binding and the float is in good condition. Make sure the high and low level switches are set within the limits specified on the Schematic Piping Diagram.

Panel Meters

Unless a competent instrument mechanic is available, it is recommended that the instrument be returned to the manufacturer, or a laboratory, for calibration and for repairs.

In general, instruments should be on “zero” when the unit is shutdown. Whenever possible, corrections should be made with the “zero” adjustment. If a pointer cannot be zeroed, it is probably bent, or the “zero” adjuster crank arm is out of the regular slot.

Inspect for sticking, or jerky pointers. The most common causes of erratic operation are dirt on the scale, pointer touching glass, dirt in a gap of moving element or damping magnet, or damaged bearing. Correct as necessary.

CONTROL DEVICES

Temperature Switches

Temperature switches are pretested, set, and locked in the factory. If trouble is experienced in the field, new pretested and set switches should be ordered. Faulty switches should be returned to the GE Company for evaluation. These switches should not be tested, adjusted, or reset in the field unless a special Fenwal Test Kit, Model 80001-0, is available since the settings require close tolerances. The arrow on the head of the thermoswitch unit indicates the direction to turn the adjusting screw for increased temperature setting. One complete turn of the adjusting screw equals approximately 100°F (56°C).

Thermostats

To check the accuracy of the space heater thermostats in the turbine, accessory and control compartments, compare the setting of the thermostat with the temperature shown on an accurate thermometer. If there is a discrepancy of more the five degrees, the thermostat should be repaired,or replaced.

Pressure Regulating Valves (VPRs)

Pressure regulating valves are of two types — pressure reducing and backpressure regulated. Except in a few instances, a line-mounted pressure gauge is available very close to the valve to check and/or set the control pressure required for that particular valve. Backpressure-regulated valves are preset at the factory and should require no adjustment for normal operation. In most applications, the valve stem is exposed to view, so valve movement can be checked visually or with a dial indicator. For valves that do not have an exposed stem, the valve setting is best accomplished with the valve removed from the stem. On some valves, it is possible to use an external pressure source, preferably dry air, to check the valve setting during shutdown of the machine. Valve travel is checked with a dial indicator inserted through a removable cover on the valve opposite the side where the valve yoke (top-works) is located.

If the valve is not operating properly, remove it and bench-check it for:

1. Sensing line restrictions
2. Ruptured diaphragm
3. Valve body obstruction
4. Bent or binding valve stem
5. Broken spring

Refer to the Schematic Piping Diagram or Device Summary for the proper setting of the valve. It is recommended that valve diaphragms and stem packings be replaced every five years, unless operating experience indicates that more frequent replacement is necessary.

Temperature Control Valves (VTRs)

The temperature control valves (VTRs) are used to regulate the cooling water flow to the lube oil heat exchanger and atomizing air pre-cooler.

The temperature control point of these valves is preset and should require no adjustment for normal operation. The control point is set to control the bearing header lube oil temperature and the atomizing air pre-cooler discharge air temperature. The required temperatures are specified on the Device Summary of the Schematic Piping Diagram for each system. The temperature for the atomizing air precooler can be measured by inserting the correct thermometer in the thermowell provided in the suction pipe of the atomizing air compressor. These temperatures should be maintained during normal operation; however, on hot days, the temperature may be exceeded. An alarm will sound if the temperatures are exceeded. If the alarm sounds, check the following:

1. VTR valve fully open.
2. Adequate coolant flow going through the lube oil heat exchanger, atomizing air pre-cooler and coolant-to-air heat exchanger.
3. Proper mixtures of ethylene glycol in water.
4. Proper air flow through coolant-to-air heat exchangers.
5. Plugged heat exchanger surfaces.

The valve proportional band is defined as that temperature difference in the controlled fluid (sensed by the bulb) which is required to fully stroke the valve. If the actual valve proportional band varies markedly from that given on the valve nameplate, the valve sensing element may have been improperly assembled into its well or have an improper charge of sensing fluid.

The element could be defective, or there may be too much friction in the valve mechanism. Sensing bulbs are marked “TOP” or “UP” and must be assembled properly. If it is noted that the valve proportional band increases with time, the sensing element probably has a small pinhole leak and should be replaced. If the temperature sensing system must be replaced, the valve can be cranked open mechanically and the temperature sensing probe, capillary tube, and diaphragm in the valve bonnet can be replaced without having to shut off the cooling water or shut down the turbine.

Note: If sensor bulb is removed for any reason make sure that the temperature well is filled with heat transfer compound prior to replacement of the sensing bulb. Refer to Standard Practices, Solvents, Sealers and Cleaners for proper compound.

Valve stem packing nuts should be tightened just enough to stop water leaks. The valve manufacturer generally states that if the packing nut is hand tightened, enough force is applied to stop water leakage. Use of excessive force causes friction between the valve stem and packing. This results in erratic operation.

It is recommended that the valve stem packing be replaced every five years unless operating experience indicates the advisability of more frequent replacement.

HYDRAULIC/MECHANICAL EQUIPMENT

Relief Valves

Spring-loaded relief valves protect the system component, or pumps from overpressure. Adjustment of the valve setting is accomplished by an adjusting screw. Turning the screw into the valve body increases the spring force (raises opening pressure). The relief valve is set to open at the pressure specified on the Device Summary Schematic Piping Diagram.

Annually, all the relief valves listed should be removed and bench-tested against the settings listed on the Device Summary.

Solenoid Valves

If any oil leakage is observed, replace the “O” ring seals. Energize the solenoid and check valve operation (a metallic click should be heard and in some cases, the valve travel can be seen).

Sluggish valve operation, or excessive leakage can result from dirt. Therefore, periodic disassembly and cleaning of all solenoid valves is desirable when improper operation or leakage is evident.

Servovalves

If any oil leakage is observed, replace O-ring seals.

Verify that lock washer, required by assembly drawings but not provided with new replacement servovalves, are in place on all servovalve mounting screws.

With lock washers installed, verify that the servovalve mounting screws are long enough to provide 1 to 1.5 times the screw diameter of thread engagement.

If longer servovalve mounting screws are required to meet minimum thread engagement, verify that the replacement screw does not bottom in the threaded hole. Rework the screw if required.

Torque all servovalve mounting screws to 17–19 inch pounds.

Check Valves, Orifices and Orifice Check Valves

During a shutdown period, the system has to be drained and the valves and orifices have to be removed to check for evidence of erosion, corrosion, or component deterioration. Check the orifices for plugging, size and sharpness of the hole. Check the valve seat for leakage. Check the condition of the seals, “O” rings, or gaskets, and replace them if there is any indication of wear.

Lube Oil Filters

The lube oil system filters should be changed once a year, regardless of the pressure drop. The pressure drops must be checked under turbine operating conditions, with the lubricant at normal operating temperature, and at rated flow through the filter. In most gas turbine lube systems, the main lube filter, which filters the lubricant to the main bearing header, can be checked for clogging by the pressure drop indication. Here, the pressure downstream from the filter is maintained by a pressure regulating valve, and the difference in the pressures shown on the gauges before and after the filter will provide a reliable indication of the filter condition. The condition of other filters in the lube system, such as the control fluid filter or hydraulic control pump filter, cannot be determined as reliably by the pressure drop indication since the flow through these filters may be very low under steady-state conditions. It is unlikely, however, that these low-flow filters will foul before the recommended annual changeout of the filter element.

On gas turbines that are expected to run continuously over long periods of time, dual filter arrangements, with a transfer valve, are usually incorporated into the lube system to facilitate the servicing of the filters without turbine shutdown. Systems with single filter arrangements require that the turbine be shut down to service the filters.

Hydraulic Supply Filters

The hydraulic supply system filter should be changed when the pressure drop across the filter is 60 psig (4.14 bars), or once a year, regardless of the pressure drop.

The pressure drop must be checked under turbine operating conditions, with the hydraulic fluid at operating temperature and at rated flow through the filter. The rated flow can be assumed to be realized during maximum transient conditions, such as at the instant of hydraulic tripout of the gas turbine. Under steady-state conditions, there will be only a small flow through the filter and any differential pressure indicated on the system gauge will probably be small and not a true indication of the condition of the filter. It is unlikely, however that these low-flow filters will foul before the recommended annual changeout of the filter cartridge.

On gas turbines that are expected to run continuously over long periods of time, dual-filter arrangements, with a transfer valve, are usually incorporated into the hydraulic supply system to facilitate servicing of the filters without turbine shutdown. Systems with single-filter arrangements require that the turbine be shut down to service the filters.

Air Filters (Air Extraction Valve)

Open the filter petcock and drain off all moisture accumulation. If the amount of moisture appears to be excessive it is suggested that the petcock can be left cracked open for a continuous bleed or the frequency of the blowdown inspection be increased.

The filter should be opened up on a scheduled basis and inspected. Clean the Poro-Stone tube in any oil solvent and blow out clean and dry. Clean the inside of the filter housing.

HEATING, COOLING AND VENTILATION

Air Conditioners

Clean dust and dirt from the condenser and evaporative coils. Clean condensate drip pan. Wash or replace the air filter. Functionally check the operation of the thermostat and air conditioner.

Space Heaters

Check electrical continuity and verify proper operation of the space heaters. Clean dust from the thermostats, heating elements and fan blades. Lubricate the fan motors per the Vendor Supplied Components Instructions.

Accessory and Turbine Compartment Vent Fans

Check fan wheel for buildup of foreign material or excessive wear from abrasion. Both can cause vibration and create a serious safety hazard. Any buildup of foreign material should be removed. If wheel shows excessive wear, replace it immediately.

Check all set screws and bolts for tightness, and mounting security. Lubricate fan motors per the Vendor Supplied Components Instructions.

MOTORS

DC Motors

Inspect to see if the brush orientation markings on the side of the brush yoke and bearing bracket are aligned. If the brushes are not properly orientated, it could affect the speed of the motor and cause excessive sparking. Check the indicator marker on the brush pigtails for evidence of brush wear. If the marker reaches the top of the brush holder box, the brush is worn to the point where it should be discarded. These checks can be made after removing the bearing bracket louvered cover.

Also check the commutator at this time for cleanliness and wear. Check the commutator for roughness while running. This is done by placing a fiber stick against the brushes and feeling to see if it jumps during rotation. Check the insulation and windings for contamination, mechanical defects and temperature defects. Check the insulation integrity for electrical resistance.

Check the vibration of the motor while coupled to the pump. The vibration should not exceed 3 mils (0.08 m). Check rpm of motor with mechanical or Reed type tach and compare to nameplate.

AC Motors

Examine the collector rings, brushes, brush holders and studs for cleanliness and wear. Collector rings should maintain their polished surface. Brushes should move freely within their holders, but set firmly in contact with the collector rings. Be sure the pigtail conductors are securely fastened to the brush holders. Check the insulation for cleanliness and wear.

Check the vibration of the motor while it is coupled to the pump. The vibration should not exceed 3 mils (0.08 m). Check the cooling passages and louvers of the motor to make sure they are clean, undamaged and unobstructed. Check rpm of motor with mechanical or Reed type tack and compare to nameplate.

COUPLINGS

Inspect couplings between motors and/or between motors and pumps for deterioration, missing or loose hardware and cleanliness. Refer to the Service Manual under systems noted for further information.

UNIT PIPING SYSTEMS

Fuel, Oil, Water and Air

A walk around visual inspection should be made to check piping systems for leaks, loose hardware, loose hangers, leaky gaskets, valve packing leaks, vibration of piping, vents are functioning and a general check for security of the systems. Corrective action should be taken to correct any abnormalities found.

LUBE SYSTEMS MAINTENANCE

Lube System Oil Pumps

Check the lube oil pumps for excessive vibration. Check the thrust bearings and bearing seal for wear. Check the clearance of the wear ring. If wear has increased this clearance to 0.016 in. (0.041 cm), the wear ring should be replaced.

Lube Oil Tank

Check the internal tubing and piping of the lube oil tank for peeling of paint and loose fittings. Check the pipe hangers for loose or missing hardware. Carefully inspect each pump intake screen (especially on the main pump) for foreign material and loose hardware. Check the sludge removed from the bottom of the tank for the presence of unusual material. Make sure the inside of the tank is thoroughly clean before refilling.

Lube Oil Properties

For instructions on determining lube oil physical properties and periodic sampling and testing, refer to the Fluid Specifications Tab of the Service Manual.

Heat Exchangers

Check the heat exchanger for leakage, efficient operation and foreign matter contamination. Exchangers are subject to fouling (scale, sludge deposits, etc.) and should be cleaned periodically, depending on specific conditions. A light sludge, or scale coating, on either side of the tube greatly reduces its effectiveness. A marked increase in pressure drop and/or reduction in performance usually indicates cleaning is necessary. Since the difficulty of cleaning increases rapidly as the scale thickens or deposits increase, the intervals between cleanings should not be excessive.

To clean or inspect the inside of the tubes, remove only the necessary tube side channel covers or bonnets, depending on the type of exchanger construction.

To clean or inspect the outside of the tubes, it may be necessary to remove the tube bundle. (Fixed tube sheet exchanger bundles are non-removable.)

If an exchanger tube should develop a leak, it may be possible to plug the tube in the heat exchanger and continue using the bundle. Consult GE for information concerning how many tubes may be plugged in a given heat exchanger and still have the heat exchanger perform satisfactorily in gas turbine service. The tapered plug material which is selected should be compatible with the heat exchanger bundle material. Stainless steel plugs are compatible with stainless steel heat exchanger tubes. Brass plugs are recommended for 90-10 copper-nickel tubes or for brass tubes or for admiralty metal tubes. These plugs are installed in the leaking tube at the tube sheet using a nylon or rawhide hammer to prevent inadvertent damage.

Radiator and Header Assemblies

For maximum effectiveness of the overall cooling system, the fins of the fin-tube radiator assemblies must be kept free of bugs, lint, oil film, and other debris. The fins should be cleaned in the direction opposite to normal flow. Washing with water, or a commercially available radiator fin cleanser will be adequate. Refer to the paragraphs on Cooling Water System maintenance for information relative to fouling of the inside of the radiator tubes. Check the radiator also for leakage, corrosion, erosion, or damage to the fins or tubes. Refer to the Cooling Water System tab in this Service Manual for cleaning the radiators.

Lube Oil Immersion Heaters

These steel sheath heaters are designed for non-circulating oil application. The heaters have to be fully immersed in a liquid while energized.

Mist Eliminator

The pressure drop across the unit should be checked at startup and periodically during operation. Refer to the lube oil system schematic piping diagram in the Service Manual. A high pressure drop could indicate, (1) the mist eliminator elements are plugging with solids, or (2) the oil vapor flow rate is too high. A low pressure drop could indicate bypassing of some sort, particularly if smoke is visible.

Mist Eliminator Fan

Periodically check the fan wheel and housing for cleanliness. If there is excessive vibration, or high bearing temperature, it may indicate motor bearing wear, blade wear, or a build up of dirt. Also check the tightness of the mounting bolts and set screws. (See Standard Maintenance Items in this section for motor inspection.)

Pipe Couplings

Check the couplings for oil leakage due to aging and heat. Replace seals as needed.

Lubricate seals prior to each assembly of seals.

COOLING WATER SYSTEM

Cooling System Checks

Cooling system fouling, with consequent performance degradation, must be checked periodically, even though the system is properly rust inhibited. Removing the water side head of the lube oil heat exchanger and inspecting the tubes will indicate the general amount of fouling that has occurred in the whole system. Fouling of the fin-tube radiators will probably be the most severe, since the tubes are the smallest in the system.

A maximum of ten percent of the tubes in each heat exchanger can be plugged to eliminate water leaks. The leaks in the water-to-air heat radiator may be repaired at a local automotive radiator repair shop. This method is preferred to plugging the tubes, since the system performance is not seriously affected. Plugging the heat exchangers will reduce system performance and result in more frequent cleaning. Cleaning of the cooling water system can be accomplished as follows:

1. Use either two or three percent by volume of formic acid, or three to four percent by volume of sulfamic acid to fill the cooling water system. *Muriatic acid is not allowed.*

2. Circulate the solution through the cooling water system for two hours. Then drain the system.

3. Flush the system completely with water. If any discoloration remains, repeat the cleaning procedure.

4. After the system has been properly cleaned, refill with pure water and the recommended amount of corrosion inhibitor or anti-freeze mixture. For detailed instructions, refer to the Fluids Specification Tab in this Service Manual.

Flow Checks

The closed cooling water system has several sharp-edged orifice plates mounted in the orifice flanges. These orifices are used to balance the pressure drop in parallel flow circuits. They also may be used to measure system flow rates. Measurement of system flow rates is extremely important for troubleshooting, if problems develop. Design flow rates for the water circuits with the temperature-actuated valves in the open position are listed on Cooling Water Schematic Piping Diagram in the Service Manual. These design flow rates are based on 100 percent turbine speed. If the turbine is not operating at rated speed, calculate a correct flow as follows:

$$\text{Flow at actual speed} = \frac{\text{Actual Speed}}{\text{Rated Speed}} \times \text{flow at rated speed.}$$

When the flow check is made, it is suggested that a single test gauge be installed to read the pressures both upstream and downstream of the orifice. The gauges should be valved so that each pressure can be read individually. This procedure will eliminate gauge errors which could occur when two separate gauges are used. Runs of pressure lines should be as short as possible.

Use of a mercury manometer is *not* recommended. Mercury will react destructively with copper and brass in system components under certain conditions, if it were accidentally injected into the cooling water system.

Flow Versus Pressure Drop

Water (or coolant) flow versus pressure drop curves may be prepared for any orifice* size by using the equation:

$$Q = 300KA \sqrt{\frac{\Delta P}{\rho}} = \text{gpm}$$

where the symbols are as follows:

$$K = \frac{C_d}{\sqrt{1 - B^4}}$$

$$B = \frac{\text{Do (orifice)}}{\text{Di}} \text{ (pipe I.D.)}$$

ΔP = PSI (orifice)

A = AREA OF ORIFICE = $(IN)^2$

ρ = WATER DENSITY $LB/(FT)^3$

C_d = ORIFICE DISCHARGE COEFFICIENT

The flow coefficient K for flange taps is determined experimentally; therefore, it may be extracted from tables available in several references.*

Water Tank

Examine the internal surface of the tank for cleanliness and the presence of algae or foreign matter. If water leaks consistently from the tank fill opening with little change in ambient conditions, check the pressure cap for the proper opening pressure setting. Also check for a missing cap gasket, poor gasket surface, or damaged filler neck sealing surface. The pressure setting should be within ± 15% of the pressure cap rating. The vacuum valve should open between zero psig (0 bars) and 1/2 psi (0.035 bars) vacuum. Check for leakage at the tank cover and gasket.

Cooling Water Fans

If the turbine is equipped with an off base cooling water module, annually check the cooling water radiator fans, the fan housings and the motors for cleanliness, vibration, noise, blade damage, rust and corrosion, and mounting bolt security. Make sure there are no obstructions in the inlet and outlet duct work and that screens are clean. For detailed information on the inspection, maintenance disassembly and reassembly of the fan, refer to the instructions under the Cooling Water System tab in the Service Manual.

*ASME publication "Fluid Meters — Their Theory and Application" (Fifth Edition). Also, Crane Co., Technical Paper No. 410 "Flow of Fluids Through Valves, Fittings and Pipe".

Cooling Water Pump

Check the pump for seal leakage either when running or stopped. Leakage is usually visible along the pump shaft and/or from the drain port on the seal mounting flange. If there is unusual leakage, it is an indication that foreign material has become lodged between the faces of the seal. This should be corrected before further pump operation. If the leakage is profuse, it is an good indication that the seal is worn and should be replaced.

Check the internal cleanliness of the mechanical seal cooling water circulating line. If this line gets clogged, the seal can overheat and result in a pump failure. Also check the cleanliness of the abrasive separator in the seal cooling line.

Whenever the pump is disassembled for any reason, the impeller-to-wear-ring clearance should be checked. If the clearance exceeds twice the value recommended by the pump manufacturer, the wear rings should be replaced and reworked to restore the manufacturer's recommended clearance values. This will restore pump efficiency insofar as this clearance is concerned.

Whenever the pump is disassembled, all parts of the pump, especially the impeller, shaft sleeve, and wearing parts of the mechanical seal should be checked and replaced, if worn. Refer to the Cooling Water System tab in the Service Manual.

FUEL GAS SYSTEM

General Notes

Fuel gas piping failures may cause a fire or explosion if an ignition source is present, or failure of the machine to operate.

Fuel Gas Stop Ratio and Control Valve

Check for excessive gas leakage at the valve stems, packing leakoff and vent lines.

If it is suspected that the valve leaks, check the seating surfaces for damage or foreign material. Contact between the valve and seat must be checked with the stem in place. Check the rod seals and wipers of the hydraulic cylinders for leakage and replace them if worn. Check the gas pre-charge pressure of the accumulator and correct it if required.

Check the trip relay for cleanliness and freedom of operation. A small amount of dirt can cause the relay to stick. Disassemble and clean if necessary.

If the movable core on the LVDT (on the control and stop valve) appears to be misaligned with the stationary coil and is rubbing the coil, realign it.

For additional information on the fuel gas stop ratio and control valve, refer to the Service Manual under the Fuel System tab.

HIGH PRESSURE CONTROL OIL SYSTEM — HYDRAULIC SUPPLY

Main Hydraulic Supply Pump

Visually inspect the pump for seal leakage at the shaft and mounting flange. Check the pump for noise and vibration. Check the inlet and discharge connections for leakage and/or loose connections.

To assure trouble free pump operation and a trouble free hydraulic system, it is important to maintain the system in a clean condition. Sludge, water, dirt or contaminants of any kind are potential for trouble.

Auxiliary Hydraulic Supply Pump

Maintenance is limited to pump operations such as leaks or sticky valves which do not require a complete system, or pump, teardown. First, tighten all screws or fittings around the leakage area. If the pump still leaks, it may be necessary to replace a gasket, or “O” ring.

If the pump does not operate properly, or if there is evidence of damage, it should be overhauled in accordance with the instructions in the Service Manual under the Hydraulic Supply System tab.

Before reassembly, make sure that all parts are clean and free from lint or other foreign matter. All parts must be washed in cleaning fluid, such as Stoddard solvent (or equivalent). All “O” rings and gaskets should be clean and carefully examined for cuts and other damage. Replace all damaged parts.

Hydraulic Supply Manifold

Leakage problems on the manifold will generally result from damaged “O” rings between the components and the manifold plate. Care must be used in reseating a part to the manifold to avoid pinching or otherwise damaging the seals.

All tubing connections and device connections should also be checked for leakage. The manifold should be cleaned and wiped down. This will help in detecting any further leakage problems.

Air Bleed Valve(s)

The air bleed valve(s) should automatically bleed any air present in the discharge lines as the pump is started. As soon as the system reaches 35 psig (2.41 bars) and a steady stream of oil is present, the valve should close.

Accumulator

Replace accumulator safety disc annually. To assure that pre-charge pressure is available and the accumulators can provide the necessary transient flow and shock absorbing characteristics for the system, the accumulator pre-charge pressure should be checked periodically and at a minimum of once a year.

The pre-charge of the hydraulic accumulators should be within ± 25 psig (1.72 bars) of that specified in the Device Summary. This check should be done with the unit at standstill. Operation of the main, or auxiliary hydraulic pump, without properly charged accumulators in service, may result in unnecessary hydraulic hammer and possible system damage.

COOLING AND SEALING AIR SYSTEM

General Notes

Loss of cooling air to various parts of the machine may cause hot wheel spaces, insufficient shell cooling or reduction in bearing sealing air pressure. Small leaks or restrictions may result in loss of machine performance or reduction in life of nozzles, buckets and wheels. Large leaks or restrictions may result in complete machine failure and, in case of sealing air, bearing oil leaks and fire if an ignition source is present.

Piping System

Using the Cooling and Sealing Air Piping Schematic as a guide, check that all orifice-flange-plates are in their respective locations. If not already done, it may be wise to identify the orifice size on the tab of the plate and locate the tab in the most convenient and accessible location for viewing when assembled. When union orifices are used verify that the orifice is in position in the union by the tab protruding thru the hole.

Compressor Bleed Valve (VA2-1 and -2)

These valves should operate freely with no evidence of sticking. Where sticking is evident, lubricate the spring and inner cylinder of the air actuator of the valve with the spray lubricant WD40 or an equivalent high temperature, anti-seize lubricant on a planned shutdown. Remove the air connection from the valve, spray the lubricant into the actuator and exercise the valve several times.

****WARNING****

The compressor bleed valves must be checked, lubricated and operated when cool. Do not attempt this servicing on hot valves or during unit operation.

Compressor Discharge Pressure Transmitter (96CD)

Check that the transmitter is calibrated within the limits described in the Control Specification.

STARTING SYSTEM

Electric Motor

See Vendor’s Preventive Maintenance Procedure in Starting Systems Tab.

Starting Clutch

Visually inspect the spline and clutch jaws for signs of uneven wear, nicks, burrs, or other physical damage. Inspect the hydraulic cylinders for leakage.

Inspect the linkage, pins and hardware for security. Check the clearances of the clutch jaws in the engaged and disengaged positions. Check the limit switch to see that the switch is operating at the proper setting.

Torque Converter

Check torque converter unloading solenoid valve 20TU plunger for freeness of operation. Apply silicone grease to plunger rod.

Ratchet System

Check ratchet pump motor (88HR) for cleanliness of commutator and brush condition. Check relief valve setting (VR–5) and obvious oil leakage of external piping. Ratchet pump should show no signs of overheating.

Accessory Gear Train

Through the various inspection openings, visually inspect the gears for pitting, scoring, galling or broken teeth. On scheduled major inspections, remove the accessory gear case cover and check the condition of the gears and bearings.

Prior to complete re-assembly, inspect lube oil spray with pump operational in regard to oil nozzle plugging and direction of oil spray.

FIRE PROTECTION SYSTEM

****WARNING****

Fire suppressant, in a concentration sufficient to extinguish fire, creates an atmosphere that will *not* support life. It is extremely hazardous to enter the compartment after the system has discharged. Anyone rendered unconscious by fire suppressant should be rescued as quickly as possible and revived immediately with artificial respiration or by mouth-to-mouth resuscitation. The extent and type of safeguards and personnel warnings that may be necessary must be designed to meet the particular requirements of each situation. It is recommended that personnel be adequately trained to cope with such an emergency.

System Package Lagging

The joints in the lagging panels, roof, doors, and base should be inspected for tightness. If the joints are not tight, the loss of medium will be too great to be replenished. The concentration will not buildup inside the compartments to the required value. The easiest way to make the inspection is to stand inside each compartment on a bright, sunny day with the lights off. No light should be visible through the joints. Particular attention should be paid to all doors. The joint between the generator compartment and the back side of the exhaust plenum, plus the joint between the generator and the turbine base should be checked in particular. In general, joints which are not tight should be fitted with new gaskets. Doors can be tightened by adjusting the striker plates.

High Pressure System

The fire protection system should be visually inspected to see that it is in proper working order. The pressure gauges on the pilot-operated cylinders should be checked to be sure the cylinders are at the proper pressure. The pressure is dependent on the cylinder temperature. For carbon dioxide, at 50°F (10°C) the pressure should be about 650 psig (44.8 bars); at 70°F (21°C) about 840 psig (57.9 bars); at 105°F (41°C) about 1250 psig (86.2 bars). For Halon 1301, at 50°F (10°C) the pressure should be about 530 psig (36.5 bars); at 70°F (21°C) about 600 psig (41.4 bars); at 105°F (41°C) about 750 psig (51.7 bars). Check the dampers to ensure they are unobstructed and properly latched.

High Pressure Storage Cylinders

Disconnect the discharge heads from all cylinders and the solenoid pilot valve assemblies from the pilot cylinder. Weigh each cylinder. If a cylinder shows more than 10 percent loss in net weight, it should be refilled, or replaced.

The empty and full weights of all cylinders are permanently stamped on the cylinder valve bodies. Each time the cylinders are weighed, the date and net weight should be recorded on the attached tag.

Fire Detectors

CAUTION

> If the fire detectors are checked in place, without removal from the system, the discharge heads must be removed from the medium cylinders to disarm the high pressure system. The isolation valve must be closed in the low pressure control cabinet to disable the low pressure system.

The temperature setting of the detector is stamped on its identification plate. It is not possible to accurately check the calibration of the detector. If it is suspected that a detector is out of calibration, it should be replaced.

CAUTION

Any physical damage to fire detectors such as but not limited to distortion, dents, twisting will cause the fire detectors to loose their calibration and serviceability. If any physical damage is found on the fire detectors they should be replaced.

Open flames such as propane or acetylene torches are not to be used under any circumstances to check the operation of detectors. The use of propane or acetylene torches causes severe drifting or destruction of the detectors internals.

If the fire detectors are functioning properly, they will pickup relay 45FTX to trip the turbine. The fire alarm bell in the accessory compartment should ring and the fire flag on the annunciator should drop.

High Pressure System Tests

Two separate tests are necessary to ensure that the high pressure system is ready for operation. These tests are: (1) Solenoid Pilot Valve test and (2) “Puff” test. Description of the test procedure can be found under the Fire Protection tab of the Service Manual.

Low-Pressure CO_2 System Electric Release and “Puff” Tests

This system consists of a single pressure vessel, refrigeration system, gauges, alarm system and safety vent assembly, all enclosed within a steel housing on a single, all-welded base. The refrigeration system automatically maintains the CO_2 in the pressure vessel at approximately 0°F (–17.7°C) and a vapor pressure of 300 psi (20.6 bars).

Operation of the low-pressure CO_2 system is fully automatic. Once installation is complete, the system requires only periodic inspection and maintenance (except when fire protection service, or system malfunction necessitates major servicing and checkout).

****WARNING****

Carbon dioxide, in a concentration sufficient to extinguish fire, creates an atmosphere that will *not* support life. It is extremely hazardous to enter the compartments after the CO_2 system has been discharged. Anyone rendered unconscious by carbon dioxide should be rescued as quickly as possible and revived immediately with artificial respiration or by mouth- to-mouth resuscitation. The extent and type of safeguards and personnel warnings that may be necessary must be designed to meet the particular requirements of each situation. It is recommended that personnel be adequately trained to cope with such an emergency.

Two separate tests are necessary to ensure that the low-pressure CO_2 system is ready for operation. These are (1) the electric release test and (2) the "puff" test.

Electric Release Test

Check the wiring in the circuit by short-circuiting each fire detector in turn. Each time this is done, solenoid valve 45CR should energize. Before performing the Electric Release test, the system must be disabled by means of the isolation valve in the control cabinet.

"Puff" Test

The "puff" test consists of discharging a small amount of CO_2 into the system as a final check on the operation of the release mechanism and to be sure that all pressure-operated latches and ventilation dampers operate properly. Conduct the test as follows:

1. Inspect the ventilation dampers in the accessory and turbine compartments and latch them in the open position with the CO_2-operated latches.

2. Check to see that solenoid valve 45CR is de-energized.

3. Clear all personnel out of the accessory and turbine compartments. Make sure all ventilating fans are on during and after testing to remove the discharged CO_2 from the area.

4. Cycle each pneumatic timer by operating a push button station or by operating the manual release to determine that the timing is as required. Cycling should be done with the discharge manifold under pressure, but with the tank shutoff valve closed so as to provide only a "puff" discharge vapor.

5. Cycling of the timers will also serve to prove operation of the pressure switches and in turn the performance of electrical shutdown and annunciation.

Note: The timing cycle can be aborted by closing the isolation valve and re-setting the pressure switch after the timer re-sets.

6. When the system starts to discharge, relay 45FTX should pick up to trip the turbine. The fire alarm bell in the accessory compartment should also ring, and the fire flag on the annunciator should drop.

7. After CO_2 discharge has stopped, re-set pressure switch 45CP. When the compartments are clear of CO_2, also inspect to see that all ventilation dampers have operated properly.

At the completion of testing, refill the storage unit to capacity, as required. Bubble test the packing glands of the tank shutoff valve and vapor supply valve for bubble tightness. Leave both locked in the full-open position. The system is now ready for operation.

CAUTION

Ventilation dampers, automatically closed by a signal from the fire protection system, must be re-opened before re-starting the turbine. Failure to do so will shorten the service life of the starting motor and reduce generator performance.

TEMPERATURE CONTROL

Exhaust Thermocouples (Control and Overtemperature)

Daily reading the exhaust thermocouples will aid in monitoring the combustion system and in detecting faulty thermocouples. Changes in the combustion system will be detected easily after a normal pattern of temperature has been established. Diverging temperatures in the exhaust system usually indicate deterioration of the combustion chamber, or poor fuel distribution (dirty fuel nozzles). Below normal thermocouple readings indicate thermocouple deterioration. It is important to define a “baseline value” of exhaust temperature *spread* with which to compare future data. This baseline data is established during steady state operation after each of the following conditions:

1. Initial startup of unit
2. Before and after a planned shutdown
3. Before and after planned maintenance

It is important when reviewing exhaust temperature readings to observe any trend which may indicate deterioration of the combustion system. Gradual and/or sudden temperature excursions should be investigated as soon as possible to determine validity of readings. Faulty thermocouples should be replaced as soon as feasible. Refer to the Control Specification drawings for actual exhaust temperature control settings and allowable spreads.

Wheelspace Thermocouple Temperature Limits

The wheelspace thermocouples, identified together with their nomenclature, are on the Device Summary. A bad thermocouple will cause a “High Wheelspace Differential Temperature” alarm. The faulty thermocouple should be replaced at the earliest convenience.

When the average temperature in any wheelspace is higher then the temperature limit set forth in the table, it is an indication of trouble. High wheelspace temperature may be caused by any of the following faults:

1. Restriction in cooling air lines
2. Wear of turbine seals
3. Excessive distortion of the turbine stator
4. Improper positioning of thermocouple

5. Malfunctioning combustion system

6. Leakage in external piping

7. Excessive distortion of exhaust inner diffuser

   Check wheelspace temperatures very closely on initial startup. If consistently high, and a check of the external cooling air circuits reveals nothing, it is permissible to increase the size of the cooling air orifices slightly. Consult with a GE Company field representative to obtain recommendations as to the size that an orifice should be increased. After a turbine overhaul, all orifices should be changed back to their original size, assuming that all turbine clearances are returned to normal and all leakage paths are corrected.

CAUTION

> Wheelspace temperatures are read on the <I> CRT. Temperatures in excess of the maximum are potentially harmful to turbine hot-gas-path parts over a prolonged period of time. Excessive temperatures are annunciated but will not cause the turbine to trip. High wheelspace temperature readings must be reported to the GE technical representative as soon as possible.

FLAME DETECTION AND PROTECTION SYSTEM

Flame Detectors

The flame detection system has two basic functional requirements:

1. It must detect the “presence-of-flame” during startup. A “presence-of-flame” signal is a prerequisite to continuation of the startup sequence.

2. During operation, the system must detect the “absence-of-flame” to trip the gas turbine. The “absence-of-flame” signal is very critical to the protection of the gas turbine and of associated heat-recovery equipment (when furnished).

3. The system is designed to detect the presence of ultraviolet radiation which is emitted by a hydrocarbon flame and to provide a signal when the radiation is sensed for a sufficient time period.

The flame detection system is composed of an amplifier and two sensors. The amplifier supplies voltage to drive the sensors and provides an output logic signal for flame and no-flame conditions. The sensors respond to ultraviolet radiation from the flame in the combustor and conducts pulses of current. The current pulses are integrated at the input on a voltage level detecting and switching amplifier. The resulting dc voltage signal, proportional to the sensor current is the “flame condition” signal.

CAUTION

The sensors are polarity sensitive. Reverse polarity will destroy the detector!!!

1. With the detector amplifier power on, verify base wiring polarity at the sensor junction box by reading 290 VDC (min.) across lead pair.
2. Turn power off and connect the black detector lead to plus (+) and the white lead to minus (–).

4. With the system connected, place an ultraviolet source in front of the sensors and check that the internal relays operate as indicated by using an ohmmeter or equivalent at the contacts. Note that a paper match flame should be detected at approximately 18 in. (45.7 cm) and the sensor should provide an orange flickering glow. If the flickering glow persists after removal of the flame, the sensor has failed and should be replaced. If no flickering glow occurs in the presence of flame, the sensor may have failed but proper operation of the electronics should be assured.

Scanner Lens

The scanner lens should be cleaned with a dry cloth as often as necessary on a regular schedule. No repair of any sort should be attempted on the scanner, or switch assembly. If damaged, or defective, it should be replaced and returned to the factory.

Refer to the Control Specification — Control System Adjustments for testing of flame detectors with the unit in operation. Refer to the Control Specification for logic signal output explanation.

OVERSPEED PROTECTION SYSTEM (ELECTRONIC)

Magnetic Pickups

The clearances between the OD of the toothed wheel and the tip of the magnetic pickup should be checked annually and at each removal and installation. The clearances should be within the limits specified in the Control Arrangement Drawing, Model List Item 0501 or the Device Summary.

Calibration Checks

These calibration checks of the overspeed protection system should be performed annually and after each major inspection, or at any time wiring has been disconnected.

SPEEDTRONIC CONTROLS AND EQUIPMENT

Control Panel and Power Supply Components

Any indication of corrosion or discoloration, due to heat, should be investigated and the equipment repaired or replaced as necessary.

In atmospheres that contain contaminants, such as hydrogen sulfide, sulfuric acid, sulfur dioxide, chlorine, and chlorine dioxide, the relative humidity of the SPEEDTRONIC control panel location should be maintained at 50 percent or less to minimize any possible corrosion problems. Conformal coatings are used to protect electronic equipment; however, high relative humidity can cause accelerated corrosion in any area not properly protected.

Refer to SPEEDTRONIC Maintenance Manual Procedures.

Relay Contacts

Contact Cleaning

The relay contact(s) must be clean and free from dust to energize the load device. The main source of problems with relays is dirty load contacts. Many industrial relays (such as the type HGA relay) are furnished with a dust-tight cover. Open-type relays, particularly in a dust-laden atmosphere, should be cleaned at regular intervals. The removable contact carriage should also be checked for mechanical freedom and alignment with the stationary contacts.

A common error in maintenance is the belief that service-roughened contacts must be filed smooth. A roughened contact will carry current as well as a smooth contact; therefore, a contact roughened by normal arcing should not be serviced. However, if a contact is deformed by unusual arcing and has developed a large projection, it should be repaired as described below.

Silver contacts oxidize more slowly than copper ones and form a self-reducing oxide. Filing is, therefore, not recommended, since it can completely destroy the silver contact's usefulness.

If it is necessary to clean the silver contact, use a burnishing tool. This tool consists of a flexible strip of metal, with an etched (roughened) surface, similar to a superfine file. Do not clean the contact with knives, files, or abrasive paper or cloth.

Copper contacts oxidize rapidly at elevated temperatures, forming a very high resistance oxide. A few strokes with a file will remove the oxide and reduce the resistance. Usually, it is not necessary to file contacts if the device is operated often. The slight abrasion produced by an ordinary closing operation is sufficient to keep the oxide cleaned off.

Contact Replacement and Pressure

Since short-circuit currents, that flow through a relay's contacts, can completely melt or weld them closed, relays, or relay contacts, should be replaced if evidence requires it.

As the contact wears, the pressure of the movable contact (when closed) is maintained against the stationary one by the wiping springs. Inspection of the spring is necessary, since heating may cause tempering and eventually reduce the pressure. The correct spring pressure is usually shown in the instruction sheet accompanying the relay. Also, the contact spring pressure on one pole can be compared to the pressure on the other poles of the same contact. The spring pressure on all poles should be approximately the same. If one is considerably lower, the contact should be replaced.

Contact Arcing

Another problem, associated with the relay load contacts, is excessive arcing. This arcing occurs when the contacts open an inductive load, such as an ignition transformer, or a small dc motor field. The resulting voltage ionizes, or breaks down, the air between the contacts and an arc is established. This arc is extinguished when the contacts are fully open. However, it may be established and extinguished several times due to contact bounce. The arc may be a glow discharge, or even a small metallic bridge, which becomes hot enough to vaporize a small portion of the contact metal. Repeated arcing causes erosion, pitting, and general deterioration, and results in high contact resistance.

Where arcing is a problem, two or more contacts can be connected in series. The voltage induced across each contact is reduced accordingly. This in turn, reduces or entirely eliminates arcing. Other solutions are:

1. Connect a capacitor and resistor across the contacts.

2. Connect a diode across the contact load.

BATTERY SYSTEM

****WARNING****

Batteries give off hazardous fumes during normal operation. Do not smoke, use open lights or allow open flames near batteries. Exercise extreme care if using metallic tools or other equipment which could short out battery terminals. Sparking or arcing could result in an explosion. Electrolyte is an acid and can cause severe burns. Always wear protective clothing such as a rubber apron, safety goggles and rubber gloves when performing any maintenance or inspections on batteries.

Battery

Refer to battery manufacturer’s recommendations in the Power Auxiliaries Support System Tab.

Battery Charger (if applicable)

Refer to battery manufacturer’s recommendations in the Power Auxiliaries Support System Tab.

MOTOR CONTROL CENTER

Circuit Breakers

Check the circuit breakers for physical damage to the switching unit. Check the switching unit for accumulation of dust, dirt and the security of all connections.

Magnetic Contactors and Starters

Check to see if the relay contacts are welded together by depressing the brown operator (actuator), located at the top of the overload relay contact housing. When the relay is in a reset condition, an audible click will be heard when the operator is depressed. This indicates that the contacts are operating normally.

A continuity check can also be made by disconnecting the control wiring from the terminals of the relay and placing a bell set, or a resistance measuring instrument, in the circuit. Connecting either of these across the relay terminals, will indicate the relay contact is closed until the contact-check operator is depressed; interrupting the circuit.

Check the magnet mating surfaces and assure they are free from dust, dirt, oil and grease.

Check the silver contacts for wear. If the silver tip is worn, and the contact tip support is exposed, replace the contacts. *DO NOT FILE THE SILVER CONTACTS* to clean off projections, nicks, scratches, etc.

Magnetic Relays

Check the contact surfaces for cleanliness, dirt, dust, oil and grease, etc.

Check the silver contacts for wear and replace them before the silver is completely gone. *DO NOT FILE THE SILVER CONTACTS* to clean off projections, nicks, scratches, etc.

General Purpose Contactors

Inspect the arc chute for physical damage. Check the arcing horn clearances. Check the armature spring adjustments, contact force, tie gaps and wires.

Starting Motor Limitamp Contactor (if applicable)

Over a period of time contactor bolts can loosen. This may cause tip misalignment and arcing. Periodic inspection, preventative maintenance and cleaning can prevent contactor damage.

Disengage the contactor from the power stabs by moving it to the service position. Check all hardware for looseness, check for loose electrical connections, blow off accumulations of dust, dirt and wipe base clean, check contacts for general conditions, check magnet assembly and align if needed. Refer to the Limitamp Devices in your Service Manual for further information.

GENERATORS

For Maintenance and Inspection Procedures for the generator refer to the Generator Maintenance section of this Service Manual.

Load Gear and Collector Compartments

Make sure there are no loose fiberglass expansion joints in this compartment, that all interfaces between the compartment and generator ends are watertight, and the seals are not damaged. If there is an accumulation of dust or dirt, it should be cleaned out. Check the cooling air discharge vents to be sure they are not clogged.

INLET AIR SYSTEMS MAINTENANCE AND SYSTEM EQUIPMENT (GAS TURBINE)

Inlet Screen

Inlet screens are provided immediately upstream of the inertial separators to prevent the entry of birds, leaves, twigs, papers and other similar objects. These screens must be kept free from any excess accumulation of such debris to assure free air flow.

Inlet Filters

Refer to manufacturer's recommendations in Air Inlet and Exhaust System Tab.

****WARNING****

Do not attempt to replace filter elements while the gas turbine is in operation.

****WARNING****

Differential pressure across the inlet filter compartment door while the gas turbine is operating may cause rapid closure of the door or difficulty in opening the door from inside the compartment. Entry into the filter compartment should not be attempted while the turbine is operating unless special provisions for safe entry have been made.

Bypass Door

Downstream of the filter elements is the bypass door(s). These doors are designed to open at a predetermined static pressure depression, typically 5 in. (13 cm) w.g. The doors should normally never open. They are designed as a safety measure to prevent turbine shutdown and/or inlet duct implosion due to a sudden or abnormal blockage of the inlet system. Therefore, it is important that the air cleaning system is serviced before the static depression builds up to the point of by-pass opening. The turbine is unprotected and will be ingesting unfiltered air when the bypass door is open. The bypass door is gasketed to prevent air leaks. This gasket should be checked periodically and repaired if possible leaks are found.

The by-pass door is supplied with a switch to alarm upon opening of the door. In the event of such an alarm, action should be taken immediately to determine and rectify the cause.

Once a year the limit switch should be manually activated to determine proper circuit operation.

Inlet Compartment, Inlet Ductwork and Silencers

During periods of shutdown the inertial separators are not in operation. This allows any blowing dust to pass through and enter the inlet compartment. Before starting the unit after periods of shutdown the compartment must be inspected and cleaned out if necessary.

The inlet ductwork and silencer should be inspected at least once a year for leakage or any entrapped material. Leaks can be sealed with an appropriate caulking compound. Entrapped material should be removed to prevent possible foreign object damage. Any rust or oxidation spots on other than Cor-Ten material should be scraped and repainted.

Inlet Guide Vanes

Inspect the inlet guide vanes for corrosion pitting. Pay special attention to the fillet area of the inlet guide vane. If pitting is seen in this area, it may be assumed that there is also pitting on the underside of the vane/platform junction. Liquid penetrant inspection should be made in the fillet area. Report findings on appropriate Inspection Report.

Moisture Separators (if applicable)

On units equipped with moisture separators, the separators will typically be located between the inertial separators and the high efficiency media filters.

Evaporative Coolers

Evaporative cooler pump controls should be manually activated when the ambient dry bulb temperature is above 60°F (16°C) and approximately one-half hour prior to gas turbine start-up. After the generator breakers close, the controls should be switched to “automatic.” This procedure will wet the entire bank of media prior to the airflow, thus precluding entrainment of liquid water into the air from the dry media.

Note: At the end of the cooling season clean out tanks and wash media with water.

Water Flow Adjustment

Open the valves controlling the water flow to the header approximately 3 turns from fully closed. With the turbine operating, check the media in the cooler. If the media is not fully wet (typically at the opposite end from the pump), open the valve by one-half turn increments until the media becomes fully wetted. Allow five minutes between valve adjustments for wetting to occur. Once the valves have been set, no further adjustments are necessary other then periodic checking of the media wetness during the day’s operation. In some coolers, the water distribution system may not allow water to reach the final 12 in. (30.5 cm) of the media away from the pumps under any condition; this is normal and causes no performance loss.

Note: Supplying an excessive amount of water to the header may cause liquid water carry-over into the airstream. Allow only enough water to maintain media saturation.

Shut Down Pump Operation

Approximately one-half hour prior to shut down of the gas turbine, switch the pump controls off. This will allow the media to thoroughly dry out, precluding possible condensation in the inlet ductwork when the turbine is not operating.

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TAB

SCHEDULED TURBINE MAINTENANCE

Scheduled Turbine Maintenance

RUNNING INSPECTIONS

Running inspections consist of observations made while a unit is in service. The turbine should be observed on a programmed schedule which should be established as part of the unit maintenance program consistent with the operator's requirements.

Housekeeping

In addition to the detailed maintenance procedures which follow, the daily (or short-term) observation of Gas Turbine operation and appearance must be considered. The following checklist, will give the operator a start toward establishing his own routine for maintaining the turbine in a clean, well–functioning condition:

Control Room

****WARNING****

Observe all safety notices and precautions when occupying unit control cab.

1. Check condition of turbine-generator-control panel and motor control center lamps.

Note: Replacement of bulbs while unit is operating could result in inadvertent unit shutdown.

2. Observe that all instruments are functional and readable – clean glass faces when dirty, replace glass if broken.

3. Periodically check cleanliness of the filter element in the room air conditioner – clean as necessary.

4. Look for evidence of loose or chafing wires – and schedule maintenance action.

5. Clean the floor.

6. Note battery charger output level.

Turbine Compartment

****WARNING****

> **Observe all safety notices when occupying the turbine compartment.**

1. Observe both AC and DC compartment lighting systems. Replace burned-out bulbs.
2. Look for evidence of air, exhaust, lube oil, fuel or water leaks on
   a. Four-way joints
   b. Turbine legs
   c. Horizontal joints
   d. Vertical joints
   e. Combustion chambers
   f. Exhaust flex seals
3. Check cleanliness. of the compartment – sweep up any dirt, pick up rags or other debris; wipe up oil and water spills.
4. Note any loose or vibrating fittings, piping or accessory components – schedule maintenance action.

Accessory Systems

1. The accessory systems that are standard for each installation are
   a. Starting means module
   b. Lubricating oil module (including gas fuel system)
   c. Cooling water module
   d. Exhaust frame cooling air blower module
   e. Fire protection skid

   The optional accessory systems are

   f. Water injection module

****WARNING****

> **Observe all safety notices when occupying the turbine accessory modules.**

2. Observe AC and DC compartment lighting–replace burned–out bulbs.
3. Look for evidence of leaks on
   a. Fire protection system
   b. Torque converter
   c. Lube oil piping
   d. Lube oil filter
   e. Cooling water piping
   f. Gauges
   g. Hydraulic piping
   h. Hydraulic filters
4. Note condition of gauges, clean dirty instruments, schedule repair of damaged gauges, check calibration if gauges do not show reasonable values.
5. Clean the floors of dirt, water, oil, rags and other debris. Try to locate source of spills.
6. Note loose or vibrating piping, conduit or other fittings and schedule maintenance action.
7. Look for evidence of overheating of accessory components (such as paint discoloration)–schedule maintenance inspection or test of suspect components.

General

1. Check door seals for deterioration–schedule replacement as required.
2. Observe oil levels for the turbine and atomizing air compressor; observe water level in the cooling water module, note discrepancies, investigate cause, refill to proper levels at next shutdown.

Data Recording

Operating data should be recorded to permit an evaluation of equipment performance and maintenance requirements. Typical data includes load, exhaust temperature, vibration, fuel flow and pressure, exhaust temperature control and variation, and startup time.

The vibration level of the unit should be observed and recorded. Minor changes in vibration level will occur with changes in operating conditions. However, major changes in the vibration level or a continuously increasing trend to increase indicate that corrective action is required.

The fuel system should be observed for general fuel flow versus load relationship. Fuel pressures through the system should be observed. Changes in fuel pressure may indicate that fuel nozzle passages are plugged (dirty) or that fuel metering elements are damaged or out of calibration.

The variation in turbine exhaust temperature should be measured. An increase in temperature spread indicates combustion system deterioration or fuel distribution problems. If this is not corrected, reduced life of downstream parts can be expected.

One of the most important control functions to be observed is the exhaust temperature control system and its backup overtemperature trip circuitry. Routine verification of the operation and calibration of these systems will minimize wear on the hot gas path parts.

Startup time (when the gas turbine is new) is an excellent reference to which subsequent operating parameters can be compared and evaluated. A curve of starting parameters of speed, fuel VCE signal, exhaust temperature, and critical sequence benchmarks versus time from the initial start signal provide a good indication of the accuracy of the control system, fuel system, fuel nozzles, ignition and combustion system. Deviations from normal conditions help pinpoint impending trouble, changes in calibration or damaged components.

Operating data should be recorded to permit an evaluation of the equipment performance and maintenance requirements. Data should be recorded after the gas turbine has reached steady state at each load condition. Steady state is defined as no more than 5°F (–15°C) change in wheelspace temperature for a 15-minute interval.

Turbines having SPEEDTRONIC∗ control systems have the capability of recording and printing many of the needed parameters. The user’s manual contains the general instructions for recording and printing these values. The control specification for the individual gas turbine should be consulted to determine the values that can be recorded automatically and those that will require recording through another system or by hand.

The following list is given as a guide to the parameters needed. All of these values should be recorded at 1/4, 1/2, 3/4 and rated load. On dual fuel machines, data should be taken on both fuels.

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MS-7001FA+e

OPERATING DATA

GENERAL DATA

Fuel	________	________	________	________
HP Turbine Speed, rpm	________	________	________	________
Fired Hours	________	________	________	________
Manual Start Counter	________	________	________	________
Total Start Counter	________	________	________	________
Fast Load Start Counter	________	________	________	________
Generator Breaker Counter	________	________	________	________
Site Altitude – feet	________	________	________	________
Site Barometer – in. Hg	________	________	________	________
Ambient Air Temp °F	________	________	________	________

Air, Ambient	________	________	________	________
Air after Evaporative Cooler				
Compressor Discharge – L	________	________	________	________
Compressor Discharge – R	________	________	________	________
First-Stage Forward Wheelspace	________	________	________	________
First-Stage Forward Wheelspace	________	________	________	________
First-Stage Aft Wheelspace	________	________	________	________
First-Stage Aft Wheelspace	________	________	________	________
Second-Stage Forward Wheelspace	________	________	________	________
Second-Stage Forward Wheelspace	________	________	________	________
Second-Stage Aft Wheelspace	________	________	________	________
Second-Stage Aft Wheelspace	________	________	________	________

OPERATING DATA (Cont'd)

TEMPERATURES (°F) (Cont'd)

	1/4	1/2	3/4	Full Load
Third-Stage Forward Wheelspace	________	________	________	________
Third-Stage Forward Wheelspace	________	________	________	________
Third-Stage Aft Wheelspace	________	________	________	________
Third-Stage Aft Wheelspace	________	________	________	________
Turbine Exhaust — No. 1	________	________	________	________
Turbine Exhaust — No. 2	________	________	________	________
Turbine Exhaust — No. 3	________	________	________	________
Turbine Exhaust — No. 4	________	________	________	________
Turbine Exhaust — No. 5	________	________	________	________
Turbine Exhaust — No. 6	________	________	________	________
Turbine Exhaust — No. 7	________	________	________	________
Turbine Exhaust — No. 8	________	________	________	________
Turbine Exhaust — No. 9	________	________	________	________
Turbine Exhaust — No. 10	________	________	________	________
Turbine Exhaust — No. 11	________	________	________	________
Turbine Exhaust — No. 12	________	________	________	________
Turbine Exhaust — No. 13	________	________	________	________
Turbine Exhaust — No. 14	________	________	________	________
Turbine Exhaust — No. 15	________	________	________	________
Turbine Exhaust — No. 16	________	________	________	________
Turbine Exhaust — No. 17	________	________	________	________
Turbine Exhaust — No. 18	________	________	________	________
Turbine Exhaust — No. 19	________	________	________	________

OPERATING DATA (Cont'd)

TEMPERATURES (°F) (Cont'd)

Turbine Exhaust — No. 20	________	________	________	__________
Turbine Exhaust — No. 21	________	________	________	__________
Turbine Exhaust — No. 22	________	________	________	__________
Turbine Exhaust — No. 23	________	________	________	__________
Turbine Exhaust — No. 24	________	________	________	__________
Turbine Exhaust — No. 25	________	________	________	__________
Turbine Exhaust — No. 26	________	________	________	__________
Turbine Exhaust — No. 27	________	________	________	__________
Lube Bearing Header	________	________	________	__________
Lube Tank	________	________	________	__________
Water Radiator Outlet – L	________	________	________	__________
Water Radiator Outlet – R				
Bearing Drains (if Used)	________	________	________	__________
Location	________	________	________	__________

PRESSURES (PSIG)

Lubricant, Main Pump Discharge	________	________	________	__________
Lubricant, Bearing Header	________	________	________	__________
Main Compressor Discharge	________	________	________	__________
Cooling Water Header	________	________	________	__________
Hydraulic Trip Circuit				
Lube Filter – In				
Lube Filter – Out				
Fuel Nozzle – No. 1				
Fuel Nozzle – No. 2				
Fuel Nozzle – No. 3				

Fuel Nozzle – No. 4

Fuel Nozzle – No. 5

Fuel Nozzle – No. 6

Fuel Nozzle — No. 7

Fuel Nozzle — No. 8

Fuel Nozzle — No. 9

Fuel Nozzle — No. 10

Fuel Nozzle — No. 11

Fuel Nozzle — No. 12

Fuel Nozzle — No. 13

Fuel Nozzle — No. 14

Fuel Gas Supply

Fuel Gas after SR and Control Valve

PERFORMANCE INPUTS

Fuel Flow

Fuel Gas Temperature (if Performance Run) °F

Fuel Heat Value - LHV or HHV (if Performance Run)

GENERATOR

Output Voltage — 1–2

Output Voltage — 2–3

Output Voltage — 3–1

Phase Current — 1

Phase Current — 2

Phase Current — 3

M—Vars

Field Voltage

Field Current

OPERATING DATA (Cont'd)

PRESSURES (PSIG) (Cont'd)

Stator Temperature (°C) 1
2
3
4
5

Kilowatt Hours — Total

Kilowatt Hours (if performance run)

Time (Seconds) for 20 revolutions of KWHR disc

KWHR meter constant

VIBRATION DATA

Record data at

Half and Full Load

Torque Converter — H

Torque Converter — V

Torque Converter — A

Starting Means Coupling — Torque Converter End

Starting Means Coupling — Motor End

Inlet Casing — H (at Support Leg)

Inlet Casing — V (at Support Leg)

Inlet Casing — A (at Support Leg)

Exhaust Frame — H (at Support Leg)

Exhaust Frame — V (at Support Leg)

Exhaust Frame — A (at Support Leg)

Load Coupling, — Gen. End

Load Coupling, — Turbine End

Driven Equipment — Generator

Starting Means End — H

Starting Means End — V

Starting Means End — A

Turbine End — H

Turbine End — V

Turbine End — A

CRANKING CHECKS (Final Settings)

1. Fuel Pump or Gas Valve Stroke

	FSR	Gas Control Valve	Fuel Pump
Fire	____________	____________	____________
Warmup	____________	____________	____________
Acceleration	____________	____________	____________
Maximum	____________	____________	____________
Minimum	____________	____________	____________

2. Speed Relay Settings (Turbine Speed)

	Pickup	Drop Out
14HM	______________	______________
14HA	______________	______________
14HS	______________	______________
14HR	______________	______________

3. Overspeed

Gas Turbine ______________ , ______________ , ______________

____

Start Device, (if applicable) ______________ , ______________ , ______________

MISCELLANEOUS

Lube Tank Level ____

Cooling Water Tank Level ____

Borescope Inspections

General

The gas turbine incorporates provisions in both turbine and compressor casings for visual inspection of an intermediate compressor rotor stage or stages, first and second stage turbine buckets and nozzle partitions by means of the optical borescope.

These provisions, consisting of radially aligned holes through the casings and internal stationary turbine shrouds, are designed to allow the penetration of an optical borescope into the gas or air-flow path regions of a non-operating gas turbine. Optical borescopes are utilized to provide visual inspection of the rotating and stationary parts without removing the upper compressor and turbine casings.

Areas of Inspection

In the hands of a qualified technician, the borescope allows rapid inspection of the following areas with minimum outage time, manpower and loss of production.

1. Turbine section
2. Axial flow compressor
3. Combustion system

Note: The primary zones and fuel nozzles for chambers 2, 3, 11, 12, 13 and 14 can be inspected by removing spark plugs and flame detectors.

Table 4-1 lists the inspection criteria for these areas of inspection. Table 4-2 lists the access hole location and number of holes in each location.

Figure 4-1 locates the borescope access holes for the various locations.

Equipment Required

A rigid borescope with high-quality rigid lens system plus a flexible fiber bundle to introduce light at the borescope tip from an external light projector is the basic equipment needed for visual inspection of the turbine and compressor. The combustion system, including the transition pieces, can only be inspected using a flexible fiber-optic borescope.

A qualified technician using this equipment can make visual observation and record the observed details.

Additional auxiliary equipment desirable to supplement the basic equipment may include a borescope support mount or fixture, camera attachments, camera and a television camera with recording capability and playback monitor.

Borescope Inspection Programming

A planned borescope inspection program results in opening a turbine unit only when necessary to repair or replace parts. It should be recognized that inspection intervals are based on average unit operating modes. Adjustment of these intervals may be made based on experience and the individual unit mode of operation and the fuels used. Refer to Table 1-1, Special Inspections, in the Introduction, Section 1, in this inspection and maintenance manual.

The borescope inspection program should include

1. Baseline inspection and recording of conditions, both written and photographic, at the time of startup

2. Periodic inspection and recording of the results

   The application of a monitoring program, utilizing the borescope, will allow scheduling outages and pre-planning of parts requirements resulting in lower maintenance costs, higher availability and reliability of the gas turbine.

Service Support for Borescope Inspections

Your GE Company Field Service Representative can quote and supply technicians and equipment to assist in setting up a program for monitoring machine condition.

Such service support also includes engineering evaluation of data and correlation of data with other units in similar application.

Inspection Procedure

1. Preparation of Gas Turbine for Borescope Inspection

   a. The gas turbine must be shutdown and the turbine wheelspace temperatures no greater than 180°F (82°C) before the borescope is inserted.

Note: Exposure of the borescope to higher temperatures may permanently damage the internal glass fiber bundle.

   b. For the location of borescope inspection access locations, see Figure 4–1. If a normal borescope inspection is to be done, remove the closing plugs only from those access holes (marked BS on turbine cases, which are defined as primary inspection access – normal inspection. See Figure 4–1.

Note: All casing holes on the MS-7001FA have an inner plug beneath the threaded plug in the casings. Both plugs must be removed to gain access. Ensure that inner plugs are correctly replaced after completing inspection.

   c. When inspecting compressor blades and turbine buckets, it is necessary to rotate the rotor incrementally to bring each bucket into the field of view of the borescope. Withdraw the borescope slightly while turning the rotor to prevent damage to the equipment.

CAUTION

A lube oil supply to the rotor bearings must be maintained during the borescope inspection.

d. A “zero” datum should be established for the rotor by marking the load coupling. This will provide the necessary reference to determine one revolution or intermediate angular positions.

e. With the access holes open the borescope can now be inserted, the light switched ON and the light intensity adjusted. It is recommended that the inspection commence with the compressor and proceed through each turbine stage.

f. The procedure should consist of visually inspecting all visible stationary parts (compressor stators and turbine nozzles) and each bucket/blade at each visible stage from root to tip, including platforms and tip seals. For inspection criteria see Table 4-1.

Note: For purposes of physical orientation the objective lens at the borescope tip is displaced 180 degrees from the light connector beneath the eyepiece.

g. Upon completion of the inspection ensure that all sealing plugs at borescope access holes are replaced and tightened.

h. If the turbine internal parts are abnormally dirty (ingested dirt or oil vapors), the turbine should be cleaned before proceeding with the borescope inspection. For compressor cleaning, see the Water Wash and Cleaning section of this Service Manual.

Note: Your GE Company Field Service Representative can supply borescope technicians if assistance is needed in operation of the borescope equipment.

TABLE 4-1

MS-7001FA

BORESCOPE INSPECTION CRITERIA

ACCESS AREA	INSPECT FOR
Compressor blades	Foreign object damage Dirt buildup Corrosion Tip erosion Trailing edge thinning Stator blade root erosion Tip clearance
Combustion (Liner and transition piece)	Carbon buildup Hot spots Cracking Bulging Wear Missing metal or thermal barrier coating
Turbine nozzles	Foreign object damage Corrosion Blocked cooling holes Cracks Trailing edge bowing Erosion Burning
Turbine buckets	Foreign object damage Corrosion Blisters Erosion Cracks Tip clearance Missing metal

TABLE 4-2

MS-7001FA

BORESCOPE ACCESS HOLE LOCATIONS

Identification	Location	No. of Holes
“0” stage compressor	0.25” (0.635 cm) aft from forward flange face of the mid compressor, case	2
First-stage compressor	12.56” (31.9 cm) aft from forward flange face of the mid compressor, case	2
Second-stage compressor	24.06” (61.1 cm) aft from forward flange face of mid compressor, case	2
Third-stage compressor	32.06” (81.4 cm) aft from forward flange face of mid compressor, case	2
Fourth-stage compressor	41.23” (104.7 cm) aft from forward flange face of the mid compressor, case	2
Fifth-stage compressor	48.46” (123 cm) aft from forward flange face of mid compressor, case	2
Sixth-stage compressor	54.80” (139.2 cm) aft from forward flange face of mid compressor, case	2
Fifteenth-stage compressor	8.152” (20.7 cm) aft from forward flange face of the compressor discharge casing	2
Sixteenth-stage compressor	12.171” (30.9 cm) aft from forward flange face of the compressor discharge casing	2
Seventeenth–stage compressor	16.301” (41.4 cm) aft from forward flange face of the compressor discharge casing	2
First-stage nozzle trailing edge and first-stage bucket leading edge	41.480” (105.4 cm) aft from forward flange face of the turbine casing	2
First-stage bucket trailing edge and second-stage nozzle leading edge	47.760” (121.3 cm) aft from forward flange face of the turbine casing	1
Second-stage bucket leading edge and second-stage nozzle trailing edge	59.400” (150.9 cm) aft from forward flange face of the turbine casing	2
Second-stage bucket trailing and third-stage nozzle leading edge	62.880” (159.7 cm) aft from forward flange face of the turbine casing	1
Third-stage bucket leading and third-stage nozzle trailing edge	76.250” (193.7 cm) aft from forward flange face of the turbine casing	3

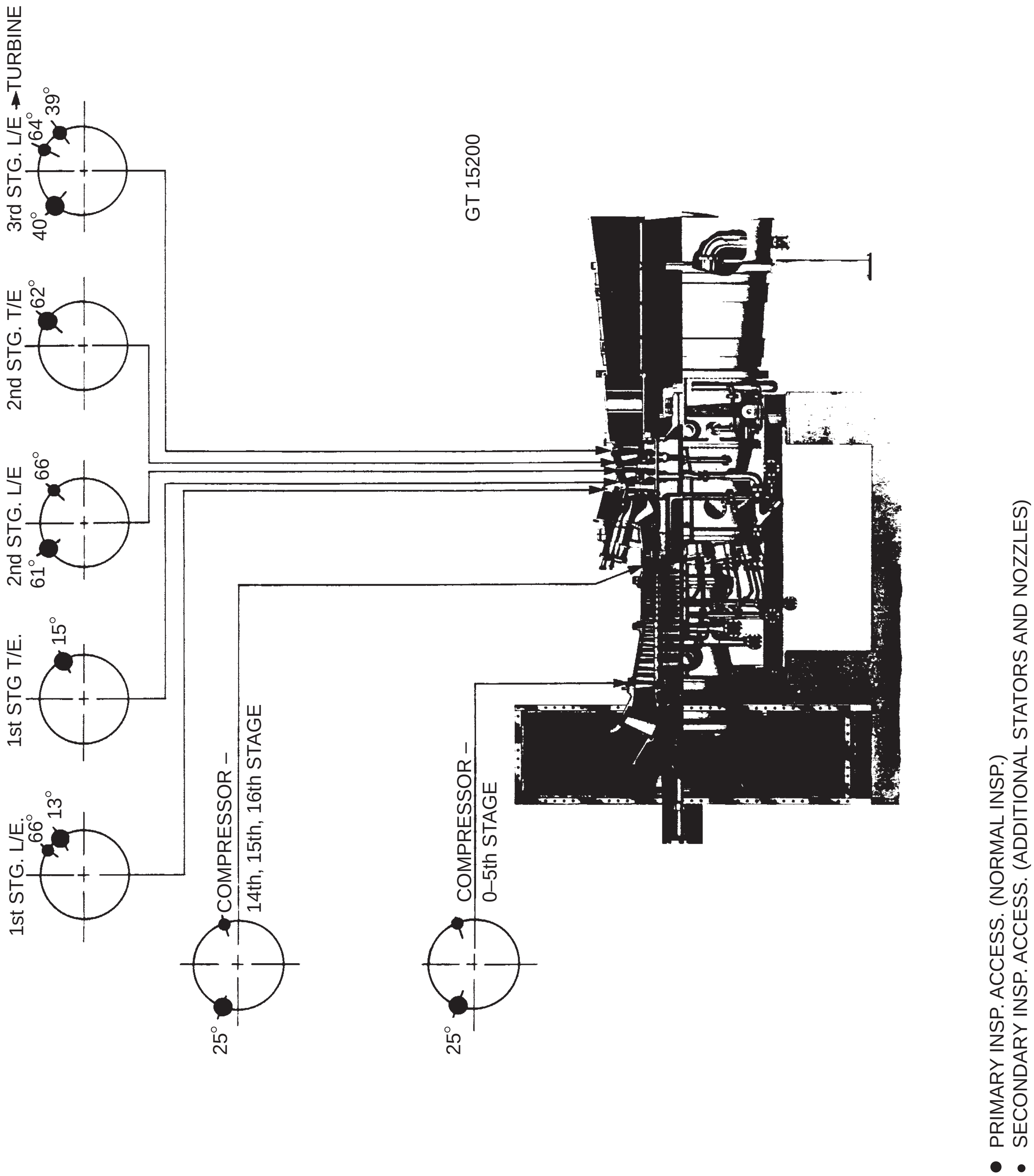

Figure 4–1. Borescope Hole Access Locations.

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TAB

COMBUSTION INSPECTION

GE Power Systems
Gas Turbine

Combustion Inspection

CAUTION

Before proceeding with a combustion inspection ensure that the gas turbine electrical power is tagged out; fire suppression system is deactivated; fuel system(s) is (are) purged, deactivated and/or blanked off. Reference the Standard Practices section in this instruction for general practices, inspection and maintenance.

CONTENTS

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I. Disassembly Procedures for MS7001FA+ and MS7001FA+e Gas Only Combustion Systems (with DLN-2.6) (Figures CI–D.1 and CI–D.1A)

Note: Obtain appropriate Inspection Forms from your local GE Field Service Representative.

Operation 1 — How to Remove the Flame Detectors (Figure CI-D.2)

1. Prior to disconnecting and removing the flame detectors and cooling water tubing, mark the flame detectors with the combustion chamber number. Also, label the tubing with the combustion cover number and whether it is a feed or return (drain) line. It is also recommended that the tubing connectors be match marked.

Note: The flame detector is mounted on the side of the combustion chamber (Figure CI-D.2). The cooling water feed manifold is located on the right-hand side downstream of the compressor discharge casing. The drain manifold is located downstream of the feed manifold.

2. Disconnect the wiring going to each of the flame detectors. This will ensure against any possibility of energizing the flame detectors.
3. Starting at combustion cover 14 and working clockwise to cover number 11, remove the $^{1}/_{2}$-inch (1.27-cm) tubing that runs from the flame detectors to the cooling water feed and drain manifolds.
4. Remove the flame detectors from combustion chambers 11 through 14, including the sealer tube that reaches the floating seal on the liner.
5. **Note: Operations 3 and 4 may be performed at the same time.**

Operation 2 — How to Remove the Spark Plugs (Figure CI-D.3)

1. Prior to disconnecting and removing the spark plugs, mark the combustion chamber number on each plug.
2. Disconnect the spark plug leads.
3. Unbolt each spark plug assembly from the casing flanges on combustion chamber numbers 2 and 3 by removing the four bolts on the spark plug flange. (See Figure CI-D.3)
4. Lift spark plugs out. Discard all gaskets.
5. Remove old anti-seize compound from all bolts; bag and identify for re-assembly. Clean matching flange surfaces.

CAUTION

Handle carefully to prevent breaking the internal ceramic parts.

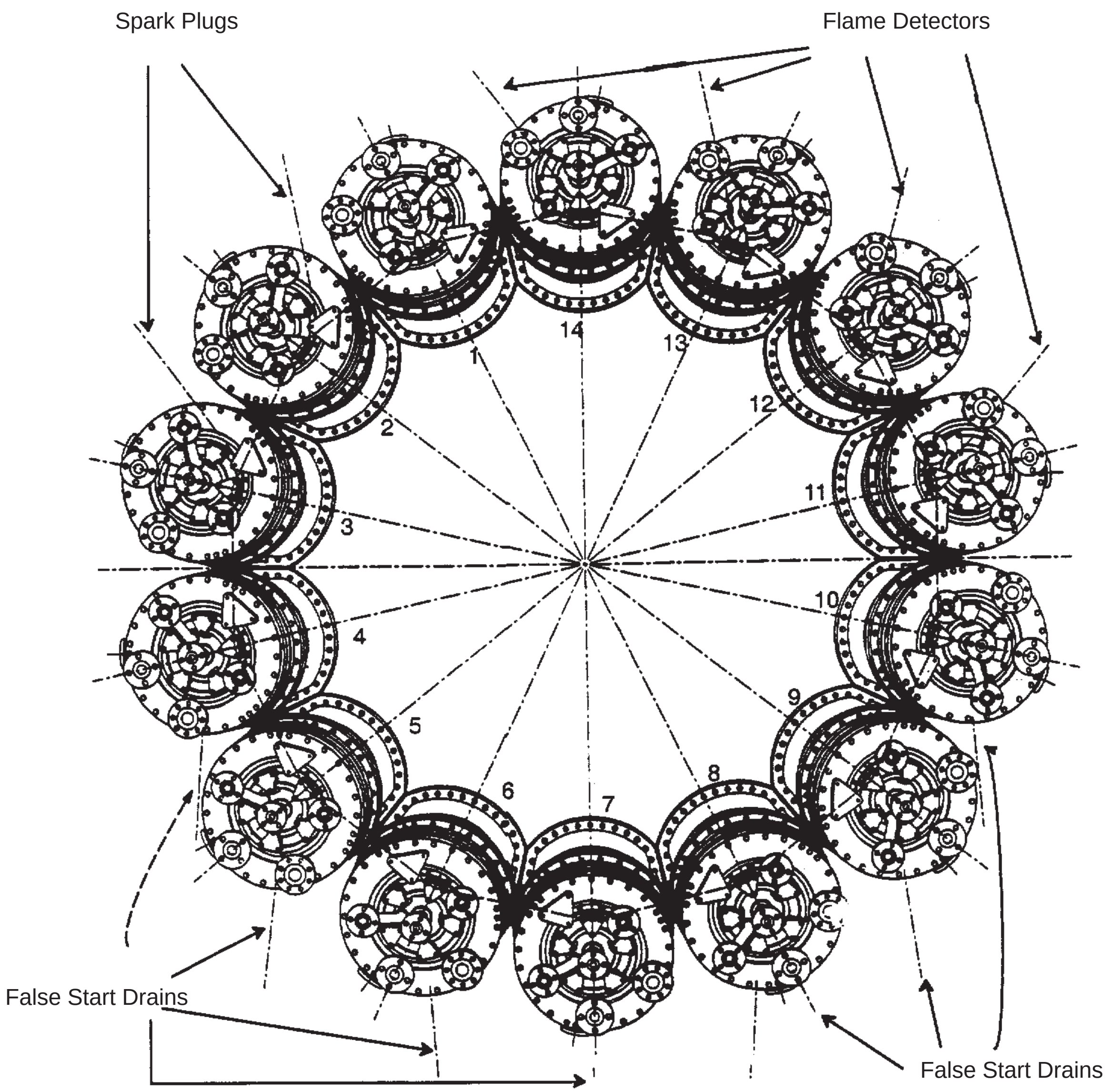

Figure CI-D.1 Combustion Arrangement

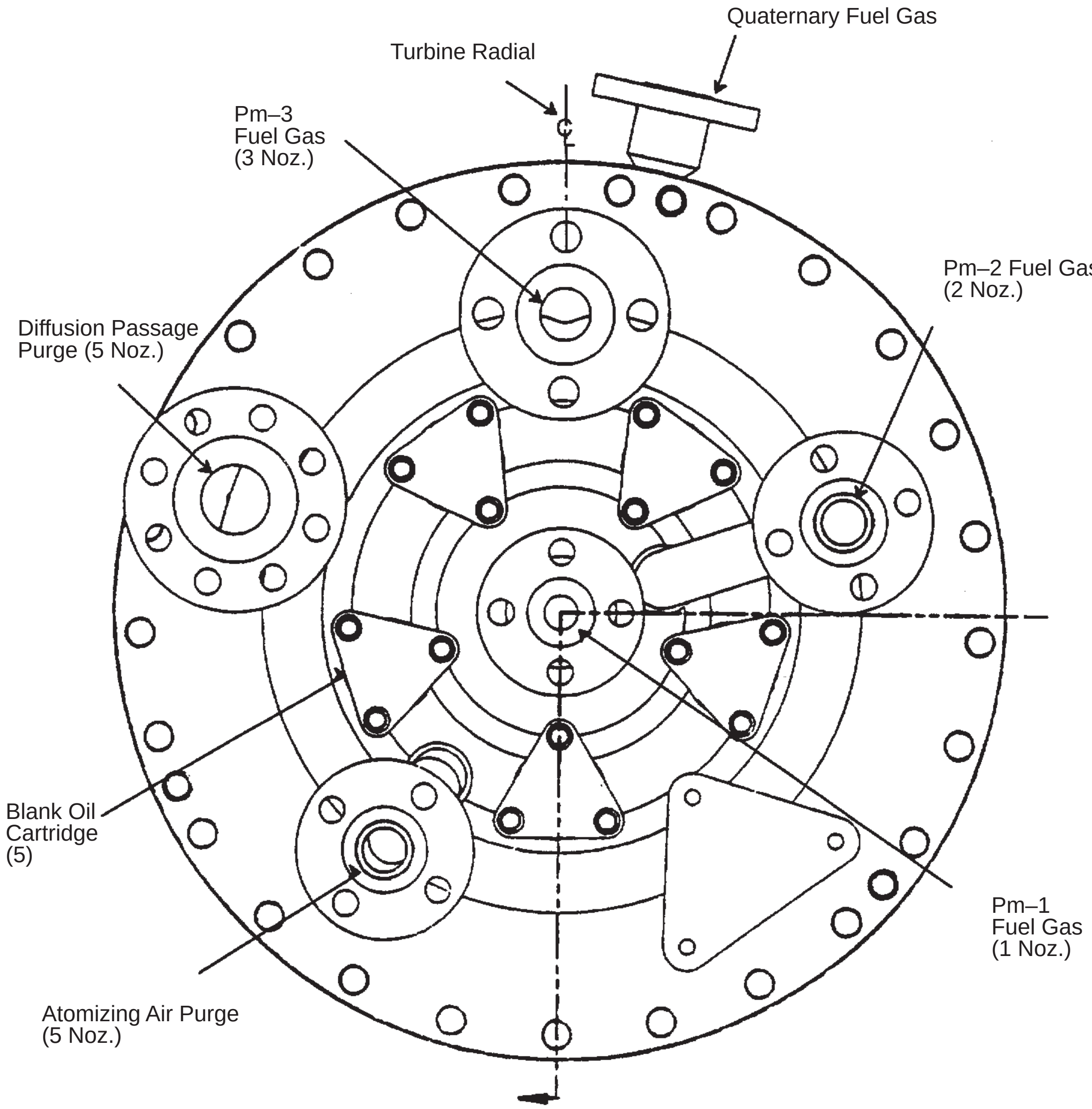

Figure CI-D.1A Fuel Nozzle End Cover

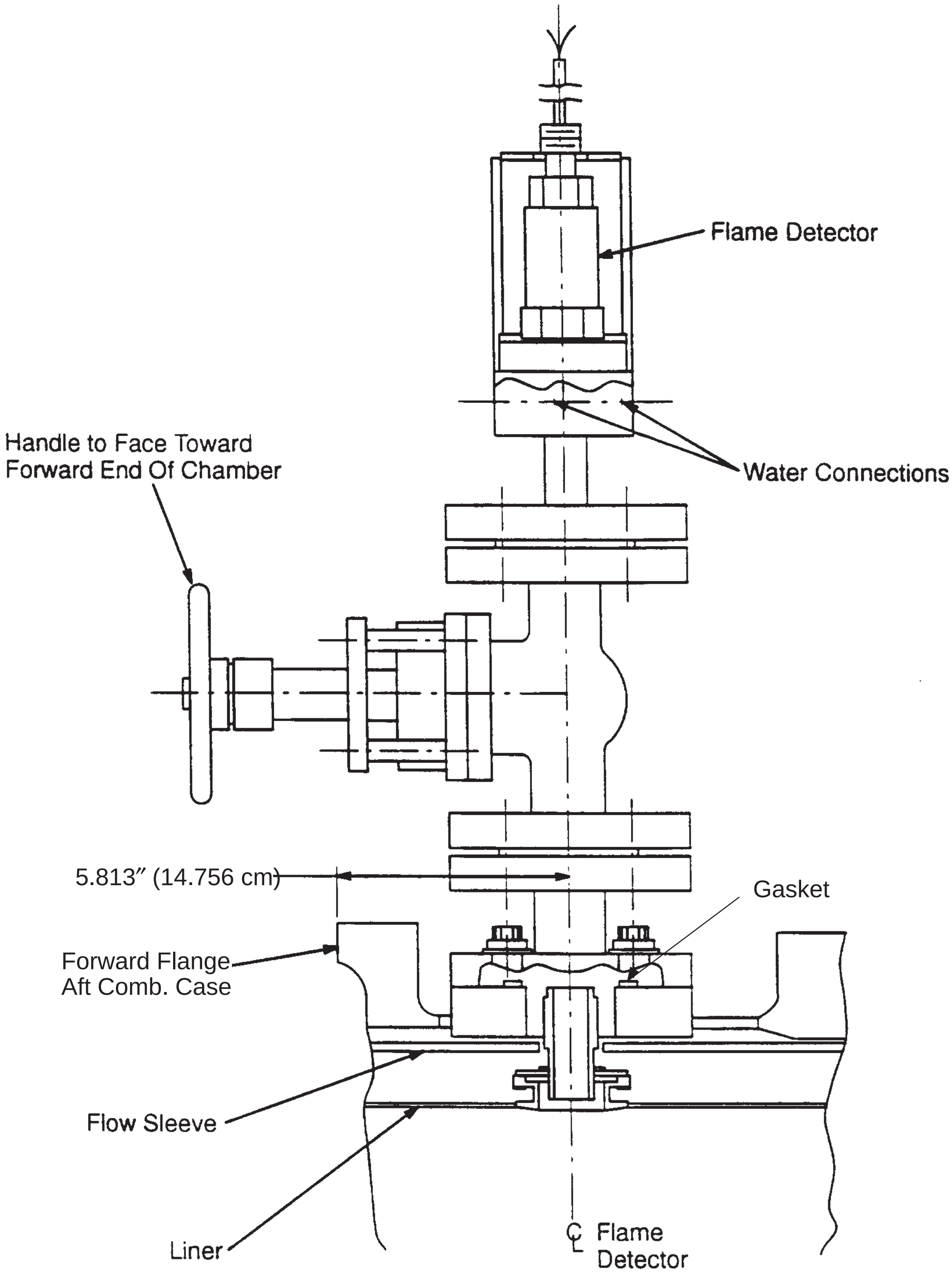

Figure CI-D.2. Flame Detector Assembly

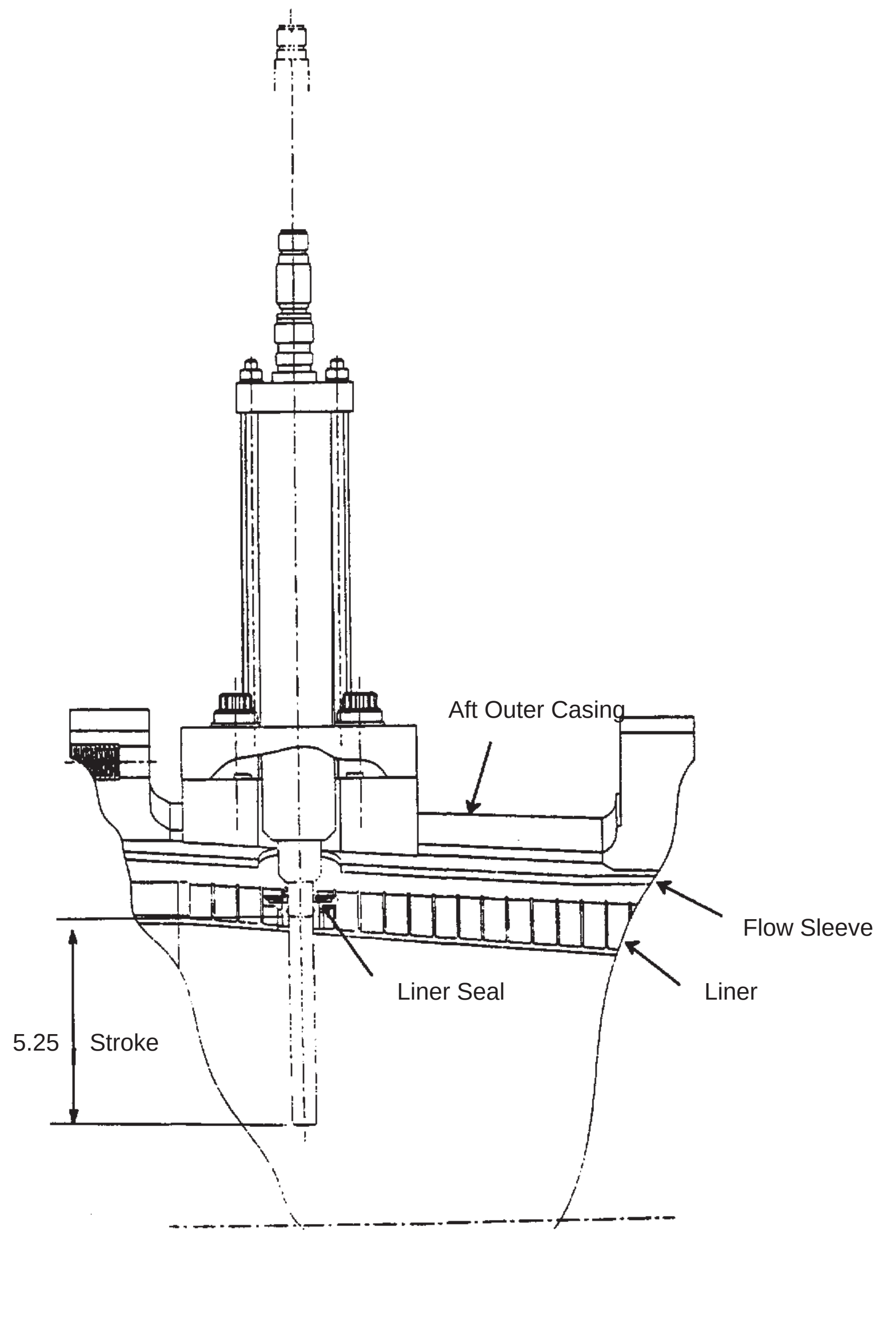

Figure CI-D.3 Spark Plug Assembly

Operation 3 — How to Remove the Gas Fuel and Purge Flex Hoses

1. Prior to disconnecting and removing the gas fuel flex hoses, mark the hoses with the combustion chamber number as well as whether it is connected to the PM-1, PM-2, PM-3 or quaternary flanges.

Note: There are five manifolds on the turbine. Four gas fuel supply manifolds and a purge manifold that supplies the diffusion and atomizing air passages in the fuel nozzle.

2. Starting at cover number 7 and working both clockwise and counterclockwise up to cover number 14, remove all five flex hoses to each combustion cover, and the hose to the quaternary flange on the fuel nozzle casing.

Operation 4 — How to Remove the Fuel Nozzle/Cover and Case Assembly (Figure CI-D.4) (Forward Combustor Module)

1. Prior to removing the cover and casing assembly, mark both parts with the chamber number.

2. Install lifting bracket provided to the end cover and eyebolts to the downstream casing flange of #14 chamber. Rig a set of slings so that the assembly can be removed axially from the downstream combustion casing.

CAUTION

> The cover and casing assembly weighs approximately 800 pounds (360 kilograms). A crane or other lifting device must be used for removal and installation.

> Do not attempt to remove cover from forward combustor module casing while installed on unit. Damage to fuel nozzle may result. Cover should be removed when forward combustor module is oriented vertically. Use the procedure described later in this manual.

3. Make sure the three guide pins are in place and that their retaining nuts are tight.

4. Raise the crane hook to support the assembly.

5. Remove the bolts from the flange between the fuel nozzle (FWD) casing and the combustion (AFT) casing. The assembly is now supported by the guide pins.

6. Attempt to slide the cover and casing axially on the guide pins. If it will not move, install three jacking bolts in the threaded holes located between the guide pins.

7. Use the jacking bolts to move the assembly axially until the spring seal on the cap assembly clears the combustion liner [approximately 2.5 in. (6.5 cm)].

8. Slide the assembly axially until the guide pins clear the casing flange.

9. The cover and casing assembly can be moved away and lifted clear of the turbine.

10. A special cart has been designed to support and transport cover/casing assembly.

CAUTION

> If the special cart is not available, the assembly may be set down on the downstream flange using blocks large enough—minimum 3 in. (8 cm)—to prevent the cap assembly from touching.

11. The remaining cover-casing assemblies can be removed in the same way. Some of the lower assemblies will require special rigging to control swing.

12. Remove and scrap casing gaskets. Do not reuse.

<u>Operation 5</u> — How to Remove the cap assembly from the cover and casing assembly (Figures CI-D.5, CI-D.5A)

1. Set up the cover and casing assembly in a horizontal position to give access to the downstream flange.

2. Remove the four machine screws that retain the cap assembly to the aft flange of the casing.

3. Attempt to slide the cap assembly out of the casing. Slide cap axially. Do not cock; damage to nozzle may occur. If it cannot be moved, install four jacking screws in the threaded holes adjacent to the machine screw holes. The cap assembly can then be moved aft—approximately 0.4 in. (1 cm)—until the cap flange clears the flange access.

4. The cap should then be slid aft until the six sleeves clear the fuel nozzles.

5. Mark the cap with the chamber location.

6. All other cap assemblies can be removed in the same way.

<u>Operation 6</u> — How to Remove the Combustion Liners and Crossfire Tubes (Figures CI-D.6, CI-D.7 and CI-D.8)

1. Be sure that the flame detectors and spark plugs have been removed. Remove the combustion liners by pulling all crossfire tube retainers away from the crossfire tube collars (two retainers per crossfire tube). Tag all retainer clamps and identify according to chamber position and side.

2. To remove the combustion liner, telescope both crossfire tubes toward the adjacent chamber until they are clear of the combustion liner. If crossfire tube tends to fall into the liner being removed, employ a long-bladed screwdriver or one of the retainers to hold the crossfire tube in the retracted position.

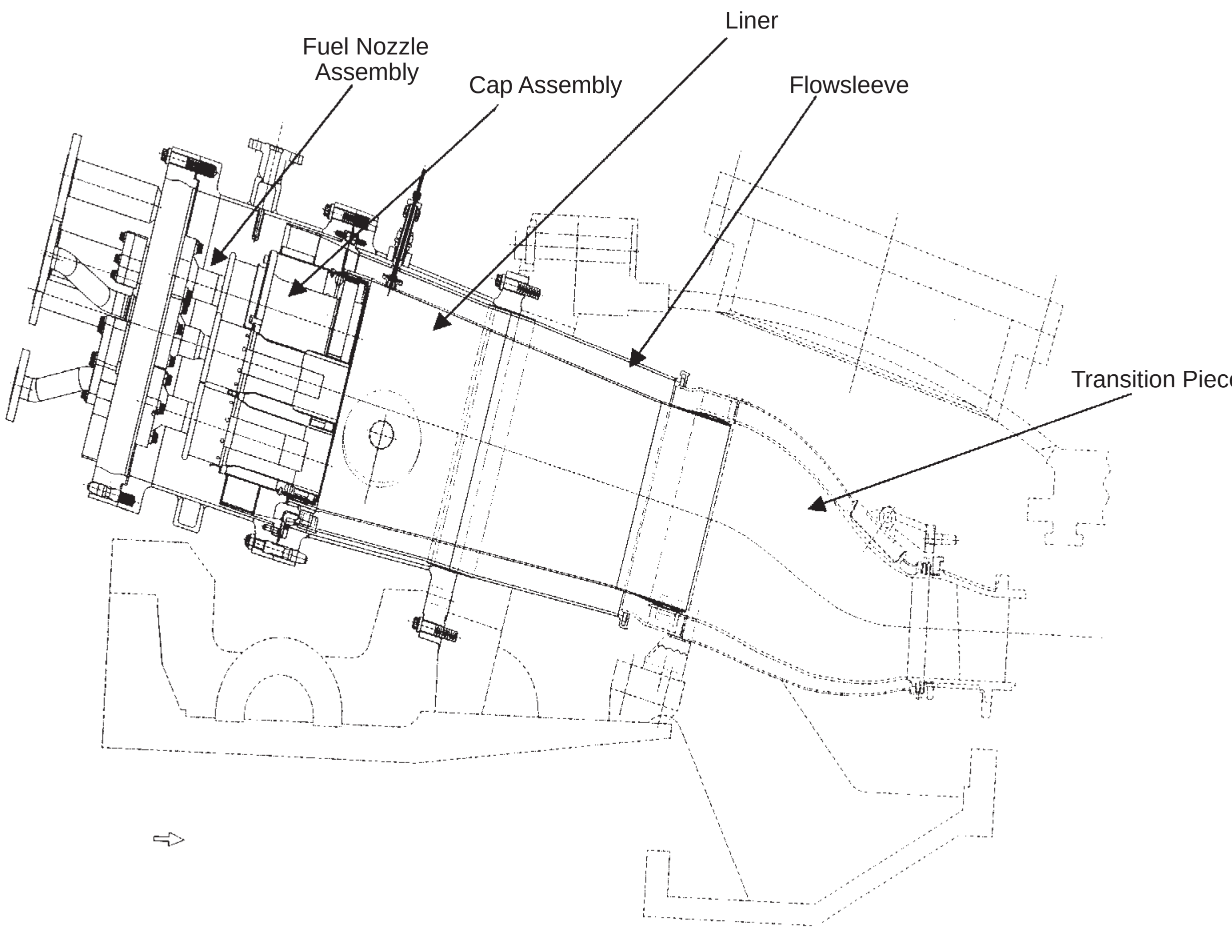

Figure CI-D.4 Combustion Chamber Arrangement

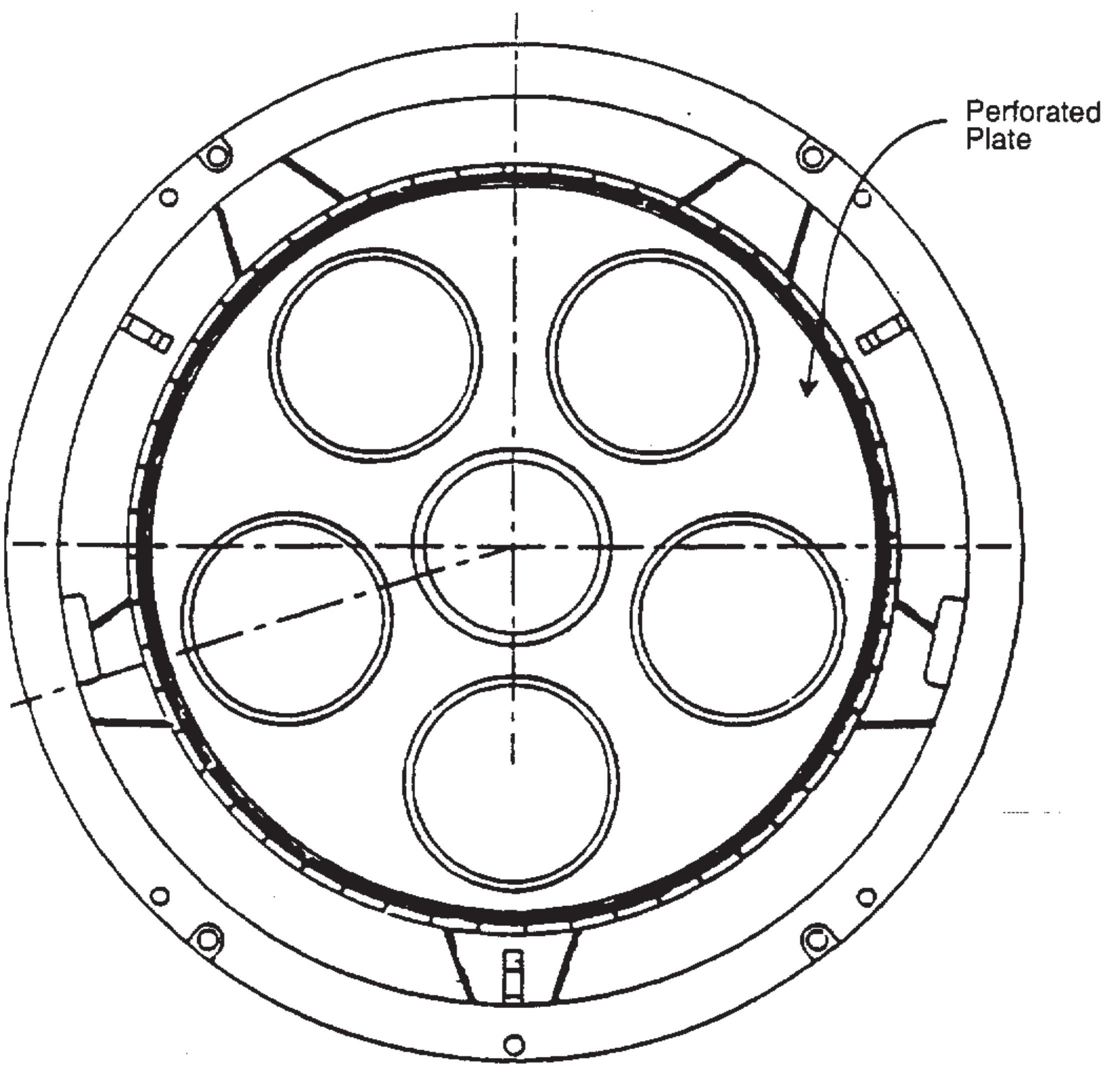

Figure CI–D.5 Cap Assembly, Downstream Face

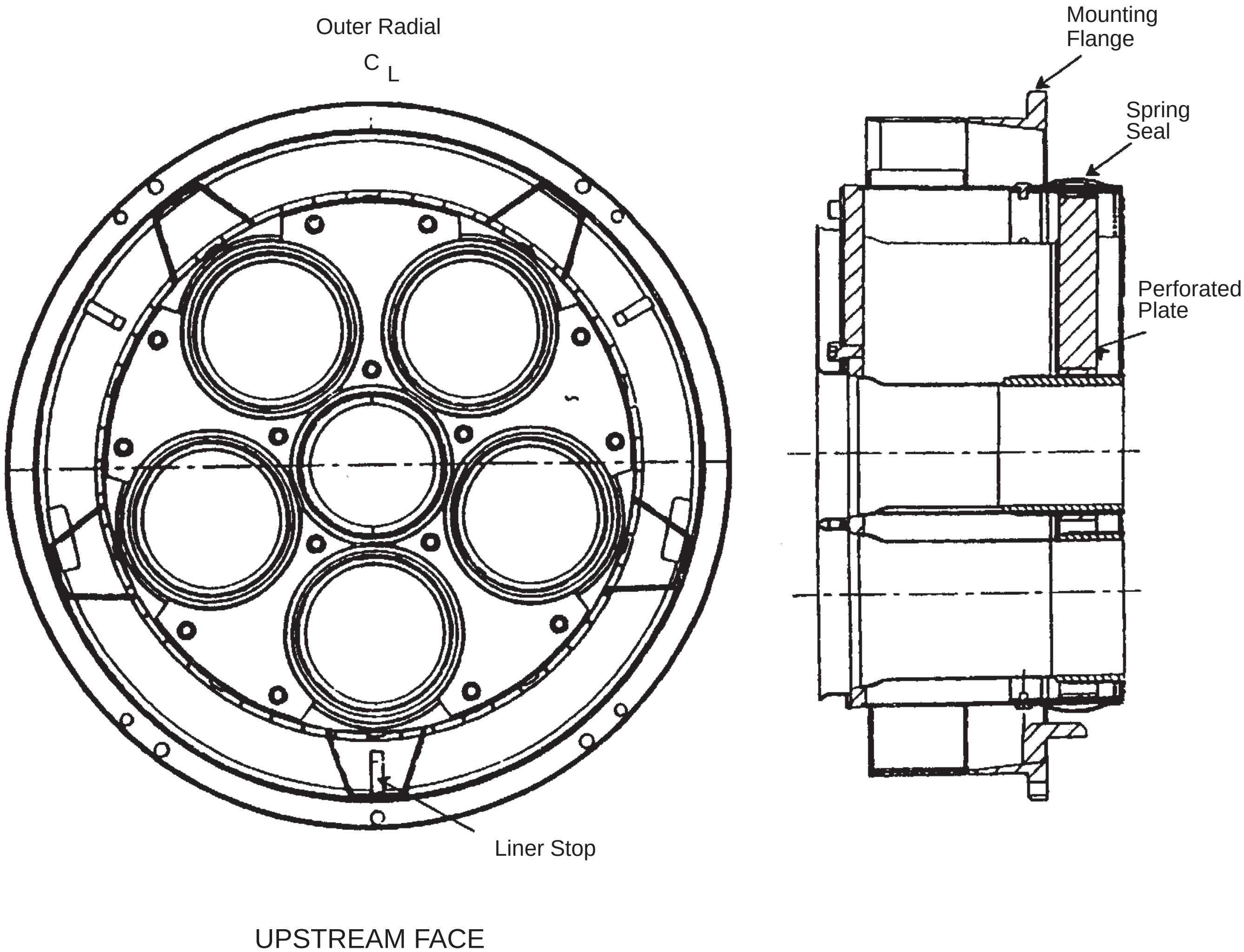

Figure CI-D.5A Cap Assembly

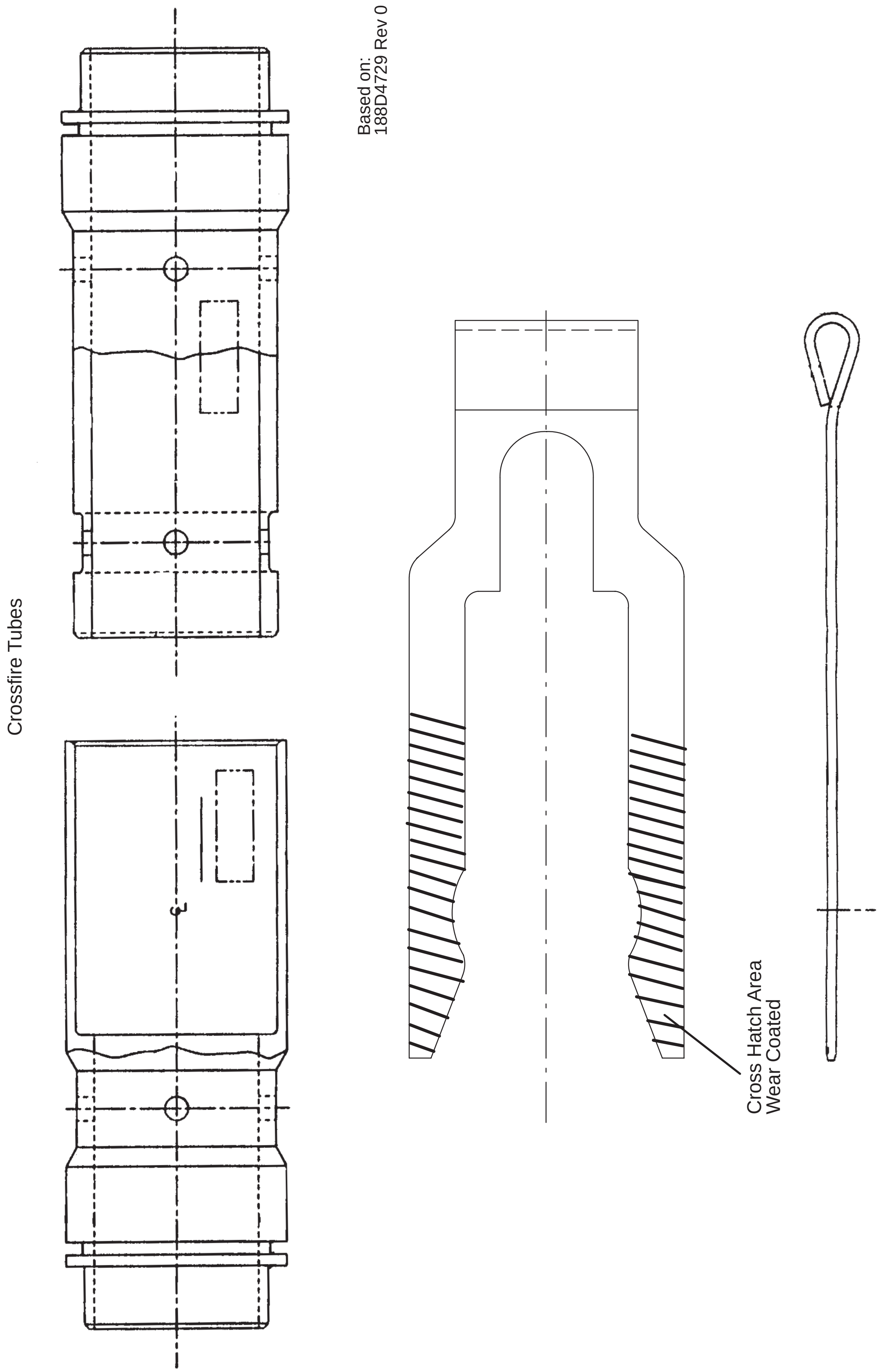

Figure CI–D.6. Crossfire Tube Parts

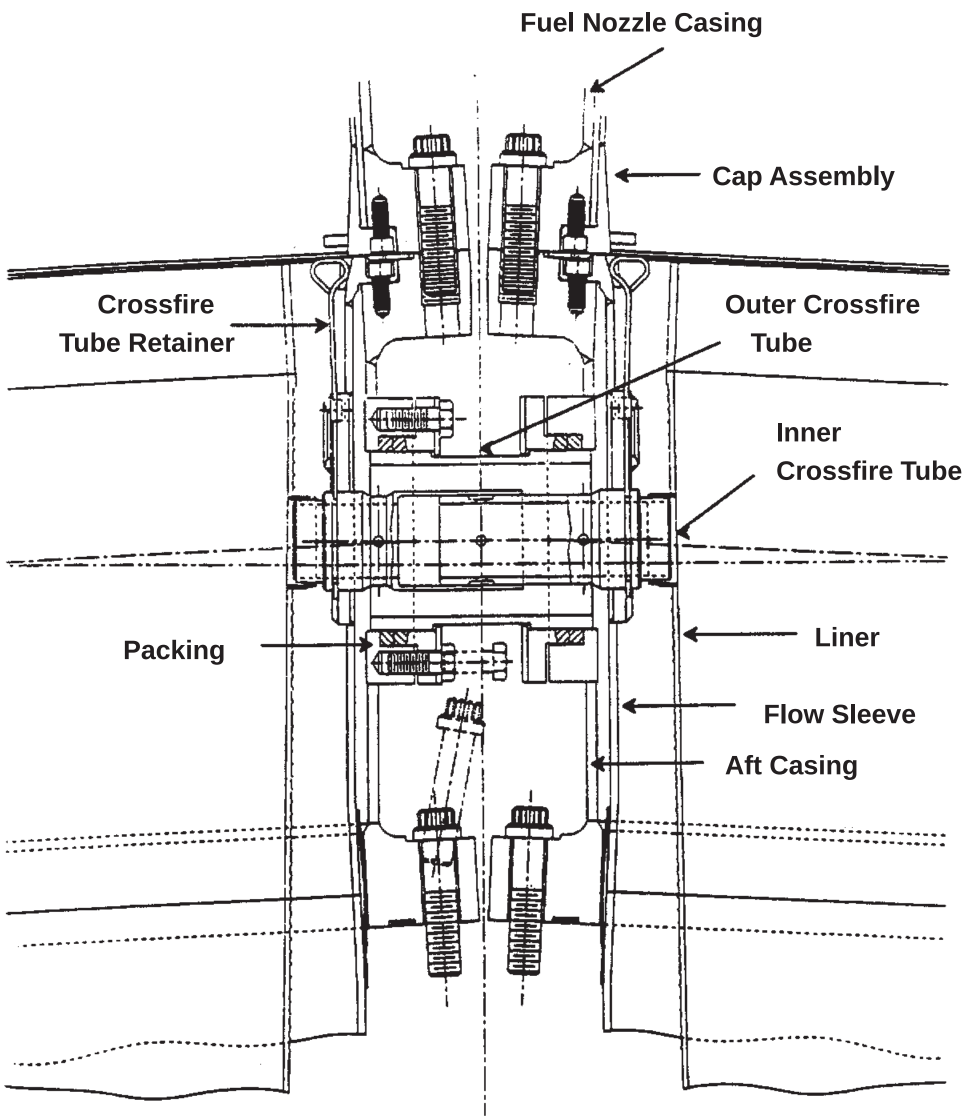

Figure CI–D.7 Crossfire Tube Assembly

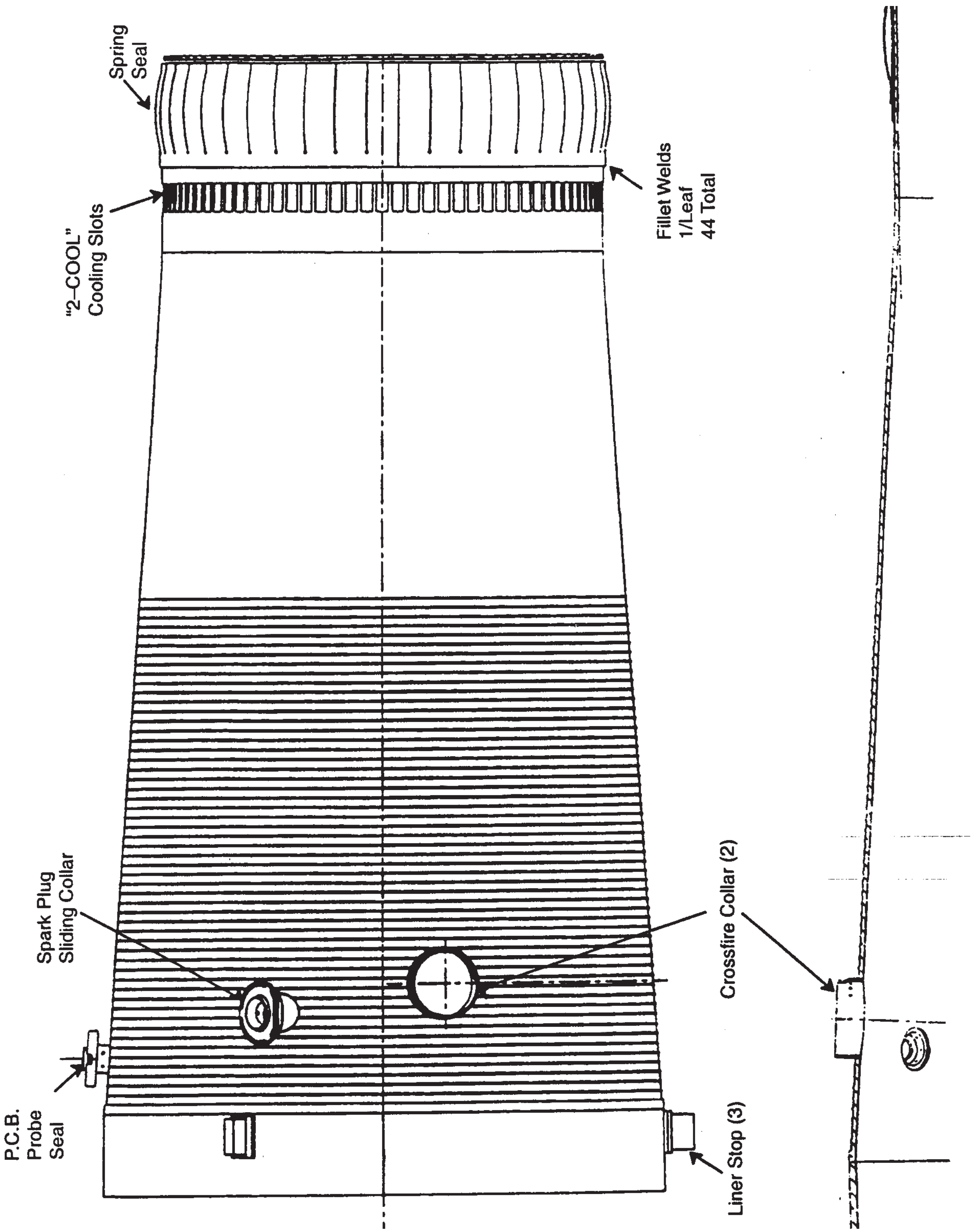

Figure CI-D.8. Combustion Liner

CAUTION

Be sure that crossfire tubes are disengaged from liner collars before attempting to move liner or damage will occur.

3. Pull liner straight out taking care not to snag the spring seals on the liner locating stops in the flow sleeve [each liner weighs approximately 60 lb (27 kg)]. Place liners on plywood to prevent damage and cover to keep dirt out.

Note: Exercise caution when removing liners to ensure that aft spring seal leaves and crossfire tube collars do not snag over liner stops on the flow sleeve.

4. Identify each liner according to chamber position. See Figure CI-D.1.

Note: Refer to the Standard Practices section in this maintenance instruction for marking of nickel-base alloys.

5. Retrieve both crossfire tube ends previously pushed into adjacent chambers by pulling each back through the empty chamber. Identify and tag each end with respect to its combustion chamber location and side.

6. Remove the remaining combustion liners and crossfire tubes in the same manner, identifying and tagging each.

Operation 7 — How to Remove the Flow Sleeves (Figure CI-D.9)

1. Remove four cap screws in flange of flow sleeve.

2. Remove flow sleeve and mark with combustion chamber number.

3. Remove remaining flow sleeves in the same manner, identifying each.

Note: Operations 9, 10 and 11 are required only if transition piece removal and inspection are required.

Operation 8 — How to Remove the Outer Crossfire Tubes (Figure CI-D.7)

1. Remove the six bolts from each sealing ring flange on the outer crossfire tube flanges. Remove the split ring retaining washers, identify them and store for reuse.

2. Back off each sealing ring in turn and chisel out a section of each sealing ring to loosen them. Push the outer crossfire tube through the remains of the packing rings into the adjacent combustion chamber and remove it.

3. Identify the tube with the combustion chamber numbers and store for reuse.

4. Clean out the remains of the packing rings.

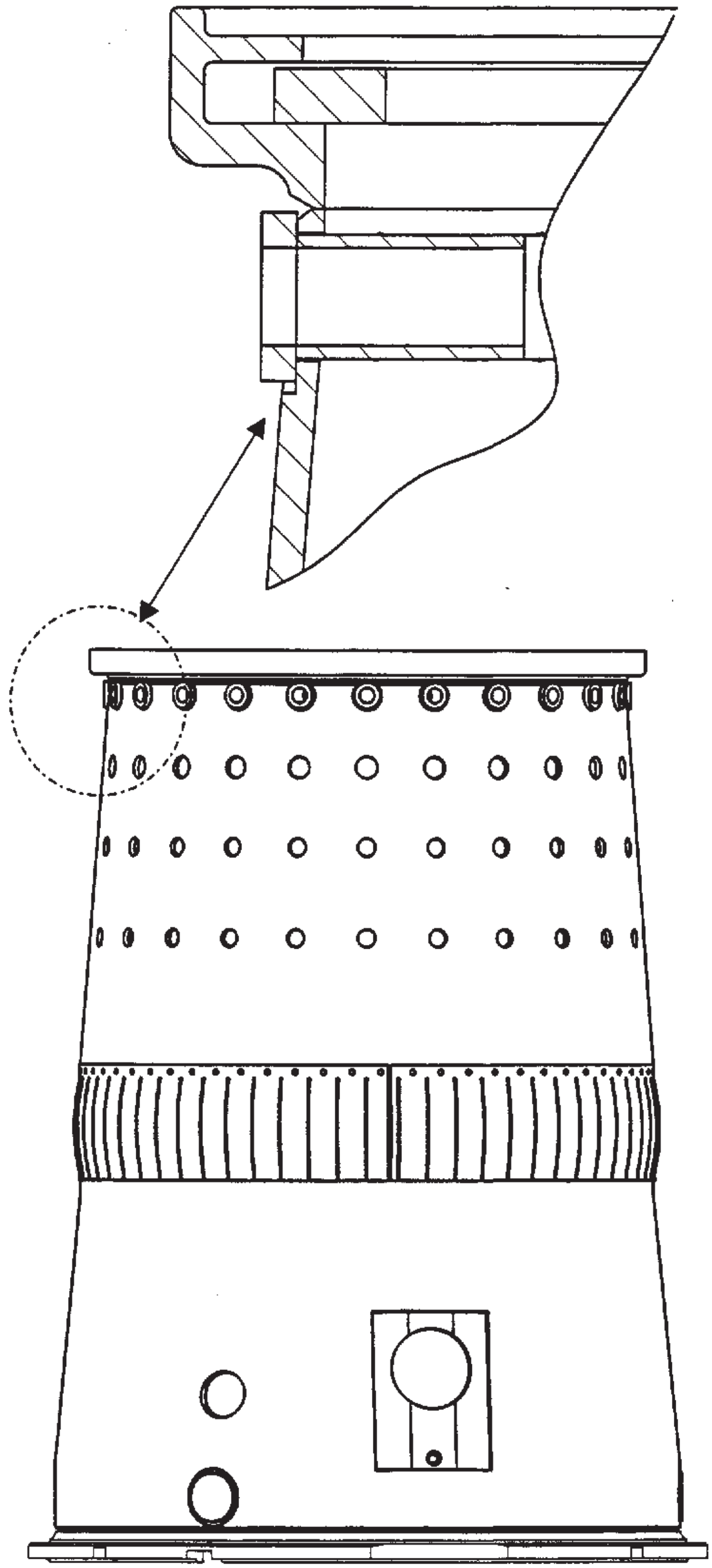

Figure CI–D.9 Flowsleeve With Thimbles

Operation 9 — How to Remove the Outer Combustion Casings (Figure CI-D.10)

1. Starting with Chamber 14, remove all but four flange bolts. Rig a sling around the casing and raise the crane hook to pick up the weight of the casing before removing the last four bolts.

2. Pick up the casing and set it down on plywood. Mark location and store until needed.

Operation 10 — How to Remove Transition Pieces (Figures CI-D.11 and CI-D.12)

1. Remove covers from the combustion access ports on the turbine casing. There are two, 24-inch- (60.9-cm-) diameter ports (top and bottom of the turbine casing), four, 13-inch- (33-cm-) diameter ports (64 degrees to the left and right of the top and bottom centerlines) and four 7-inch- (17.8-cm-) diameter ports (45 degrees to the left and right of the top and bottom centerlines).

Note: **When removing transition pieces, it is suggested to start with the top chamber, and then proceed with the removal of adjacent transition pieces.**

Note: **Refer to Section 2, Standard Practices, for marking practices in this instruction.**

Note: **Discard bolts and lockplates as directed, as those so specified are not intended for reuse.**

2. Remove the bolts and lockplates from both side seal retainer blocks of the transition piece to be removed. Remove, identify and store the side seal retainer blocks and side seals (which are removed radially outward).

3. Wrap a flat sling around the transition piece body upstream of the aft mount. Raise the crane hook to pick up some of the transition piece weight.

Note: **Care must be taken to avoid damage to the floating seals and the thermal barrier coating during handling.**

4. Remove and discard both aft mounting bracket bolts and lockplates. Move the transition piece upstream [about 3/8 inch (0.952 cm)] until the inner and outer seals disengage Continue to move the transition piece upstream until the forward mount “H” blocks clear the forward (bullhorn) support clamp and the aft mount guide pin clears the nozzle retaining ring.

Note: **The three top and three bottom transition pieces may be easily removed through the adjacent access ports. All transition pieces can be removed through the combustor openings in the compressor discharge casing flange. Removal through these ports requires rotating the transition piece 90 degrees to allow the aft frame to come through the elongated ports.**

Note: **It may not be necessary to remove the forward (bullhorn) support clamps if condition is within acceptable limits.**

5. Remove and discard both forward (bullhorn) support clamp bolts and their lockplates. Remove identify and store the forward (bullhorn) support clamps. Collect, identify and store any shims. Rotate, remove, identify and store the transition piece.

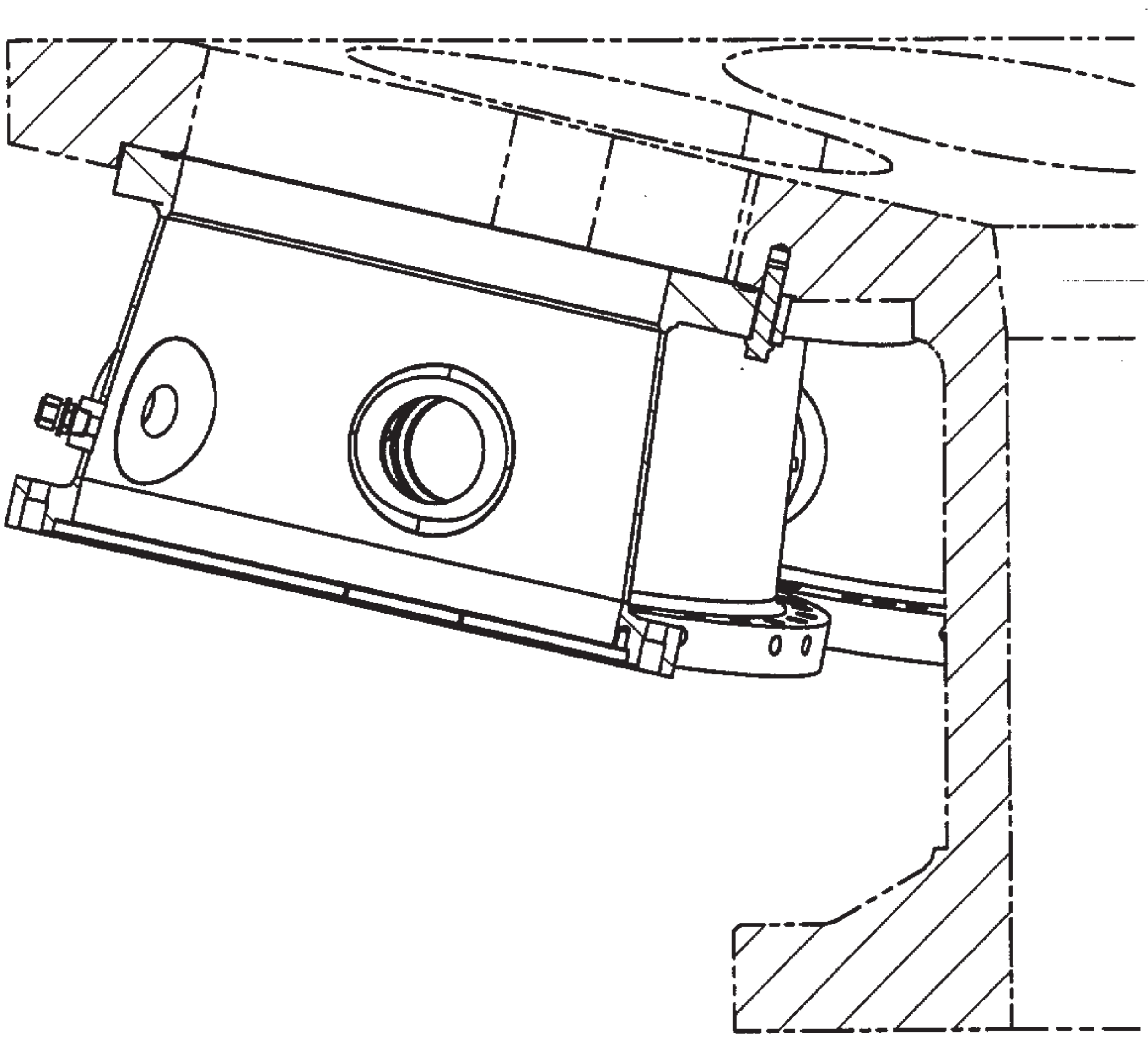

Figure CI–D.10 Aft Casing Assembled to Compressor Casing

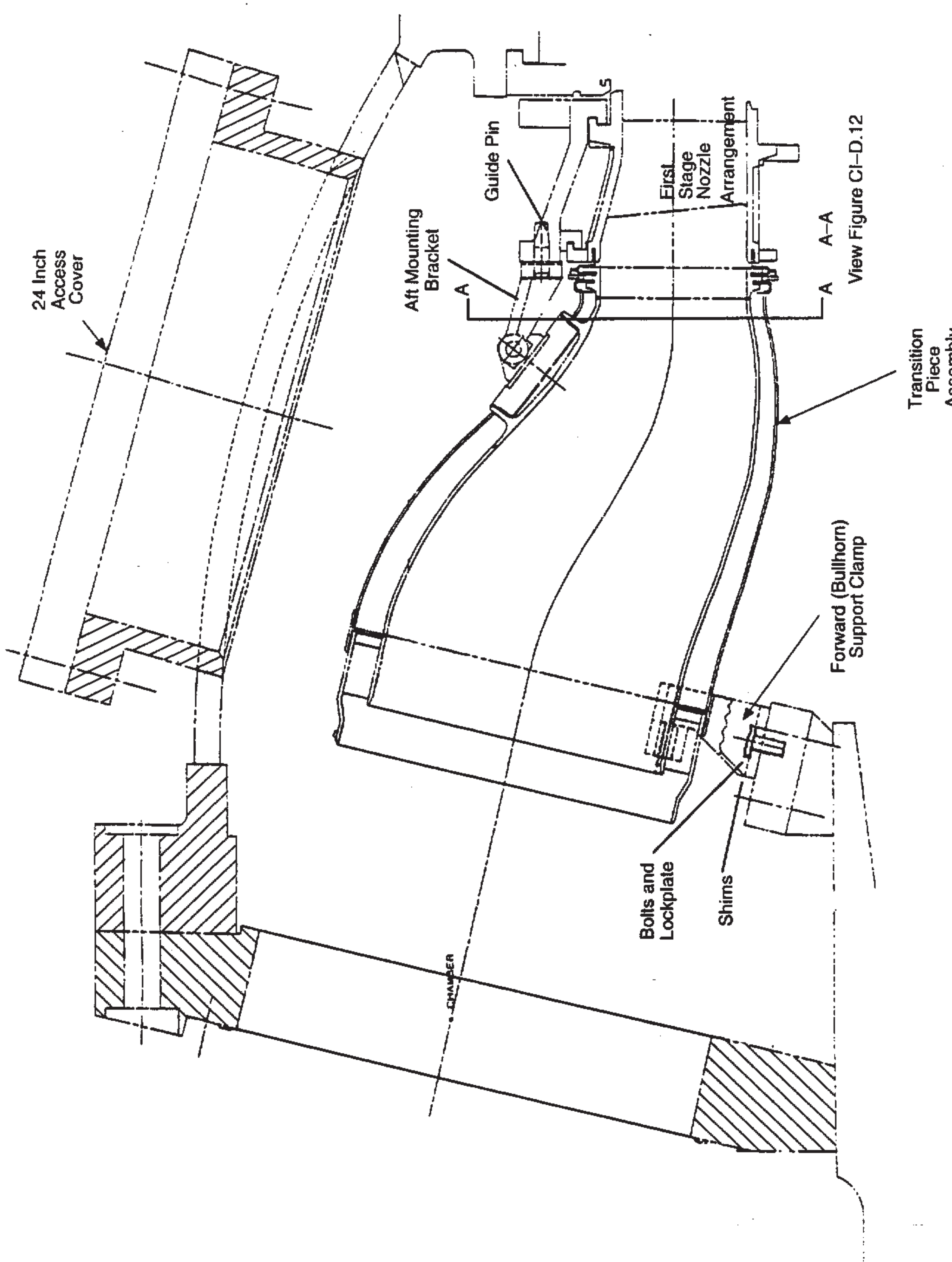

Figure CI–D.11 Transition Piece – Installed

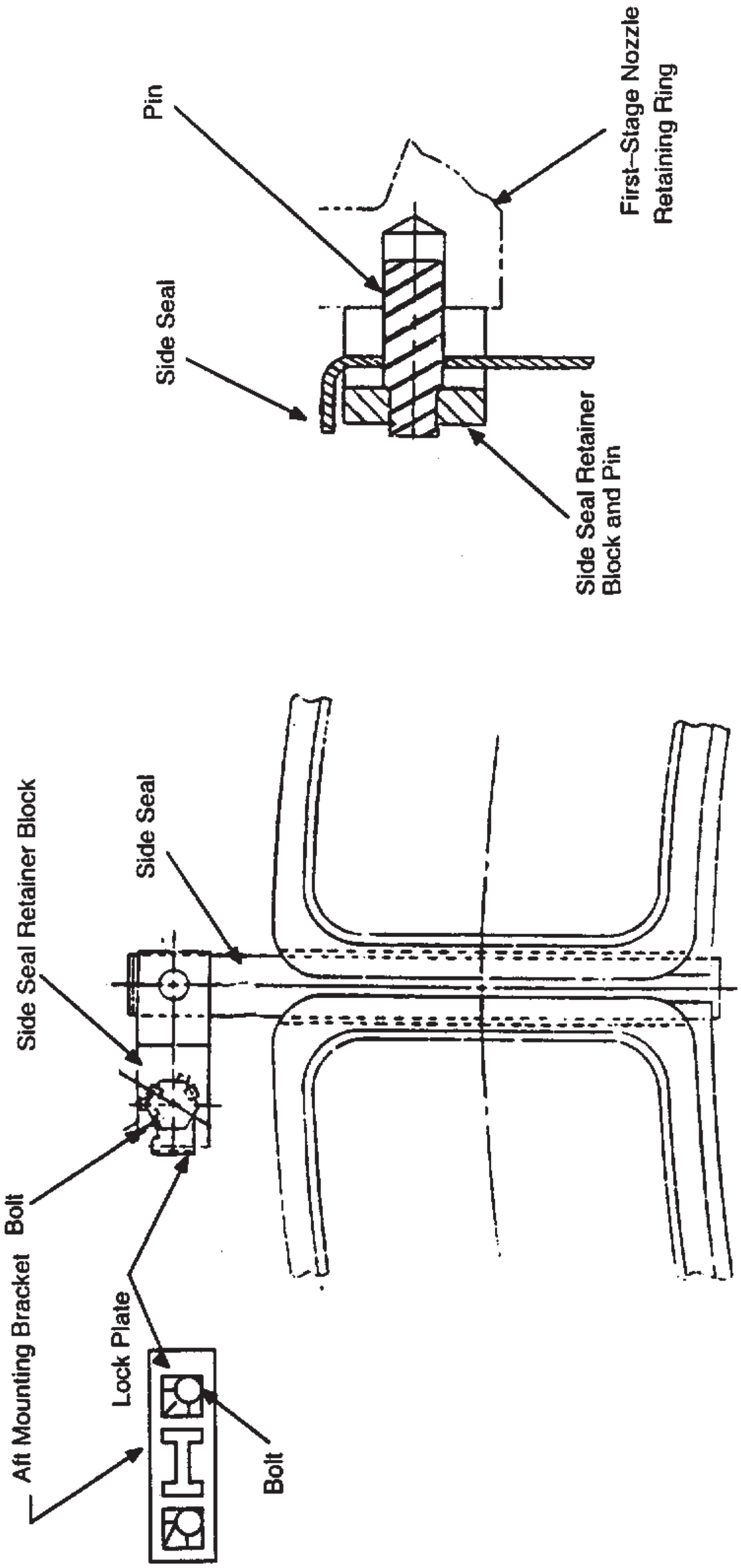

Figure CI–D.12 Transition Piece – Aft Bolting Details

6. Repeat steps 2 through 5 for the remaining transition pieces.

7. All hardware (identified as stipulated above) should be set aside for inspection and reuse.

II. Inspection Procedures for MS7001FA+ and MS7001FA+e Combustion Systems (with DLN-2.6)

Note: Obtain appropriate Inspection Forms from your local GE Field Service Representative.

Operation 11 — Fuel Nozzle Inspection (Figure CI-I.1, IA, 2, 3, and 3A)

CAUTION

It is critical that any fuel nozzle disassembly, cleaning, inspection, reassembly, testing and reinstallation in the unit be performed in accordance with the following procedures.

GENERAL

This section details the tooling and fixtures: disassembly, inspection, reassembly procedures, and the requirements for testing the reassembled fuel nozzles prior to returning to service.

If the customer/user does not have the facilities or trained personnel for performing these tests, the nozzles should be returned to Gas Turbine Division or a qualified Gas Turbine repair facility for inspection, reassembly and testing.

Your local GE Field Service Representative can assist you in material return procedures to send the fuel nozzles to the Gas Turbine Division or a qualified Gas Turbine repair facility.

How to Remove the Casing from the End Cover

1. Orient cover/casing assembly in vertical position. Supported on downstream flange of the fuel nozzle casing.
2. Remove bolts between cover and casing. Install swivel eyebolts 180° apart on cover OD.
3. Check the guide pins to be sure they are tight.
4. Remove the end cover to casing bolts. The cover is now supported by the pins and the hoist.
5. Lift cover and nozzles assembly from casing. Use jacking screws if necessary.
6. Move the cover axially until the five fuel nozzle tips clear the flange of the casing.

CAUTION

Do not allow any part of the fuel nozzle assemblies to touch the casing or flange.

7. Set the cover on blocks long enough to clear the fuel nozzle tips or bolt the flange to a secure frame for further disassembly or transfer cover and nozzle assembly to fuel nozzle assembly fixture.

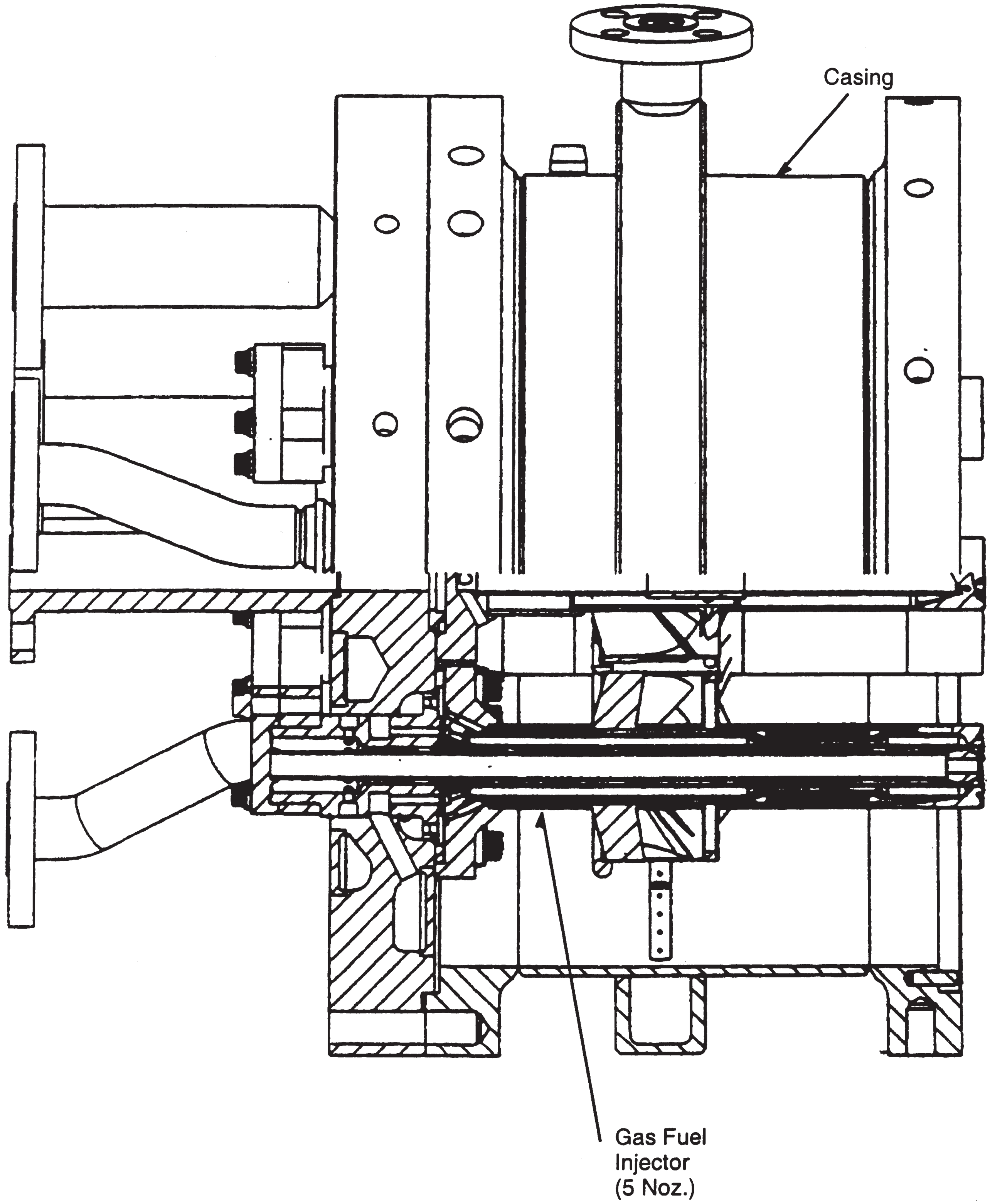

Figure CI–I.1 Fuel Nozzle Cover and Casing Assembly (Gas Only)

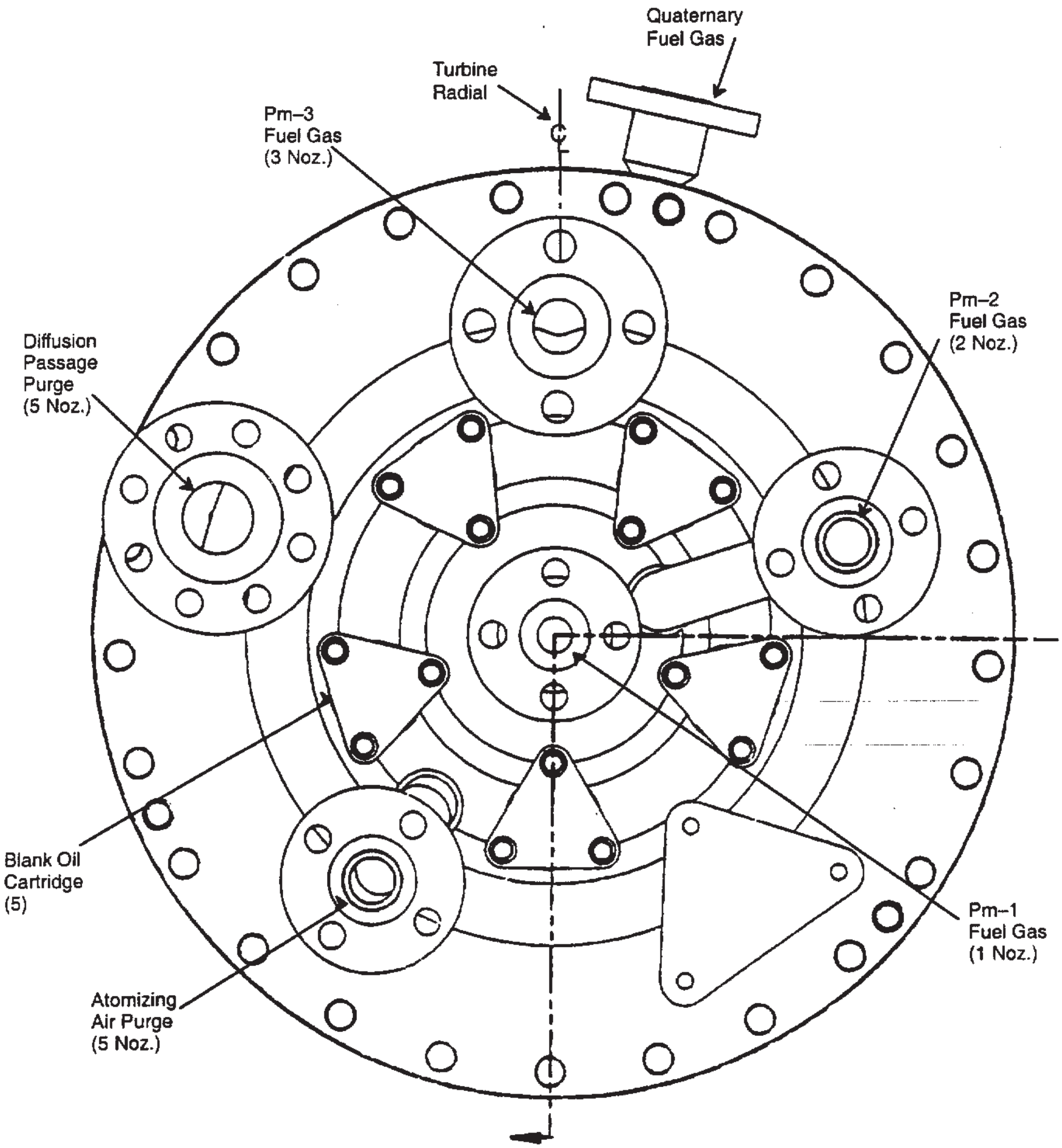

Figure CI–I.1A Fuel Nozzle End Cover

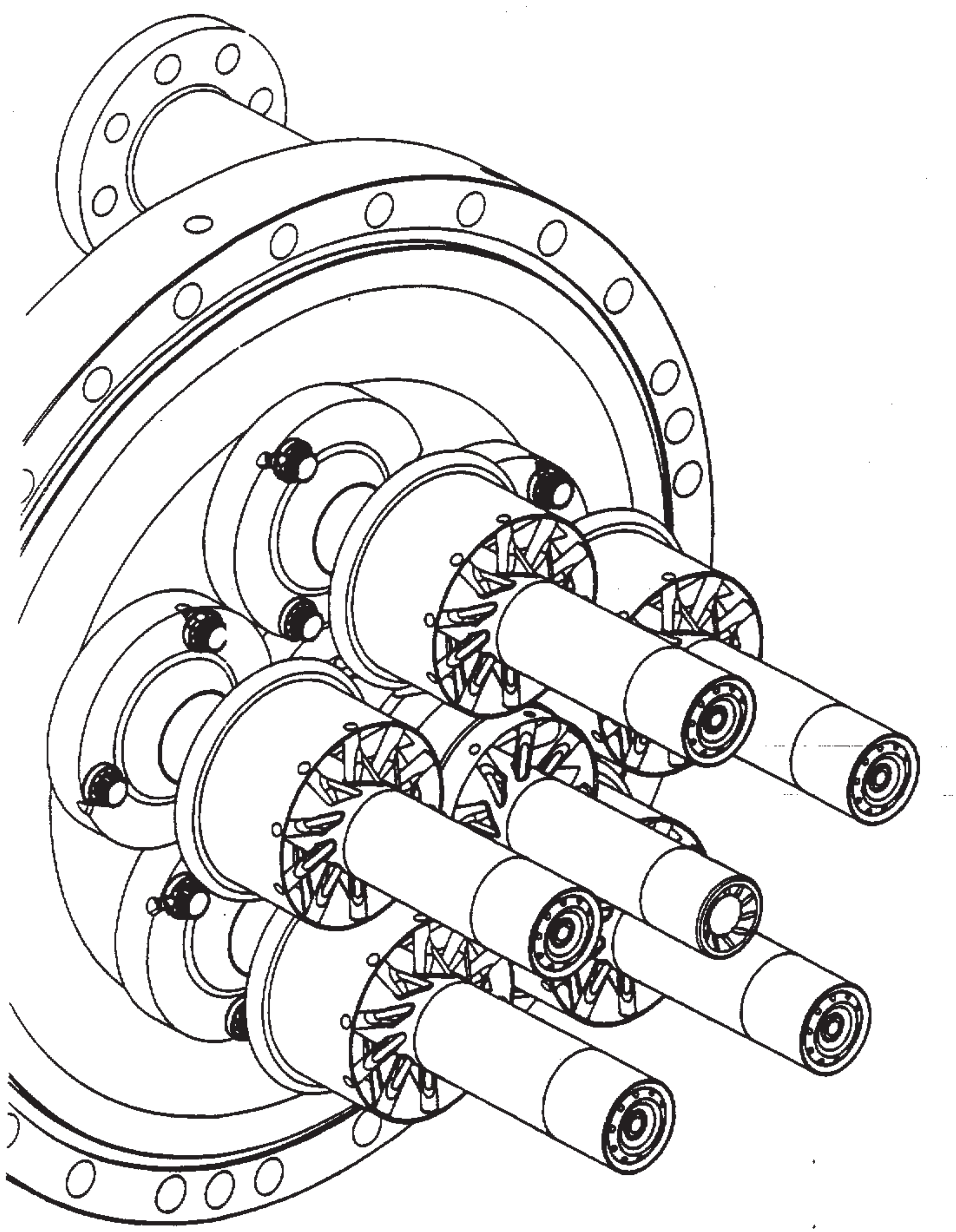

Figure CI–I.2 Fuel Nozzle–End Cover Downstream Face with Partial Fairings

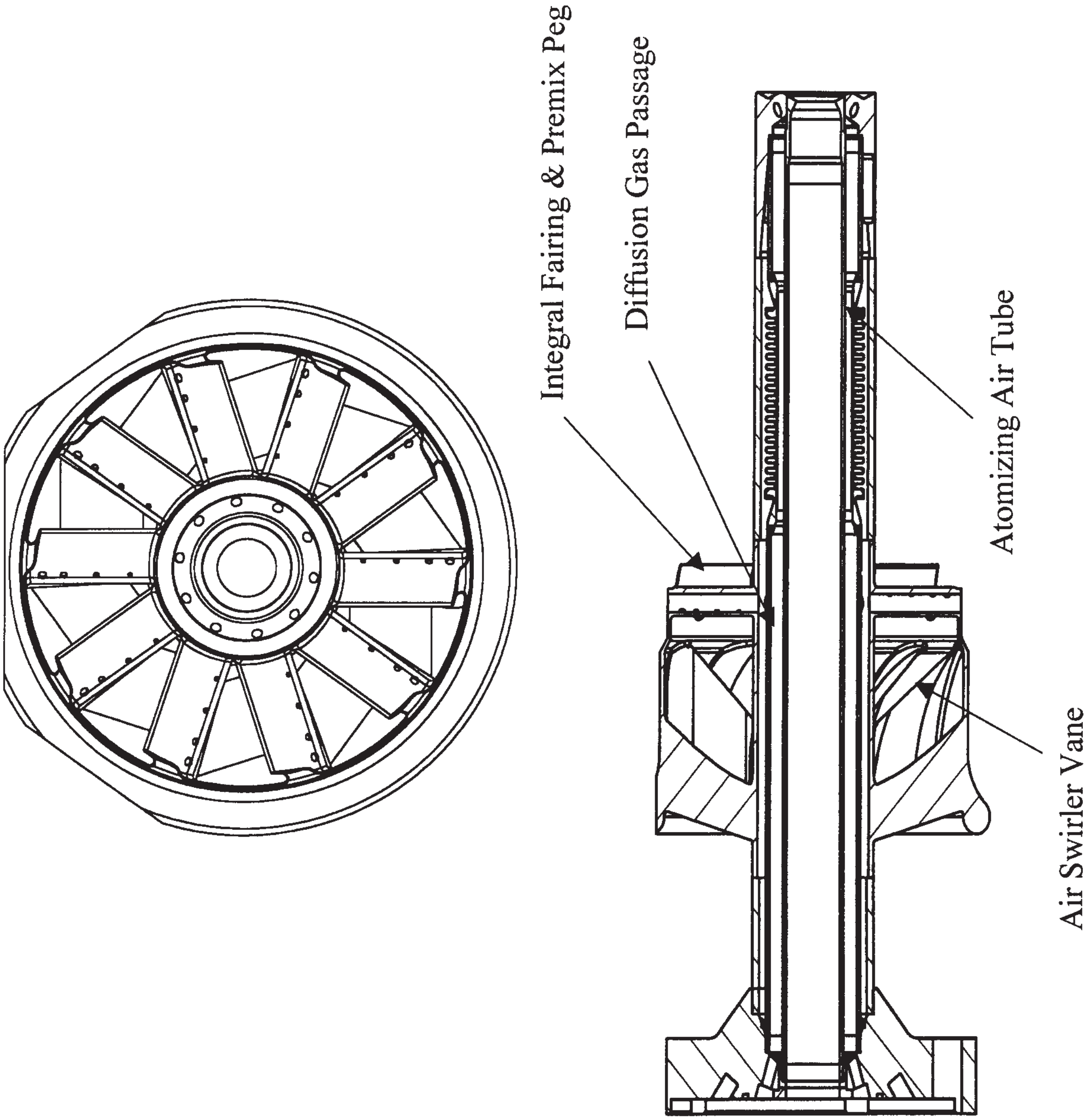

Figure CI-I.3 Outer Gas Injector (5)

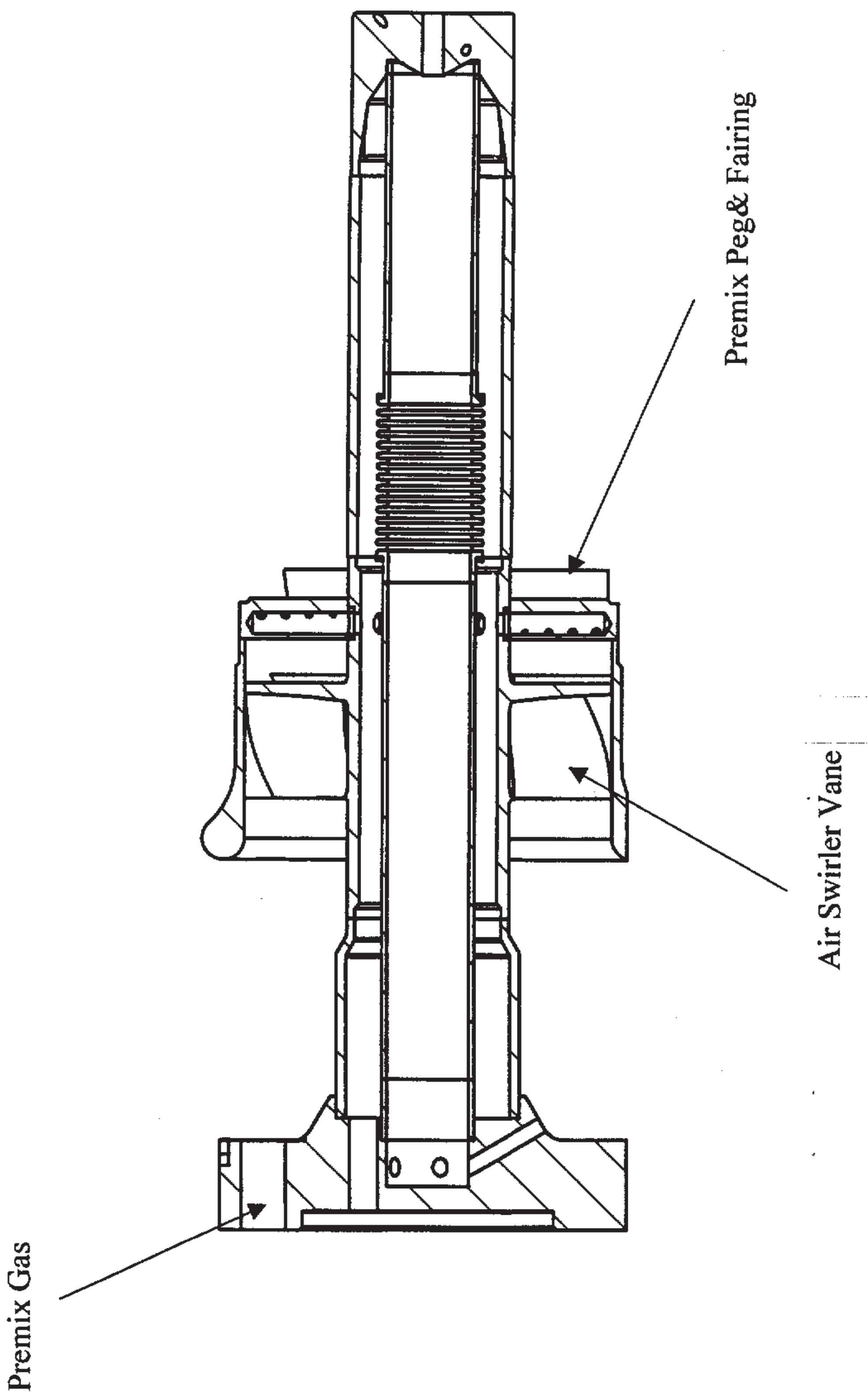

Figure CI–I.3A Center Gas Injector (1)

8. Discard the gasket between the cover and casing.

How to Remove the Liquid Fuel Blank Cartridges.

1. Secure the end cover face down on fixture.
2. Remove the three bolts that hold each blank cartridge to the end cover and slide the assemblies out of the cover. Discard seal ring.
3. Mark the chamber number and nozzle location on the injector and set aside for cleaning and inspection.

Operation 12 — Liquid Fuel Injector Inspection

General

The liquid fuel blank cartridge has no internal flow circuits. This section provides for inspection. See Figures CI-I.3, and CI-I.4

Inspection

Visually inspect the injector for evidence of burning, distortion and handling damage. Check atomizing air orifices for obstructions and wear. Remove all obstructions before returning the injector to service. Inspect per Table CI-1.

How to Clean the Liquid Fuel Blank Cartridge

This section describes the procedures for cleaning the liquid fuel injector.

1. This cartridge cannot be disassembled.
2. If the cartridge has any deposits, clean as outlined in the following procedure.

CAUTION

> Cleaning solution may affect skin, eyes and respiratory tract. Use in a well-ventilated area. Chemical goggles, neoprene gloves and rubber apron shall be worn.

Note: Change Oakite solution frequently because of evaporation of water. When solution becomes black in color and thick it should be replaced.

3. Place the assembly in the cleaning solution. Use Alkaline Cleaning Solution (Table CI-1) heated to 175-185°F (80-85°C). If Alkaline Cleaning Solution is not available, use Oakite 33 (Table CI-1) Cleaning Solution diluted with water at 40% (40% Oakite, 60% water) by volume, heated to 175-185°F (80-85°C).
4. Ultrasonically clean each assembly for fifteen minutes minimum.
5. After ultrasonically cleaning, rinse with flowing water at 180-200°F (82-93°C) until water is clear.

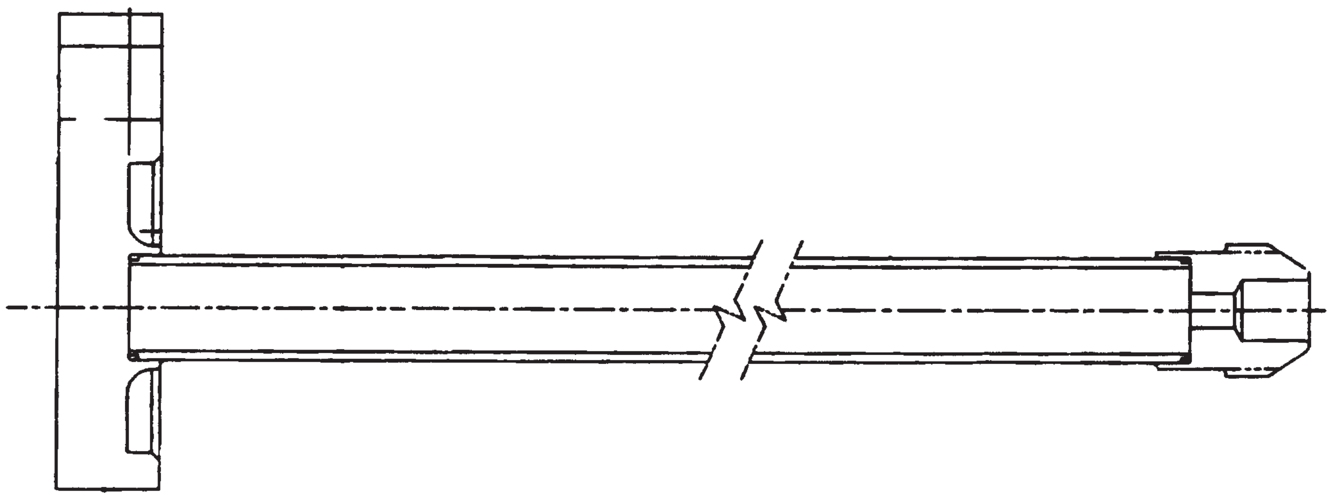

Figure CI-I.4. Liquid Fuel Blank Cartridge

6. If any residue remains, use a soft nonmetallic brush to remove the residue and repeat steps 2 through 4.

7. Dry with filtered (10 micron) compressed air (30 psig maximum air pressure).

8. After cleaning degrease as follows:

   a. Mix one part Citrikleen HD Degreasing Solution (Table CI-1), with four parts water.

   b. Completely submerge assemblies in the degreasing solution and soak for thirty minutes minimum at room temperature.

   c. After soaking, rinse with flowing water at 180-200°F (82-93°C) until water is clear.

   d. Dry with filtered (10 micron) compressed air (30 psig maximum air pressure).

Table CI-1
Cleaning Materials and Compounds

Product Name	Manufacturer	Application
Lix 400	Lix Corp. P.O. Box 8742 Kansas City, MO	Removal of carbon deposits.
Turco 9045 Turco 4181 Turco 5668 Turco 6776 Thin	Turco Products 7320 Bolsa Ave. Westminster, CA	Removal of carbon deposits.
Citrikleen HD	West Penetone Corp. 74 Hudson Ave. Tenafly NJ 07670	Removal of carbon deposits.
Turco 4181 & 4338	Turco Products	Removal of oxides

Remove and Clean Gas Fuel Injectors

1. Mark the five outer gas fuel injectors with the chamber number and position on the cover.

2. Using the appropriate socket wrench, override the cup lock washers and remove the three bolts holding each injector to the cover.

3. Remove each injector from the cover and store for disassembly and cleaning.

4. Remove the three concentric seal rings from the cover and scrap.

Operation 13 — Gas Fuel Injector Inspection

GENERAL

The gas fuel injector has two gas flow circuits, the premix system and the diffusion system. See Figure CI-I.5. This section provides procedures for inspection, disassembly, cleaning, assembly and testing of the injector. If you do not have the capability to perform these procedures, return the injector to

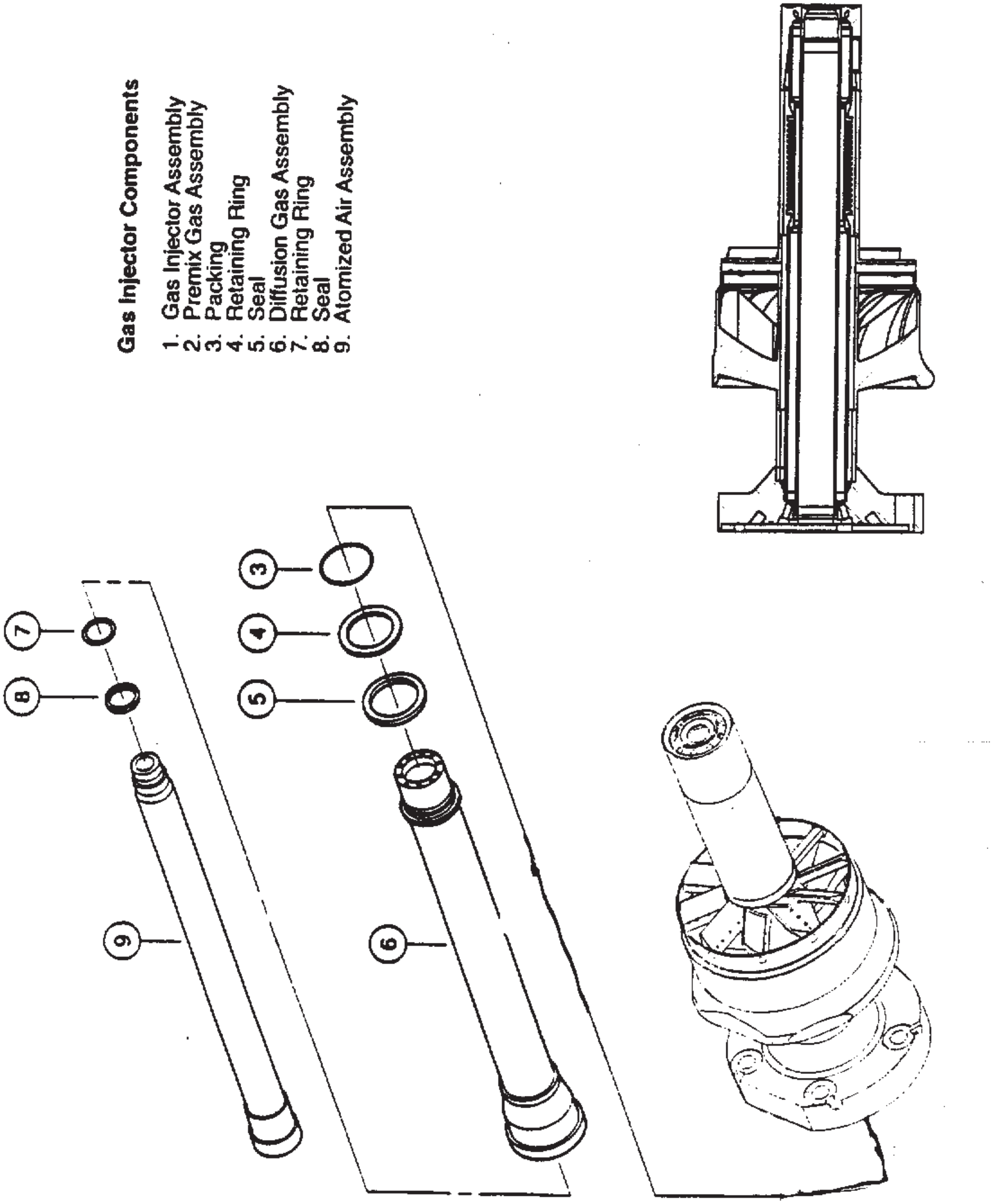

Figure CI–I.5 Gas Injector Assembly

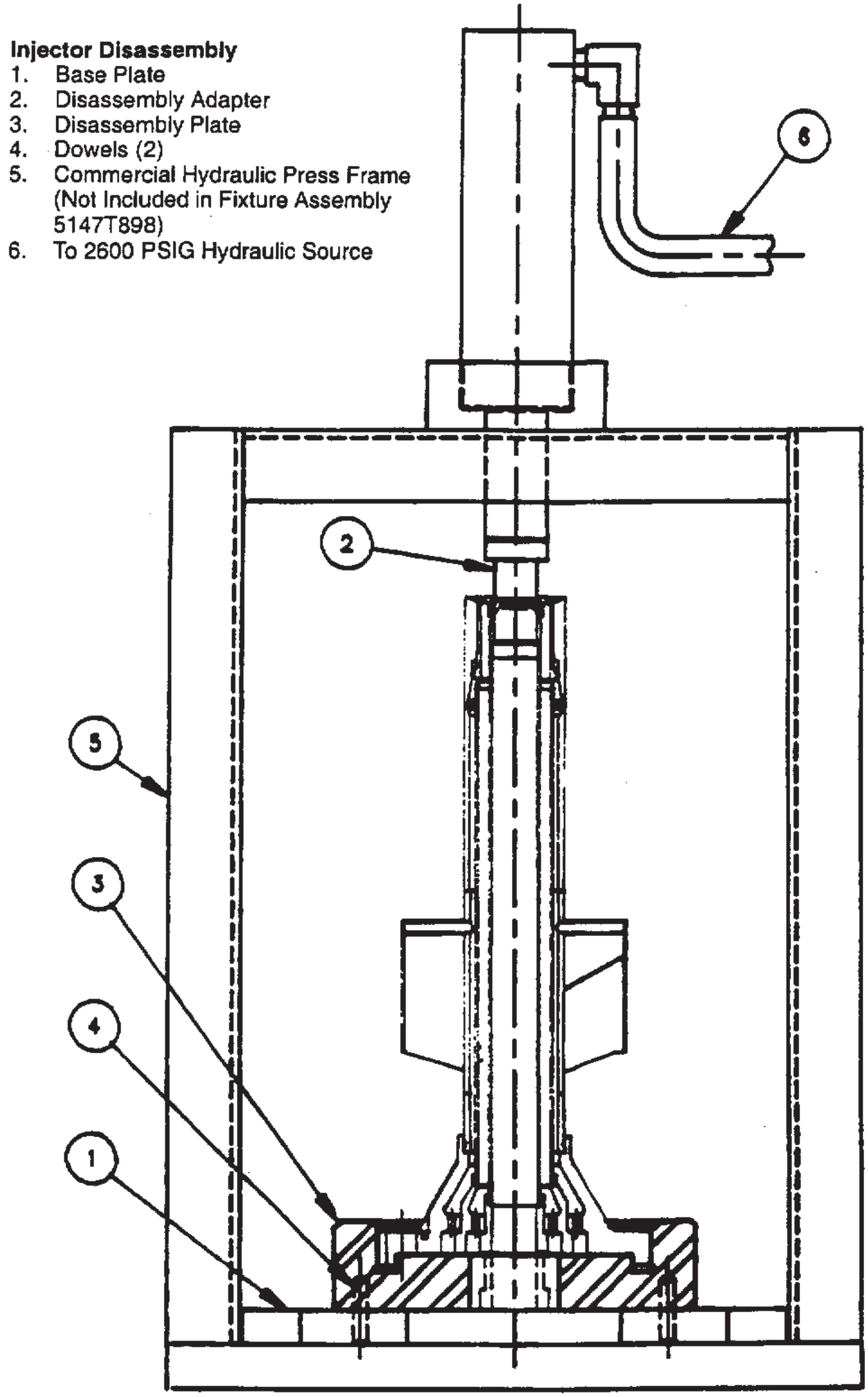

Figure CI–I.5A Gas Fuel Injector Disassembly Using Fixture 514T898

the qualified GE Power Generation Service Center. Your GE Field Service Representative can assist you in the returned material procedures.

Inspection

Visually inspect the injector, Figure CI-I.5, for evidence of burning, distortion and handling damage. Check discharge orifices for obstructions and wear. Remove all obstructions before returning the injector to service. Inspect per Table CI-2.

How to Disassemble an Outer Gas Fuel Injector

Disassemble the gas fuel injector, Figure CI-I.5, as follows:

CAUTION

The fuel injector shall be disassembled in a clean area free from dust and grip to prevent blockage of flow passages and orifices.

1. Mount the gas fuel injector in fixture 514T898 (Figure CI-I.5A).

2. Remove the Air Atomized Assembly (9), Figure CI-I.5.

Note: The center gas fuel injector is an assembly that cannot be disassembled (See Figure CI-I.3A).

How to Clean the Gas Fuel Injector

This paragraph describes the cleaning procedure for the Gas Fuel Injector.

CAUTION

Alkaline cleaning solution may affect skin, eyes and respiratory tract. Use in a well-ventilated area. Chemical goggles, neoprene gloves and rubber apron shall be worn.

1. Place the Premix Gas and Diffusion Gas Assembly (2) and Air Atomized Assembly (3) in the cleaning solution.

Note: Change Oakite solution frequently because of evaporation of water. When solution becomes black in color and thick it should be replaced.

2. Ultrasonically clean each assembly for fifteen minutes in Alkaline Cleaning Solution (Table CI-1) heated to 175-185°F (80-85°C). If Alkaline Cleaning Solution is not available, use Oakite 33 (Table CI-1) Cleaning Solution diluted with water at 40% (40% Oakite, 60% water) by volume, heated to 175-185°F (80-85°C).

3. After ultrasonically cleaning, rinse with flowing water at 180-200°F (82-93°C) until water is clear.

Table CI-2
Gas Fuel Injector Inspection Limits

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
1. Premix Swirler Shroud		
a. Wear	Maximum of 0.030 in. wear in any shroud OD location	Repair—weld
b. Cracks	Maximum of 0.125 in. long in any 0.5 in.	Repair—weld
2. Premix Air Swirler Vanes (10)*		
a. Cracks	Maximum of 0.125 in. long	Weld repair or replace swirler
3. Premix Injector Peg(s) & fairings		
a. Hole Blockage	None allowed.	Remove blockage
b. Erosion, Cracks	None allowed.	Repair or replace
4. Outer Sleeve		
a. Cracks	None allowed.	Weld repair
5. Cap		
a. Cracks, Nibbling or Erosion	Maximum of 0.125 in. in any one direction.	Weld repair or replace
6. Diffusion Injector Tip		
a. Cracks, Burning, Distortion	None allowed.	Replace
7. Atomizing Air Cap		
a. Cracks, Burning, Distortion	None allowed.	Replace
. Atomized Air Shroud		
a. Burning, Distortion, Cracks, Wear/Erosion	Maintain 0.005 in. radius maximum exit edge break.	Repair or replace
	No distortion allowed.	Replace
	Wall thickness not less than 50% of original.	Replace

* Visually inspect with 3× minimum magnification. Dye penetrant inspect to verify crack location.

4. If any residue remains, use a soft nonmetallic brush to remove the residue and repeat steps 1 through 3.

5. Dry with filtered (10 micron) compressed air (30 psig maximum air pressure).

6. Place the Premix Gas and Diffusion Gas Assembly and Air Atomized Assembly in the cleaning solution.

7. After cleaning degrease as follows:

   a. Mix one part Citrikleen HD degreasing solution, Table CI-1, with four parts water.

   b. Place the Premix Gas Assembly (2), Diffusion Gas Assembly (6) and Air Atomized Assembly (9) in the degreasing solution.

   c. Soak these items in the degreasing solution for thirty minutes minimum at room temperature.

   d. After soaking them, rinse with flowing water at 180-200°F (82-93°C) until water is clear.

   e. Dry with filtered (10 micron) compressed air (30 psig maximum air pressure).

How to Assemble the Gas Fuel Injector

1. Install the Air Atomizing Assembly in Fixture 514T898 (Figure CI-I.5B).

2. Load the Gas Premix and Diffusion Assembly over the Atomized Air Assembly until it self centers.

3. Use Fixture 514T898 to seat the Atomizing Air Tube (Figure CI-I.5B)

4. Verify proper assembly by checking the relative flange locations of the Atomizing Air Assembly, Diffusion Gas and Premix Gas Assembly using a gauge block and 0.010 in. feeler gauge (Figure CI-I.5C). The maximum allowed difference between the two flanges in 0.010 in. If the difference exceeds 0.010 in., repeat step 8. If 0.010 in. cannot be met, check for internal contamination. If there is no evidence of contamination the injector should be returned to your GE Power Generation Service Center for disposition.

How to Pressure Test the Gas Fuel Injector

Pressure testing of the Gas Injector checks the injector tip for leakage.

****WARNING****

Compressed nitrogen gas can generate flying debris and can cause severe injury if the blast penetrates skin or eyes. Wear protective eye goggles when pressure testing the injector.

1. Load the assembled Gas Injector in Leak Test Fixture 514T767 (Figure CI-I.5D).

2. Connect to the nitrogen gas source to the inlet of Fixture 514T767. The nitrogen gas source shall be capable of supplying 200 psig pressure. Tighten all connections.

3. Apply 30 psig nitrogen gas pressure to the inlet of the fixture and visually verify that all joints are tight. Increase nitrogen gas pressure to 200 psig. Quickly close the nitrogen source valve to trap

Injector Assembly
1. Base Plate
2. Assembly Cap
3. Assembly Pin
4. Assembly Plate
5. Dowels (2)
6. Commercial Hydraulic Press Frame (Not Included in Figure Assembly 514T878)
7. To 2600 PSIG Hydraulic Source

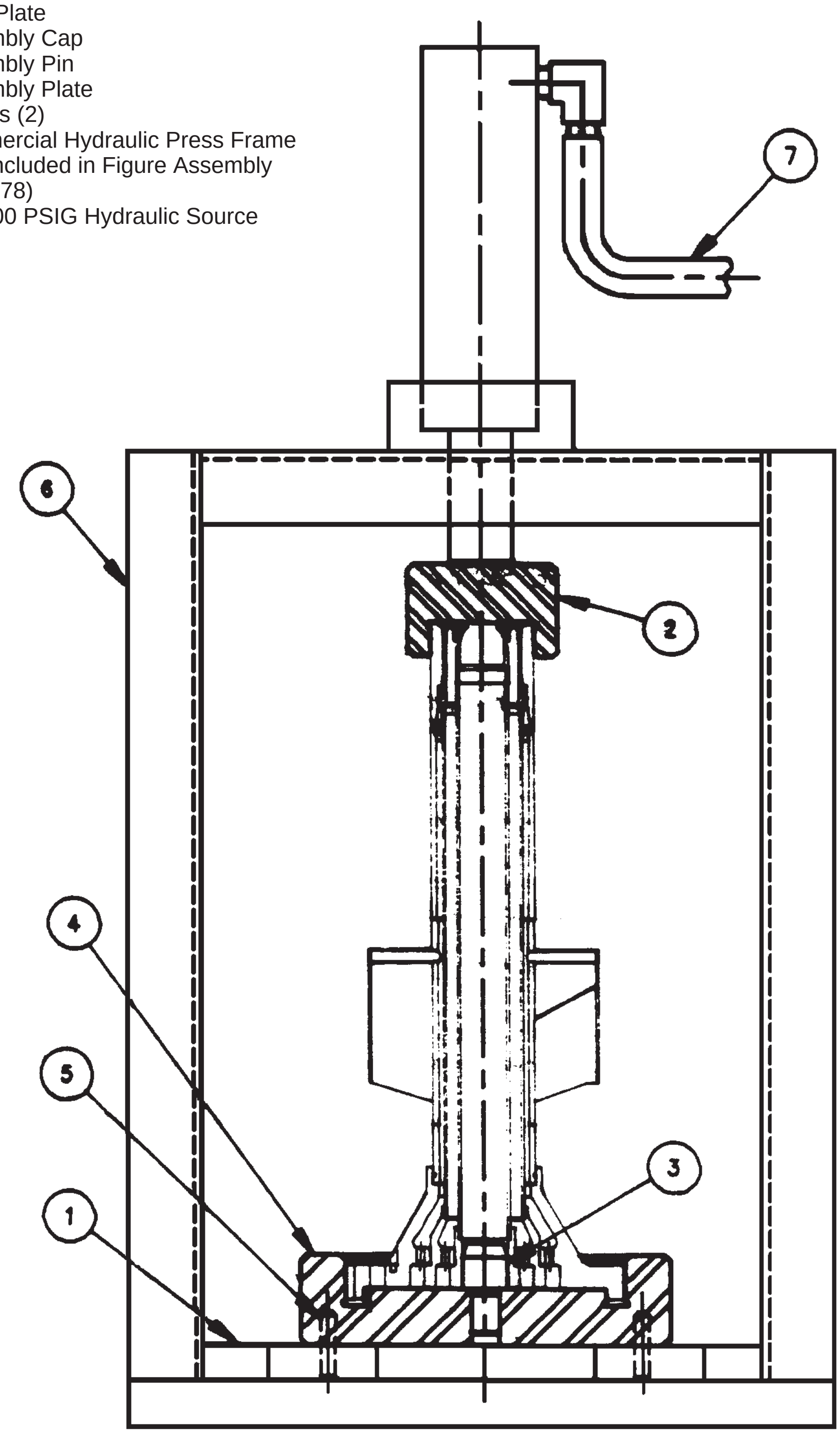

Figure CI-I.5B Gas Fuel Injector Assembly Using Fixture 514T898

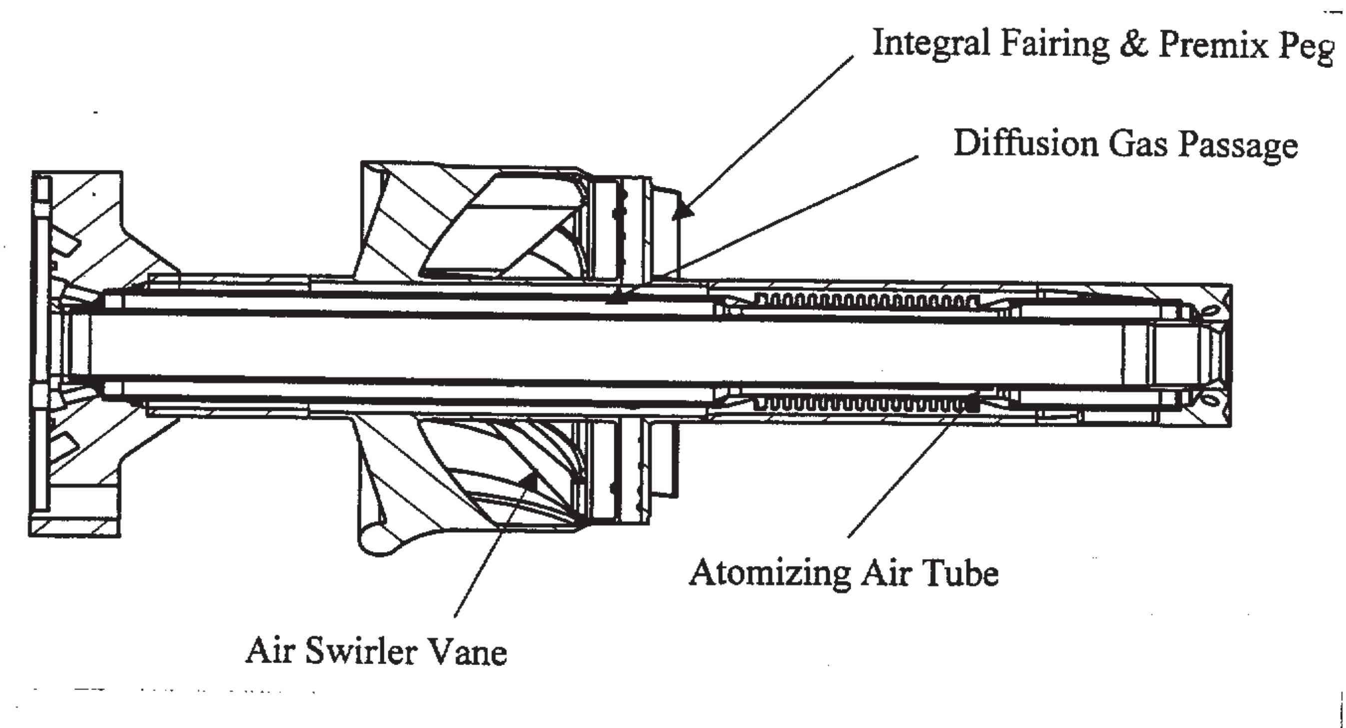

Figure CI–I.5C Gas Injector Assembly Inspection

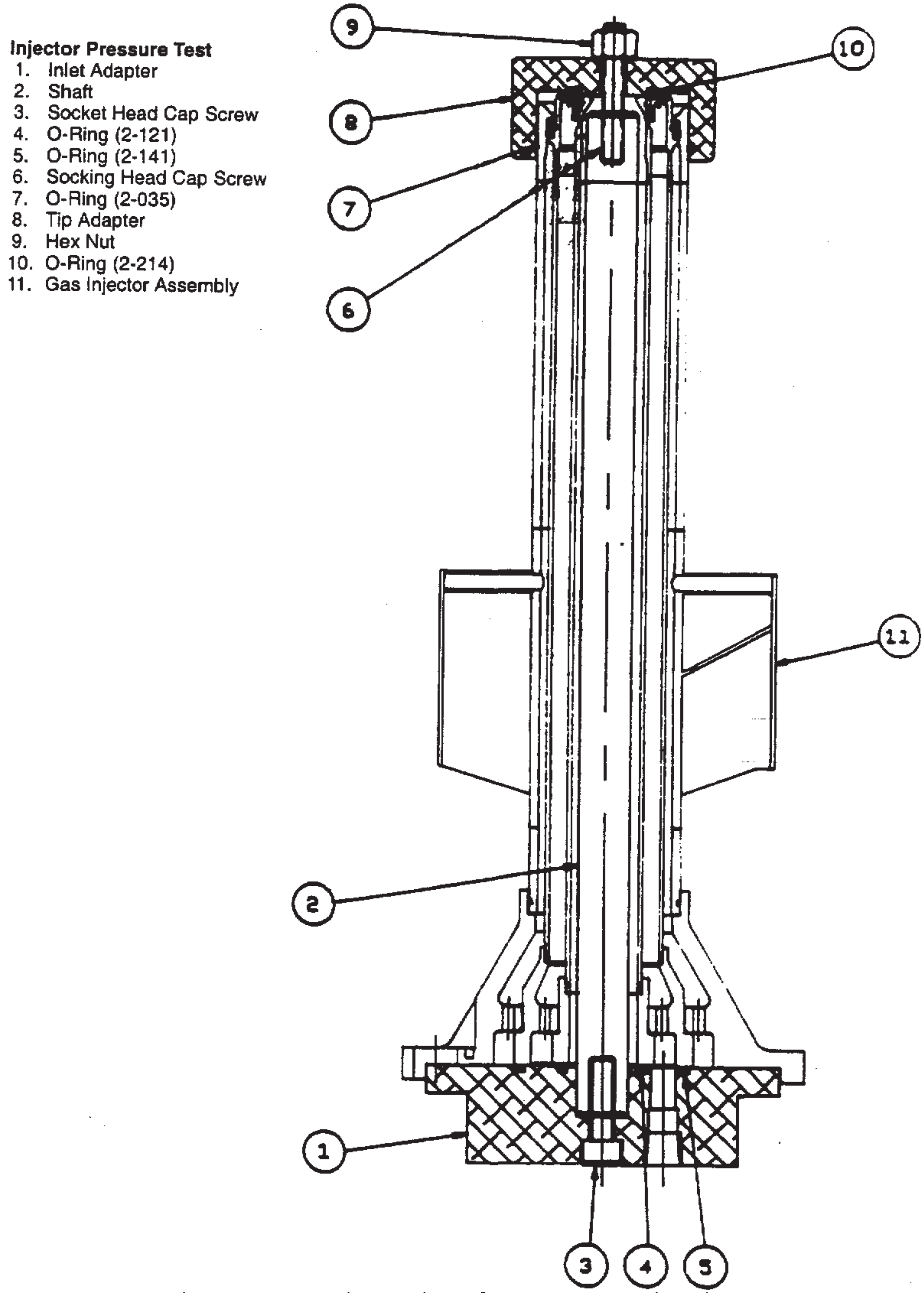

Figure CI–I.5D Injector Tip Seal Pressure Test Using Fixture 514T767

nitrogen gas between the valve and the seals in the injector tip. One minute after the valve is closed, the pressure of the trapped nitrogen shall be 100 psig minimum. If pressure is less than 100 psig after one minute, replace the seals. See above for disassembly instructions.

Table CI-3
MS7001FA Special Tools, Fixtures and Equipment

Tool Number	Nomenclature	Source
514T898	Fixture, Assembly/Disassembly	Fuel Systems Textron Zeeland MI 49464
514T767	Fixture, Leak Test	Fuel Systems Textron Zeeland MI 49464

End Cover Inspection and Cleaning

1. Inspect seal grooves for both the liquid fuel injection and the gas fuel injection. They must be clean and free of any nicks or scratches across the sealing surface.

2. Check the seating surfaces between the seal grooves for any burrs or raised metal. These may be stoned flat.

3. All openings should be inspected and cleaned out if necessary.

4. The internal passage should be blown out with clean, dry air.

Operation 14 — Reassembly of Gas and Liquid Injectors to End Cover

1. After all components have been cleaned and inspected, set the end cover up with the inside surface up.

2. Prior to installation of gas injector, pretorque all 0.625-11 Helicoil inserts. Run bolt in and out to seat in insert.

3. Install four concentric metallic C-seals for the outer gas injector and one metallic C-seal on the center injector while cover is oriented horizontally. Do not apply sealants. Grease may be used as an assembly aid. C-seals must be replaced.

4. Apply thread lubricant to mounting bolts.

5. Install gas nozzle, cup washer and bolts. Evenly snug down bolts. Tighten bolts, using torque wrench, in sequential steps: 30 ft-lb, 45 ft-lb and 55 ft-lb. Maintain even loading around flange during torque steps. Repeat for all gas nozzles.

6. Flip cover and install seal for blank cartridge in groove on raised cover surface.

7. Apply thread lubricant to mounting bolts.

8. Install liquid fuel blank cartridge and bolts. Evenly snug down bolts. Tighten bolts, using torque wrench, in sequential steps: 25 ft-lb and 40 ft-lb. Maintain even loading around flange during torque steps. Repeat for all liquid fuel cartridges. Note fitting orientation.

9. Attach all gas nozzle flow test tags to tubing prior to cover assembly flow test.

10. Cap all inlets and nozzle tips during handling.

11. Fuel nozzle assembly should now be tested in accordance with the instructions on the fuel nozzle assembly drawing.

12. After testing is complete, stake cup washers as shown on assembly drawing, using 0.06 in. spherical radius nose drift punch. Verify staking of all bolts prior to next level of assembly.

13. The same procedure should be used for the rest of the end cover/fuel nozzle assemblies.

14. All openings should be covered to protect them until the cover is to be assembled on the gas turbine.

Operation 15 — How to Inspect and Test Spark Plugs (Figure CI-I.6)

Note: The possibility exists that the electrical components, may be found damaged during disassembly of spark plug tip, or broken while handling. Therefore, spare parts should always be available for this emergency.

1. Inspect the spark plug assembly for binding, galling, burning, tip/piston weld cracks, ceramic insulator cracks and damaged threads on electrical lead connection. See Table CI-4 for inspection criteria.

2. Check the movement of the spark plug piston assembly by pulling on the lead end of the piston. If any evidence of binding exists the cylinder assembly must be disassembled. To disassemble the cylinder, remove the four long bolts from the top cover, then remove the top cover and the piston.

CAUTION

> Take care not to lose or damage the gasket at the top of the cylinder.

3. Remove all foreign material, such as dust, dirt or chips, from the cylinder and piston assemblies. Remove all oxidation and galling marks. Be sure that any galling has been corrected.

4. The ignitor needs to be replaced if it has been damaged at the hot end, or fails to fire properly when tested. To remove the ignitor may then be slid out of the piston assembly, unscrew the ignitor retaining nut at the cold end. The ignitor may then be slid out of the piston assembly. It should be replaced with a new ignitor including a new retaining nut and firrule. Slide the ignitor assembly into the piston until the retainer nut is against the fitting and the stop collar is against the retainer nut. Then tighten the retaining nut 11/4 turns to set the ferrule

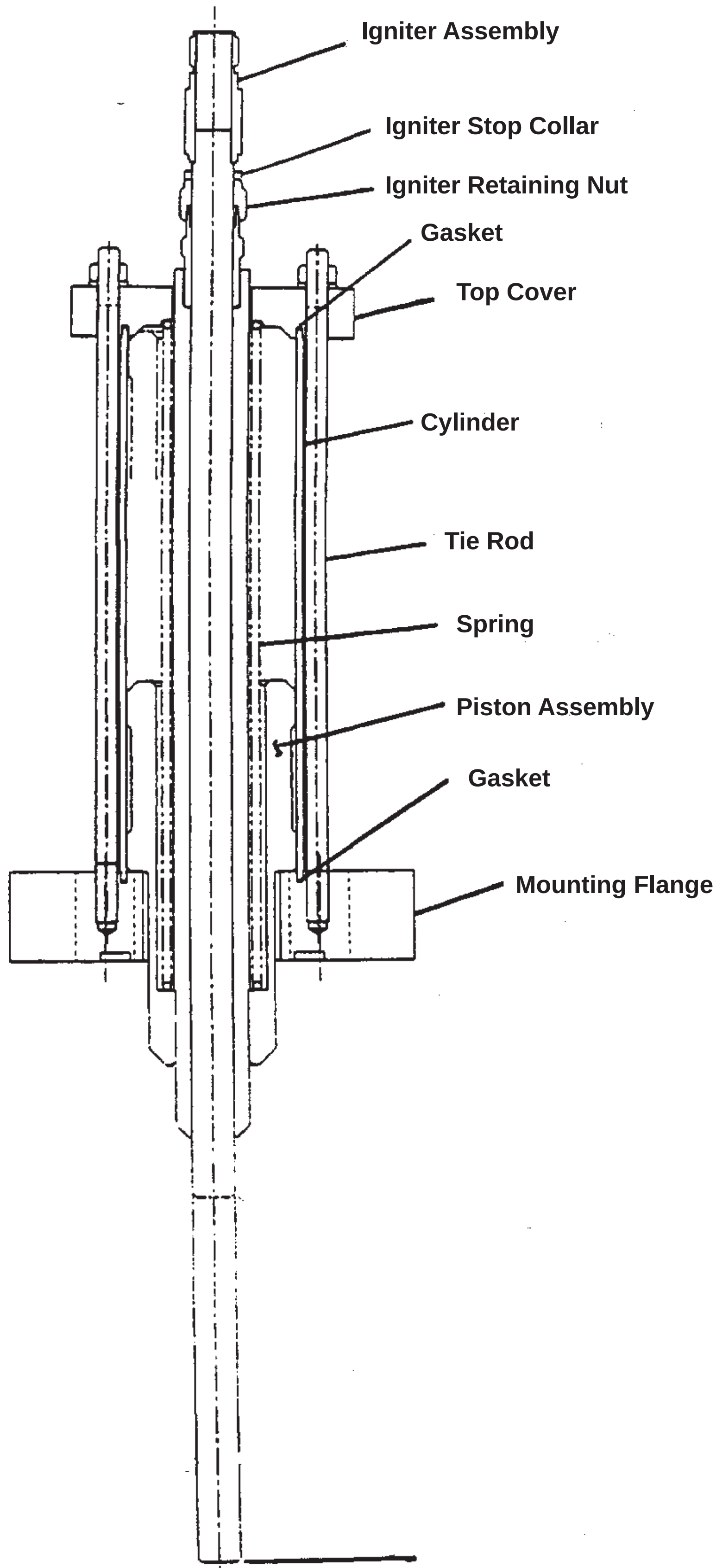

Figure CI–I.6 Spark Plug Assembly

Table CI-4
Spark Plug Inspection Limits

CAUTION

The inspection criteria in this table apply to GE Company supplied spark plugs only.

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
1. Spark Plugs		
a. Binding	None.	Disassemble and clean.
b. Galling	None.	Polish with fine abrasive cloth.
c. Burned spark gap	None.	Replace ignitor.
d. Bad threads on electrical connection	None.	Replace ignitor.
e. Test firing	None.	Replace ignitor.
f. Wear at tip	.030	Replace ignitor.

****WARNING****

Do not test ignitors in or near an area with an explosive atmosphere.

Reconnect the spark plug lead, with the spark plug removed from the turbine. Rest the body of the spark plug against the turbine shell (or other grounded metal). Make sure the electrode end of the spark plug is not grounded.

****WARNING****

Be careful of high voltage.

Energize the ignition circuit and check the spark of the spark plug for approximately two minutes. If heating occurs at any point along the length of the ignitor or if the spark is weak or erratic replace the ignitor.

Operation 16 — How to Inspect and Test Flame Detectors

1. The dry low NOx-2 combustion system has four flame detectors. They are mounted on the combustion casings looking across the upstream end of the reaction zone.

Note: The flame detector tube is contained in the flame sensor subassembly. Combined with the body and window subassembly, the two subassemblies form the ultraviolet flame sensor. Either of these subassemblies are field replaceable, but neither subassembly is field repairable (except for cleaning), and it must be returned to the manufacturer for repair or replacement.

2. Clean the scanner lenses. Reconnect flame detector wiring and energize the control panel. With power on the control panel, check that FL-1 and FL-2 indicating lights are out.

CAUTION

Sensor is polarity sensitive and will be damaged if connected with reverse polarity. Black lead of sensor is positive.

3. Using a match or candle, check to assure that each flame detector picks up and drops out when the light source is placed in front of the sensor and removed. The unit should be capable of detecting the match or candle at approximately 18 inches (45.7 centimeters).

Operation 17 — How to Inspect Combustion Caps and Liners

1. Record combustion liner inspection results on Inspection Forms.

Note: Combustion chamber parts will not be dealt with by any specific drawing number. It is generally recommended that repairs concerning the replacement of caps, liner sleeves, and hula seals be performed by qualified GE personnel. Deterioration less than maximum allowable limits indicates that reuse may be permissible based on the premise that consideration has been given to the operating hours and firing conditions experienced by the liners to date, and the subsequent operations expected from the liners.

2. Inspect, Multi-Nozzle Caps and Liners (see Figures CI-I.7, CI-I.8 and CI-I.9).

   a. Table CI-5 is a guide to aid in decision making on reuse or replacement of combustion caps and Table CI-6 is a guide in decision on reuse or replacement of combustion liners.

   b. Figures CI-I.7 and CI-I.8 should be used to identify areas of the combustion caps called for on Table CI-5.

   c. Figure CI-I.9 should be used to identify areas of the combustion liners called for on Table CI-6.

   d. Weld cracks shall be detected using fluorescent penetrant. Zyglo ZL-22 is acceptable, using the *spot* method.

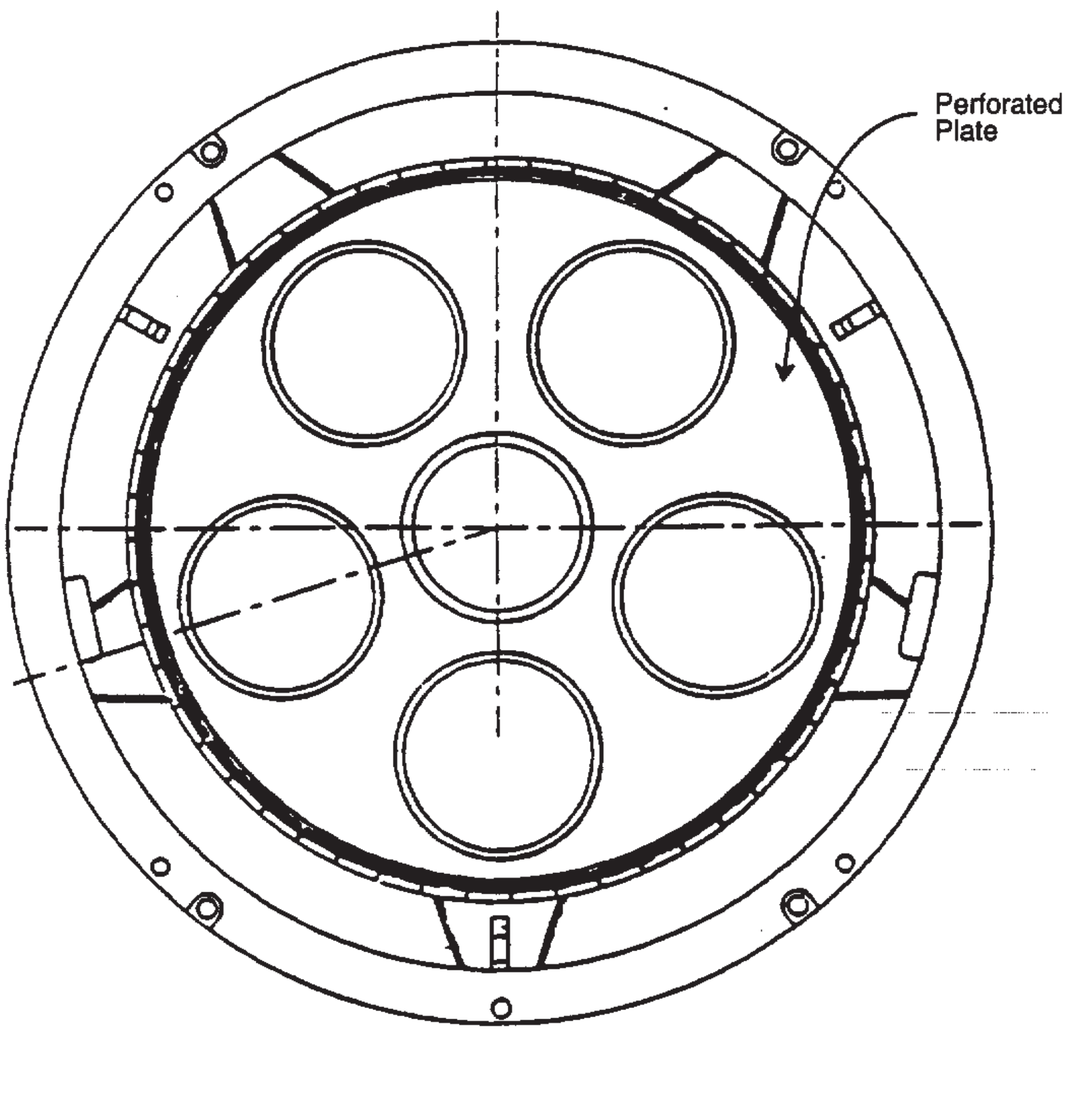

Figure CI–I.7 Cap Assembly – Downstream Face

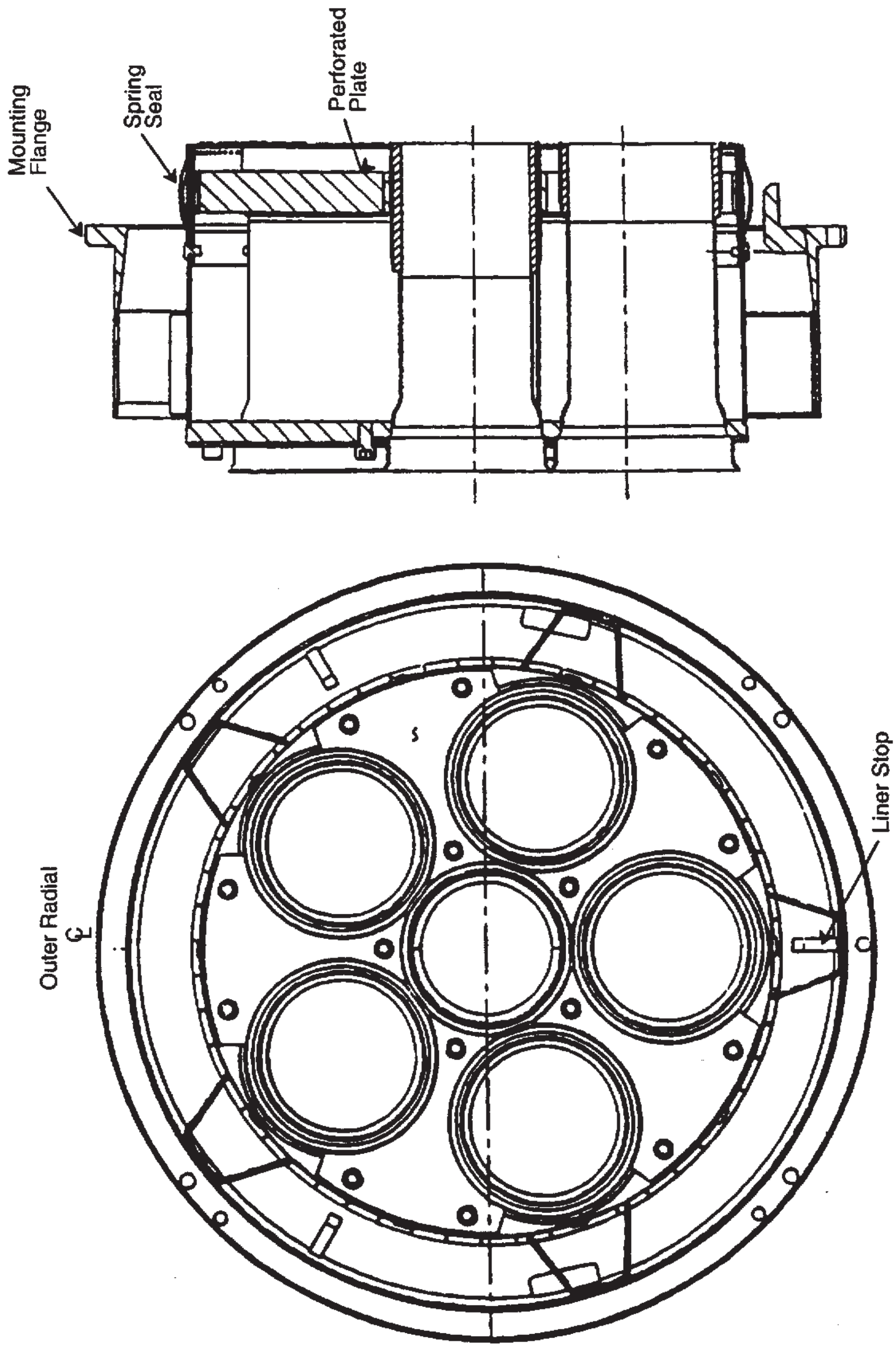

Figure CI–I.8 Cap Assembly

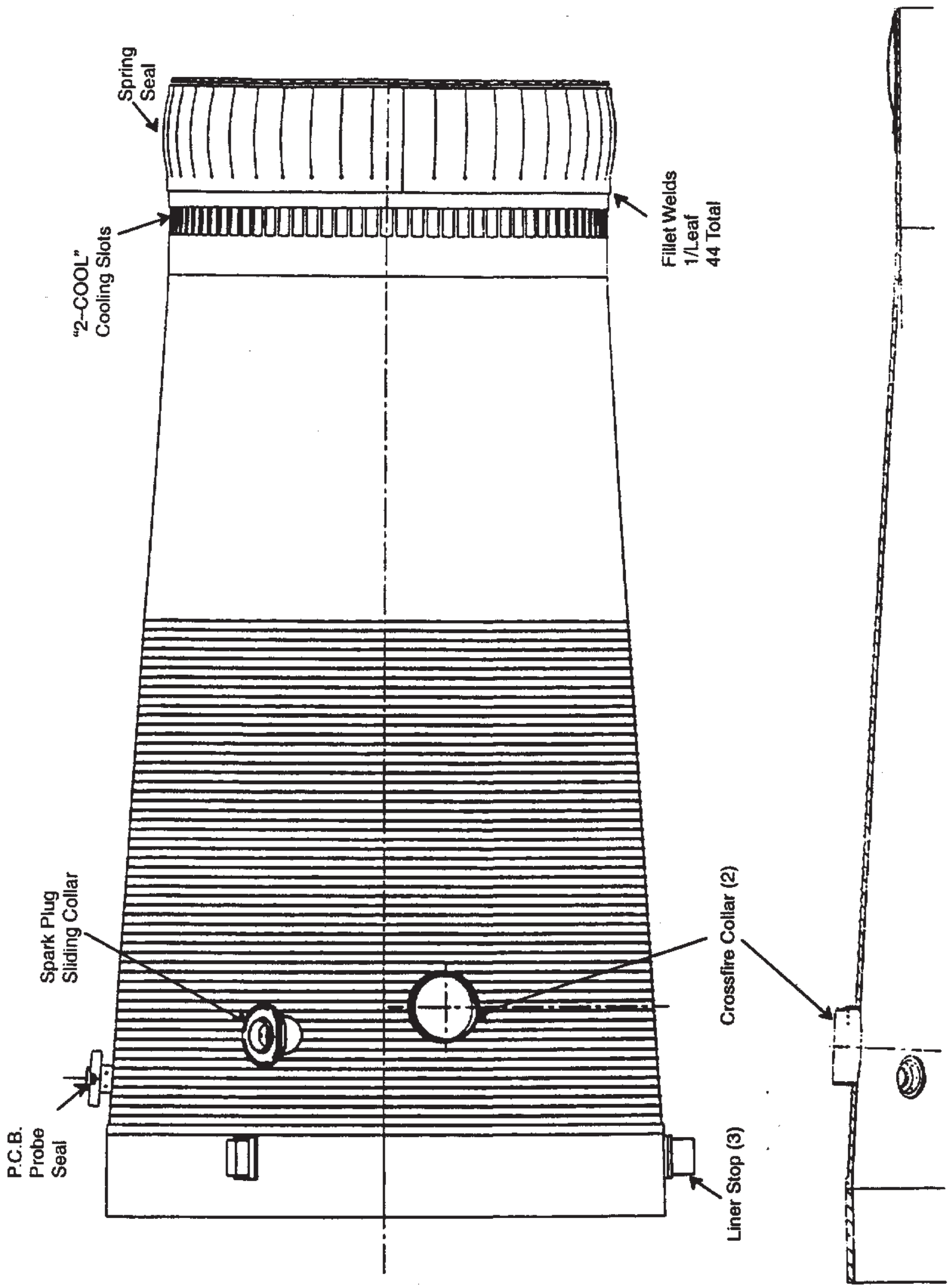

Figure CI-I.9. Combustion Liner

e. Parts that have thermal barrier coating should be inspected with a bright light and a 10× glass. Do not allow any of the Zyglo materials to contaminate the thermal barrier coating.

f. Figure CI-I.9 shows the ”2cool” slots near the downstream end of the combustion liner.

g. Inspect the liner seals (Hula seals) for axial cracks, circumferential cracks, distortion (flattening), wear, missing leaves, bent leaves or spotweld cracks. See Table CI-6 for inspection criteria.

h. If any spring seals are reshaped, ensure the leaf curvature height is similar to adjacent leaves and “PI” tape dimension [14.47/14.53 inches (36.75/36.91 centimeters)] is satisfied.

i. Fluorescent penetrant check any spring seal leaves that have been reshaped.

Table CI-5
DLN-2.6 Combustion Cap Inspection Limits

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
1. Cap Assembly		
a. Fuel nozzle collar wear (ID)	0.030 in. wear or less	Reuse
	greater than 0.030 wear	Repair
b. Fuel nozzle collar free to slide	Movable with light tapping	Reuse
	Not movable	Repair
c. Perforated plate cracks	0.25 in. max length	Repair
	no more than 2 cracks per 1/5 sector	Repair
d. Warpage of perforated plate	0.060 in. locally	Repair
e. Burn through or loss of material	None	Repair
f. Fuel nozzle collar wear from collar retainer	0.030 in. metal remaining	Repair
g. Collar retainer wear from collar	0.030 in. metal remaining	Repair
h. Liner stop	0.060 in. metal loss	Repair
i. Perforated plate assembly loosens in cap assembly	None	Repair
j. Premixing tube cracks (weld or base metal)	None	Repair
2. Cap Assembly Spring Seal		
a. Axial cracks	None	Repair
b. Circumferential cracks	None	Repair
c. Distortion (flattening) Pi tape OD	None	Repair
d. Wear, Pi tape OD	50% material loss at slots	Repair
e Missing leaves	None	Repair
f Spot weld cracks	Four per cap, no more than two adjacent	Repair

Table CI-5 (continued)

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
g. Fillet weld cracks	None	Repair
h. Bent leaves	Any number	Straighten and penetrant check
i. Loss of elasticity	Seal leaves must be tight to cap sleeve, no clearance	Repair

Table CI-6
Combustion Liner Inspection Limits

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
1. Liner Sleeve		
a. Cracks	None	Repair
b. Burn through (missing metal)	None	Repair
c. Out-of-roundness	1/4 in. from original contour	Repair
d. Local distortion	1/8 in. from original contour	Repair
e. Liner wear beneath spring seal	40% material thickness beneath seal	Repair
2. Liner Downstream Cooling System		
a. Axial cracks	None	Repair
b. Weld cracks	None	Repair
c. Circumferential cracks	None	Repair
d. Burn through (missing metal)	None	Repair
e. Thermal barrier coating	Isolated patches 1/2 in. × 1/2 in.	Repair

Table CI-6 (continued)

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
3. Liner Spring Seal		
a. Axial cracks	None	Replace
b. Circular cracks	None	Replace
c. Distortion (flattening) Pi tape OD	None 0.219-0.239 in. height 14.47-14.53 in. diameter	Replace Replace
d. Wear Pi tape OD	50% material removal at slots 14.47-14.53 in. diameter	Replace
e. Missing leaves	None	Replace
f. Weld cracks	None	Replace
g. Bent leaves	Any number	Straighten and penetrant check
h. Loss of elasticity	Seal leaves must be tight to liner, no clearance	Replace
4. Crossfire tube collars		
a. Cracks	None	Repair
b. Wear	0.030 in. material remaining	Repair
c. Distortion	1.98 in. minimum ID	Reform with hand tools
d. Burning of collar	None	Repair
5. Liner Stops		
a. Wear on downstream end	0.060 in.	Repair
b. Wear on upstream end	0.060 in.	Repair
c. Wear on sides	0.190 in. metal remaining	Repair
d. Cracks (weld or parent metal	None	Repair
6. Floating Collars Spark Plug, Flame Detector, and P.C.B Probe		
a. Through hole wear	0.050 in. from original diameter	Replace collar

Table CI-6 (continued)

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
6. Floating Collars Spark Plug, Flame Detector, and P.C.B. Probe (continued)		
b. Collar sliding wear	0.030 in. material remaining	Replace collar
c. Retainer cracks (weld or parent metal)	None	Repair

<u>Operation 18</u> — How to Inspect Crossfire Tubes and Retainers (Figures CI-I.10, 10A)

1. Inspect crossfire tubes for evidence of distortion, cracks, missing metal, burn-through and wear. Use Table CI-7 for inspection criteria.

2. Inspect crossfire tube retainers for wear and evidence of bending. Use Table CI-7 for inspection criteria.

3. Record inspection results on Inspection Form.

<u>Operation 19</u> — How to Inspect Combustion Chamber Flow Sleeve (Figure CI-I.11)

1. Using a bright light and a 10 power magnifying glass, inspect the combustion chamber flow sleeve.

2. Use Figure CI-I.11 for identification of parts and Table CI-8 for inspection limits. Record all inspection results on Inspection Report Form.

   a. Inspect the sleeve for body or weld cracks, out-of-roundness, burn-through, missing metal.

   b. Inspect forward flange to body weld for cracks or cracks in the flange.

Table CI-7
Inspection Limits, Crossfire Tubes and Retainers

CAUTION

The inspection criteria applies to GE supplied crossfire tubes and retainers.

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
1. Crossfire Tubes		
a. Burn through; missing metal	None	Replace
b. Distortion	None	Replace
c. Wear	50% of original material	Repair
2. Crossfire Tube Spring Retainers		
a. Wear	0.030” (0.076 cm) material	Replace
b. Evidence of distortion	None	Replace

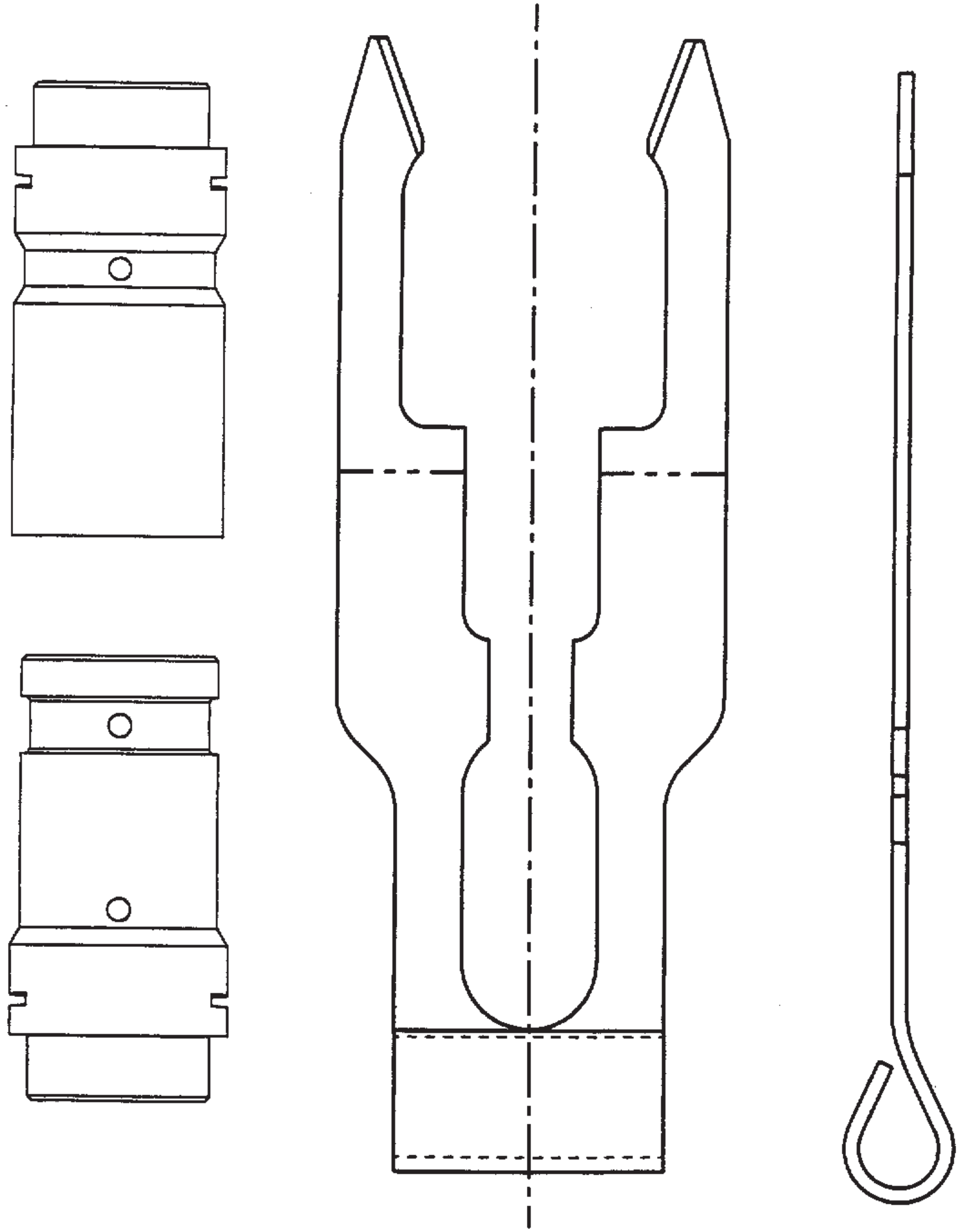

Figure CI–I.10 Crossfire Tube Parts

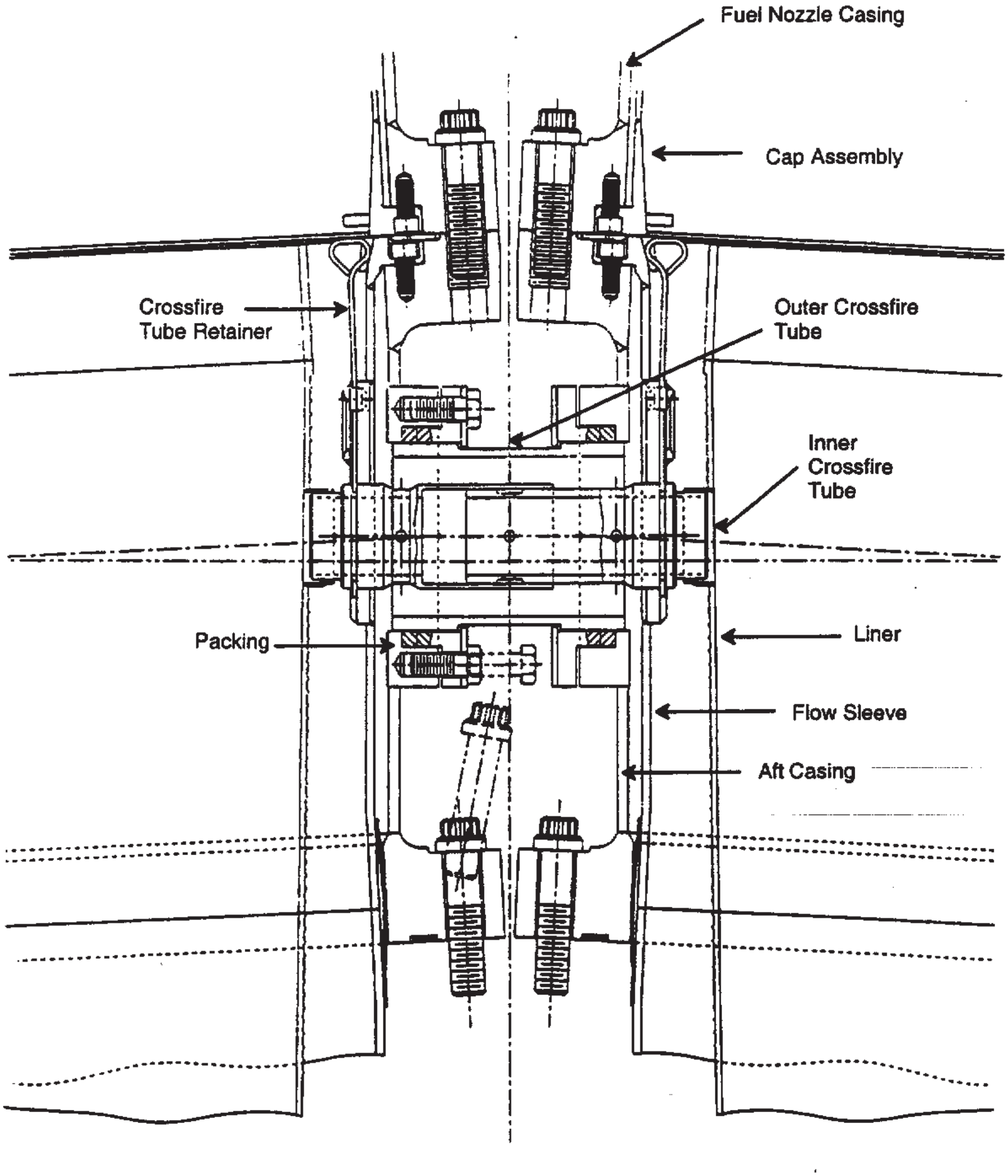

Figure CI–I.10A Crossfire Tube Assembly

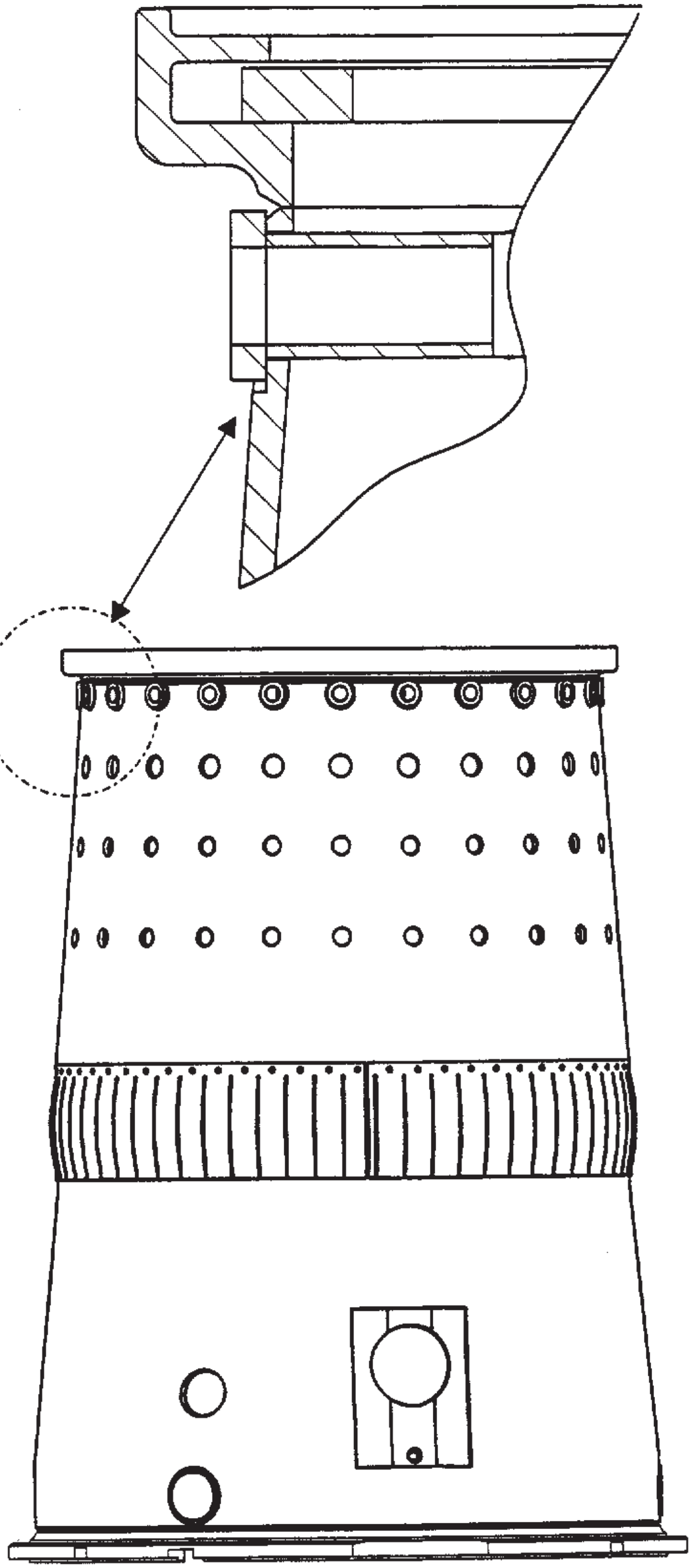

Figure CI–I.11 Flowsleeve With Thimbles

c. Inspect liner stops for wear, body and stop weld cracks.

d. Inspect crossfire tube retainer bracket for weld cracks or bracket cracks.

e. Inspect floating seal at aft end for excessive wear on ring or retainers.

f. Inspect the spring seals at mid length for axial cracks, circumferential cracks, distortion (flattening), wear, missing leaves, bent leaves or spotweld cracks. See Table CI-8 for inspection criteria.

g. If any spring seals are reshaped, ensure the leaf curvature height is similar to adjacent leaves and “PI” tape dimension (19.66 $\pm$0.03 inches) is satisfied.

h. Fluorescent penetrant check any spring seal leaves that have been reshaped.

Operation 20 — How to Inspect Fuel Nozzle (Forward) Outer Casing (Figure CI-I.12)

1. Inspect the inside and outside of the casing for cracks, bulging, buckling or signs of overheating and corrosion.
2. Inspect the gas injection pegs for plugged gas holes and for cracks in the weld to the casing shell.
3. Check all Helicoil inserts in upstream flange. Replace if unserviceable.
4. Record inspection results on Form**.**

Operation 21 — How to Inspect Combustion Outer Casings (Figure CI-I.13)

1. Inspect inside and outside of combustion casings for cracks, bulging, buckling, signs of overheating and corrosion.
2. Inspect each combustion outer casing for foreign objects.
3. Check Heli-Coil inserts in flange at upstream end of casing. Replace if unserviceable.
4. Record inspection results on Inspection Form.

Operation 22 — How to Inspect Transition Pieces (Figures CI-I.14 through CI-I.16)

1. For inspection guidelines, see Table CI-9. Clean and fluorescent penetrant check the aft (rectangular) body end 6” (15.24cm) length. Use the Zyglo with the “spot” method after a general inspection with a bright light and a 10 power glass. Do not allow any of the Zyglo materials to contaminate the thermal barrier coating. If there is reason, based upon inspection of the inside surface of the transition piece, for removal of the impingement sleeve, it should be done at a qualified GE repair facility. This is because reinstallation of an impingement sleeve requires special fixtures. Record all inspection results on appropriate Inspection Form. Check the following:

   a. Aft frame side seal and inner and outer floating seal slot surfaces for wear or cracks.

   b. Aft frame/body corners for cracks in welds, frame/body or wear inserts and measure opening of gas path height.

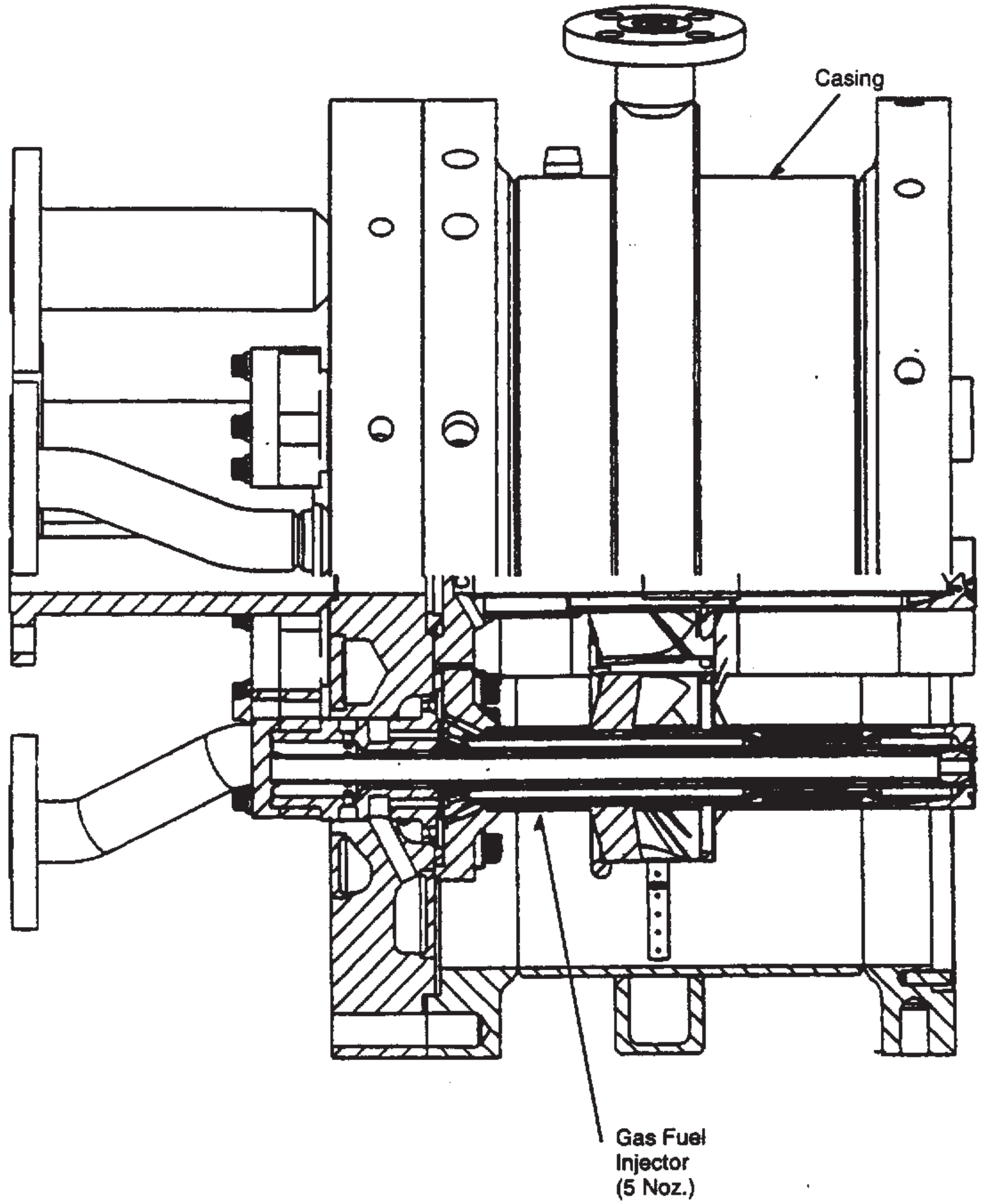

Figure CI–I.12 Fuel Nozzle Cover and Casing Assembly (Gas Only)

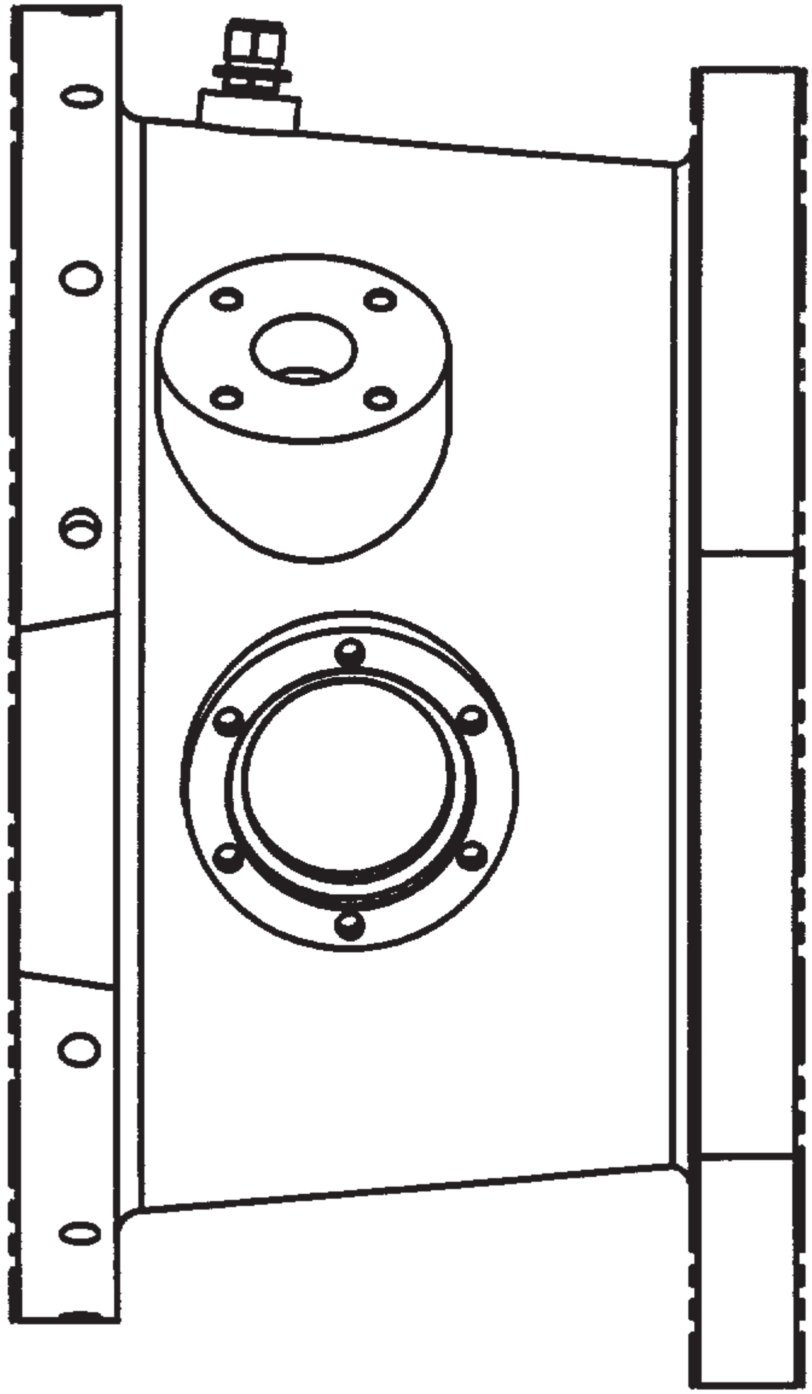

Figure CI–I.13 Aft Casing

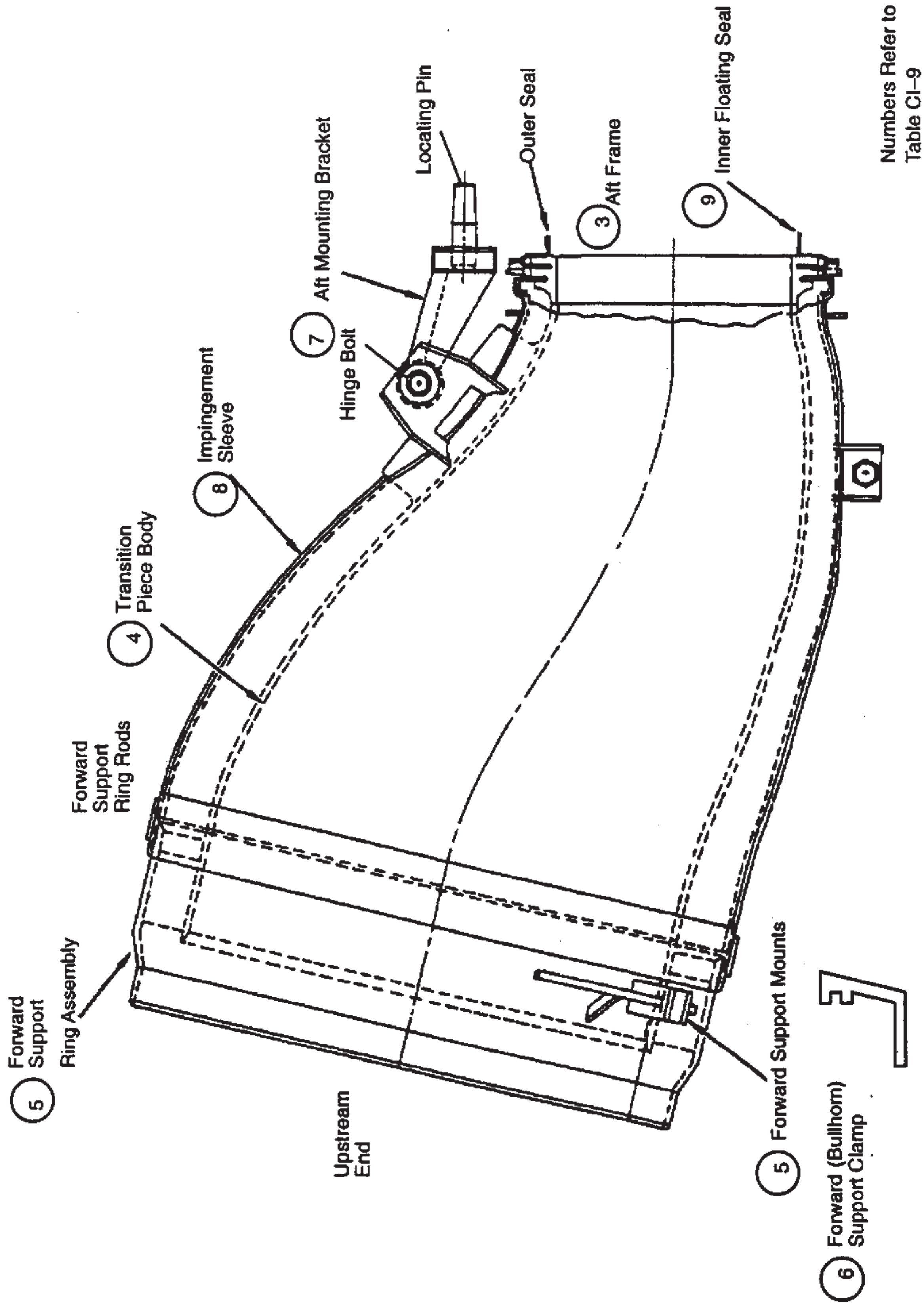

Figure CI–I.14 Transition Piece Inspection Area – Side View

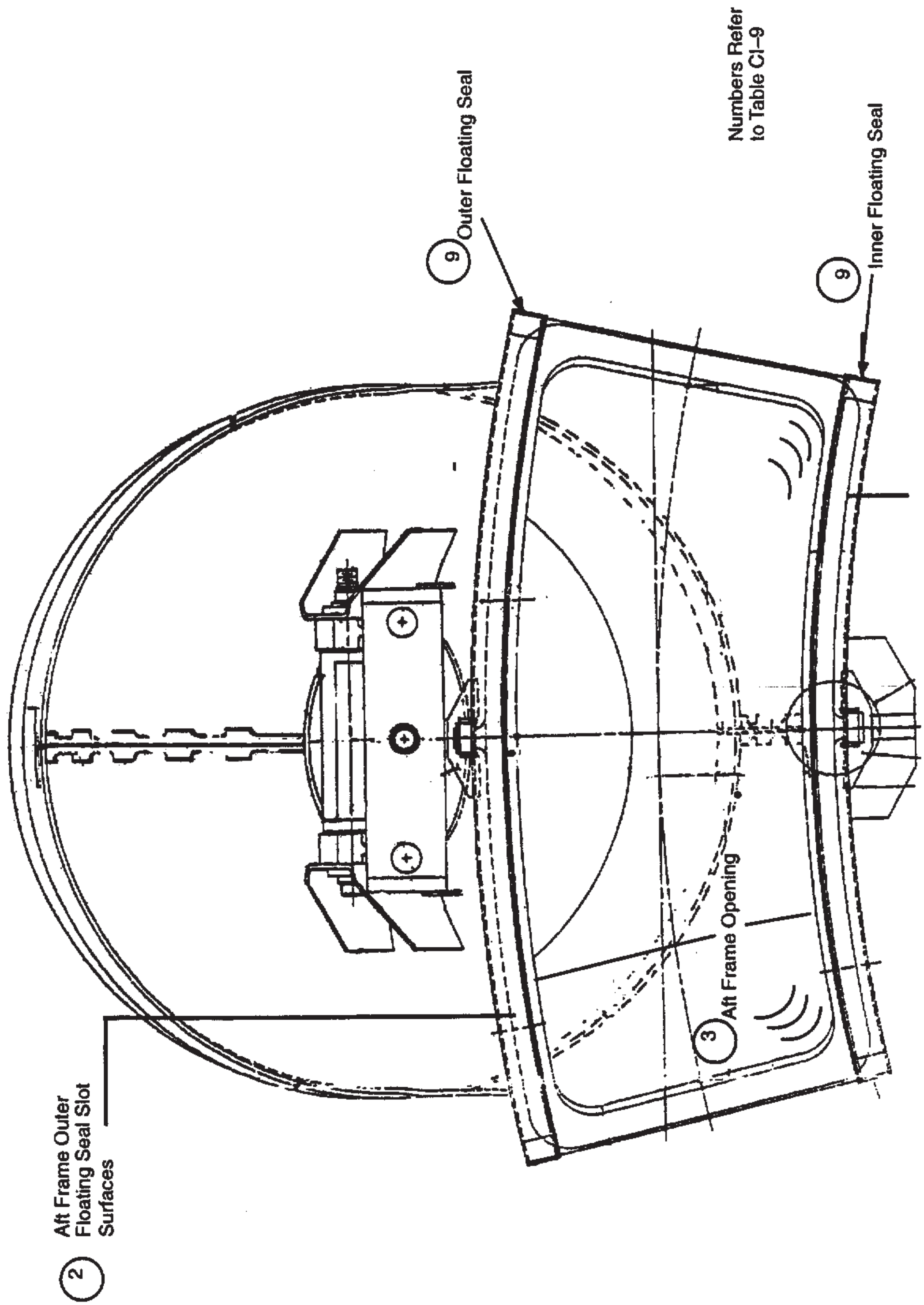

Figure CI–I.15 Transition Piece Inspection Areas – Downstream End View

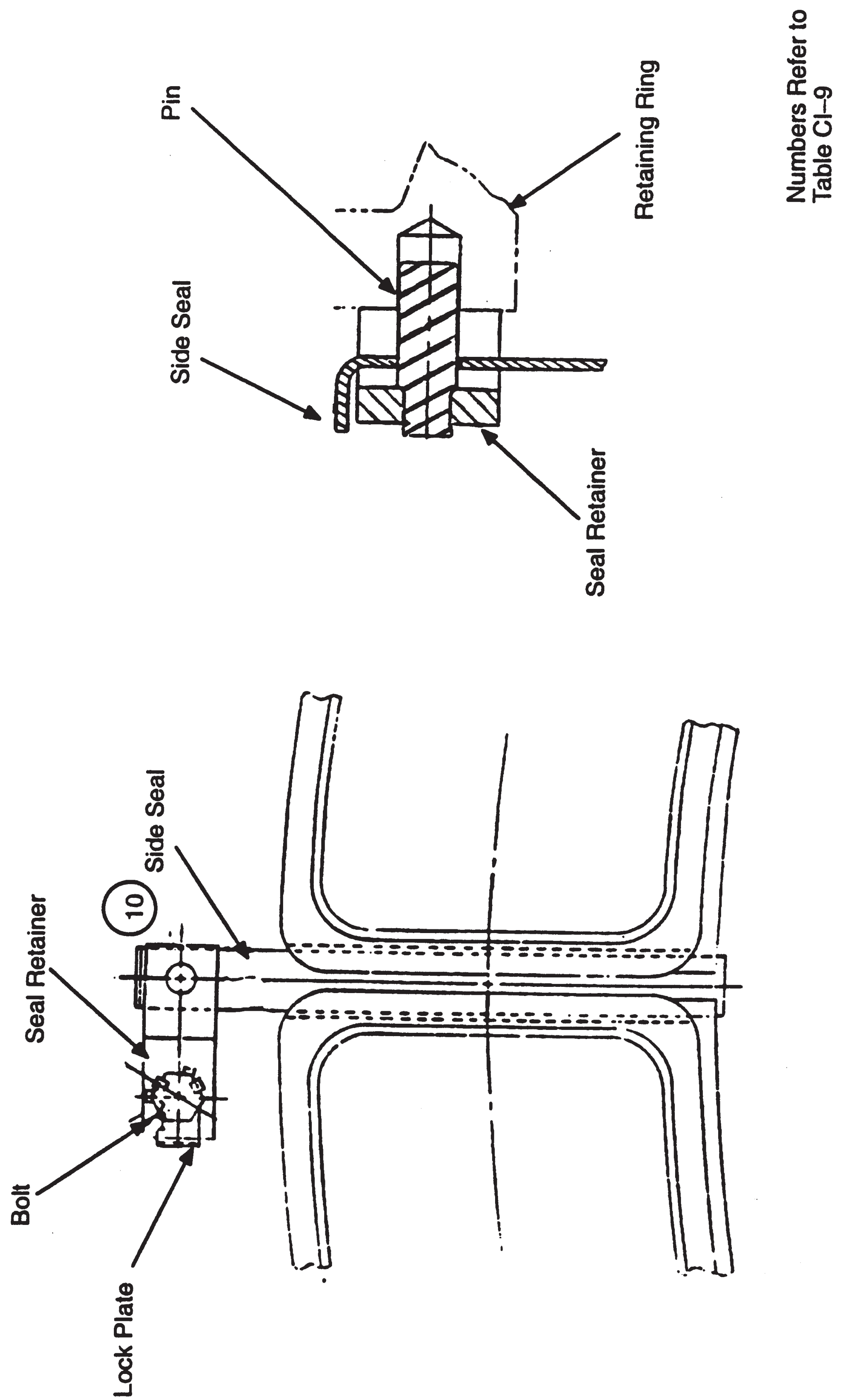

Figure CI–I.16 Side Seal Inspection Area – Aft View

Table CI-8
Inspection Limits for Flow Sleeves
See Figure CI-I.11

CAUTION

The inspection criteria applies to GE supplied flow sleeves.

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
1. Sleeve		
a. Body or weld cracks	0.250″ (0.635 cm) long	Repair
b. Out-of-roundness	0.250″ (0.635 cm) from original contour	Repair
c. Local distortion	0.190″ (0.481 cm) from original contour with no cracks	Repair
d. Burn-through (missing metal)	None	Repair
2. Forward Flange		
a. Flange to body weld crack	None	Repair
b. Cracks	None	Repair
3. Liner Stops		
a. Wear	0.020″ (0.051 cm) from original material	Repair
b. Body stop weld cracks	None	Repair
4. Floating Seal Ring		
a. Cracks	None	Replace Ring
b. Wear	0.120″ (0.31 cm) radial	Replace Ring
5. Floating Seal Retainer		
a. Cracks	None	Replace
b. Wear	0.06″ (0.15 cm)	Replace

Table CI-8
Inspection Limits for Flow Sleeves (Cont'd)
See Figure CI-I. 11

CAUTION

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
6. Crossfire Tube Retainer Bracket		
a. Weld Cracks	0.130 in. (0.33 cm) long	Replace
b. Cracks	None	Replace
7. Spring Seal		
a. Axial Cracks	None	Replace Seal
b. Circular Cracks	None	Replace Seal
c. Distortion 7FA+e (flattening)	None 0.219-0.239 in. height	Replace Seal
Pi-tape OD	20.19-20.13	Replace Seal
c. Distortion 7FA+ (flattening)	None 0.219-0.239 in. height	Replace Seal
Pi-tape OD	19.69-19.63	Replace Seal
d. Wear 7FA+e	50% mat'l removal at slots	Replace Seal
Pi-tape OD	20.19-20.13	Replace Seal
d. Wear 7FA+	50% mat'l removal at slots	Replace Seal
Pi-tape OD	19.69-19.63	Replace Seal
e. Missing Leaves	None	Replace Seal
f. Spot Weld Cracks	Four per flow sleeve, no more than two adjacent	Replace Seal
g. Bent Leaves	Any number	Straighten and penetrant check

*"Replace" does not mean flow sleeve must be scrapped — this part can be repaired by qualified GE personnel.

j. Forward mounts and support ring for wear from flow sleeve seal ring, cracks in brackets, ring or mounts and for H-block wear.

k. Forward (bullhorn) support clamp for cracks and wear.

l. Aft mounting bracket for cracks and wear.

m. Impingement sleeve bracket, body, and welds for cracks, wear and proper pad gaps.

n. Inner and outer floating seals and side seals for wear.

2. Repair welding procedures.

Note: Welding repair procedures will not be described except to note that Gas Tungsten Arc Welding is the only authorized welding repair procedure allowed on MS7001F/FA transition pieces. It is generally recommended that transition pieces requiring repairs be done by qualified GE personnel. The transition pieces require heat treatment after weld repairs.

Table CI-9
Transition Piece Inspection Limits

CAUTION

The inspection criteria applies to GE supplied transition pieces.

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
1. Aft Frame Side Seal Slot Surfaces		
a. Wear	0.030″ (0.0.76 cm) deep 0.250” (0.635 cm) original thickness (7FA)	Replace*
b. Cracks	None	Replace*
2. Aft Frame Inner & Outer Floating Seal Slot Surfaces		
a. Wear	0.030″ (0.0.76 cm) deep 0.250” (0.635 cm) original rail thickness (7FA)	Replace*
b. Cracks	None	Replace*
3. Aft Frame		
a. Weld or frame cracks	None	Replace*
b. Gas Path Opening	<8.400 (7.20” 7FA)	Replace*
4. Transition Piece Body		
a. Weld or Body cracks (including corners)	0.250” (0.635 cm) long	Replace*
b. Out-of-roundness (forward end)	0.080″ (0.020 cm) from original contour	Replace*
c. Wear from liner seal	0.060” (0.152 cm) reduction of original material thickness [.188” (0.48 cm) original thickness]	Replace*
d. Corrosion	0.030” (0.076 cm) reduction of original material thickness [.188” (0.48 cm) original thickness]	Replace*

Table CI-9
Transition Piece Inspection Limits (Cont'd)

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
e. Deposits	0.030" (0.076 cm) thick	Remove*
f. Loss of thermal barrier coating	0.75 × 0.75 sq. in. (1.905 × 1.905 sq. cm) isolated patches	Replace*
5. Forward Mounts & Support Ring Assembly		
a. Wear from flow sleeve seal ring.	0.040" (0.102 cm) [0.150" (0.38 cm) min. nominal]	Replace
b. Out-of-roundness -outside.	0.080" (0.020 cm) from original contour	Replace*
c. Cracks in bracket welds between transition piece body and forward support ring.	None	Replace*
d. Cracks in ring or mounts	None	Replace*
e. Wear on mount H-blocks	0.060" (0.152 cm) reduction of original material thickness [.232" (.59 cm) original thickness (7FA+e) [.229" (0.58 cm) original thickness (7FA)]	Replace*
6. Forward (Bullhorn) Support Clamp		
a. Cracks	None	Replace*
b. Wear	0.060" (0.152 cm) from original material [.490" (1.24 cm) original thickness]	Replace*
7. Aft Mounting Bracket		
a. Weld or body cracks	None	Replace*
8. Impingement Sleeve		
a. Cracks at brackets	None	Replace*
b. Cracks from impingement holes	None	Replace*

Table CI-9
Transition Piece Inspection Limits (Cont'd)

Inspect	Maximum Acceptable Limits	Disposition (For Parts Beyond Max. Limits)
c. Cracks at welds	None	Replace*
d. Wear at Forward Support Ring Pads	0.030" (0.076 cm) [min. nominal dimension of .062]	Remove*
e. Gap at Forward Support Ring Pads	None	Replace*
f. Crack at Scoopweld	None	Repair
g. Crack at trip Strpweld	None	Repair
9. Inner & Outer Floating seals		
a. Wear	50% of original material thickness [0.125" (0.32 cm) at doubler-0.062" (0.16cm) all other locations]	Replace*
b. Cracks	None	Replace*
10. Side Seals		
a. Wear	50% of original material thickness [0.062" (0.16 cm) original thickness]	Replace*
b. Cracks	None	Replace*
c. Retainer	No movement in Pin	Replace*

*"Replace" does not mean transition piece must be scrapped-this part can be repaired by qualified GE personnel.

III. Re-assembly Procedures for MS7001FA+ and MS7001FA+e Gas Only Combustion Inspection (with DLN-2.6)

Note: Obtain appropriate Inspection Forms from your local GE Field Service Representative.

Operation 23 — How to Install Transition Pieces

Note: It is recommended that installation of the combustors wait until all the transition pieces are installed, rather than immediately after each transition piece, so that the transition pieces may be switched to meet gap requirements if necessary.

Pre-assembly Inspection and Checks

1. Prior to installation, inspect transition pieces for obvious handling or transportation damage such as deformed floating seals or other damage. Trial fit end seals onto transition piece before installing the transition piece into the machine.

2. Trial fit, using hand force only, each forward (bullhorn) support clamp to its respective transition piece prior to installing the transition piece into the machine.

3. Inspect first-stage nozzle segments for axial displacement (steps) between adjoining segments. Displacement greater than 0.030 inch (0.076 cm) should be reseated with a 5-pound rawhide mallet. *Do Not* Use Metal Hammer. Refer to first-stage nozzle procedures.

4. Inspect all tapped holes for dirt, chips, rust or damaged threads. Re-tap damaged threads; re-machine for helicoil insert if threads are elongated or stripped.

5. Inspect all helicoils for cross threading, elongation, stripping or inserts backing out. Remove and replace all damaged helicoils.

6. To minimize handling and adjustments inside the compressor discharge case, set the positions of the inner and outer floating seals as shown in Figure CI-R.1. *Do Not* Use Metal Hammer to Position Seals. Secure (only) with masking tape.

Note: The aft mounting bracket hinge bolt has been torqued and welded to the retaining nut at the factory/service shop and should not be adjusted during inspections or maintenance.

Assembly Procedure

Note: Prior to and at reinstallation of transition pieces, verify and record information called for on appropriate Inspection Report Form MS 7001 Model F Transition Piece Installation Record.

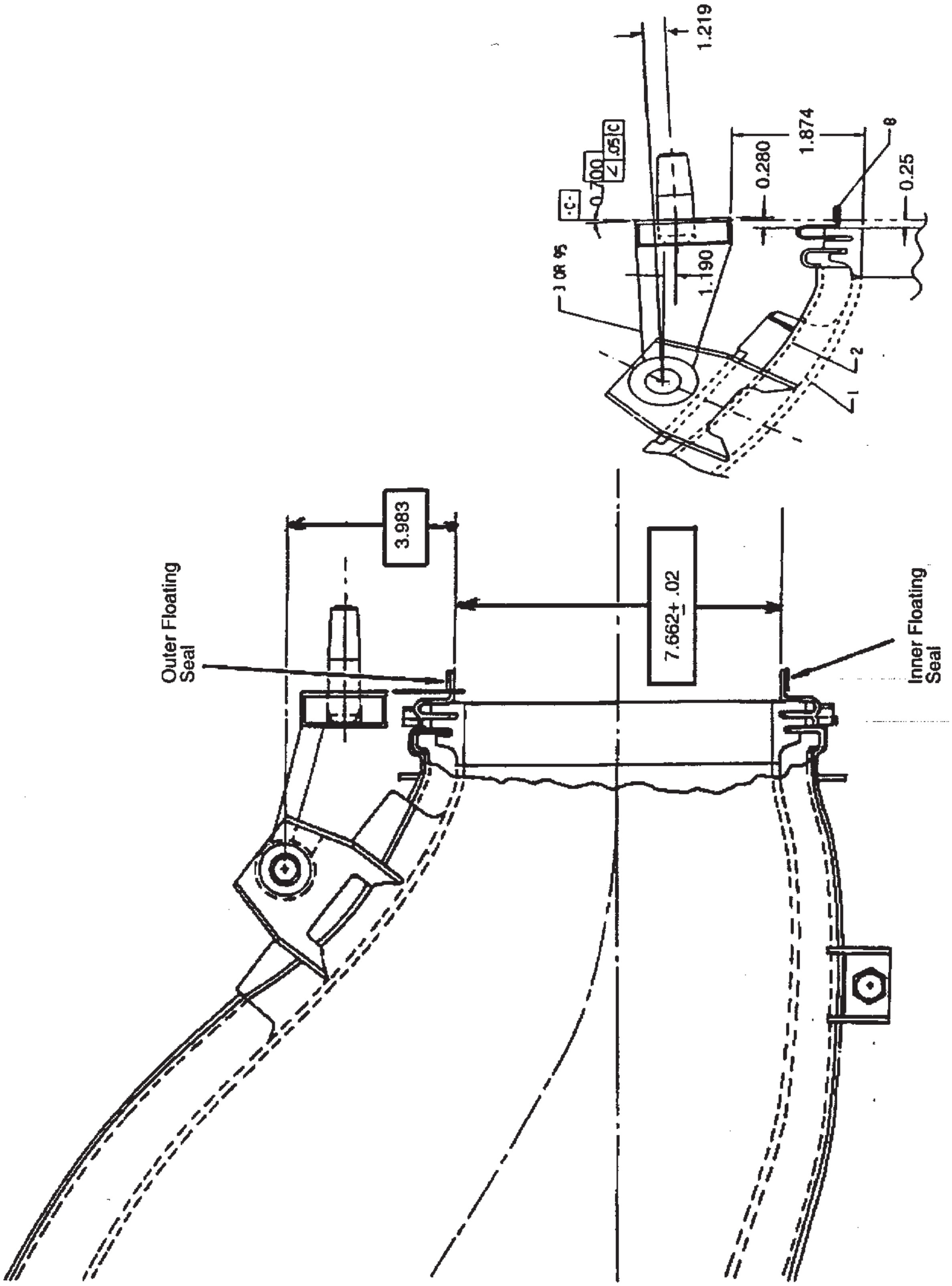

Figure CI–R.1 Floating Seal Position for Assembly

CAUTION

> All new bolts and lockplates must be used at re-assembly without exception. Use Fel-ProC-102 thread lubricant on all bolt threads.

Note: When installing transition pieces, start with the bottom chamber position, then proceed with the installation of adjacent transition pieces, alternating side-to-side to the top.

1. Lift transition piece into the opening to position it in the appropriate chamber. Rig a line to support the weight of the transition piece. At the bottom of the machine, a side line will be needed to bring the transition piece over to its correct position.

2. It is generally easier to align the transition piece seals if it is done without the presence of the forward (bullhorn) support clamp.

3. Move the transition piece aft until the locating guide pin in the aft mounting bracket engages the hole in the nozzle retaining ring.

4. Move the transition piece further aft making sure the inner and outer floating seals line up with the slots in the first-stage nozzle.

5. After the seals have entered the slots in the nozzle, the transition piece should be moved aft until the aft bracket face contacts the retaining ring.

6. Install aft mounting bracket bolts and lockplates hand tight to first-stage nozzle retaining ring. Do not torque or bend lockplate tabs at this time. Check for proper floating seal engagement.

7. Slide the forward (bullhorn) support clamp into place engaging the "H" block mounts on the transition piece forward support ring assembly. Install the forward (bullhorn) support clamp hand tight to the forward mounting block with two bolts and a lockplate, but do not torque bolts or bend lockplate tabs. Adjust support clamp by sliding on block until at least one bearing surface on each side of support clamp makes contact when transition piece is loaded toward turbine centerline.

8.

Note: Prior to executing this step and those that follow, the first-stage nozzle and retaining ring MUST be totally secured (torqued and locked) to BOTH the upper and lower turbine shells. Transition pieces are only to be torqued and locked to fully secured retaining rings. Movement of the retaining ring (in securing it to the turbine shell) with transition pieces already torqued to the ring may lead to undue stress in the transition piece mounting system and misalignment of upper clearances.

Torque the aft mounting bracket bolts to 70-80 foot-pounds (94.9-108.4 N-m). Do not bend lock tabs at this time. (Figure CI-R.2)

Adjust the forward (bullhorn) support clamp (Figure CI-R.3) by sliding it on the forward mounting block until at least one bearing surface on each side of the forward (bullhorn) support clamp makes

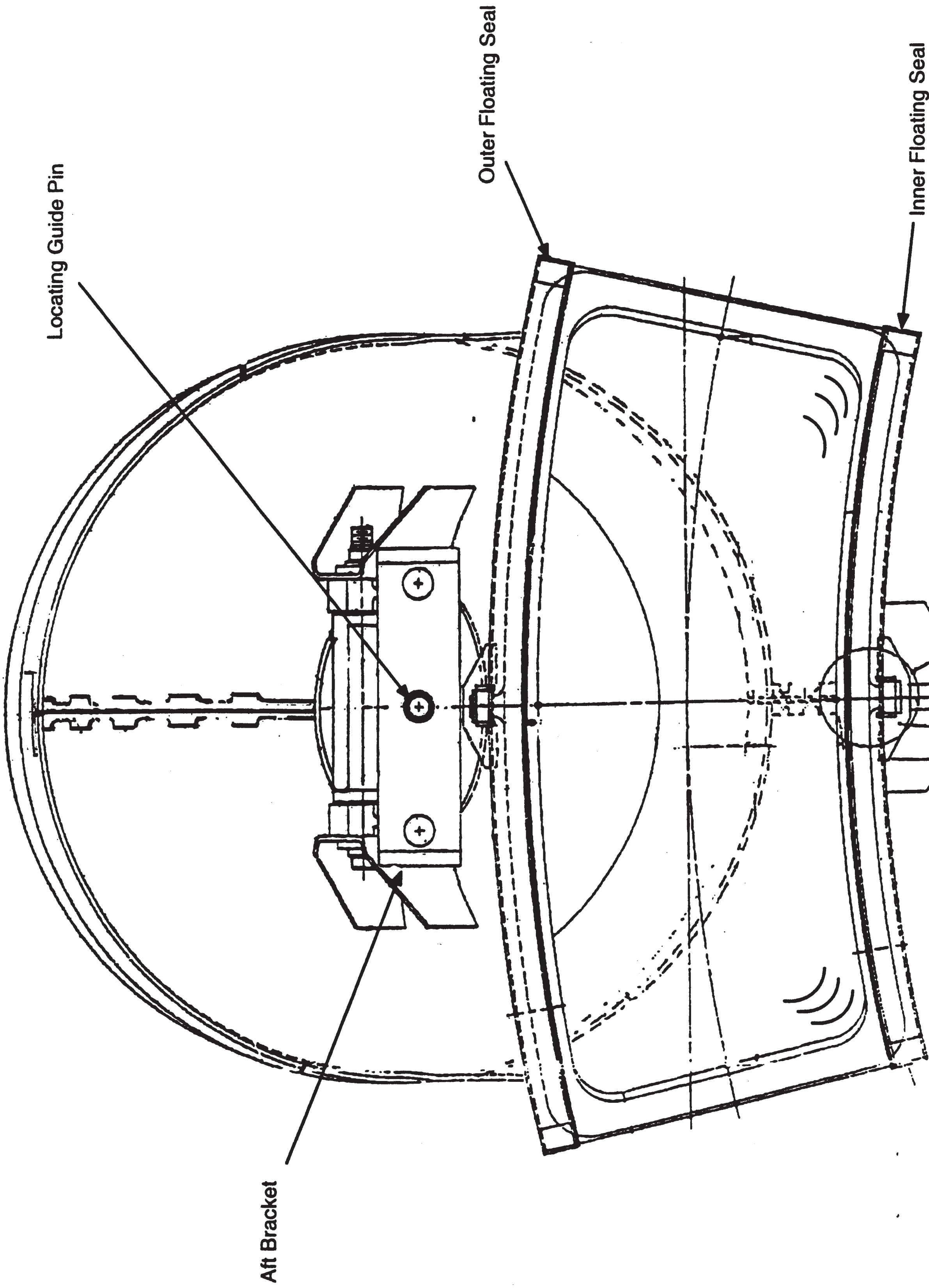

Figure CI–R.2 View of Aft Bracket

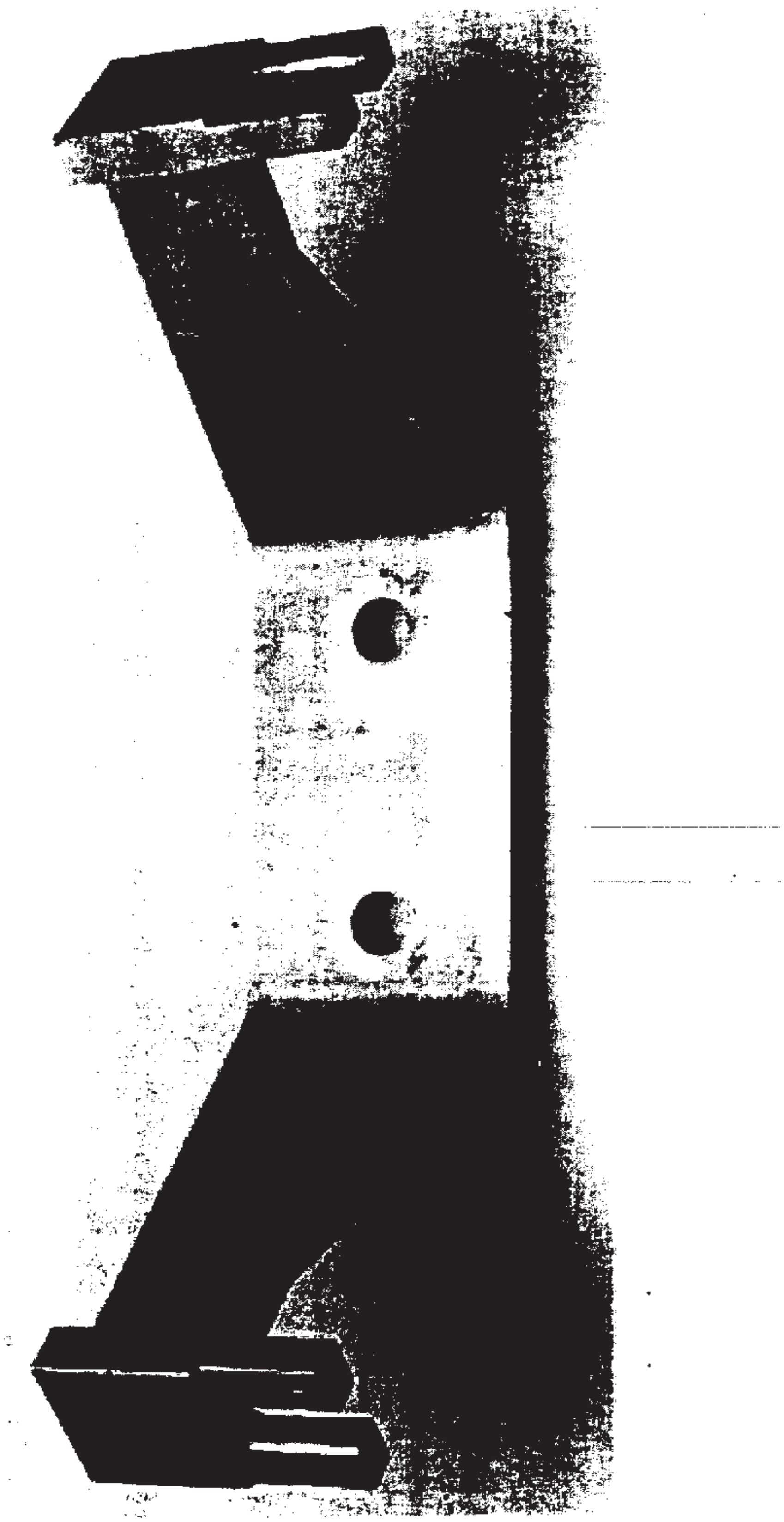

Figure CI–R.3 Transition Piece – Forward (Bullhorn) Support Clamp

contact when the transition piece is loaded toward the turbine centerline (Figure CI-R.4) Torque the forward (bullhorn) support clamp bolts to 60-68 foot-pounds.

9. Check the “B” and “C” dimensions (Figure CI-R.5) between the nozzle and the transition piece aft frame in six locations while the first-stage nozzle is loaded aft on the nozzle support ring. These dimensions must agree with the values given on the Transition Piece Arrangement drawing. Note that the values must be achieved on each transition piece for both clearance and assembly of side seals between adjacent transition pieces (See ML0717).

   If the “B” and “C” dimensions are more than that specified in ML0717, up to two lockplates may be used as shims between the forward (bullhorn) support clamp and the forward mounting block. If the “B” and “C” dimensions are more than that specified in ML0717 for a small fraction of all the transition pieces, switching “high” and “low” gap dimensioned transition pieces may provide a solution.

   As a last resort, if the “B” and “C” dimensions are still more than that specified in ML0717, slight machining of the forward (bullhorn) support clamp may be done. It is highly recommended that all forward (bullhorn) support clamps be equally machined, so that future interchangeability is maintained.

   When the “B” and “C” dimensions meet the drawing requirements, bend up the lockplate tabs on the forward (bullhorn) support clamp (Figure CI-R.6) and the aft mounting bracket (Figure CI-R.7).

10. Install the side seals after adjacent transition pieces have been installed. Slide the side seal in the aft frame slot (hand force only should be required). Assemble the side seal retainer, lockplate and bolt Figure (CI-R.8). Torque side seal retainer bolt to 70-80 foot-pounds (94.9-108.4 N-m) and bend the lockplate tabs.

11. Follow the same procedure for each transition piece until the last one is installed.

WARNING

Failure to comply with the above locking procedures could result in loss of preload, liberated hardware and damage to the turbine.

Operation 24 — How to Install Outer Combustion Chambers and Outer Crossfire Tubes (CI-R.9 and CI-R.10)

Note: Begin by installing the outer casing on Chamber No. 7 and work up to the top of the turbine.

1. Apply a light coating of anti-seize compound to all mating parts and bolts.

2. Install a new spiral wound gasket into groove in the downstream flange of the outer combustion chamber.

3. Rig a support sling and lift the outer combustion chamber into place.

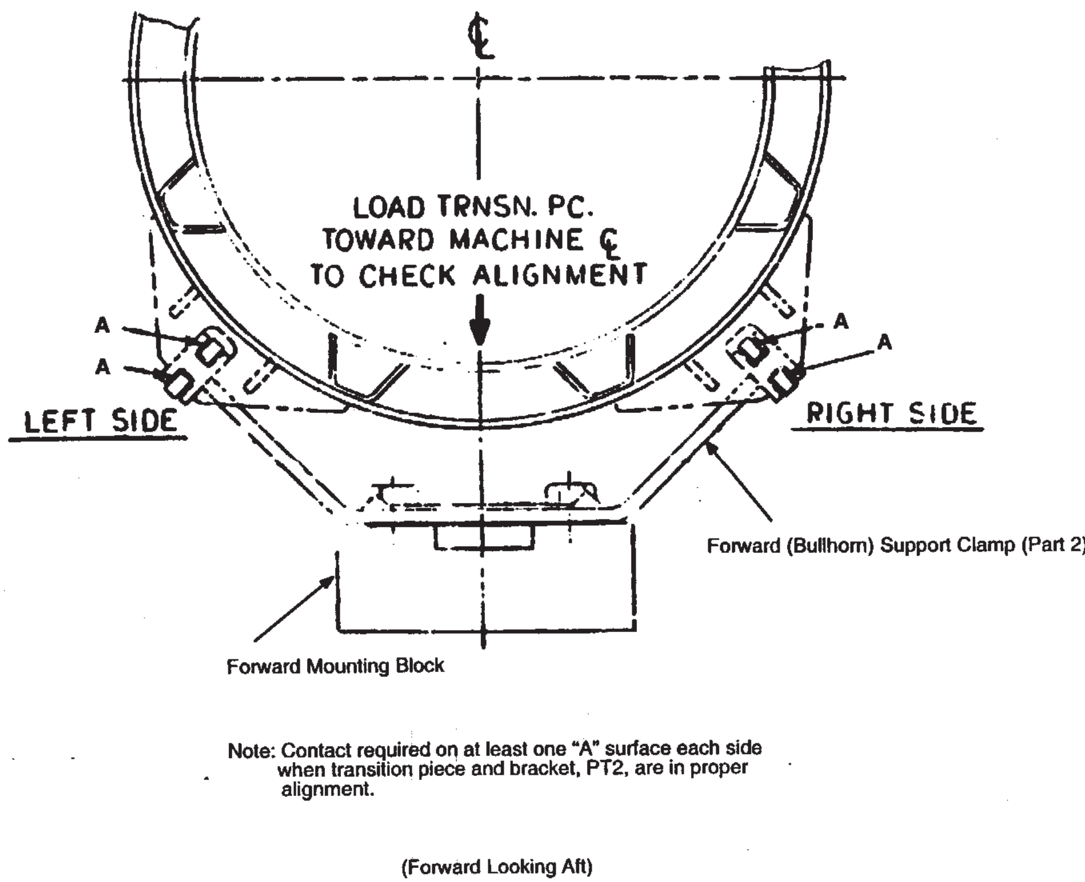

Figure CI–R.4 Transition Piece Forward (Bullhorn) Support Clamp Alignment

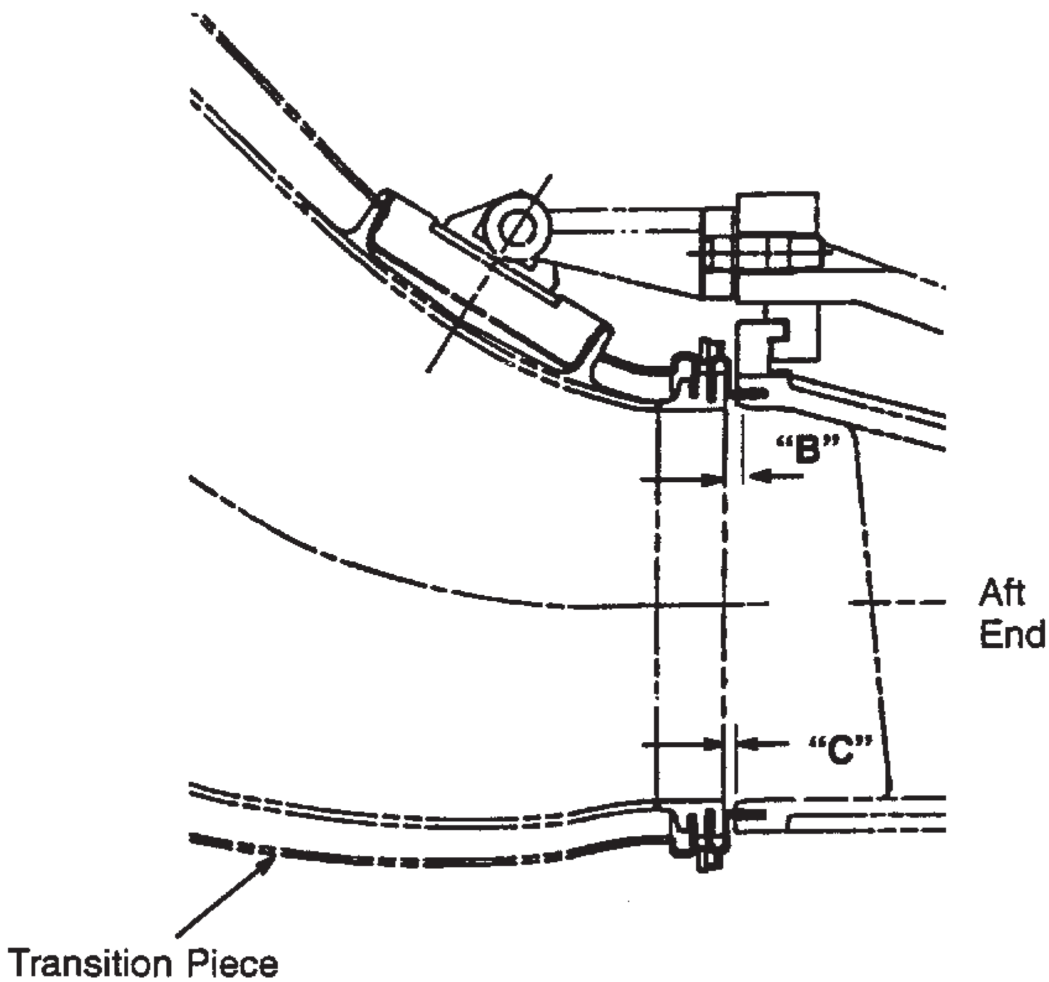

Figure CI–R.5 Transition Piece to First–Stage Nozzle Clearance Checks

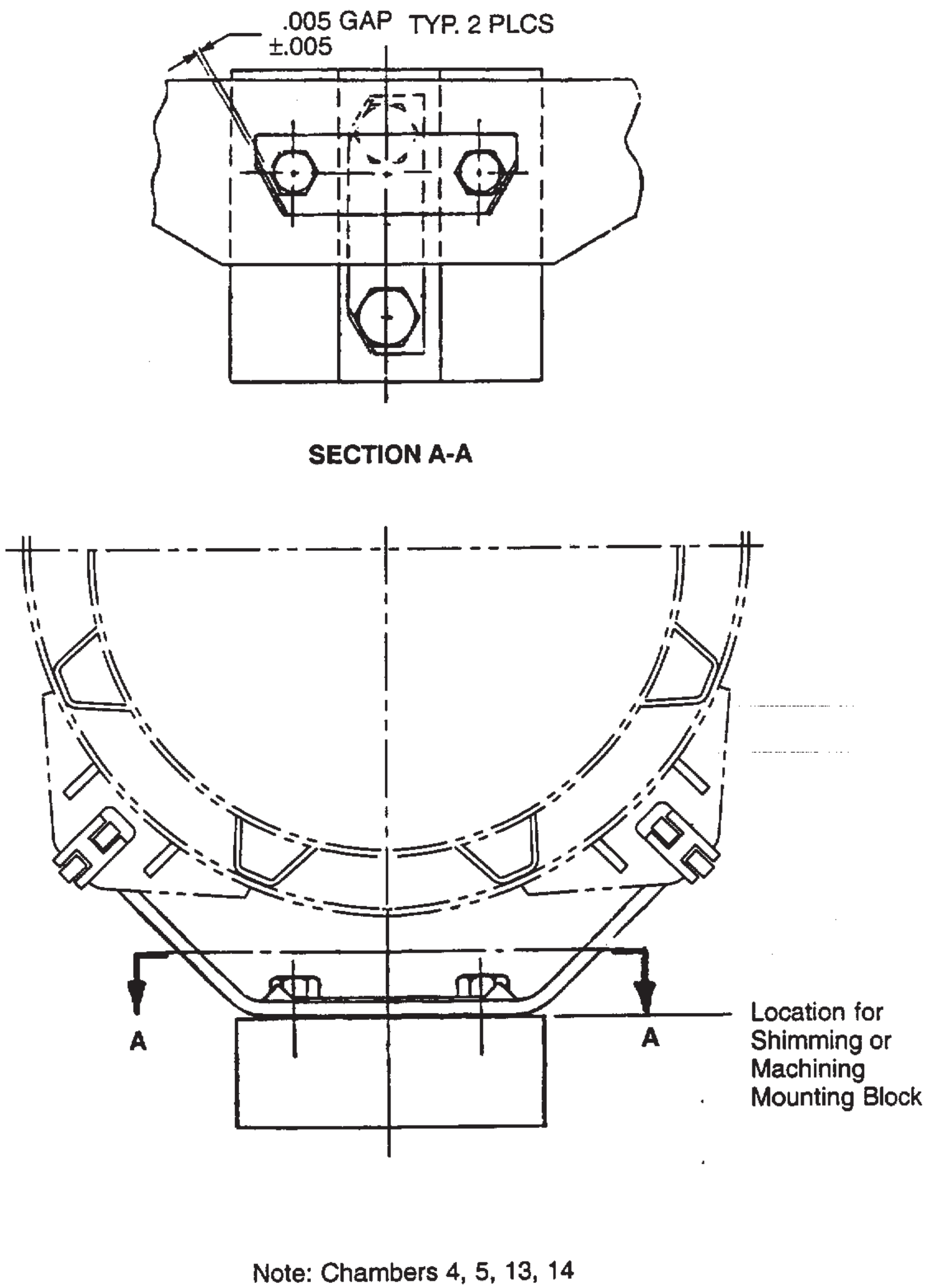

Figure CI–R.6 Forward (Bullhorn) Support Clamp Bolt Lockplating

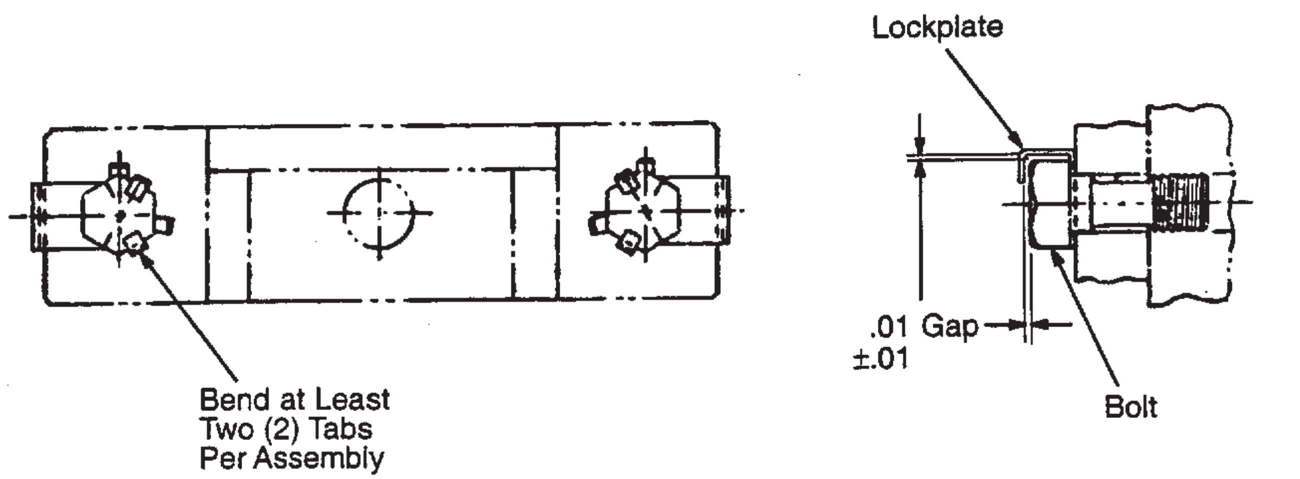

Figure CI–R.7 Aft Bracket Bolt Lockplating

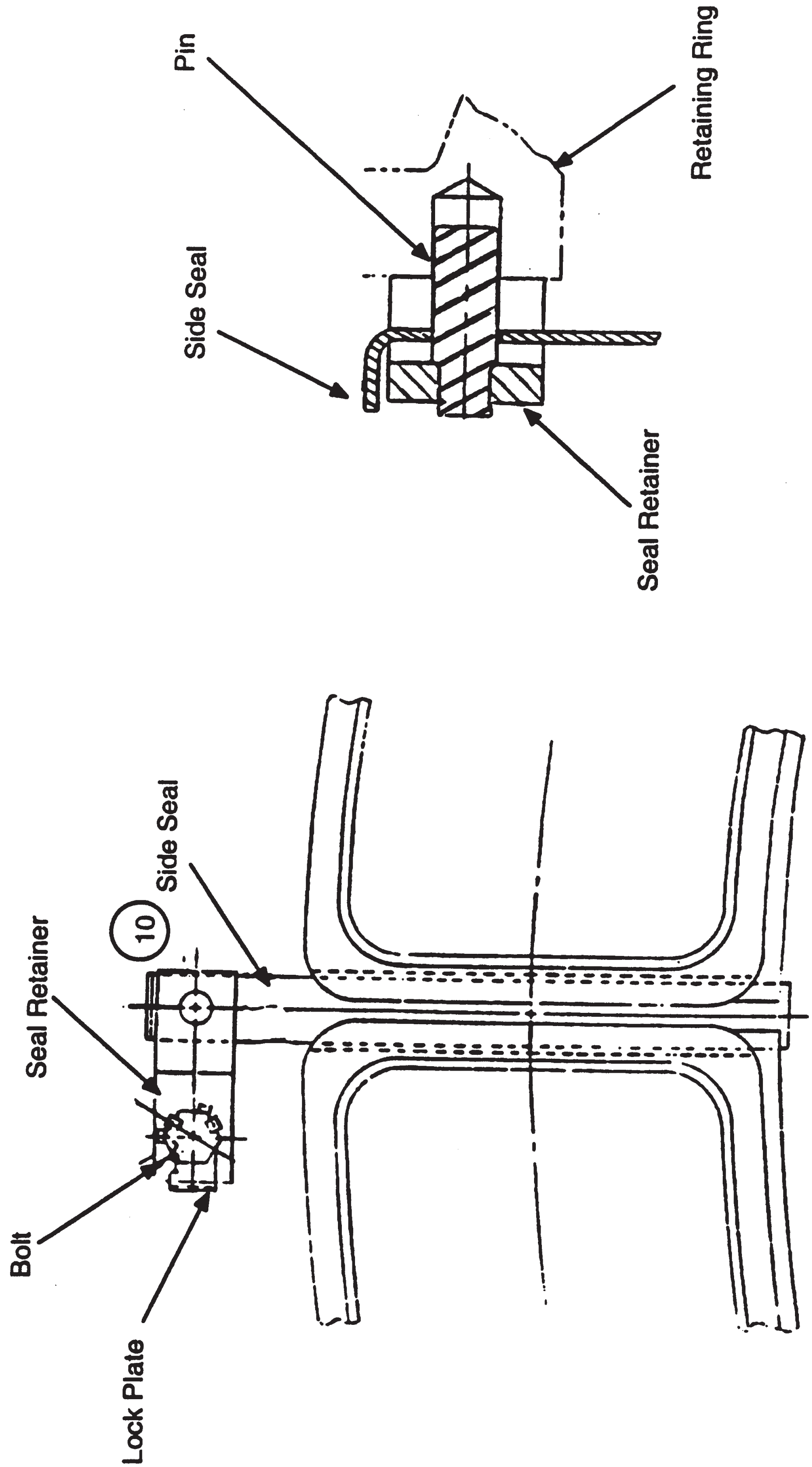

Figure CI–R.8 Side Seal Details

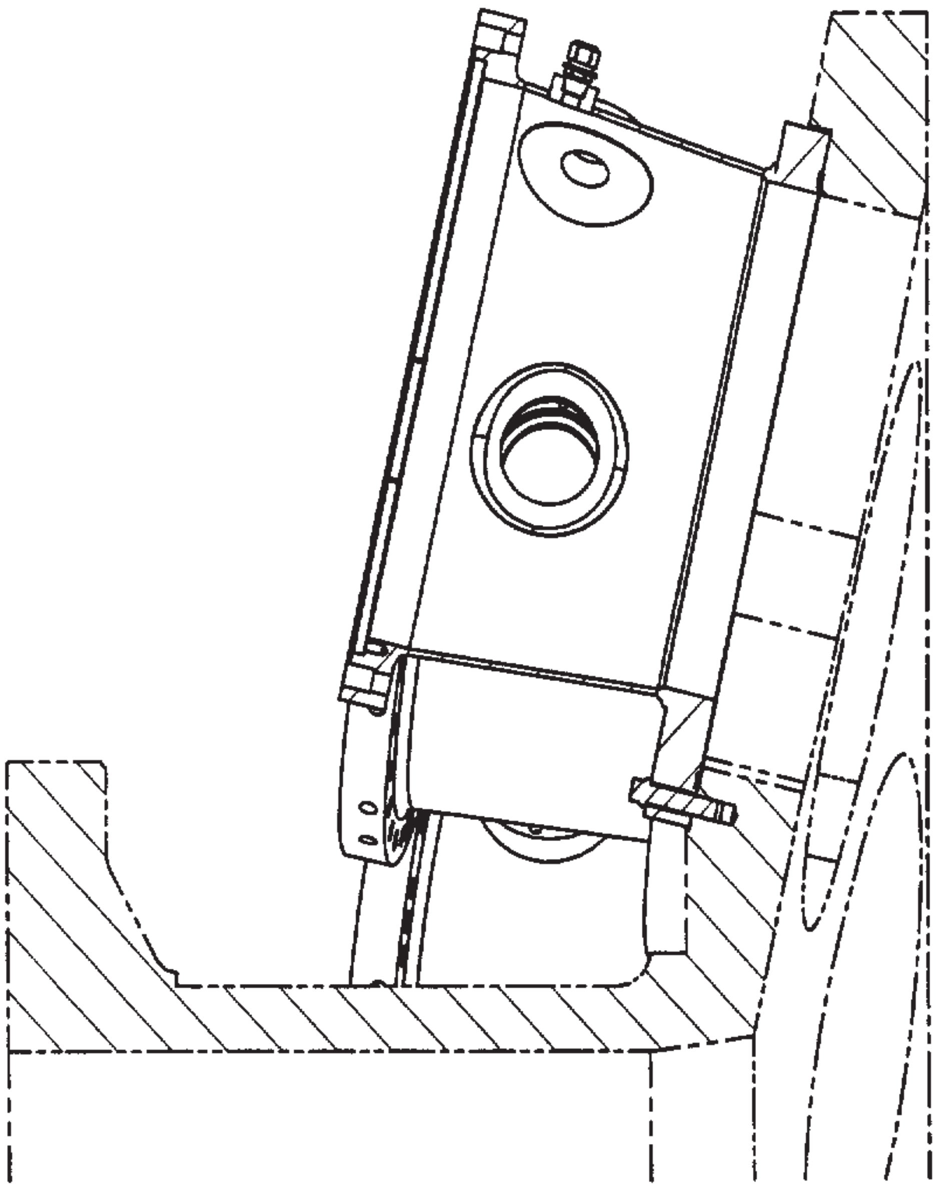

Figure CI–R.9 Combustion Outer Casing

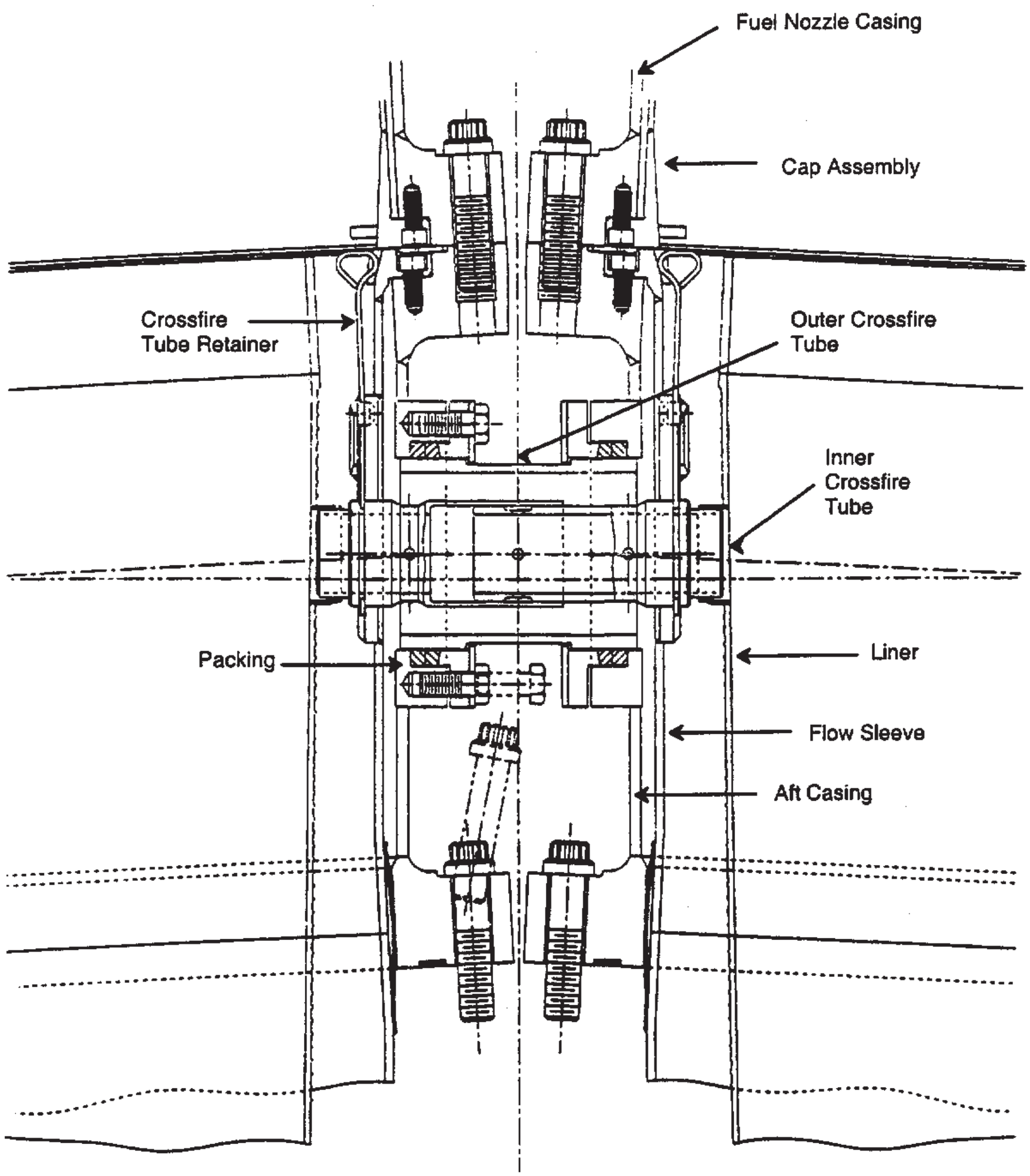

Figure CI–R.10. Crossfire Tube Assembly

CAUTION

The weight of the combustion outer casing is approximately 400 pounds.

4. Install two locating pins in the compressor discharge casing in the two bolt holes at the line connecting the centerlines of adjacent combustors (see ML0701).

5. Raise outer casing and engage the locating pins. Install all other bolts and torque to about 50% of final value and then remove alignment pins and replace with bolts.

6. Tighten the combustion casing flange to compressor discharge casing flange bolts. Tighten bolts 180º apart and work around the flange bolting circle in this sequence until all bolts are tight.

7. Continue to install outer casings until all are in place and properly torqued.

8. Inspect sealing surface of outer crossfire tube to be sure it is free of nicks or burrs.

9. Install new packing rings in each end.

10. Slide outer crossfire tube from inside one outer casing through the crossfire flange and into the adjacent casing. Thread on the packing rings and the sealing ring flanges to the outer tube in the appropriate order.

11. Install the split ring retaining washers and bolts to compress the packings hand tight.

12. Center the outer tube between the two outer casings and use the bolts to compress the packing to the dimension given in ML0701.

13. Repeat the process until all outer crossfire tubes are in place and the packings are compressed.

Operation 25— How to Install Flow Sleeves, Crossfire Tubes, and Combustion Liner Assemblies

1. Use a wood or aluminum rod to expand the piston ring at the downstream end of the flow sleeve to allow the ring to slide over the end of the transition piece.

Note: Secure the rod with a line to allow easy retrieval and to prevent the rod from falling into the turbine.

2. Slide the flow sleeve into the outer casing until the piston ring slides over the transition piece impingement sleeve. When the piston ring is in place, the rod holding the ring open will be dislodged, allowing the ring to spring back into contact with the impingement sleeve.

3. Push the flow sleeve downstream until the flange at the upstream end is seated in the recess in the outer casing flange.

4. Install the four socket head cap screws through the flange in the flow sleeve and tighten them to secure the flow sleeve in its proper position.

5. After each flow sleeve is installed, insert the two inner crossfire tube parts before installing the next flow sleeve. Install the two crossfire tube halves so that the male end is at the clockwise end of the crossfire tube assembly.

6. Use the crossfire tube retainers to lock the inner crossfire tube parts away from the combustor centerline to allow assembly of the liner assemblies.

7. Slide the liner assembly into the flow sleeve until the downstream end begins to enter the transition piece. Before proceeding, be sure that the liner stops are aligned with the correct brackets in the flow sleeve. Then push the liner aft until the liner stops are against the brackets and the spring seal is in the transition piece.

8. Insert the crossfire tube into the collar in the combustion liner and lock it in position with the crossfire tube retainer.

9. Continue to install liner assemblies and crossfire tubes until all are installed.

Operation 26 — How to Install Spark Plugs

1. Install new gaskets and spark plug assembly in combustion chambers 2 and 3. Be sure that spark plug tip enters the hole in the flow sleeve and the hole in the sealer on the liner assembly.

2. Coat bolts with anti-seize compound and bolt the spark plug assembly to flange.

3. Check to see that spark plug electrode moves freely.

Operation 27 — How to Assemble the Fuel Nozzle/End Cover to the Fuel Nozzle Casing

1. Bolt the aft flange of the fuel nozzle casing securely to a frame so that the centerline of the casing is horizontal.

2. Install three guide pins in the upstream flange.

3. Rig the end cover with fuel nozzles assembled to it so that the cover is in line with the fuel nozzle casing.

4. Move the cover horizontally so that the fuel nozzles enter the casing. Move the cover until the guide pins are engaged.

CAUTION

> Do not allow the fuel nozzles to touch the casing or the quaternary gas fuel pegs.

5. Slide the cover until the rabbet is engaged. Use three or more bolts to draw the flanges together.

6. Install the rest of the bolts, tighten and torque them.

7. Assemble the other casings to their respective end covers.

Operation 28 — How to Assemble the Cap to the Fuel Nozzle and Casing Assembly.

1. Support the fuel nozzle and casing assembly so that the aft flange is accessible.
2. Slide the cap assembly into the casing, being careful to align the cap tunnels with the fuel nozzles.
3. When the cap flange is seated in the recess in the fuel nozzle casing aft flange, install the four machine screws to secure the cap.
4. The rest of the caps may be assembled to their respective casings in the same way.

Operation 29 — How to Assemble the Fuel Nozzle Casing to the Combustion Casing.

1. Check to be sure that the three alignment pins in the aft flange of the fuel nozzle casing are in place and tight.
2. Install eye bolts in the flanges of the fuel nozzle cover and casing and rig so that the assembly will be in proper alignment for its combustion casing.
3. Place a new gasket in the recess of the combustion casing.
4. Lift the casing assembly and move it to the combustion casing. Move it axially until the alignment pins engage the flange of the casing.
5. Move the case axially until the spring seal on the cap enters the combustion liner. Three or more flange bolts may be used to draw the flanges together.
6. Install the rest of the flange bolts, tighten and torque them.
7. Continue to assemble until all 14 assemblies are complete.

<u>Operation 30</u> — How to Install the Diffusion Passage and Atomizing Air Purge Lines

1. This combustion system uses a diffusion passage purge line which connects the purge manifold on the radial inside of the combustion outer casing to the flange on the end cover.

2. Install new gasket at each end of the purge line and install the flange bolts.

3. This turbine has flanged connections on the purge manifold which is connected to the atomizing air flange on the cover. This line may be connected using new gaskets at this time.

<u>Operation 31</u> — How to Install Primary, Secondary, Tertiary and Quaternary Gas Fuel Lines (Figure CI-R.11)

1. Using new gaskets, connect the flexible gas fuel lines between the fuel nozzle flange and the manifold flange.

2. The order of installation of these flexible gas lines is generally from the bottom of the turbine to the top, and from the radial inside to the radial outside.

3. Tighten bolts in a criss-cross pattern to give uniform gasket compression.

<u>Operation 32</u> — How to Install Flame Detectors

1. Install new gasket.

2. Coat bolts with anti-seize compound, being careful not to get any of the compound into the hot gas path.

3. Install flame detectors on chambers 11 through 14. The valve handle should be facing upstream.

4. Reconnect wiring to flame detectors.

5. Reconnect feed and drain water cooling lines to each flame detector.

6. Re-energize power supply to flame detectors by reinstalling the flame detector cards.

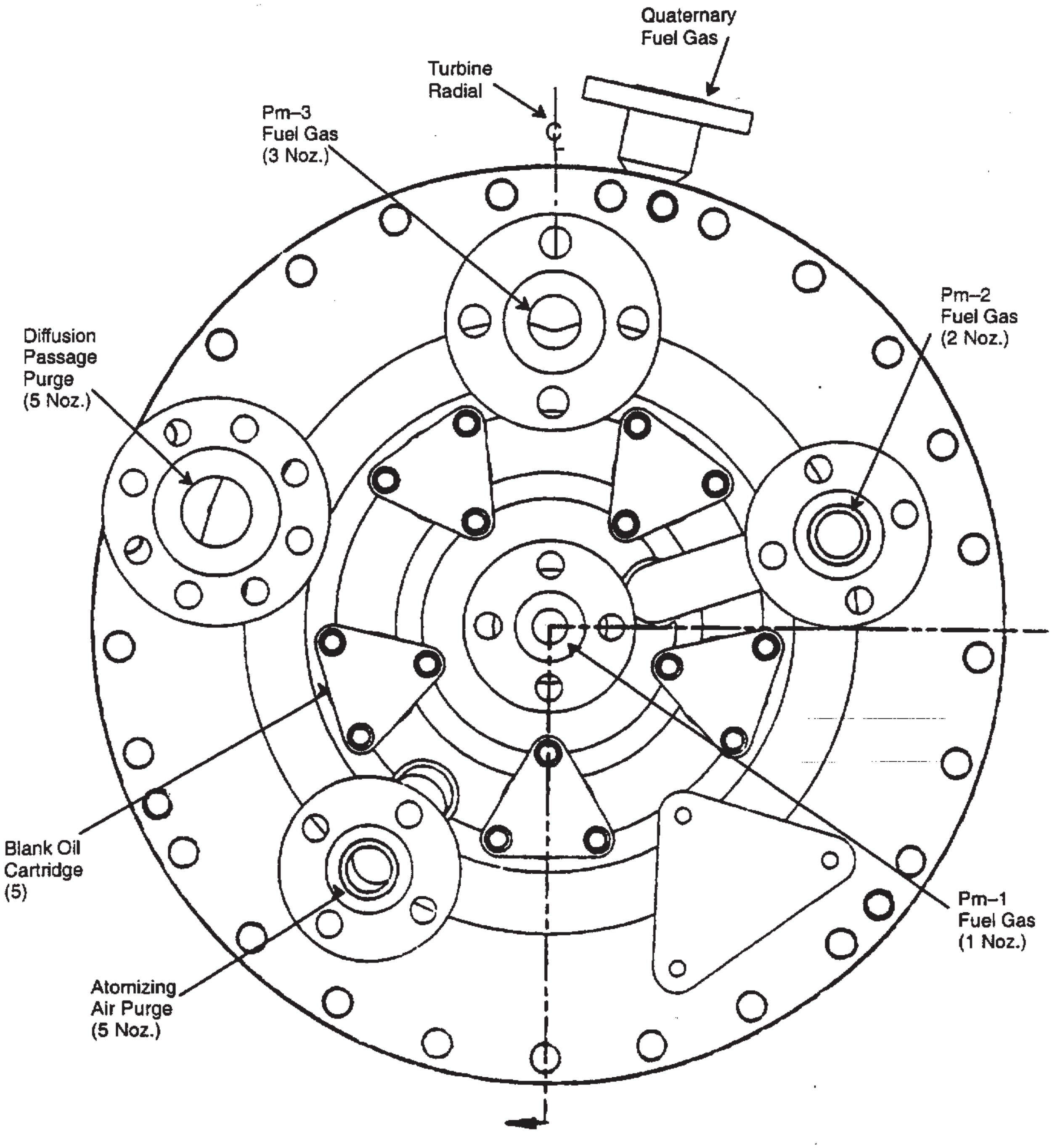

Figure CI–R.11 Fuel Nozzle End Cover

IV. Startup Checks for MS7001FA+ and MS7001FA+e Gas Only Combustion Inspection (with DLN-2.6)

<u>Operation 33</u> — Cleanup, Visual Inspection, Prestart/Startup Checks

1. Clean up all lube oil and water spills.
2. Make a visual inspection of the unit and check to ensure that the following has been completed.
   a. Check that all removed piping has been replaced.
   b. Check that all removed conduit has been replaced and electrical connections made. Confirm function of all devices.
   c. Inspect inlet and exhaust plenums.
3. Reconnect power to all systems disabled at start of job.
4. Perform pre–cranking checks as follows:
   a. Record all panel counter readings.
   b. Check operation of cooldown/emergency lube pumps.
   c. Check operation of auxiliary hydraulic pump.
   d. Make visual inspection to see if oil is flowing in bearing drains.
   e. Block out excitation and generator breaker equipment.
   f. Place unit on turning gear and observe for leaks, rubs, and control deficiencies.
5. Perform cranking checks as follows:
   a. Observe pickup RPM of speed sensors versus time.
   b. Inspect for casing air leaks.
   c. Observe and record vibration channel outputs.
   d. Observe and record crank speed.
   e. Check starting means for proper operation.
   f. Listen for rubbing noises.
   g. Check temperature of lube oil in bearing drains or at the bearing header and tank.
   h. Observe all panel and hydraulic manifold pressure gauge readings for abnormalities.
   i. Trip the unit using the emergency trip and listen for abnormal noises from gas turbine and associated equipment during coastdown.

j. Observe proper dropout RPM of speed sensors.

6. Initiate a start and perform the zero to full speed, no load firing checks as follows:

a. Observe applicable firing check parameters, relay sequences, exhaust temperature, vibration and speed.

b. Check spark plugs and flame detectors.

c. Observe and record acceleration rates.

d. Record full set of vibration readings.

e. Observe and record temperature suppression set point.

f. Note and record pick-up time of all appropriate electrical speed relays.

g. Check full-speed-no-load RPM.

h. Check digital setpoint.

i. Take a complete set of running data. See Running Inspection section of this instruction.

j. Check for air, oil, gas and water leaks.

7. Perform load checks (if applicable) as follows:

a. Take a full set of load data, including the staging times from primary only to lean–lean, and the change from lean–lean to mixed gas operation and from mixed gas to premix.. This can be done automatically by the control system.

b. Check for air, oil, gas and water leaks.

8. Observe normal unloading and shutdown as follows:

a. The times and loads for transition from premix through mixed and lean–lean to primary should be recorded during the unloading period.

b. Note and record coastdown time.

c. Listen for abnormal noises from gas turbine and associated equipment during coastdown.

d. Observe unit vibration readings during coastdown.

e. Complete preparation of all inspection, startup and operation data reports.

9. Perform DLN Tuning

Guidelines for MS7001FA DLN tuning can be found in the operation section of this manual. DLN tuning is required following each inspection.

INSERT

TAB

HOT GAS PATH INSPECTION

Hot Gas Path Inspection

CAUTION

Before proceeding with a hot gas path inspection, ensure that the gas turbine electrical power is tagged out; fire protection system is deactivated, fuel system(s) is (are) purged, deactivated and/or blanked off. Refer to the Standard Practices section in this inspection and maintenance instruction for general practices.

CONTENTS

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I. Disassembly Procedures (Hot Gas Path Inspection) for MS-7001FA+ and MS-7001FA+e Gas Only Equipped Machines

Note: Obtain appropriate Inspection Forms from your local GE Field Service Representative.

Operation 1 — How to Prepare Turbine Compartment Roof Sections for Removal

1. Remove turbine compartment side panels to gain access to turbine compartment. Store panels and/or doors in an upright position in a protected area.
2. Remove roof-mounted electric wiring at nearest pullbox and disconnect conduit.
3. Move the one-ton travelling crane into the forward roof section.
4. Unbolt the forward and aft roof sections from the sidewall frames and from each other. Unbolt only the lower set of bolts at the sidewall frames.

Operation 2 — How to Remove Turbine Compartment Roof Sections

1. Attach four eyebolts to a roof section in threaded receptacles provided for lifting.
2. Attach four equal length cables or two equal length cables and comealongs to chainfall connected to crane.
3. Check to ensure the roof section is mechanically free to be lifted, and carefully lift with chainfall until clear.
4. Set the roof section on appropriate cribbing.
5. Repeat steps 1 through 4 for the remaining roof section.
6. The one-ton crane should be moved with the forward roof section.

Operation 3 — How to Remove Exhaust and Inlet Duct Access Panels

1. On axial exhaust configurations, unbolt the removable exhaust duct access panel.
2. Unbolt removable inlet lagging panel.
3. Rig and lift the panels clear of unit and store panels off the ground.

Operation 4 — Remove Flame Detectors per Combustion Inspection Disassembly Operation 1

Operation 5 — Remove the Spark Plugs per Combustion Inspection Disassembly Operation 2

Operation 6 — Remove the Gas Fuel Flex Hoses per Combustion Inspection Disassembly Operation 3

Operation 7 —Remove the Fuel Nozzle/End Cover Assemblies

1. Perform Steps 1 through 12 of Combustion Inspection Disassembly Operation No.4.

Operation 8 — Remove the Cap Assembly From the Cover and Casing Assembly per Combustion Inspection Disassembly Operation 5

Operation 9 — Remove Combustion Liners and Crossfire Tubes per Combustion Inspection Disassembly Operation 6

Operation 10 — Remove Flow Sleeves per Combustion Inspection Disassembly Operation 7

Operation 11 — Remove Outer Crossfire Tubes per Combustion Inspection Disassembly Operation 8

Operation 12 — Remove Outer Combustion Casings per Combustion Inspection Disassembly Operation 9

Operation 13 — Take Opening Compressor and Turbine Rotor Position Checks

Note: **Rotor position checks must be made with all casings bolted in place and unit supported on its own supports.**

CAUTION

Do not confuse clearanceometer holes and probe holes. Clearanceometer holes are too small for a depth micrometer. Use probe holes for taking tip clearances on turbine and compressor.

1. Using random first-stage compressor blades, take feeler clearance checks at six points: top centerline, bottom centerline, and above and below the horizontal joint on each side. Record clearances on appropriate Inspection Form.

Note: **It may be necessary to use the rotor turning device to position a random blade tip below the probe holes for the 2nd, 10th, and 17th stage compressor and second-stage turbine for rotor position checks.**

CAUTION

A lube oil supply to the rotor must be maintained during rotor position checks. Do not rotate the rotor with any probe sticking into the blade path.

2. The second-stage compressor holes (four total) are located 21.86 inches (55.5 centimeters) forward of the forward compressor casing aft flange face.

3. The 10th stage compressor probe holes (4 total) are located 11.87 inches (30.15 centimeters) forward of the aft compressor casing aft flange.

4. The 17th stage compressor probe holes (4 total) are located 17.93 inches (45.54 centimeters) aft of the compressor discharge casing forward flange face.

5. The second-stage turbine probe holes (4 total) are located 61.55 inches (156.34 centimeters) aft of the turbine casing forward flange face.

6. Compressor tip clearances at the 2nd 10th, and 17th stages are taken by removing the plugs located at the top and bottom vertical centerline and ten (10) degrees above each horizontal joint. A stamped number next to the plug counter bores indicates the thickness of the casing from the bottom of the counter bore to the inside diameter of the casing. Record clearances on appropriate Inspection Form.

7. Turbine casing probe holes exist (4 total) so that the turbine bucket tip shroud clearances can be taken on the second-stage turbine buckets. Record the turbine tip clearances on appropriate Inspection Form. Turbine rotor tip clearance readings are taken as follows:

   a. Remove plug and place an adapter into the machined counter bore of the casing. The adapter will allow the base of the depth micrometer to rest squarely on the casing, thereby allowing the micrometer rod to penetrate the probe hole accurately.

Note: The adapter can be made from a piece of 0.75 inch (1.9 cm) diameter pipe approximately two inches long. The ends of the pipe faces should be parallel within 0.0005 inch (0.00127 cm). See Figure HGP-D.1.

   b. Take the depth micrometer and measure to the tip of the blade. This measurement will be the distance from the blade tip to the top of the adapter. Add the adapter length to the thickness stamped on the turbine casing. Subtract this measurement from the depth micrometer reading. The result is tip shroud clearance.

   c. The third-stage rotor position check is made by clamping a dial indicator to the third-stage buckets and sweeping the third-stage stator shrouds. Exercise care to protect the bucket surface when attaching the dial indicator to the bucket. Entrance to the area is gained through the exhaust diffuser man-way. The dial indicator should be zeroed at the top centerline. Rotate the rotor and record readings above and below both horizontal joints and at the bottom centerline. Record results on appropriate Inspection Form.

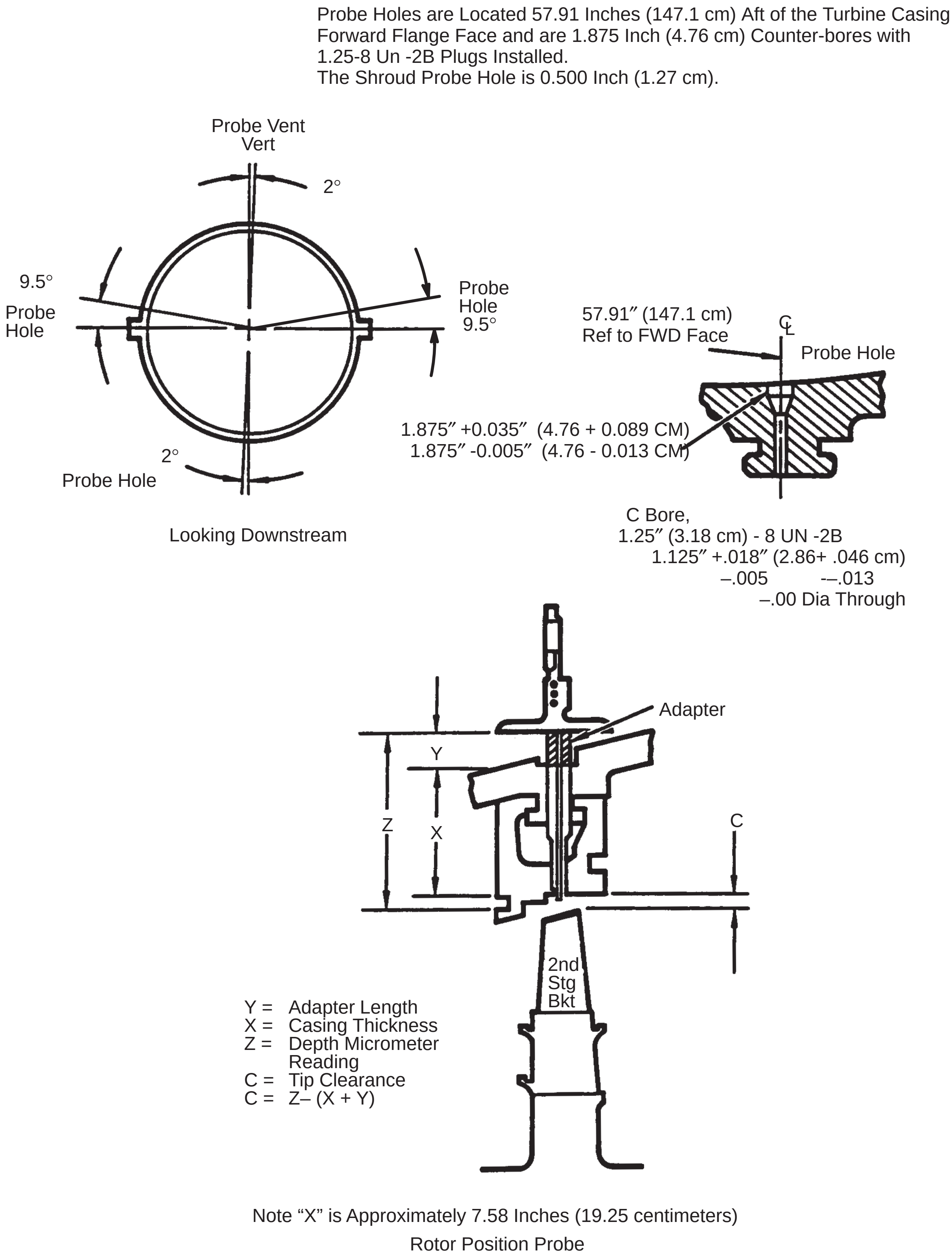


Figure HGP-D.1. Rotor Position Probe.

Operation 14 — How to Remove Upper-Half Cooling and Sealing Air Piping

1. Unbolt and remove the four 13th stage upper-half piping and two lower-half flex-piping connections from the turbine casing. Disconnect the other ends of these flexible pipes near the turbine horizontal centerline.

2. Unbolt and remove the two atomizing air upper-half piping connections from the turbine casing cone.

3. Store pipe sections so as to prevent damage.

4. Clean all nuts and bolts of old anti-seize compounds.

5. Clean all flange gasket sealing surfaces.

CAUTION

Cover all flange openings with protective material to prevent foreign objects from entering the openings. Rags are not adequate.

Operation 15 — How to Remove Turbine Thermocouples

1. Tag 12 thermocouples that are in the upper and lower halves of the turbine casing and two in the discharge casing. Use the same code as stamped on the casings in order to replace them in the same location at re-assembly.

2. Disconnect the thermocouples from the compression fittings on the casing and remove from tube clips that hold down the thermocouples in the turbine compartment. See Figure HGP-D.2.

3. Pull the thermocouples carefully through the hole in the base “I” beam and coil them up and secure them to the “I” beam web near the junction boxes JB #18A and JB #18B, where they will be protected from damage.

4. It is also necessary to remove eight compression fittings and associated outer guide tubes from the turbine casing so that they are not damaged in subsequent second- and third-stage nozzle segment removal. Tag these fittings for location for later re-assembly.

Operation 16 — How to Place Mechanical Support Jacks Under Unit Casings (See Figure HGP-D.3)

1. Remove the turbine compartment floor plate covers, provided beneath the vertical flange joints, so that the concrete pad can be used as a jacking support surface. Ensure jacks are mounted perpendicular to the gas turbine.

Note: a. **Jacking points are provided at the bottom centerlines of the casing flanges for 2.5 in. (6.35-cm) ball top mechanical screw jacks.**

b. **Dial indicators should be used at each jacking location. The dial indicators must be mounted separately from the jacks.**

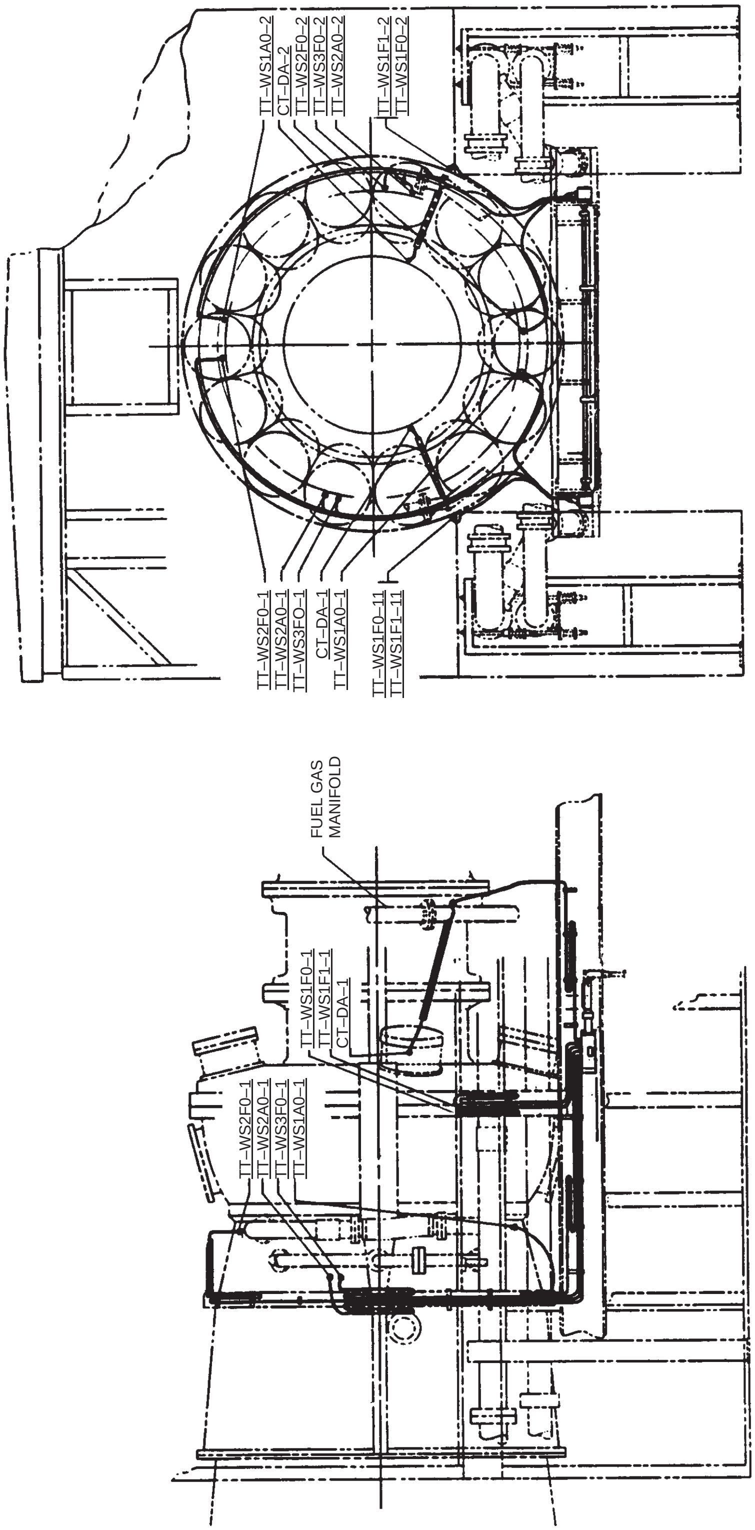


Figure HGP–D.2. Wheelspace Thermocouple Arrangement.

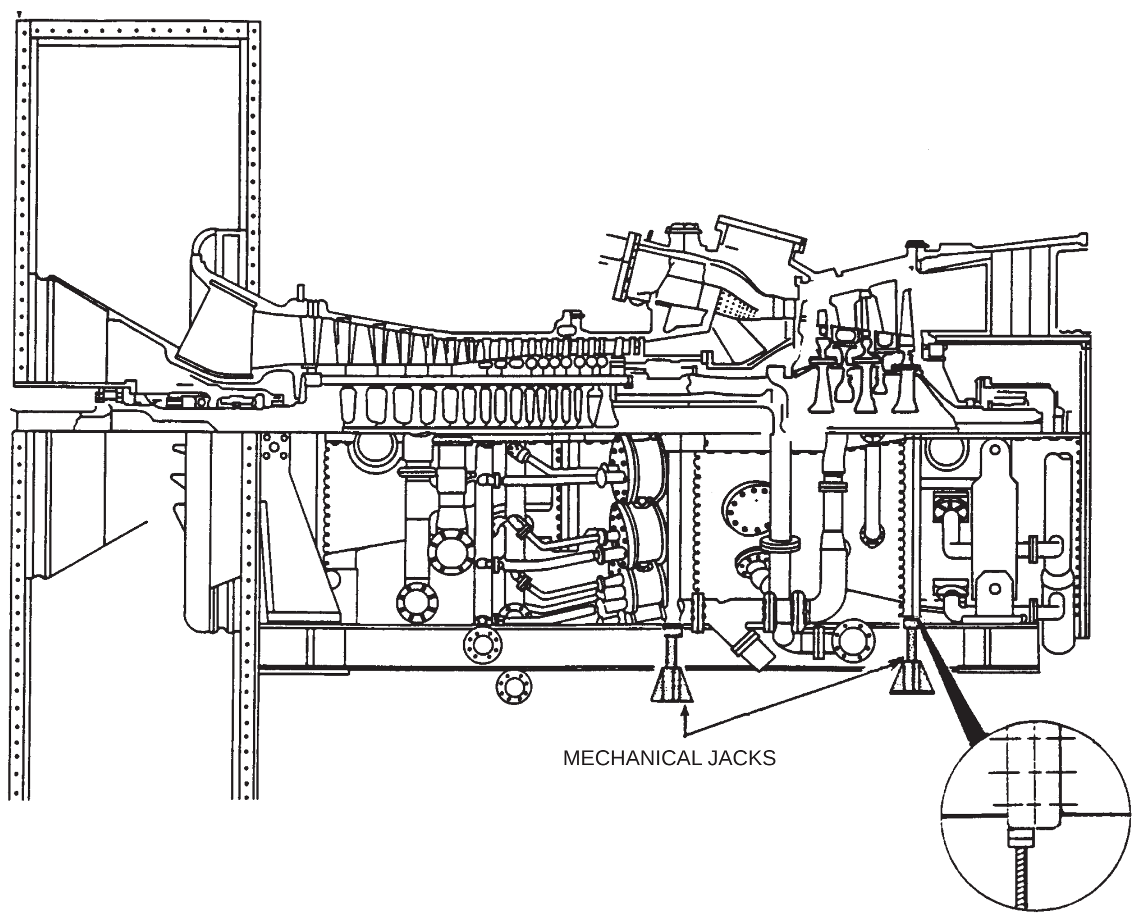


Figure HGP-D.3. Turbine Casing and Casing Support Jack Locations.

2. Install a screw jack at the turbine exhaust flange. Jack to obtain 0.006 + 0.001 reading on indicator.

3. Install a screw jack at the compressor discharge turbine flange. Jack to obtain 0.004 + 0.001 indicator reading.

4. Record dial indicator readings.

Note: All jacks must be in place at all times when any upper-half casing is removed and must remain until all upper-half casings have been replaced and bolted up.

Operation 17 — How to Remove Turbine Casing Bolts and First-Stage Nozzle Top Key and Clamps (See Figure HGP-D.4)

1. Unbolt the upper-half vertical flange bolting between the turbine casing and exhaust frame.

2. Unbolt the upper-half vertical joint bolting between the turbine casing and the compressor discharge casing.

3. Unbolt and remove cover over 24-in. (61-cm) access port at top of casing.

4. Remove the horizontal joint bolting and body-bound bolting. (Horizontal joint body-bound bolts are removed by driving them upward.)

5. Mark body-bound bolts for replacement in same holes.

6. Remove first-stage nozzle top key and shims. Remove two upper-half retaining clamps.

7. Stamp parts for location.

Operation 18 — How to Remove Upper-Half Turbine Casing

1. Lubricate and install guide pins and jackbolts.

2. Guide pins are used in the four body-bound bolt hole provisions. (See Figure HGP-D.5.)

3. Rig to lift the turbine casing level. Use a four-point attachment arrangement as shown in the weight and center of gravity drawing in the Reference Drawings section of the unit Service Manual. The total weight of the upper-half turbine casing with the second- and third-stage nozzles and shrouds is approximately 21,280 pounds (9652.5 kilograms). The upper-half first-stage nozzle is not lifted with the casing.

CAUTION

Prior to jacking the turbine casing, a visual check should be made of the third-stage axial shroud keys through the exhaust casing. If keys have moved downstream they will cause interference and prevent turbine casing removal. If keys have moved downstream, tap keys in the forward direction.

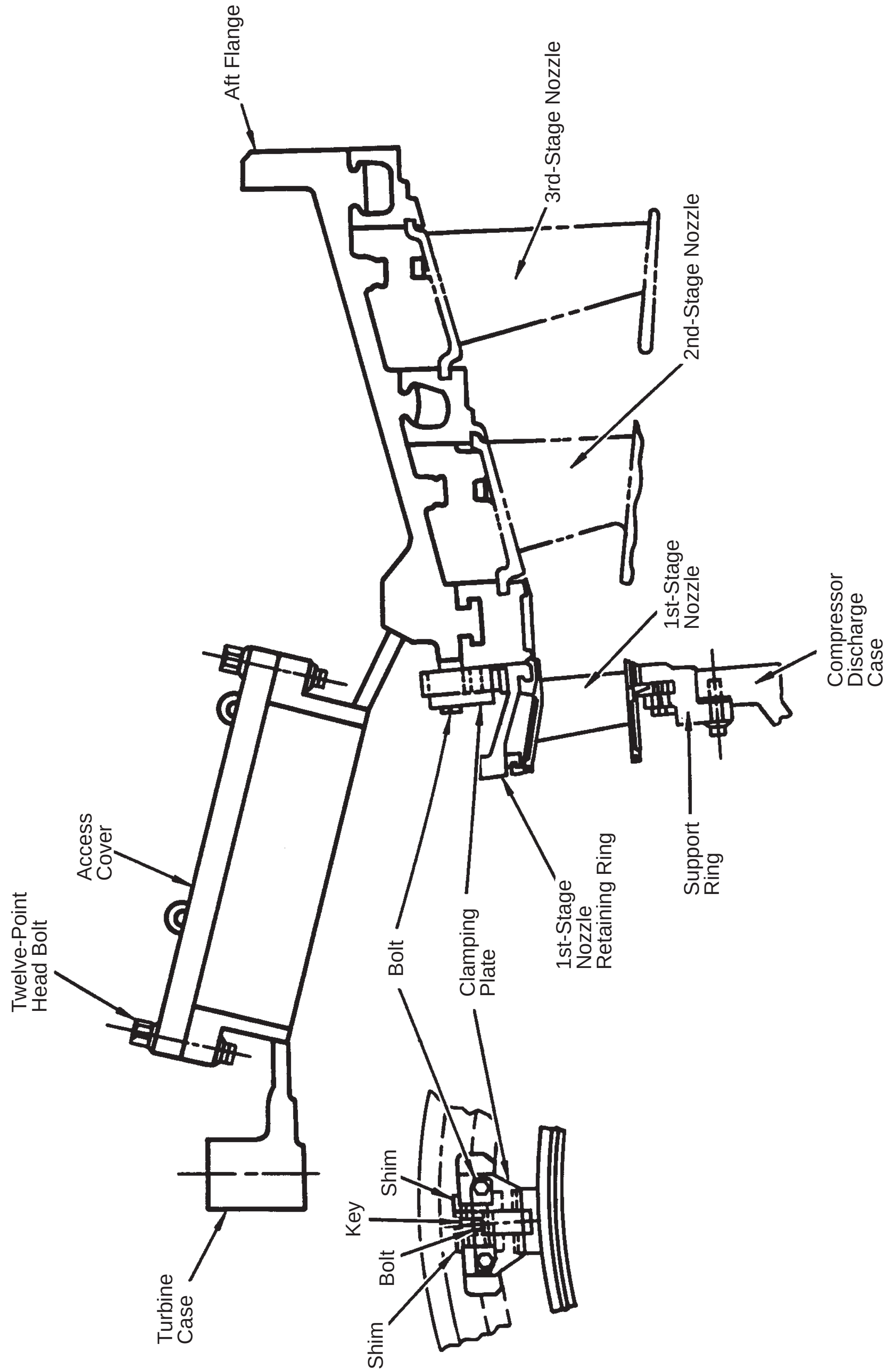
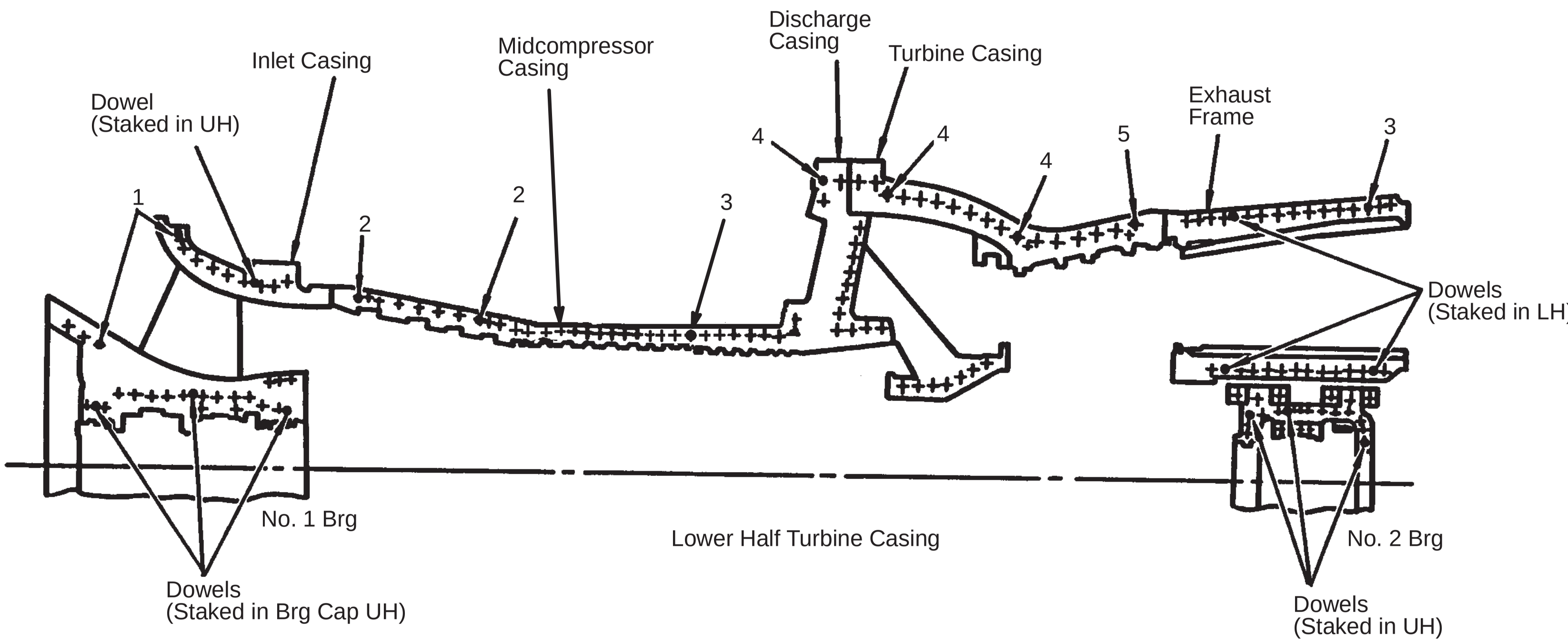
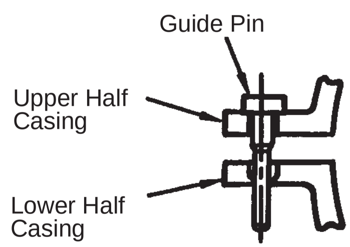


Figure HGP–D.4. Turbine Casing Assembly.





ITEM	GUIDE PIN	LOCATION
1	197C390P1	Inlet Casing
2	197C390P2	Midcompressor Casing
3	197C390P3	Disch Casing/Exh Frame
4	197C3930P4	Disch/Turbine Casing
5	197C3930P5	Turbine Casing

NOTES:

1. Guide Pins Are Used In Body-bound Stud Holes Of Casings.
2. Used Dowel Pins Where Shown As Guide Pins.
3. Instruction Used On Tool Kit, Major Disassembly.

Figure HGP–D.5. Body-bound Bolt Guide Pin Locations.

4. Jack casing up at least two inches (5.1 centimeters); casing must be jacked so it remains level at all times. If binding is evident at this point, the third-stage axial shroud keys are possibly preventing the turbine casing from being lifted.

CAUTION

> In some cases, the third-stage shroud seal segments near the horizontal joint may bind on the upper-half casings. If this has occurred, the turbine casing will hang up as it is being initially separated at the horizontal joint. Free any binding shroud segments.

5. Using chainfalls, carefully lift the upper-half turbine casing clear of the turbine buckets before using the crane to lift and move clear of the unit.

6. Using suitable cribbing, set the turbine casing on its forward vertical flange for later removal of nozzle segments.

Operation 19 — Remove Transition Pieces per Combustion Inspection Disassembly Operation 10

Operation 20 — How to Take First-Stage Nozzle Radial Concentricity Checks

Note: Concentricity is the condition wherein the center of one symmetrical feature coincides with the center of another. The measurement of concentricity of the first-stage nozzle is the amount of deviation of the nozzle assembly from the center of the hot gas path. Assistance from your GE Field Service Representative is recommended when taking concentricity checks.

1. Prior to taking concentricity checks on the first-stage nozzle, ensure that the bottom locating key is installed and that the lower-half support ring dowel pins are assembled.

2. The first-stage nozzle should be fully assembled.

3. Take the concentricity readings as shown on Figure HGP-D.6. Record all readings on the appropriate Inspection Forms. Report readings to your GE Field Service Representative for evaluation and disposition.

Note: The first-stage nozzle is to be concentric with the support ring (hot gas path) within a tolerance of 0.050 inch inch (0.127 cm), taking into account any ellipticity in the nozzle assembly. See the Alignment Diagram in the Service Manual.

Operation 21 — How to Remove Upper-Half First-Stage Nozzle (See Figure HGP-D.7)

1. Remove the horizontal joint bolting from first-stage nozzle. Do not remove the joint dowels.

2. Remove 24 bolts and retaining plates under the first-stage nozzle inner sidewall.

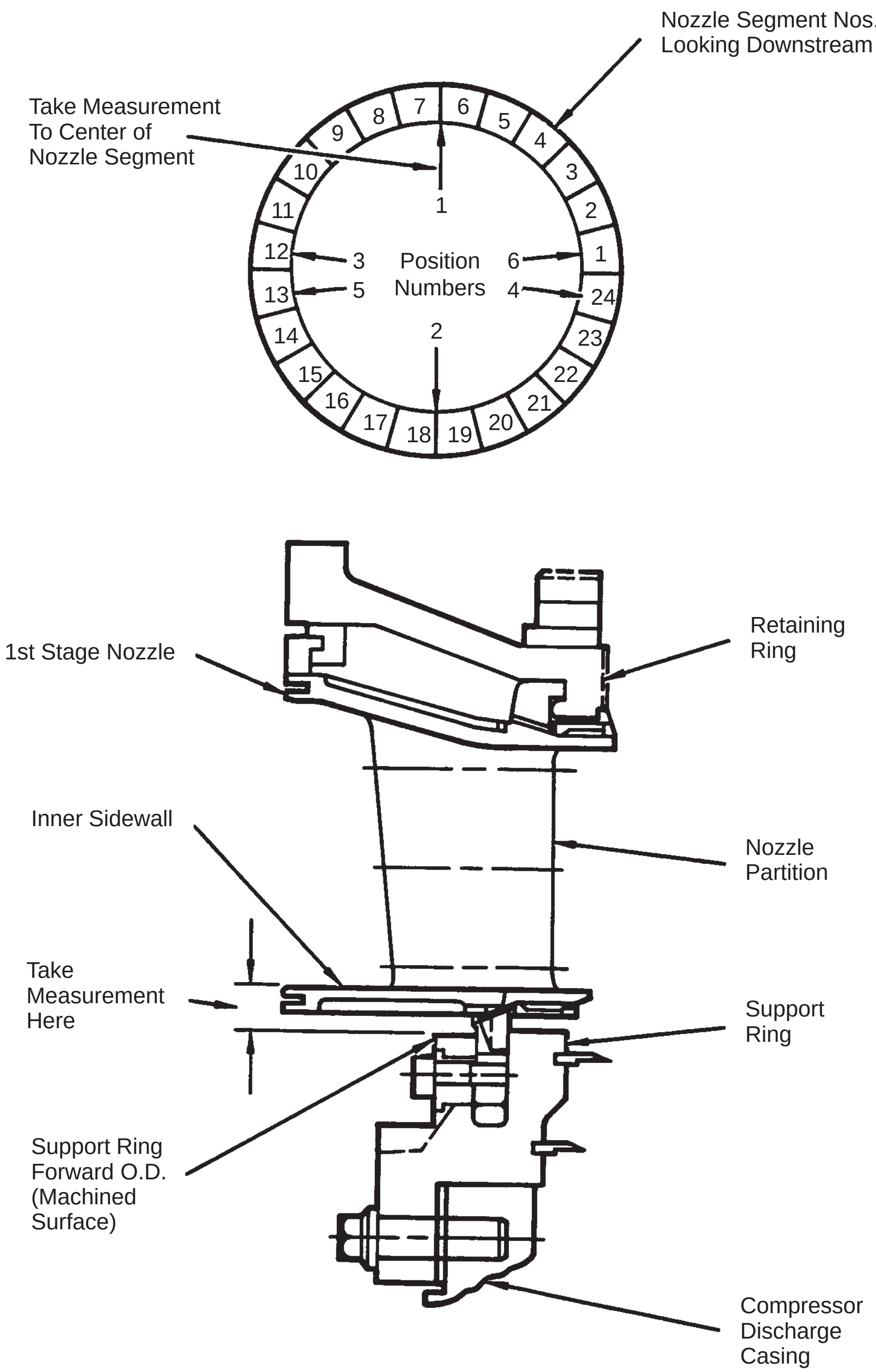


Figure HGP-D.6. First-Stage Nozzle Concentricity Checks.

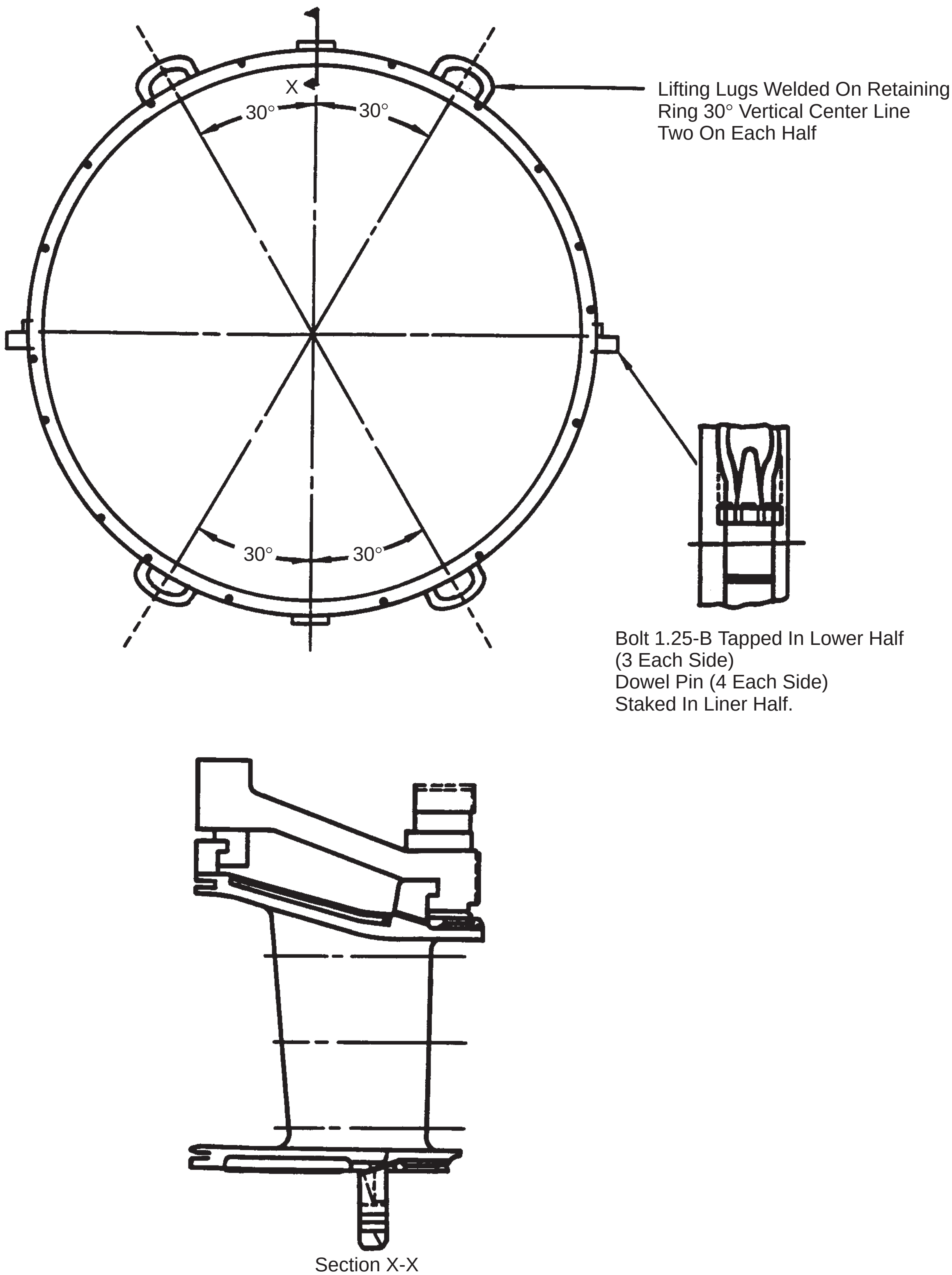


Figure HGP-D.7. Lifting First-Stage Nozzle.

3. Remove 24 support pins from the bushings in the support ring.

4. Rig and lift the nozzle upper-half using 0.38-inch (0.097-cm) wire rope slings, clevises and chainfall. Assemble the slings to the lifting lugs at 30 degrees each side of top center and to the chainfall.

CAUTION

Do not allow the nozzle to swing into the first-stage buckets.

5. Clean the tongue and groove fits and remove any burrs.

Operation 22 — How to Remove Upper-Half, First-Stage Nozzle Support Ring

1. Apply penetrating fluid (Plus-Gas Formula "A") or equivalent to the nozzle support ring horizontal joint and to the horizontal and vertical joint bolts. Do this well in advance of disassembly if possible.

2. Do not remove horizontal joint dowels.

3. Rig to lift the support ring upper-half using 0.25-inch (0.635-cm) wire rope slings, clevises, eyebolts and chainfall. Assemble the eyebolts 30 degrees each side of top center and rig slings to the chainfall. The support ring half weighs 550 pounds (249.48 kilograms).

4. Using an impact wrench and long extension, loosen and remove the six horizontal joint bolts.

5. Remove the 14 upper-half vertical joint bolts. (See Figure HGP-D.8.)

6. Use metal wedges at the horizontal joints to separate upper and lower halves.

CAUTION

When lifting, the support ring should be controlled to prevent the ring from swinging into the first-stage buckets.

7. Using chainfall and crane, lift the support ring clear of the unit and set on suitable wood blocking for cleaning and inspection. Clean all mating joint surfaces and clean all bolts and dowel pins.

Operation 23 — How to Take Turbine Rotor Float (Thrust Clearance)

1. The maximum total fore and aft movement of the rotor without distorting any of the rotor or bearing mounts is usually 0.025-0.030 inches (0.0635-0.0762 centimeters).

Note: The turbine rotor should be against the active thrust bearing but not loaded to deflect the bearing or casings when the indicator is read.

2. The rotor float is measured by mounting a dial indicator from the No. 1 bearing housing and indicating on the load coupling hub. Rotor float is referenced to the No. 1 bearing housing.

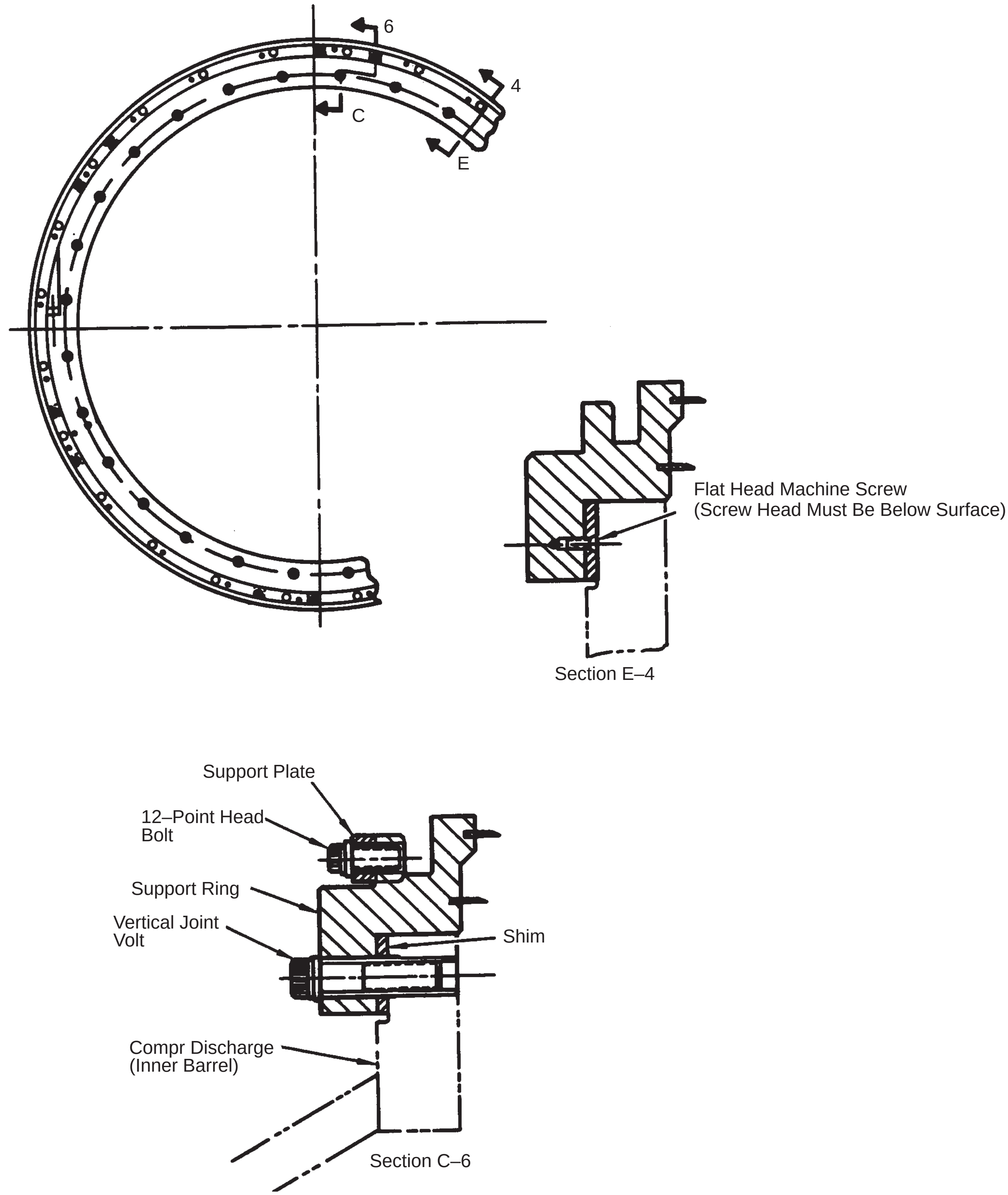


Figure HGP-D.8. Removing First-Stage Nozzle Support Ring.

3. The rotor is moved from the generator/turbine load coupling. Remove the upper half of the load coupling guard. A small hydraulic jack and wood blocking can be placed between the forward generator bearing housing and the coupling flange to push the rotor aft. The rotor will move suddenly with a solid “bump”. Release the jack loading before reading the dial indicator. Reposition the jack and blocking to push the rotor forward from the turbine bearing housing No. 1. The rotor will “bump”; release the jack and read the indicator. Repeat three times to assure repeatability.

CAUTION

Do not jack against the inlet duct.

Operation 24 — How to Take Turbine Clearance Checks

General

It is suggested that turbine clearances be taken under the guidance of your GE Field Service Representative. The need to closely monitor the internal gas turbine clearances is critical. On every removal of the turbine casing, the internal clearances should be verified. Any clearances not within specified tolerances, as indicated on the Unit Clearance Diagram in the Gas Turbine Maintenance tab of the unit Service Manual, should be reported before any parts are removed to the GE Field Service Representative in case rechecks are needed. The data will be compared to the unit’s original clearance data so that a determination for corrective action, if any, can be made. The clearances listed below should be taken and recorded on appropriate Inspection Form.

1. First-stage nozzle clamp clearance (E).
2. First-stage nozzle “L” seal clearances (1N1).
3. Axial rotor clearances (1F1, 1A1, 2F1, 2A1, 3F1).
4. Axial seal clearances (1F3, 1F5, 1A3, 2F3, 2A3, 3F3, 3A2*).
5. Axial diaphragm to rotor clearances (1A4, 2F4, 2A4, 3F4).
6. Rotor set dim (“A” set).
7. Radial seal clearances (1F2, 1F4, 1A2, 2F2, 2A2, 3F2, 3A1*, 3A3*).
8. Bucket tip clearance (1R).
9. Shroud-to-bucket clearances (2F, 25A, 2S, 3F, 3SA, 3S).
10. Diaphragm axial seal clearances (1PA, 1PAC, 2PA, 2PAC).

After all clearances have been completed and approved and prior to the six point check.

Install wooden block as shown in Figure HGP-D.8A, between aft side of 2nd STG shroud and against outer side wall of 3rd STG nozzle at horizontal joint. (4 places).

* These clearances cannot be taken with the exhaust frame in place.

Check gap between shroud hook and nozzle side wall as shown in Figure HGP-D.8A. Maintain distance of gap within +/– .01, 4 places. Block to be left in place for unit test.

11. Diaphragm radial seal clearances (1PH, 1PL, 2PH, 2PL).

12. First-stage nozzle support ring shim (“D”).

Note: The use of proper tools for taking clearance measurements is an important factor in obtaining correct readings.

CAUTION

> String tie all hand tools to the wrist to avoid loss of tools in the turbine.

Left Side and Right Side (Definition)

The left side of the machine by definition is the left side when the observer is facing the compressor inlet and looking downstream (direction of air flow) toward the generator load coupling end.

Turbine Rotor Clearances

The rotor must be positioned downstream against the active thrust bearing but not loaded. Any pressure applied in moving the rotor aft for the float check should be released at this time.

1. Prepare for and take clearances around the first-stage nozzle.

   a. Ensure that the nozzle is seated downstream against the first-stage shrouds, and the first-stage shrouds are seated downstream against the turbine casing.

   b. Take all clearances around the first-stage nozzle.

2. Prepare for and take clearances around the second-stage nozzle.

   a. With the rotor still in downstream position, position the second-stage nozzle and diaphragm (left and right) downstream by first wedging a screwdriver in the first-stage shroud to second-stage nozzle outer sidewall gap. Assure that the second-stage nozzle aft outer sidewall hooks are seated downstream in the second-stage shrouds, and that the second-stage shrouds are seated downstream against the turbine casing. See Figure HGP-D.9.

   b. Second, drive a wooden wedge until the diaphragm forward male hook is seated downstream against the nozzle female hook. At this point, the wooden wedge should be firmly in place. The downstream seated condition is indicated in Figure HGP-D.9 with notation, ”These gaps must be closed”.

   c. Third, drive the wooden wedge until the diaphragm forward male hook is seated downstream against the nozzle female hook. At this point, the wooden wedge should be firmly in place. The downstream seated condition is indicated in Figure HGP-D.9 with notation, “These gaps must be closed”.

   The wooden wedges can be cut from 2x4 and when possible, should be made from a structural grade of wood. Dimensions of the wedge are shown in Figure HGP-D.11.

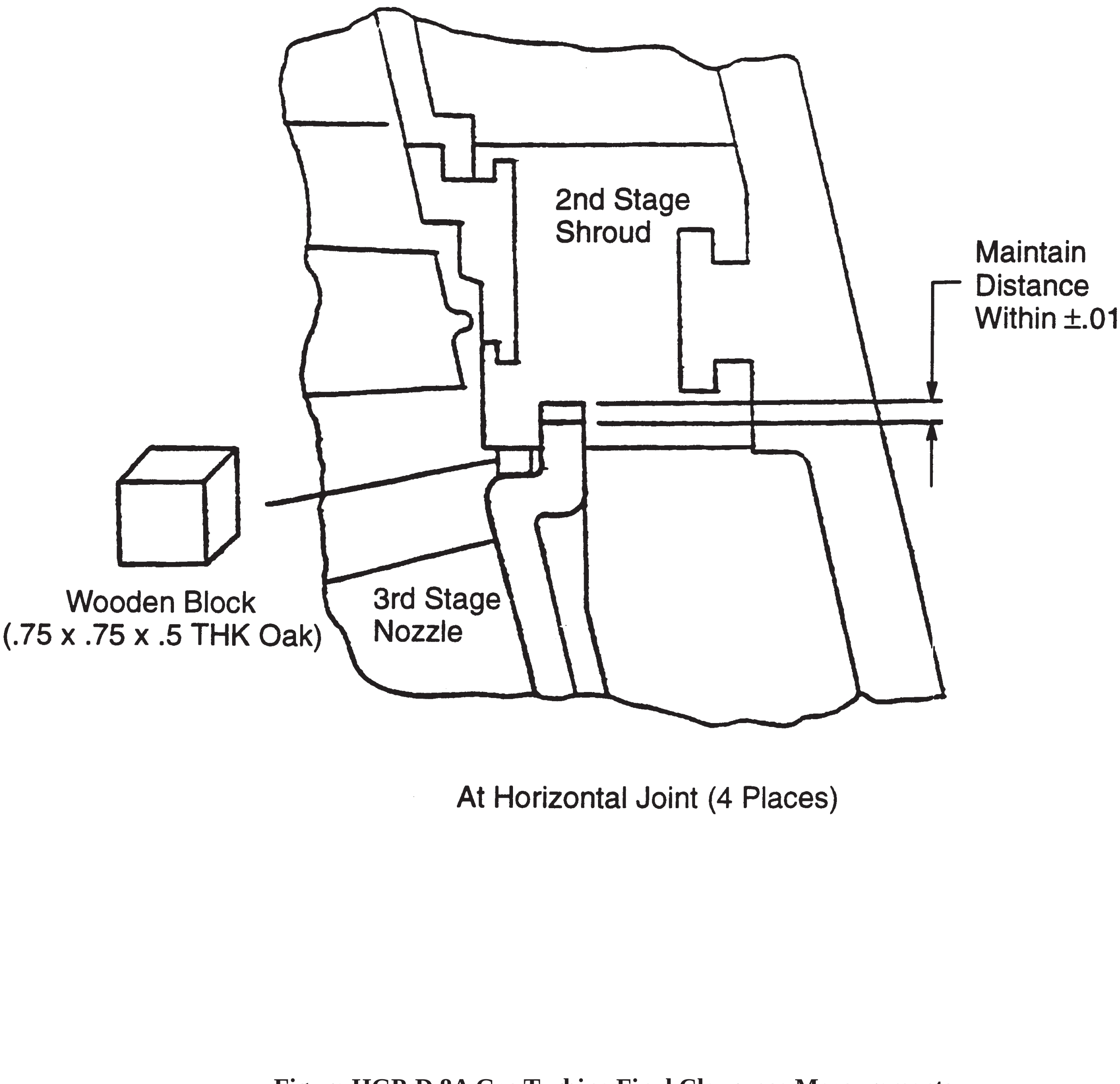


Figure HGP-D.8A Gas Turbine Final Clearance Measurements

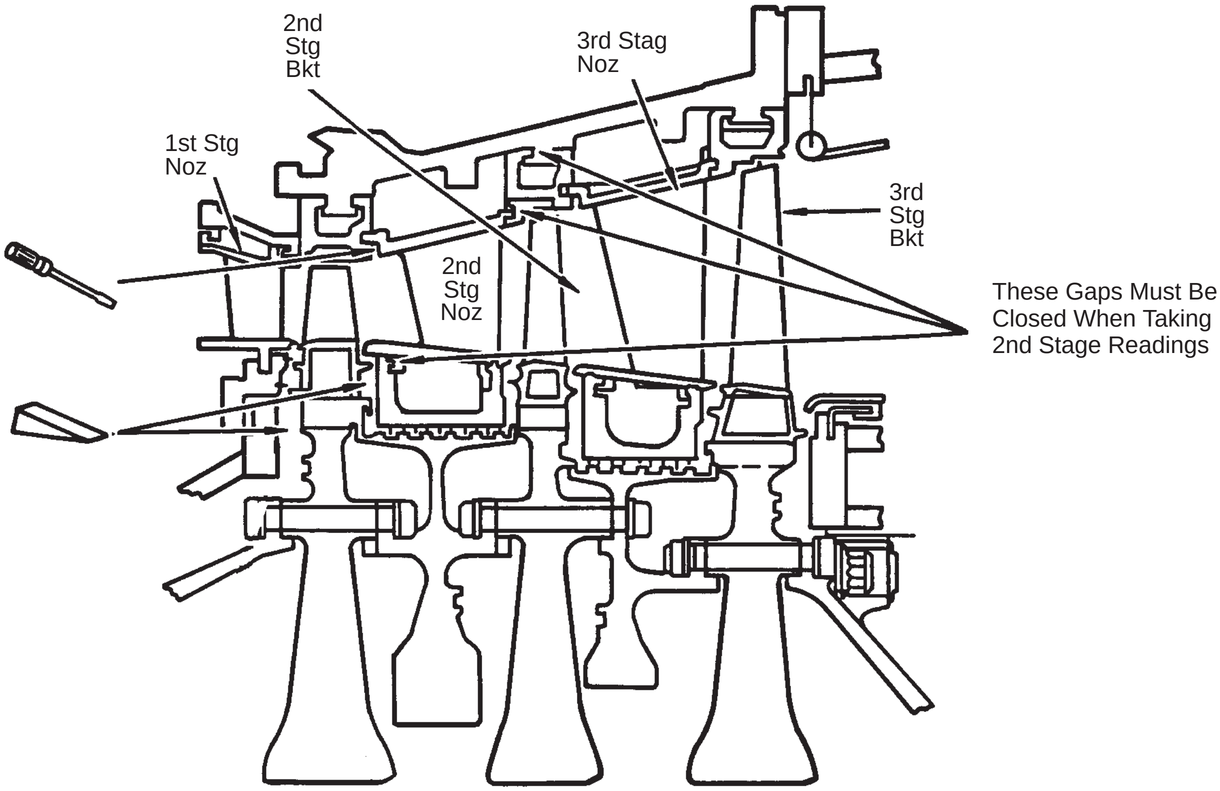


Figure HGP-D.9. Loading for Second-Stage Nozzle Clearances.

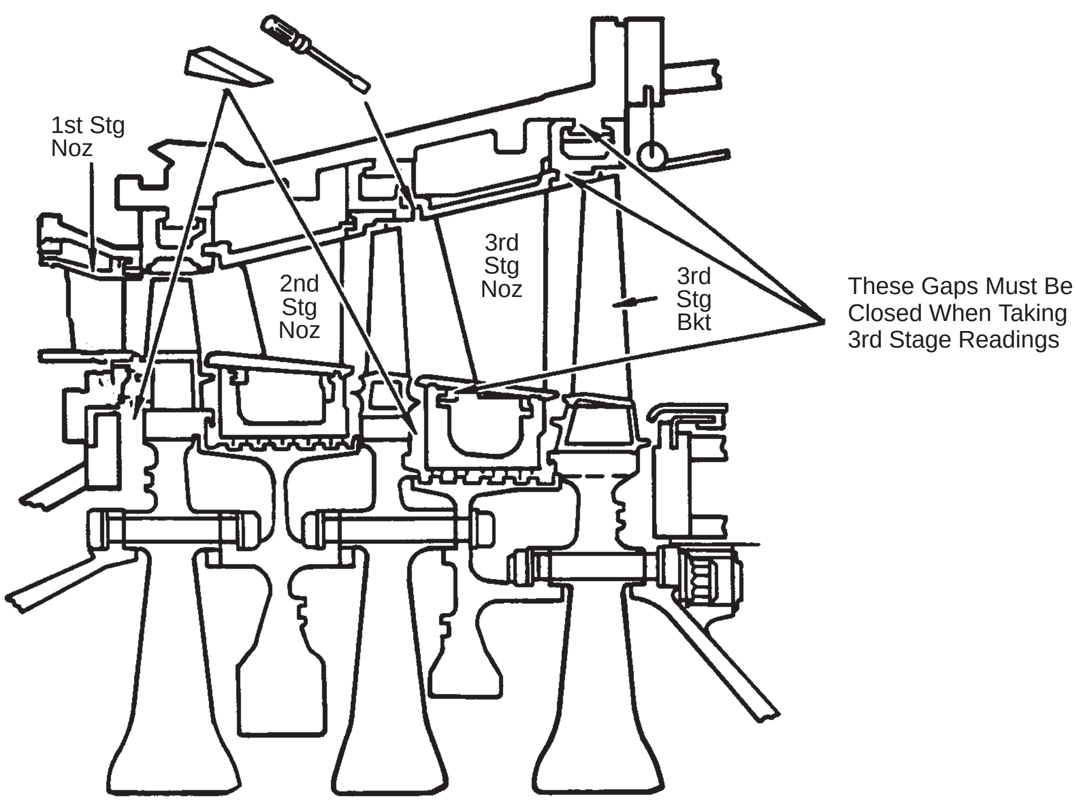


Figure HGP-D.10. Loading for Third-Stage Nozzle Clearances.

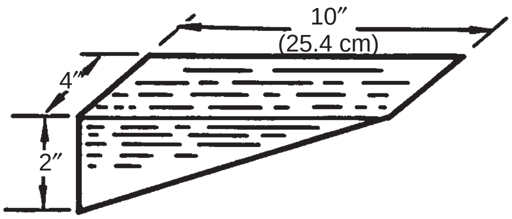


Figure HGP-D.11.
Nozzle Clearance Wedging Tool.

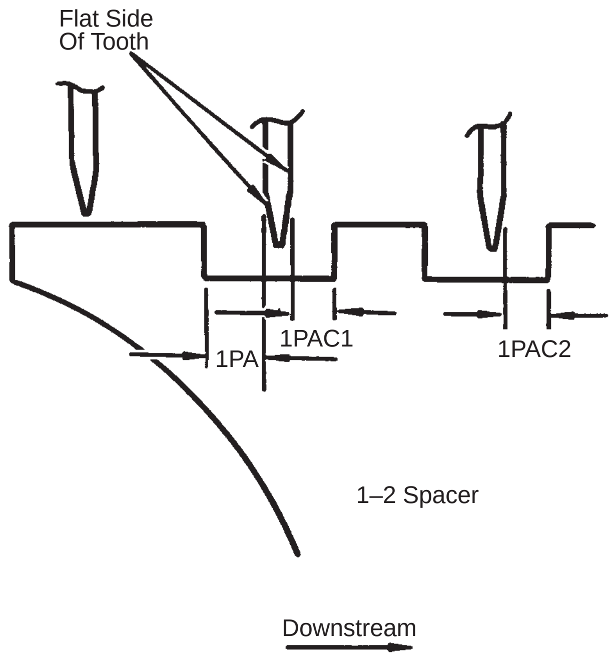


Figure HGP-D.12. Axial Clearances “1PA,” “1PAC.”

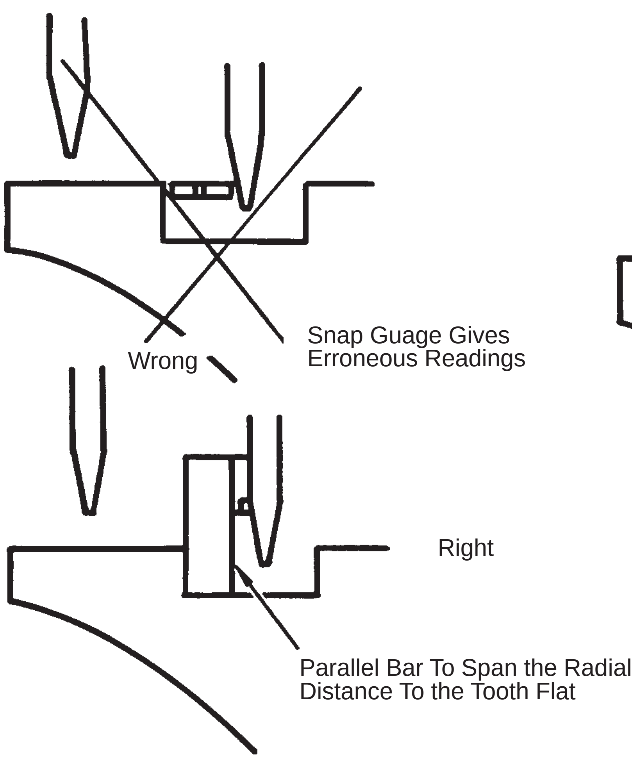


Figure HGP-D.13.
Proper Method, Reading Axial Clearances.

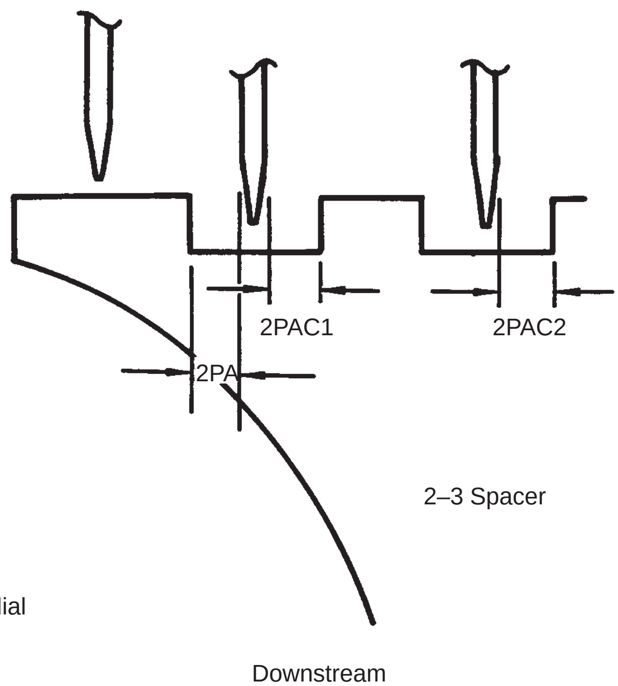


Figure HGP-D.14.
Axial Clearances, “2PA,” “2PAC.”

Note: Do not wedge third-stage nozzle and diaphragms until all second-stage nozzle area clearances have been taken.

d. Measure the 1PA dimension and 1PAC dimension complements. See Figure HGP-D.12.

(1) Measure the 1PA dimension between the forward flat side, not the pointed portion of the first long diaphragm seal tooth and and aft side of the first land of the 1-2 spacer.

(2) Measure the complements, 1PAC, between the aft side seal, not the pointed position of each diaphragm seal tooth and the forward side of each spacer land. Proceed with the forward tooth first for 1PAC1, and proceed downstream for 1PAC2, 1PAC3, etc. Record on appropriate Inspection Form.

(3) Measure all radial and axial clearances around the second- stage nozzle. Record results on appropriate Inspection Form.

Note: a. Do not measure the 1PA dimension or complements with a snap gauge. It is recommended that a parallel bar and feeler stock be used. See Figure HGP-D.13.

b. The wooden wedge is used only to maintain proper downstream seating of the diaphragm while taking clearances. Do not drive the wedges hard. The wedge should produce inappreciable nozzle elastic deformation. If the wooden wedge has to be driven hard to "shock" the diaphragm downstream, take the wedge out and drive another wedge just until it becomes firmly in place before taking clearances.

3. Prepare for and take clearances around the third-stage nozzle.

a. With the rotor still wedged in the forward position, position the third-stage nozzle and diaphragm (left and right) downstream by first wedging a screwdriver in the second-stage shroud to third-stage nozzle outer sidewall gap. Assure that the third- stage nozzle aft outer sidewall hooks are seated downstream in the third-stage shrouds, and that the third-stage shrouds are seated downstream against the turbine shell. See Figure HGP-D.10.

Second, drive a wooden wedge between the forward face of the nozzle diaphragm and the second- stage bucket shanks. Drive the wooden wedge until the diaphragm forward male hook is seated down-stream against the nozzle female hook. At this point, the wooden wedge should be firmly in place. The downstream seated condition is indicated in Figure HGP-D.12 with notation, "These gaps must be closed".

b. Measure the 2PA dimension and 2PAC dimension (complement). See Figure HGP-D.14.

Measure the 2PA dimension, between the forward flat side, not the pointed portion of the second long diaphragm seal tooth and the aft side of the second land of the 2-3 spacer.

Measure the complement, 2PAC, between the aft flat side, not the pointed portion, of each diaphragm seal tooth and the forward side of each spacer land. Proceed with the forward tooth first for 2PAC1 and proceed downstream for 2PAC2, 2PAC3, etc.

c. Measure all other radial and axial clearances around the third-stage nozzle. Record on appropriate Inspection form.

Note: Measure the 2PA dimension and 2PAC (complements) using similar techniques in 1PA dimension and 1PAC (complement) measurements.

4. Take all other accessible clearances and record results on appropriate Inspection Form .

Operation 25 — How to Remove Lower-Half First-Stage Nozzle, Key and Nozzle Clamps (See Figure HGP-D.4)

1. Unbolt the bottom retaining strap from the turbine casing and remove the lower-half first-stage nozzle key and shims. Stamp the key and shims to identify them.

2. Unbolt and remove the horizontal joint clamps and support blocks.

3. Identify and tag the horizontal joint clamps and support blocks for left and right sides.

Operation 26 — How to Remove Lower-Half First-Stage Nozzle

1. Remove the two outer support clamps, one on either side of the turbine casing, which hold the nozzle assembly to the first-stage turbine shroud assembly. The support clamp is retained by a bolt and lockplate installed in the turbine casing.

2. Remove 24 bolts and retainer plates under the first-stage nozzle inner sidewall.

3. Remove 24 support pins from the bushings in the support ring.

4. Roll out the lower-half nozzle by attaching one end of it to a hook with a straight cable and attaching the other end to a one-ton “come-along” or chainfall. By alternately raising on the cable and lowering on the chainfall, the retaining ring and nozzle can be rotated 60 degrees.

5. Reattach the chain hoist to pick up the nozzle at a lifting lug. Continue the “roll-out” process until the lower-half nozzle can be lifted clear of the turbine.

CAUTION

Do not allow the nozzle to swing into the first-stage buckets.

6. Clean the tongue and groove fits and remove any burrs.

Operation 27 — How to Remove Lower-Half Second- and Third-Stage Nozzle Radial Retaining Pins

1. Remove the 12 threaded retaining plugs and 12 retaining pins that hold the second-stage nozzle segments in the turbine casing lower half. (See Figure HGP-D.15.)

2. Remove the 10 plugs and 10 retaining pins that hold the third-stage segments in the lower half. (See Figure HGP-D.16.)

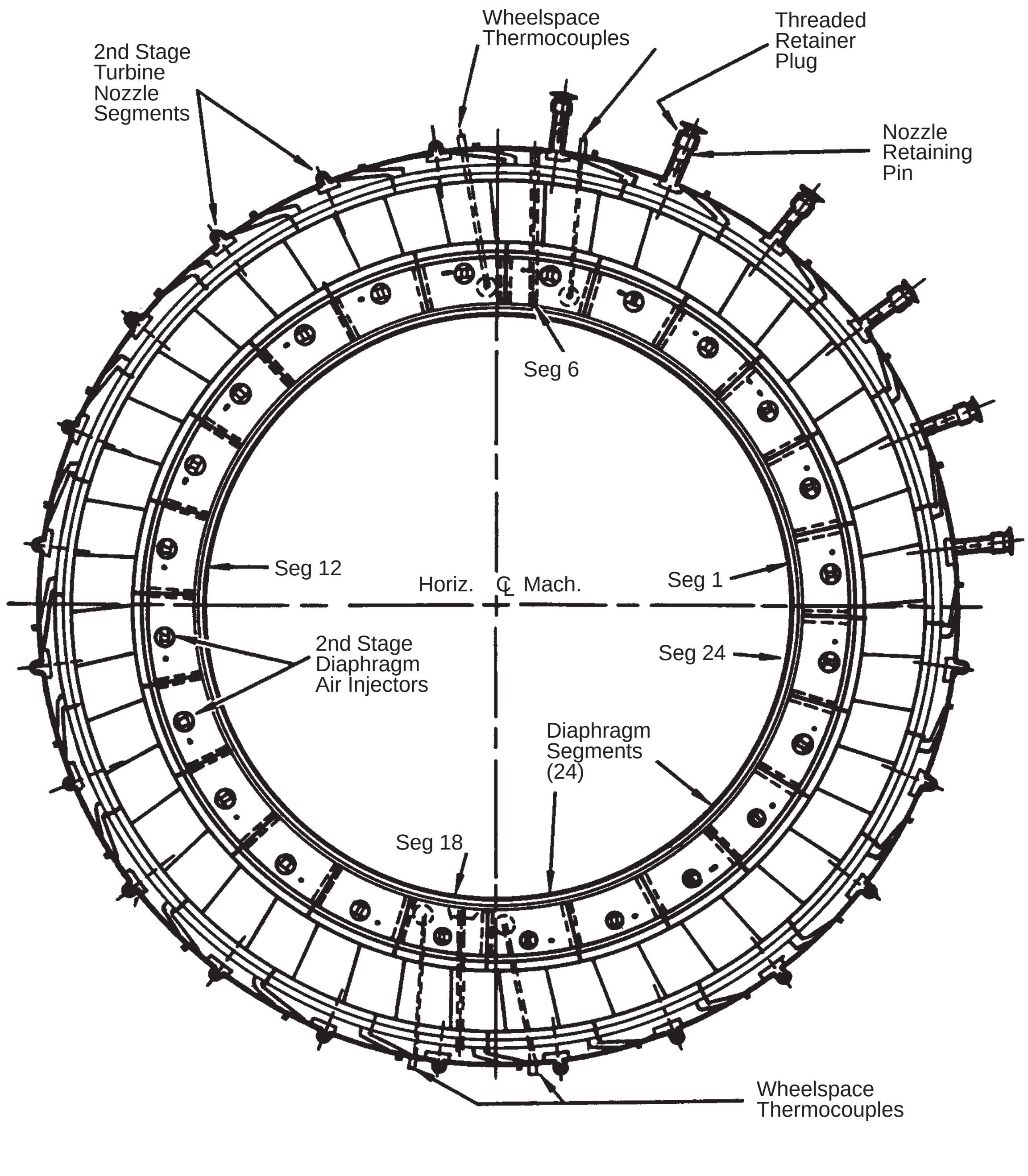


Figure HGP-D.15. Second-Stage Nozzle Arrangement.

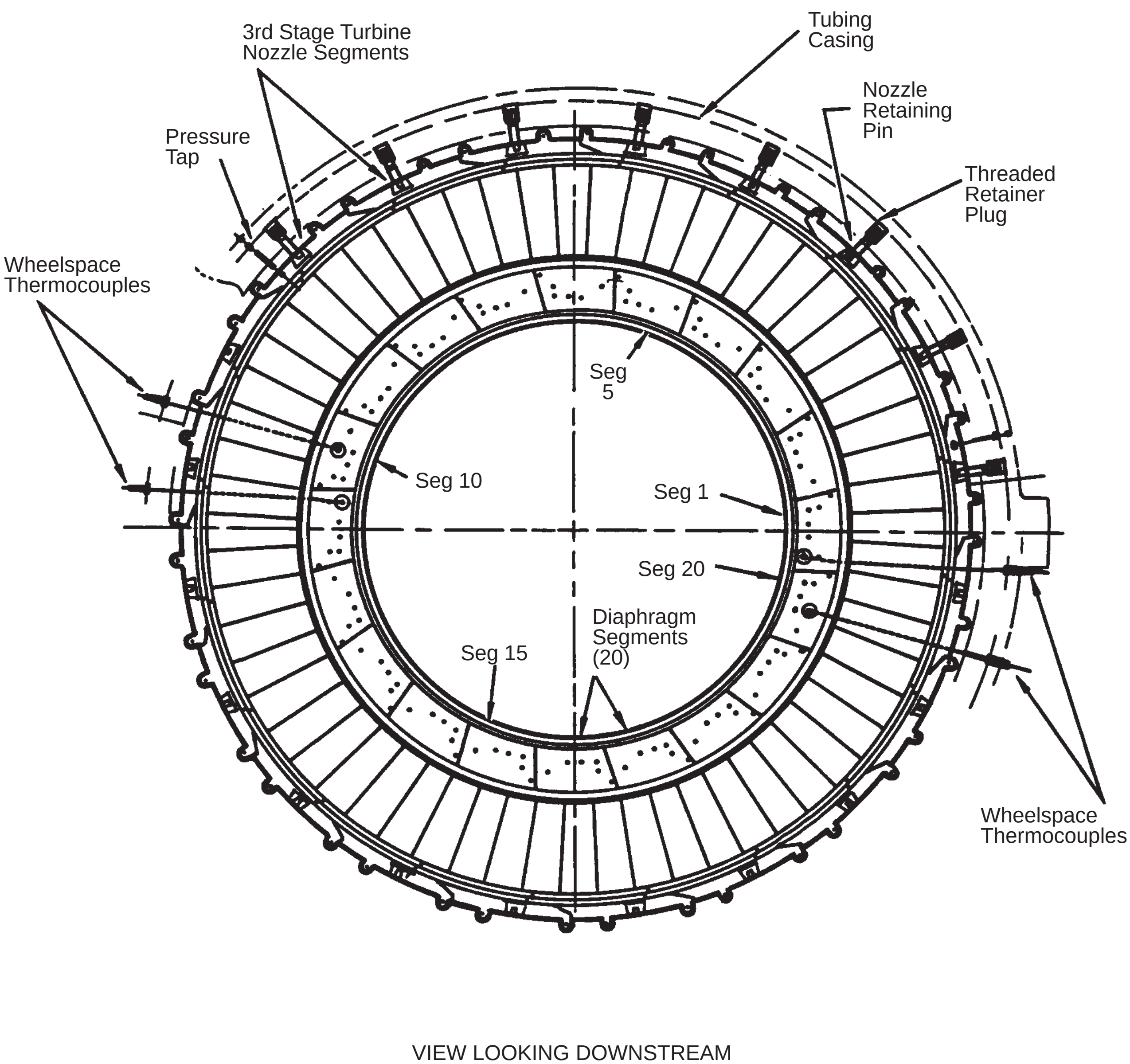


Figure HGP-D.16. Third-Stage Nozzle Arrangement.

3. Make sure the pins are stamped for location.

Operation 28 — How to Remove Lower-Half Second- and Third-Stage Nozzle Segments (See Figures HGP-D.15 Through HGP-D.17)

Note: The wheelspace thermocouples and guide tubes must be removed prior to removal of the nozzle segments. (See Figures HGP-D.15, 16 and 17.)

If problems arise and the nozzle segments will not roll out as described below, then alternate removing shrouds and nozzle segments starting with the third-stage shrouds. (See Figure HGP-D.17.)

Remove two third-stage shrouds and then a third-stage nozzle segment working from the horizontal joint toward the center from sides. Once the third-stage nozzle segments have been removed, follow the same procedure with the second-stage shrouds and second-stage nozzle segments.

CAUTION

Ensure that all plugs and shroud pins have been removed prior to removal of shrouds.

1. Each nozzle segment can be removed from the turbine case by rolling it out individually on its outer sidewall forward and aft hook fits. Each diaphragm segment is removed along with its adjacent nozzle segment as one piece. Mark each segment per appropriate Inspection Forms numbering sequence.

CAUTION

At all points where the segment and pulling cable come in contact, there should be ample padding to distribute the load and protect the partition surfaces. Wood, rubber or padded steel plates can be used.

Excessive shock and vibration should be avoided. Attach cabling to the center nozzle partition if possible. A maximum force of 2,000 lbs. (8896 newtons) should not be exceeded.

2. Tooling required for nozzle segment removal are: a pulley assembly a one-ton (907.2-kilogram) “come-along”, and 0.375-inch (0.953-cm) wire rope or fiber sling.

3. For the second-stage segments, attach cable to nozzle segment 24 and remove the segment using a one-ton “come- along” attached to the overhead crane. Each nozzle-diaphragm segment weighs 175 pounds (79.38 kg). There are 12 segments in each half of the nozzle.

4. Attach cable to nozzle segment 23 and remove.

5. Install pulley assembly in retaining pin hole 24. Pass cable through pulley and attach to nozzle segment 22. Pull nozzle segment to position vacated by nozzle segment 23. Remove pulley assembly and remove nozzle segment 22 as above.

6. Install pulley assembly in retaining pin hole 23. Pass cable through pulley and attach to nozzle segment 21. Pull nozzle segment 21 to position vacated by nozzle segment 22. Move pulley to pin hole 24 and remove nozzle segment 21 as above.

7. Install pulley assembly in retaining pin hole 22. Pass cable through pulley and attach to nozzle segment 20. Pull nozzle segment to position vacated by nozzle segment 21. Move pulley assembly to pin hole 23 and then to pin hole 24 and remove nozzle segment 20 as above.

8. Install pulley assembly in retaining pin hole 21. Pass cable through pulley and attach to nozzle segment 19. Pull nozzle segment to position vacated by nozzle segment 20. Move pulley assembly to pin hole 22 and then to pin hole 23 and then to pin hole 24 and remove nozzle segment 19 as above.

9. Move to other side of unit and remove segments 13 through 18 in the same manner as described above.

10. Remove the third-stage nozzle segments in the same manner as described above, working from the turbine casing horizontal joints. There are ten segments in each half of the nozzle. Each nozzle-diaphragm segment weighs 232 pounds (105.2 kilograms).

Operation 29 — How to Remove Upper-Half Second- and Third-Stage Nozzle Radial Retaining Pins

1. Remove the 12 threaded retaining plugs and 12 retaining pins that hold the second-stage nozzle segments in the turbine casing upper half.

2. Remove the 10 plugs and 10 retaining pins that hold the third-stage segments in the upper half.

3. Make sure the pins are stamped for location.

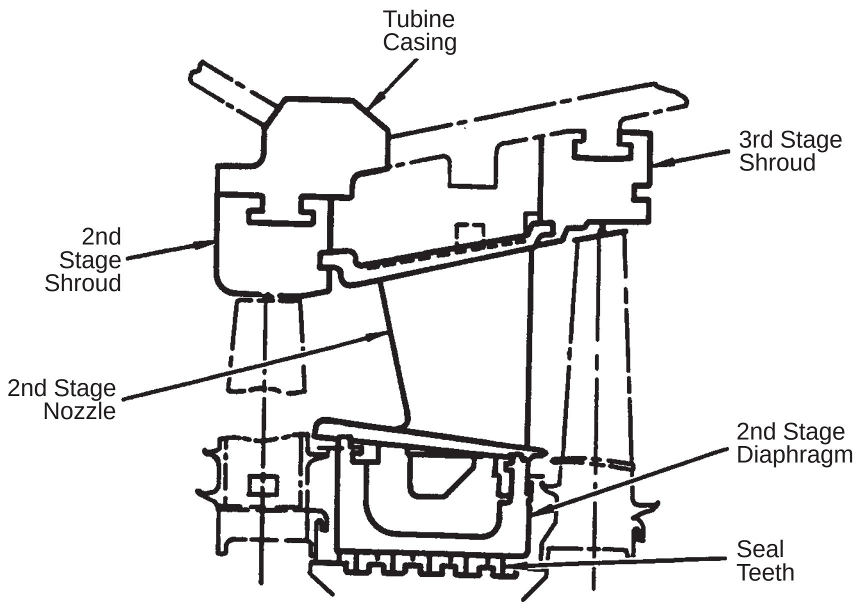
Operation 30 — How to Remove Upper-Half Second- and Third-Stage Nozzle Segments (See Figures HGP-D.15 through HGP-D.17.)

1. Each nozzle segment can be removed from the turbine case by rolling it out individually on its outer sidewall forward and aft hook fits. Each diaphragm segment is removed along with its adjacent nozzle segment as one piece.

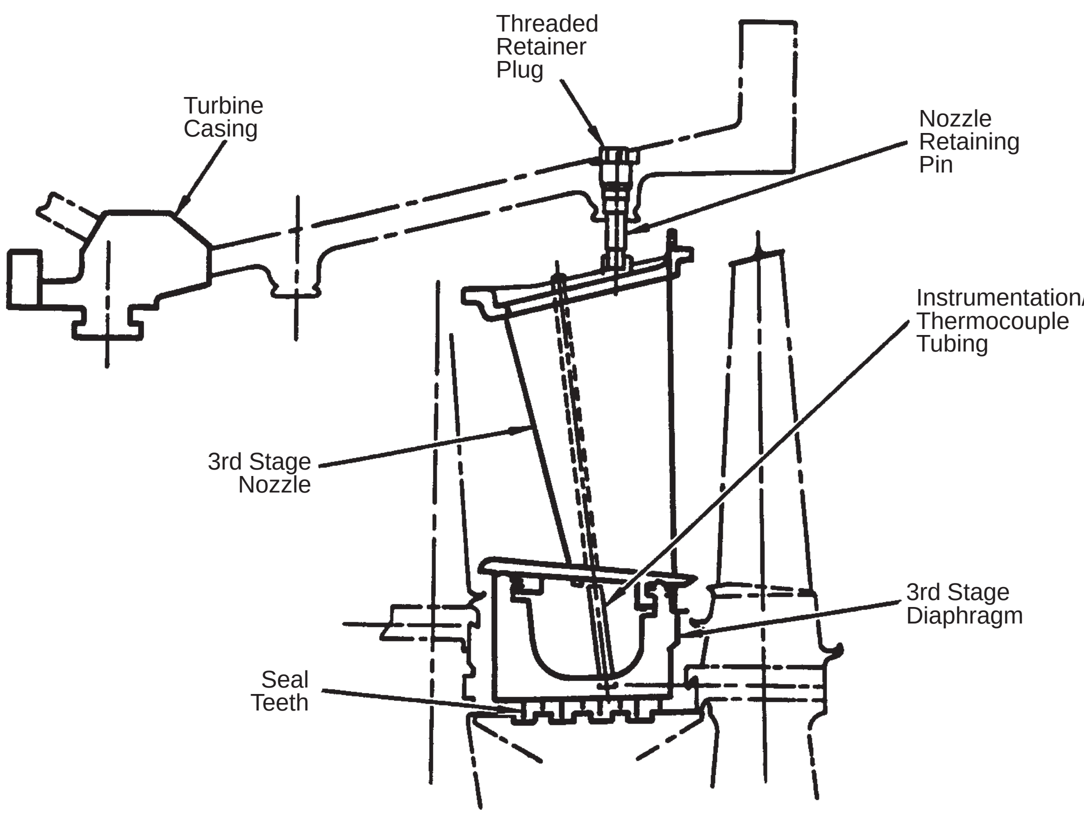
Note: The turbine casing should be on its forward vertical flange for nozzle segment removal.

CAUTION

At all points where the segment and pulling cable come in contact, there should be ample padding to distribute the load and protect the partition surfaces. Wood, rubber or padded steel plates can be used.



SECOND-STAGE NOZZLE ARRANGEMENT



THIRD-STAGE NOZZLE ARRANGEMENT

Figure HGP-D.17. Second- and Third-Stage Nozzle Details.

2. Remove the wheelspace thermocouples and guide tubes prior to removal of the nozzle segments. Check segments for pressure tap tubing and remove. (See Figure HGP-D.16.)

3. Tools required for nozzle removal are: a pulley assembly (normally supplied with unit), a one-ton (907.2-kg) “come-along”, and 0.375-inch (0.953-cm) diameter wire rope or fiber sling.

4. Commence by attaching the cable to the nozzle segment closest to the horizontal joint. Remove the nozzle segment using a one-ton (907.2-kg) “come-along”.

5. Attach the one-ton (907.2-kg) “come-along” to a suitable support point and use the pulley assembly. Continue on the remaining second- and third-stage nozzle segments and remove in a similar manner, as described above.

II. Inspection Procedures (Hot Gas Path Inspection) for MS-7001FA+ and MS-7001FA+e Gas Only Equipped Machines (with DLN-2.6)

Note: Obtain appropriate Inspection Forms from your local GE Field Service Representative.

Operation 31 — Perform Combustion Component Inspection Operations 11 Through 22

11. Fuel nozzle inspection
12. Liquid fuel injector inspection.
13. Gas fuel injector inspection.
14. Reassembly of injectors to end covers.
15. Inspect and test spark plugs.
16. Inspect and test flame detectors.
17. Inspect combustion caps and liners.
18. Inspect crossfire tubes and retainers.
19. Inspect combustion chamber flow sleeve.
20. Inspect fuel nozzle outer casing.
21. Inspect combustion outer casings.
22. Inspect transition pieces.

Operation 32 — How to Inspect First-, Second- and Third-Stage Nozzles

Note: The first-stage nozzle may become available for partial or complete inspection at less than hot gas path inspection intervals because of other inspection or maintenance requirements. It is important that these inspection results be accurately interpreted, evaluated, and recorded to minimize operator's maintenance expense while providing high reliability.

CAUTION

Extreme care must be exercised when grit blasting nozzle segments so no grit will enter the nozzle partition cooling holes. Using an air pressure of 40 psig (2.76 bars) or less, work the blasting nozzle in the direction of normal hot gas flow path across the nozzle partition. Normal hot gas path flow is leading edge to trailing edge. Do not dwell in one area as excessive amounts of metal may be removed.

1. Clean nozzles by blasting with aluminum oxide 220 grit or finer, (reference the Standard Practices section). Air blast nozzles to assure removal of all blasting grit from surfaces and openings.

2. Fluorescent penetrant (Zyglo) check for cracks, inspect for foreign object damage, erosion, corrosion, and cracks.

Nozzle Cracking

Nozzles experience severe thermal gradients during starting as well as high temperatures during loading operation. Such conditions frequently cause nozzle cracking and, in fact, cracking is expected. With certain exceptions, this cracking does not impair the efficiency or the mechanical integrity of the nozzle. Figures HGP-I.1 through HGP-I.5 display typical cracking patterns. The cracks shown are acceptable and do not require immediate repair. If uncertainty arises regarding any cracks, such as types not represented by Figures HGP-I.1 through HGP-I.5, contact your General Electric Company Field Service Representative for disposition. Obtain specific advice prior to making repairs when nozzle condition is considered beyond established limits.

Although to date we have found very few cracks that could impair the mechanical integrity, they exist. The inspector should be alert for the following which may require immediate disposition; for example, repair or scrap:

1. Open cracks in critical areas — Open cracks can permit ingestion of hot gases. An open crack is defined as a crack sufficiently open to pass a 0.005-inch (0.0127-cm) feeler gauge and having a length of 1.0 inch (2.54 cm) or more. The critical areas are certain regions of the vane and inner sidewalls and are shown in Figure HGP-I.6.

2. Cracks that could cause part break-out — Cracks whose orientation and growth rate are such as to raise questions of the dislodgement of significant portions of the nozzle must be evaluated. See Figures HGP-I.7 and HGP-I.8 for more details.

3. Continuous fillet cracks on one vane side — Cracks such as this can cause air-foil separation. See Figure HGP-I.8 for further details.

Nozzle Foreign Object Damage

Nozzles can be severely damaged by foreign objects in the gas stream. This damage can impair the structural integrity and aerodynamic performance of the nozzle. Such damage should be evaluated by the following criteria:

1. All tears and breaks must be evaluated by the same criteria given above for cracks.

2. Raised metal must be blended to the adjacent surface contours.

3. Nicks and chips must not exceed 50 percent of the wall thickness.

4. Cooling holes must be open [capable of passing a 0.050-inch (0.127 cm) wire].

Corrosion or Erosion of Nozzles

There have been no cases of severe corrosion or erosion of nozzles to date. The following guidelines are provided, however, in the event that such cases develop:

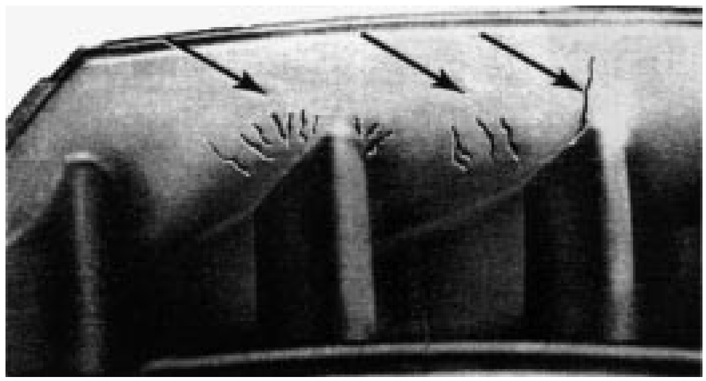


Figure HGP-I.1. Nozzle Sidewall Cracks.

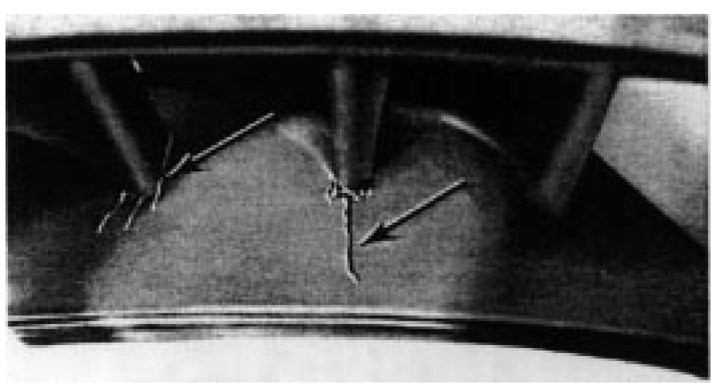


Figure HGP-I.2. Nozzle Sidewall Cracks.

Figure HGP-I.3.
Nozzle Partition Fillet Cracks.

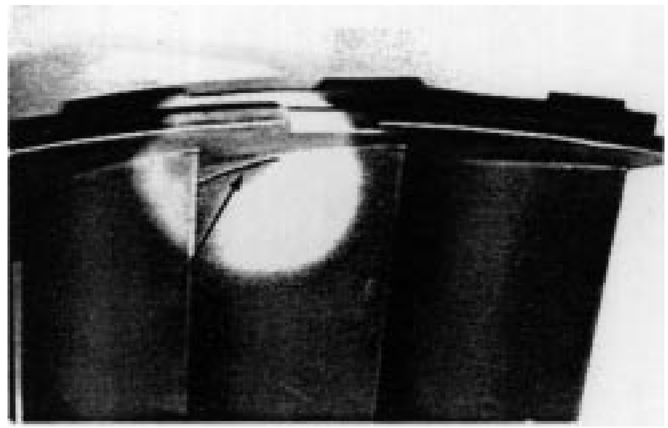


Figure HGP-I.4.
Nozzle Partition Fillet Cracks.

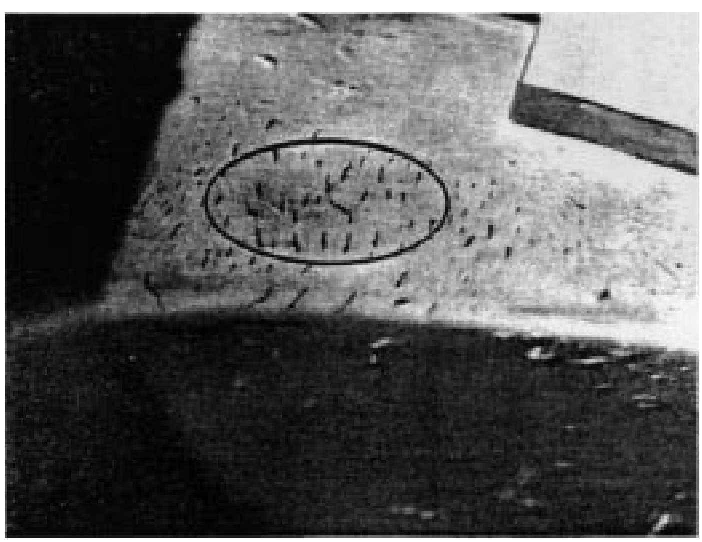


Figure HGP-I.5. Nozzle Sidewall Surface Cracks.

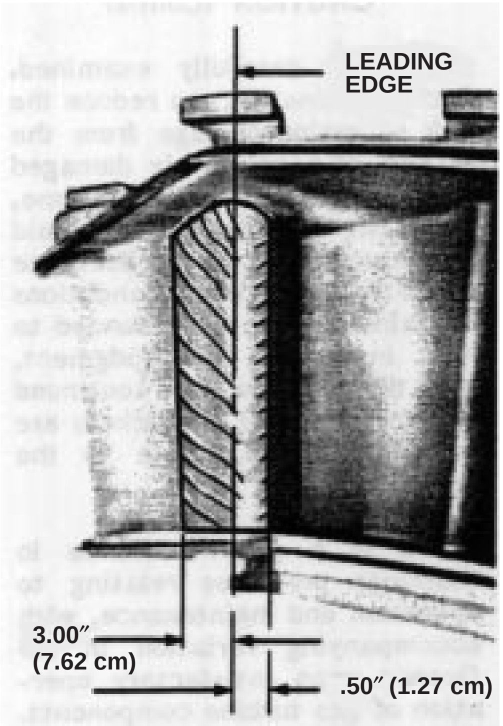


Figure HGP-I.6.
Unacceptable Crack Areas.

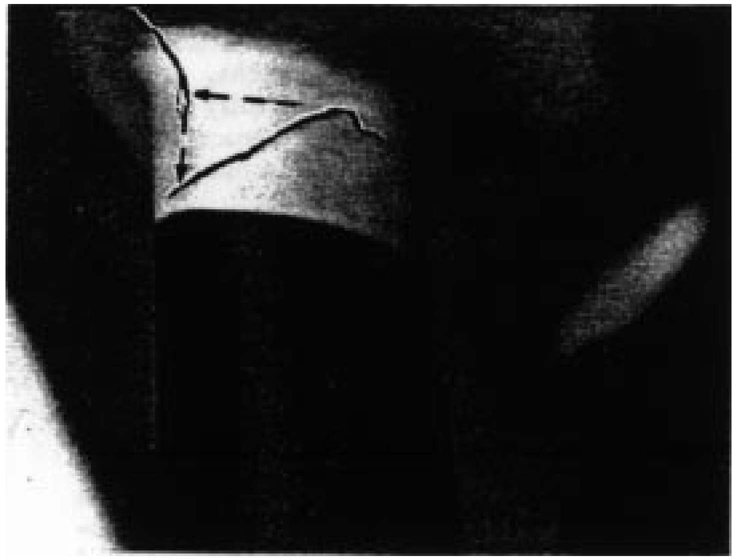


Figure HGP-I.7.
Unacceptable Crack Propagation.

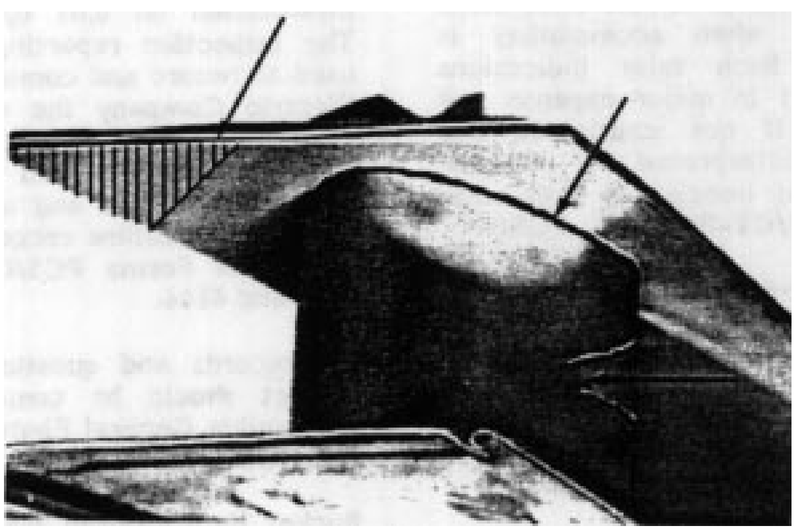


Figure HGP-I.8. Unacceptable Crack Propagation.

1. The allowable amount of vane region metal removal is 50 percent of the wall thickness [0.100 inch (0.254 centimeter)].
2. Sufficient trailing edge material must be maintained to prevent nozzle cooling hole exposure.
3. Area and harmonic checks must be performed where significant material removal has occurred.

Recommendations

First-stage nozzles should not be removed for repair except at normal hot gas path inspection intervals unless the above guidelines have been exceeded.

If the nozzle is removed earlier than hot gas path inspection interval for other reasons, all cracks, damage, etc., should be carefully mapped using proper non-destructive test procedures and reported to the responsible General Electric Company Field Service Representative. Do not send to repair facility until mapping has been reviewed and specific Gas Turbine Division recommendations are received from your General Electric Company Field Service Representative.

At all other times that the nozzle becomes partially or wholly accessible, the nozzle should be inspected as completely as possible using appropriate techniques and results reported to your General Electric Company Field Service Representative.

All inspections should be reported using the appropriate Field Inspection forms. It should be noted that extreme care should be used to ensure accuracy. False indications can occur when accessibility is limited. Such false indications could result in major expense and lost time if not scrutinized and properly interpreted.

Record condition of nozzles on appropriate Inspection Forms.

Operation 33 — Inspect First-, Second- and Third-Stage Buckets

CAUTION

Each time the upper-half shell is removed, the turbine buckets should be carefully examined. Such examination can reduce the risk of major damage from the failure of a previously damaged bucket. At the same time, judgment is necessary to avoid replacement of adequate buckets. The recommendations contained herein are intended to help in making this judgment, and the criteria for continued service or repair of buckets are furnished as a service to the customer.

There is a great variance in customer practices relating to operation and maintenance, with accompanying variation in influence upon satisfactory operation of gas turbine components. GE has little knowledge of or no control over these practices. Accordingly, the responsibility for decisions as to continued usage or replacement of buckets must remain solely with each customer.

The results of a bucket inspection should be documented along with the relative information on unit operation and fuels. The inspection reporting forms should be used to record and communicate to GE the exact location and type of abnormality observed.

These bucket inspection records will be filed for each particular turbine and used as a basis for present and future recommendations.

All records and questions arising on the subject should be communicated to the responsible GE Field Service Representative.

Bucket deterioration may be classified as cracks, dents, missing metal, and corrosion. Visually inspect the turbine buckets for these abnormalities. See Figure HGP-I.9 for first-stage bucket details and Figure HGP-I.10 for second- and third-stage bucket details.

Note: It is recommended that bucket rework be done by qualified GE personnel.

In all cases, the bucket rework area must be cleaned and fluorescent penetrant inspected with Zyglo ZL-22A or equivalent when rework is completed.

CAUTION

Do not attempt to clean buckets prior to inspection.

Visually inspect the vane section, platform and dovetail areas, using a ten power (10X) glass. Examine the critical areas of vane section (root fillets, top 25% of tip including squealer tips and shrouds, and trailing edges). Any suspected cracks shall be locally cleaned using "paddlewheel" polishing discs to prepare the surface area for fluorescent penetrating testing. Surface temperatures during polishing operations should not exceed 100 degrees Fahrenheit or ambient temperature, whichever is greater. High temperature will cause metal to yield and flow covering defects so that they cannot be detected.

CAUTION

All three stages of buckets on the MS7001FA units have a corrosion-resistant protective coating. Extreme care must be taken to avoid damaging this coating when cleaning, repairing, or handling these buckets. Coated buckets must be cleaned with aluminum oxide 220 grit at an operating pressure of not more than 40 psi (2.76 bars). Reworking of coated buckets is allowed, but the rework should be held to a minimum so that no more coating is removed than is absolutely necessary to effect the repair.

First-Stage Buckets

1. Cracks — Cracks on first-stage buckets are unacceptable with one exception: radial cracks on the bucket squealer tip less than 0.3 inch (7.6mm) long are permissible. These cracks usually occur as

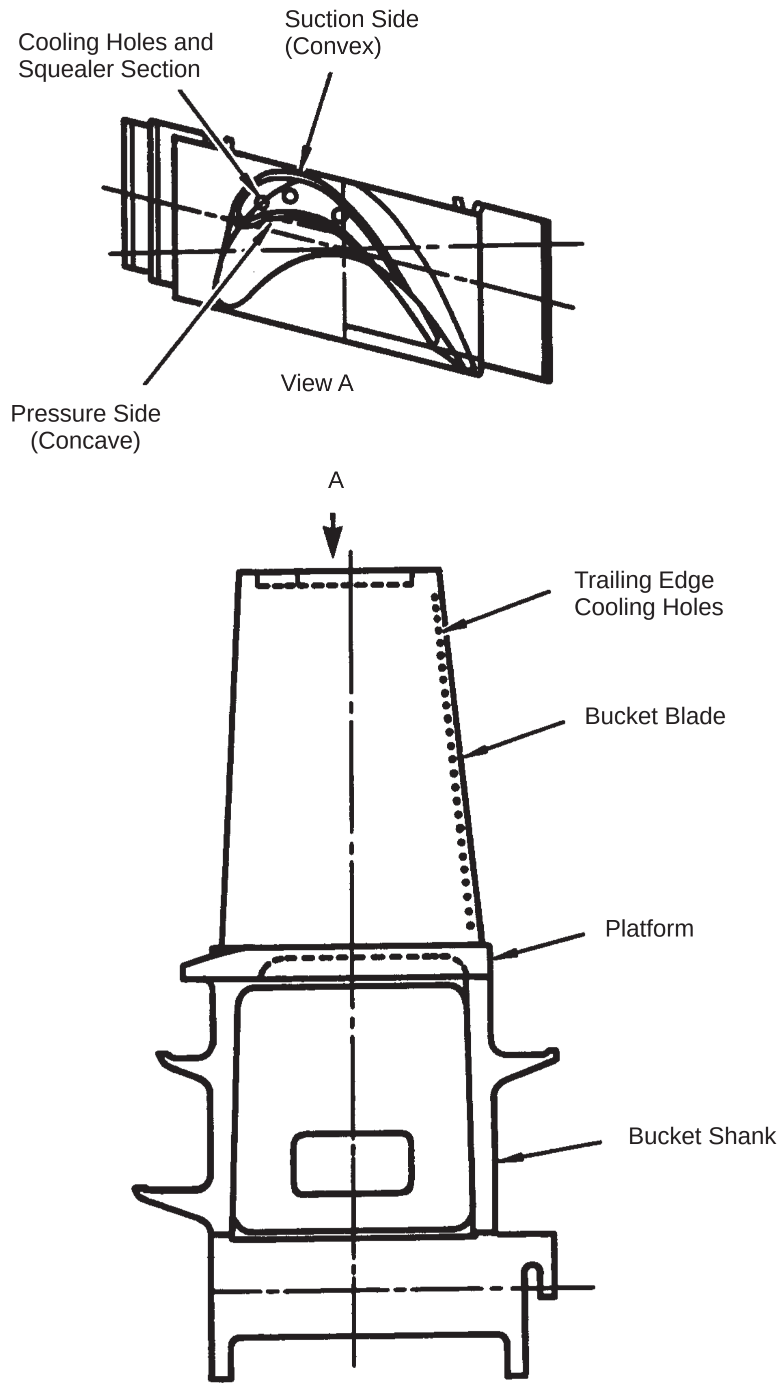


Figure HGP-I.9. First-Stage Bucket Details.

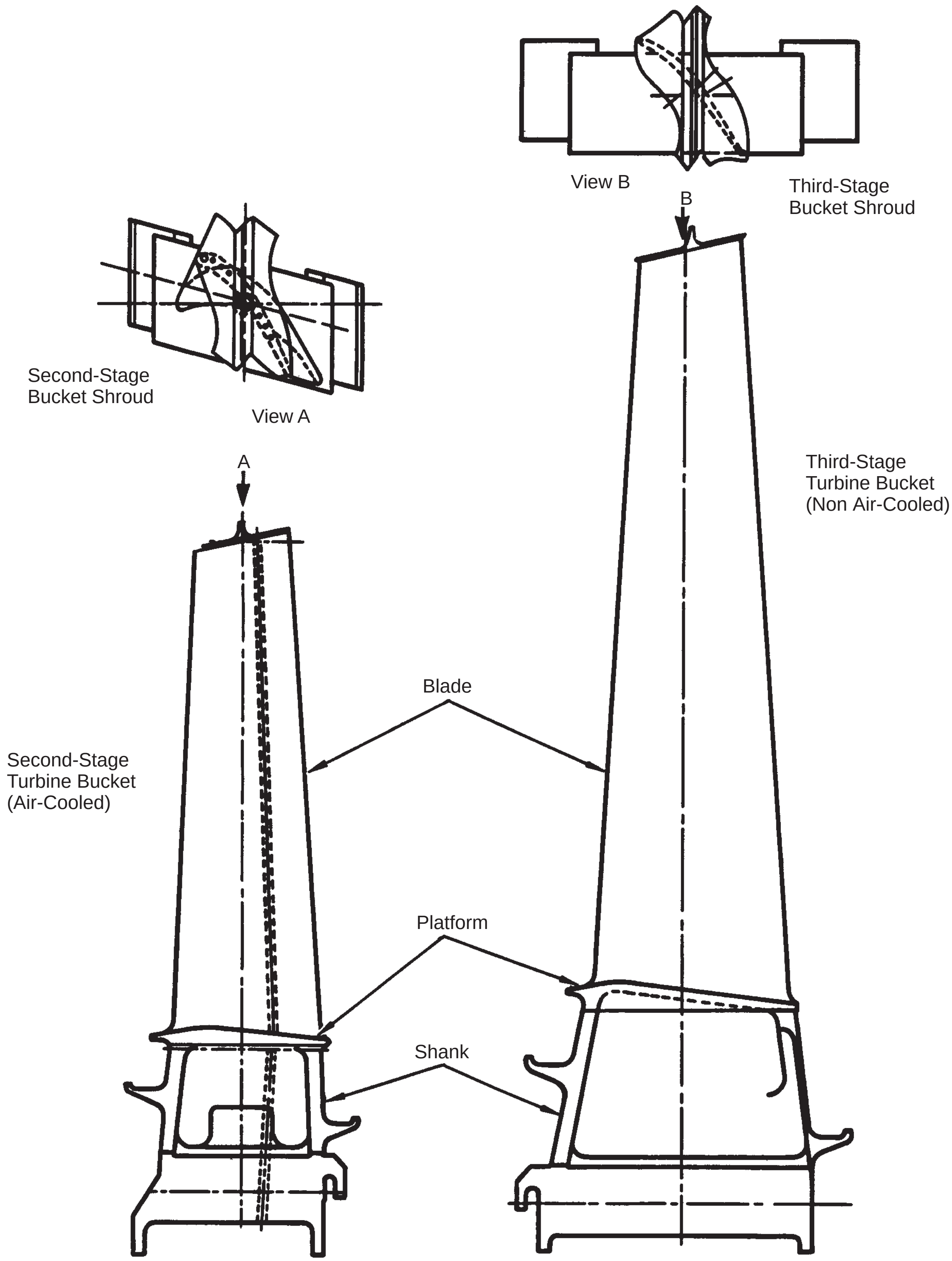


Figure HGP-I.10. Second- and Third-Stage Bucket Details.

a result of Foreign Object Damage. Crack detection requires the use of fluorescent penetrant on buckets. Zyglo ZL-22A penetrant is desirable because it will detect tight cracks which red dye type penetrant cannot detect. Radial cracks in certain areas of the squealer tip may be remedied by removing material. The limits are covered in paragraph “3”, Missing Metal.

2. Dents — Dents are permissible with the following limits:

   a. The dent must not contain any cracks per the above paragraph.

   b. The dent must not obstruct or penetrate into a cooling air passage. The cooling opening closest to the tip leading edge should pass a 0.150 inch (3.8 mm) diameter wire or 5/32-inch (3.97 mm) ball to be acceptable. Hole 2 must pass a 0.174 inch (4.42 mm) diameter wire or a 11/64-inch (4.36 mm) ball to be acceptable. The trailing edge slot must pass a 0.081-inch (2.06 mm) diameter wire or 5/64-inch (1.98 mm) ball to be acceptable.

   c. A dent must not be more than 0.125-inch (3.2 mm) deep. Therefore in areas where metal thickness to a cooling passage is not the limiting factor, a dent may be blended to remove resulting cracks or metal displacement, provided the 0.125-inch (3.2 mm) limit is not exceeded.

3. Missing Metal — Missing metal on first-stage buckets occurring in the squealer portion can be repaired by blending. Missing metal or radial cracks in the squealer portions can be corrected within the following limits:

   a. The squealer tip wall may be removed for a surface distance of 1.5-inch (38 mm) from the leading edge on the suction side of the bucket.

      The squealer tip wall may be removed for a surface distance of 0.75-inch (19 mm) from the leading edge on the pressure side of the bucket. See Figure HGP-I.11, Squealer Tip Repair Limit.

   b. Missing metal, dents and blending of cracks in the leading edge must not extend more than 1.125-inch (28.6 mm) down from the top edge of the bucket. No more than five buckets total may have leading edge blending below the squealer section without a resultant loss in performance. See Figure HGP-I.11, Leading Edge Repair Limits.

4. Corrosion — First-stage buckets are more susceptible to damage by corrosion, erosion, and oxidation than second- or third-stage buckets.

   This condition usually first appears on the leading edge of the airfoil as a flattening and roughening of the surface; however, the entire airfoil is susceptible to corrosion, erosion, or oxidation attack.

   Direct measurement of this wearing is difficult, if not impossible; however, a general criteria can be established. The cooling passage closest to the leading edge is approximately 0.18-inch (4.6 mm) from the leading edge and about 0.18-inch (4.6 mm) from the airfoil suction side surface. The corrosion pattern on the leading edge will allow a maximum of 0.125-inch (3.2 mm) corrosion before a breakdown of the hole closest to the leading edge occurs. This breakdown appears as a depression on the suction side surface, near the leading edge. If this condition appears on the first-stage buckets, replacement is required.

   If some lesser amount of corrosion is observed, judgment is required to weigh the possibility of a corrosion-related failure against the cost of replacement of buckets at the time of inspection. Realize that 0.125-inch (3.2 mm) of corrosion constitutes a total corrosion life. The fraction of

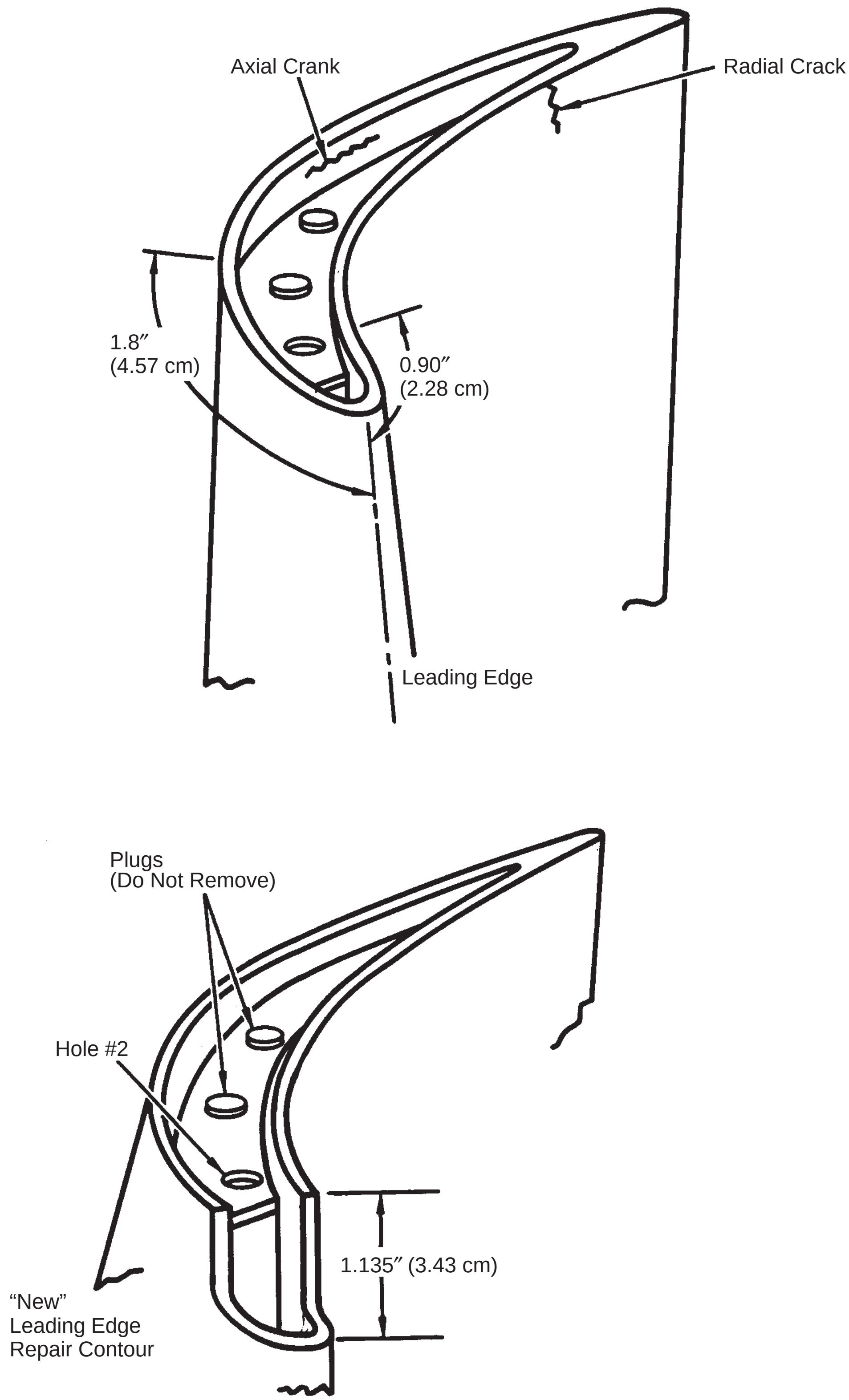


Figure HGP-I.11. First-Stage Bucket Repair Limits.

0.125-inch (3.2 mm) removed is the fraction of the life used. (It is assumed that corrosion progresses linearly with time.) Replace the buckets if total corrosion life is predicted before the next planned inspection.

Second- and Third-Stage Buckets

1. Cracks — Cracks also occur in the second- and third-stage buckets due to foreign object damage. These cracks usually occur at the airfoil leading edge in the outer span sections.

    a. Second- and third-stage bucket cracks are repairable if located in the outer (1/3) one-third of the airfoil and up to 0.35-inch (8.9 mm) in length. See Figure HGP-I.12, Second- and Third-Stage Bucket Repair Limits.

    b. These cracks can be repaired by blending the airfoil in the area of the crack while maintaining radii at all intersection points. The leading edge radius must not be retained in the repaired area.

2. Missing Metal — Missing material in the second- and third-stage buckets is acceptable if the airfoil can be contoured to the same limits as the crack repair.

3. Dents — Dents are acceptable, as long as the dent is not located in the bucket root fillet (interface between airfoil and platform) or in the shroud fillet (interface between airfoil and shroud).

    Dents containing cracks or those located in the shroud fillet are repairable. Repairable dents should be hand polished to remove foreign material in the area of the dent, and fluorescent penetrant inspected for cracks. Blend smooth all dents.

4. Air-cooled second-stage buckets must pass a 0.111-inch (2.8 mm) diameter wire through six holes counting from the leading edge. The 7th, 8th and 9th holes must pass a 0.090-inch (2.3 mm) diameter wire. An additional check should be made to ensure that the passageway through the bucket shank is open and clear.

5. Corrosion on second and third-stage buckets to a depth of more than 0.025-inch (0.64 mm) has not been observed. Such a condition is acceptable. If a more serious corrosion is noted, the observations should be reported to the responsible General Electric Company Field Service Representative.

Radial Seal Pin Grooves

Cracks and damaged material may be blended within these allowances:

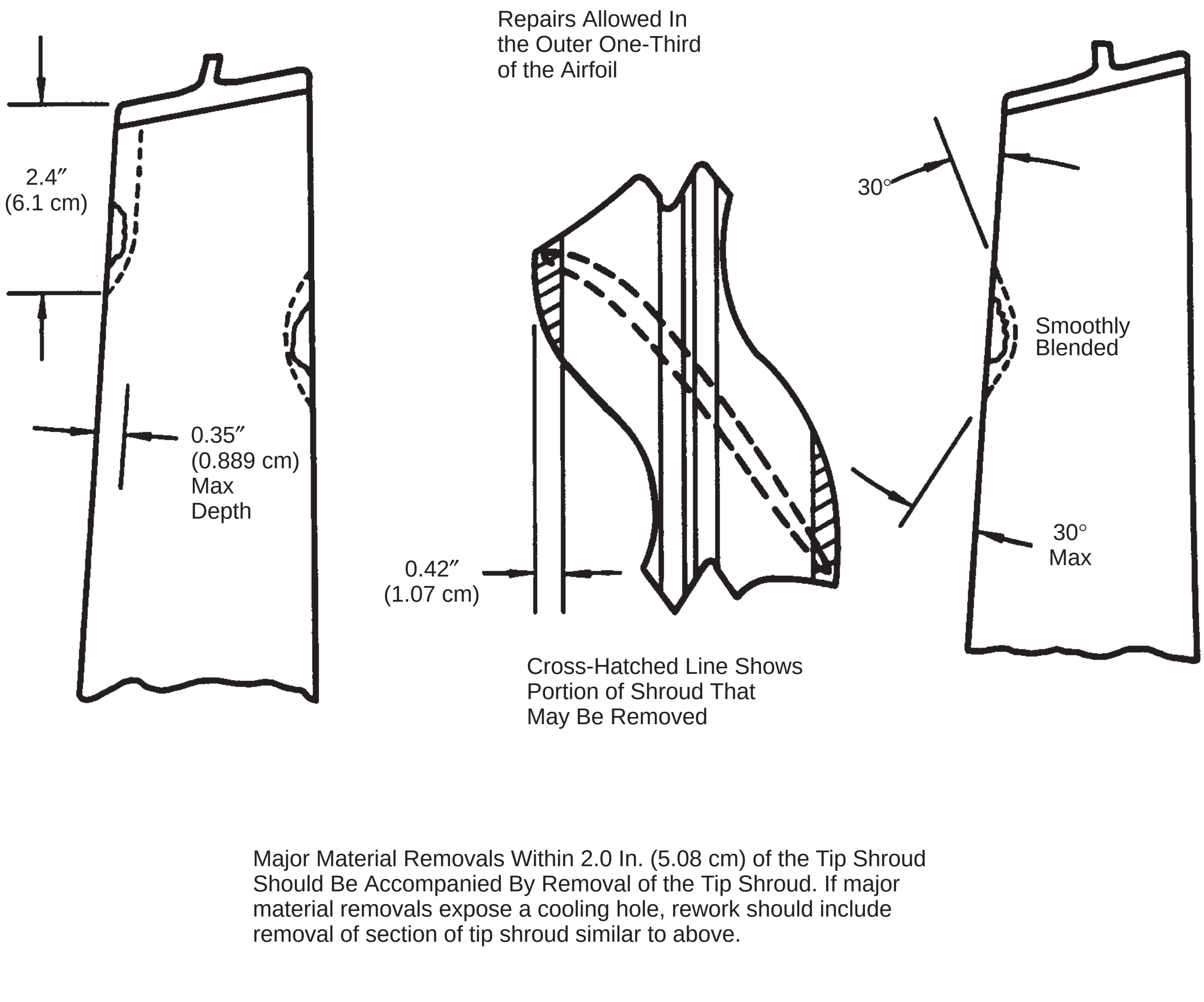
1. See Figure HGP-I.13, Radial Seal Pin Groove Repair Limits.

    a. Region I — No missing material allowed.

    b. Region II — Outer land 0.750-inch (19 mm) missing metal on both sides.

    c. Region III — No missing material allowed.

    d. Region IV — Blending allowed in this region.



Major Material Removals Within 2.0 In. (5.08 cm) of the Tip Shroud Should Be Accompanied By Removal of the Tip Shroud. If major material removals expose a cooling hole, rework should include removal of section of tip shroud similar to above.

Figure HGP-I.12. Second- and Third-Stage Bucket Repair Limits.

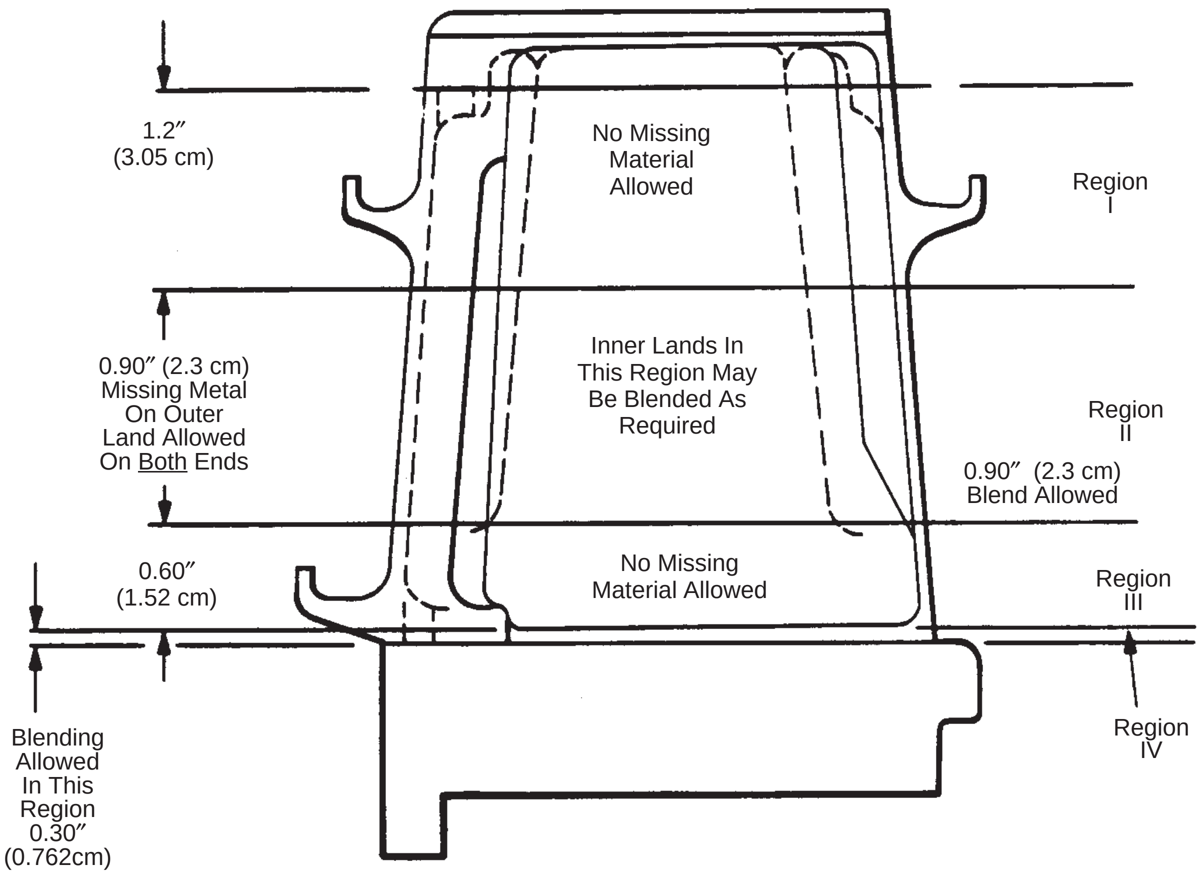


Figure HGP-I.13. Radial Seal Pin Groove Repair Limits.

Wheelspace Seal/Angel Wings

1. Rubbed wheelspace seals are suitable for continued operation as long as the corresponding wheelspace temperatures are within operating limits.

2. Axial cracks are common and are acceptable in region “A” provided they do not penetrate the seal to shank radius “B” as shown in Figure HGP-I.14.

3. Seals that have been rubbed off to a length “C” of 0.500 inch (13 mm) or less are unsuitable for use. See Figure HGP-I.14.

Shroud Tip Rework

Rework and metal removal is allowed in the cross-hatched areas. No rework is permitted which penetrates below the shroud surface. See Figure HGP-I.15.

Operation 34 — How to Inspect Shroud Blocks

1. Visually check the shroud segments for deposits, corrosion, erosion (pitting), cracks and nicks or dents. Record inspection results on appropriate Inspection Forms.

2. Check for cooling hole plugging in first-stage shrouds.

3. Visually inspect the shroud seals for distortion, rubs, wear and missing pieces.

Operation 35 — How to Inspect Second- and Third-Stage Diaphragm Segments

1. Clean nozzle assembly by blasting with aluminum oxide 220 grit or finer as detailed in Standard Practices section, Abrasive Cleaning in this maintenance instruction.

2. Check for cracks using fluorescent penetrant. Zyglo ZL-22A is preferred. Record inspection results on appropriate Inspection Forms.

3. Make a visual inspection for foreign object damage, burning, corrosion, erosion and excessive deposit buildup. Report inspection results on appropriate Inspection Forms.

   Note: Each diaphragm segment is normally removed along with the nozzle segment. The diaphragm segments are not normally separated from the nozzle segments in the field to make checks.

4. Make a visual inspection of all diaphragm seal teeth, first-stage forward and aft wheelspace seals, second-stage forward wheelspace seals and second-stage aft and third-stage forward wheelspace seals.

5. Record inspection results on appropriate Inspection Forms.

6. Inspect diaphragm teeth as follows: Observe the worst rubbed tooth and measure its tooth height. Compare this measurement to the height of the tooth on the diaphragm segment previously positioned at the horizontal joint where the tolerance of the gap (1PL and 1PH or 2PL and 2PH) is known. Verify that the gaps are within the minimum specified allowance for the worst diaphragm tooth condition.

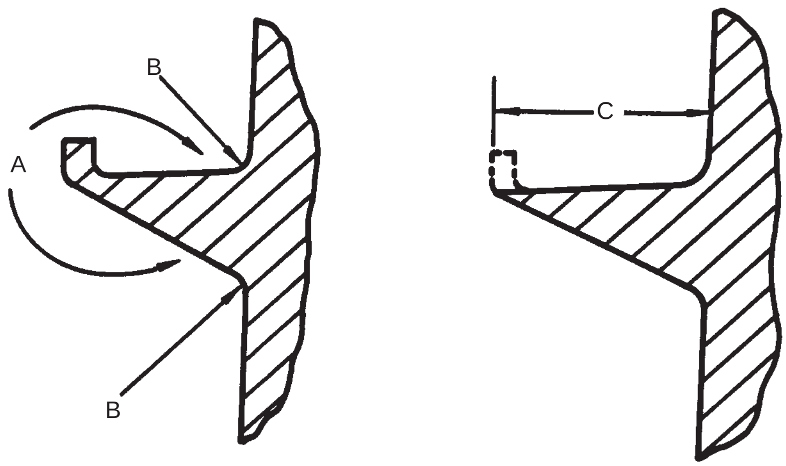
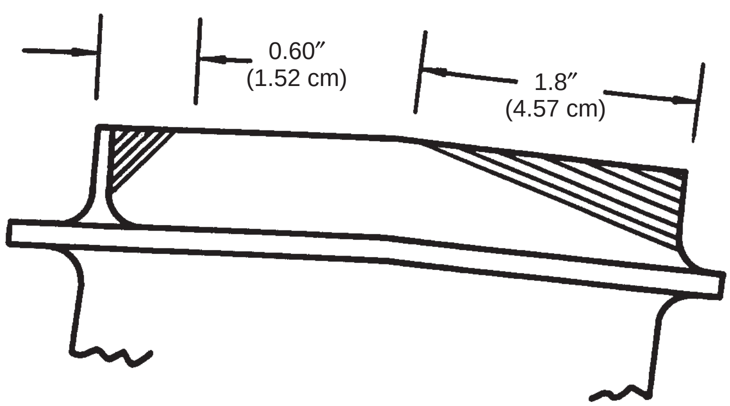
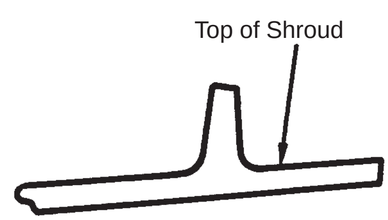


Figure HGP-I.14. Wheelspace Seal Angel Wings Cross Sections.



Rework and Metal Removal Is Allowed In the Cross-Hatched Areas.



No Rework Is Permitted Which Penetrates Below the Shroud Surface.

Figure HGP-I.15. Shroud Tip Rework Limits.

<u>Operation 36</u> — Make First-Stage Nozzle Ellipticity Checks

Note: Ellipticity is the condition of deviation from a circular form. Measurement of the first-stage nozzle is to determine the amount of deviation, or the "Out of Roundness", of the nozzle assembly when it is measured out of the unit. Ellipticity can be measured on only MS-7001FA first-stage nozzles because the second- and third-stage nozzle roundness is fixed by the turbine casing.

Assistance from your GE Company Field Service Representative in obtaining ellipticity readings is recommended.

Set the upper and lower halves of the first- stage nozzle on a reasonably level surface and take ellipticity readings as described on appropriate Inspection Form.

III. Re-assembly Procedures (Hot Gas Path Inspection) for MS-7001FA+ and MS-7001FA+e Gas Only Equipped Machines (with DLN-2.6)

Note: Obtain appropriate Inspection Forms from your local GE Field Service Representative.

Operation 37 — How to Install Lower-Half First-Stage Nozzle, Key and Nozzle Clamps

1. Thoroughly clean the nozzle to support ring tongue and groove fits and apply a light coating of anti-seize compound to the fits.

2. Thread a shouldered eyebolt into the center bolt hole in each of the nozzle horizontal joint flanges (one eyebolt for each end of the nozzle). These will be needed after the nozzle half is partially installed.

3. Using cable slings and chainfalls attached to the lifting lugs on the back of the nozzle assembly, rig to lift the nozzle half inverted (ends point down), over the turbine casing.

4. If the unit's rotor is in place, begin rolling the nozzle half assembly into the turbine casing by letting out on one chainfall and taking up on the other, moving the crane as necessary to lead the assembly around the rotor.

5. Continue the roll-in process by taking up on the leading end cable and letting out on the following end cable.

6. By the time the nozzle half horizontal joints are oriented in the horizontal plane, both cable slings must be attached to the eyebolts, previously installed, in the horizontal joint bolt holes. With the chainfalls attached to the cable slings, lift the first-stage nozzle half slightly and install the support blocks under the horizontal flanges.

   Note: Be sure that the horizontal flange support blocks are replaced in their original positions. These blocks are ground at factory assembly of the turbine to obtain the proper clearances for first-stage nozzle concentricity.

7. Lower the first-stage nozzle half onto the horizontal joint blocks and remove the lifting slings, chainfalls and eyebolts.

   Note: Ensure that the support pad joints are staggered at least 3/4 inch (1.9 cm) from the first-stage nozzle segment joints.

8. Assemble the two outer support clamps, one on either side of the turbine casing, which hold the nozzle assembly to the first-stage shrouds, lockplate bolts.

9. Assemble the horizontal joint clamps, bolt them securely and record the clearances. Record the nozzle-to-rotor clearance on appropriate Inspection Form. Refer to the Unit Clearance Diagram in the Unit Service Manual for clearance specifications.

10. The key and shims are to be fitted to the first-stage nozzle lower half after the nozzle has been assembled and properly positioned but before the upper-half casing is installed. See Figure HGP-R.1.

    Note: The first-stage nozzle alignment should not be changed without first consulting your GE Company Field Service Representative.

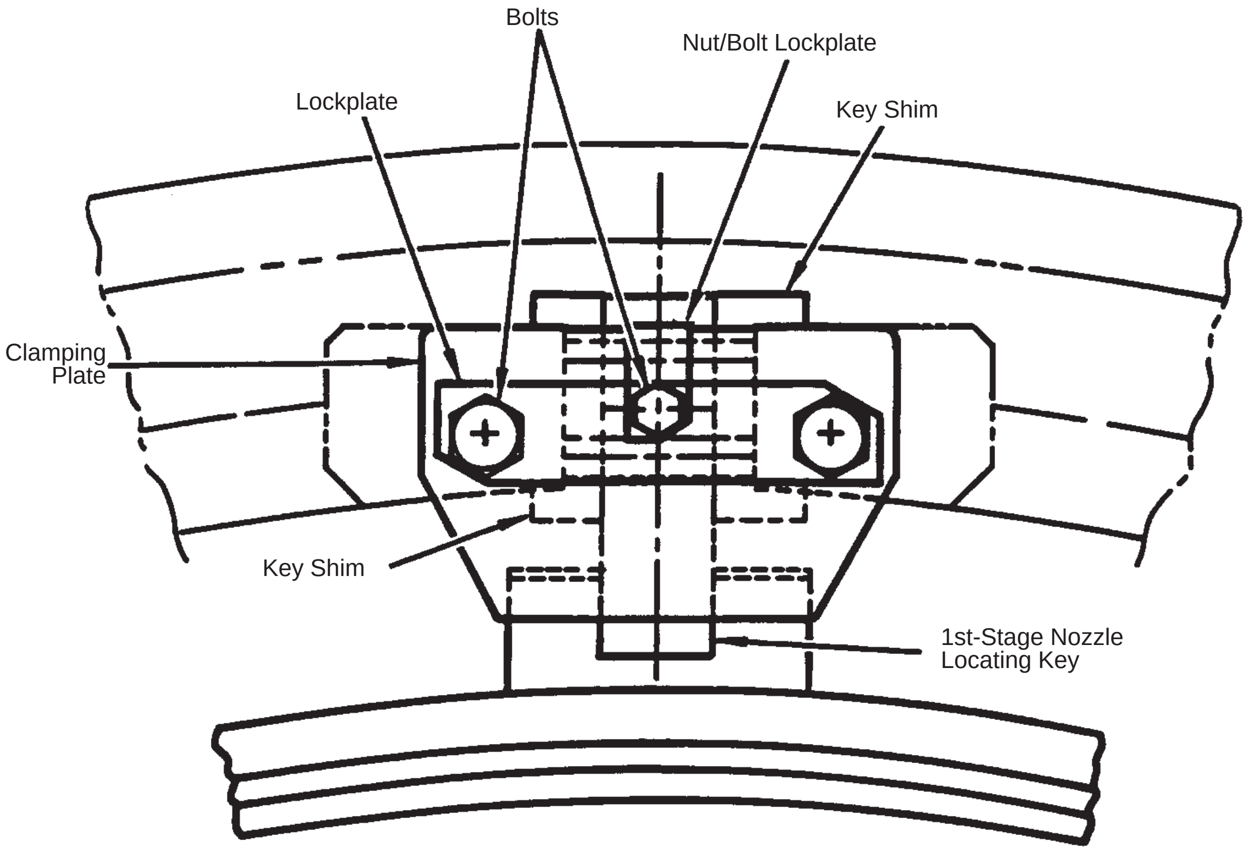


Figure HGP-R.1. Stage-1 Nozzle Locating Key and Clamp Arrangement.

11. Install and hand tighten the two sets of lower key retaining straps, bolts and lockplates (each at 45 degrees from the bottom centerline) that axially secure the first-stage nozzle assembly to the lower turbine shell. Do not torque as this will be done when the assembly is a full ring in Operation 47.

12. Assemble (24) support pins through the bushings in the support ring lower half.

13. Install and properly tighten (24) bolts and retainer plates that hold the pins in the bushings.

Note: At this point, for ease of assembly, the lower half transition pieces can be installed in position. The transition pieces do not need to meet "B" and "C" gap requirements at this time. Bolts are to be loosely installed (hand tight) to hold the transition pieces in place, but not loaded. DO NOT TORQUE the transition piece bolts. Follow Combustion Inspection Re-assembly Operation 23: Pre-assembly Inspection and Checks– Steps 1–6 and Assembly Procedure Steps 1–7, DO NOT EXECUTE Steps 8–11 at this time; this is done in Operation 48.

Operation 38 — How to Install Lower-Half Second- and Third-Stage Nozzle Segments

Note: This operation assumes that the diaphragm and nozzle segments are being installed as one assembly.

1. Thoroughly clean the hook fits. Buffing the nozzle hook fits may be helpful prior to applying anti-seize compound. Apply a light coating of anti-seize compound.

CAUTION

Use of anti-seize compound must be restricted to a thin film such that the compound is not forced into the inner gas path. Should this occur, it must be carefully removed.

2. Install the nozzle forward and aft seals into the nozzle segment in accordance with the Second- and Third-Stage Nozzle Arrangement Drawing.

CAUTION

Do not stake the forward and aft seals at the horizontal joint.

3. Ensure that the forward seals are bottomed out and that the ends of the aft seals are in contact with the forward seals. Assemble the axial seal strip with the notch facing out. Then, assemble the radial seal strip with the notch facing in. Appropriately stake both seals.

Note: Step four following applies only if the second- and third-stage turbine shrouds were removed during disassembly of the second- and third-stage nozzle segments. If they were not removed, omit this step and proceed to step 5.

4. Working from the bottom center to the horizontal joints on both sides the assembly procedure is as follows:

   a. Assemble two second-stage shroud segments and then one nozzle segment, continue in this manner until all shroud and nozzle segments are in place.

   b. Apply a light coating of anti-seize compound to the shroud pins and plugs and install pins and plugs to each shroud block and stake the plug at four places.

   c. Repeat steps 4a and 4b for the third-stage shroud and nozzle segment.

5. Lift the nozzle and diaphragm segment on its hook fit and slide it along to its proper position. Install nozzle segments from each horizontal joint to the bottom centerline of the casing.

6. Nozzle segment locating pins should be installed after each segment is moved into position. Stake each plug at the threads in the turbine shell after it has been tightened.

7. After inserting the nozzle segments containing the wheelspace thermocouples into place ensure that the tubing adapters are engaged to the thermocouple guide tubing. Refer to Figures HGP-D.15 through HGP-D.17.

Operation 39 — How to Install Lower-Half Second- and Third-Stage Nozzle Radial Retaining Pins

1. Apply a light coat of anti-seize compound to all radial retaining pins.

   Note: Prior to installing the radial retaining pin threaded access plugs, clean the plug threads in the retaining pin hole. This will assist in making re-assembly of access plug easier.

2. Install the retaining pins as each nozzle segment is installed. Install the access plug so that it just bottoms on the retaining pin. Stake each plug at four places on the edge of the threads.

Operation 40 — How to Recheck Turbine Clearances

1. All turbine clearances should be retaken per Operation 24, and checked with your General Electric Company Field Service Representative. The Field Service Representative will provide recommendations before re-assembly of the turbine shell upper half.

2. Record results on appropriate Inspection Form.

Operation 41 — How to Install Upper-Half First-Stage Nozzle Support Ring

1. Clean and deburr the mating joints.

2. Apply a light coating of anti-seize compound to the horizontal joint dowels and the horizontal and vertical joint bolts.

3. Assemble the support ring locating shim to the support ring.

4. Rig and lift the first-stage nozzle support ring and lower into position on the lower half.

5. Install all horizontal and vertical bolting. Tighten and torque bolting.

Operation 42 — How to Install Upper-Half First-Stage Nozzle

1. Thoroughly clean the nozzle to support ring tongue and groove fits and apply a light coating of anti-seize compound to the fits.

2. Using the two lifting lugs, rig and lift the first-stage nozzle, upper-half assembly (ends pointing down) and carefully lower it onto the lower half.

3. Install and torque the horizontal joint bolts.

4. Assemble (24) support pins through the bushings in the upper-half support ring.

5. Install and properly tighten (24) bolts and retainer plates that hold the pins in the bushings.

Operation 43 — Recheck First-Stage Nozzle Concentricity

Note: Assistance from your General Electric Company Field Service Representative is recommended when making concentricity checks.

1. Recheck first-stage nozzle concentricity. Follow the procedures outlined in Operation 20 in the Hot Gas Path Dis–assembly section.

2. Record results on appropriate Inspection Form.

Note: The first-stage nozzle alignment should not be changed without first consulting your General Electric Company Field Service Representative.

Note: At this point, for ease of assembly, the remaining upper half transition pieces can be installed in position. The transition pieces do not need to meet "B" and "C" gap requirements at this time. Bolts are to be loosely installed (hand tight) to hold the transition pieces in place, but not loaded. DO NOT TORQUE the transition piece bolts. Follow Combustion Checks–Steps 1–6 and Assembly Procedure Steps 1–7, DO NOT EXECUTE Steps 8–11 at this time; this is done in Operation 48.

Operation 44 — How to Install Upper-Half Second- and Third-Stage Nozzle Segments

1. Thoroughly clean the hook fits. Buffing the nozzle hook fits may be helpful prior to applying anti-seize compound. Apply a light coating of anti-seize compound to the hook fits.

CAUTION

Use of anti-seize compound must be restricted to a thin film such that the compound is not forced into the inner gas path. Should this occur, it must be carefully removed.

2. Install the nozzles forward and aft seals to the nozzles segments in accordance with the Second-Stage Nozzle Arrangement Drawing in the Service Manual.

CAUTION

Do not stake the forward and aft seals at the horizontal joint.

3. Ensure that the forward seals are bottomed out and that the ends of the aft seals are in contact with the forward seals. Assemble the axial seal strip with the notch facing out. Then, assemble the radial seal strip with the notch facing in. Appropriately stake both seals.

Note: Each second-stage nozzle-diaphragm weighs 175 pounds (79.4 kilograms). Each third-stage segment weighs 232 pounds (105.2 kilograms).

4. Lift the nozzle and diaphragm segment onto its hook fit and slide it along to its proper position. Install nozzle segments from each horizontal joint to the center of the casing.

5. Nozzle segment locating pins should be installed after each segment is moved into position. For segments that are positioned by retaining plugs, stake each plug at four places on the edge of the threads in the turbine casing after it has been tightened.

Note: Ensure that each threaded retaining plug is just bottomed against the radial retaining pin.

6. After inserting the nozzle segments containing the wheelspace thermocouples into place, ensure that the tubing adapters are engaged to the thermocouple guide tubing. Refer to Figures HGP-D.15 through HGP-D.17.

Operation 45 — How to Install Upper-Half Second- and Third-Stage Nozzle Radial Retaining Pins

1. Apply a light coat of anti-seize compound to all radial retaining pins.

Note: Prior to installing the radial retaining pin threaded access plugs, clean the plug threads in the retaining pin hole. This will assist in making reassembly of access plug easier.

2. Install the retaining pins as each segment is installed. Where plugs are used to hold the retaining pins, install the access plug so that it just bottoms on the retaining pin. Stake each plug at four places on the edge of the threads.

Operation 46 — How to Install Upper-Half Turbine Casing

1. Coat the mating surface of the turbine casing with a light film of anti-seize compound excluding the four way joint.

CAUTION

> Only a thin film of anti-seize is to be used or it will interfere with pulling joints together and act as a gasket. Do not get anti-seize compound into the hot gas path.

2. Check and assure that all items are secure within the casing prior to assembly.

   a. Install wooden block as shown in Fig. HGP-R.2 between aft side of 1st stage shroud and against outer side wall of 2nd stage nozzle at horizontal joint (4 places).

      Check gap between shroud hook and nozzle side wall as shown in Fig. HGP-R.2. Maintain distance of gap within + .01, 4 places. Block to be left in place for unit last.

   b. After all clearances have been completed and approved and prior to the six point check:

      Install wooden block as shown in Fig. HGP-R.3 between aft side of 2nd stage shroud and against outer side wall of 3rd stage nozzle aft horizontal joint (4 places).

      Check gap between shroud hook and nozzle side wall as shown in Fig. HGP-R.3. Maintain distance of gap within ±.01 (.25 mm), 4 places. Block to be left in place for unit test.

   c. 2 stage nozzle to be wedged prior to 3 stage nozzle.

3. Rig the casing to lift level. For rigging and weight data, refer to the “Weight and Center of Gravity”, drawing in the Unit Service Manual.

4. Install guidepins in the horizontal joint of the turbine casing. The guidepins are to be placed in the body-bound stud hole locations.

5. Position the upper-half turbine casing directly over the lower-half turbine casing with the crane.

CAUTION

> Do not allow casing to swing and hit the turbine buckets while it is being lowered into position.

6. Lower the casing utilizing the guidepins provided, and ensure that the nozzle and shroud joint sealing strips at the second- and third-stage joints are in position.

   Note: Make certain that the upper- and lower-half turbine nozzles are loaded in the same direction to avoid mismatch at the horizontal joint seals.

7. Install the vertical joint dowel pins on the forward and aft casing flanges.

8. Install all bolts hand tight, including body-bound bolts. Tighten the horizontal joint bolts, starting at the mid-point and working alternately to the ends.

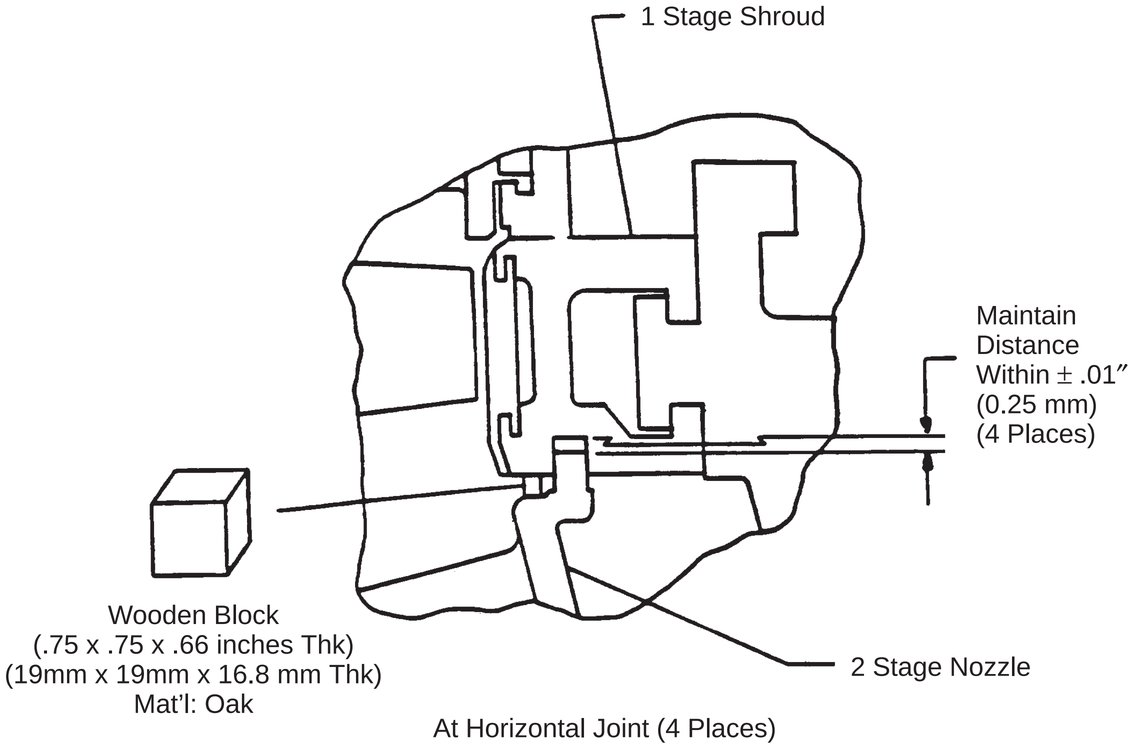


Figure HGP-R.2 Stage 1 Shroud Clearance Checks

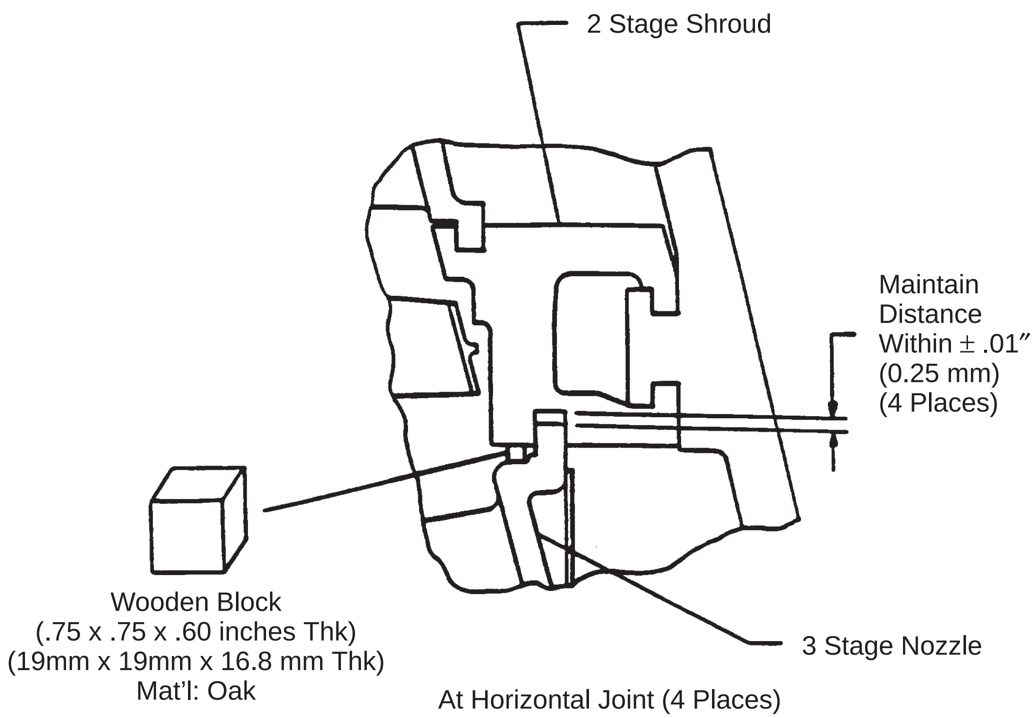


Figure HGP-R.3 Stage 2 Shroud Clearance Checks

9. Alternate the bolt tightening from the right side of the casing to the left side (or vice versa) (Figure HGP-R.4).

10. Alternately tighten all the vertical bolts, working down each side from the top vertical centerline.

Note: Work both the aft and forward vertical flanges simultaneously.

Operation 47 — How to Install Upper-Half First-Stage Nozzle Clamps, Key and Shims

1. Assemble the two outer support clamps, one on either side of the turbine casing, which hold the nozzle assembly to the first-stage shrouds, lockplate bolts.

2. The key and shims are to be fitted to the first-stage nozzle upper-half after the nozzle has been assembled and properly positioned. See Figure HGP-R.1.

Note: The first-stage nozzle alignment should not be changed without first consulting your General Electric Company Field Service Representative.

3. Install and properly tighten the two sets of upper key retaining straps, bolts and lockplates (each at 45 degrees from the top centerline) that axially secure the first-stage nozzle assembly to the upper turbine shell. Also properly tighten the previously installed two sets of lower key and retaining straps, bolts and lockplates. This secures the first-stage nozzle assembly to the turbine shell in a full ring configuration.

4. Replace the 24-inch (61-cm) access port cover using a new gasket.

Operation 48 — Install Transition Pieces and Replace Access Cover

1. If all transition pieces are in position, begin this operation at Step 8 of Combustion Inspection Re-assembly Operation 23's Assembly Procedure, and complete all remaining steps (8-12).

2. Complete all steps of Combustion Inspection Re-assembly Operation 23 if not all transition pieces are in position.

3. Upon completion of this step, all transition pieces are to be fully torqued and locked in place and all "B" and "C" gap requirements met..

4. Replace the 24 inch (61 cm) access port cover and any other covers using new gaskets.

Operation 49 — Install Turbine Thermocouples

1. Install eight compression fittings and outer guide tubes in the same locations they were removed from. Be sure they engage the guide tubes attached to the second- and third-stage nozzle segments. Refer to the Second- and Third-Stage Nozzle Arrangement Drawings.

2. Prior to installing the turbine thermocouples, test the thermocouples to insure they are operational. This can be done by applying a small amount of heat to the tip and reading the output on a temperature meter.

3. Install a total of 12 thermocouples in the turbine casing and two in the discharge casing.

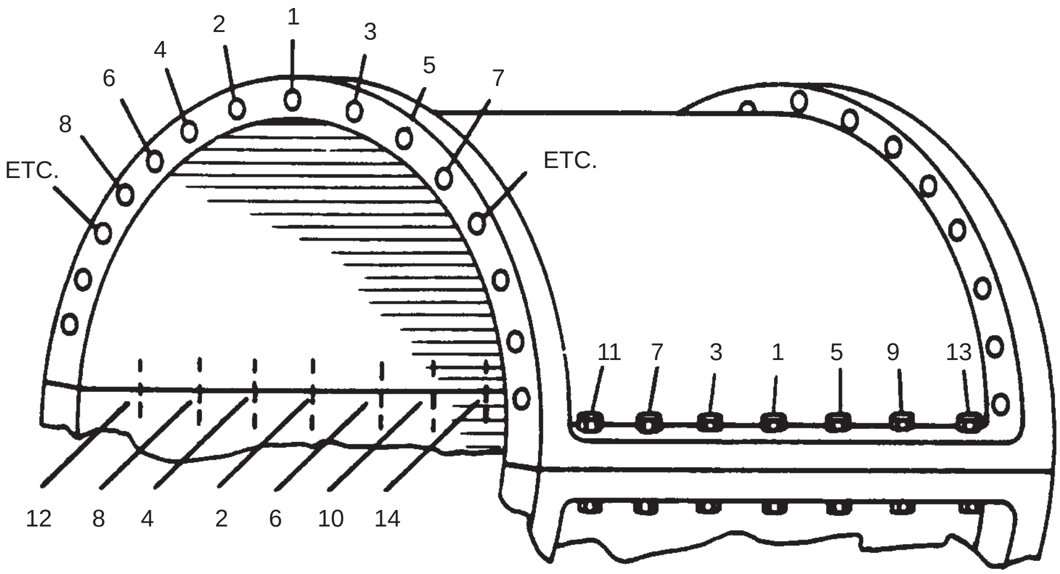


Figure HGP-R.4. Casing Torquing Sequence.

Note: The assembled length of the engaged portion of the thermocouple is stamped on the turbine casing adjacent to the thermocouple tubing installation hole. This dimension may be used for reference when installing the thermocouples. The reference dimension is from the top Swagelok ferrule to the tip of the thermocouple.

4. Install the wheelspace thermocouples through the installation tubing in the turbine casing into the second- and third-stage nozzle segments. Refer to Figure HGP-D.2. Tighten Swagelok fittings.

5. Replace the thermocouple tubing in its original position and replace all tube clips.

Operation 50 — How to Install Upper-Half Cooling and Sealing Air Piping

1. On re-assembly of piping, use new gaskets on all gasketed joints.

2. Assemble the four 13th stage upper-half and two lower-half flexible pipe connections at the turbine casing and at existing piping flanges.

3. Assemble the two atomizing air piping connections to the turbine casing cone.

Operation 51 — How to Remove Jacks and Supports From Under Turbine Casing

CAUTION

Jacks are not to be removed until all upper casings have been installed and bolted up.

1. Place two dial indicators (one on each side of the machine) at the horizontal joint near the area that the jacks are supporting. Attach dial indicators to turbine enclosure frame and set to indicate on turbine casing. Set dial indicators at zero.

2. Release the jacks and observe whether turbine casing has lowered.

3. If turbine casing moved downward when the jacks were released, remove the jacks and jack supports from under the turbine.

4. If turbine casing did not move downward when jacks were released, contact your GE Company Field Service Representative for disposition and corrective action.

Operation 52 — How to Take Final Rotor Position Checks

Note: All rotor position checks should be submitted to your local GE Company Field Service Representative for evaluation. Both the opening and closing readings should be submitted. All closing readings must be within tolerances as specified on the “Clearance Diagram” Drawing.

1. To take closing rotor positioning checks, follow procedures outlined for opening rotor position checks in Operation 13 of this section.

2. Record the results on appropriate Inspection Form.

Operation 53 — Perform Combustion Inspection Re-assembly Operations 24 through 30

24 Install outer combustion chambers and outer crossfire tubes.

25. Install flow sleeves, crossfire tubes, and combustion liner assemblies.

26. Install spark plugs.

27. Assemble the fuel nozzle/end cover to the fuel nozzle casing.

28. Assemble the cap to the fuel nozzle and casing assembly.

29. Assemble the fuel nozzle casing to the combustion casing.

30. Install tertiary cooling lines and atomizing air purge lines.

Operation 54 — How to Install the Diffusion Passage and Atomizing Air Purge Lines

1. This combustion system uses a diffusion passage purge line which connects the purge manifold on the radial inside of the combustion outer casing to the flange on the end cover.

2. Install new gasket at each end of the purge line and install the flange bolts.

3. This turbine has flanged connections on the purge manifold which is connected to the atomizing air flange on the cover. This line may be connected using new gaskets at this time.

Operation 55 — How to Install Primary, Secondary, Tertiary and Quaternary Gas Fuel Lines

1. Using new gaskets, connect the flexible gas fuel lines between the fuel nozzle and the manifold.

2. The order of installation of these flexible gas lines is generally from the bottom of the turbine and working from the radial inside to the radial outside.

3. Tighten bolts in a criss-cross pattern to give uniform gasket compression.

Operation 56 — How to Install Flame Detectors and Cooling Water Manifolds

1. Install new gasket.

2. Coat bolts with anti-seize compound, being careful not to get any of the compound into the hot gas path.

3. Using new gaskets, install flame detectors on chamber numbers 11, 12, 13 and 14.

4. Leave the bolts and connections loose until the manifolds are in place.

5. Install the feed and return cooling water manifolds.

6. Install the two flex hoses on the right side of the unit.

7. Once the manifolds are in place, tighten bolts to each flame detector in a criss-cross pattern to give uniform gasket compression.

8. Reconnect wiring to flame detectors.

9. Reconnect water cooling feed and drain lines to flame detectors, starting at the lowest flame detector on each side and working upward.

10. Re-energize power supply to flame detectors by reinstalling the flame detector cards.

Operation 57 — How to Install Turbine Compartment Roof Sections

1. Reassemble side panel vertical beams if any were previously removed at disassembly.

   Note: If the vertical side beams were cut off with a torch, they can be reinstalled using doubler plates and nuts and bolts to facilitate future disassembly and re-assembly. See Figure HGP-R.5.

2. Apply new gaskets or caulking seal to roof sections where needed.

3. Rig a turbine roof to lift it level. See Figure HGP-R.6.

4. Position over turbine compartment with crane and lower into place using the chainfalls.

5. Repeat steps 3 and 4 for the remaining roof section.

6. Apply anti-seize compound to bolts and install all bolts.

Operation 58 — How to Reassemble Inlet and Exhaust Duct Access Panels

1. Apply anti-seize compound to all bolting.

2. Attach gaskets to duct access panel flanges.

3. Lift access panels into place and bolt up.

Operation 59 — How to Reassemble Turbine Compartment Roof Components and Side Panels

Note: The turbine roof can contain different configurations of piping, electrical hardware and ventilation components.

CAUTION

Clean all flange openings and inspect for foreign objects.

1. Reassemble all piping previously removed.

2. Reassemble any tubing conduit and wiring previously removed.

3. Reassemble the forward and aft interface lagging joints.

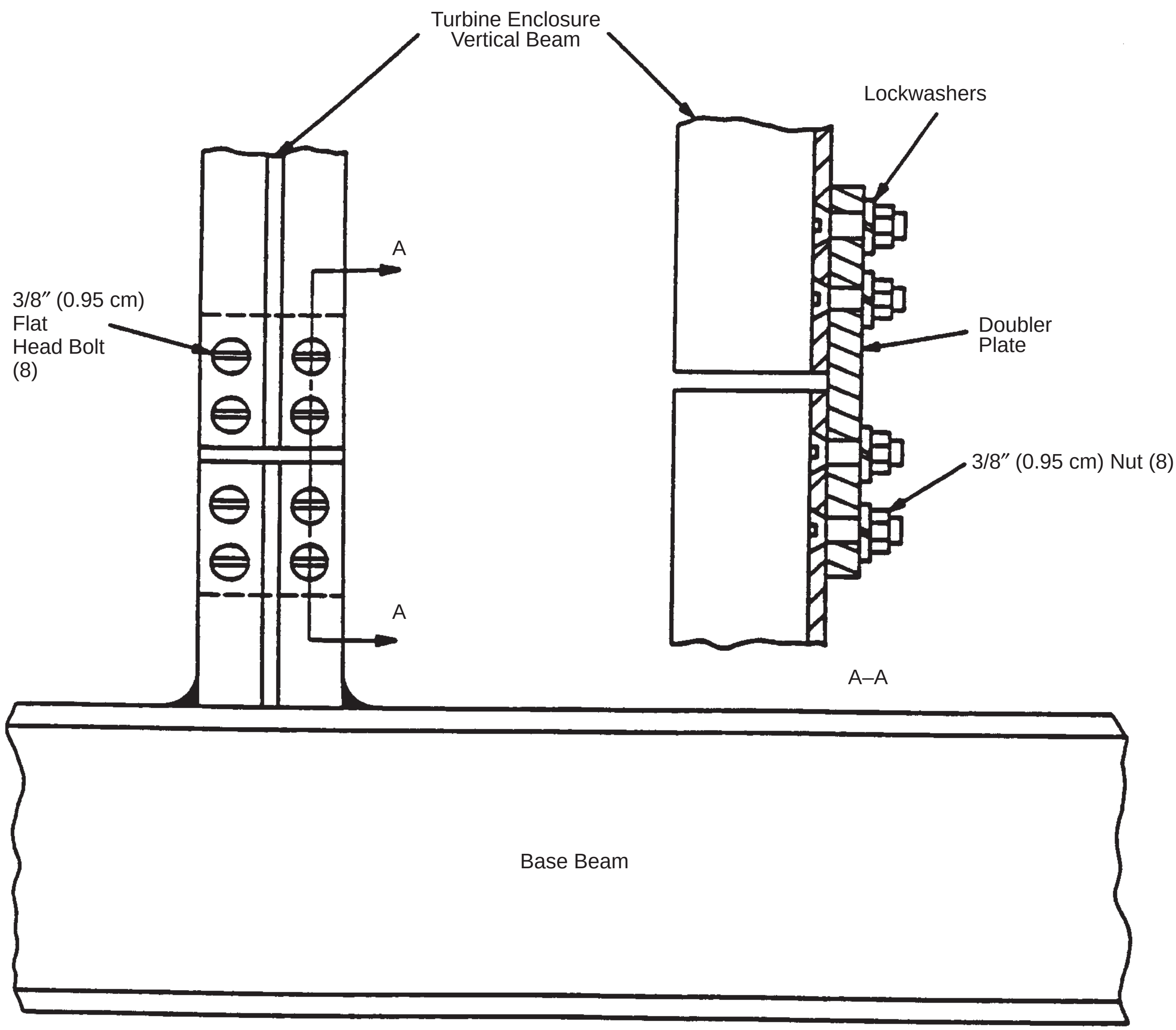


Figure HGP-R.5. Doubler Plates and Bolts Used During Re-assembly.

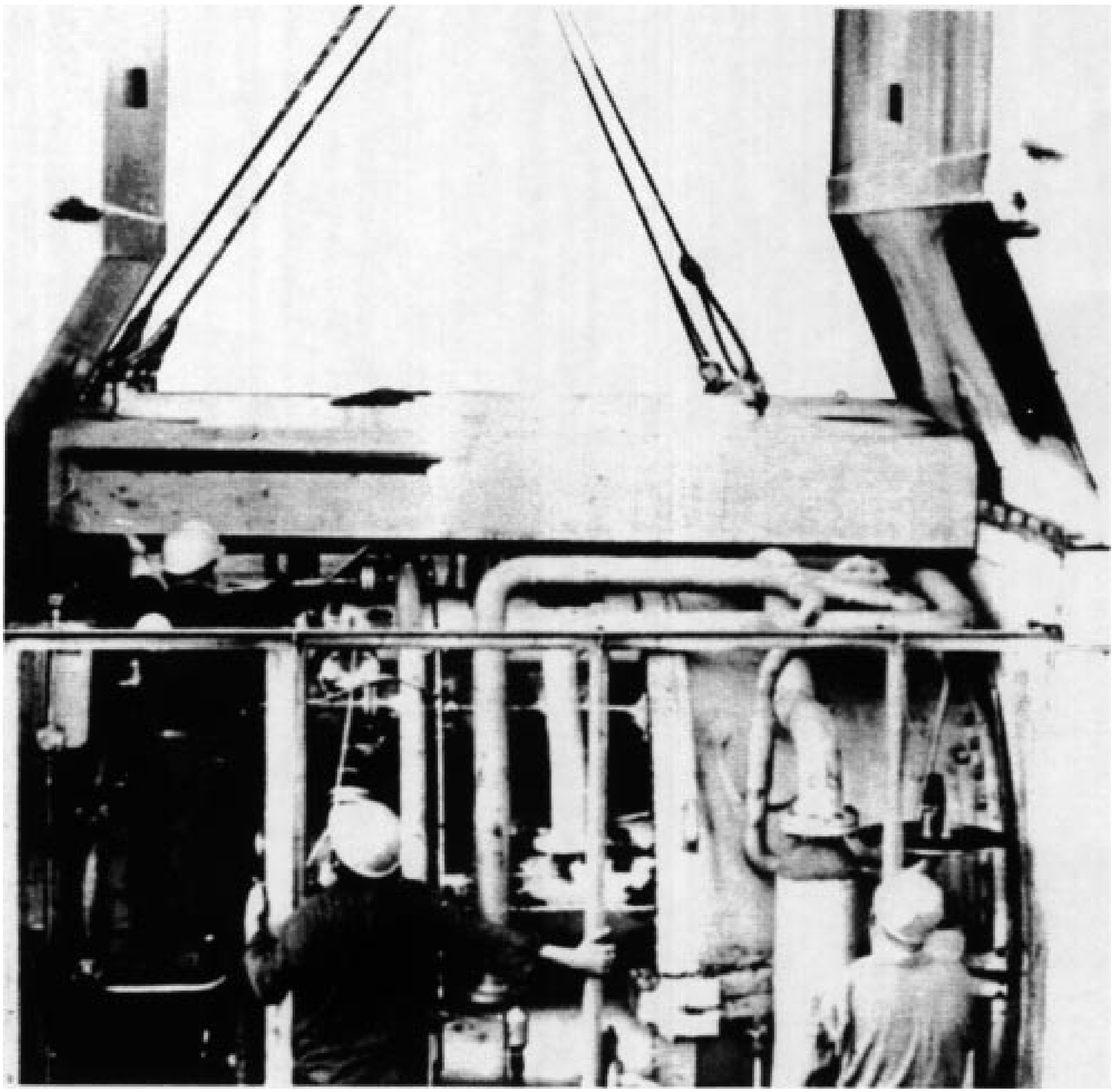


Figure HGP-R.6. Typical Turbine Roof Installation

4. Install all doors and side panels.
5. Apply anti-seize compound to bolts and install all bolts.

IV. Startup Checks (Hot Gas Path Inspection) for MS-7001FA+ and MS-7001FA+e Gas Only Equipped Machines (with DLN-1)

Operation 60 — Clean Up, Operate and Leak Check Unit

1. Clean up all fuel oil, lube oil and water spills.
2. Make a visual inspection of the unit, check to insure that the following has been completed:
   a. Check that all removed piping has been reinstalled.
   b. Check that all removed conduit has been reinstalled and electrical connections have been made.
   c. Confirm proper function of all devices.
   d. Correct any fuel, oil and water leaks observed.
   e. Inspect inlet and exhaust plenums for cleanliness and secure shut.
3. Reconnect power to all systems disabled at start of job.
4. Re–arm the fire protection system.

Note: It is recommended that the following checks be made under the guidance of your local GE Company Field Service Representative.

5. Perform pre-cranking checks as follows:
   a. Record all panel counter readings.
   b. Check operation of the cooldown/emergency lube oil pump.
   c. Make visual inspection to see if oil is flowing in bearing drains.
   d. Block out excitation and generator breaker equipment.
6. Place unit on turning gear.
   a. Observe for leaks, abnormal noises, or control deficiencies.
   b. Prime the fuel pump.
7. Crank the unit, and perform the following checks:
   a. Observe pickup rpm of speed sensors versus time.
   b. Inspect for casing air leaks.
   c. Observe and record vibration levels.

d. Observe and record maximum crank speed.

e. Check starting means for proper operation.

f. Listen for abnormal noises.

g. Check temperature of lube oil in bearing drains or at the bearing header and tank.

h. Observe all panel pressure gauge readings for abnormalities.

i. Trip unit using the emergency trip, and listen for abnormal noises from gas turbine and associated equipment during coastdown.

j. Observe proper drop-out rpm of speed sensors.

8. Initiate a start, and perform the following zero to full-speed-no-load checks:

a. Observe applicable firing check parameters.

b. Observe and record acceleration rates.

c. Record full set of vibration readings.

d. Observe and record temperature suppression set point.

e. Note and record pickup time of all appropriate electrical speed relays.

f. Adjust full-speed-no-load rpm to specifications.

g. Check digital set point.

h. Take a complete set of running data and record on Operating data form as shown in the Running Inspection section in this instruction.

i. Make governor checks.

j. Make overspeed checks per units control specifications in unit service manual.

9. After synchronizing the unit and closing the breaker, perform the following load checks (as applicable):

a. Take full set of load data per (1) and (2) below and record on Operating Data form as shown in Running Inspection section.

(1) Preselect load points.

(2) Base load.

b. Check for air, oil, gas and water leaks.

10. Observe normal unloading and shut-down as follows:

a. Note and record coastdown time.

b. Listen for abnormal noises from gas turbine, and associated equipment, during coastdown.

c. Observe unit vibration readings during coastdown.

11. Field Inspection forms.

a. Submit a complete set of all Field forms and operating data filled out during the hot gas path inspection, including Site Information to your General Electric Field Service Representative.

12. Perform DLN Tuning

Guidelines for MS7001FA DLN2.6 tuning can be found in the operation section of this manual. It is required that tuning be done following each inspection.

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MAJOR INSPECTION

Major Inspection

CAUTION

Before proceeding with a major inspection, ensure that the gas turbine electrical power is tagged out; fire protection system is deactivated, liquid fuel system is purged, deactivated and/or the gas supply is blanked off. See the Standard Practices section in this Service Manual.

CONTENTS

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I. Disassembly Procedures (Major Inspection) for MS-7001FA+ and MS-7001FA+e Gas Only Equipped Machines (with DLN-1)

Note: Obtain appropriate Inspection Forms from your local GE Field Service Representative.

Operation 1 — How to Perform Alignment Checks Before Starting Any Unit Disassembly

Note: It is suggested that assistance be obtained from your General Electric Company Field Service Representative when performing alignment checks.

1. Unbolt and remove the load compartment cover, side door and panels.
2. Unbolt and remove the two metal covers from the bottom of the load coupling guard.
3. Unbolt the turbine end section of the coupling guard from the bracket on the inlet casing and remove it.
4. Unbolt and remove the generator end section of the coupling guard.
5. Remove the starting means coupling guard by removing bolting from the guard and lifting off the section.

Remove the Starting Means Coupling (Figure MI-D.1)

1. The torque converter shaft is match marked at the factory. Do not metal stamp or prick punch this piece. Match mark the coupling hub to the torque converter shaft, both hubs to the coupling spacer shaft, and the coupling hub to the generator rotor.

CAUTION

> The two coupling hub bolted flanges that contain the disk packs have been assembled and torqued in the factory and must not be disassembled in the field.

2. The coupling spacer shaft should be suitably slung for support. The generator flange of the coupling spacer should be unbolted from the disk pack hub flange and jacked apart.
3. In the free state, there should be a pre-stretch gap of 0.200 inches (0.508 cm) between these flange faces. If the gap is significantly different than 0.200 + 0.040 inches (0.508 – 0.102 cm), contact your GE Field Service Representative.
4. Assemble the shipping screws to steady the two end disk pack hubs. See Figure MI-D.1.
5. Unbolt the coupling spacer shaft end near the torque converter, then take up on the shipping screws to gain room for spacer shaft removal.
6. Remove spacer shaft and store to prevent damage.

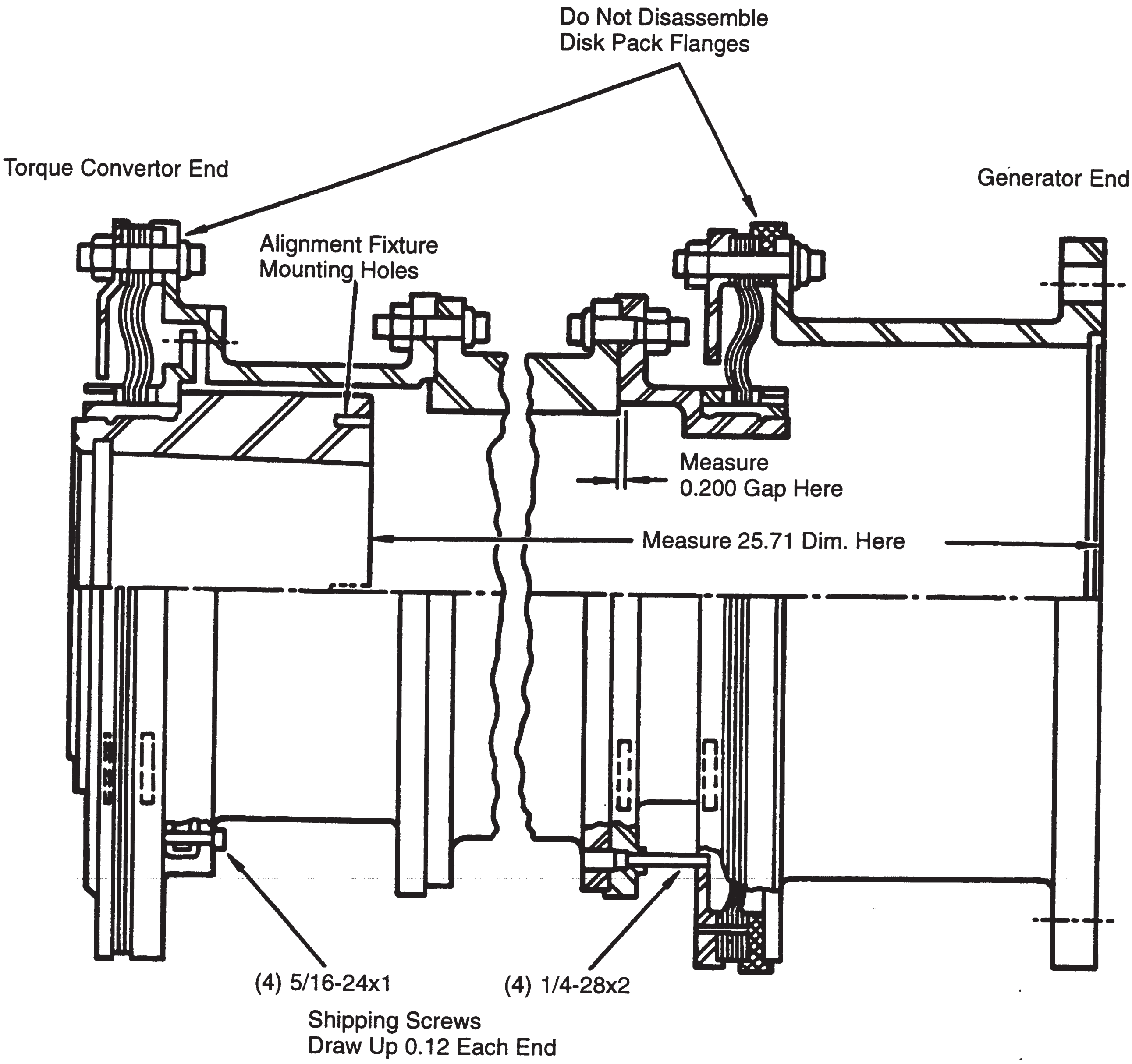


Figure MI–D.1 Starting Means Coupling

7. Unbolt and remove the disk pack hub from the generator collector end flange. Jack the flanges apart carefully to prevent damage to disk pack.

8. Check generator collector flange face distance to end of coupling hub sleeve on torque converter shaft. This distance should measure 25.71 + 0.020 inches (65.3 + 0.051 cm) cold and with the turbine-generator shafting aft against the turbine active thrust bearing. If the dimension is outside of tolerance, contact your GE Field Service Representative.

9. Leave the disk pack hub on the torque converter shaft. An alignment fixture will be bolted to the coupling hub inner sleeve.

10. Clean up hubs, spacer and bolting and protect from damage.

Check Torque Converter to Generator Alignment

Note: The method described utilizes an alignment fixture (supplied in the turbine tool kit), in place of the coupling shaft.

1. Using a felt tipped pen, mark two lines (one vertical, the other horizontal) across the face of the generator coupling. The lines should intersect at the center of the coupling face.

2. Tightly attach the alignment fixture to the disk pack hub inner sleeve that is mounted on the torque converter shaft.

3. Place dial indicators to read from the alignment fixture to the face of the generator coupling.

4. The indicators must be placed in such manner to permit face readings to be taken without being affected by end float (thrust) of the torque converter shaft when turning the shaft. This is accomplished by placing one indicator (designated “indicator A”) near the periphery of the generator coupling face and a second indicator (designated “indicator B”) at the center of the face.

5. Place dial indicators to read from the fixture to the rim of the generator coupling flange.

Note: The face and the rim readings may be taken either separately or together.

6. Rotate torque converter gear coupling with the alignment fixture and dial indicators attached until indicator “A” (at edge of face) is aligned on the top vertical face mark. Set all dial indicators to read zero.

7. Rotate the torque converter coupling (and alignment fixture) through one full revolution (360°) taking readings at each face mark (90°). Record the dial indicator readings. Indicator “B” (at the center of the shaft) will indicate any thrust (axial movement) of the gear shaft during rotation. Indicator “B” readings should be subtracted from the indicator “A” readings. For example:

Indicator A reading	–10		–10
Indicator B reading	+ 2		– 2
Corrected A reading	–12	or	–8

8. Take rim readings in the same manner, except that no corrections are necessary for axial movement of the shaft. Record all readings on appropriate Inspection Form.

9. The indicators should return to zero (corrected reading of zero for the face indicators) when returning to the top vertical mark. If they do not, check tightness of the set-up and repeat the readings. (See Field Alignment Instructions in the Service Manual.)

Check Turbine - Generator Alignment

Note: **As a result of maintenance preference, no turning fixture will be supplied. It is expected that any rotor turning will be done using comealongs and pins fitted to coupling flange bolt holes and with lube oil supplied to the bearings.**

Indicate both face and rim readings on the stationary generator rotor.

1. Check alignment of the turbine-generator at the generator end of the load coupling. This allows an alignment procedure which is identical to that employed during installation. The generator end of the coupling must be unbolted and jacked apart.

CAUTION

> All upper-half casings must be installed and the turbine supported on its own support mounts prior to checking alignment.

2. Position a dial indicator for a vertical reading on the OD of the load coupling every 45 degrees. Rotate turbine rotor and record coupling runout on appropriate Inspection Form. For runout tolerances, refer to Field Alignment Instruction in the Service Manual.

CAUTION

> The generator field does not have a thrust bearing; therefore, there will be a tendency for the rotor to “walk” axially.

3. Inaccurate face readings can be avoided by making a temporary HP steam turbine thrust bearing out of hard wood blocking and bolting it to the forward generator bearing housing. When the temporary thrust is used, position the rotor away from the end of its float positions.

4. If a temporary thrust is not used, the “walking” can be compensated for by using two dial indicators. One indicator will be mounted on the rotating flange and will measure the actual face runout. The other indicator will mount to the stationary flange and it will see mechanical face runout plus axial movement, if any. Both indicators must be read simultaneously.

5. Record coupling alignment readings on appropriate Inspection Form. (See Field Alignment Instructions in the Service Manual.)

<u>Operation 2</u> — How to Remove Turbine Instrumentation

1. Tag twelve thermocouples that are in the upper and lower halves of the turbine casing and two thermocouples in the discharge casing. Use the same code as stamped on the casings in order to replace them in the same location at re-assembly.

2. Disconnect the thermocouples from the compression fittings on the casings and remove from tube clips that hold down the thermocouples in the turbine compartment. See Figure MI-D.2.

3. Pull the thermocouples carefully through the hole in the base “I” beam ad coil them up and secure them to the “I” beam web near the junction boxes JB #18A and JB #18B, where they will be protected from damage.

4. It is also necessary to remove the eight compression fittings and associated outer guide tubes from the turbine casing so that they are not damaged in subsequent second- and third-stage nozzle segment removal. Tag these fittings for location for later re-assembly.

5. Tag and remove two thermocouples and one RTD from the forward wall of the inlet plenum.

6. Tag and remove proximity probes from the #1 bearing coded:

   77RP
   96VC-1 & -2p
   39VS-11 & -12

   Plug all holes in bearings to prevent oil spills if pumps are turned on.

7. Match mark and remove the magnetic pickup arrangements from the inlet casing by unbolting the brackets holding junction boxes “JB58” and “JB58A”. See Figure MI-D.3.

8. Coil all wiring and store to prevent damage.

<u>Operation 3</u> — Begin Unit Disassembly with Procedures Described in the Hot Gas Path Inspection Disassembly Operations 1 through 3

1. Prepare turbine compartment roof sections for removal .

2. Remove turbine compartment roof sections.

3. Remove exhaust and inlet duct access panels.

Note: The secondary manifold is located just aft of the compressor discharge casing and is the most forward of the two water injection manifolds.

The water injection purge valve is attached to the left side of the liquid fuel purge module.

<u>Operation 4</u> — How to Remove the Air Purge Supply Line to the Purge Module

Note: The air supply line is an inch-and-one-half diameter pipe that runs parallel to the primary gas manifold on the right-hand side of the turbine.

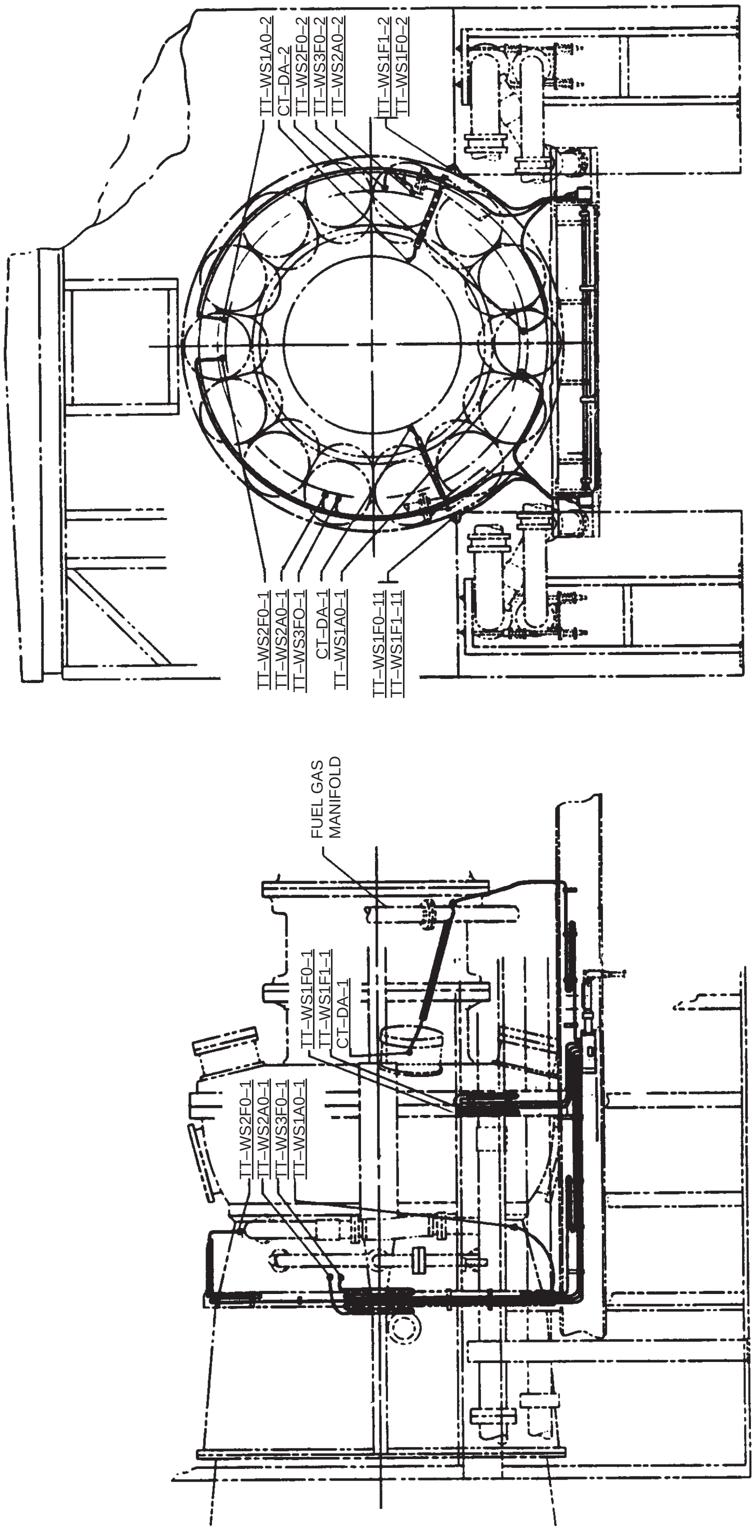


Figure MI-D.2. Thermocouple Arrangement.

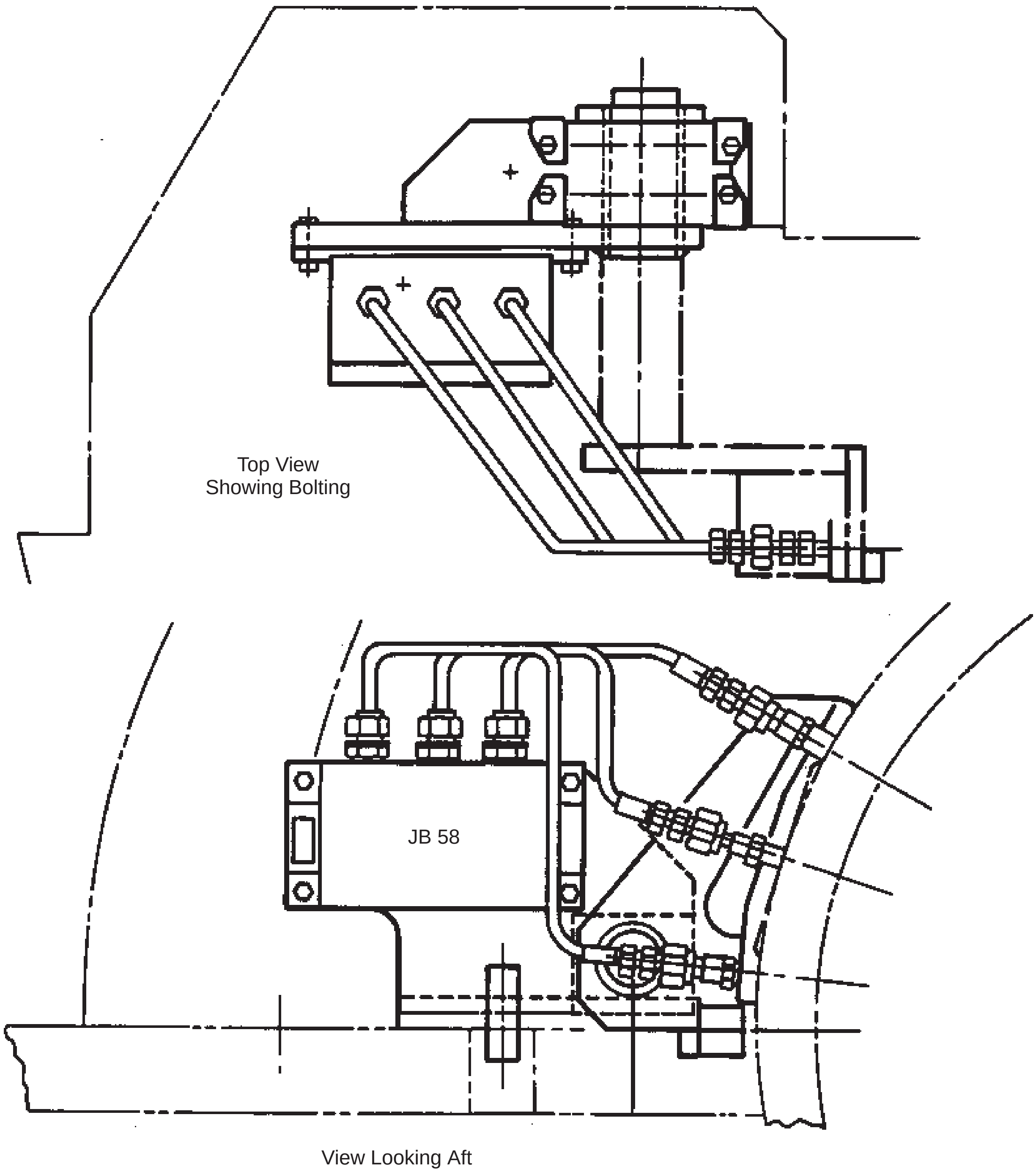


Figure MI-D.3. Typical Magnetic Pickup Arrangement at No. 1 Bearing (Two Places).

1. Disconnect the supply line at two locations — at the tube connector, which is located between the purge module and the flex hose; and at the pipe flange at the horizontal centerline of the unit.

<u>Operation 5</u> — Carry Out Disassembly Operations 1 and 2 of the Combustion Inspection

1. Remove the flame detectors.
2. Remove the spark plugs.

<u>Operation 6</u> — How to Remove the Gas Fuel Flex Hoses and Manifolds

1. Remove the gas fuel flex hoses per Combustion Inspection Disassembly Operation 3.
2. Remove the upper half of the secondary gas manifold. Do so by unbolting the two flanges (left and right) near the horizontal centerline of the unit. This will allow removal of the two upper sections of the manifold as one piece.
3. Remove the upper half of the primary manifold as in Step 2 above.
4. Remove the upper half of the transfer manifold as in Step 2 above.

<u>Operation 7</u> — How to Remove the Cooling and Sealing Air Pipe

1. Remove the piece of pipe (on the left and right) going to the upper half of the compressor aft casing. This is the pipe that comes off the tee after the isolation valve. Do the right side first. Support the pipe with an overhead crane, unbolt the two flanges and remove the pipe. Do the same for the other side.
2. The cooling and sealing air is also connected to the upper half of the turbine case at two locations. The upstream or forward connection consists of a flex hose and the pipe connected to the turbine case. Do the right side first. Remove these two as one piece by supporting the pipe and flex hose with an overhead crane and unbolting the flange attached to the turbine case and the flange at the bottom of the flex hose with three flanges. Two of the flanges connect to the turbine case and the third is connected to a 90-degree elbow. Remove the flex hose and elbow as one piece.
3. Perform Step 2 above for the left side.

<u>Operation 8</u> — Perform Combustion Inspection Dis-assembly Operations indicated below

4. Remove the fuel nozzle/end cover assemblies..
5. Remove the cap assembly from the cover and casing assembly.
6. Remove combustion liners and crossfire tubes.
7. Remove flow sleeves.
8. Remove outer crossfire tubes.
9. Remove outer combustion casings.

<u>Operation 9</u> — Take Opening Compressor and Turbine Rotor Position Checks in accordance with Hot Gas Path Dis-assembly Operation 13

<u>Operation 10</u> — How to Remove Upper-Half Piping

1. Unbolt and remove all upper-half casing piping connections at the turbine casings and at the first flange away from the casings.

2. Remove the upper-half water wash manifold from the inlet casing.

3. Remove two 5th-stage extraction connections and two 13th-stage extraction connections from the aft compressor casing.

4. Remove six 13th-stage cooling and sealing air connections from the turbine casing.

5. Remove six flex pigtails from the exhaust frame and remove two quarters of the cooling air manifold.

6. Disconnect and remove the upper-half fire protection piping from the turbine compartment and the load compartment.

7. Clean up all flanges and bolting. Discard old gaskets.

8. Use plywood or composition covers taped or bolted over all pipe openings to prevent entry of debris.

<u>Operation 11</u> — How to Remove Inlet Plenum Upper Half

Note: Due to variations in design of inlet duct work, consult the Renewal Parts Volume of this Service Manual for bolting details.

1. Support the adjacent parts of ductwork to prevent damage to the expansion joints when the plenum upper half is released from the assembly.

2. Unbolt and remove the rubber expansion joint and batten strips at the forward and aft walls of the inlet plenum. Remove top and bottom halves. See Figure MI-D.4.

3. Unbolt the inlet duct from the inlet plenum upper half.

4. Release the lagging supports from the plenum upper half.

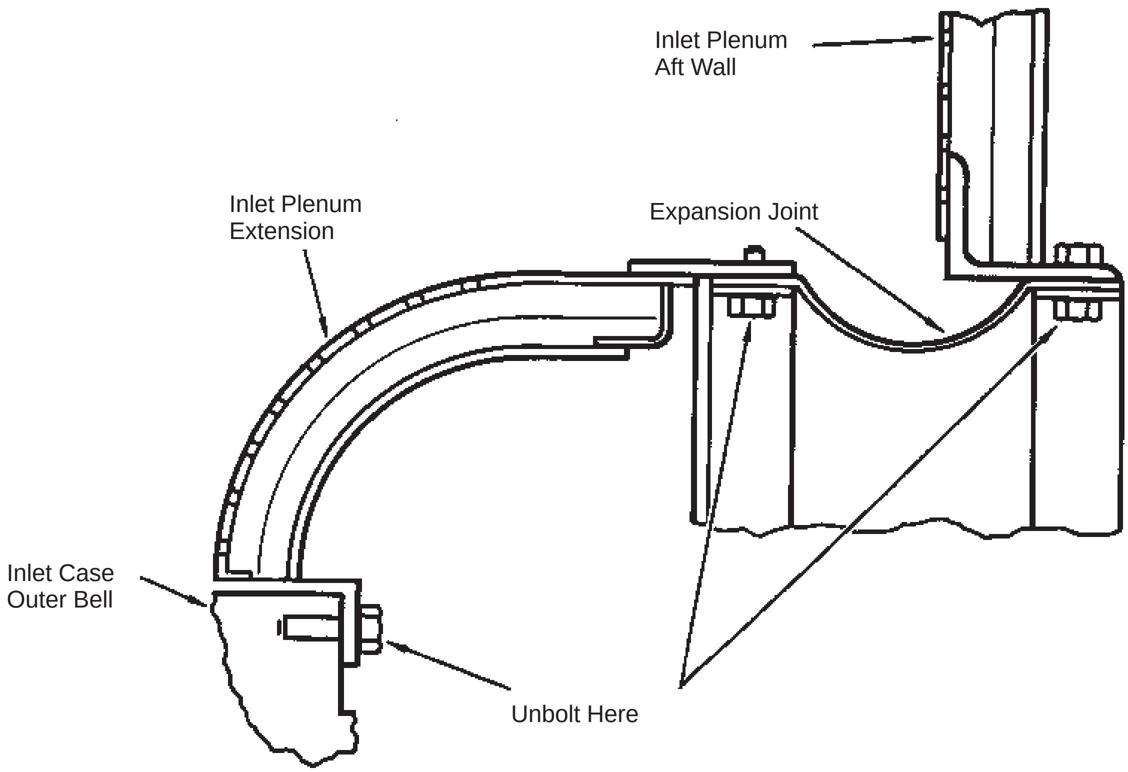
5. Unbolt the horizontal joint all around the inlet plenum.

Note: The plenum upper half may be lifted as two quarters by unbolting the top vertical joints.

6. Lift the plenum after making sure that it is mechanically free and set it on blocking.

7. Unbolt and remove both upper and lower halves of the inlet plenum extension and the inlet plenum cone. This is necessary for access to jacking locations.

8. Unbolt and remove four foundation access plates from the floor of the plenum.



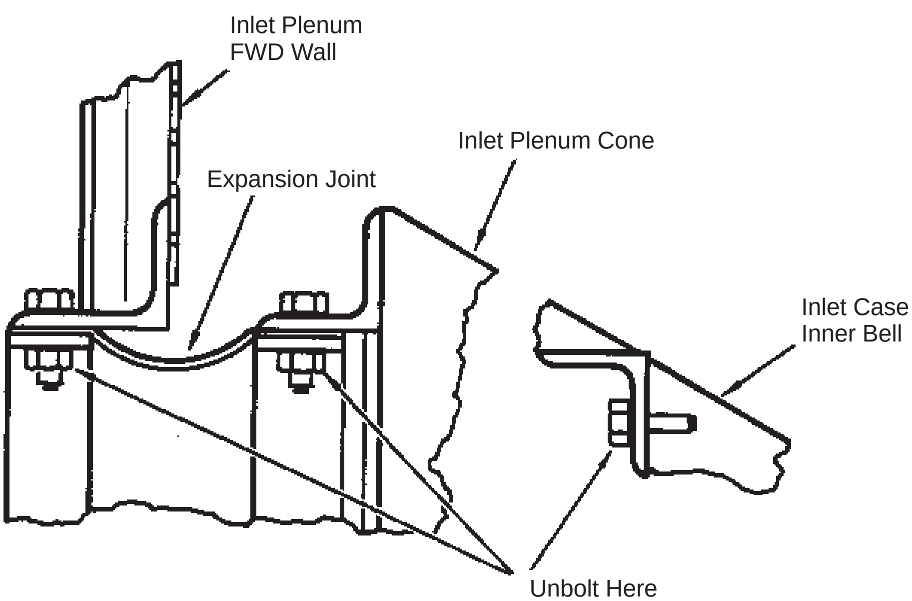


Figure MI-D.4. Inlet Expansion Joints.

Operation 12 — How to Remove Turbine Compartment Aft Wall

1. Disconnect and remove a section of compartment vent ductwork.

2. Unbolt and remove batten strips that hold the fiber glass gasket on the aft vertical flange of the exhaust frame. Remove the gasket down to the horizontal joint on both sides.

3. Rig to lift the middle panel of the compartment aft wall.

4. Unbolt the middle panel from the side panels. Remove and store this panel.

Operation 13 — How to Place Mechanical Support Jacks Under Unit Casings and Inlet Bellmouth

Note: The inlet plenum floor has four removable covers which provide access to set up the mechanical support jacks on the turbine foundation. Other locations are already accessible.

Before removal of any top casings, screw jacks must be placed at all vertical flanges as shown in Figure MI-D.5. Jacks should be located on the machine center line and be perpendicular to the foundation.

Provision has been made for using 2.5-inch (6.35-cm) ball top jacks at each jacking location.

Dial indicators are required at each jacking location and are to be mounted separately from the jacks.

1. Remove the inlet plenum floorplate covers provided beneath the vertical flange joints to gain access to the concrete foundation. Set suitable steel cribbing in place.

2. Install support jacks at the bottom centerline of each vertical casing flange. Snug the jacks up finger tight. Set up dial indicator to read upward casing deflection and set indicator to zero.

3. Jack the outer inlet bell flange (Position 1) to 0.009 + 0.001 inch. Record all dial indicator readings at all jacking locations. Recheck all jacks for snugness.

Note: If upon reaching a flange to be jacked the dial indicator reading already exceeds the value to be jacked to, then only snug the jack to the flange and record all dial indicator readings.

4. Jack the turbine case to exhaust frame flange (Position 2) to 0.006 + 0.001 inch. Record all dial indicator readings. Recheck all jacks for snugness.

5. Jack the compressor discharge to turbine casing flange (Position 3) to 0.004 + 0.001 inch. Record all dial indicator readings. Recheck all jacks for snugness.

6. Jack the inner inlet bell flange (Position 4) to 0.009 + 0.001 inch. Record all dial indicator readings. Recheck all jacks for snugness.

7. Jack the exhaust frame aft flange (Position 5) to 0.007 + 0.001 inch. Record all dial indicator readings. Recheck all jacks for snugness.

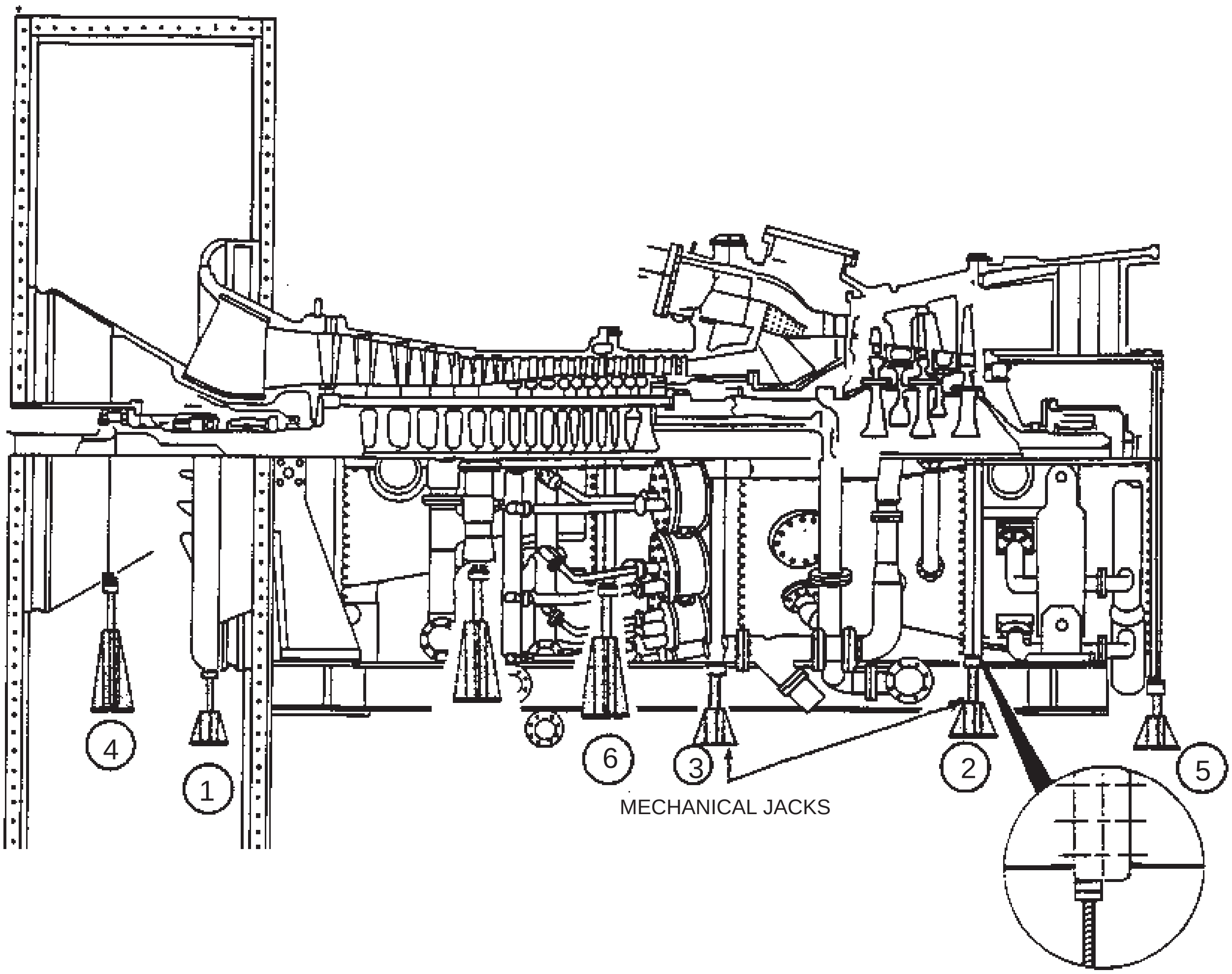


Figure MI-D.5. Turbine Support Jack Locations.

8. Jack the aft compressor case to compressor discharge flange (Position 6) to 0.004 + 0.001 inch. Record all dial indicators. Recheck all jacks for snugness.

9. Jack the forward compressor case to aft compressor case flange (Position 7 if applicable) to 0.004 + 0.001 inch. Record all dial indicators. Recheck all jacks for snugness.

CAUTION

Do not, under any circumstances, remove the mechanical support jacks until all upper-half casings have been reinstalled and bolted up.

Note: To prevent out-of-roundness from occurring, all casings should not be unbolted much prior to removal. This is very tempting to do when running more than one shift operation with only one shift crane coverage.

It is permissible to remove every other bolt on the horizontal joint and every other bolt in the vertical joint except for the top six. Casings should not be replaced without being bolted. Again, every other bolt on the horizontal and vertical joint with six on top is permissible.

Casings should be removed in the following sequence: exhaust frame, turbine case, inlet case, forward and aft compressor cases, and compressor discharge. Reinstallation is in the reverse order, i.e., compressor discharge case, aft compressor case, etc.

<u>Operation 14</u> — How to Prepare for Removal of Exhaust Frame (See Figure MI-D.6)

1. Enter the exhaust diffuser area through the access manway in the outer duct.

2. To improve access to the inner exhaust frame bolting, rig to remove the dished end cover on the aft end of the inner barrel of the diffuser. Unbolt and remove this cover.

3. Lay down a plywood walkway over the inner diffuser barrel. Ribs or spacers should be used under the plywood near the Number 2 bearing drain to prevent damage to instrumentation in that area.

4. Install 1–1/2″ (3.81 cm) angle iron braces just aft of the aft vertical joint of the exhaust frame. These braces should be tack welded in a radial orientation at the top centerline and at each horizontal centerline between the inner and outer diffuser sidewalls. This will help keep the diffuser vertical joint bolt holes lined up.

<u>Operation 15</u> — How to Remove Upper-Half Exhaust Frame and Air Cone (See Figure MI-D.6)

Note: For weight and rigging information, refer to weights and center of gravity drawing in the Reference Drawings section of this service manual.

1. Unbolt and remove outer barrel clamp ring from upper half of exhaust frame aft vertical flange.

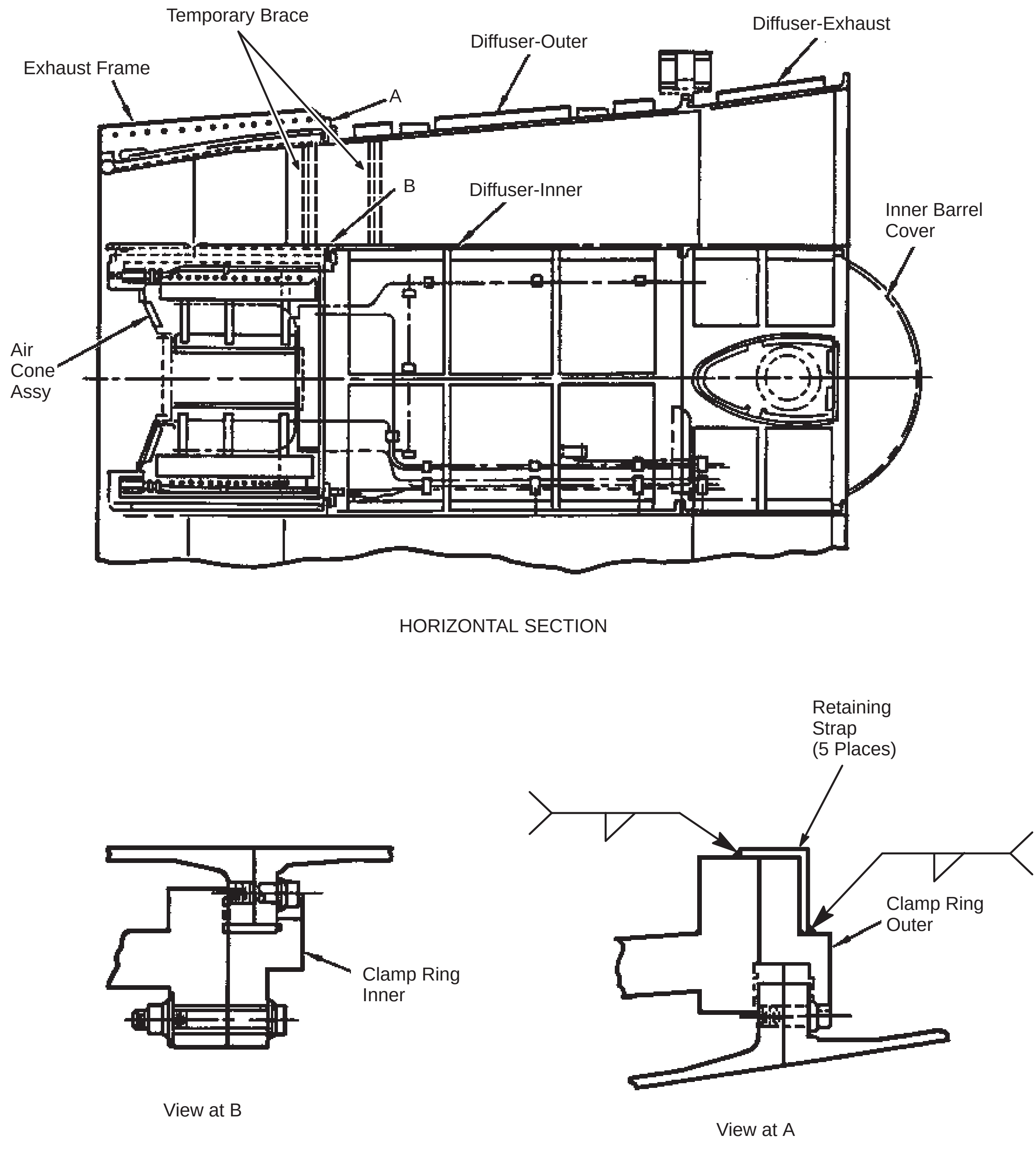


Figure MI-D.6. Exhaust Frame Assembly.

2. Unbolt and remove inner barrel clamp ring from upper half of exhaust frame aft inner vertical flange.

3. Unbolt the inner and outer diffuser vertical flanges at the aft end of the exhaust frame.

Note: Air-arc equipment may be needed for removing some bolts.

4. Remove the upper-half vertical bolting between turbine case and exhaust frame.

5. Remove outer horizontal joint bolting left and right sides and install guide pins.

6. Remove the inner barrel horizontal joint bolts left and right sides.

7. Jack up the exhaust frame upper-half using the jack bolt holes provided.

8. Slowly lift the exhaust frame vertically until the fit between the frame and air cone flange separates. Lifting lugs are provided on the outer barrel.

9. Remove the exhaust frame assembly using a straight vertical lift.

10. Remove the horizontal joint bolting of the air cone.

11. Slide the upper-half cone forward until it clears bearing housing No. 2.

12. Lift the exhaust air cone assembly clear of the unit.

Operation 16 — Perform Disassembly Procedures Described in the Hot Gas Path Operations 17 through 22

17. Remove turbine casing bolts and first-stage nozzle top key and clamps.

18. Remove upper-half turbine casing.

19. Remove transition pieces. (Combustion Inspection Dis-assembly Operation 10.)

20. Take first-stage nozzle radial concentricity checks.

21. Remove upper-half first-stage nozzle.

22. Remove upper-half first-stage nozzle support ring.

Operation 17 — How to Remove Upper-Half Inlet Casing

1. Remove the horizontal joint bolts in the upper-half casing.

Note: There are twelve point bolts in the air passage of this casing which must be removed. See Figure MI-D.7.

2. Remove the horizontal flange body-bound bolts located on the inlet casing bellmouth and install guide pins.

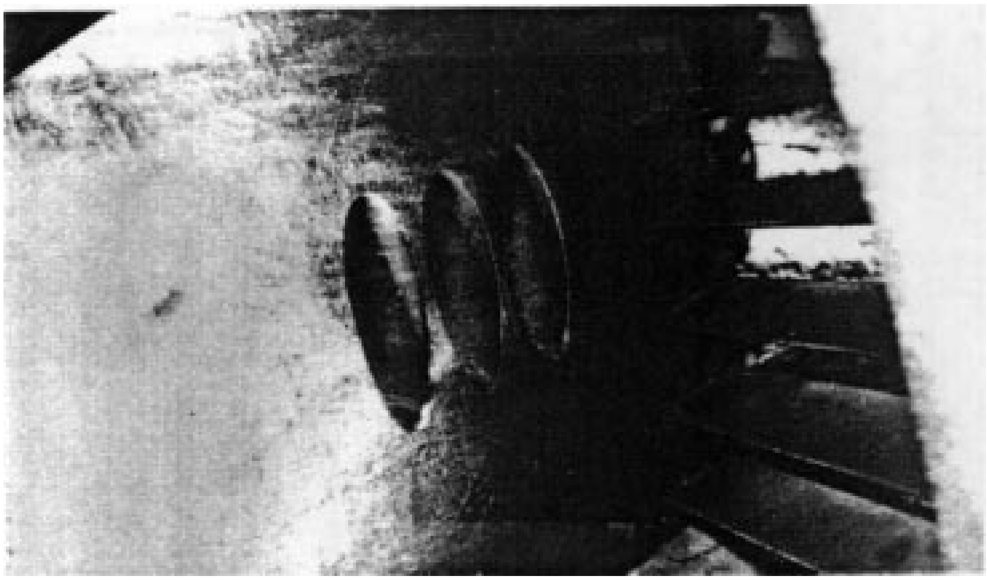


Figure MI-D.7. Bolts in Inlet Casing.

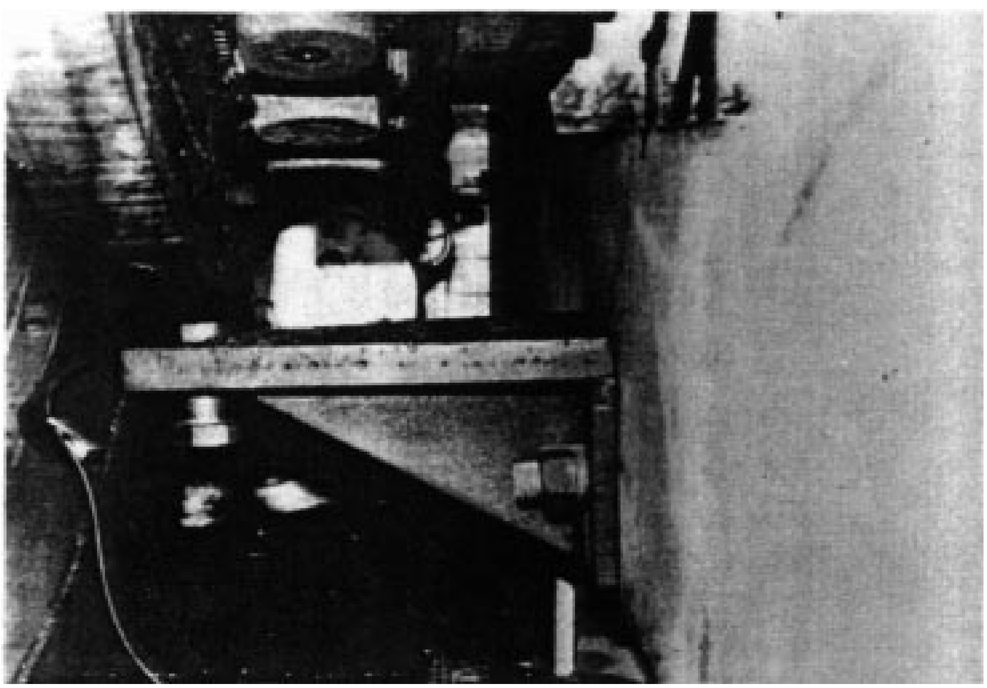


Figure MI-D.8. Mechanical Support for Lower-Half IGV Actuator Ring.

3. Before unbolting the IGV ring rack, install the support angle (See Figure MI-D.8) so the lower-half IGV ring doesn't drop.

4. For weight and rigging information, refer to Weights and Center of Gravity drawing in the Reference Drawings section of the unit service manual.

5. Rig lifting cables and chainfalls to lift inlet casing straight up.

6. Use chainfall to initially lift the inlet casing. Place casing in the vertical position.

7. Roll lower-half rub ring around the shaft and remove.

Note: The upper-half rub ring is lifted as part of the upper-half inlet casing.

Operation 18 — How to Remove Mid Compressor Casing (See Figure MI-D.9.)

1. Disconnect the wiring to vibration detectors 39V-2 and remove the detectors if this was not done previously.

2. Remove the upper-half bolting between the mid compressor casing and the compressor discharge casing vertical flanges.

3. Remove the horizontal flange bolting.

4. Remove the horizontal flange body-bound bolts and install guide pins.

Note: When removing the horizontal joint body bound bolts, they must be driven upwards.

5. Utilizing the jack bolts provided, separate the casing at the horizontal joint; rig and lift the casings clear.

Operation 19 — How to Remove Compressor Discharge Casing (See Figure MI-D.10)

1. Remove the outer crossfire tubes at the horizontal joint of the discharge casing.

2. Remove the vertical flange bolting between the upper halves of the compressor discharge casing and inner compressor discharge casing.

3. Remove all horizontal joint bolting and the body-bound bolting.

4. Insert guide pins into the body-bound bolt holes.

5. Jack the casings apart utilizing the jacking bolt holes provided.

6. Lift compressor discharge casing clear.

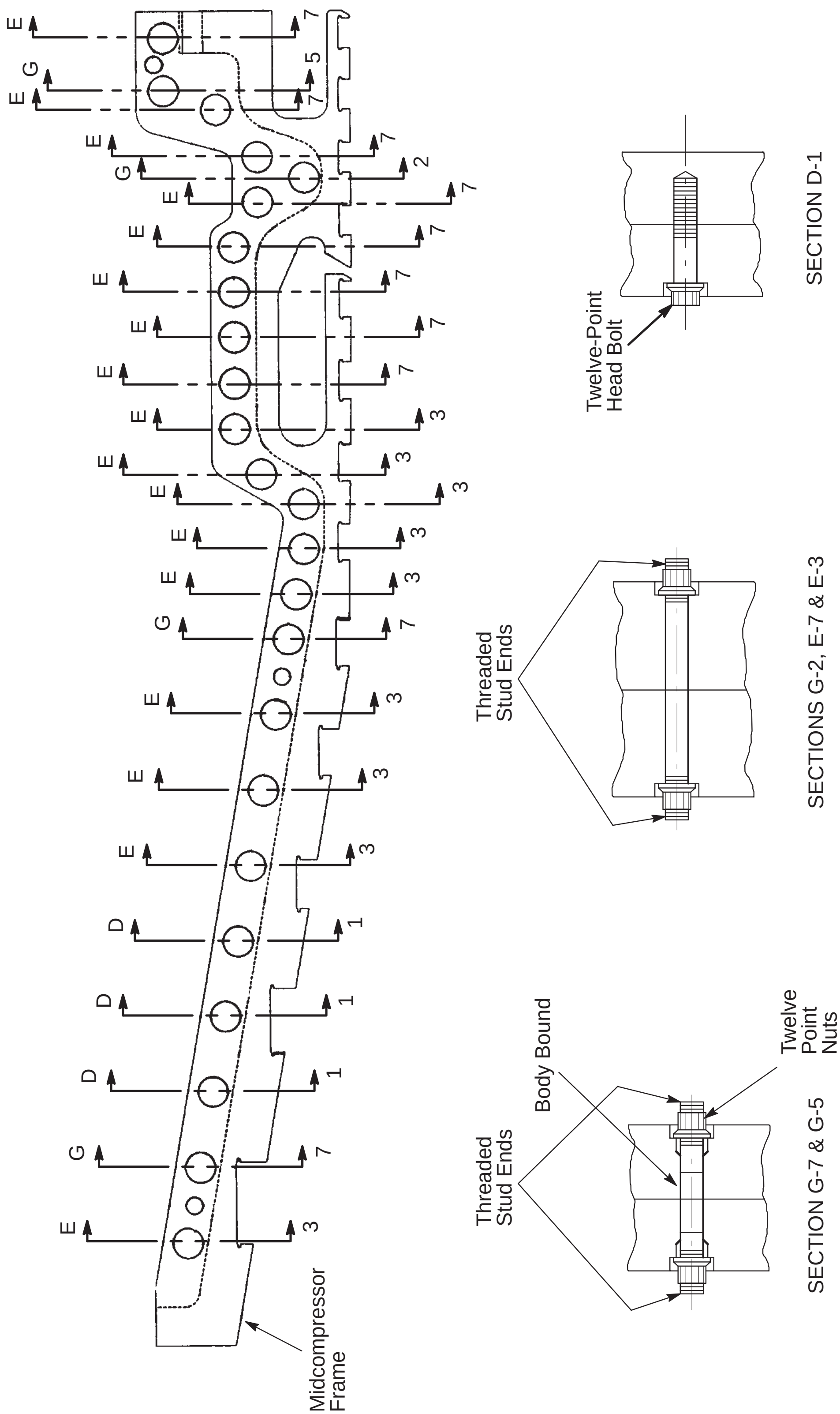


Figure MI-D.9. Midcompressor Case Assembly

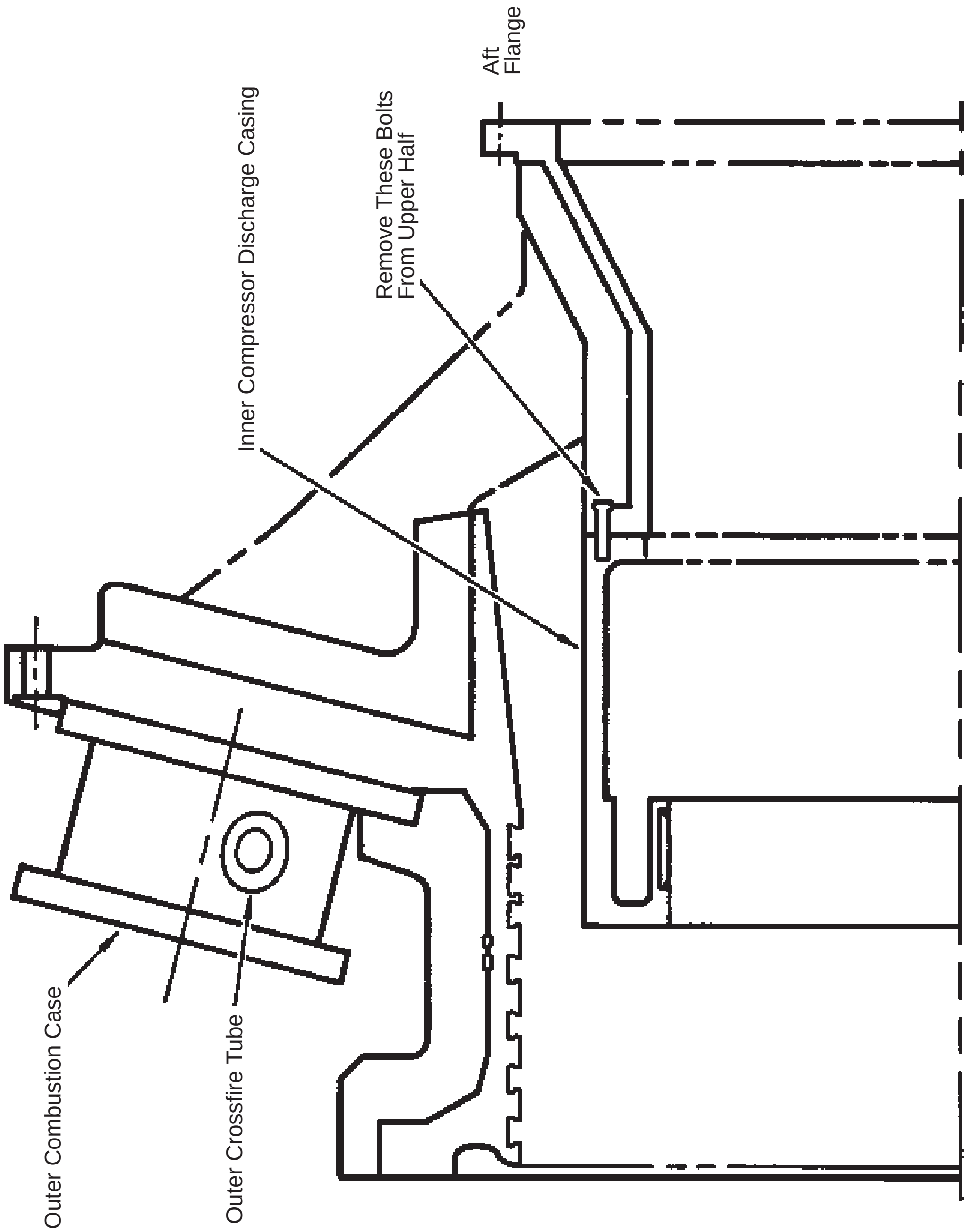


Figure MI-D.10. Compressor Discharge Casing Assembly.

Operation 20 — How to Remove Upper-Half Inner Compressor Discharge Casing (Figure MI-D.10)

1. Unbolt the recessed horizontal joint bolts in the inner compressor discharge casing. Install the lifting eyes and lift the top half clear. Use care when starting to lift because there are no jack bolts to separate the joint.

Operation 21 — How to Measure Rotor Thrust and Compressor Clearances

1. To take rotor thrust clearances, mount an indicator on the No. 1 bearing housing and read the axial movement of the turbine rotor.

Note: To prevent erroneous readings, do not use any stationary reference point other than the No. 1 bearing housing.

2. Move the rotor axially with a small hydraulic ram and blocking between the inlet casing and the compressor rotor toward the inlet end of the turbine until the rotor “bumps” against the unloaded thrust face. Set the dial indicator to zero.

3. Move the rotor axially toward the exhaust end using a small ram and blocking between the generator coupling and the aft generator bearing housing. The rotor should be firmly against the loaded thrust face but not loaded so as to deflect the bearing or casings when the indicator is read.

4. Read the amount of rotor movement as shown on the dial indicator.

5. The range of axial movement of the rotor without distorting the rotor or bearing mounts is usually between 0.025 and 0.030 inches (0.0635 and 0.0762 centimeters). Repeat the rotor thrust check at least three consecutive times to assure repeatability.

Note: Do not use heavy oil on the thrust bearing.

6. Record thrust movement on appropriate Inspection Form. Take compressor clearance readings and record them on appropriate Inspection Form.

Note: All axial compressor clearances are to be measured with the rotor in contact with the aft or “normally loaded” face of the thrust bearing.

7. Measure and record stator blade tip clearances for all 17 compressor stages (S0 to S17).

8. Measure and record compressor rotor blade tip clearances for all 17 compressor stages (R0 to R17).

9. Measure the record exit guide vane stator blade clearances (EGV1 and EGV2).

10. Measure and record the compressor rotor leakoff clearances as well as the radial and axial high pressure air seal clearances (RA, XA, XB, XC and XD).

11. Measure and record the inlet guide vane and rub ring clearances (X, X1 and X2). Clearances are referenced on appropriate Inspection Form.

Note: If dirt has been left on compressor blade tips after running cleaning prior to shutdown, it may be necessary to hand clean the blade tips, per

the Standard Practices section, Cleaning Turbine and Compressor, before making clearance checks or proceeding with any visual inspection.

12. Make visual check for compressor blade tip rubs, visible cracks, corrosion, erosion and foreign object damage.

13. Report the conditions observed on appropriate Inspection Form.

<u>Operation 22</u> — Perform Hot Gas Path Inspection, Operations 24 through 30

24. Take turbine clearance checks.

25. Remove lower-half first-stage nozzle key and nozzle clamps.

26. Remove lower-half first-stage nozzle.

27. Remove lower-half second- and third-stage nozzle radial retaining pins.

28. Remove lower-half second- and third-stage nozzle segments.

29. Remove upper-half second- and third-stage nozzle radial retaining pins.

30. Remove upper-half second- and third-stage nozzle segments.

<u>Operation 23</u> —How to Remove First-, Second- and Third-Stage Turbine Buckets

Note: Turbine bucket removal and re-assembly should be done by qualified General Electric Company personnel.

CAUTION

If the second- and third-stage lower-half turbine shrouds were not removed during the disassembly of the second- and third-stage lower-half nozzle segments from the turbine casing, they must be removed prior to starting any turbine bucket disassembly from the turbine rotor. Refer to Hot Gas Path, Operation 28, in this maintenance instruction.

<u>Operation 24</u> — How to Remove Upper-Half Bearing Housings 1 and 2

CAUTION

Any instrumentation on the upper half of the bearing housings must be removed and properly protected from damage prior to unbolting and removing the bearing housing.

Note: Upper half of No. 1 bearing housing weighs 2000 lbs. (907 kg), No. 2 weighs 1,800 lbs. (816 kg).

Bearing No. 1 Housing. See Figure MI-D.11

1. Loosen and remove horizontal joint bolts. Dowels are staked in bearing housing cap. Do not remove, they are used as guide pins.

2. Use jack bolts to separate the housing upper and lower halves.

CAUTION

Ensure that the thrust bearing metal temperature thermocouples are removed, cut and destroyed prior to rolling out the thrust bearing.

3. Remove the loaded thrust bearing from No. 1 housing by carefully sliding out the top four pads, rotating the cage to the split line, and lifting off the top of the cage. The lower pads can be removed one at a time as the lower cage is rolled out. See Figure MI-D.12.

Bearing No. 2 Housing. See Figure MI-D.13

1. Unbolt and remove aft cover plate and gasket.

Note: With the exhaust frame upper half removed, it is not necessary to unbolt the vertical joint of the No. 2 bearing cap.

2. Unlock and unbolt horizontal joint bolts.

3. Dowels are staked in bearing housing cap. Do not remove.

4. Use jack bolts to separate the housing.

5. Rig a chainfall and lift housing clear.

6. Unlock and unbolt liner strap.

Operation 25 — Accessory Systems

1. Maintenance can now be performed on unit auxiliaries while inspection and cleaning of turbine parts continues. For the list of systems to be checked, see the Auxiliary and Control System Maintenance section in this instruction.

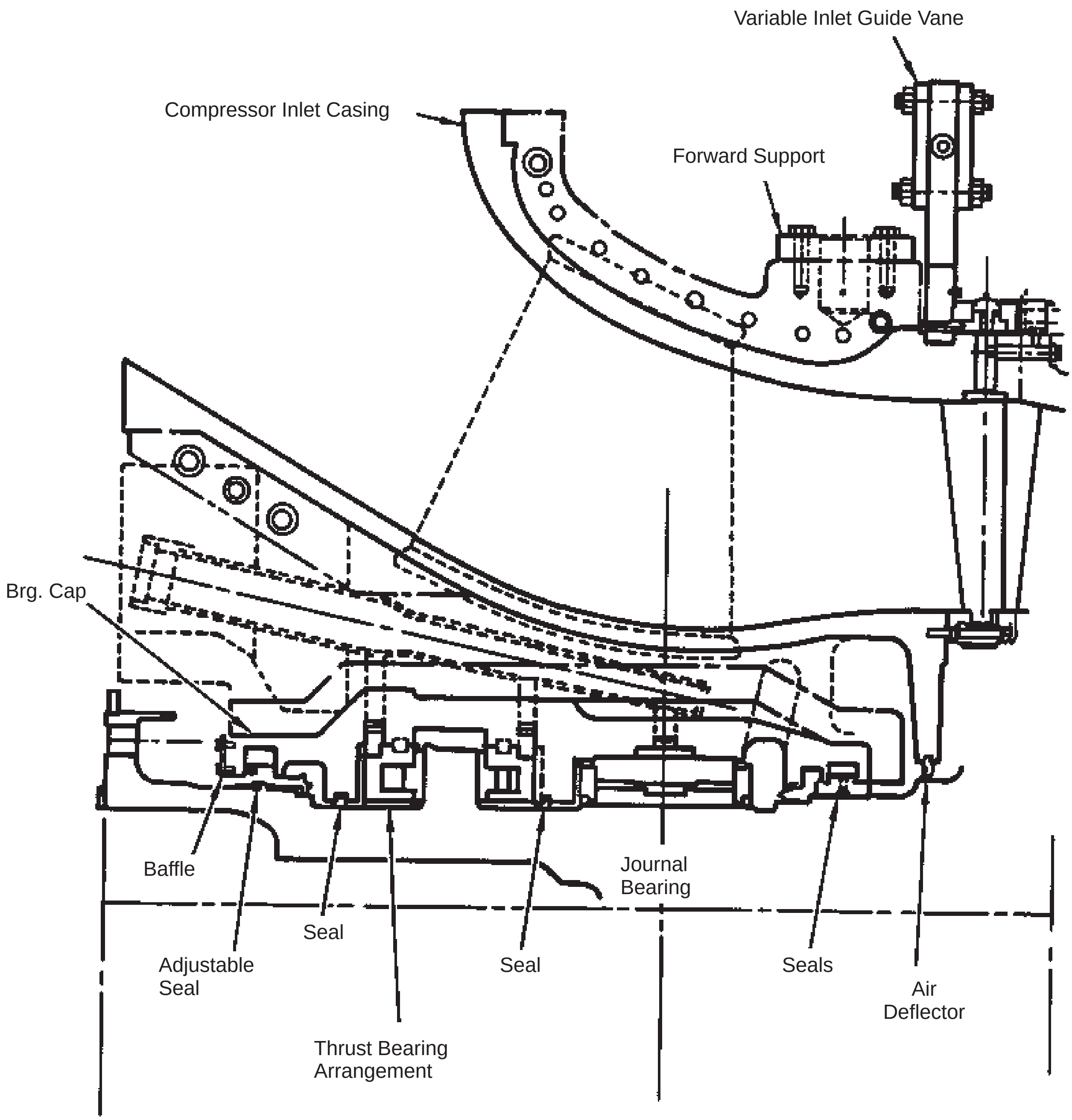


Figure MI-D.11. Compressor Inlet Casing and No. 1 Bearing Housing

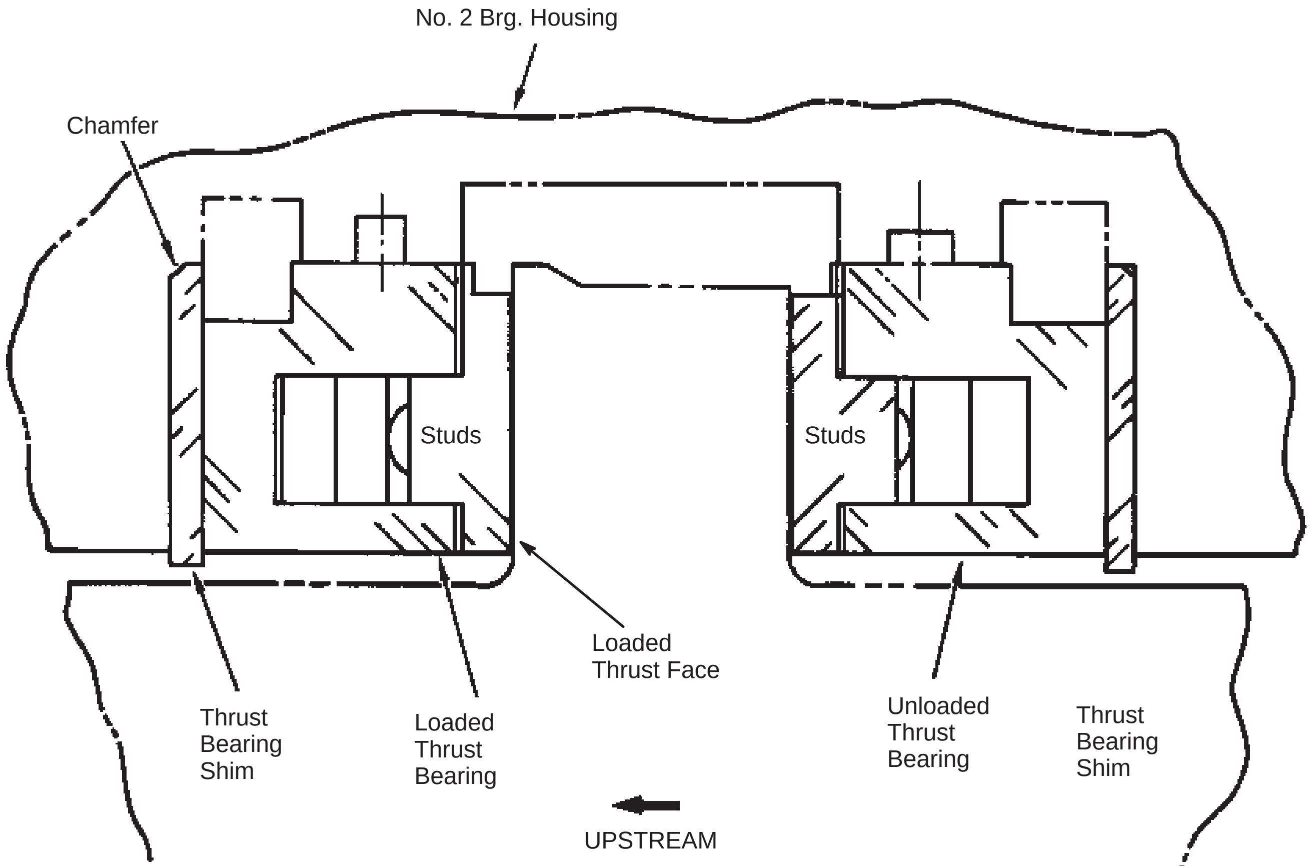


Figure MI-D.12. Turbine Thrust Bearings.

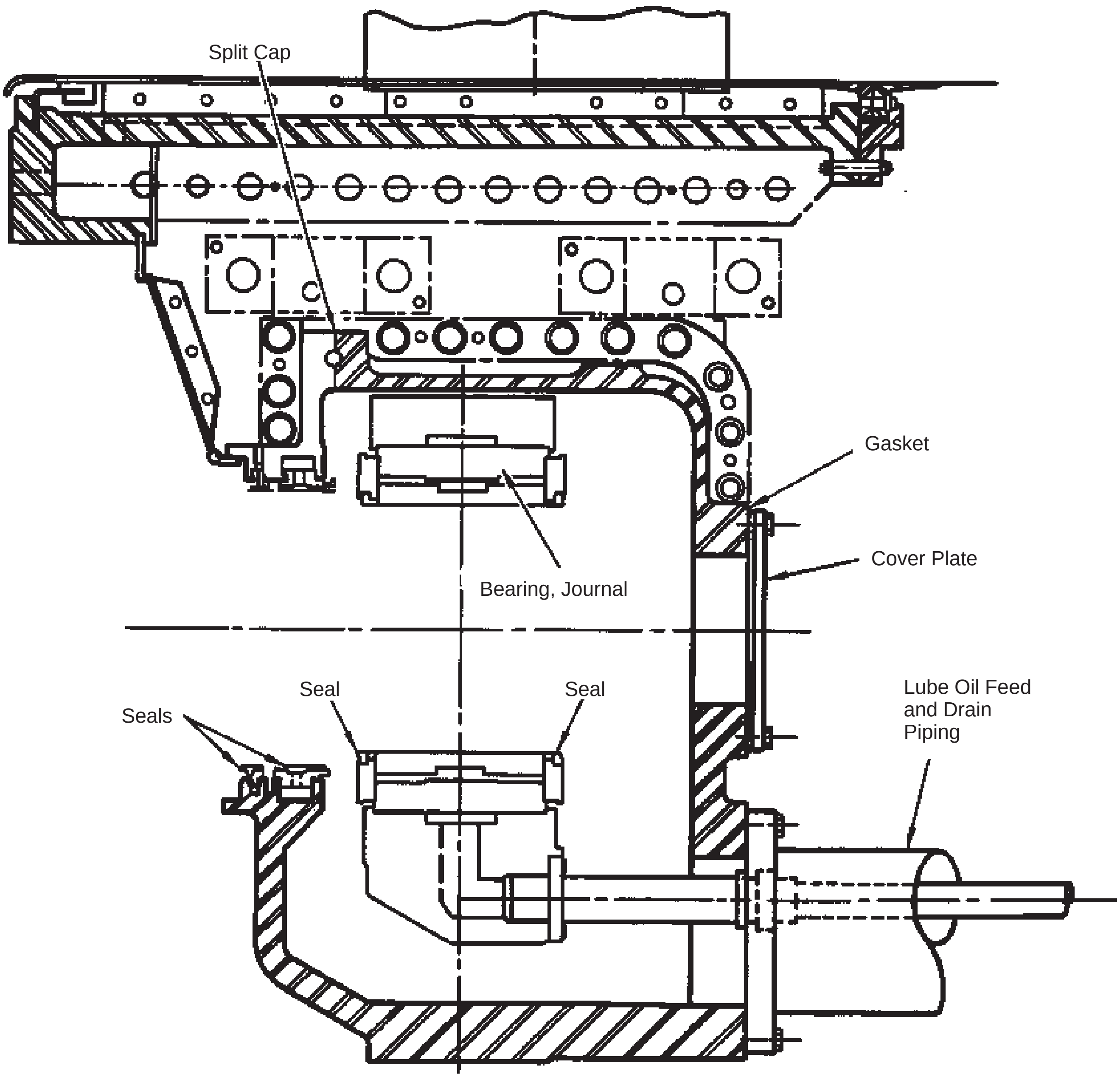


Figure MI-D.13. No. 2 Bearing Housing

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II. Inspection Procedures (Major Inspection) for MS-7001FA+ and MS-7001FA+e Gas Only Equipped Machines (with DLN-2.6)

Note: Obtain appropriate Inspection Forms from your local GE Field Service Representative.

Operation 26 — Perform Combustion Inspection Operations 11 through 22

11. Fuel nozzle inspection.
12. Liquid fuel injector inspection.
13. Gas fuel injector inspection.
14. Reassembly of injectors to end cover.
15. Inspect and test spark plugs.
16. Inspect and test flame detectors.
17. Inspect combustion caps and liners.
18. Inspect crossfire tubes and retainers.
19. Inspect combustion chamber flow sleeves.
20. Inspect fuel nozzle forward, outer casings.
21. Inspect combustion outer casings.
22. Inspect transition pieces.

Operation 27 — Inspect Hot Gas Path Components Per Hot Gas Path Inspection Operations 32 through 36

32. Inspect first-, second- and third-stage nozzles.
33. Inspect first-, second- and third-stage buckets.
34. Inspect shroud blocks.
35. Inspect second- and third-stage diaphragm segments.
36. Make first-stage nozzle ellipticity checks.

Operation 28 — How to Inspect First-, Second-, and Third-Stage Bucket Locking and Turbine Wheel Dovetails

1. Clean and non-destructive test the turbine bucket locking grooves and turbine wheel dovetails.

Note: Cleaning and non-destructive tests of the turbine bucket locking grooves and turbine wheel dovetails should be done by qualified General Electric Company personnel.

Operation 29 — How to Clean and Inspect Compressor Rotor, Stator Blading, Inlet Guide Vanes and Compressor and Turbine Casings

1. Cleaning of the compressor casing parts and rotor can be accomplished with the rotor assembly either installed or removed.

CAUTION

> The thrust bearing must be installed if the unit is rotated when cleaning the compressor. Take precautions to keep the bearing areas protected during cleaning.

a. The following process may be used for casing cleaning with the compressor rotor installed. Choice of the process depends on equipment availability and kind of deposits in the machine.

CAUTION

> The compressor extraction air piping must be removed or blind flanged to prevent ingestion of cleaning material and contaminants.

Solvent Cleaning — Useful for removing organic contaminants such as oils and greases. The solvent should be Petroleum spirits, GE No. 1500 thinner, or Multicleaner No. 44, applied by spray, or with a well-saturated clean cloth, followed by wiping with another clean cloth.

Steam Cleaning — Can be used for removing grease and oil and water soluble contaminants. Spray the parts thoroughly using an inhibitor such as Turco Cold Spray to minimize subsequent rusting and to leave a thin protective film on the assembly after drying. Dry the parts with an air blast.

2. Rotor removal may be required for cleaning if fouling/deposits on the compressor cannot be successfully removed in place. The following process, in addition to the two above processes, may be used.

   Shell Blasting — Useful mostly for removing relatively soft, dry deposits. The rotor parts must be dry before attempting shell-blast cleaning. Oily deposits or residue must also have been removed from the rotor. The gap between each rotor stage must be covered with adhesive tape to keep out the cleaning media.

3. Inspect the inlet guide vanes carefully for deposits, erosion (thinning or trailing edges and rounding of leading and trailing tip corners) or corrosion pitting.

4. Liquid penetrant check the inlet guide vanes for cracks in the blade root and vane.

5. If any blade deposits are found, two samples should be collected and sent to a testing laboratory for analysis. The analysis is important to the overall inspection.

6. Clean and inspect operating rack and gears for damage and corrosion. Re-lubricate and protect from dirt and weather.

7. Check for presence of oil on the guide vanes or any part of the inlet casing. If any oil is found, this could indicate casing porosity, bearing seal leakage, or oil vapor ingestion from upwind oil tank vents. The cause should be corrected to prevent compressor fouling.

Note: For corrective action or repair procedure, contact your General Electric Company Field Service Representative.

8. Record inlet guide vane inspection on appropriate Inspection Form.

9. Make a visual check for compressor blade tip rubs, cracks, corrosion, deposits, erosion and foreign object damage. Use Table MI-1 and Figures MI-I.1 and MI-I.2 for inspection and repair criteria.

10. Record blade/vane condition on appropriate Inspection Form.

Note: It is recommended that your General Electric Company Field Service Representative supervise the inspection of the compressor components and any repairs or replacement of blading by done by General Electric Company Apparatus Service Shop.

Operation 30 — How to Inspect Bearings

Note: Upper half of No. 1 bearing liner weighs 165 lbs. (74.84 kilograms) and No. 2 weighs 165 lbs. (74.84 kilograms).

1. Lift off upper half of each bearing liner. Support the rotor with a suitable jack and jack upward just enough to release pressure on the lower-half bearing liner [not to exceed 0.010 inch (0.0254 cm)]. Use a dial indicator to measure lift.

Note: Use the rotor jacking ring at the Number 1 bearing. Take appropriate precautions to assure that the shaft is not damaged by the jack when lifting.

2. Roll out the lower-half bearing liners.

3. Inspect tilt pad bearing surfaces for cracks, wiped Babbitt, scoring, foreign material, pitting, spalling, and excessive or abnormal wear patterns. Cracked and chipped Babbitt can generally be repaired in an approved General Electric Company Repair Facility, if the damage is not excessive. The cause of the damage within the unit must be eliminated to prevent further cracking and chipping.

4. Some scratching will always occur on babbitted bearing surfaces during normal operation because of impurities which accumulate in the lubricating oil system. Scratches that are less than 0.001 inch deep and less than one-inch long are acceptable and require no further attention. Deeper scratches are cause for concern, particularly if they run in the axial direction and occur in the high pressure zone (lower half) of the bearing liner. Scratches that are in the range of 0.001 - 0.005 inch (0.0025 – 0.0127 cm) deep, but less than one inch long, may be repaired on site. Any foreign par-

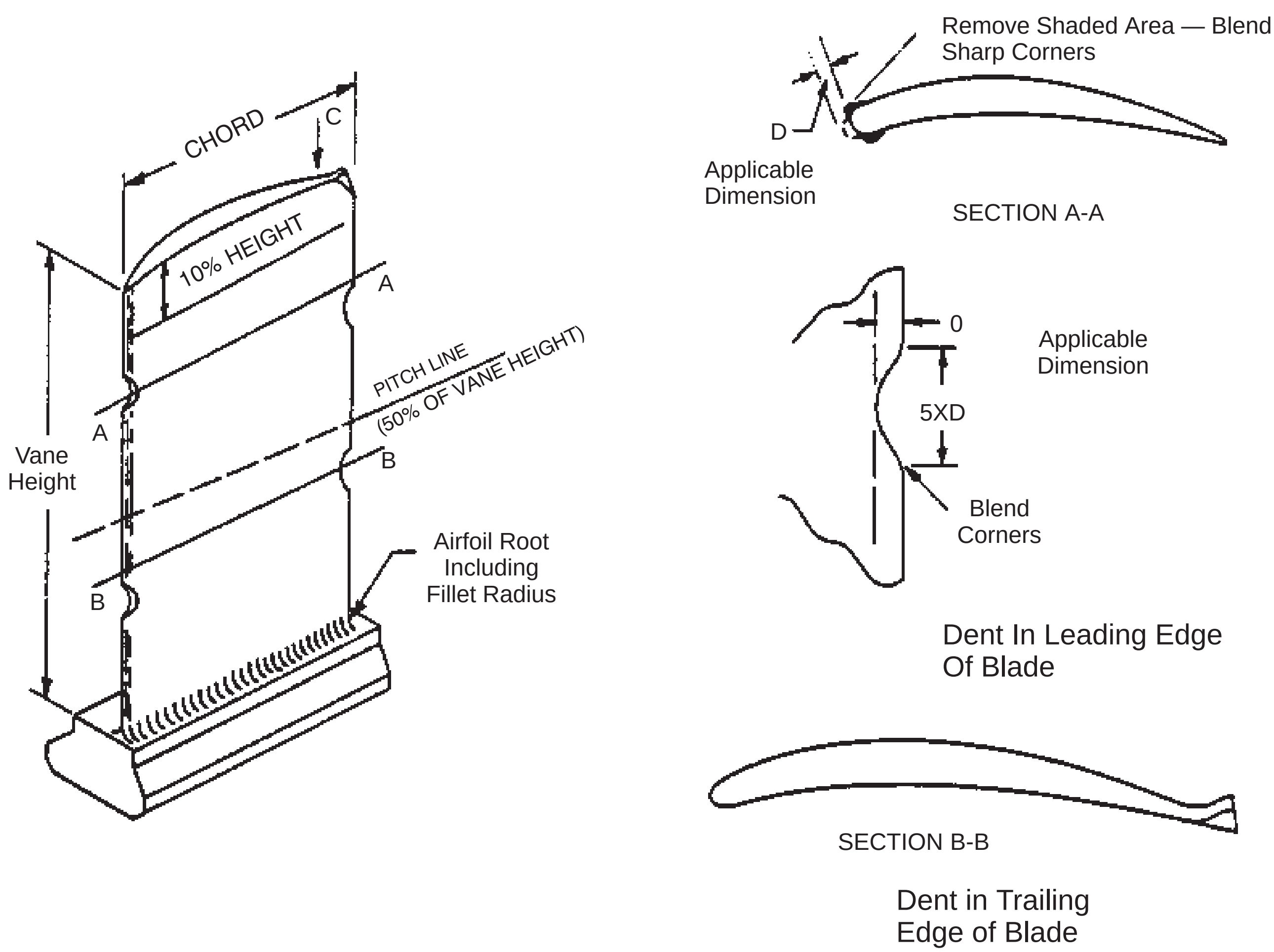

Figure MI-I.1. Typical Compressor Blade Showing Areas of Damage.

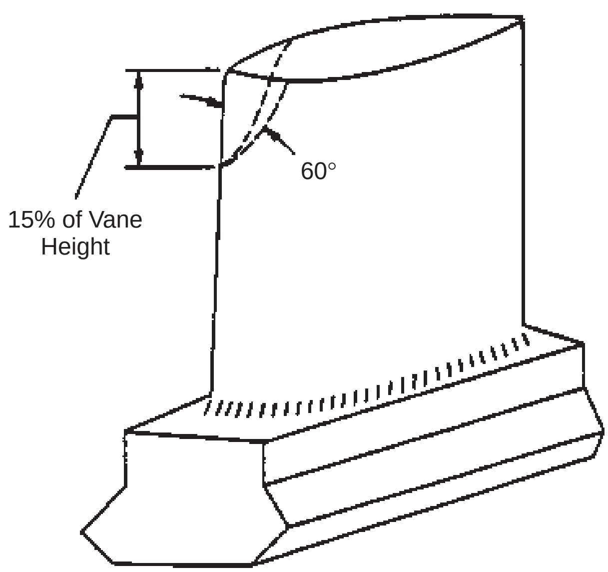

Figure MI-I.2. Cold Straightening of Tip Damage.

ticles embedded in the scratch should first be removed. Scratches deeper than 0.005 inch (0.0127 cm) should be repaired in an approved General Electric Company Repair Facility.

5. If the bearing pads have experienced excessive temperatures, the babbitt will show evidence of smear and wiping. If the wiped area is less than five-percent of the liner lower-half area, the bearing may be reused after repair of the wiped surface. Larger wiped areas must be repaired by an approved General Electric Company Repair Facility. Before replacing the liner, the cause of the wipe must be determined and corrected.

6. Most tilt pad bearings develop polished areas during low-speed cranking or coastdown conditions. The polished area is usually found at the centerline of the bearing pads and should extend along the entire length of the bearing. This type of pattern is normal and should not be cause for any alarm.

7. As with journal bearings, the Babbitt surfaces of the thrust bearings must be inspected for cracks, chips, scratches, and wiping. Cracks or chips must be eliminated before the turbine is placed in operation. A small amount of scratching will always occur because of impurities which collect in the oil system. Scratches that are less than 0.001 inch (0.0025 cm) deep and less than one inch long are acceptable without further consideration. Scratches that are in the range of 0.001 to 0.005 inch (0.0025 – 0.0127 cm) deep may be repaired after removing any imbedded dirt particles. Repair of scratches may require the assistance of a General Electric Company Field Service Representative or a qualified General Electric Company Repair Facility. Babbitt wipes that occur in an area representing ten percent or less of the respective pad area can be repaired. Wiping that extends over larger areas requires re-babbitting of the pad. It will be necessary to determine the cause of the wiping prior to reinstalling the bearing.

8. Inspect thrust runners for galling, pitting, scoring and excessive wear. The runner surface should be inspected for scratches and gouges. Scratches that are less than 0.001 inch (0.0025 cm) deep can be ignored. Scratches ranging from 0.001 to 0.005 inch (0.0025 – 0.0127 cm) deep should be repaired. Scratches deeper than 0.005 inch (0.0127 cm) require re-machining.

Note: It is recommended that re-machining operations be accomplished at an authorized General Electric Company Repair Facility.

9. Measure journal diameter at two planes, fore and aft. Roundness and taper are two of the most critical dimensions associated with a bearing journal. These dimensions are established with a four-point check taken in the vertical and horizontal planes (at 90 degrees to one another) at both the forward and aft edge of the journal. If the journal diameter is 0.002 inch (0.0051 cm) or more outside of its drawing tolerance, and if the liner-to-journal clearance falls outside of the drawing tolerances, it may be necessary to re-machine the journal. It should be noted that whenever a journal is re-machined, the rotor must be re-balanced. Journal tapers that fall outside of the specified drawing tolerances may also require re-machining and re-balancing. Surfaces that have been scratched, pitted, or scraped to depths of 0.001 inch (0.0025 cm) or less are acceptable for use. Deeper imperfections in the range of 0.001 to 0.005 inch (0.0025 – 0.0127 cm) must be restored by “strapping”. The amount of metal “strapped” from the journal must not exceed 0.002 inch (0.0051 cm) on the diameter. Scratches deeper than 0.005 inch (0.0127 cm) require re-machining and subsequent re-balancing of the rotor.

Table MI-1

COMPRESSOR BLADE FOREIGN OBJECT DAMAGE INSPECTION AND BLEND LIMITS

Inspect	Maximum Acceptable Limits	Corrective Action
	(See Note 1)	
1. *Bent tips	Up to 15% of airfoil height from the tip and maximum deflection of 60°. See Figure MI-I.2.	Cold straighten and dye penetrant inspect.
2. Bent blades	Up to 10% of airfoil height from the tip and up to 25% of the chord length. See Figure MI-I.1.	Cold straighten and dye penetrant inspect.
3. Cracks due to foreign object damage	Blend out and evaluate per nicks and dents limit.	- - -
4. Erosion. Knife edges at leading and trailing edges.	Loss of 10% of cross-sectional area.	Blend with minimum radius to remove rough knife edges.
NICKS AND DENTS		
General limit, all compressor blading		
1. Small nicks or dents around leading edge.	0.07-inch (0.178-cm) diameter or less by 0.02 inch (0.051 cm) deep.	Should be left alone, no action necessary.
2. Nicks and dents on the leading and trailing edge.	Dents and nicks located above the pitch line and having a surface area of less than 0.02 sq. in. (0.051 sq. cm) per inch of blade chord and less than 0.07 inch (0.178 cm) deep.	Polish smooth to remove roughness, remove as little metal as possible. Dye penetrant inspect.
3. Dents, nicks or tears in the airfoil root section including the fillet radius.	None permitted.	Contact GE

*For Stage “0” rotor blade tip additional blend limits for icing damage, contact GE.

Notes

1. For conditions exceeding the above limits, contact GE for additional information or specific component evaluation.

Table MI-1 (Cont'd)

COMPRESSOR BLADE FOREIGN OBJECT DAMAGE INSPECTION AND BLEND LIMITS

Inspect	Maximum Acceptable Limits (See Note 1)	Corrective Action
****Stages 0 through 4**		
4. Dents in area around leading *or* trailing edge of blade.	One dent 0.22 inch (0.559 cm) deep and 1.12 inch (2.84 cm) diameter. See Figures MI-I.1 and MI-I.2	Polish smooth to remove roughness, remove as little metal as possible. Dye penetrant inspect.
5. Dents in both leading and trailing edges.	Combination of conditions not to exceed above dimensions.	Polish smooth to remove roughness, remove as little as possible. Dye penetrant inspect.
6. Dents in vane section other then leading and trailing edges.	Two 0.06 inch (0.152 cm) deep above the pitch line. One 0.06 inch (0.152 cm) deep below the pitch line.	Polish smooth to remove roughness. Remove as little metal as possible. Dye penetrant inspect.

**For Stages 5 through 8, use 75% of dimension criteria, i.e., 0.22 inch (0.559 cm) becomes 0.16 inch (0.406 cm).

**For Stages 9 through final stage, use 50% of dimensional criteria.

CAUTION

Disassembly instructions are not given here because the tilt pad bearing should never be fully disassembled. Removal of individual pads for cleaning and pivot pin inspection can be accomplished by loosening retainer screws. DO NOT REMOVE PIVOT PINS. Only the manufacturer is prepared to disassemble, realign and check clearances of this type bearing.

10. Inspect the No. 1 and 2 bearing tilt pads. Attention should be given to the lower pad support pins to be sure they do not exhibit fretting or excessive wear. The pads should be inspected for scratches, loose particles and any high or low spots which may exist. These can be removed or repaired in accordance with procedures used in the maintenance of all Babbitted surfaces. (See paragraphs 4, 5 and 6 of this operation.) Excessive burnish, wipe or loss of Babbitt, support pin distress or wear of oil seal surface of retainer is cause for corrective action to be taken. Contact your General Electric Company Field Service Representative for proper repair and return procedures.

Operation 31 — How to Inspect First-Stage Nozzle Support Ring

1. Check the nozzle support ring for rotor seal damage or wear.

2. Inspect the nozzle support pad seal fit for galling or fretting.

3. Record inspection results on appropriate Inspection Form.

III. Re-assembly Procedures (Major Inspection) for MS-7001FA+ and MS-7001FA+e Gas Only Equipped Machines (with DLN-2.6)

Note: Obtain appropriate Inspection Forms from your local GE Field Service Representative.

Operation 32 — How to Reassemble Bearings (See Figures MI-D.11, MI-D.12 and MI-D.13)

1. Journal No. 1 and No. 2 bearings are assembled in the same manner. Coat the lower-half liner with turbine oil and set the liner on the journal. Roll the liner carefully into the lower half. Restrain the liner from falling into the lower half.

CAUTION

> No. 1 bearing liner weighs 330 lbs. (150 kg) complete and No. 2 liner weighs 330 lbs. (150 kg).

2. Number 1 and 2 journal bearings consist of tilting pad liners. Coat the pads with turbine oil and roll in the liner as above. Position the upper-half liner and align the anti-rotation pin before lowering the shaft jack. Re-splice metal temperature thermocouple pigtails.

3. Reassemble the thrust bearings in the reverse manner as they were disassembled. Roll in the unloaded thrust lower and upper halves and position the anti-rotation pin. See Figure MI-D.12. Install new thrust bearing metal temperature thermocouples as the bearing is rolled. Work must be done by a skilled instrumentation technician. Also, cut window in bearing No. 1 oil drain line to allow installation of new thermocouples.

   Note: When the unloaded thrust bearing is in position, thrust the rotor against it lightly to allow room to assemble the loaded thrust bearing.

4. Roll in the lower half of the active thrust bearing base ring, installing the pads as it enters the lower housing. Set the upper half of the base ring on the active thrust bearing and install the upper-half pads. Roll the assembly around to position the anti-rotation key. After the active thrust bearing is assembled, slide the rotor position shim into place behind it.

   Note: Use only a light coating of turbine oil during assembly of the thrust bearings.

CAUTION

> Carefully check all bearing housings to assure all tools, parts, rags and debris have been removed and the housing is clean before closing.
>
> Assure slots in forward thrust shim are aligned properly for proximity probe installation.

5. With the anti-rotation keys aligned in the No. 1 bearing area, apply a light film of joint sealant, see the standard Practices section, Lubricants and Sealants, and lower the upper half of the bearing housing into place. Apply anti-seize compound lightly to dowel pins and bolt threads. Install new bolts. Torque bolts alternately from the center of each flange.

6. Check the anti-rotation key and assemble the No. 2 bearing strap using new bolts. Torque bolts alternately from side to side. Re-splice metal temperature thermocouple pigtails.

7. Remove burrs or high spots from the Number 2 bearing housing horizontal joints. Clean up the joints and perform a red and blue check to meet oil tight requirements. (Continuous band of contact 1/4 inch (0.64 mm) wide inside the line of housing bolts.)

8. Apply joint sealant, see the Standard Practices Section, Lubricants and Sealants, to the Number 2 bearing housing flanges. Lower the upper half of the housing into place. Lightly coat the bolts with anti-seize compound. Install new bolts. Bolt the housing and torque bolts alternately.

9. Reassemble the Number 2 bearing aft cover plate using new bolts and a new gasket. Apply joint sealant to both sides of the gasket.

Operation 33 — How to Reassemble First-, Second- and Third-Stage Turbine Buckets to the Turbine Wheel

Note: Turbine bucket re-assembly to the turbine wheel should be done by qualified General Electric Company personnel.

Operation 34 — How to Install the Compressor Rub Ring (See Figure MI-R.1)

1. Apply a very light coating of turbine oil to the compressor rub ring and roll it into the lower half.

Operation 35 — Assemble Hot Gas Path Components Per Hot Gas Path Inspection Re-assembly Operations 37, 38 and 39

37. Install lower-half first-stage nozzle, key and nozzle clamps.

38. Install lower-half second- and third-stage nozzle segments.

39. Install lower-half second- and third-stage nozzle radial retaining pins.

Operation 36 — How to Recheck Clearances and Thrust

1. Recheck all thrust and all compressor clearances after the bearings have been reassembled. Use the same procedure as described in Operation 21 in this section.

2. Record inspection results on appropriate Inspection Form.

3. Take turbine clearance checks per Hot Gas Path Dis-assembly, Operation 24.

4. Record inspection results on appropriate Inspection Form.

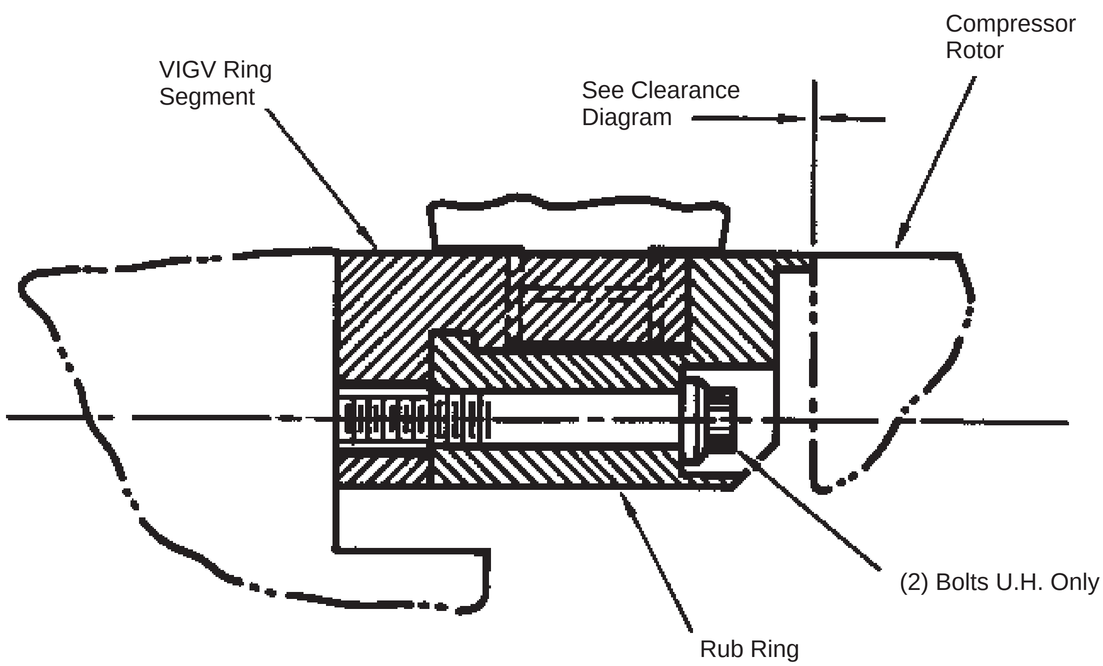

Figure MI-R.1. Rub Ring Assembly.

Operation 37 — How to Install Upper-Half Inner Compressor Discharge Casing

CAUTION

Check for tools and debris before closing.

1. Set the upper half of the inner discharge casing in place using chainfalls to lower it.
2. Bolt and torque horizontal joint using only a thin film of anti-seize compound on all bolts.

Operation 38 — How to Install the Compressor Discharge Casing Upper Half

1. Lower the compressor discharge casing using the guidepins provided.
2. Apply anti-seize and joint compound per the Standard Practices section. Install horizontal joint body-bound bolts.
3. Bolt the horizontal and vertical flanges.
4. Tighten the horizontal joint bolts starting at the midpoint of the flange and working to the ends alternately on both sides simultaneously. Then torque the vertical joint bolts at the inner compressor discharge casing flange.
5. Reinstall the two crossfire tubes at the horizontal joints of the discharge casing. Tighten the packing clamp bolts.

Operation 39 — Assemble Hot Gas Path Components Per Hot Gas Path Inspection Re-assembly Operations 41 through 48

41. Install upper-half first-stage nozzle support ring.
42. Install upper-half first-stage nozzle.
43. Recheck first-stage nozzle concentricity.
44. Install upper-half second- and third-stage nozzle segments.
45. Install upper-half second- and third-stage nozzle radial retaining pins.
46. Install upper-half turbine casing.
47. Install upper-half first-stage nozzle clamps, key and shims.
48. Install transition pieces and replace access cover.

Operation 40 — How to Install the Upper-Half Forward and Aft Compressor Casings

1. The forward and aft compressor casings should have been left bolted together and can be reinstalled as one piece as they were removed. Insure the compressor is clean and free of foreign objects. Lift the casings over the unit and install the guide pins.

2. Apply anti-seize per the Standard Practices section, Recommended Solvents, Sealants and Cleaners.
3. Lower the casing with chainfalls, being particularly careful not to swing the casings into the rotor or the adjacent vertical flanges and insure no foreign objects enter the compressor during this operation.
4. Install the body-bound bolts.
5. Bolt up the horizontal and vertical flanges.
6. Torque horizontal joint bolts of each casing from the center to the end, alternating sides. Torque vertical joint bolts from top center alternatively down both sides.

Operation 41 — How to Install the Upper-Half Inlet Casing (See Figure MI-R.2)

CAUTION

Check for tools and debris before closing casing.

1. Lift the inlet casing and install the guidepins.
2. Lower the casing with chainfalls taking care to prevent the case from swinging into the rotor or any of the adjacent flanges.
3. Apply anti-seize per the Standard Practices section, Recommended Solvents, Sealants and Cleaners. Make up horizontal joint bolting. Do not overlook six internal bolts in the inner bellmouth. (See Figure MI-R.2.)
4. Torque bolting from the center of the flanges toward each end.
5. Bolt up inlet guide vane control ring.
6. Release control ring support.

Operation 42 — How to Install Exhaust Air Cone and Exhaust Frame (See Figure MI-R.3)

1. Set the exhaust air cone forward of the bearing housing No. 2.
2. Slide the air cone aft to engage the front of the bearing housing. Bolt up the horizontal joints, lock bolts.
3. Lower the exhaust frame carefully, making sure the air cone flange fits into the groove. Use guide pins.
4. Apply anti-seize compound to all bolt threads.
5. Bolt the inner and outer barrel horizontal joints securely. Watch for areas where thermal distortion may try to hold the joints open.
6. Bolt up the vertical joints at the turbine casing and at the aft inner and outer diffuser flanges.

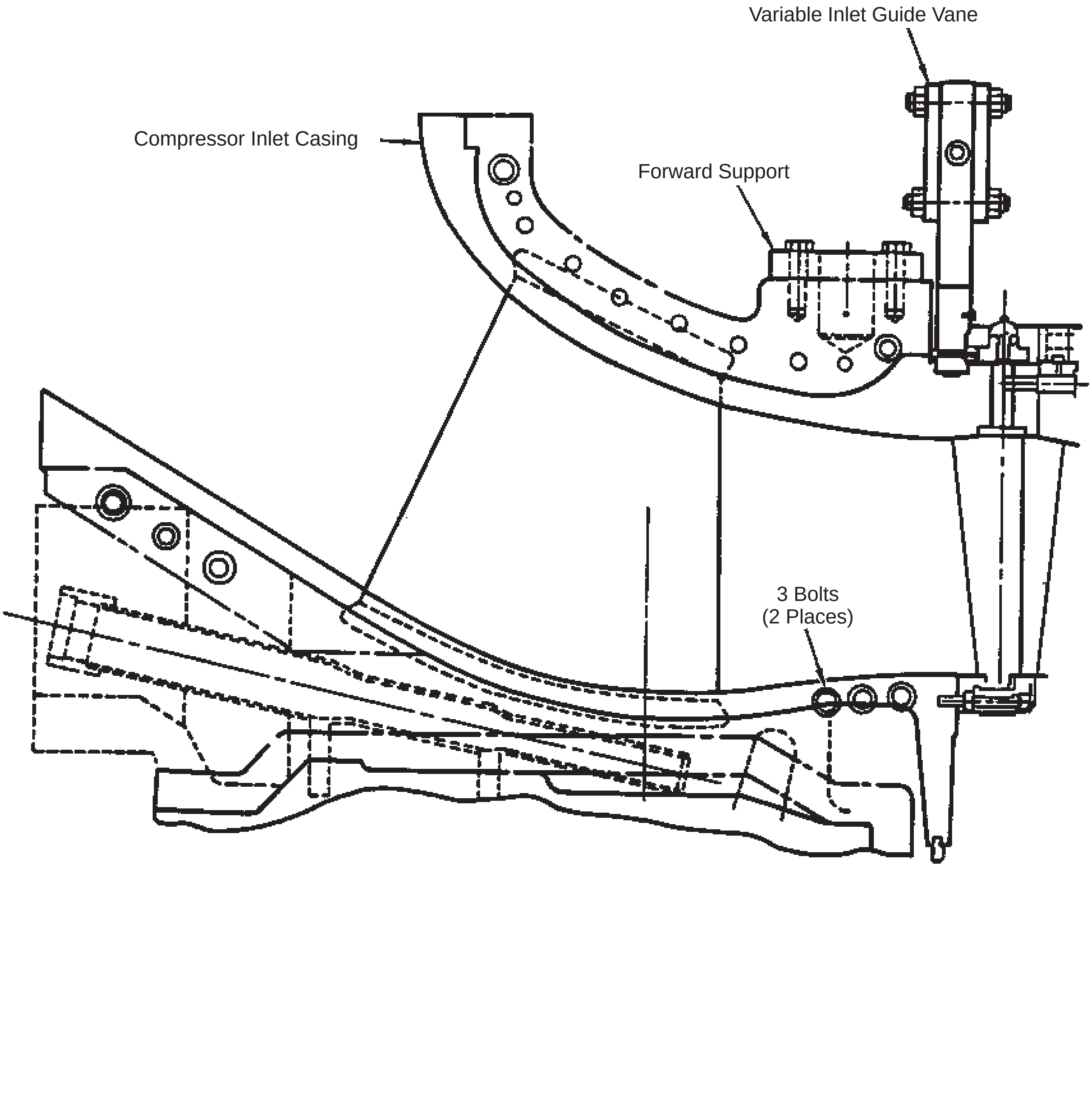

Figure MI-R.2. Inlet Casing Arrangement.

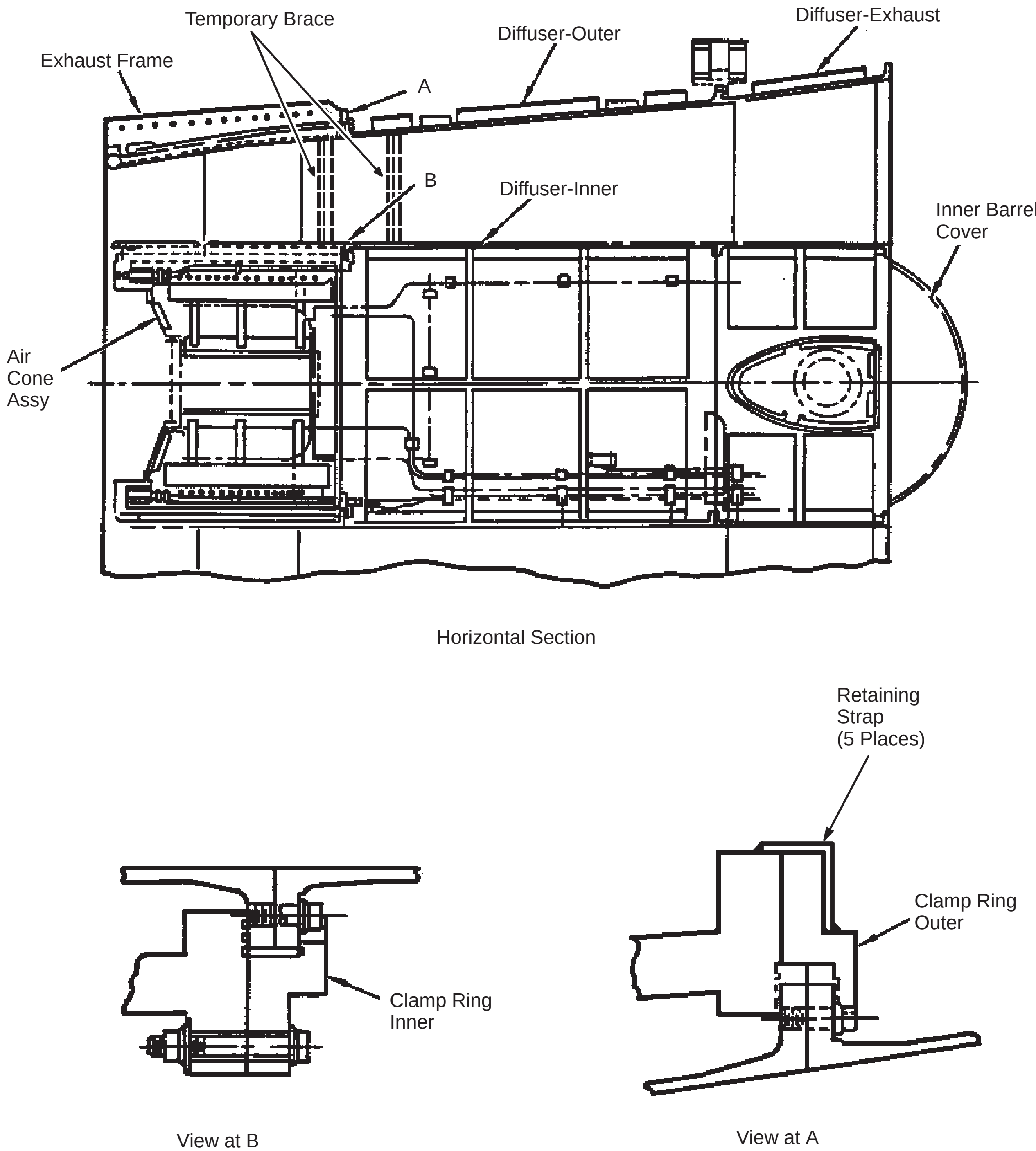

Figure MI-R.3. Exhaust Frame Assembly.

7. Reassemble the clamp rings at the aft inner and outer diffuser flanges.

8. Check aft wheelspace and No. 2 bearing thermocouples for operation after installing exhaust frame and diffuser.

9. Remove the 1-1/2 inch (38 mm) angle iron braces from the inner and outer diffuser walls. Remove all added bracing and angle clips.

Operation 43 — How to Reassemble Exhaust Inner Diffuser End Cover (See Figure MI-R.3)

1. Inspect and install all Number 2 bearing and aft wheelspace instrumentation.

2. Remove inner diffuser wood walkway structures.

3. Reinstall the dished inner diffuser end cover. Install new lockplates and bolts and lock all bolts after torquing.

Operation 44 — How to Remove Casing Jacks

1. Set up a dial indicator to check that the cases relax the same amount they were deflected when the jacks were installed.

2. Remove jacks from under the inlet, compressor, combustion wrapper and turbine.

3. Replace four access covers in inlet plenum floor.

Operation 45 — How to Install Turbine Compartment Aft Wall (See Figure MI-R.4)

1. Rig and lift the aft wall middle panel into position using new gaskets.

2. Bolt up the middle panel to the side panel flanges.

3. Fit a new fiberglass gasket between the panel and the exhaust frame aft flange.

4. Hold the gasket in place with the batten strips and bolt up.

5. Reinstall the turbine compartment duct-work.

Operation 46 — How to Reassemble the Upper-Half Inlet Plenum (See Figure MI-R.5)

1. Reassemble both upper and lower halves of the inlet plenum extension and the inlet plenum cone.

2. Rig and lift the inlet plenum into position, installing new gaskets at the horizontal and vertical joints.

3. Bolt up the horizontal and vertical joints with the gaskets in position.

4. Bolt the inlet duct to the inlet plenum.

5. Install new rubber expansion joints at the inlet cone and inlet extension using batten strips and bolts.

6. Remove any temporary inlet duct supports.

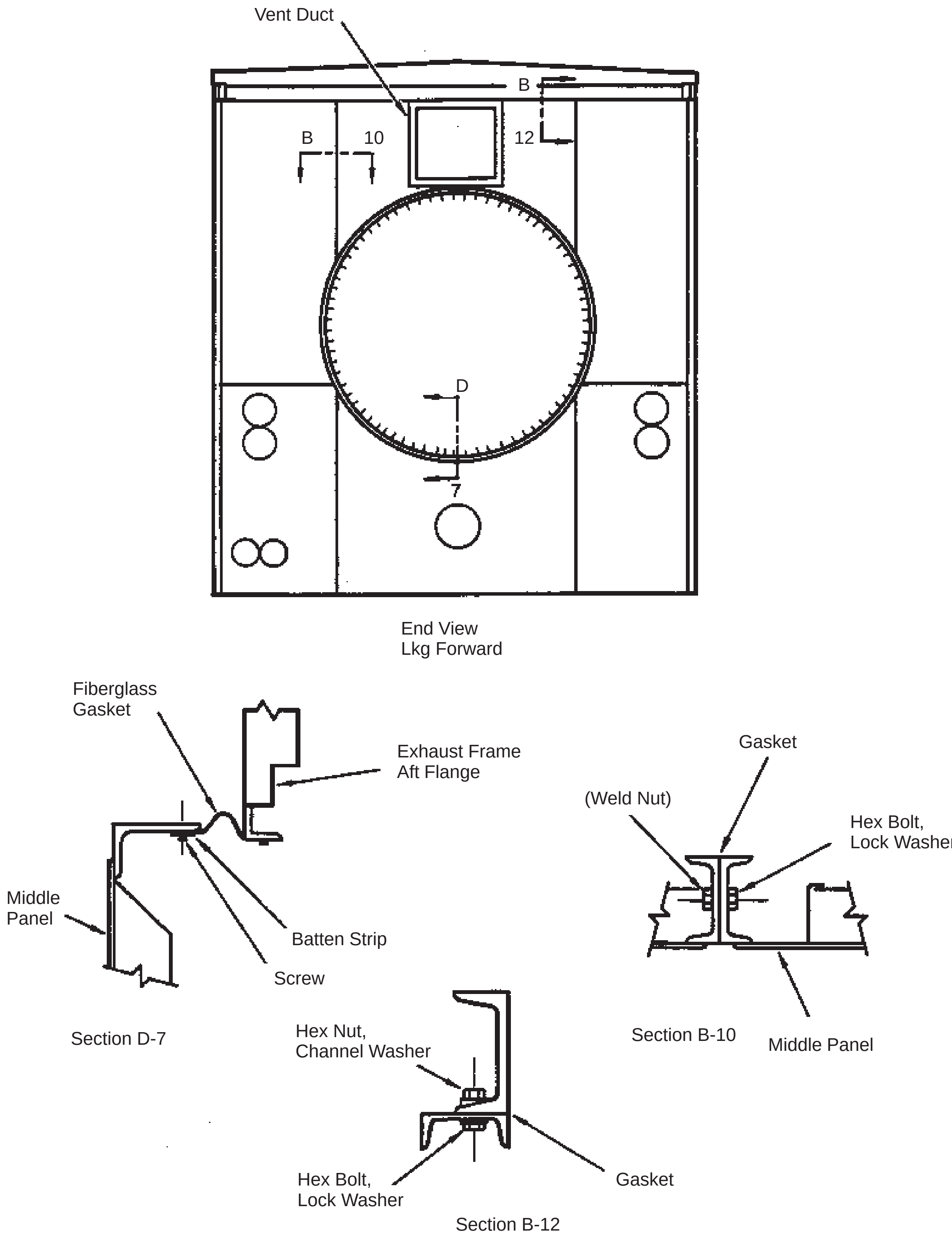

Figure MI-R.4. Turbine Compartment Aft Wall Assembly.

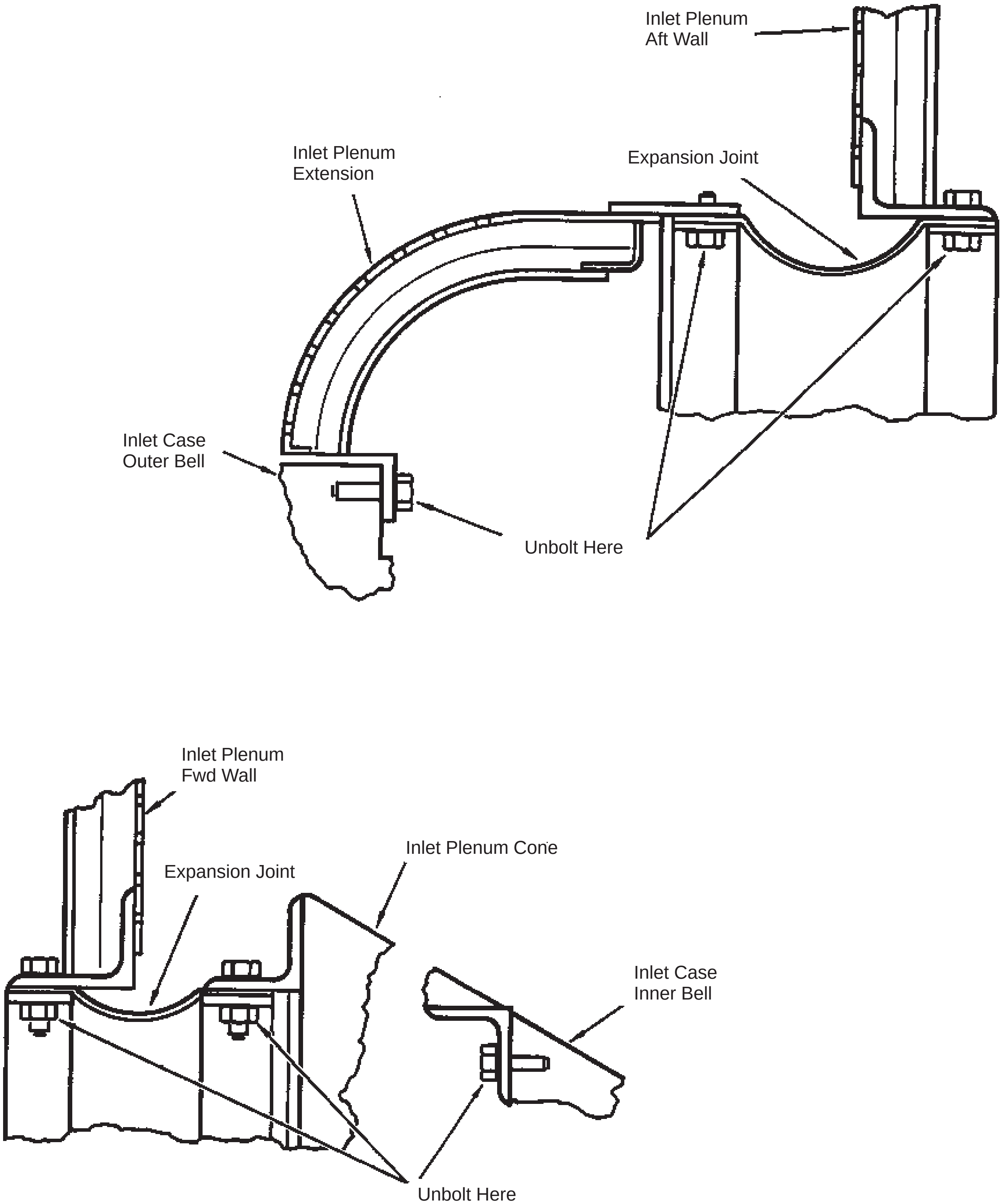

Figure MI-R.5. Inlet Expansion Joints

Operation 47 — How to Reassemble Upper-Half Piping

1. Remove flange covers and check piping for debris as piping is reassembled.
2. Clean flanges and install new gaskets.
3. Reassemble the fire protection piping.
4. Reassemble exhaust frame cooling air piping and manifold.
5. Reassemble six 13th stage air connections on the turbine casing.
6. Reassemble the extraction piping connections to the aft compressor casing.
7. Reassemble the water wash manifold and flex hole at the forward end of the inlet casing.
8. Reassemble any remaining brackets and hangers.

Operation 48 — Take Final Rotor Position Checks in accordance with Hot Gas Path Re–assembly Operation 52

Operation 49 — Perform Combustion Inspection Re-assembly Operations 24 through 29

24. Install outer combustion chambers and outer crossfire tubes.
25. Install flow sleeves, crossfire tubes, and combustion liner assemblies.
26. Install spark plugs.
27. Install fuel nozzle/end cover assemblies.
28. Assemble the cap to the fuel nozzle and casing assembly.
29. Assemble the fuel nozzle casing to the combustion casing.

CAUTION

> Check repeatedly for tools and debris in combustion section.

Operation 50 — How to Install the Cooling and Sealing Air Pipe and Air Extraction Pipe

1. Follow Steps 1, 2 and 3 of Operation 7 of this Major Inspection Disassembly Instruction in the reverse order to reconnect the cooling and sealing air pipe.
2. Reinstall the air extraction 90-degree elbows connected to the upper half of the turbine case on both the right and left side.

Operation 51 — How to Install the Gas Fuel Manifolds and Flex Hoses

1. Install the upper half of the secondary gas manifold.
2. Install the upper half of the transfer manifold.
3. Install the upper half of the primary gas manifold.
4. Starting at cover number 14 and working clockwise and counterclockwise, install the three flex hoses to each combustion cover.

Operation 52 — Install Flame Detectors and Cooling Water Manifolds in accordance with Hot Gas Path Re-assembly Operation 56

Operation 53 — Install the Air Purge Supply Line to the Purge Module in accordance with Major Inspection Dis-assembly Operation 4

Operation 54 — How to Install the Fuel Oil Purge Tubing

1. Install the two lines that were connected to the left-hand panel of the purge module. These lines run down the left side of the turbine.
2. Install, as a bundle, the 9 lines that were connected to the right-hand panel of the purge module.
3. Starting at cover number 8 and working counterclockwise to 14, install both the primary and secondary liquid fuel purge tubing. Do the same starting at cover number 7 and going clockwise to cover number 1.

Operation 55 — Perform Hot Gas Path Dis–assembly Operations 1, 2 and 3 in Reverse Order as Follows

1. Install inlet and exhasut duct access panels.
2. Install turbine compartment roof sections.
3. Re–bolt roof sections to sidewall frames, reconnect electrical conduit and wiring and reinstall turbine compartment side panels and/or doors.

Operation 56 — How to Reinstall Turbine Instrumentation

1. Reinstall the magnetic pickup arrangements at the forward end of the No.1 bearing.
2. Reinstall proximity probes in the No. 1 bearing.
3. Reinstall two thermocouples and one RTD in the forward wall of the inlet plenum.
4. Install eight fittings and guide tubes in the turbine casing.
5. Check all thermocouples with heat before installation.

6. Install a total of twelve thermocouples in the turbine casing and two in the compressor discharge casing.

Operation 57 — How to Re-check Turbine-Generator Alignment

Note: The turbine-generator and torque convertor-generator alignment should be rechecked using the same procedure detailed in Operation 1 in this section.

1. First ensure that the load coupling is within runout tolerances. Tolerance is 0.006 inch (0.015 cm) TIR (total indicator reading). If runout is excessive, check for burrs.

Note: The runout can be refined slightly by differential tightening of the coupling bolts. Maximum stretch on any generator flange coupling bolt is not to exceed 0.012 inch (0.030 cm) total.

2. If alignment is within limits (see Alignment Drawing in the Service Manual), no realignment is required; dismantle the alignment equipment and turning mechanism.

3. If alignment is not within limits, realign as necessary under the direction of your GE Field Service Representative.

Operation 58 — How to Re-assemble the Load Coupling-Generator Flange

1. The load coupling will already be in place bolted to the turbine rotor. The load coupling will have to be reconnected to the generator coupling flange.

2. Accurately measure the length of the coupling studs and record the lengths. The studs are weight matched in pairs. Each stud is etched with an identification symbol; for example, a stud will be marked 1-1 and its opposite mate will be marked 1-2. Other paired mates will be etched 2-1, 2-2, 3-1, 3-2, and so on. The matched sets must be installed on diametrically opposite sides of the coupling flange. Check to see that the nuts provided with the studs are of the locking type. If they are not the locking type, notify your GE Field Service Representative immediately.

3. Measure the interference fit of the rabbet on the coupling and record it. Generally, it will be from 0.001 to 0.005 inch (0.00254 to 0.0127 cm). Immediately prior to coupling the assembly, clean the rabbit fits thoroughly. When mating the two flanges, the two stamped locations (“F” markings) should be 180 degrees apart or as close to the 180 degrees as possible while maintaining bolt hole alignment.

Note: The “F” markings are heavy spot locations, not match marks.

4. When ready to assemble the flanges, align the bolt holes by using two of the coupling studs. The coupling studs should be installed according to good bolting practice. Assemble one lock nut to each stud with 1-1/2 to 2 threads extending beyond the nut. Measure free length of studs and record. The stud assemblies (stud and two lock nuts) are weighed and match marked in sets of two. The matched sets must be installed 180 degrees apart.

****WARNING****

Be certain to wear proper protective clothing when handling dry ice.

5. Due to the interference fit on the load coupling, the flange on the (turbine output) load coupling should be packed in dry ice and the rabbet coated lightly with anti-seize compound before assembly. Experience has shown that approximately 150 pounds (68.04 kg) of dry ice are sufficient to achieve the required results. When ready to assemble flanges, install two pairs of matched studs.

6. Pull up tight and check with 0.0015 inch (0.0038 cm) feeler gauge that no gap exists between flanges.

7. It is recommended that a hydraulic torque wrench be used to obtain the proper elongation. Torque studs 180° apart. Use anti-seize on the threads. The length of each stud is to be remeasured, recorded, and compared to the original measurement. The required elongation is 0.010 – 0.008 inch (0.0254 – 0.02 cm). Studs which do not meet this elongation requirement are to be corrected by being either re-tightened or backed off. Record final stud elongation on appropriate Inspection Form .

Operation 59 — How to Re-check Torque Converter-to-Generator Alignment

1. Attach the alignment fixture to the disk pack hub mounted on the torque converter shaft.

2. Check the alignment using the procedure in Operation 1 in this section.

3. If alignment is within limits (see Alignment Drawing) no realignment is required; dismantle the alignment equipment and turbine mechanism.

4. If alignment is not within limits, realign as necessary under the direction of your GE Field Service Representative.

Operation 60 — How to Re-assemble the Starting Means Coupling

1. Install the disk pack hub on the generator shaft by using dry ice on the generator flange for four hours.

2. Use a light coating of anti-seize on the generator rabbet and pull the flange faces together so that a 0.0015 inch (0.0038 cm) feeler gauge will not go between the flange faces.

3. Torque bolts per the alignment instruction drawing.

4. Use a sling to support the spacer shaft and lower it into position between the two disk pack coupling hubs.

5. Bolt up the flange at the torque converter end using correct bolt torquing procedures.

6. The gap measurement at the generator end should be 0.200 + 0.040 inches (0.508 + 0.1016 cm), with the shipping screws removed.

7. Bolt up the flange at the generator end to correct bolt torque and remove the sling.

Operation 61 — How to Reinstall Coupling Guards and Load Compartment Cover

1. Reinstall the starting means coupling guard.
2. Reinstall the turbine end section of the load coupling guard, bolting it to the bracket and the bracket to the inlet plenum.
3. Reinstall the generator end section of the load coupling guard by bolting to the generator end–shield.
4. Bolt the two sections together at the top center.
5. Install the two flat plates at the bottom of the load coupling guard sections.
6. Install and bolt up the load compartment side door and panels and the compartment cover.
7. Reinstall remaining fire protection piping and electric wiring and conduit.

Operation 62 — How to Clean Up, Operate, and Leak Check Unit

1. Complete the clean up and operation of the unit by following the procedure outlined in the Hot Gas Path, Operation 60.

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