LM2500 LM5000 LM6000 LMS100

WTUI 2023 New Conference Attendee

Good Morning and welcome to the 2023 WTUI conference.

My name is Andrew Gundershaug and I will be leading the New Conference session this year – we encourage your interaction during the sessions – this is your conference and the more participation we have, along with sharing of information, will provide for a far greater conference experience.

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Email : andrewg@calpine.com

Whats App Group

If you have a conference related question you can ask it within the Whats App Group for new users…

Join the WTUI group

Then join the “New User

Chat Group”

ANTITRUST STATEMENT

The purpose of the WTUI Conference is to provide a means to advance the availability and reliability of General Electric aeroderivative gas turbines, to provide members an environment for discussion of same, to establish communication links with General Electric to convey the needs and interests of plant owners and to enhance the economic viability of our facilities.

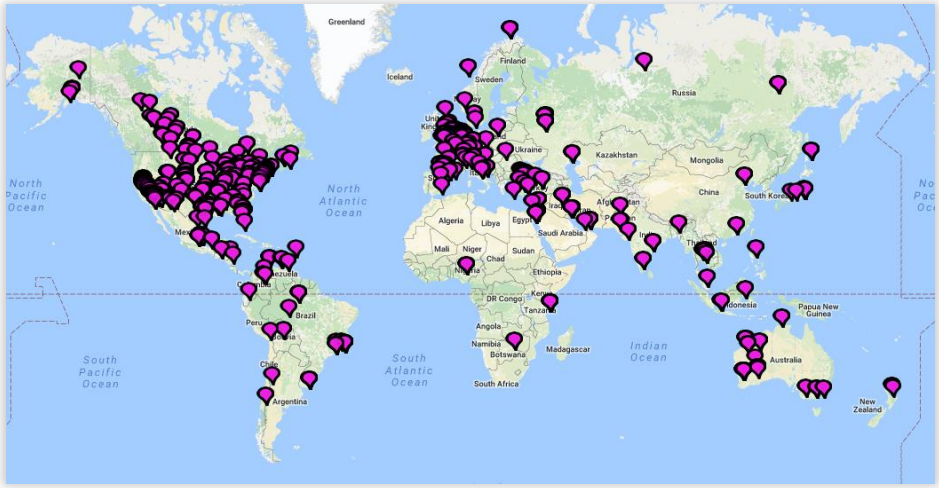
WTUI meetings are in no way intended to afford an opportunity to discuss any practices that may restrain competition or improperly or illegally affect power production equipment or gas or electric markets or otherwise violate antitrust laws.

If, at any point during this meeting, anyone present becomes concerned that any discussion taking place here is leading toward discussion of such inappropriate matters, that person should so indicate and the discussion will be immediately discontinued.

Introductions

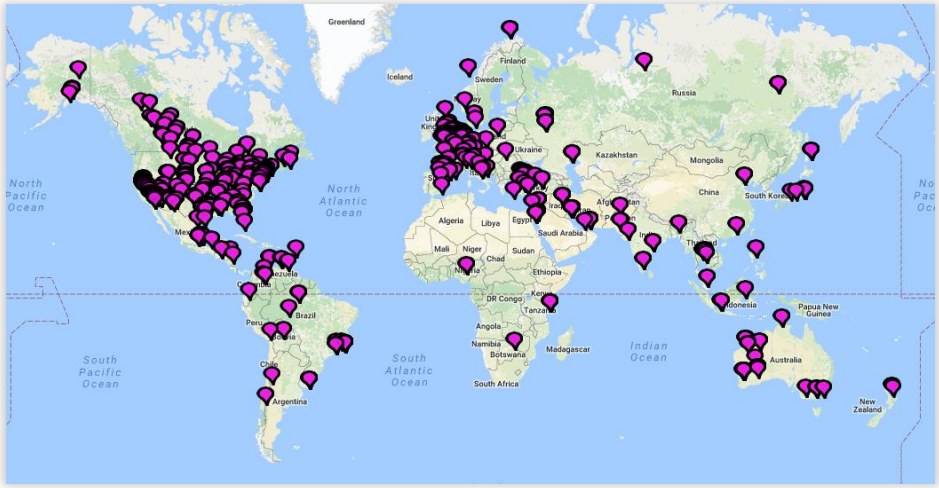
WTUI brings people for all over the word, its not unusual to meet people from diverse places around the world. Below is a map from a few years ago noting the location of LM6000 units around the world…

25 Countries in attendance including USA/ 42 States



Introductions

- Where are you from…NA, Europe…
- What type of plant – Mechanical Drive, Simple Cycle, Combined, Cogeneration? Off shore
- LM2500, TM, LM5000, LM6000, LMS100??



WTUI Participation Checklist

Without goals we leave outcome to chance, please consider the following questions:

- What do you expect to learn?
- What sessions are you planning to attend?
- WTUI is a large organization (someone can likely help you and has seen your issue previously), what problems are you trying to solve?
- If you don’t understand please ask
- Participate in the discussions
- Solve your problem
- Network

How is WTUI different than an OEM Conference?

1. *WTUI is a volunteer organization*. The board is comprised of plant owners and engine operators. You can become a member of the board !!

2. *WTUI values the expertise of Users, Technical Experts, ASPs, and the OEM.*

3. *The goal is to help you understand how to achieve the highest level of availability and to decrease failures and downtime.*

4. *No one is selling you anything, the solutions should sell themselves.*

WTUI

San Diego 2023

LM2500 LM5000 LM6000 LMS100

WTUI 2023 Session Chairs

Andrew Gundershaug, New User Session Chair.
Plant Manager with Calpine Corporation.
11+ Years with WTUI 2011-2023.
Experience with LM2500, LM5000, LM6000, TM2500

WTUI San Diego 2023

Dave Fink, LM6000 Session Chair.
Instrument & Control Technician with Onward Energy.
5 Years with WTUI 2019-2023.

WTUI
San Diego 2023

Steve Worthington, LMS100 Session Chair.
Plant Manager with Arizona Public Service. 6 Years with WTUI 2018-2023.

Garry Grimwade, LM2500 Session Chair.
Utilities Generation Technician with Riverside Public Utilities.
8 Years with WTUI 2016-2023.

Perry Leslie, LM5000 Session Chair.
Plant Technician with Wellhead Services.
10 Years with WTUI 2014-2023.

WTUI
San Diego 2023

WTUI History

- Established in 1990, WTUI conference and exhibition is an event supporting the aeroderivative power generation industry. The organization believes in the education, training and development of power professionals, power plant employees, students, and equipment/parts suppliers to continue to advance the power generation sector. With the support of a board of directors and a management field of leading industry experts, the conference is known in the industry as the best place to meet, network, gain knowledge of operations and maintenance issues affecting power generation plants while staying current on regulations, policies, safety and best practices in an ever-changing industry. In 2013 it became the world's largest aeroderivative users group supporting power generators.

- On Monday WTUI founding member and historian Mike Raaker will be giving a comprehensive overview

There is a lot of information, how do I digest the content

As mentioned in the previous slides, have a plan:

- What sessions should I attend?
- What is all of the Jargon?
- Engine nomenclature

Agenda Overview – What session should I attend??

- WTUI is a large conference – what sessions should I attend
  - General Session
  - Breakout Sessions
  - Technical Sessions
  - Vendor Area
  - Social Events

Agenda Overview - Sunday

Sunday, March 12, 2023

7:30AM - 1:00PM	**Golf Tournament** - Riverwalk Golf Club Bus departs Hilton Bayfront lobby 6:15AM
2:00PM - 7:30PM	**Conference Registration** - Sails Pavilion Lobby
3:30PM - 5:00PM	**Welcome to WTUI / Conference Familiarization** - Room 9 All new registered conference attendees
5:30PM - 8:30PM	**Exhibitor Sponsored Welcome Reception** - Sails Pavilion All registered conference attendees and spouses/guests

Agenda Overview – Monday – What do I attend?

Monday, March 13, 2023

7:00AM - 4:00PM	**Conference Registration** - Sails Pavilion Lobby
7:00AM - 8:00AM	**Breakfast** - Sails Pavilion All registered conference attendees
7:00AM - 5:30PM	**Exhibit Hall** - Sails Pavilion **Must have name badges to enter**
8:00AM - 9:30AM	**General Session/WTUI 1990-Present** - Room 6AB All registered conference attendees **Note: WTUI jackets will be raffled precisely at the beginning of session.**
9:30AM - 10:30AM	**Authorized Service Providers Presentations (IHI, MTU, TCT)** - Room 6AB All registered conference attendees
10:30AM - 10:45AM	**Break** - Sails Pavilion
10:45AM - 11:45PM	**Worldwide Gas Turbine Business Update - Axford Consulting** - Room 6AB All registered conference attendees
11:45AM - 12:00PM	**GE Services Presentation** - Room 6AB All registered conference attendees
12:00PM - 1:00PM	**Lunch (Activities Awards)** - Sails Pavilion **Must have name badges to enter**
12:00PM - 2:30PM	**Exhibit Hall - Sails Pavilion** **Must have name badges to enter**
1:30PM - 2:30PM	**Women In Power** (JoAnn Haynes, CleanAir Engineering) **-** Room 9
2:30PM - 5:30PM	**Breakout Meetings: Users + Authorized Service Providers + GE** LM2500 - Chairperson: Garry Grimwade, Riverside Public Utilities - Room 6DE LM5000 - Chairperson: Perry Leslie, Yuba City Cogeneration - Room 10 LM6000 - Chairperson: Dave Fink, Onward Energy - Room 6CF LMS100 - Chairperson: Steve Worthington, Arizona Public Services - Room 11AB **Note: WTUI jackets will be raffled precisely at the beginning of selected sessions.**
6:30PM - 10:00PM	**Monday Night Reception** - Room 6AB **ALL CONFERENCE ATTENDEES AND REGISTERED GUEST/SPOUSES MUST HAVE NAME BADGES/WRISTBANDS AND MUST BE 21 YEARS OLD FOR ENTRY**

Agenda Overview – Tuesday – What do I attend?

Tuesday, March 14, 2023

7:00AM - 8:00AM	**Breakfast** - Sails Pavilion All registered conference attendees
7:00AM - 4:00PM	**Conference Registration** - Sails Pavilion Lobby
7:00AM - 2:30PM	**Exhibit Hall - Sails Pavilion** **Must have name badges to enter**
8:00AM - 9:30AM	**Breakout Meetings: Users Only** LM2500 - Chairperson: Garry Grimwade, Riverside Public Utilities - Room 6DE LM5000 - Chairperson: Perry Leslie, Yuba City Cogeneration - Room 10 LM6000 - Chairperson: Dave Fink, Onward Energy - Room 6CF LMS100 - Chairperson: Steve Worthington, Arizona Public Services - Room 11AB **Note: WTUI jackets will be raffled precisely at the beginning of selected sessions.**
9:30AM - 10:00AM	**Break** - Sails Pavilion
10:00AM - 12:00PM	**Breakout Meetings: Users + Authorized Service Providers + GE** LM2500 - Chairperson: Garry Grimwade, Riverside Public Utilities - Room 6DE LM5000 - Chairperson: Perry Leslie, Yuba City Cogeneration - Room 10 LM6000 - Chairperson: Dave Fink, Onward Energy - Room 6CF LMS100 - Chairperson: Steve Worthington, Arizona Public Services - Room 11AB **Note: WTUI jackets will be raffled precisely at the beginning of selected sessions.**

Agenda Overview – Tuesday – What do I attend?

12:00PM - 1:00PM	**Lunch (Recognition Awards)** - Sails Pavilion **Must have name badges to enter**
12:00PM - 2:30PM	**Exhibit Hall** - Sails Pavilion **Must have name badges to enter**
2:30PM - 3:30PM	**Combined Cycle Journal's Best Practices** (CCJ) **-** Room 6DE All registered conference attendees
2:30PM - 3:30PM	**Monitoring Bearing Health with Confidence** (GasTops) - Room 11AB All registered conference attendees
2:30PM - 3:30PM	**Firm Dispatchable Clean Power** (Industrom Power LLC) - Room 6CF All registered conference attendees
3:30PM - 4:30PM	**Increasing Turbine Plant Performance by 10% Through Wet Fogging** (ProEnergy) - Room 6DE All registered conference attendees
3:30PM - 4:30PM	**Best Practices for Root Cause Analysis in Context of a Potential Dispute** (Exponent) - Room 11AB All registered conference attendees
3:30PM - 4:30PM	**Utilizing Integrated Path Optical CEMS (IP-CEMS) to Meet EPA Regs** (CEMTEK) - Room 6CF All registered conference attendees
4:30PM - 5:30PM	**Shaft Voltage and Current on Generators** (Iris Power) - Room 6DE All registered conference attendees
4:30PM - 5:30PM	**Benefits of Servicing & Maintaining Turbine Emissions Systems & HRSG Equip** (Groome) - Room 11AB All registered conference attendees
4:30PM - 5:30PM	**Gas Turbine SCR** (Cormetech) - Room 6CF All registered conference attendees
	Note: WTUI jackets will be raffled precisely at the beginning of each technical presentation.
5:30PM -	**Free Night - Private receptions not sponsored by WTUI**

Agenda Overview – Wednesday – What do I attend?

Wednesday, March 15, 2023

7:00AM - 8:00AM	**Breakfast** - Hawaiian Corridor (adjacent to Rooms 7-11) All registered conference attendees
8:00AM - 10:30AM	**Breakout Meetings: Users + Authorized Service Providers + GE** LM2500 - Chairperson: Garry Grimwade, Riverside Public Utilities - Room 6DE LM5000 - Chairperson: Perry Leslie, Yuba City Cogeneration - Room 10 LM6000 - Chairperson: Dave Fink, Onward Energy - Room 6CF LMS100 - Chairperson: Steve Worthington, Arizona Public Services - Room 11AB **Note: WTUI jackets will be raffled precisely at the beginning of selected sessions.**
10:30AM - 10:45AM	**Break** - Hawaiian Corridor (adjacent to Rooms 7-11)
10:45AM - 11:45AM	**GE New Products Update** - Room 6AB All registered conference attendees
11:45AM - 12:00PM	**Wrap-up and Adjourn** - Room 6AB All registered conference attendees **Note: WTUI jackets will be raffled precisely at the beginning of session.**

Acronyms

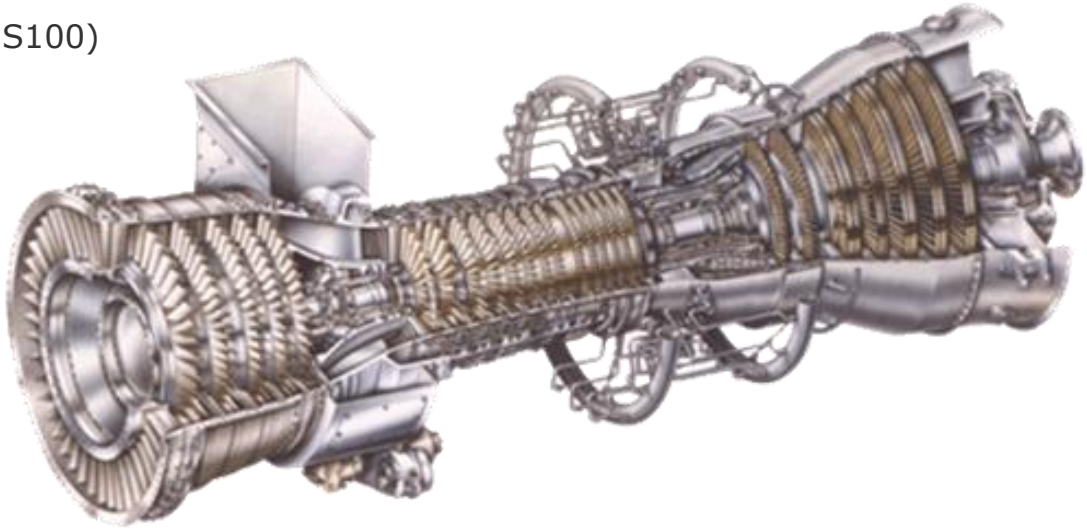
Good guide @ https://www.ccj-online.com/lm-engine-common-acronyms/

WTUI Specific

- ASP – Authorized Service Provider
- OEM = GE
- Session Chair – Individual who is the MC of your engine type. LM2500, 5000, 6000, 100

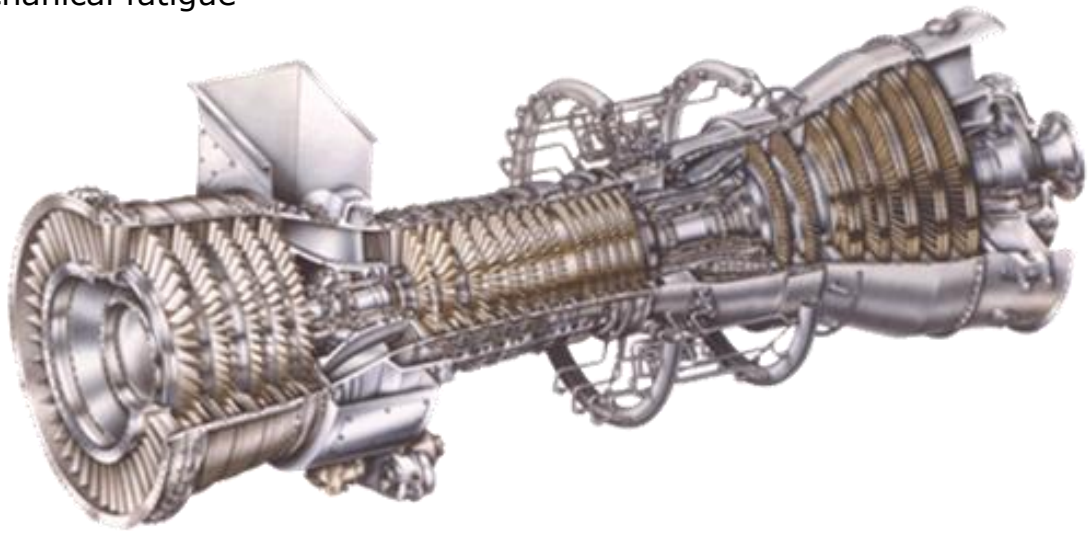
Acronyms

AGB—Accessory gearbox (also called the transfer gearbox)
CDP—Compressor discharge port
CFF—Compressor front frame
CRF—Compressor rear frame
DLE—Dry, low emissions combustor
DOD—Domestic object damage
FOD—Foreign object damage
GG—Gas generator (consists of the compressor and hot sections only)
GT—Gas turbine (consists of the gas generator pieces with the power turbine attached)
HGP—Hot gas path
HPC—High-pressure compressor
HPT—High-pressure turbine
IGB—Inlet gearbox
IGV—Inlet guide vane
IPT—Intermediate-pressure turbine (LMS100)
IRM—Industrial repair manual



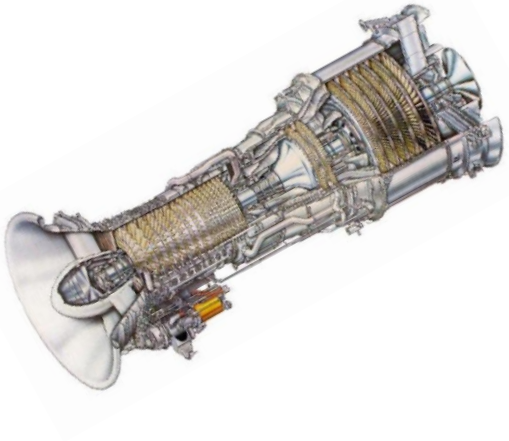
Acronyms

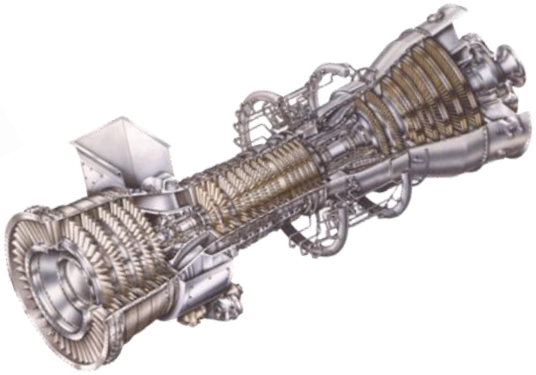
LPC—Low-pressure compressor (not on LM2500; just LM5000 and LM6000)
LPT—Low-pressure turbine
OEM—Original equipment manufacturer
PT—Power turbine (turns a generator, pump, compressor, propeller, etc)
RCA—Root cause analysis
RDS—Radial drive shaft
RFQ—Request for quote
SAC—Single annular combustor
SB—Service bulletin
SL—Service letter
SUP—Superseded part
STIG—Steam-injected gas turbine
TA—Technical advisor
TBC—Thermal barrier coating
TGB—Transfer gearbox (also called the accessory gearbox)
TMF—Turbine mid frame and thermal mechanical fatigue
TRF—Turbine rear frame
VBV—Variable bleed valve
VIGV—Variable inlet guide vanes
VSV—Variable stator vane

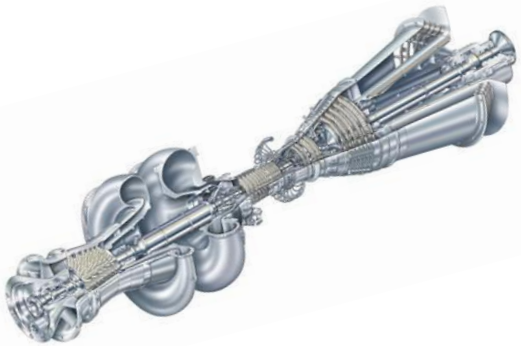


Engine Basics

Introduction to Gas Turbine Engine

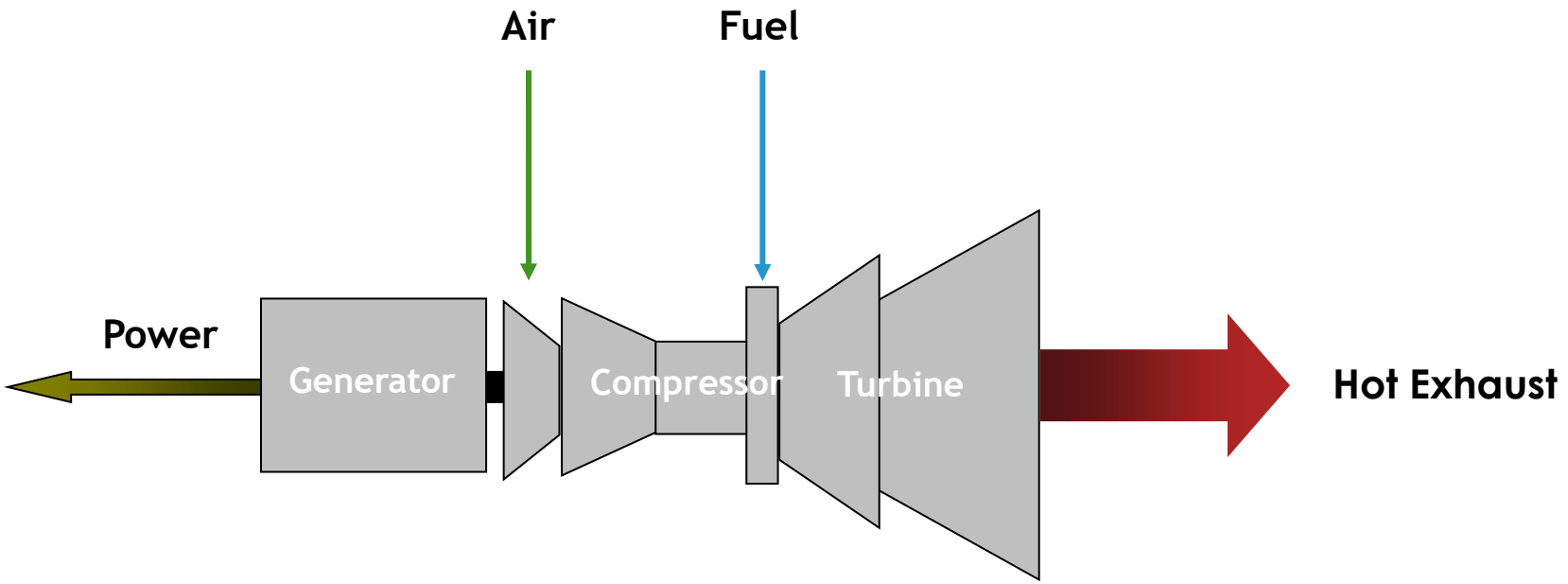






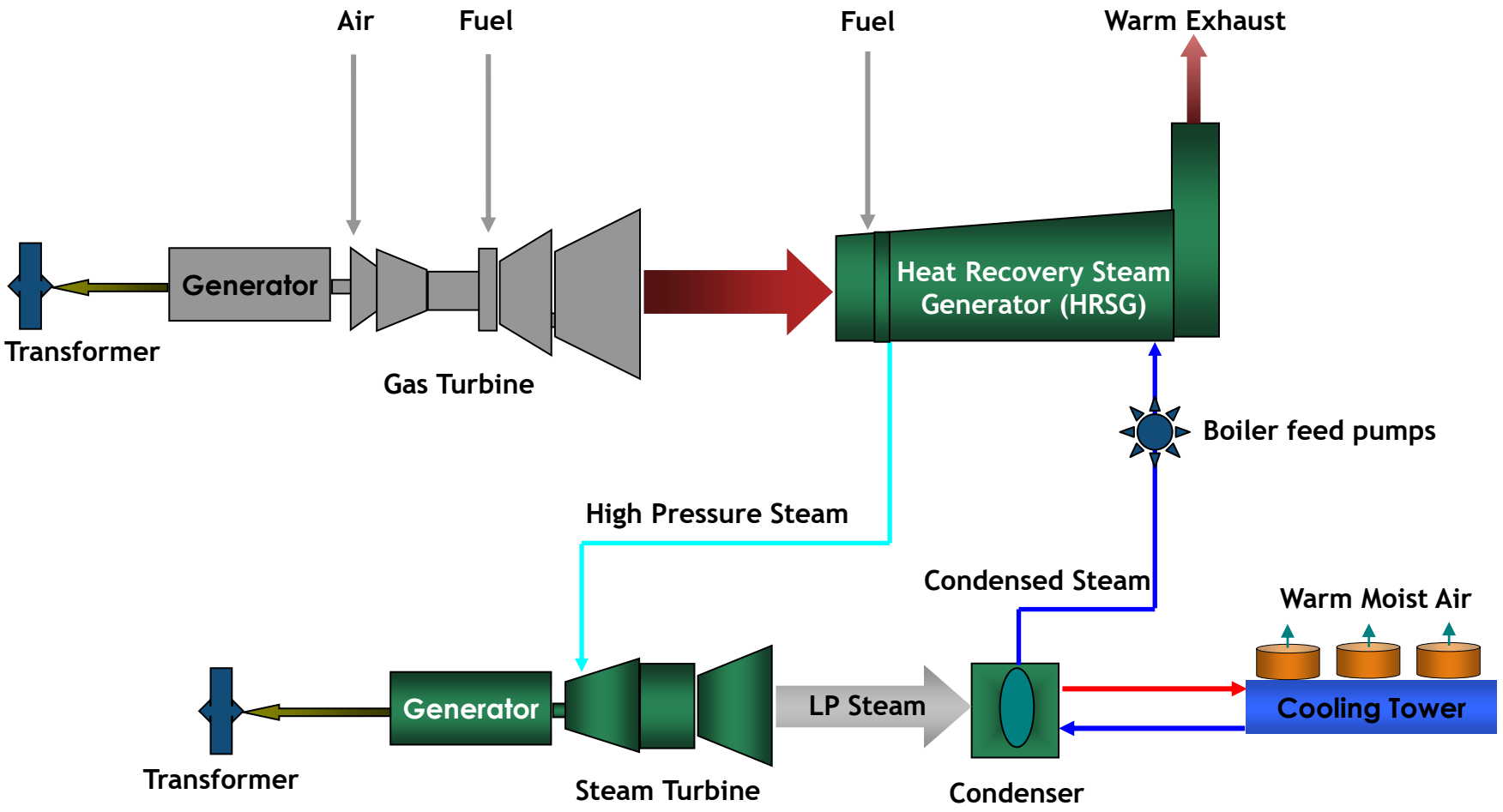
Simple-Cycle Configuration

"Peaking" technology provides ability to start up, shut down, and handle load changes quickly



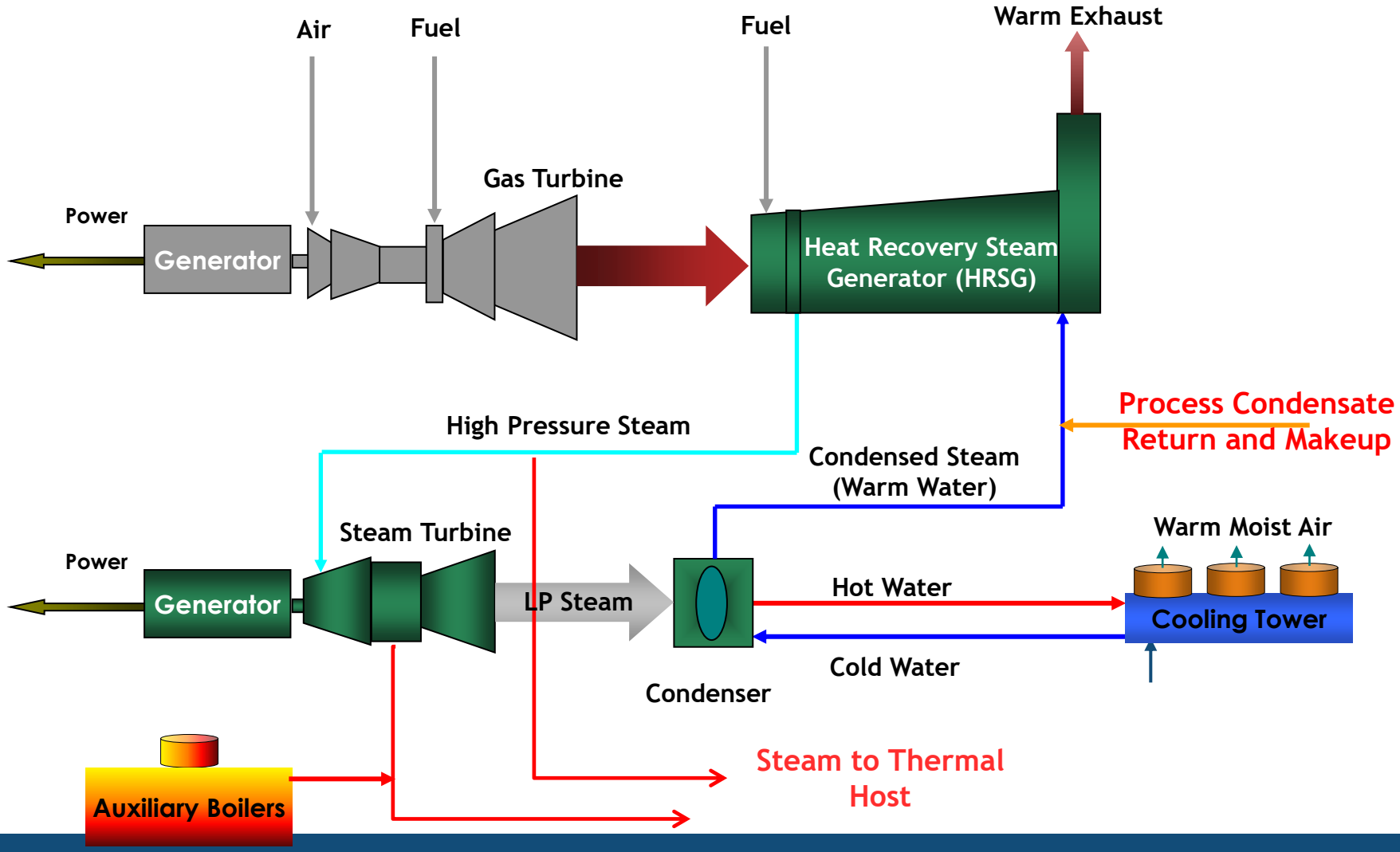
Combined-Cycle Configuration

Employs more than one thermodynamic cycle (gas and steam turbine) for improved efficiency

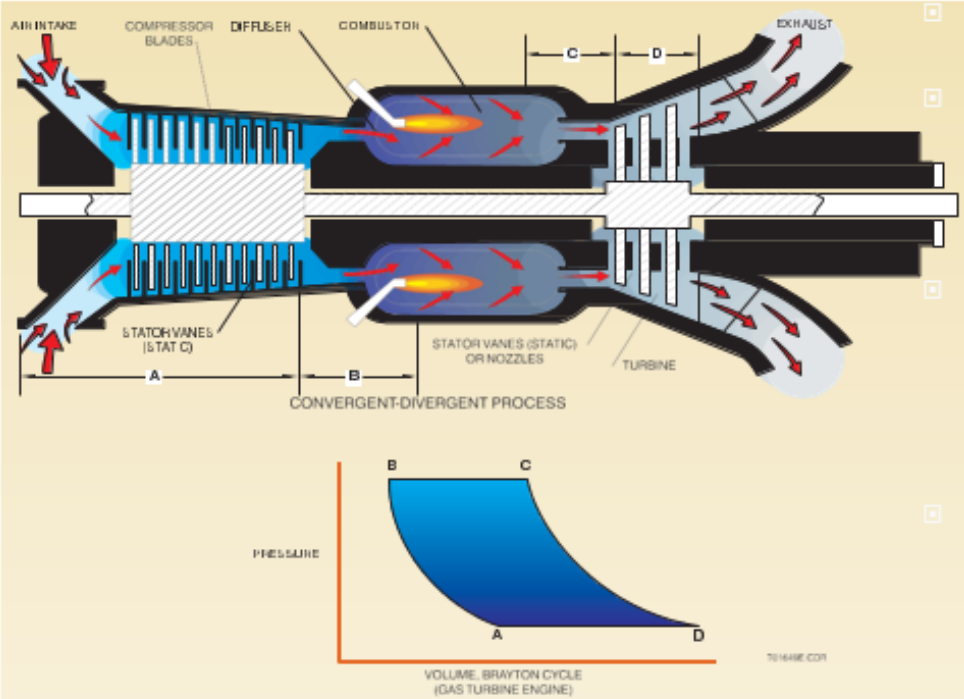


Cogeneration Configuration

Combining heat and power technology – producing more than just electricity for sale



Gas Turbine Brayton Cycle



BRAYTON CYCLE

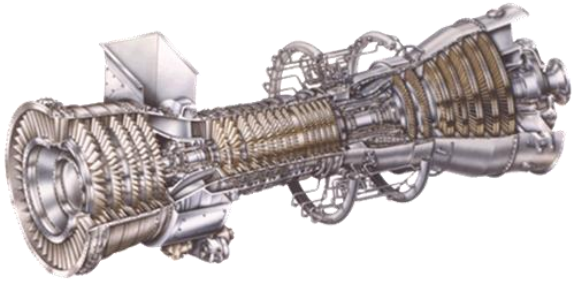
The BRAYTON steps are as follows:

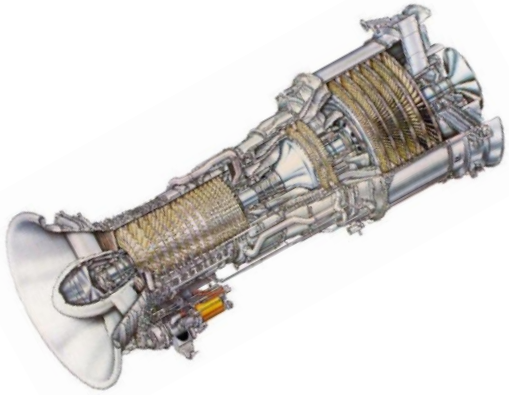
Compression occurs between the intake and the outlet of the compressor **(Line A-B).** During this process, pressure and temperature of the air increases.

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).**

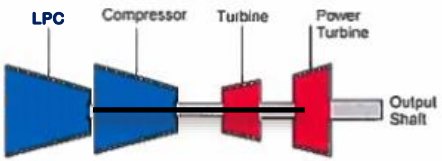
Engine Basic - Direct vs Power Turbine





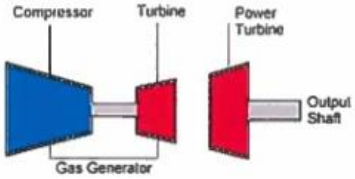
ENGINE CONFIGURATIONS

LM 6000



SINGLE SHAFT

LM 2500



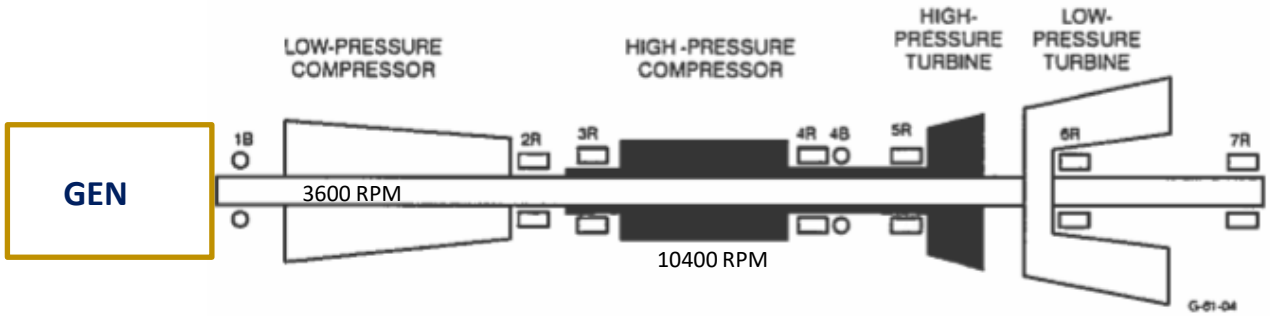
TWIN SHAFT

SINGLE SHAFT VS TWO SHAFT ENGINE CONFIGURATION

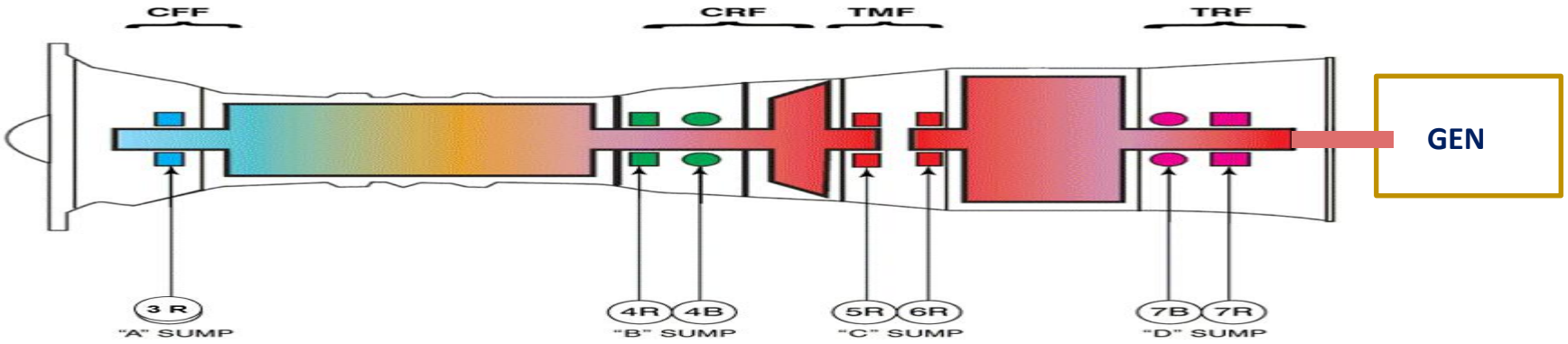
The figure above shows the two standard gas turbine shaft arrangements. Single shaft illustration is the traditional single shaft assembly. It consists of the axial flow compressor; Turbine and Power Turbine are all mechanically linked. If we add to this shaft the generator and gearbox, we have a shaft system with a high moment of inertia. This is the favored configuration for electrical generation because this provides additional speed (Frequency) stability of the electrical current during large load fluctuations.

The twin shaft illustration shows the standard two shaft arrangement with the compressor and turbine only connected, and an unconnected power turbine and output shaft that will rotate independently. This configuration is favored for variable speed-drive packages, such as pumps and compressors, because the gas generator or gas producer can run at its own optimum speed for a given load.

Engine Basic - Generator Coupling and position

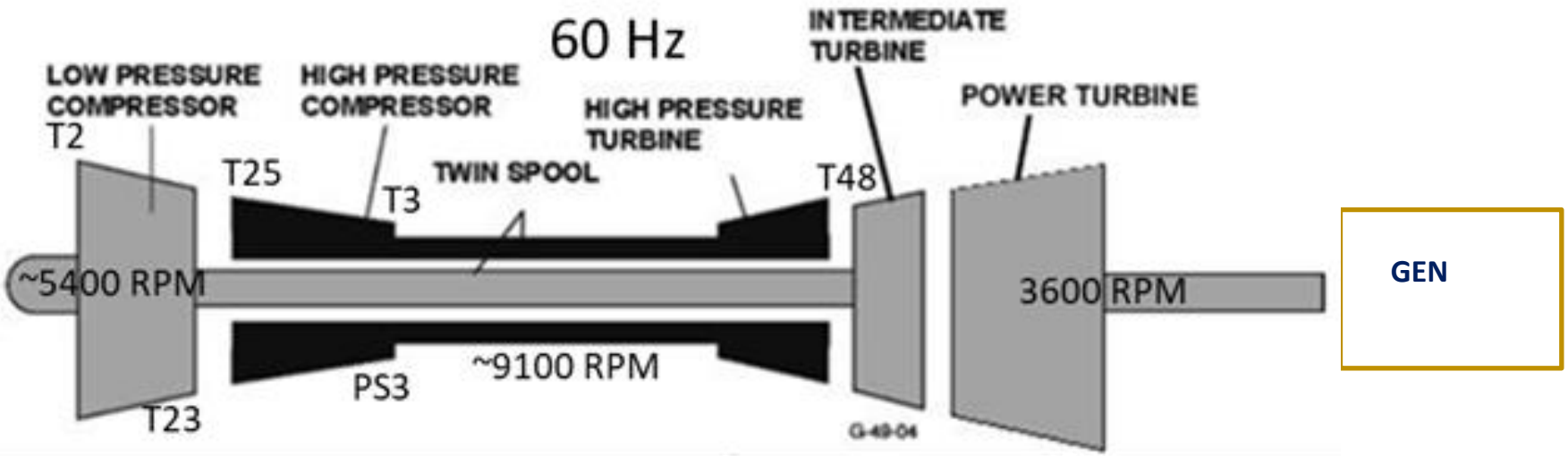


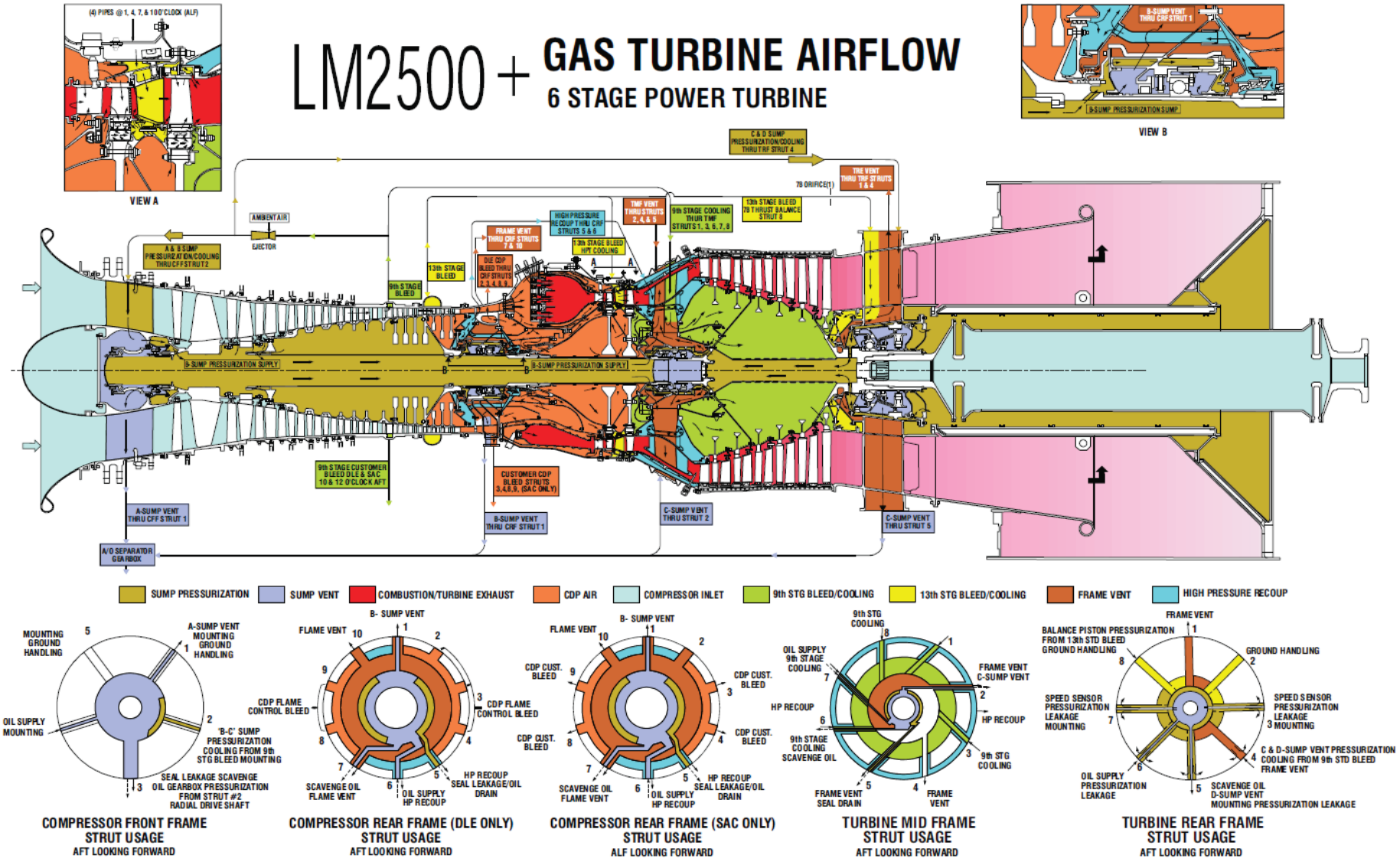
SPLIT SPOOL SHAFT DESIGN LM6000



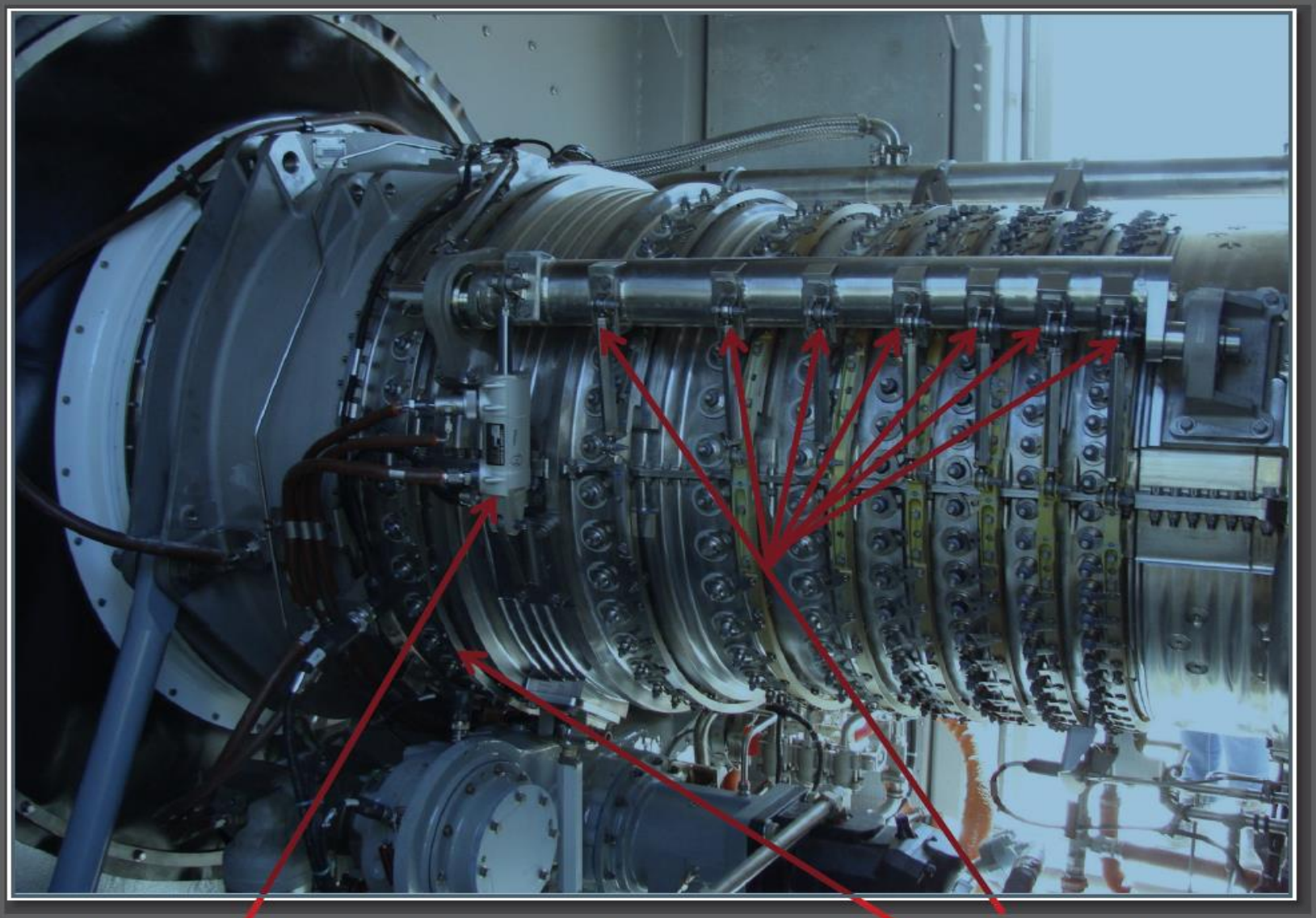
Gas Generator/PT Design LM2500

Engine Basic - Generator Coupling and position

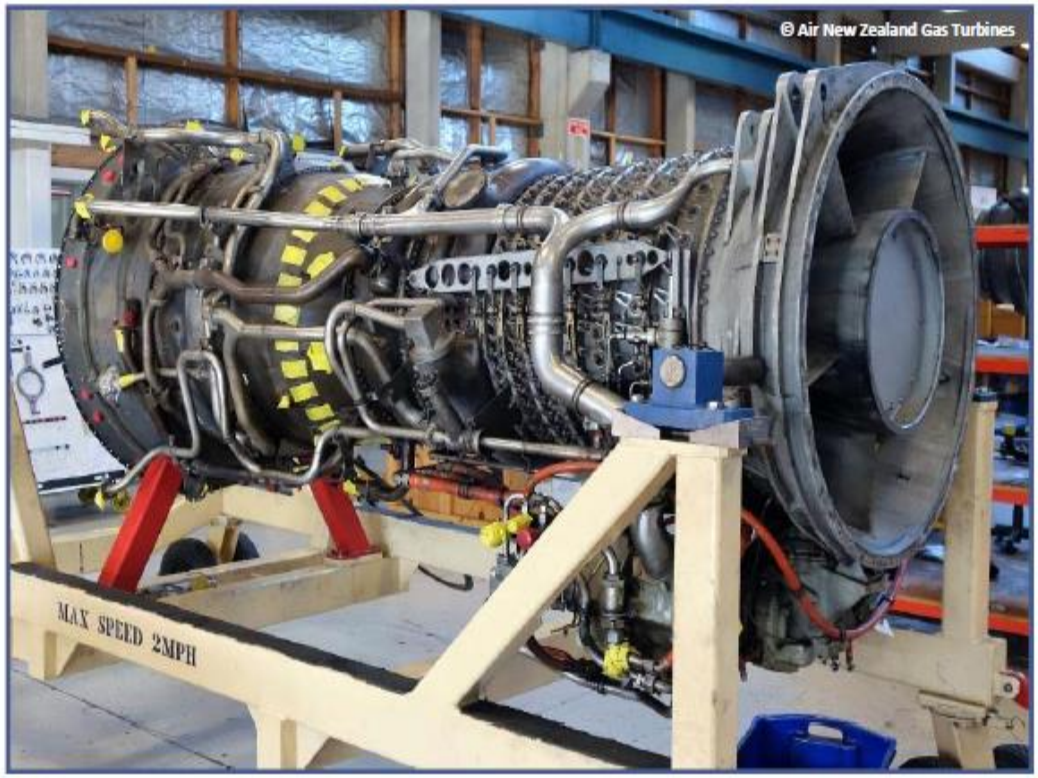


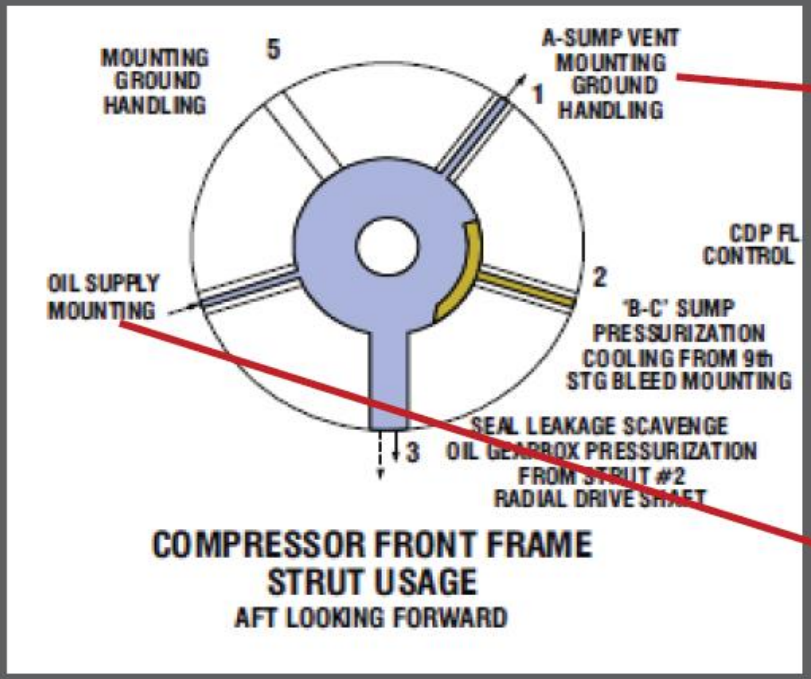


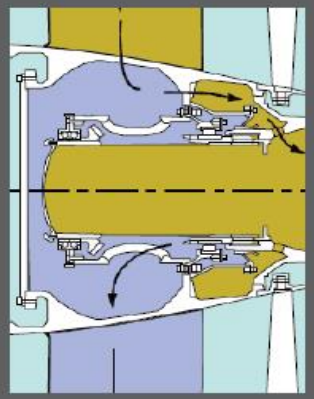
LM2500 + Gas Turbine

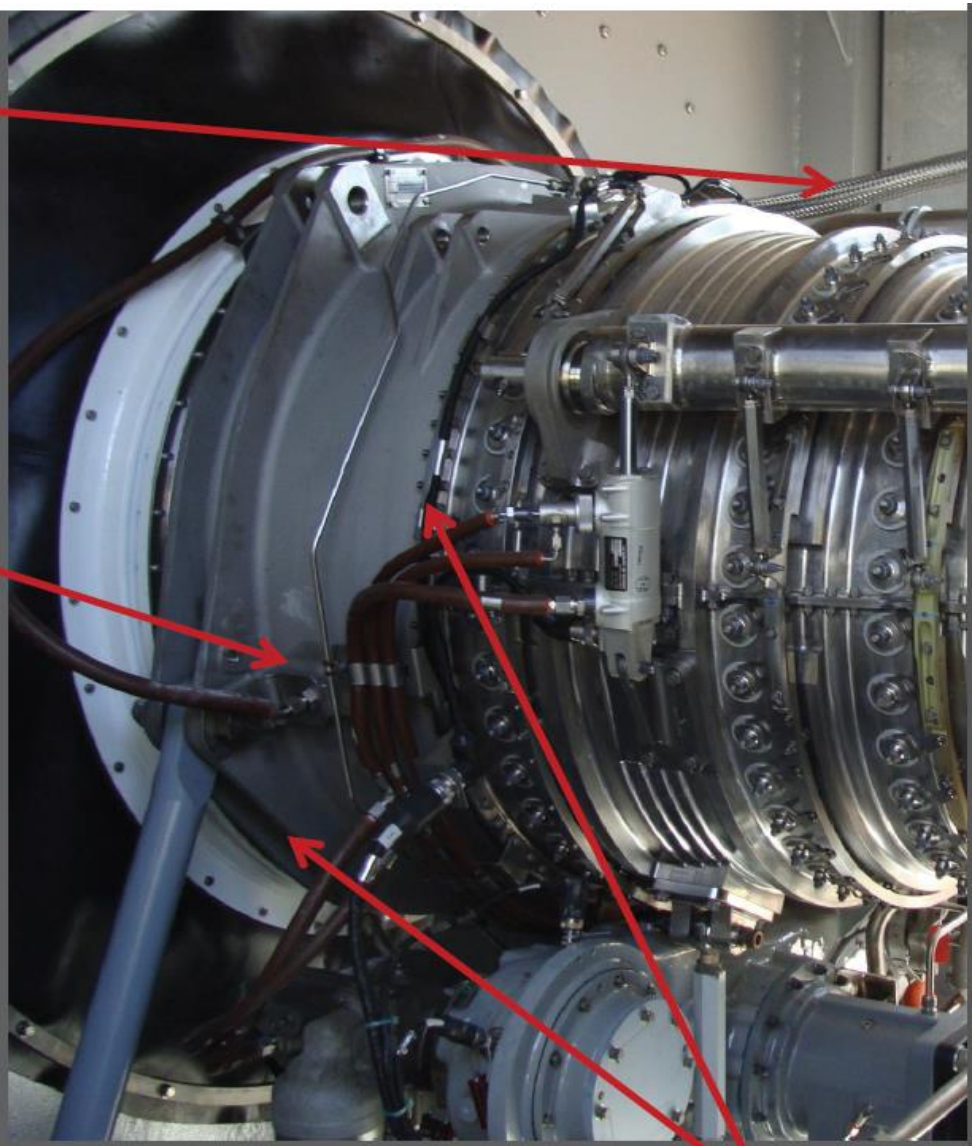


LM2500+ - HPC-High Pressure Compressor –(1) IGV & (0-6)VSV's
VSV Actuator

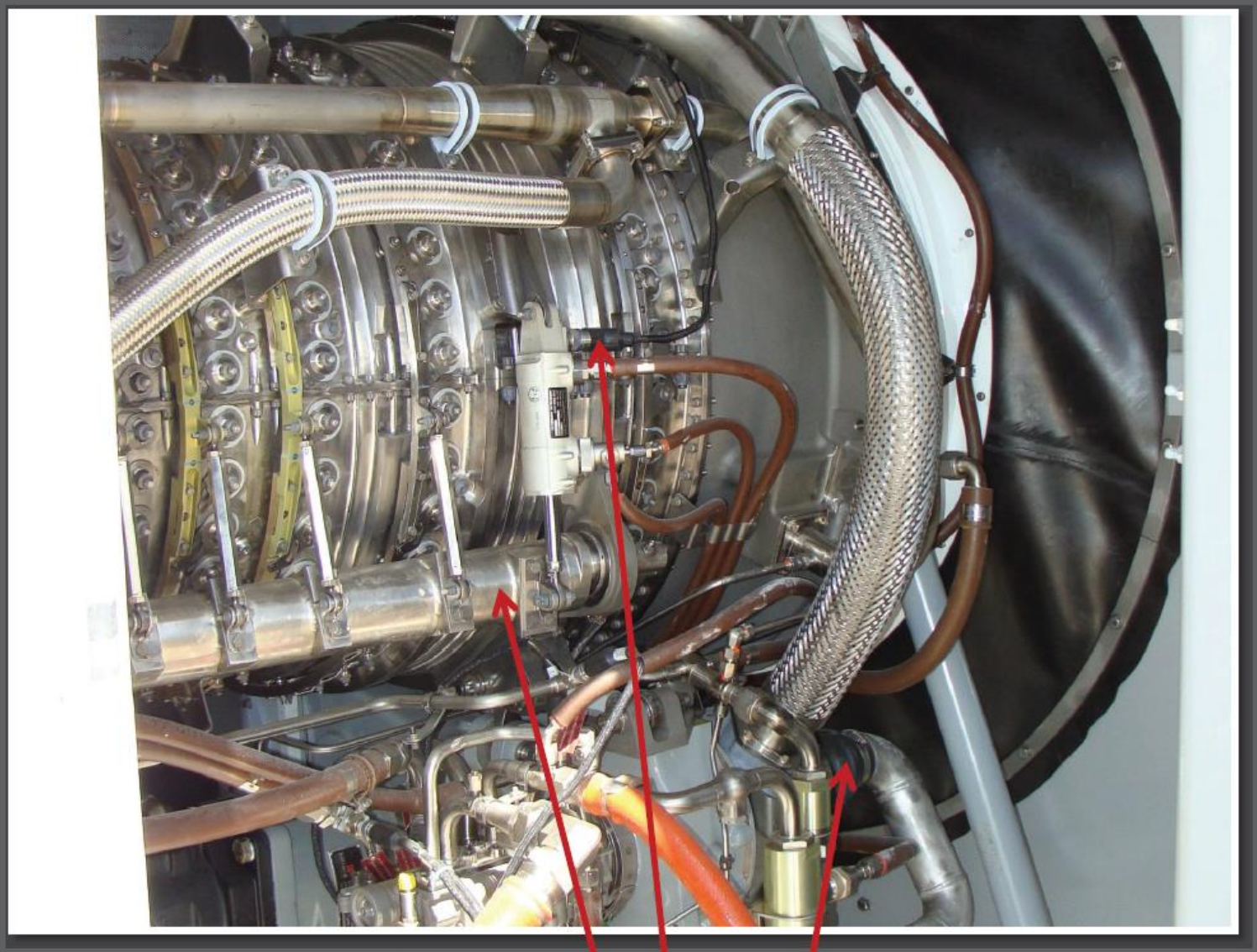

© Air New Zealand Gas Turbines
MAX SPEED 2MPH







CFF – Compressor Front Frame – Sump A



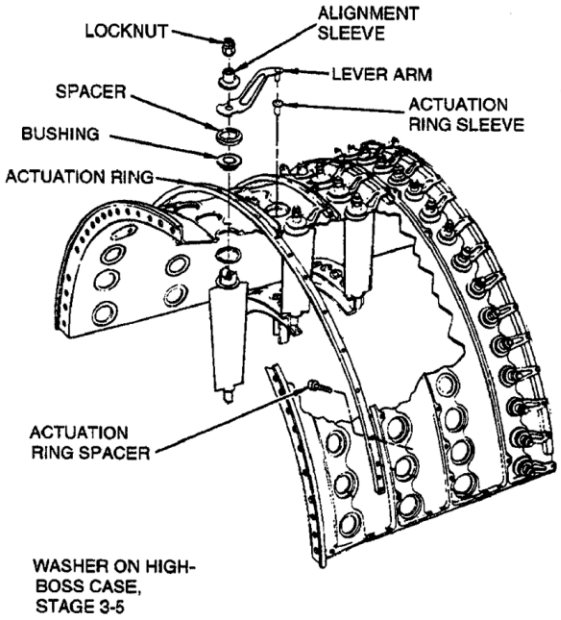
VSV System – Right Hand Side

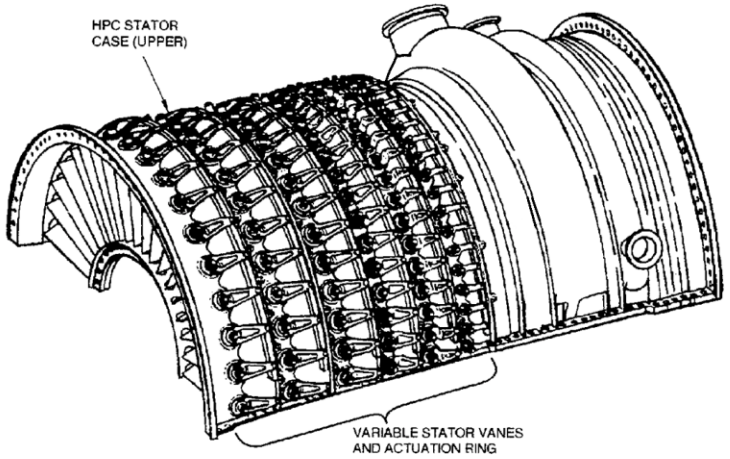
VSV Actuator – LVDT Feedback

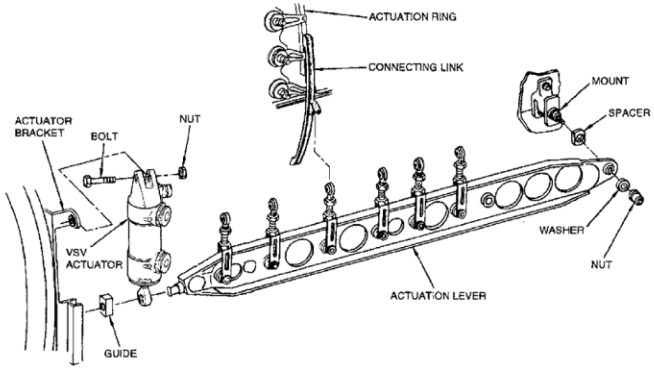
Air-Oil Separator

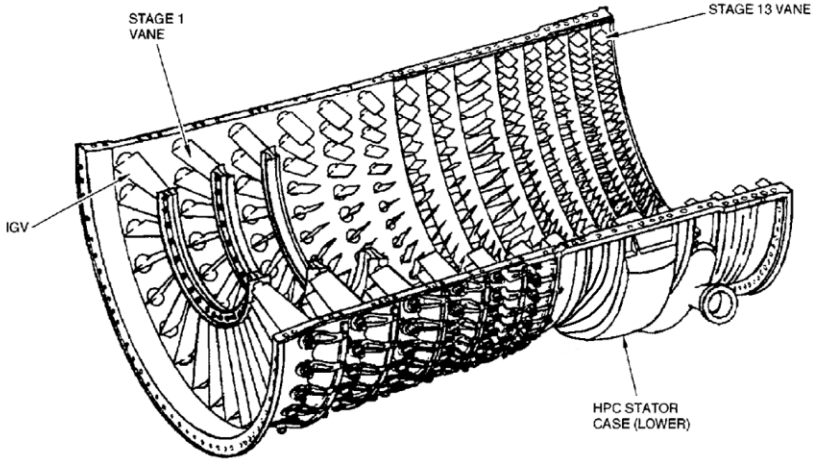
Basic Engine

Engine Core Module HPC



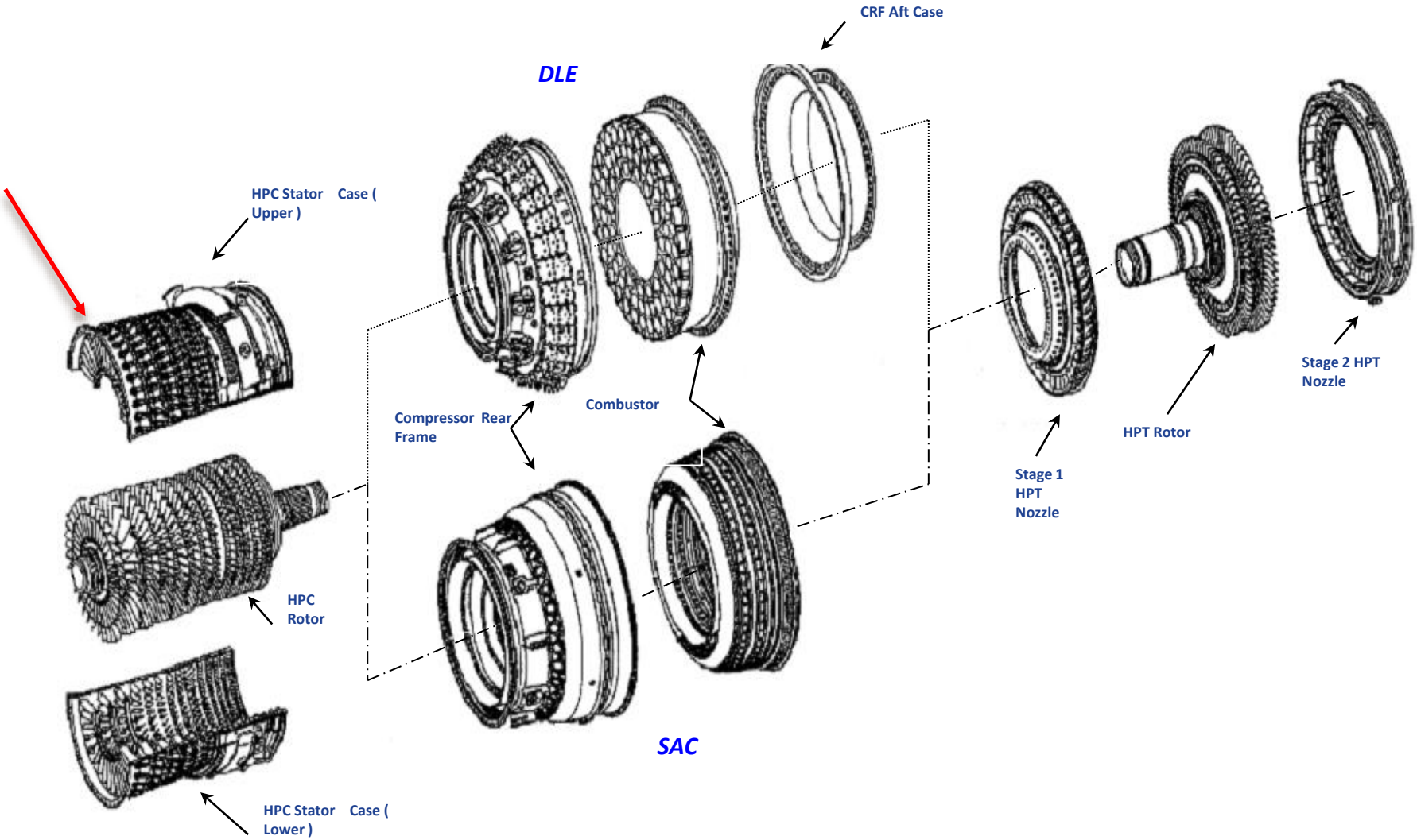


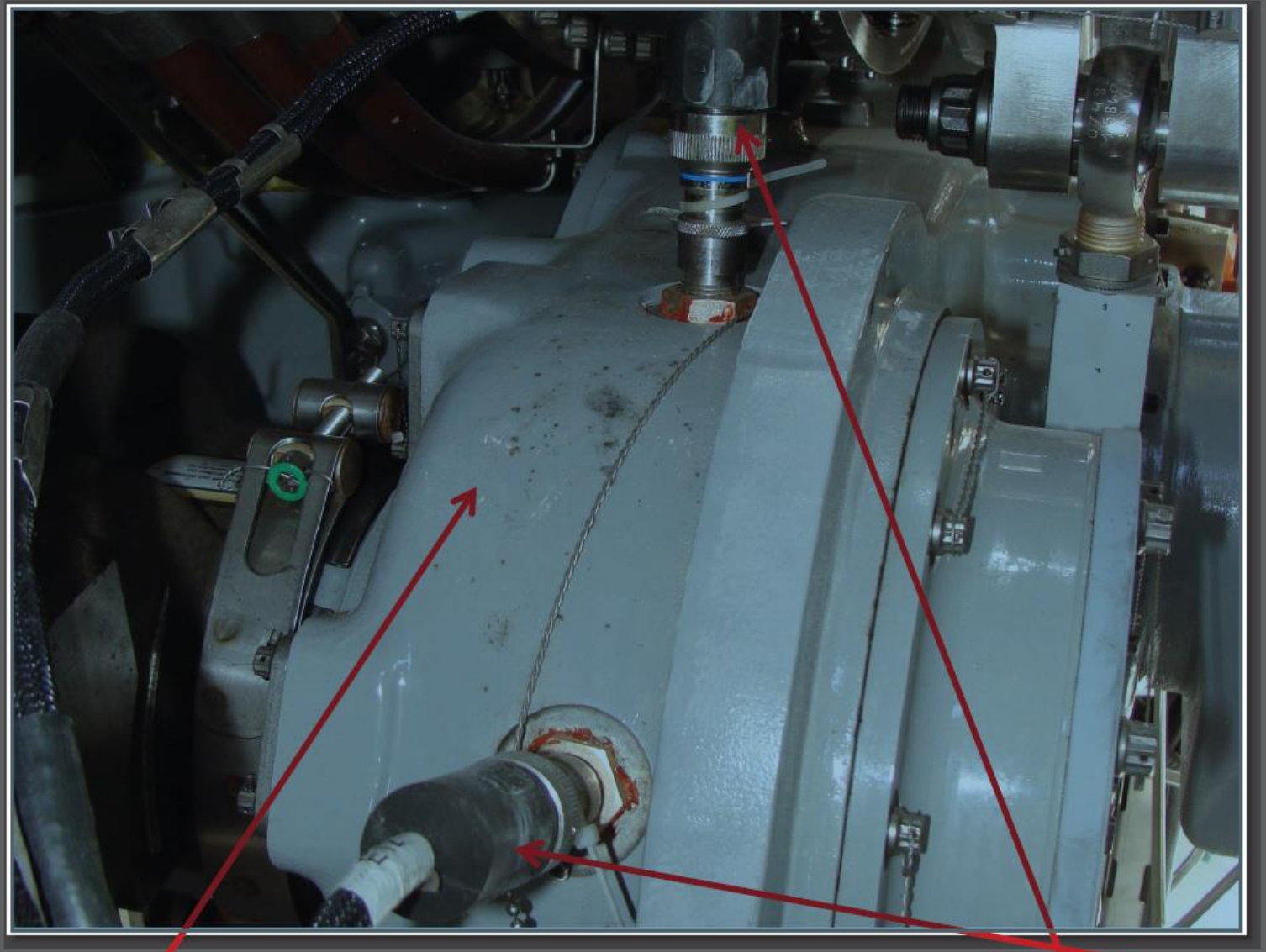




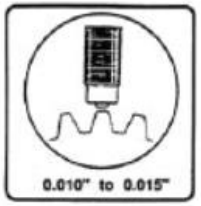
Basic Engine

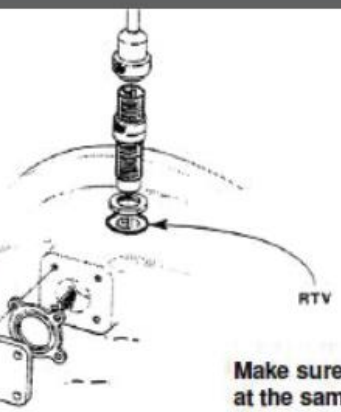
Engine Core Module HPC





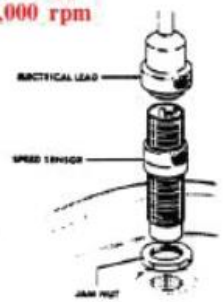
AGB - Accessory Gear Box with (NGG) Speed Sensor A & B





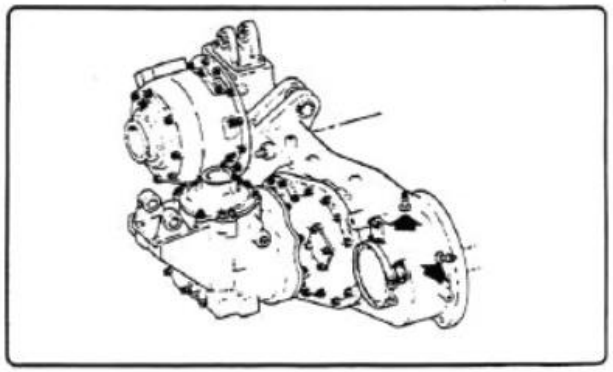
Magnet creates frequency off ferrous gear

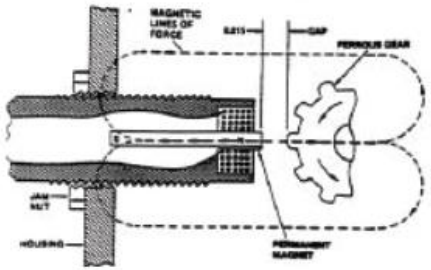
2 each Reluctance type
Reads 100-12,000 rpm



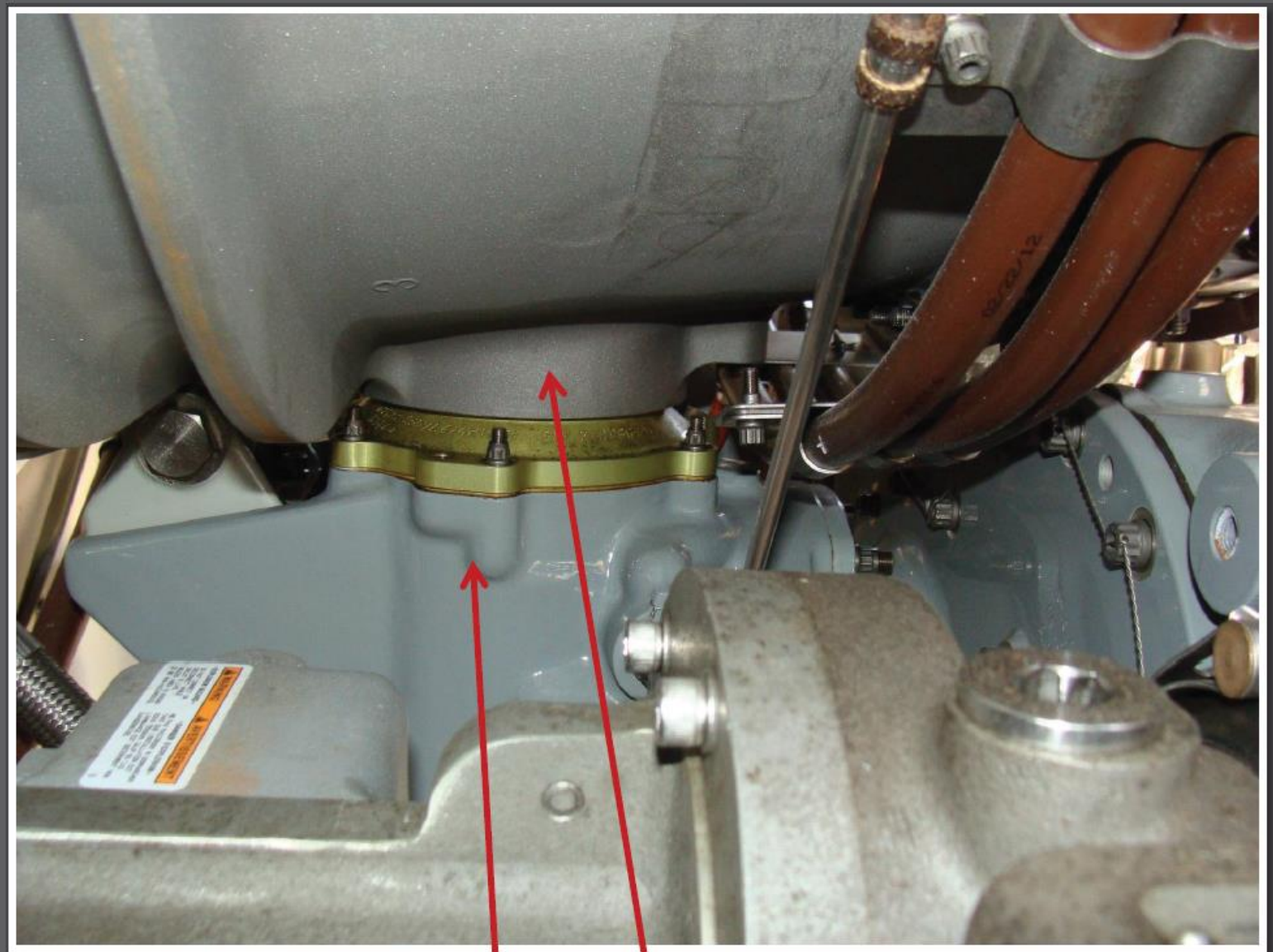
Make sure the two sensors are set at the same distance to avoid a signal mismatch alarm.

NGG VS FREQUENCY



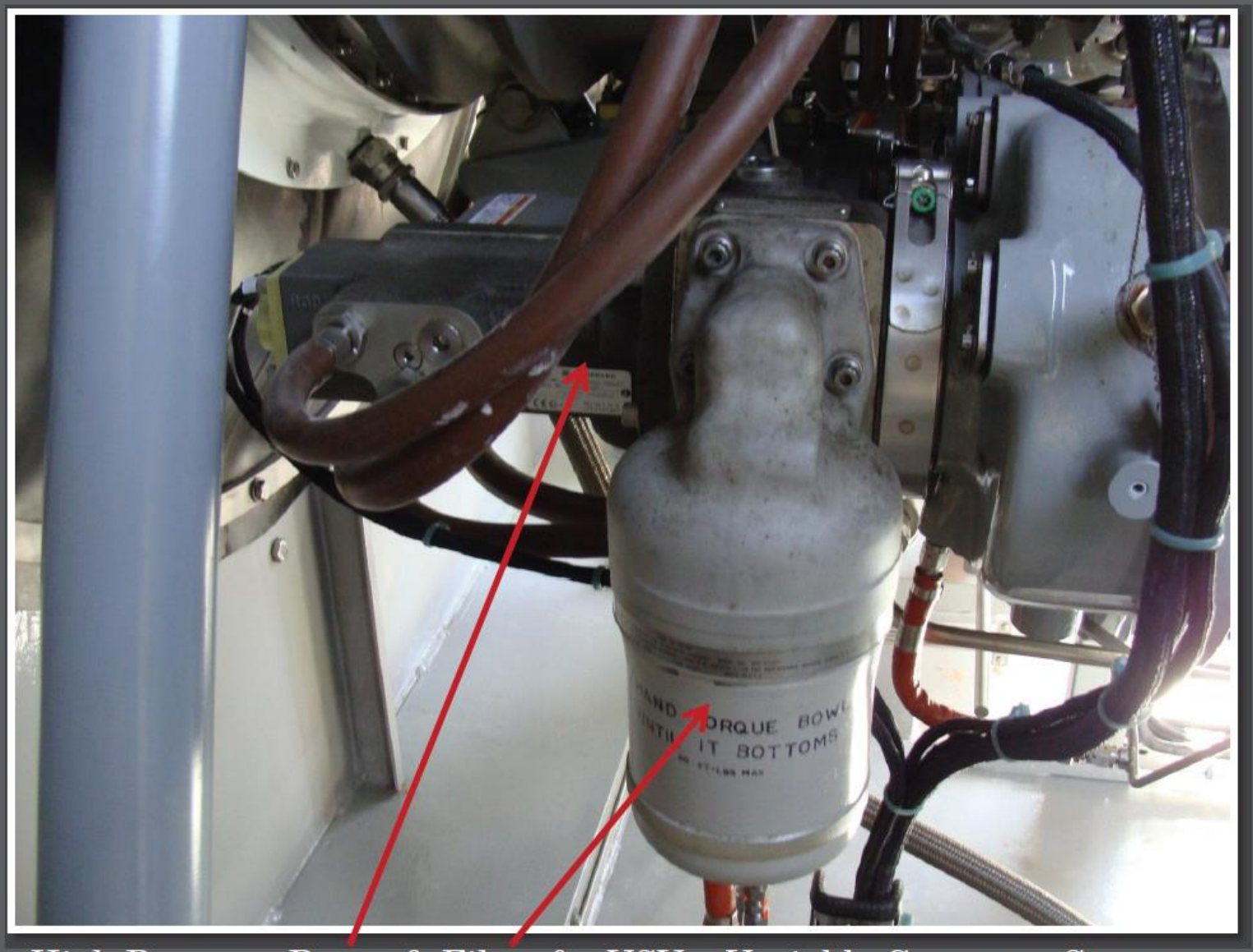


Gas Generator Speed sensor

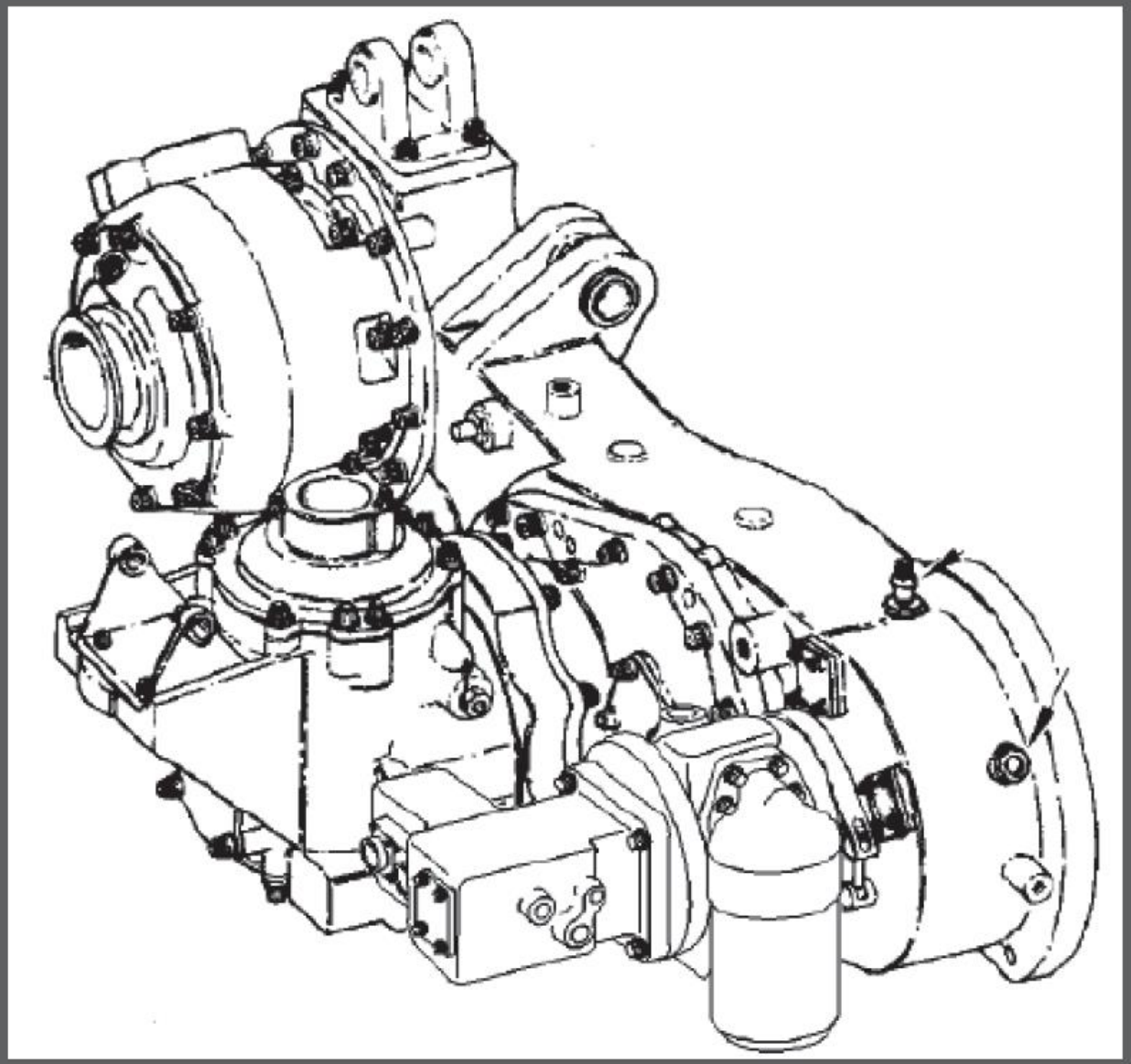


TGB – Transfer Gear Box

Radial Drive Shaft – Strut 3 CFF

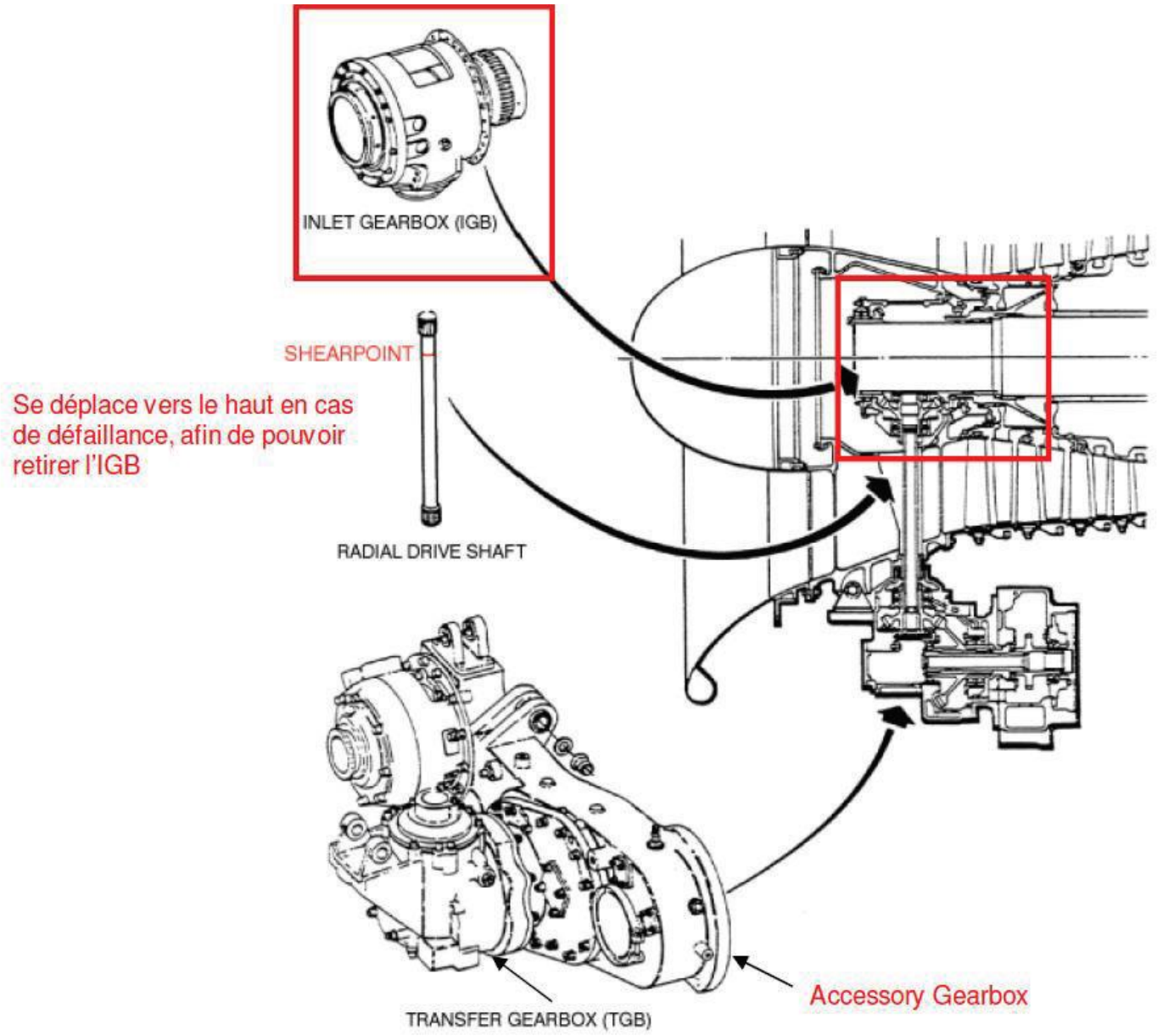


High Pressure Pump & Filter for VSV – Variable Geometry System



Accessory Gear Box – Transfer Gearbox


Inlet gbox (LM2500+)
07/10/2008


INLET GEARBOX (IGB)
SHEARPOINT
Se déplace vers le haut en cas de défaillance, afin de pouvoir retirer l'IGB
RADIAL DRIVE SHAFT
TRANSFER GEARBOX (TGB)
Accessory Gearbox

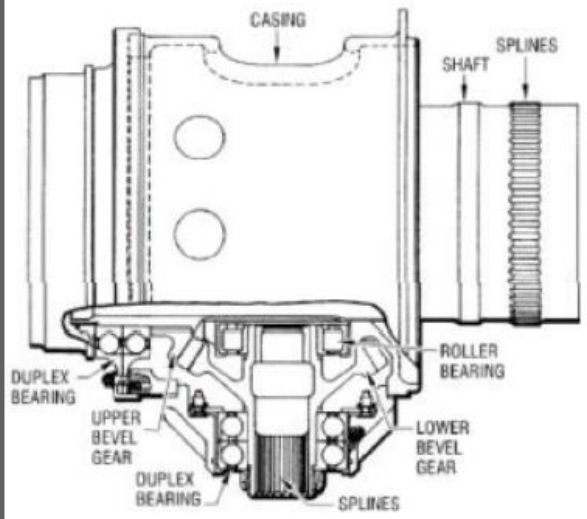


Figure 4-23. Inlet Gearbox

IGB

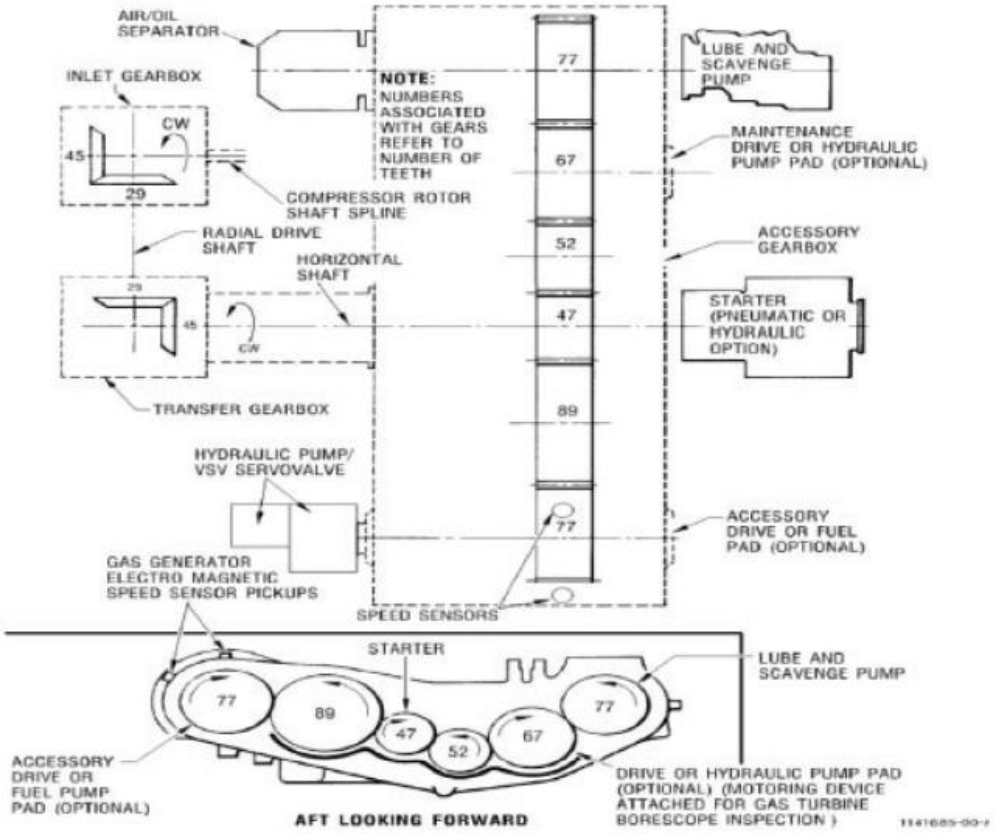
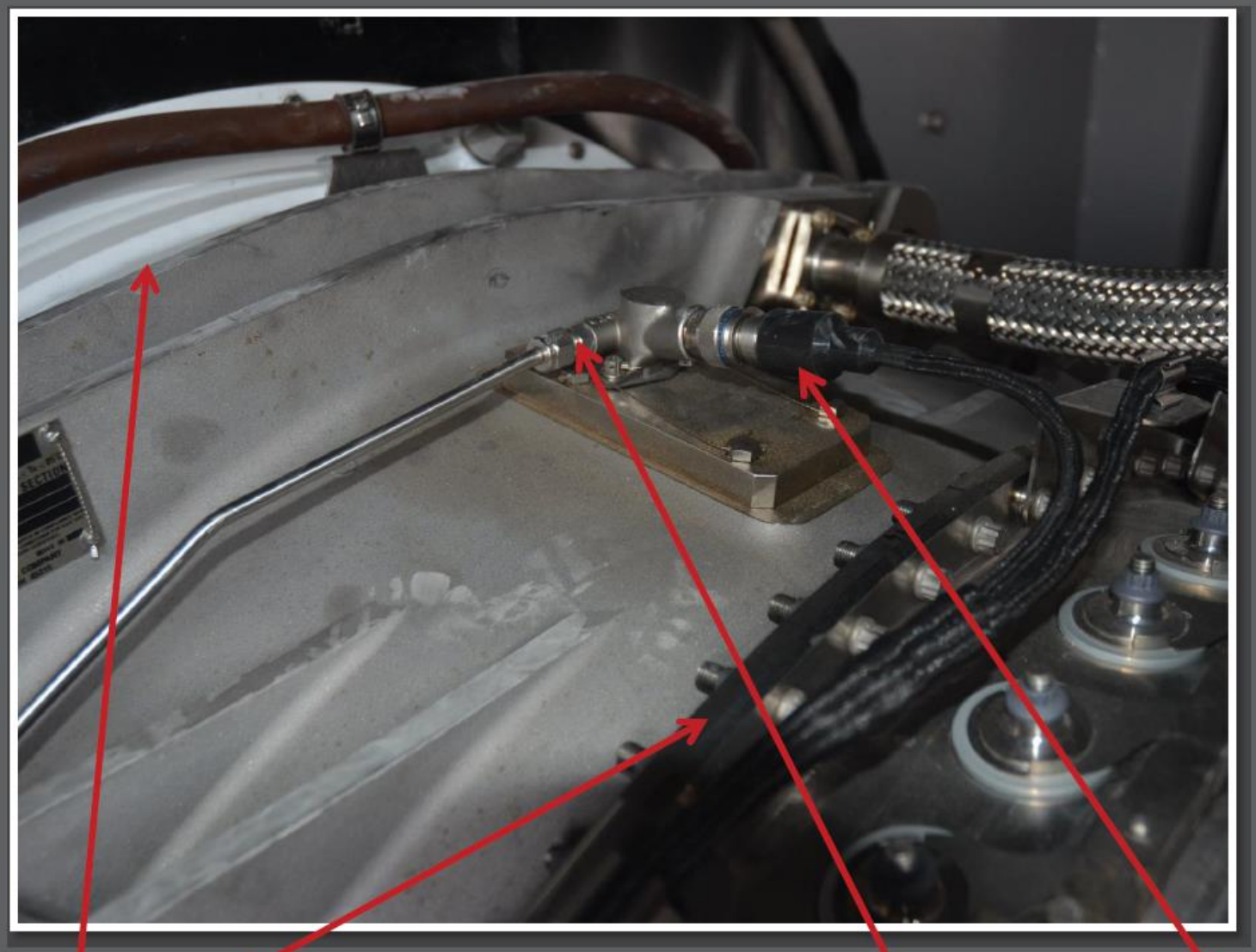


Figure 5-4. Accessory Gearbox Assembly

AGB

F-025-10-20-103-00 LM2500+ Turbine Lube Oil System with 6-stage PT

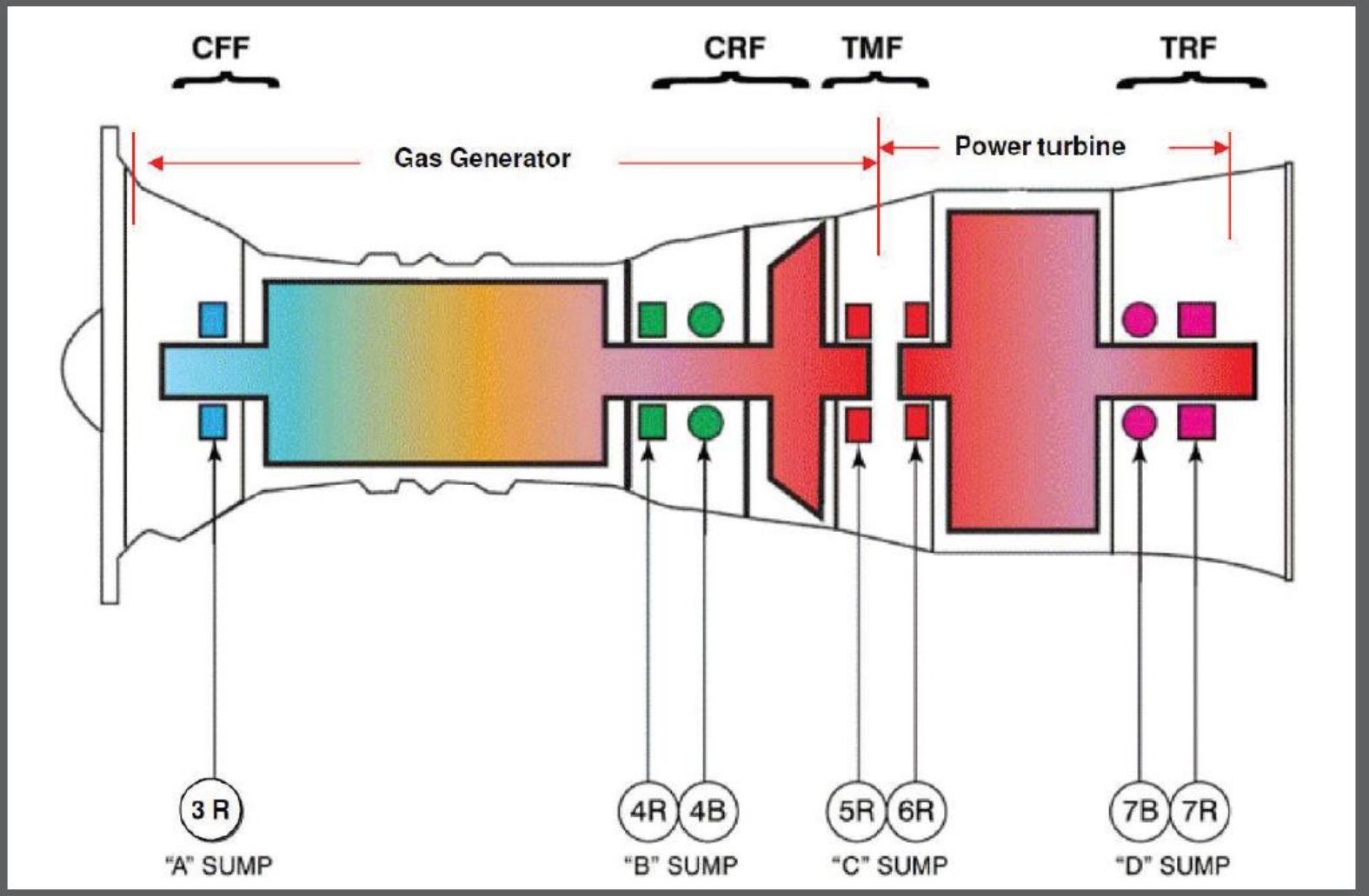
Accessory Gearbox – Inlet Gearbox

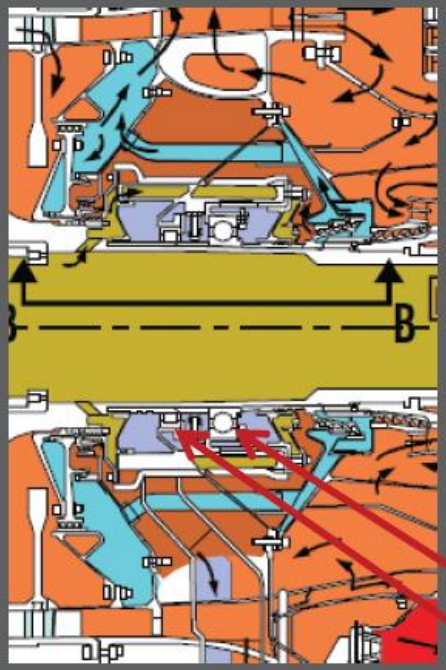


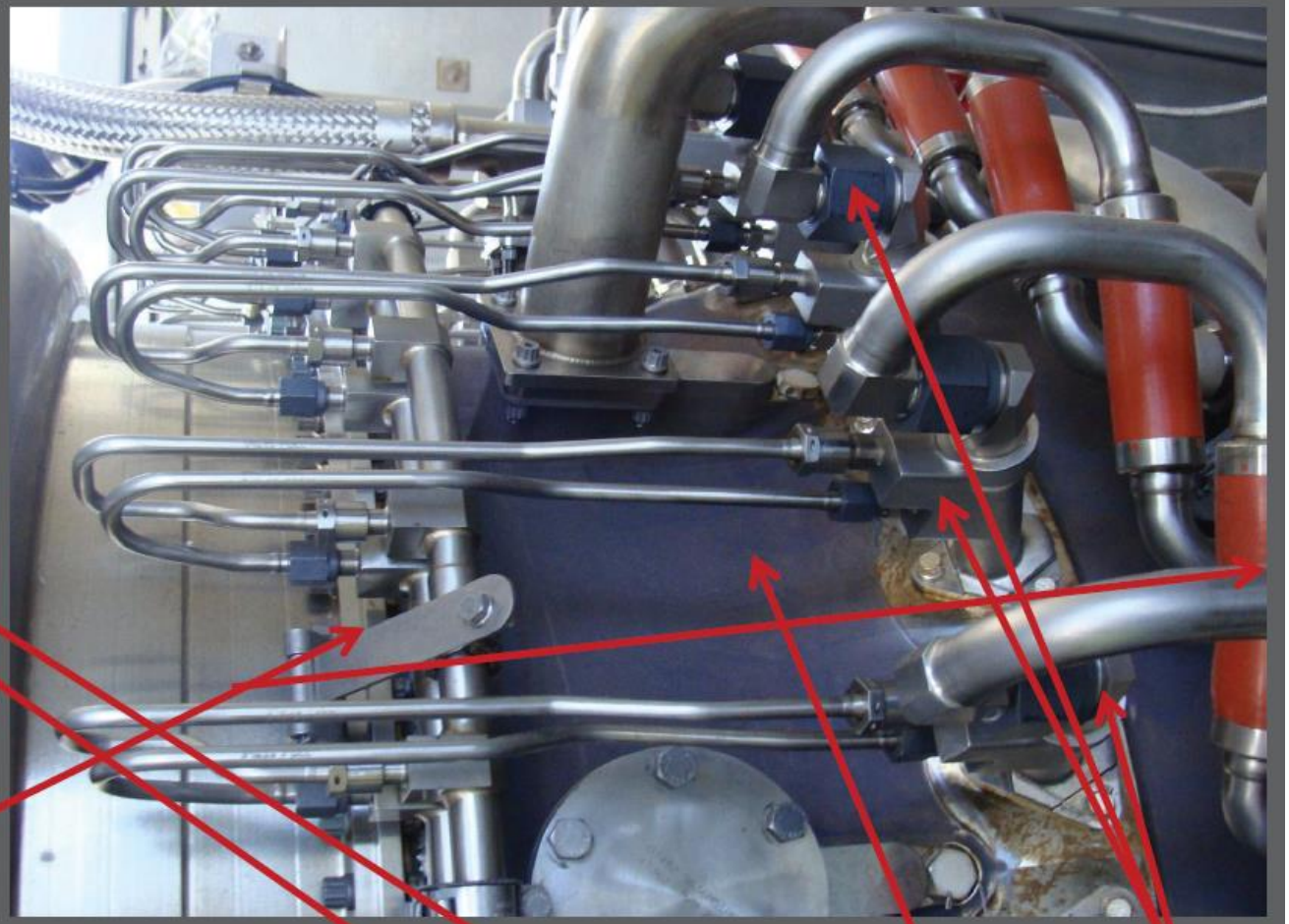
CIP – Compressor Inlet Pressure (P2)

CIT – Compressor Inlet Temperature(T2)

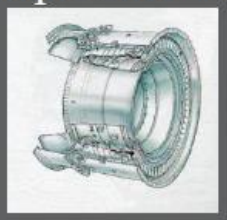
CFF-Compressor Front Frame


CFF
CRF
TMF
TRF
Gas Generator
Power turbine
3 R
"A" SUMP
4R
4B
"B" SUMP
5R
6R
"C" SUMP
7B
7R
"D" SUMP





CRF – Compressor Rear Frame – Bearings 4R & 4B – Sump B

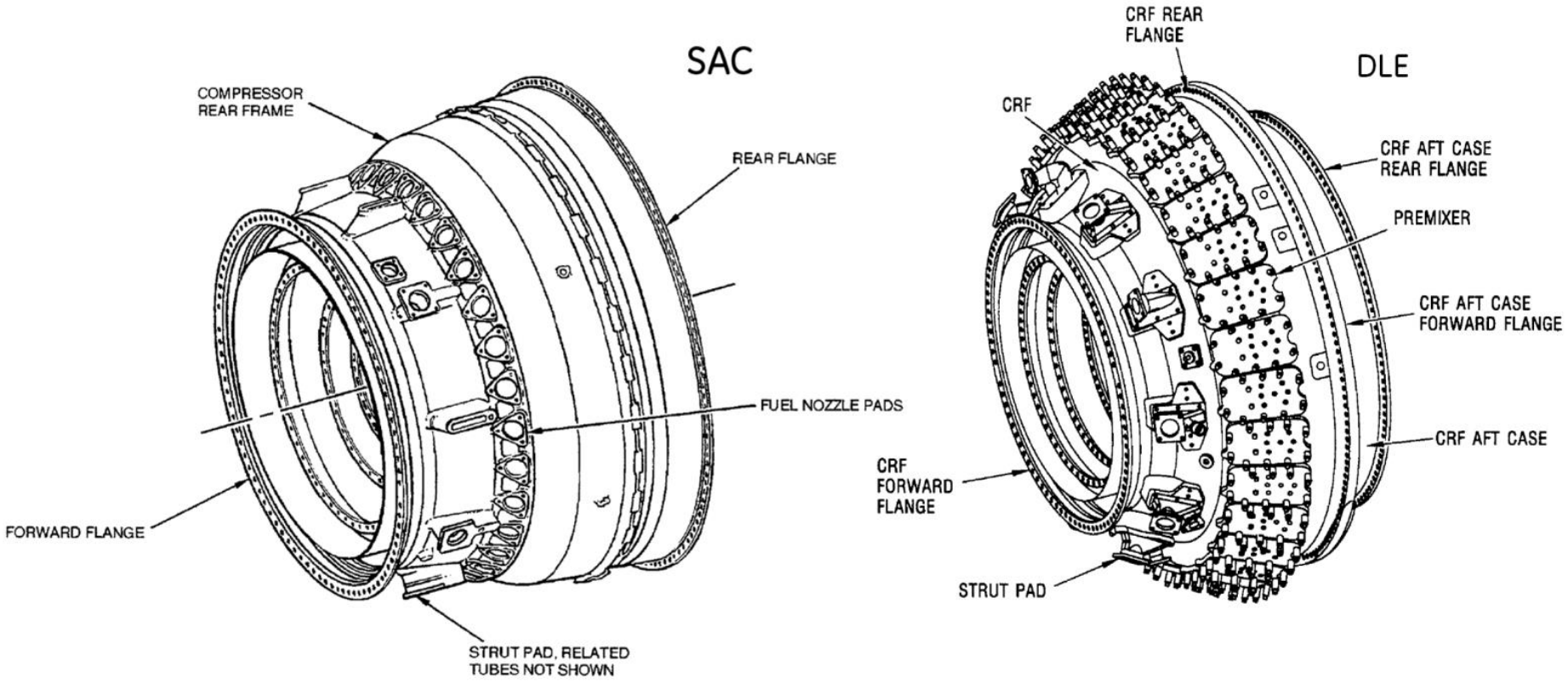


SAC – Single Annular Combustor Section

Dual Fuel Nozzles (Qty. 30)

Basic Engine

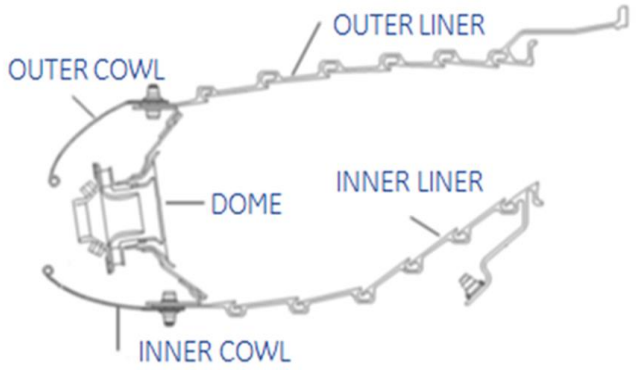
Compressor Rear Frame (CRF) Assembly



Basic Engine
Combustor

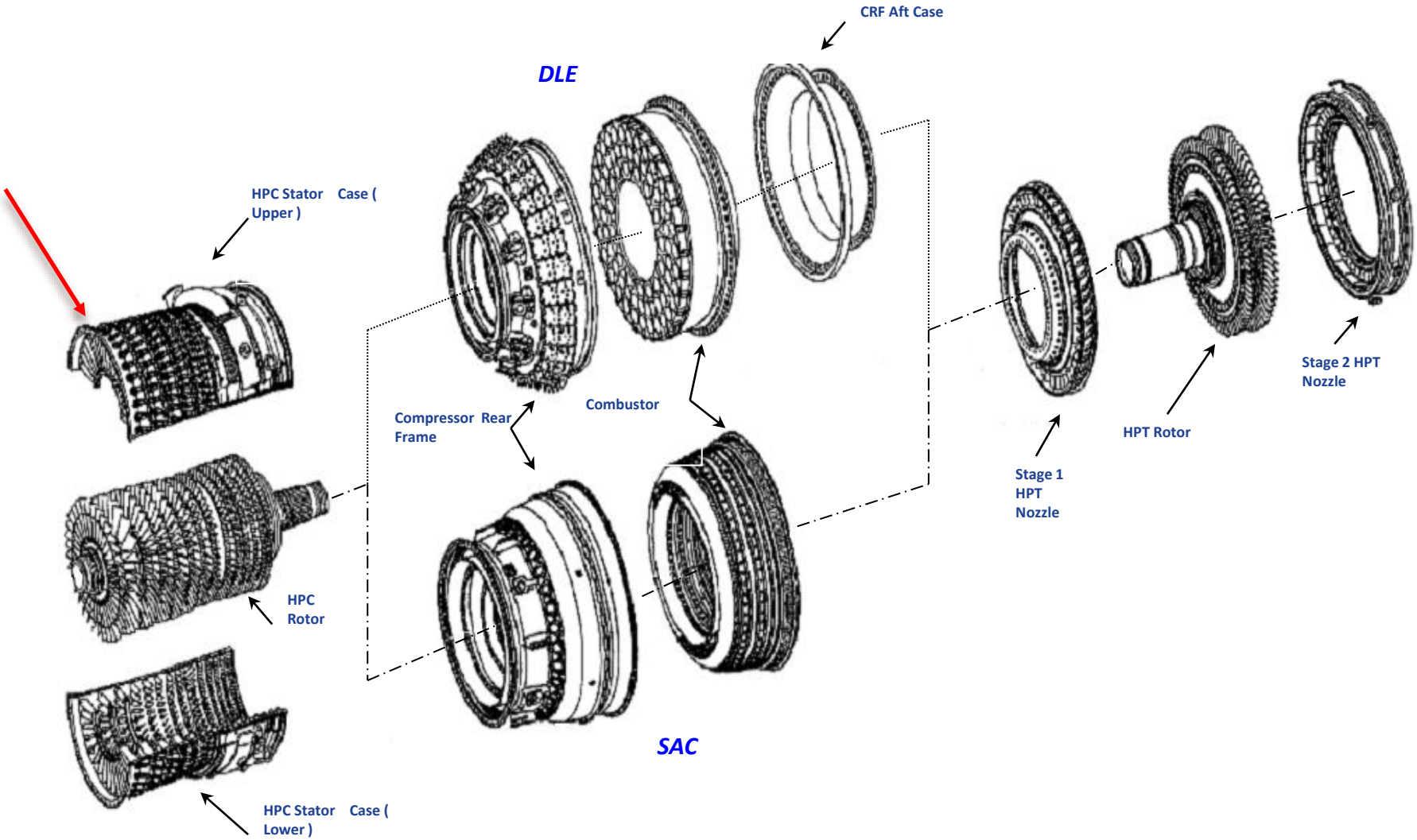
Basic Engine
SAC

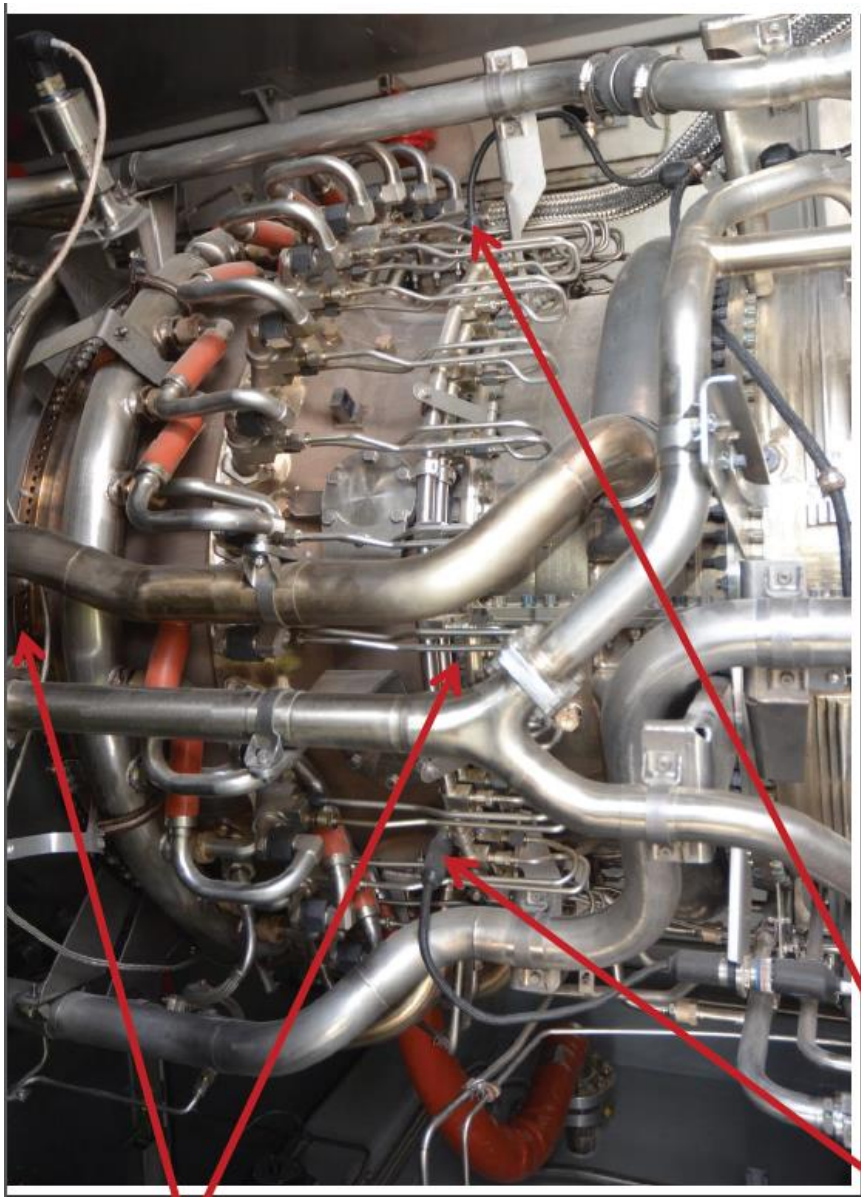
Basic Engine
SAC: Single Annular Combustor



Basic Engine

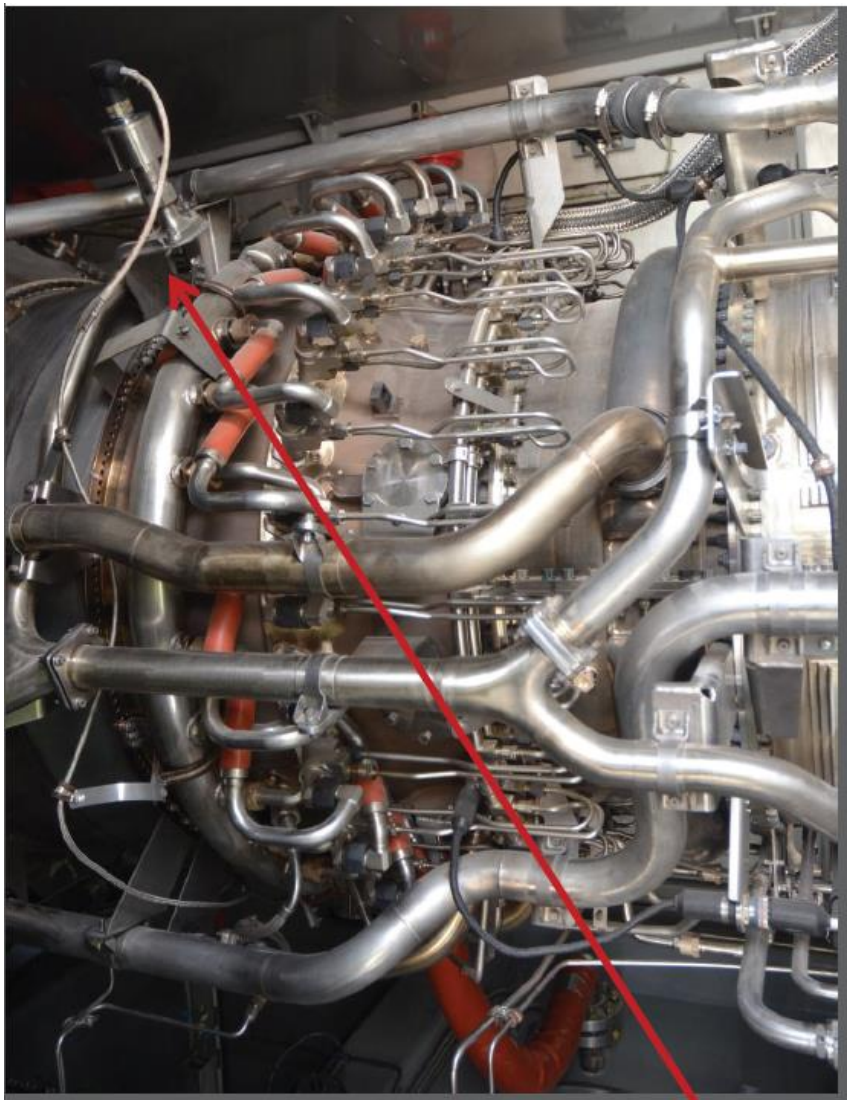
Engine Core Module HPC



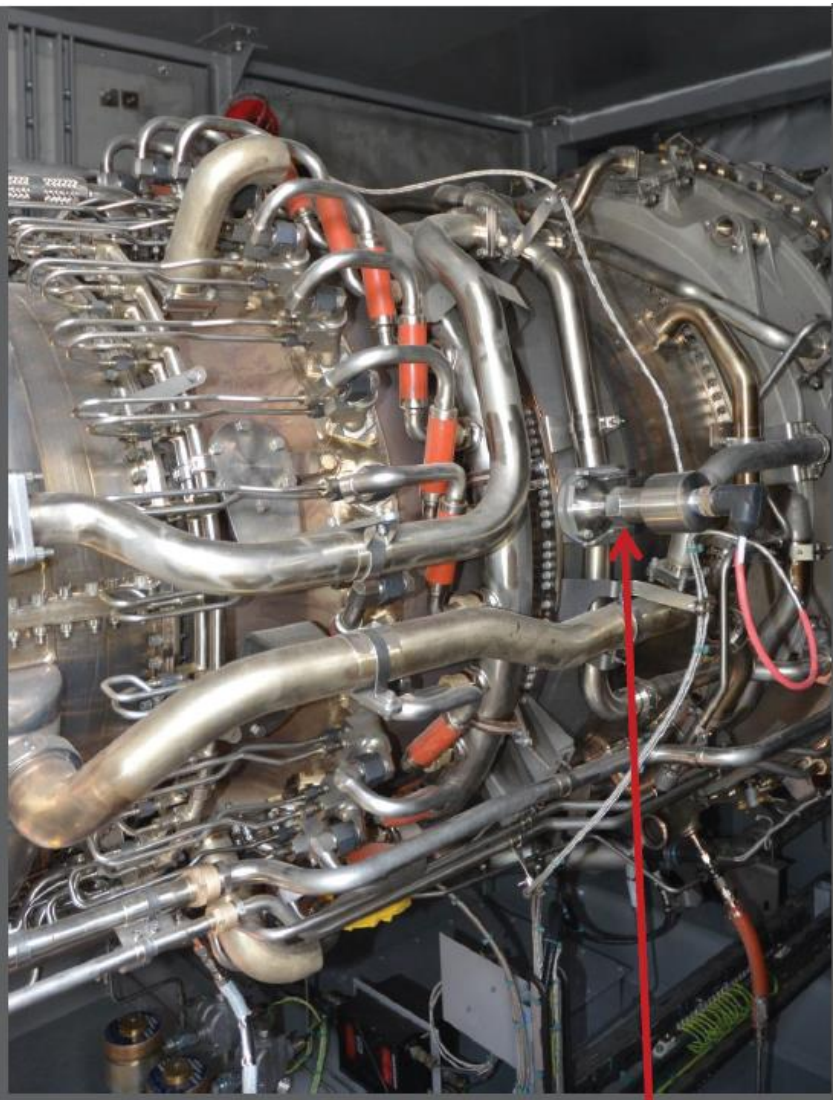


CRF – Compressor Rear Frame

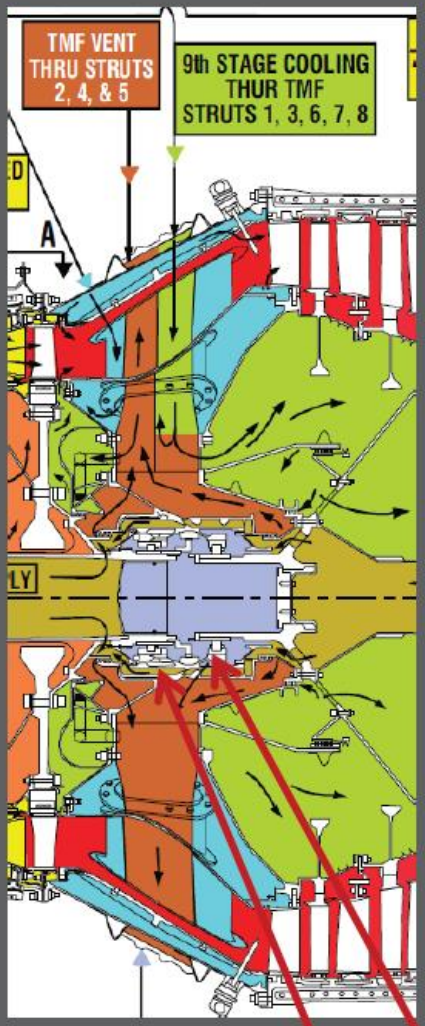
Compressor Discharge Temperature (T3-CDT) & Pressure (P3-CDP)

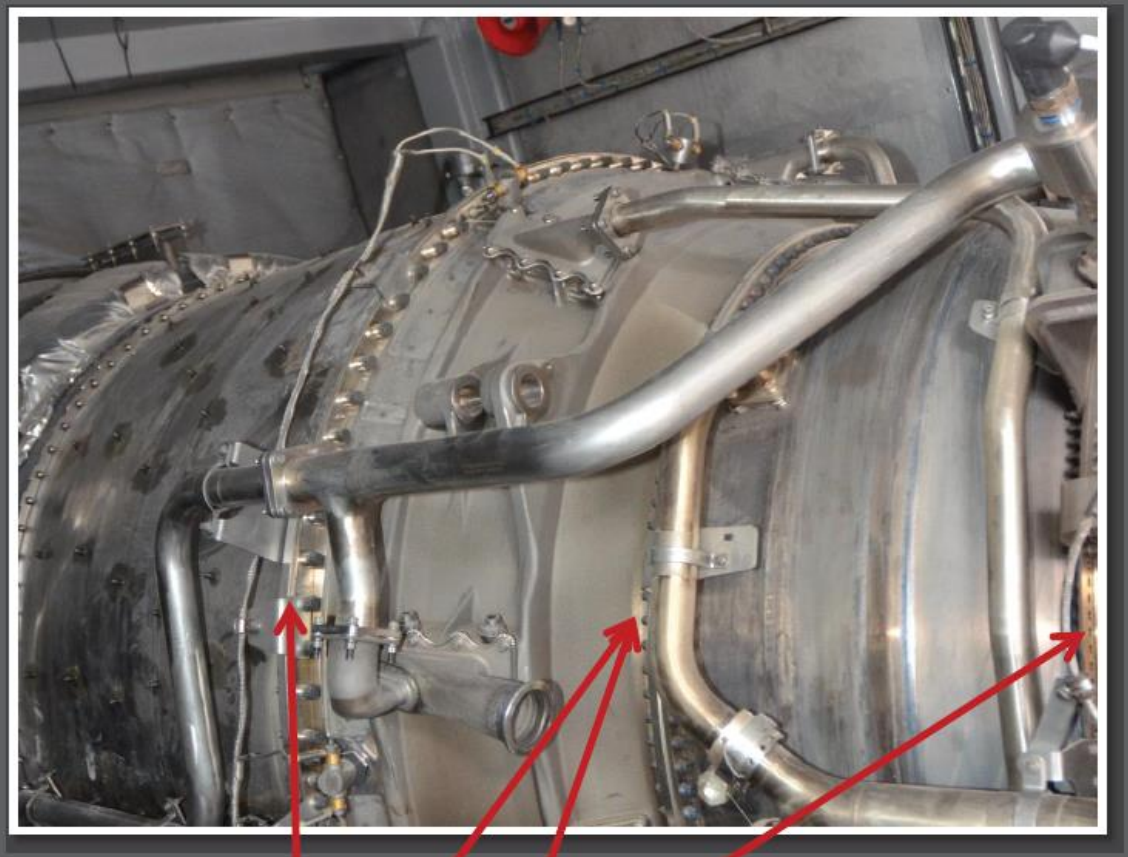


UV – Detector (Right Side)



UV – Detector (Left Side)





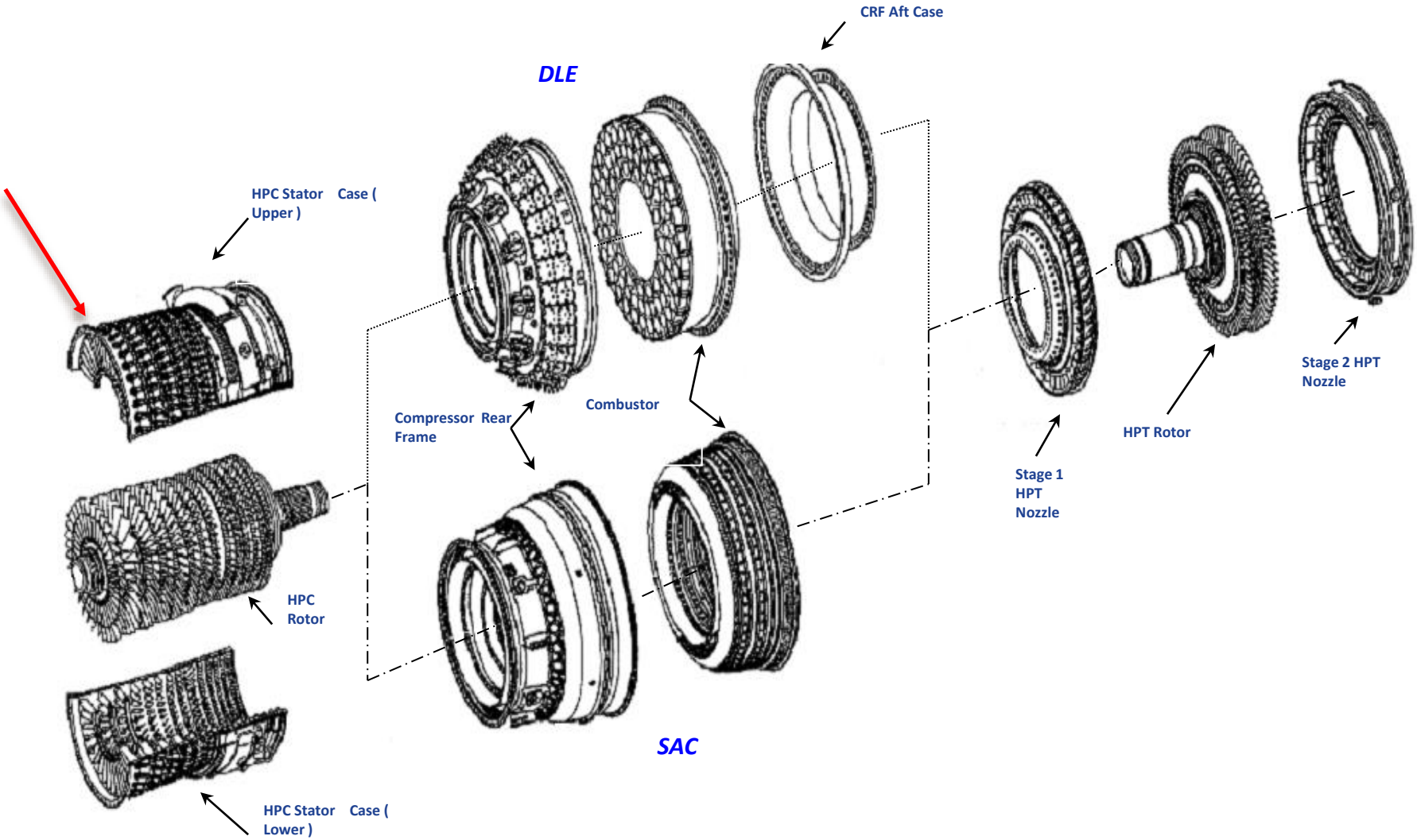
Bearings 5R & 6R – Sump C

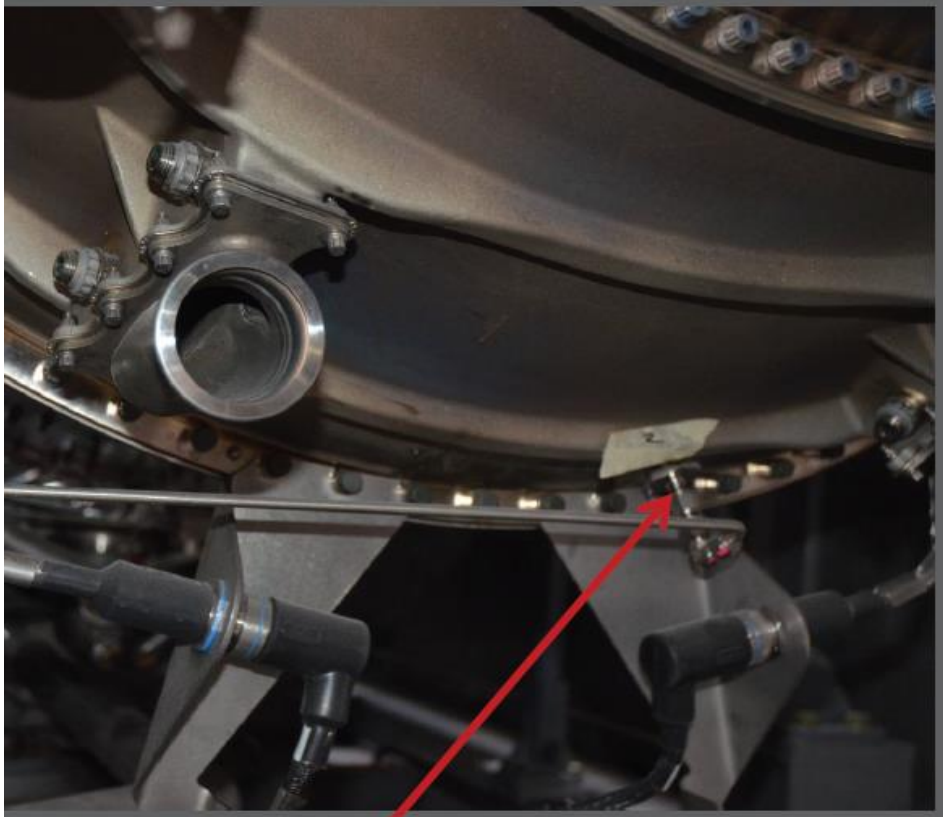
TMF – Turbine Mid Frame

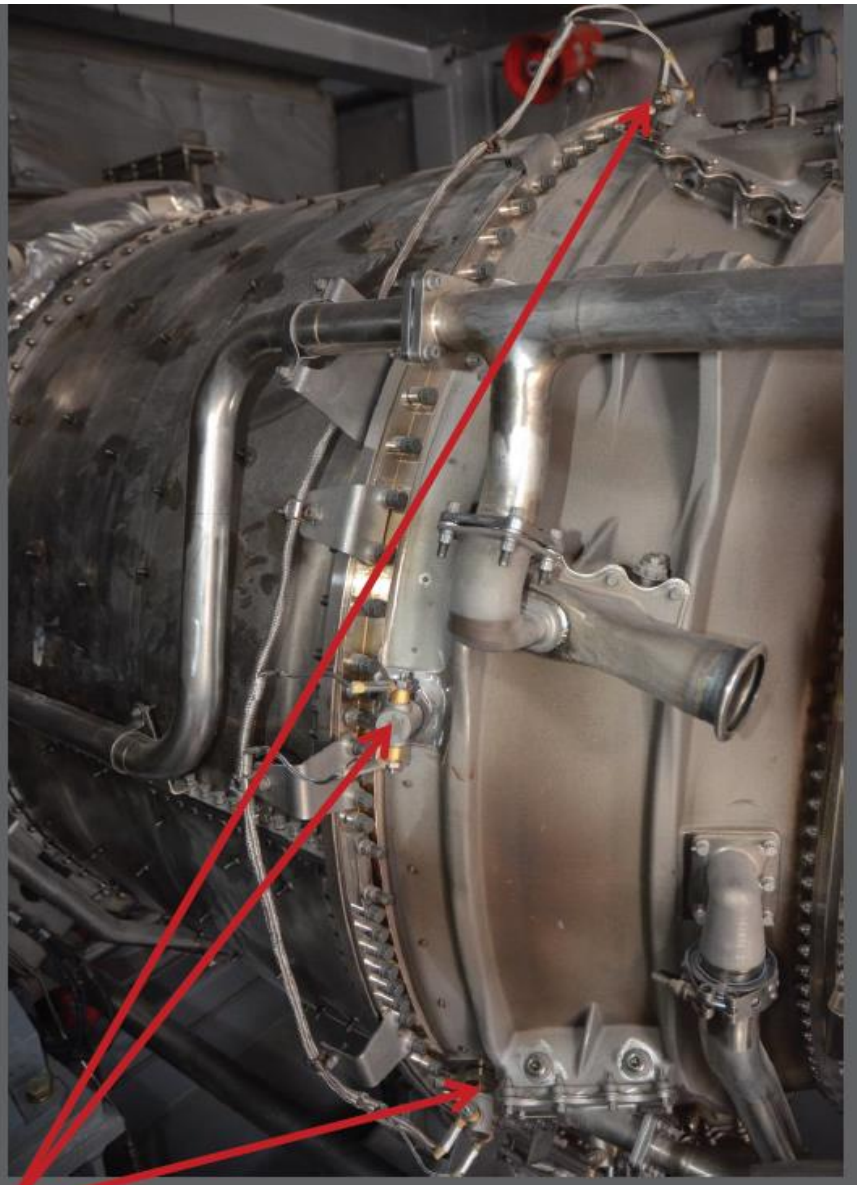
HPT – High Pressure Turbine

Basic Engine

Engine Core Module HPC

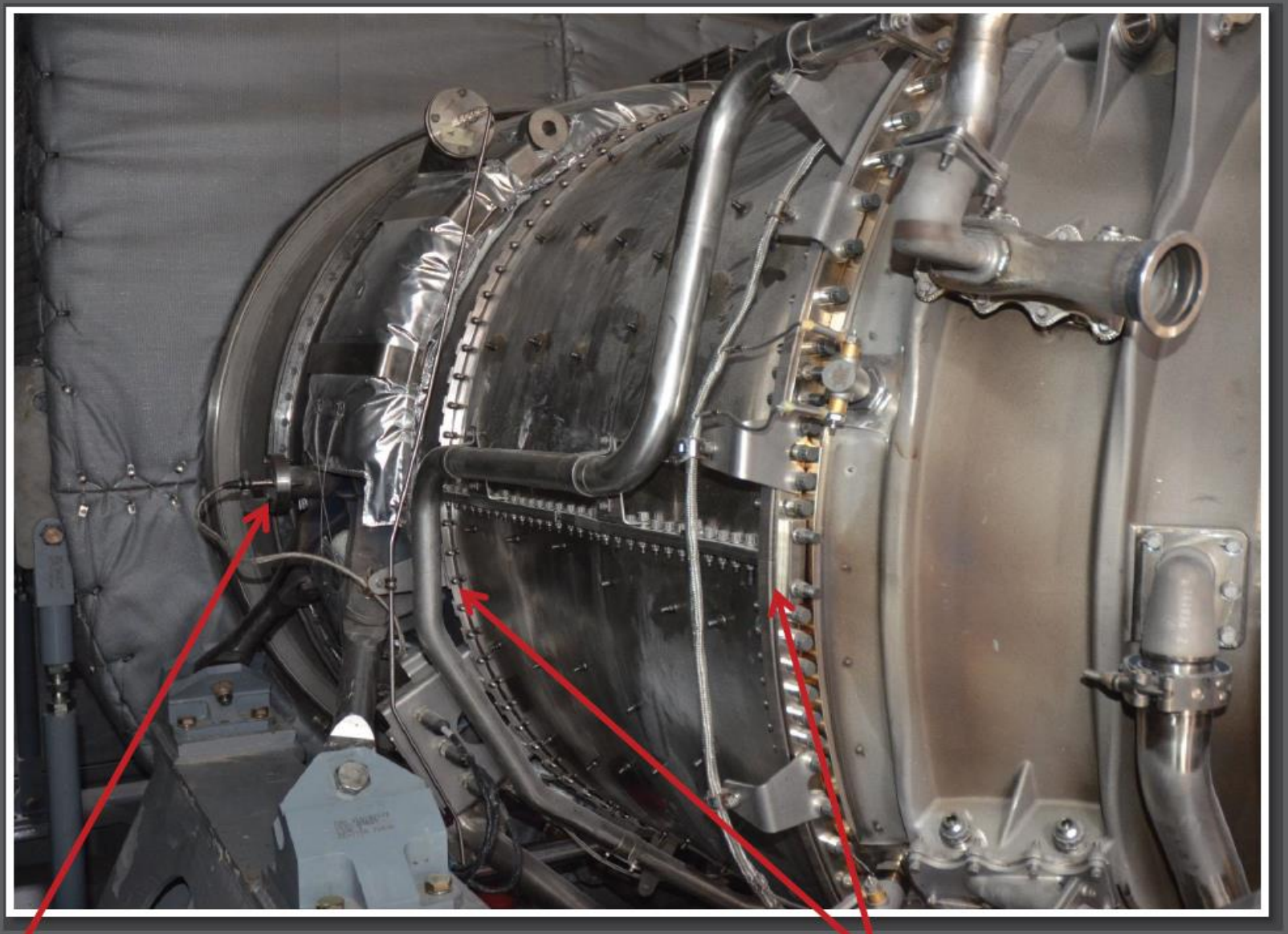


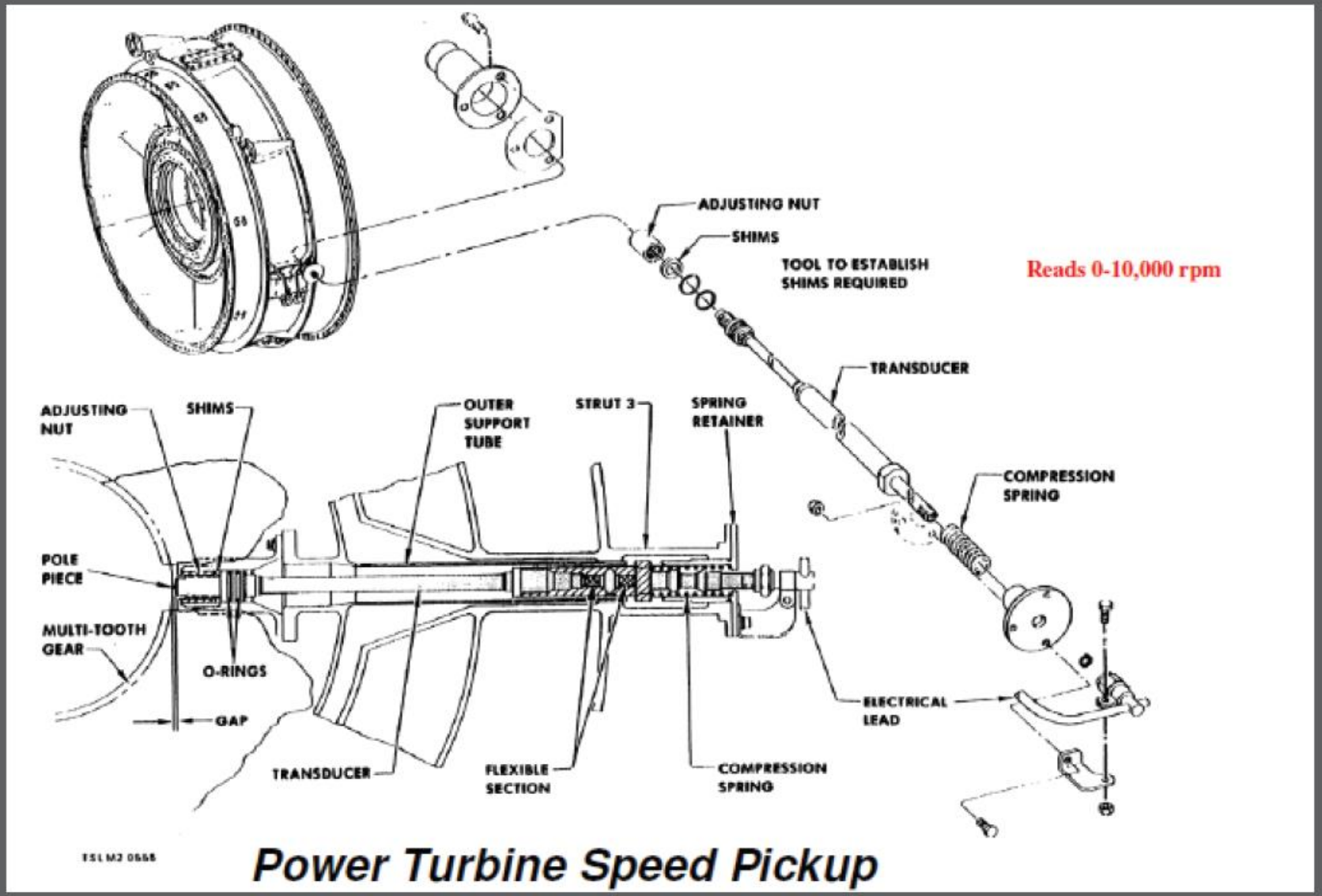




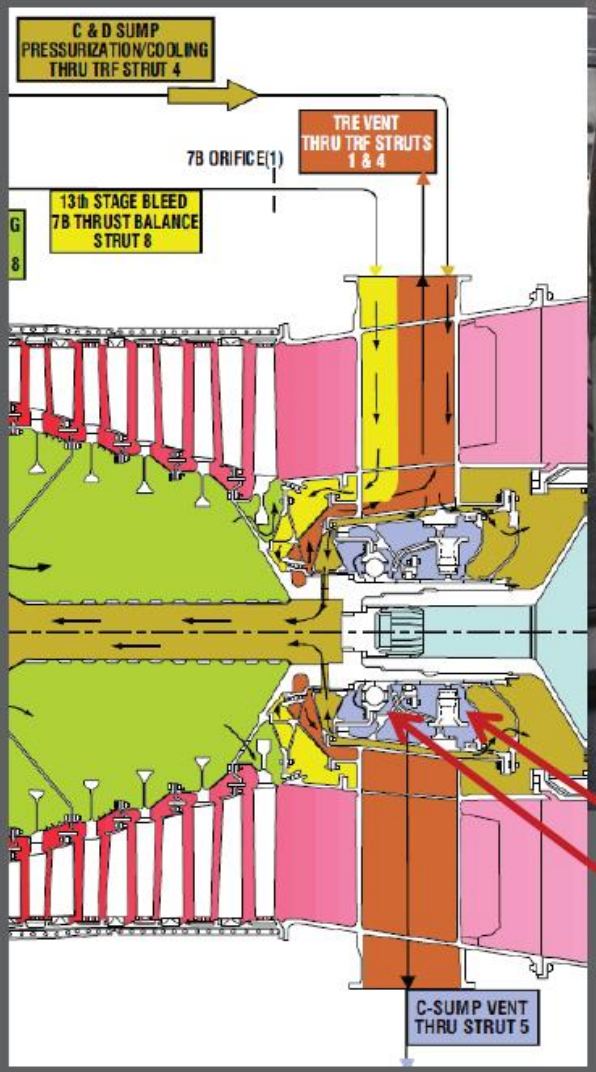
P48 – Power Turbine Inlet Pressure

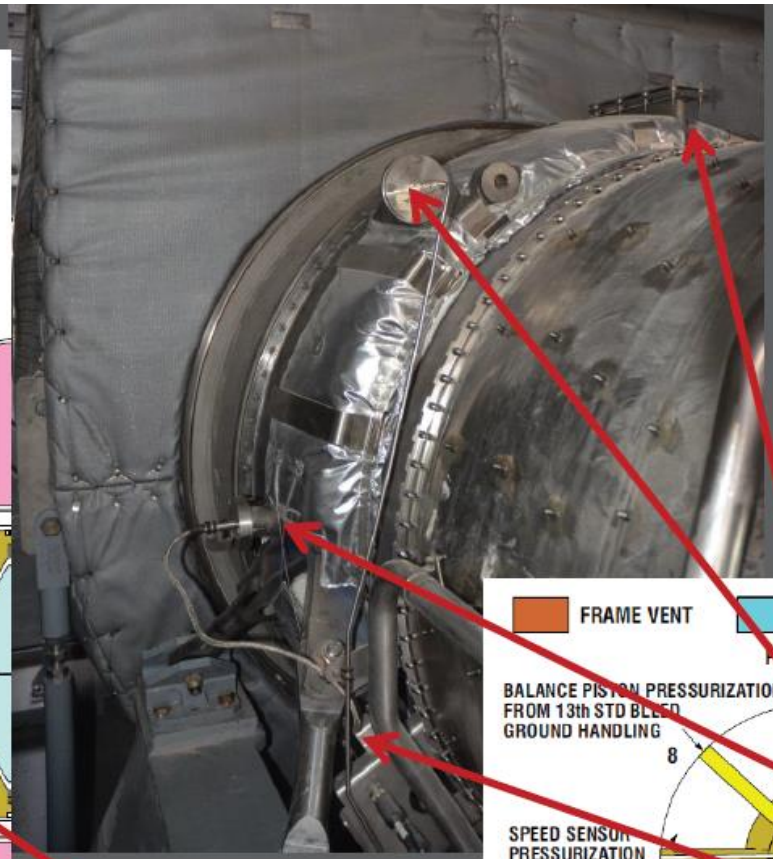
T48 – Power Turbine Inlet Temperature
(Qty. 8 Sensors)

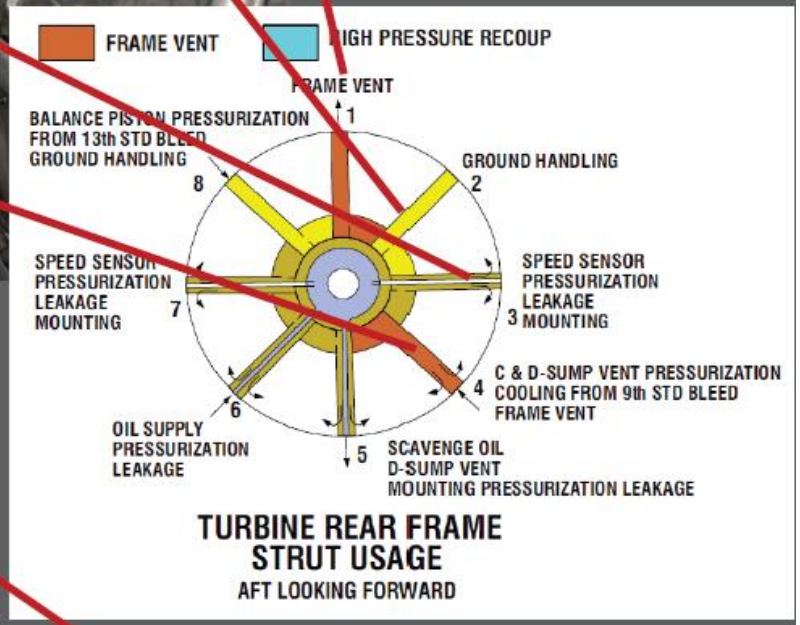

NPT – Power Turbine Speed Senor A&B
PT – Power Turbine



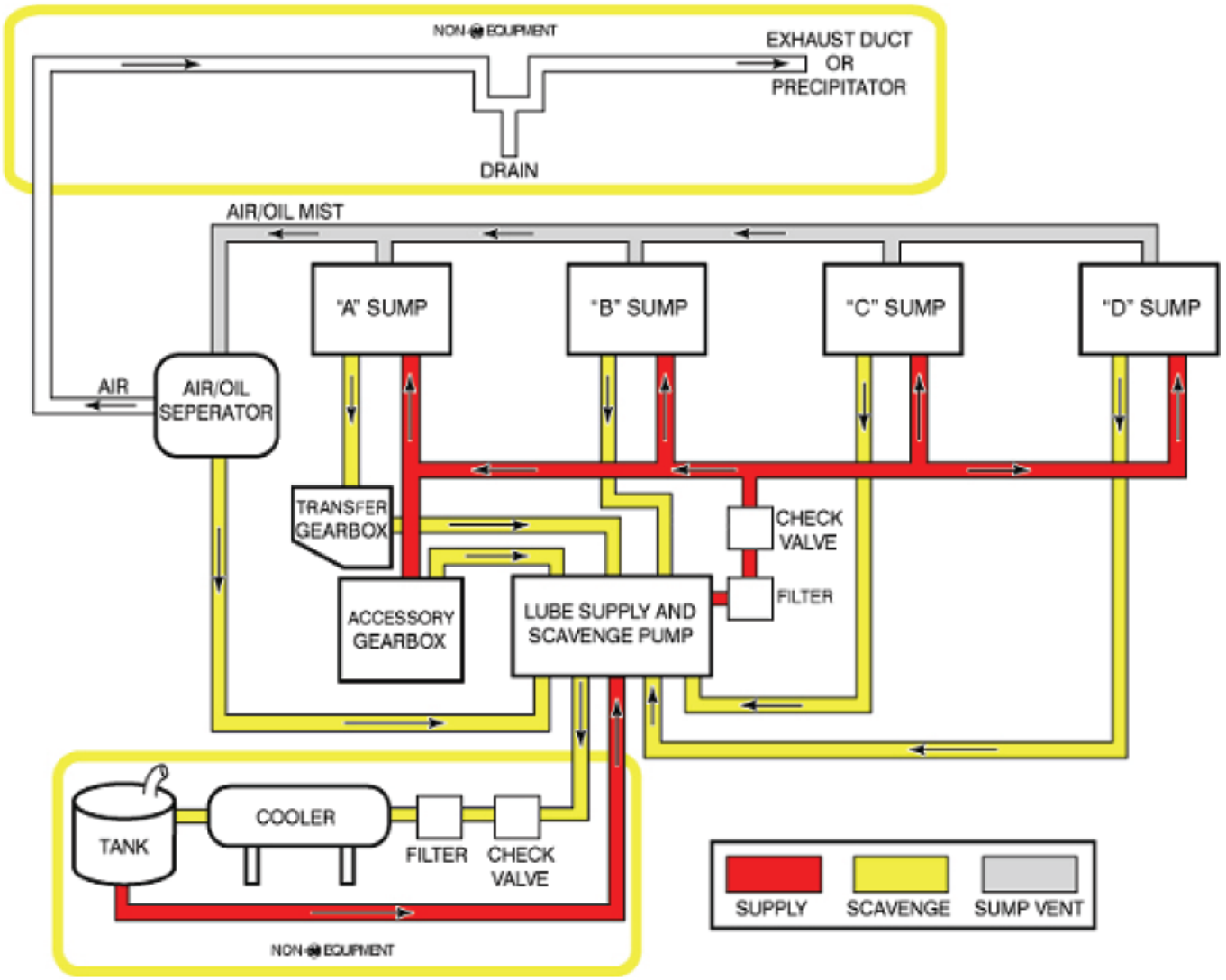
Power Turbine Speed Pickup



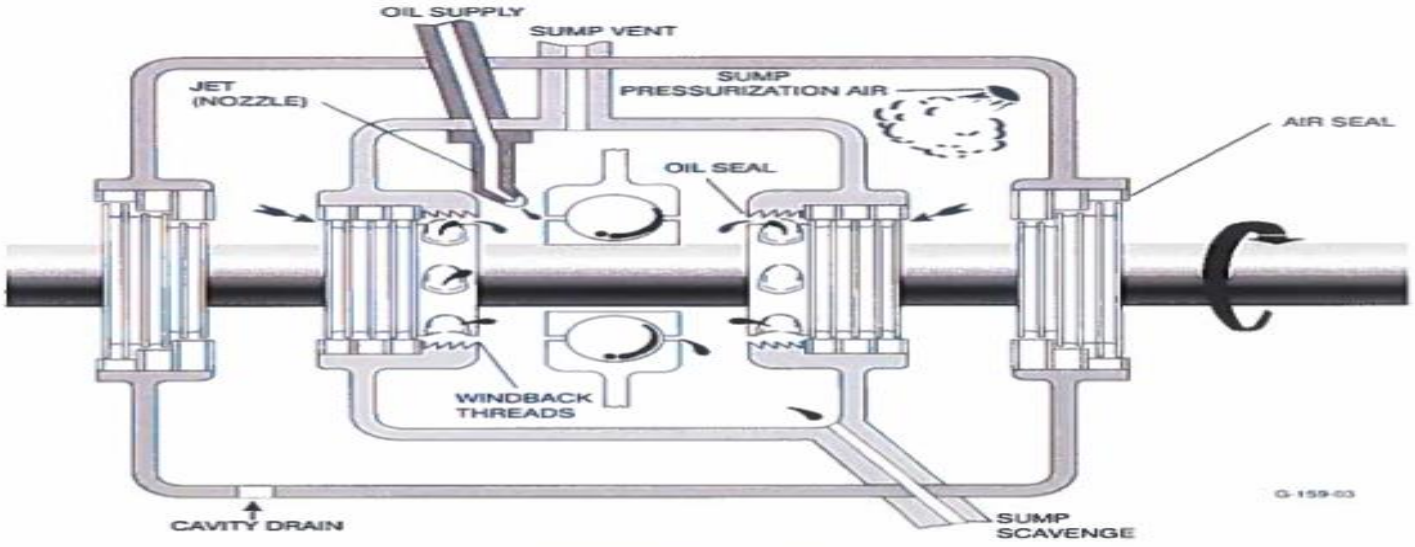




TRF – Turbine Rear Frame – Bearings 7B & 7R – Sump D



LM2500+ Turbine Lube Oil System



BEARING SUMP

SUMP PURPOSE

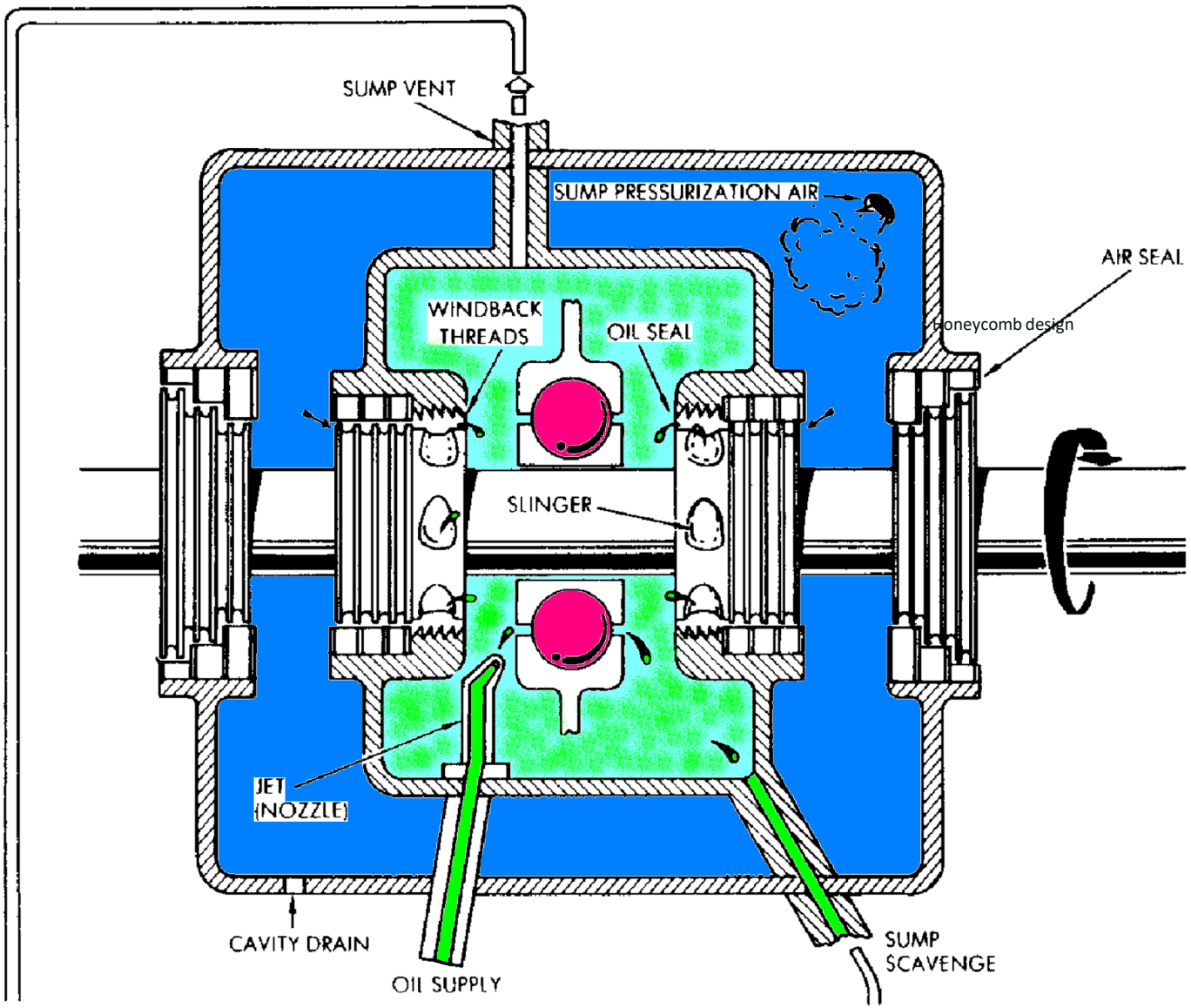
The gas turbine design uses the dry sump system to provide lubrication to the gas turbine main bearings. The dry sump system employs five subsystems:

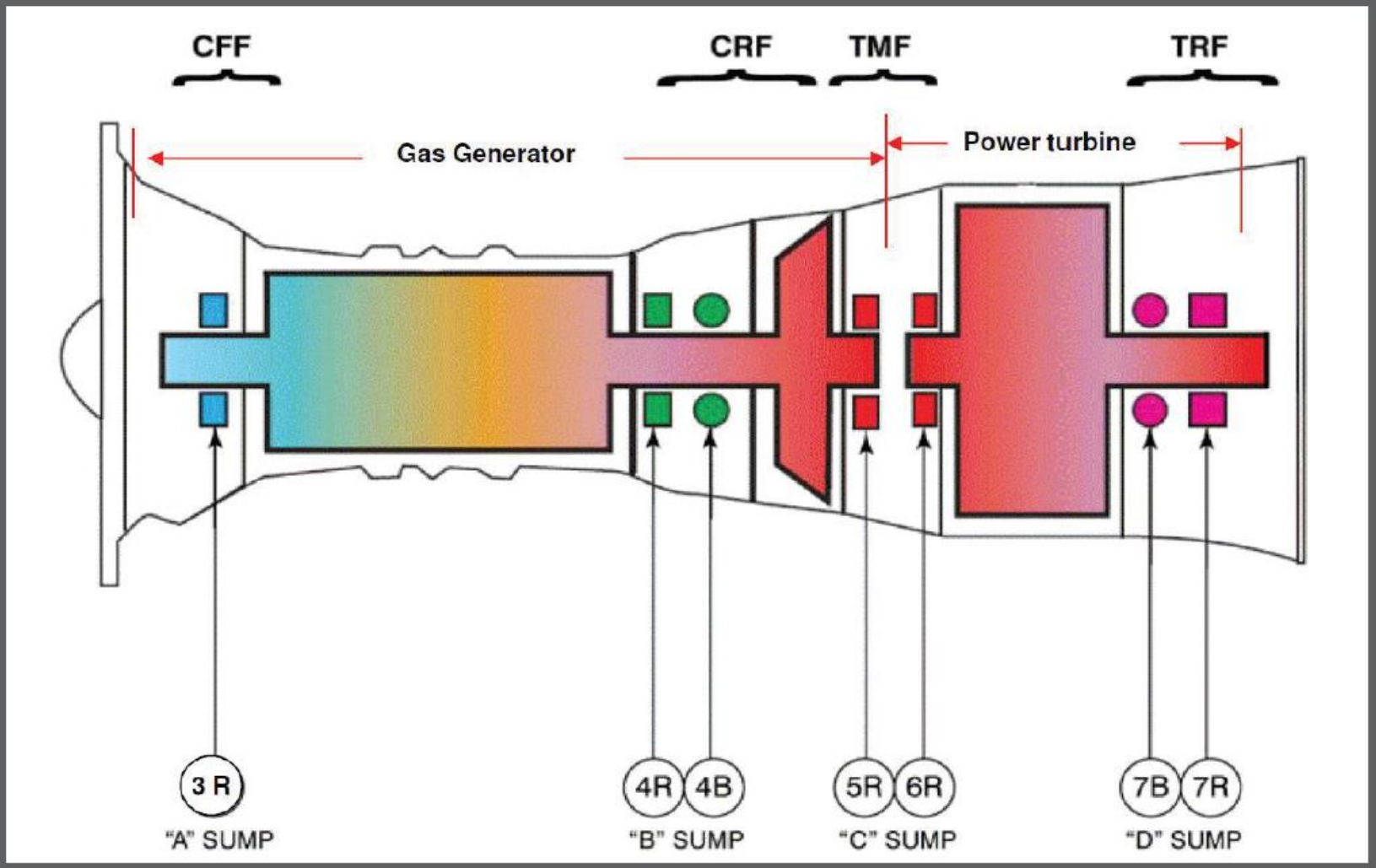
- Oil supply. Oil is delivered to the bearings through jets pressurized by a supply pump deliver oil onto the bearings.
- Oil Scavenge. Oil scavenge is accomplished when suction, created by the pumping action of a scavenge oil pump, is applied to a port in the lowest point of the oil-wetted cavity.
- Seal Pressurization. Bleed air, directed to the sump cavity by ports or tubes in the engine structure, pressurizes seals.
- Sump Vent. By venting the oil-wetted cavity out the top to ambient air pressure, a positive flow of pressurizing air to the sump is maintained.
- Cavity Drain. Oil leaked from the seals (sump B and sump C) is carried to an overboard dump location.

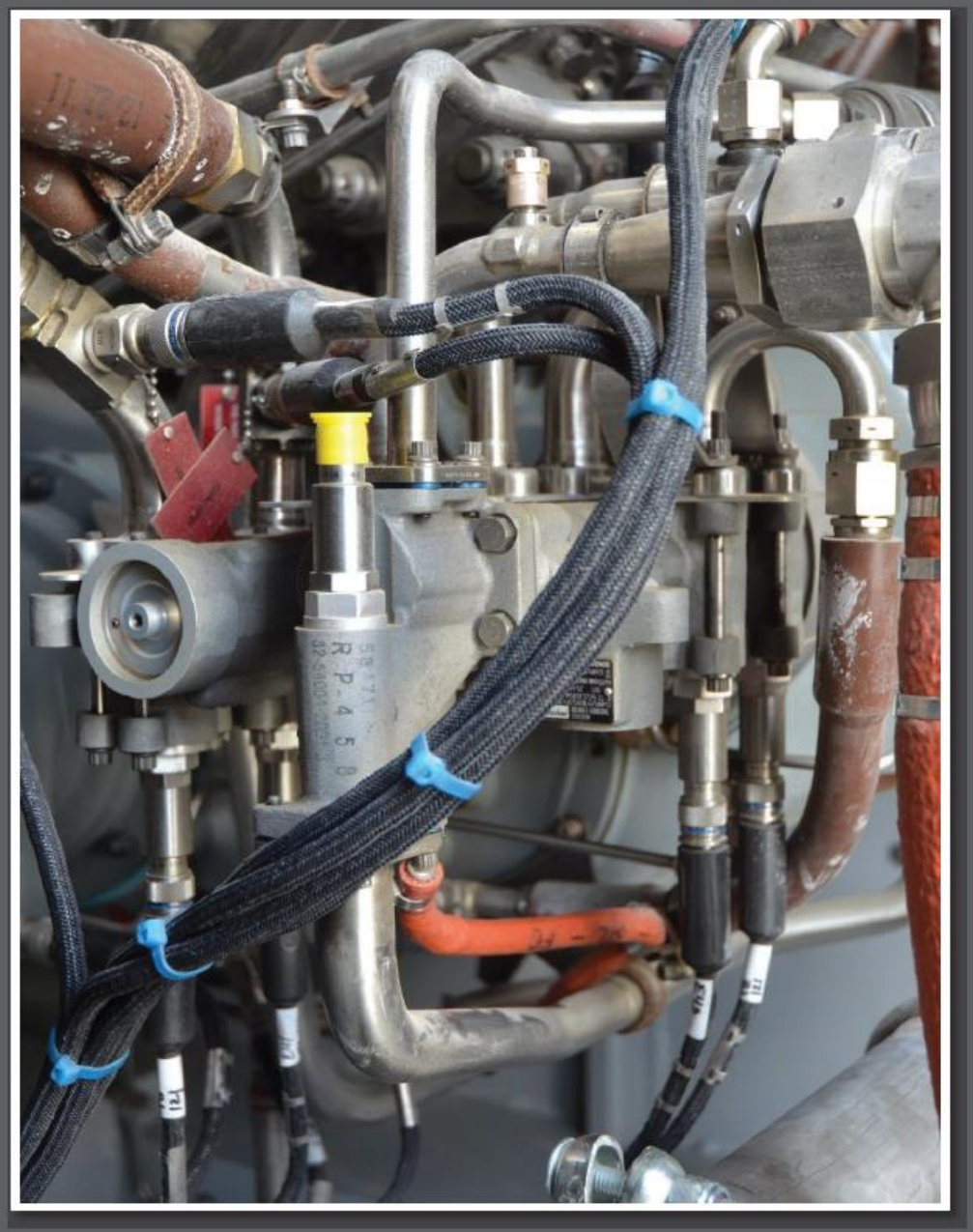
When some fault occurs and oil does leak across the oil seals, it must not be allowed to become a fire hazard or to contaminate the customer bleed air. Therefore a drain is provided to the pressurization chamber. The drainage line is directly connected to an

Airflow

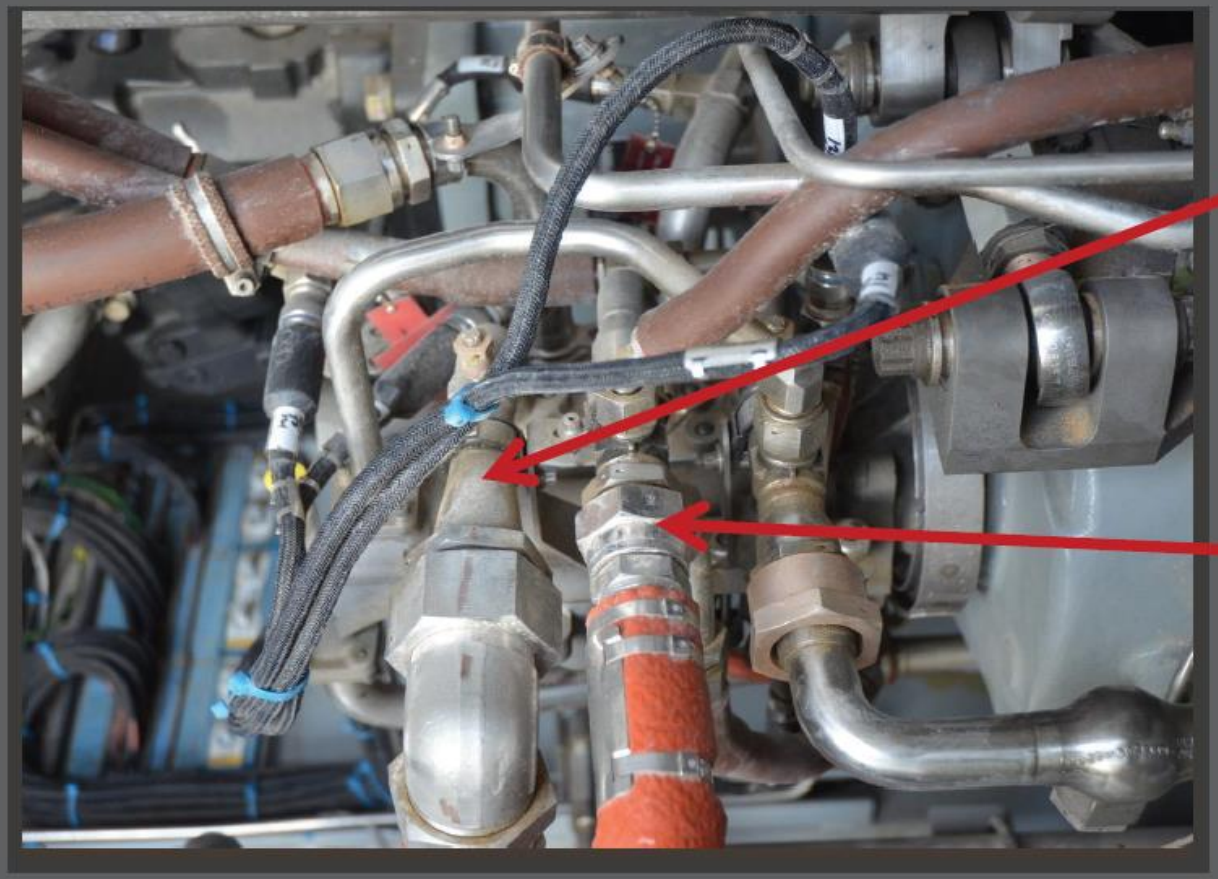
Sump Philosophy

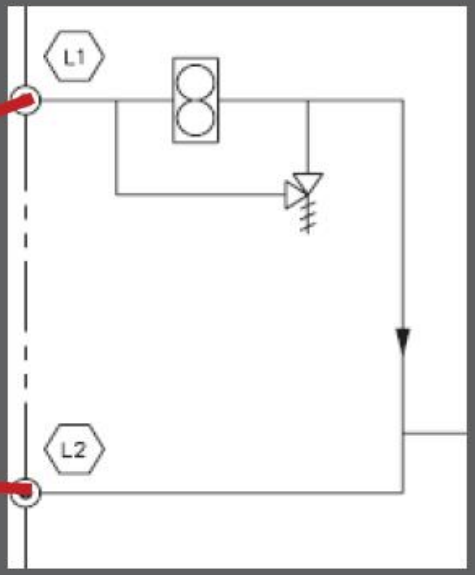



CFF
CRF
TMF
TRF
Gas Generator
Power turbine
3 R
"A" SUMP
4R
4B
"B" SUMP
5R
6R
"C" SUMP
7B
7R
"D" SUMP

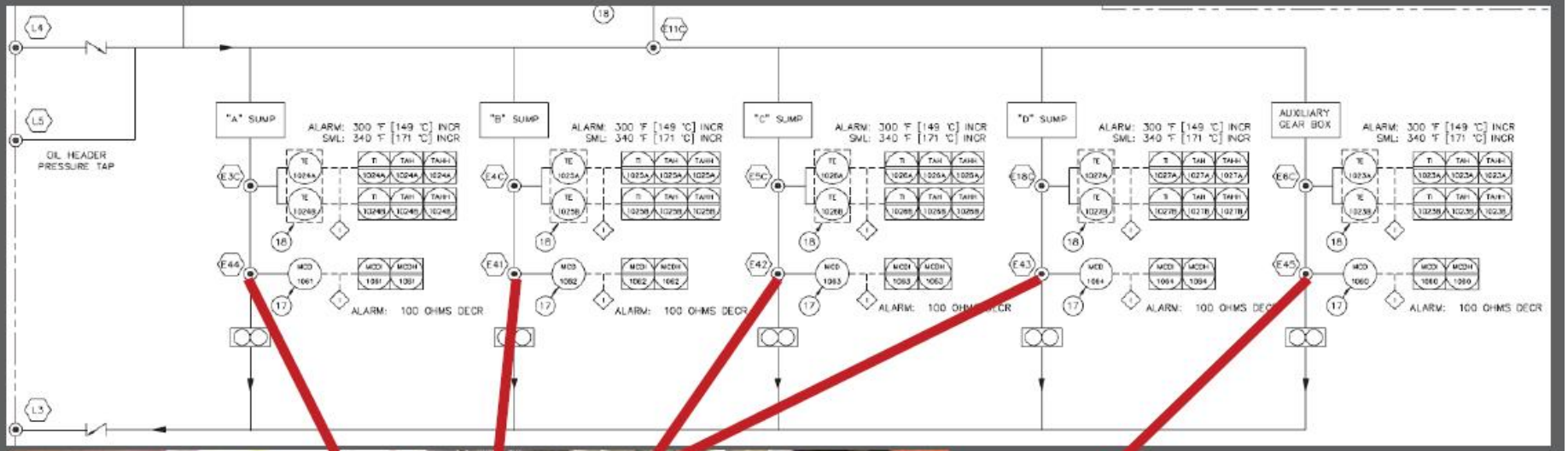


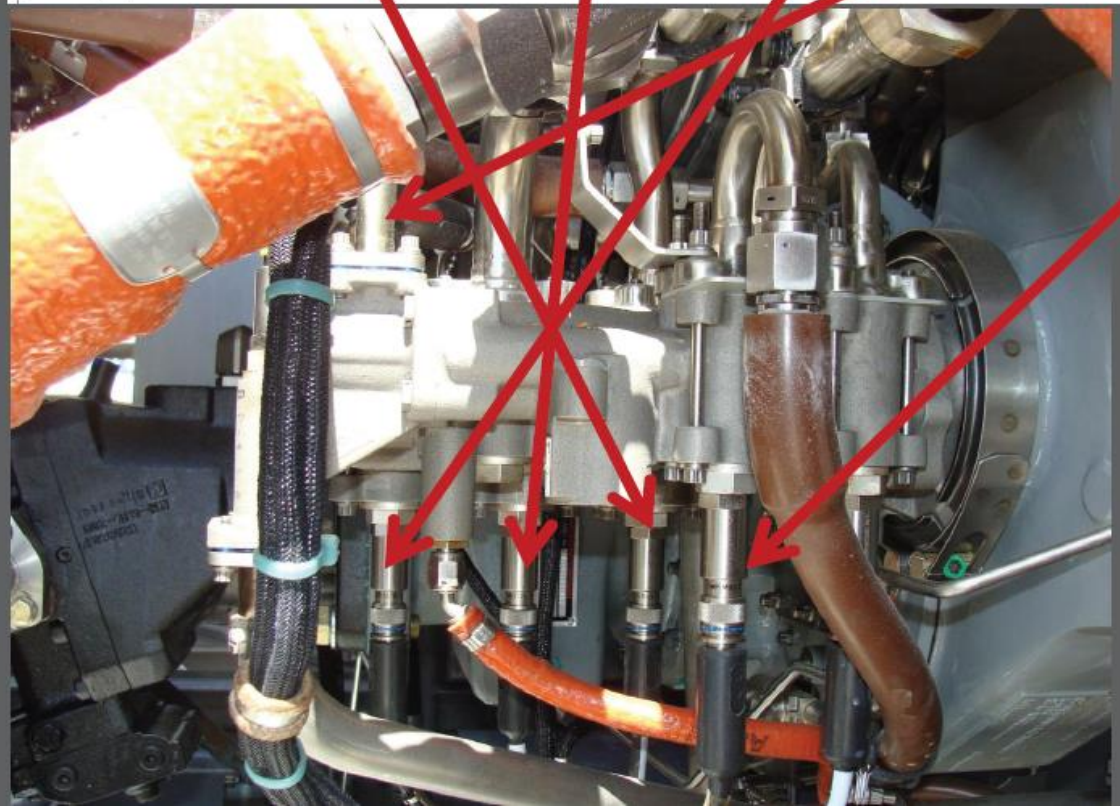
TURBINE LUBE OIL SYSTEM





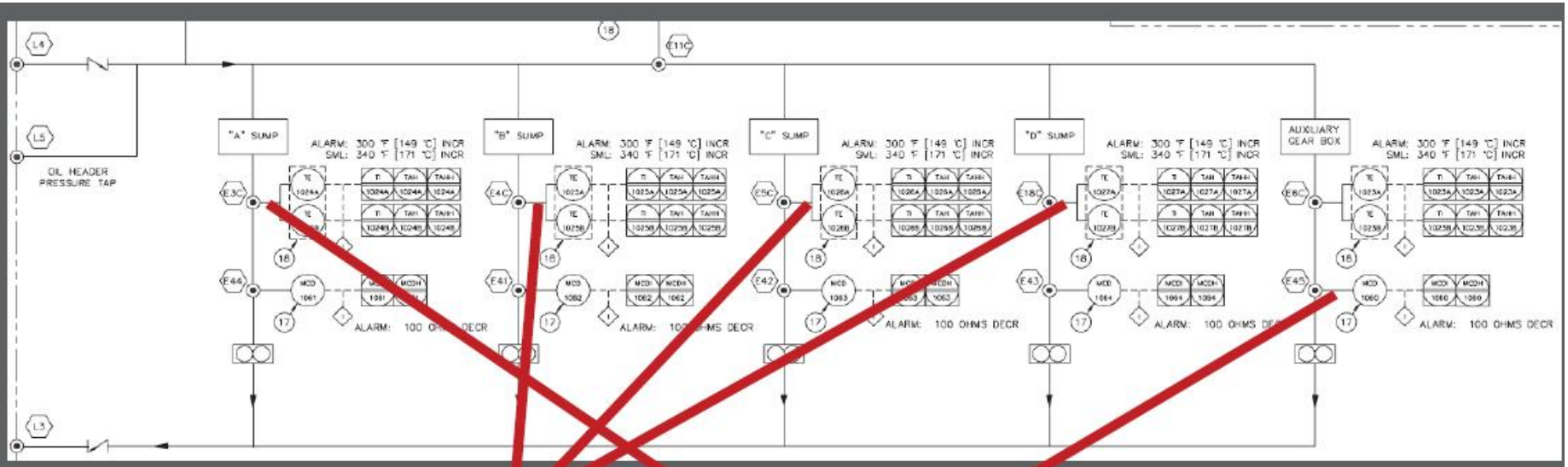
Turbine Lube Oil Supply Pump – (Pump 1)





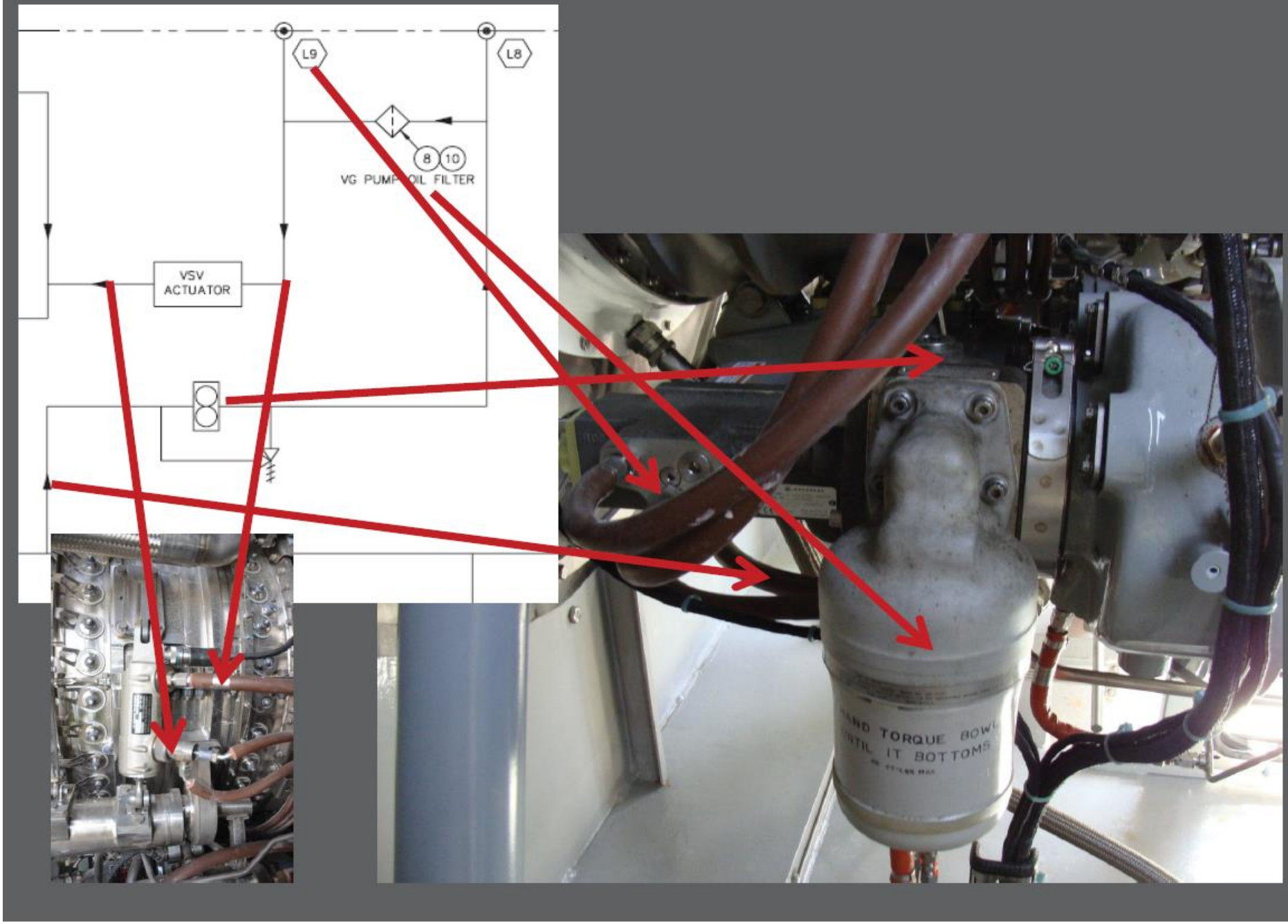
Turbine Lube Oil Supply (1) & Scavenge Pumps (5) (Total 6 pumps)

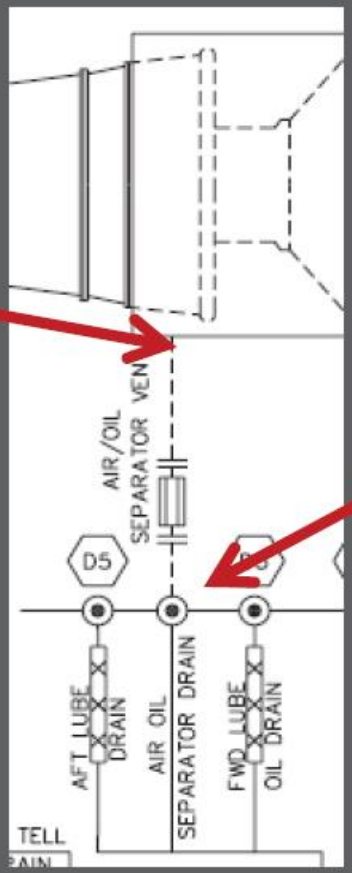
MCD – Magnetic Chip Detectors



Turbine Lube Oil Supply (1) & Scavenge Pumps (5)

Temperature Sensors


L9
L8
8
10
VG PUMP OIL FILTER
VSV
ACTUATOR



Turbine Air/Oil Separator

Questions