

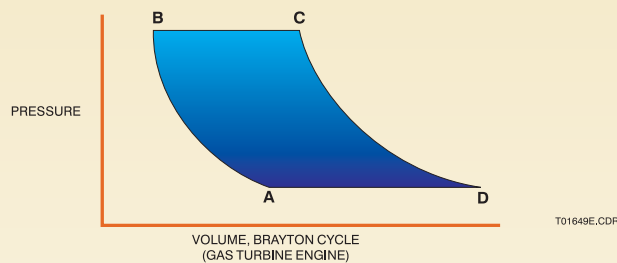
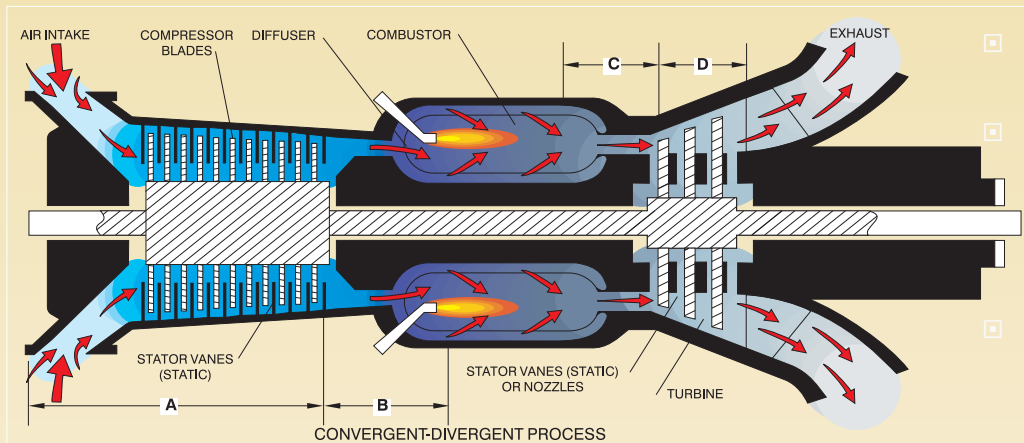
# GAS TURBINE BASIC FAMILIARIZATION

LM2500, TM2500, LM5000  
LM6000, and LMS100  
Gas Turbine Engines

Robert Boozer



# Gas Turbine Basic Cycle



## BRAYTON CYCLE

The BRAYTON steps are as follows:

Compression occurs between the intake and the outlet of the compressor (**Line A-B**). During this process, pressure and temperature of the air increases.

Combustion occurs in the combustion chamber where fuel and air are mixed to explosive proportions and ignited. The addition of heat causes a sharp increase in volume (**Line B-C**).

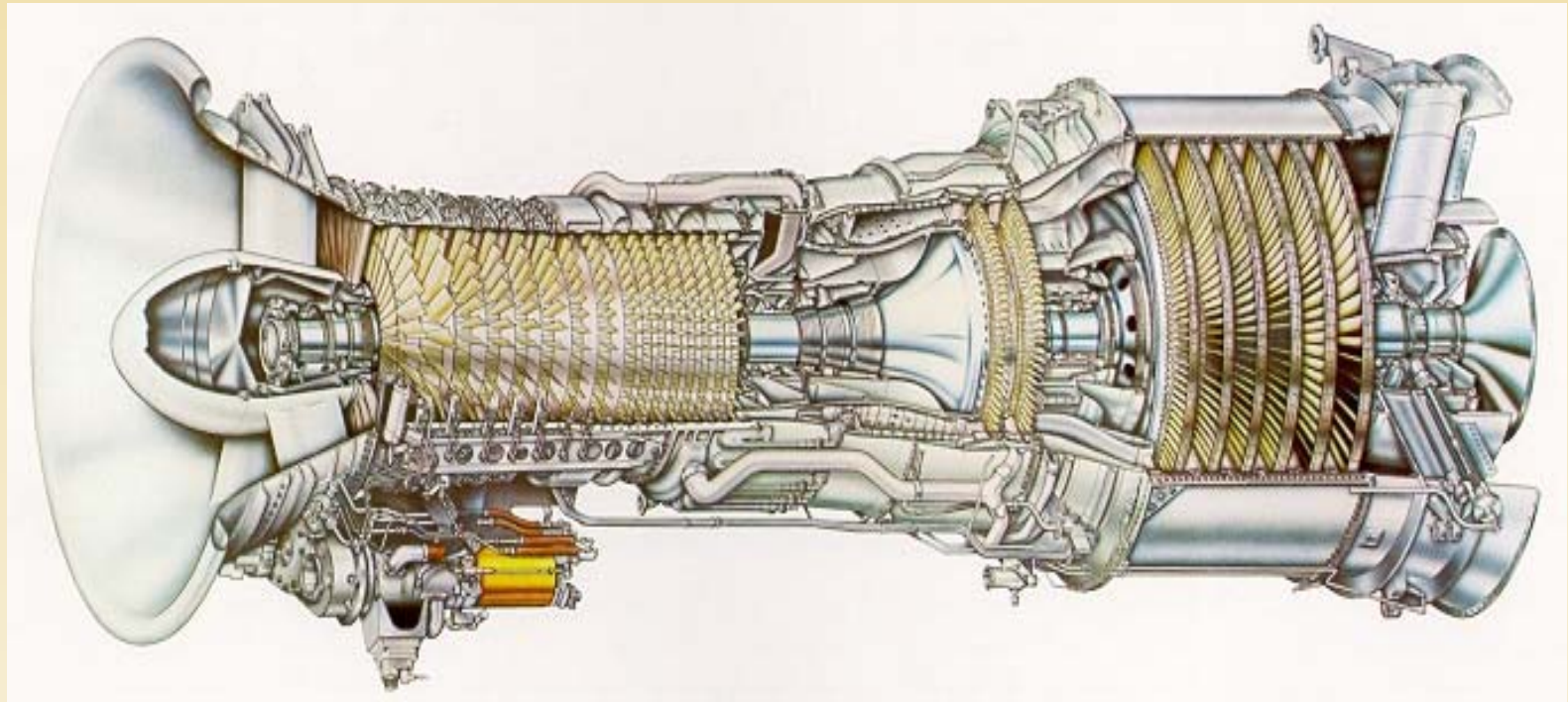
Expansion occurs as hot gas accelerates from the combustion chamber. The gases at constant pressure and increased volume enter the turbine and expand through it. The size of the passages is also increased, which allows a further increase in volume and a sharp decrease in pressure and temperature (**Line C-D**).

# GE Terminology

- LM - Land and Marine. General Electric's power plant, platform and marine versions of their flight engines.
- LM2500 based on the CF6-6 aero engine
- LM5000 based on the CF6-56 aero engine
- LM6000 based on the CF6-80 aero engine



# LM2500



# TM Aeroderivative Gas Turbine



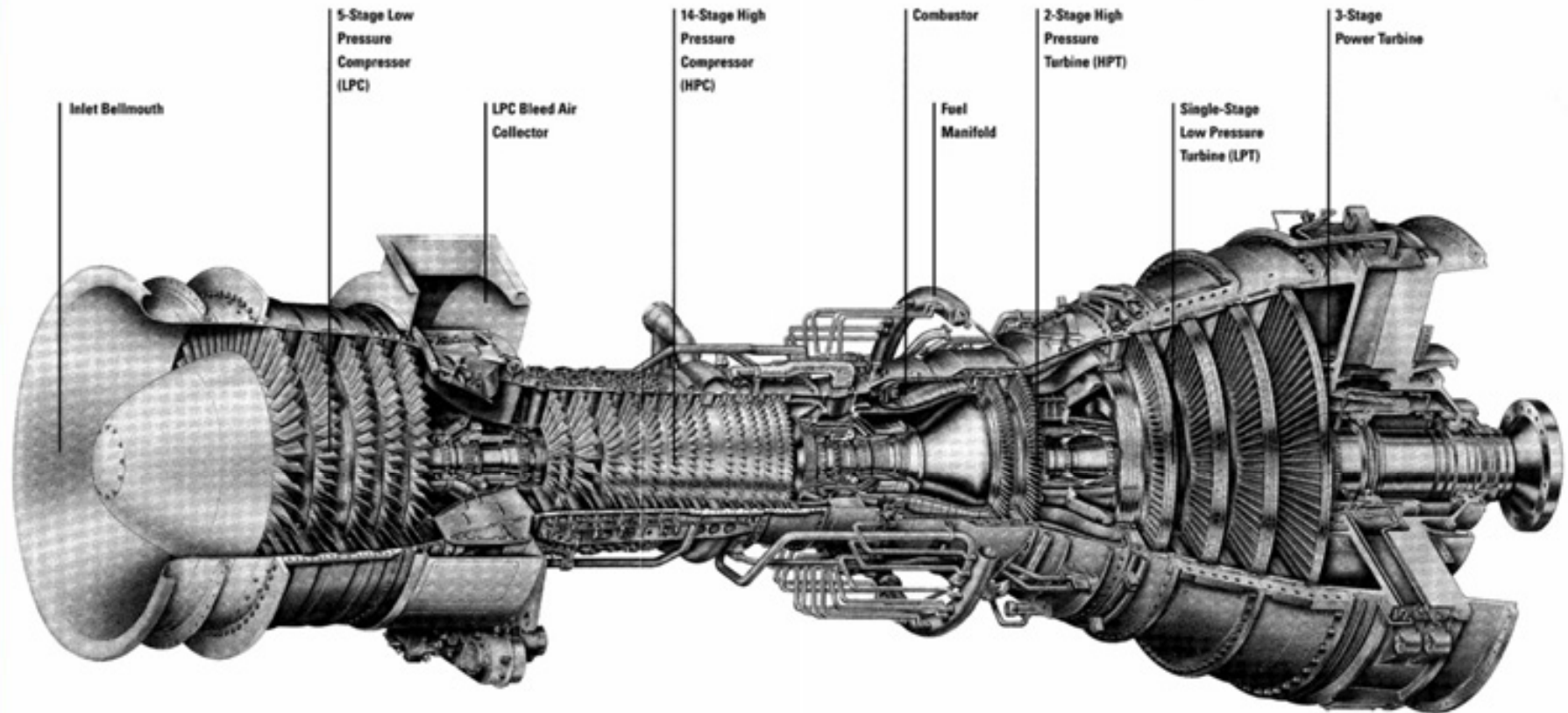


# TM2500 Trailer Mounted Gas Turbine

- ❑ -Heat rate 9800 Btu/kW-hr 50 Hz/9500 60 Hz
- ❑ -11.0 Kv (50 Hz) 13.8 kV (60 Hz)
- ❑ -TM2500 ideal for temporary peak shaving, plant shutdowns, equipment maintenance, or emergency disasters.
- ❑ -Liquid or natural gas
- ❑ -Operating on Natural Gas at ISO baseload conditions 60 Hz 37% efficiency and 35% 50 Hz.
- ❑ - TM2500 Power Plant on Wheels capable producing 21 Mw's on short notice.
- ❑ -Can be transported by ship, air, and road.

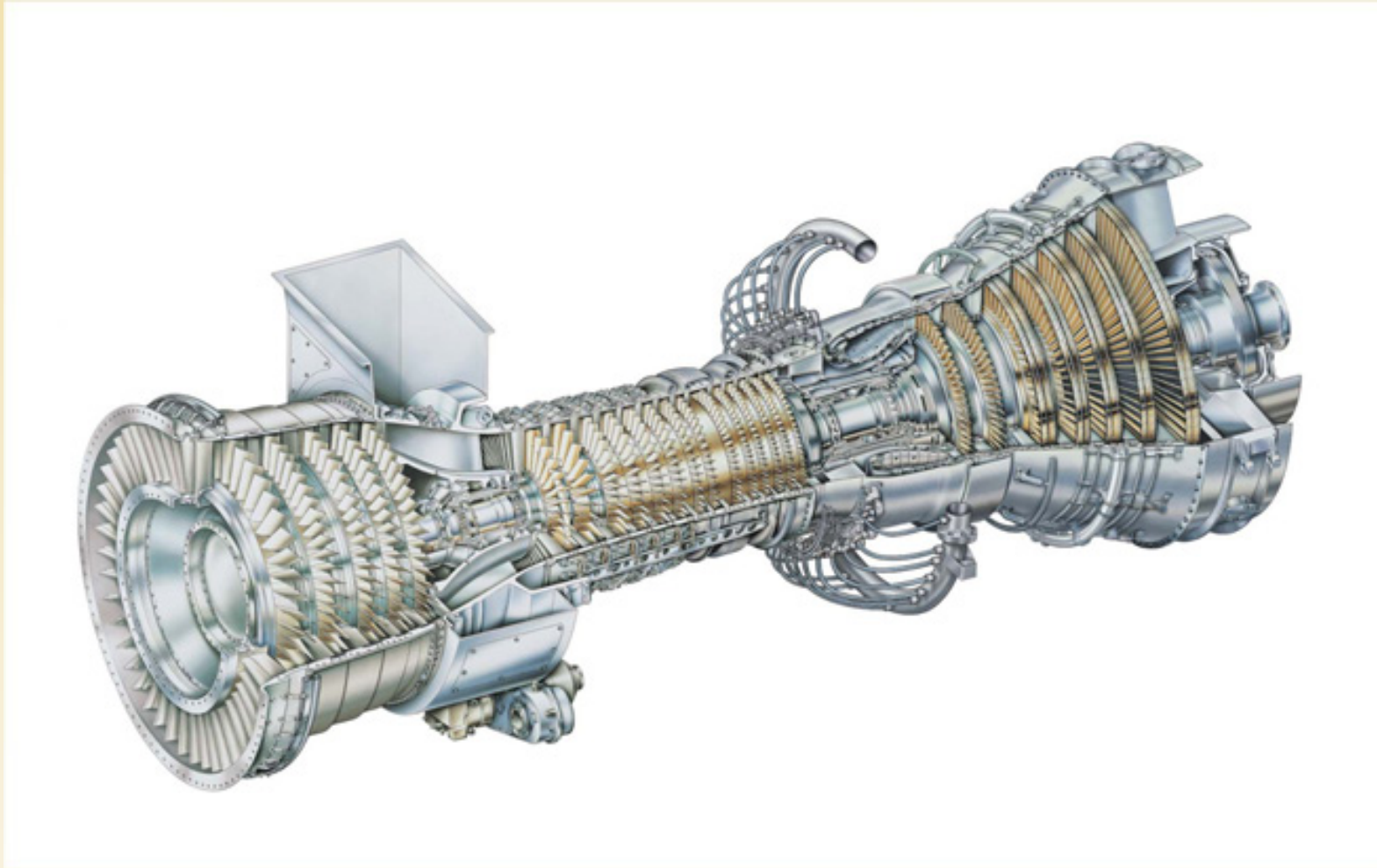


# LM5000



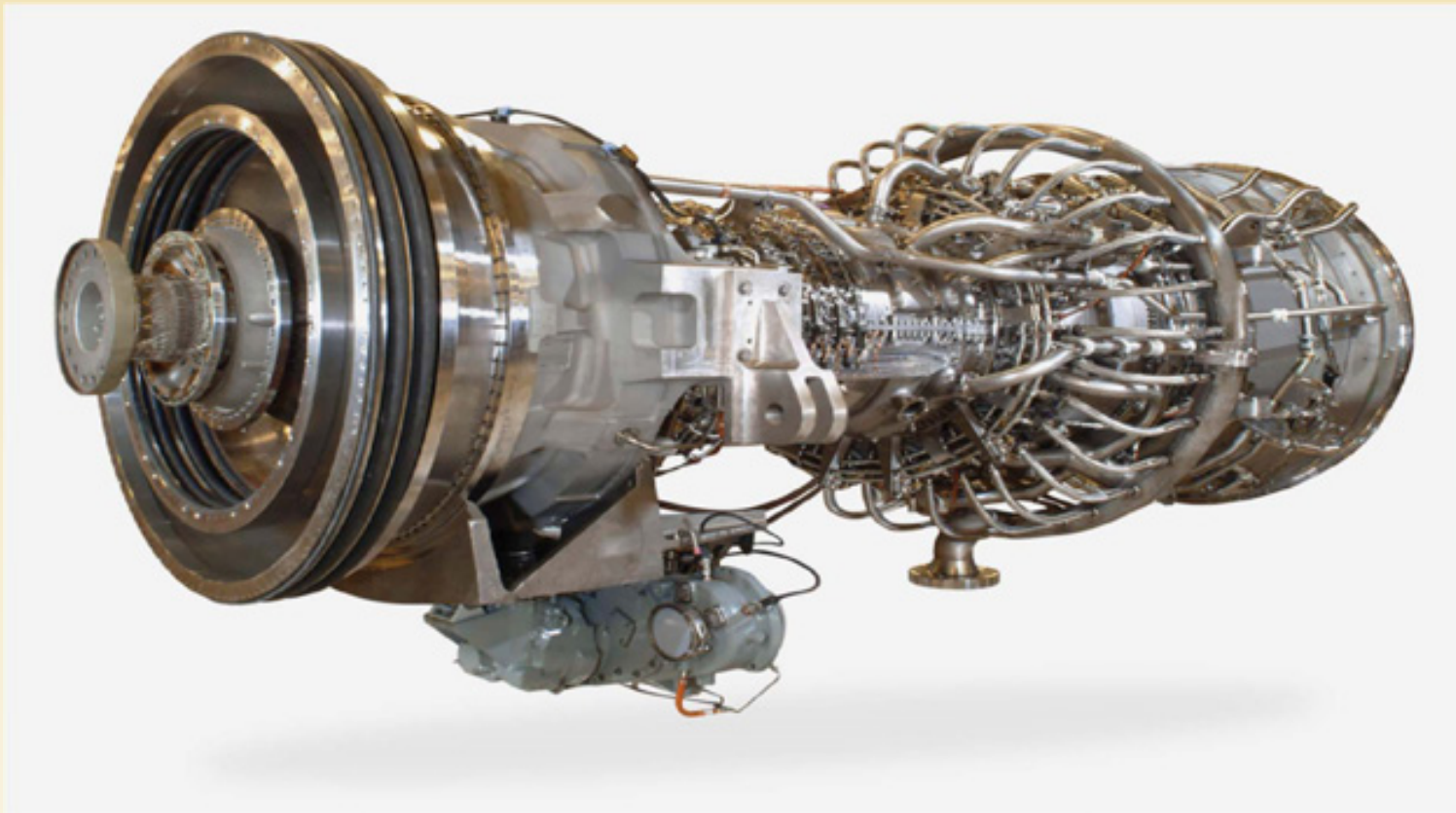


# LM6000



# LMS100

LMS100 comprises a low pressure compressor, an intercooler, a supercore and a power turbine. Supercore (comprising HP compressor, compressor rear frame, high pressure turbine and intermediate pressure turbine) is a development of the LM6000. The low pressure compressor is from the 6FA industrial gas turbine.



## LMS100 Site

LMS100 comprises a low pressure compressor, an intercooler, a supercore and a power turbine.



# LMS100

## Quick Specs:

Power Class: 98 to 103 Mw

Thermal efficiency: 43.9% to 45%

Heat Rate: 7,592 – 7,773 BTU/kW-hr

Three Spool aero derivative industrial gas turbine hot-end drive.

Intake-Radial inlet

LP Compressor- Axial compressor 6 stages. Air deliver to an intercooler

HP Compressor- 14 stage. Over pressure ratio 42:1

Combustor - SAC/DLE

HP Turbine- Two stage

IP Turbine- two axial stages that drive the LP /Power Turbine.

LP/Power Turbine- five stage free power turbine. 3600 RPM 60-Hz and 3000 RPM 50-Hz

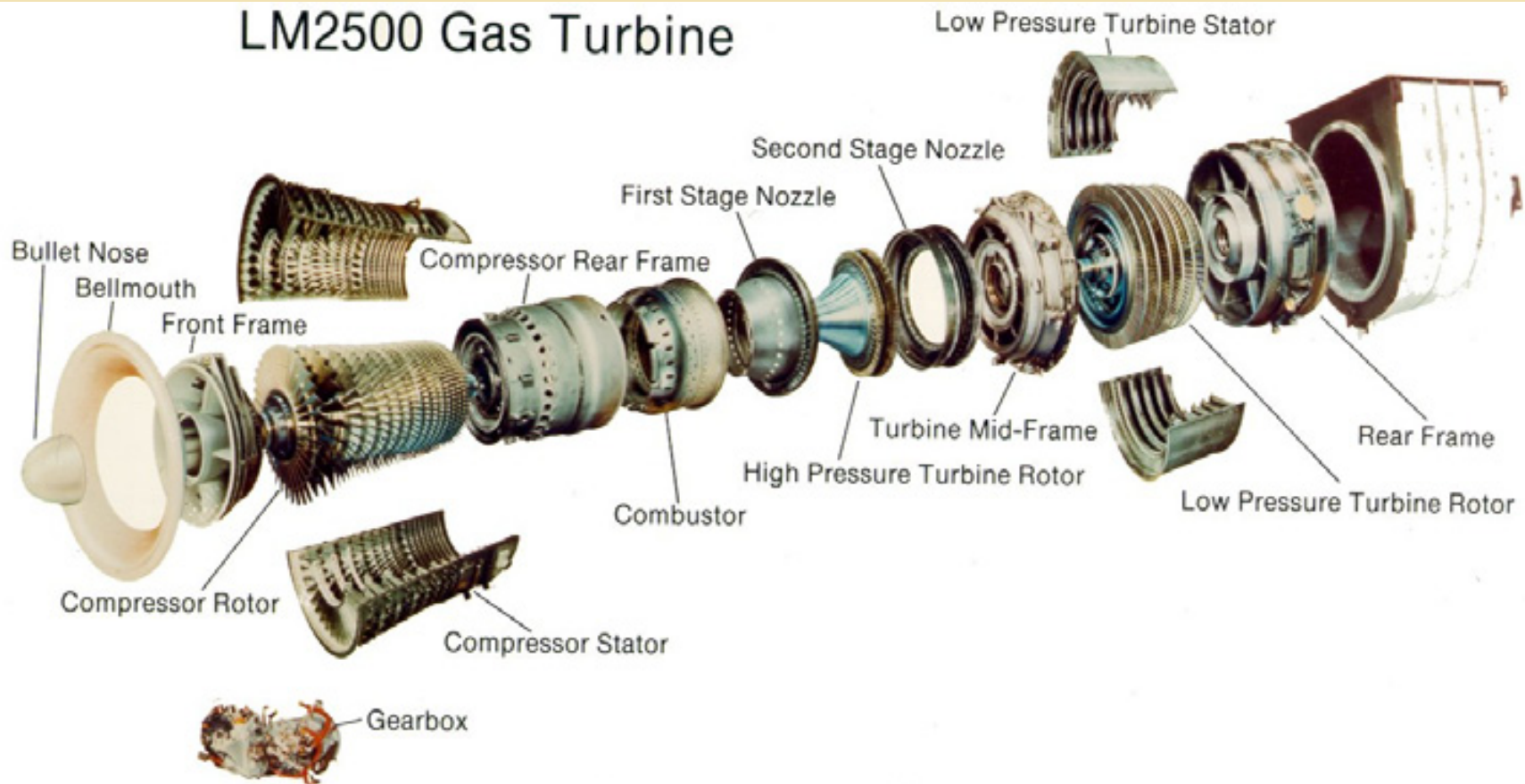


# Turbine Install



# Modules

LM2500 Gas Turbine



# Terminology



**HPC – High pressure compressor**

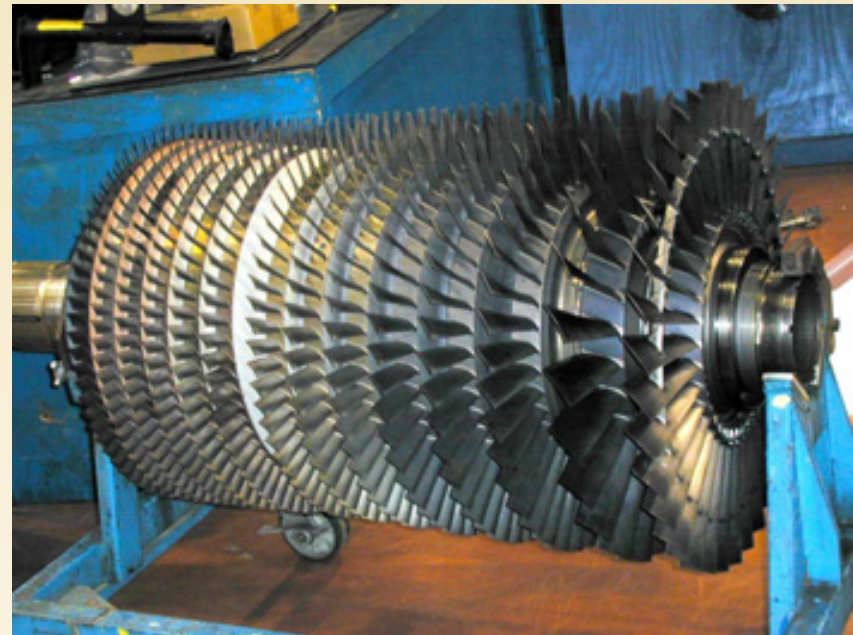
LM5000 & 6000 - 14 stages,  
LM2500 - 16 stages

**CRF – Compressor Front Frame**

Modules/Frames:

**LPC – Low Pressure Compressor**  
LM5000 & 6000 - 5 stages

**CFF – Compressor Front Frame**





# Terminology (Cont.)



**HPT – High Pressure Turbine**  
2 stages

## **LPT – Low Pressure Turbine**

LM5000 – 1 stage,

LM6000 – 5 stage,

LM2500 – 6 stage

## **TMF – Turbine Midframe**

## **PT – Power Turbine**

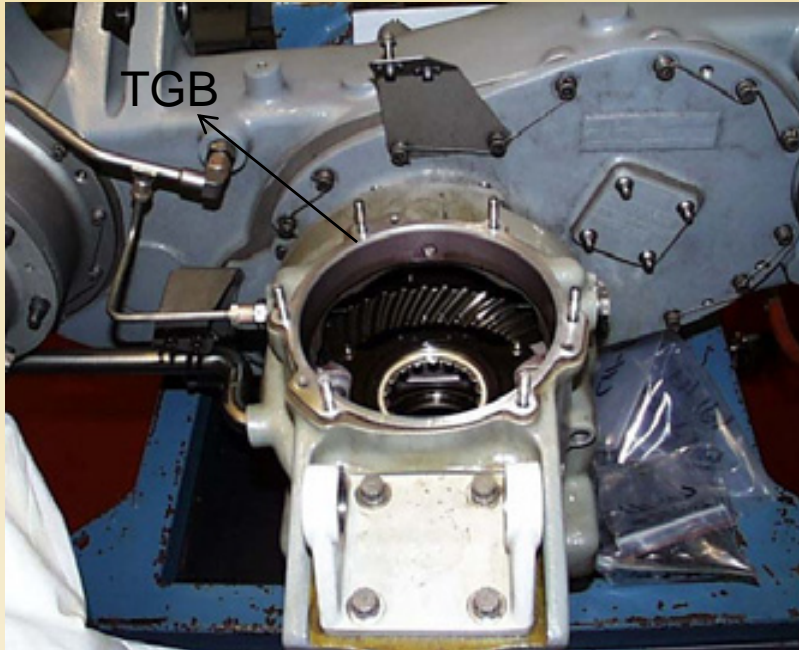
LM5000 – 3 stage power turbine,

LM2500 – PT (6 stage)



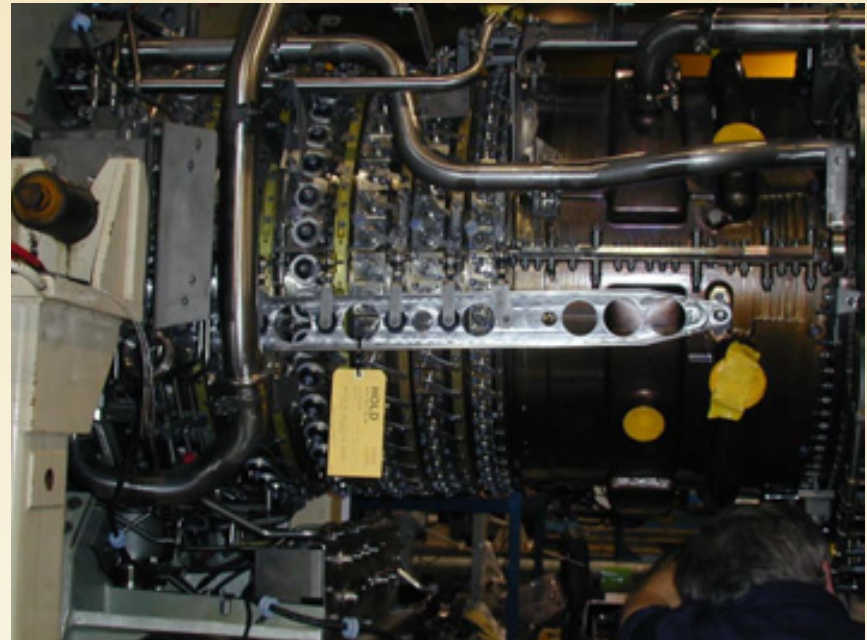


# Terminology (Cont.)



Non-Module  
Accessories/Parts  
AGB – Accessory Gearbox  
IGB – Inlet Gearbox

IGV – Inlet Guide Vanes  
VG – Variable Geometry  
VSV – Variable Stator Vanes  
VBV – Variable Bleed Valves  
(Doors)  
Collector – LM5000 and LM6000



# Terminology (Cont.)

## Engine Locations

temperatures (T), pressures (P) and speeds (XN)

0 (Zero) - Temperature and pressure at ambient conditions

1 - Temperature and pressure at the inlet to the GT (after cooling, etc.)

2 - Temperatures, pressure and speed at the inlet of the LPC

2.5 - Temperature, pressure and speed at the inlet of the HPC

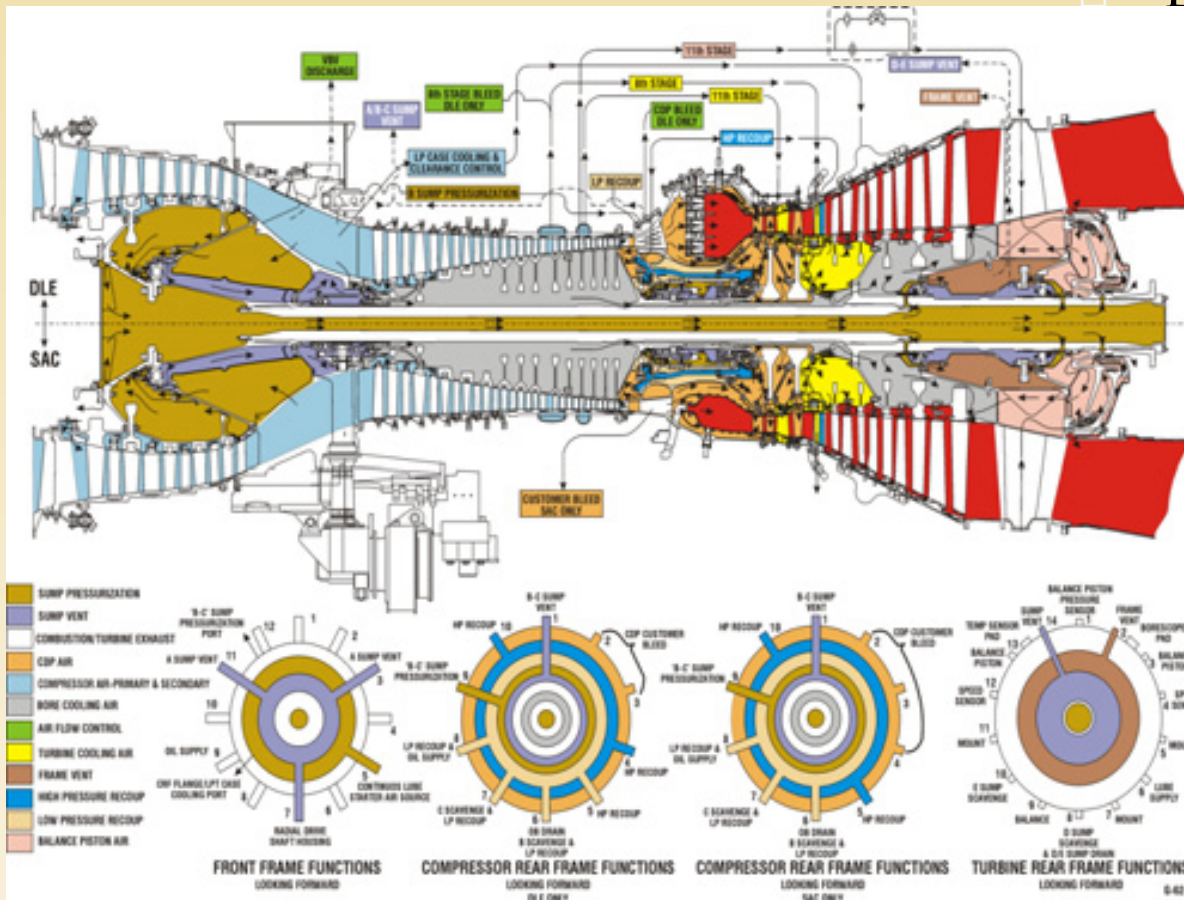
3 - Temperature and pressure at the discharge of the HPC (CDP)

4 - Temperature and pressure at the inlet to the HPT

4.4, 4.8, 5.4 - Temperature and pressure at the controlling thermocouples on the inlet to the LPT.

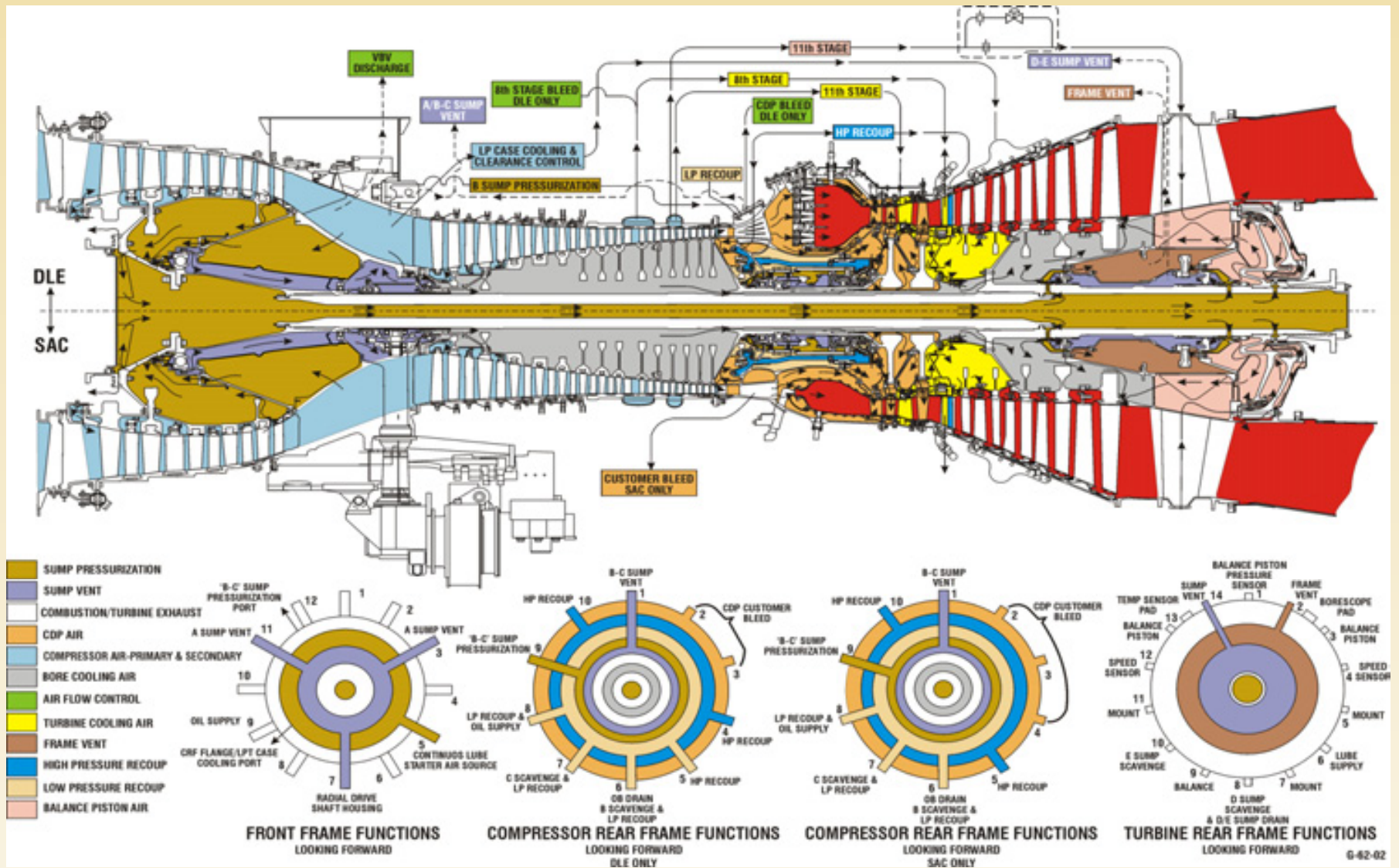
(This where the numbering schemes for each engine line starts to deviate)

XNPT - Speed of the LM5000 power turbine





# Terminology (Cont.)



# Terminology (Cont.)

- ▣ Operating/ Augmentation terms
  - STIG (Steam injection) – NO<sub>x</sub> control & power augmentation
    - ▣ STIG 80 8000 lb/Hr Steam 60 Hz 48.1 Mw 50 Hz 46.3 Mw
    - ▣ STIG 120 120000 lb/Hr Steam 60 Hz 51.6 Mw 50 Hz 49.6
    - ▣ PE
    - ▣ PH
  - Water Injected – NO<sub>x</sub> Control
  - Sprint – Power augmentation
    - ▣ Enhanced Sprint
  - DLE – Dry, low emissions



# Troubleshooting Tables

- ▣ Maintenance Levels
- ▣ Level 1 Any maintenance associated with the exterior of the engine, up to and including engine removal
- ▣ Level 2 Any maintenance activity associated with the interior or flowpath. This includes engine module assemblies, and other components
- ▣ Level 1 and 2 maintenance activities are detailed in Work Packages (WP)

# WORK PACKAGES

LM6000 PC  
GE Industrial AeroDerivative Gas Turbines

GEK 105059  
Volume II  
WP 1516 00

## WORK PACKAGE

### TECHNICAL PROCEDURES

#### IGNITER PLUG REPLACEMENT

#### (LEVEL 1 MAINTENANCE)

EFFECTIVITY: LM6000 PC GAS TURBINE MODELS

### LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 8

Page No.	Change No.	Page No.	Change No.	Page No.	Change No.
1 - 7	..... 0				
8 Blank	..... 0				

### Alphabetical Index

Subject	Page
Igniter Plug Inspection.....	4
Igniter Plug Installation.....	4
Igniter Plug Removal.....	3

# Troubleshooting Tables

## Lube Oil System

System /Event	Alarm	Shutdown or Emergency Shutdown	Step Decel to Core-Idle, Shutdown 10 Seconds Later	Slow Decel to Minimum Load	Abort Start	Notes	Troubleshooting Reference
Chip Detector Alert (Any Sump, TGB Assy)	<100 Ohms >2.5 sec						TS-13

TS-13: Chip Detector

Symptoms	Possible Causes	Troubleshooting	Corrective Action
Chip detector alert	Sensor system failure	Check chip detector per WP 4017 00 SPAM	Replace chip detector per WP 1910 00 as required
	Engine bearing failure	Check all scavenge screens, chip detectors, and system filters for debris (bearing debris plus increased engine vibration) per WPs 4017 00, 4020 00, and 4021 00	Flush lube and hydraulic systems Replace engine as required
	Lube or VG hydraulic pump failure	Check lube and hydraulic screens and system filters for debris per WPs 4020 00 and 4021 00	Flush lube and hydraulic systems Replace defective VG or lube/scavenge pump per WP 1812 00 or WP 1813 00, as required
Chip detector failure	Sensor system failure	Check chip detector per WP 4017 00 Clean chip detector SPAM	Replace chip detector per WP 1910 00 as required

# Maintenance Intervals / Work Packages

GEK 105059  
Volume 1

LM6000 PC  
GE Industrial AeroDerivative Gas Turbines

**Table 12-1** Preventive Maintenance and Servicing Checks

Maintenance Item (Note 1)	Maintenance Interval: 4000 Operating Hours, 450 Fired Starts, or Annually (whichever comes first)	Procedure Reference
Borescope Inspection	X and (Note 5)	<a href="#">WP 4015 00</a>
Inlet and Coupling Inspection	X and (Note 4 and 5)	<a href="#">WP 4010 00</a> and Packager's Manual
Enclosure Inspection	X and (Note 4 and 5)	Packager's Manual
External Engine Inspection	X and (Note 4 and 5)	<a href="#">WP 4012 00</a>
Lube and Scavenge Pump Inlet Screen and Filter Inspection	X and (Note 5)	<a href="#">WP 4020 00</a>



# Maintenance and Service Check Notes

## NOTES:

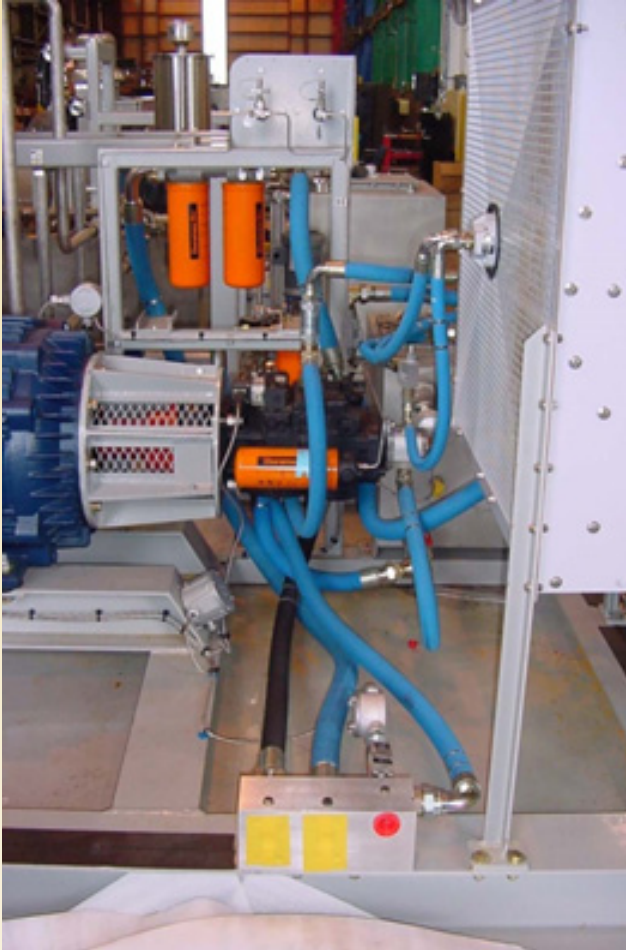
1. Inspections within the enclosure shall not be made with engine operating above idle speed.
2. Semiannual inspections shall be made with the engine shut down.
3. Change on-engine liquid fuel filter element whenever a 5-7 psi filter  $\Delta P$  is noted on user gage.
4. Inspections shall be made anytime maintenance is performed in the area or when the area is accessible.

*Table 12-1B. Special Inspections*

Maintenance Item (Note 1)	Maintenance Interval: 4000 Operating Hours, 450 Fired Starts, or Annually (whichever comes first)	Procedure Reference
High Pressure Turbine Diffuser	X (Until Service Bulletin LM6000-IND-0216 is incorporated)	Service Letter LM6000-03-06 R1
Inlet Gearbox Spline	X	Service Letter LM6000-04-01 R2
High Pressure Compressor Stage 11 Manifold Check Valve	X	Service Letter LM6000-04-02

# BOP Equipment

Hyd Start



Sprint



# BOP Equipment

Generator



Aux Skid





# BOP Equipment

**CHILLER**



**COOLING TOWER**

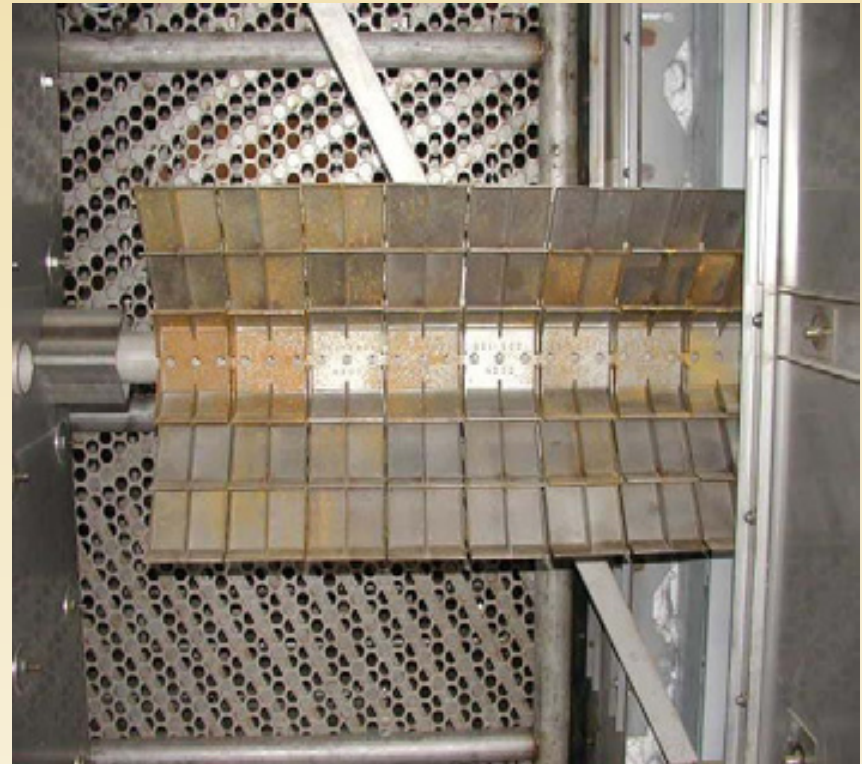


# BOP Equipment

Gearbox



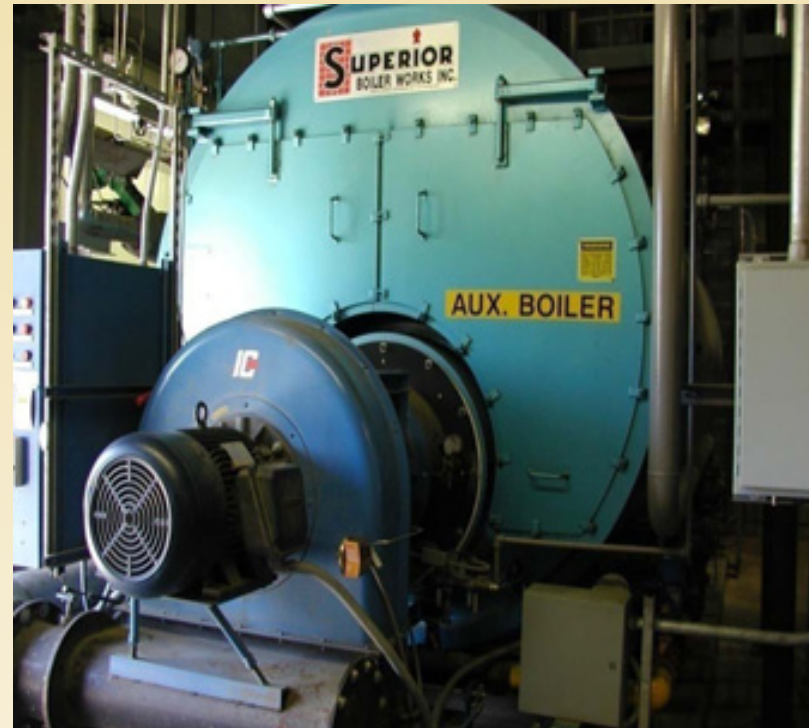
Duct Burner



# BOP Equipment

Air Compressor

Aux Boiler





# BOP Equipment

## Steam Turbine

## OTSG



# BOP Equipment

**AMMONIA  
INJECTION**



**AIR DILUTION  
BLOWER**



# BOP Equipment

SCR

50 HZ GEN/GEARBOX  
OIL





# Recommended SOP's

- Do you have access to LM Tech Doc's? Contact CSM
- Oil/Gas Analysis Program
- Vibration Analysis (BOP)
- Site Specific Start and Stop Procedures
- Material History
- CMMS/Inventory/Special Tooling/Budgeting/Spare Parts
- Training Plan



An aerial photograph of an industrial facility, likely a power plant or refinery. The scene is dominated by large, rectangular water treatment tanks in the upper half, with a large body of water in the center. To the right, several large industrial buildings are visible, with thick white steam or smoke rising from them. In the foreground, there are numerous large, cylindrical storage tanks arranged in rows. The facility is surrounded by a mix of green fields, brownish soil, and dense evergreen forests. The overall lighting suggests a clear day with some shadows cast by the structures.

ANY QUESTION?

Enjoy Your  
Conference