



Irrigation Department, Government Of Sindh **Project**:

CONSTRUCTION OF

**NEW 2X2.5MW HFO GTG OPEN CYCLE POWER PROJECT
AT NABISAR – THAR DISTT – PROVANCE OF SINDH**

**EPC/TURNKEY
CONTRACT ON LUMP-
SUM FIXED PRICE
BASIS**

**BIDDING DOCUMENT
(VOLUME-III)**

SEP 2016 – Rev 0

CONSULTANT



G3 Engineering Consultants Pvt Ltd

160-D, Model Town, Lahore - **Phone:** (042) 35947231

List of Drawings

| S No | DESCRIPTION |
|-----------------|---|
| A | <ul style="list-style-type: none"> i. Site location – Distt Map ii. Site location – Nabisar iii. Site approach iv. Facility plan |
| B | <ul style="list-style-type: none"> i. Project Life Cycle ii. P&ID Symbols iii. Tank form area iv. Plant Layout Concept v. Control Room Concepts vi. |
| C | <ul style="list-style-type: none"> i. Open Cycle Combustion Turbine ii. Air Inlet Cooling Concept iii. EVAP cooling Concept iv. Lube Oil Cooling v. |
| D | <ul style="list-style-type: none"> i. Cooling Air Concepts ii. Enclosure Fire Prevention iii. Water Treatment Concepts iv. Continuous Emission Monitoring System |
| E | <ul style="list-style-type: none"> i. Compressor Water Wash System Concept ii. Fuel Supply Systems iii. Fuel Treatment and Service Systems iv. Waste and Sludge Handling System v. Black Start Conceptual vi. vii. |
| F | <ul style="list-style-type: none"> i. Electrical SLD ii. Plant Operating Systems iii. Synchronizing Concept iv. v. |
| G | <ul style="list-style-type: none"> i. Plant control Systems Concept ii. B.O.P control iii. Rotating Doors |
| H | <p>Typical P&IDs and Specific Technical Information – Available on Request</p> <ul style="list-style-type: none"> i. ii. iii. iv. v. vi. vii. |

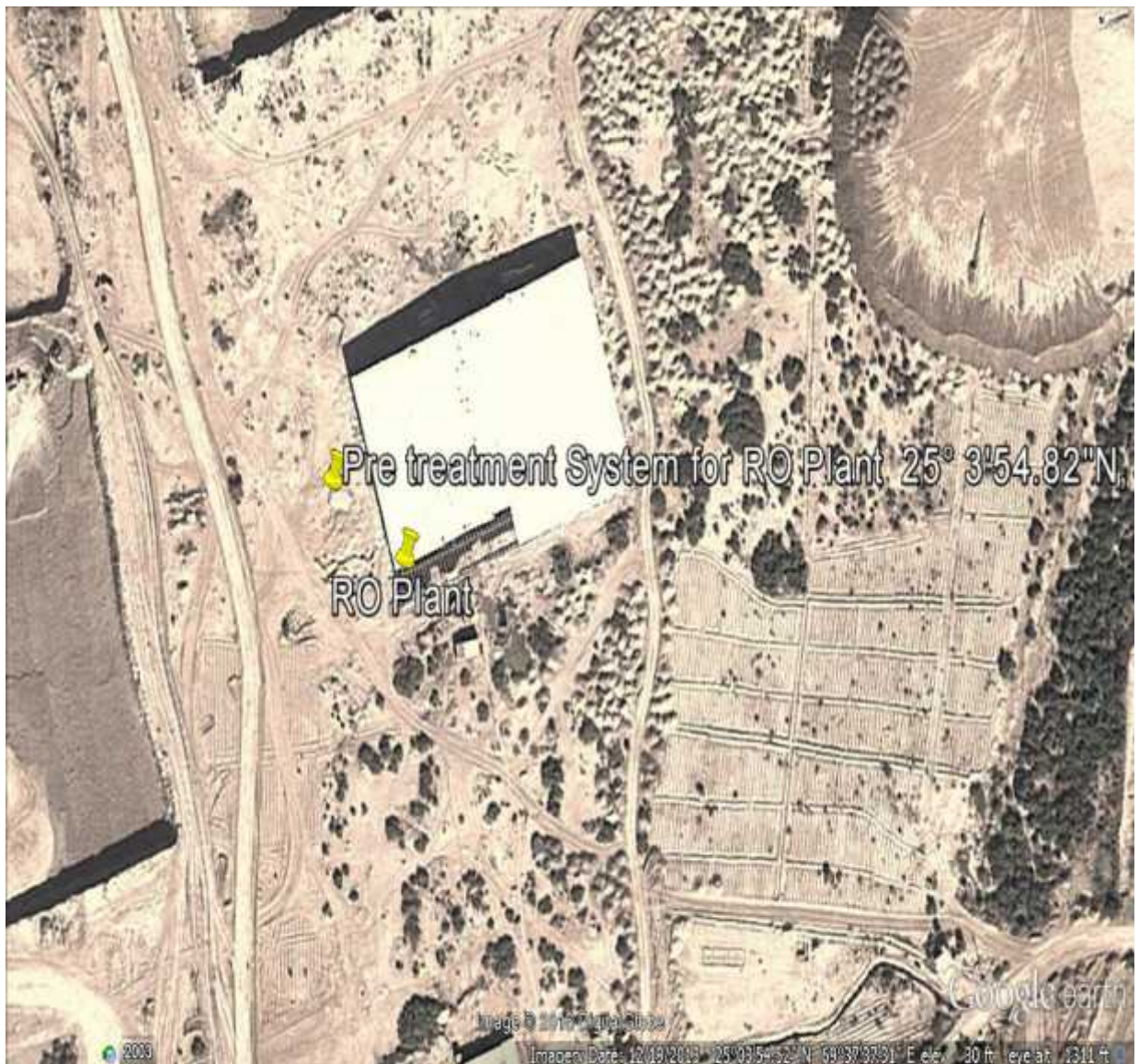
PART A - SITE LOCATION



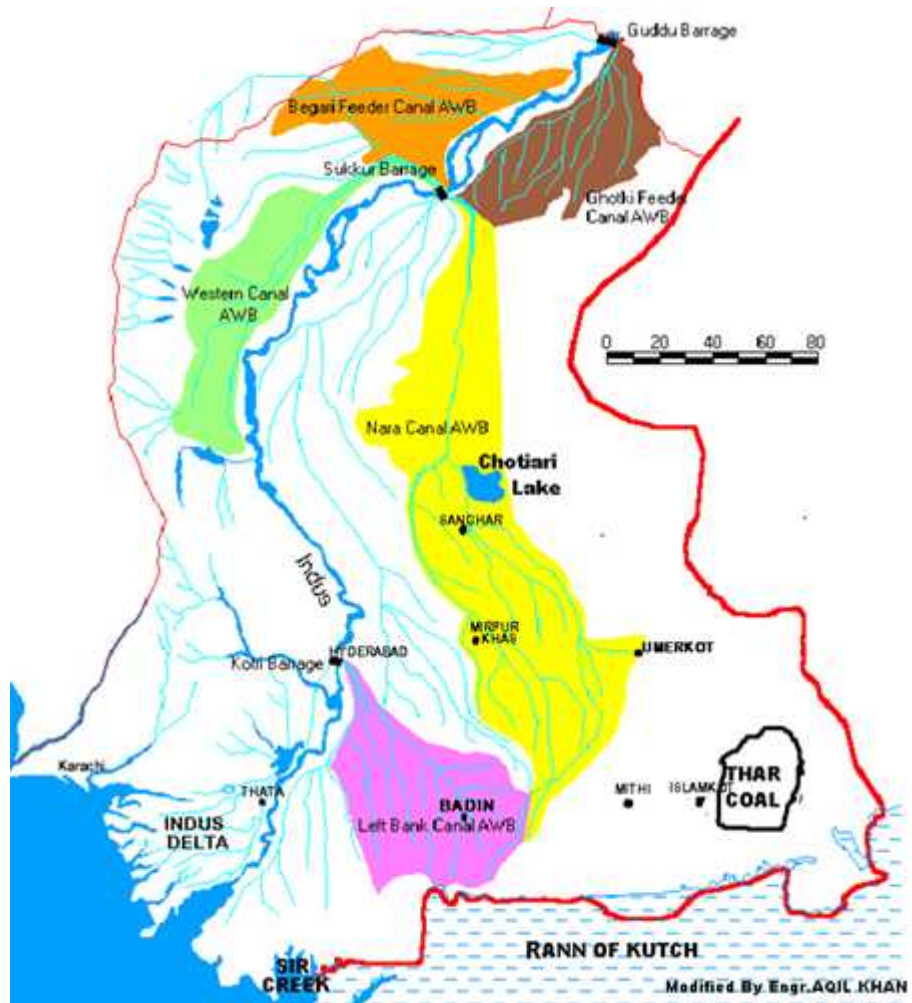
PROJECT SITE LOCATION MAP-THARPARKAR



SITE LOCATION – Google Earth Map



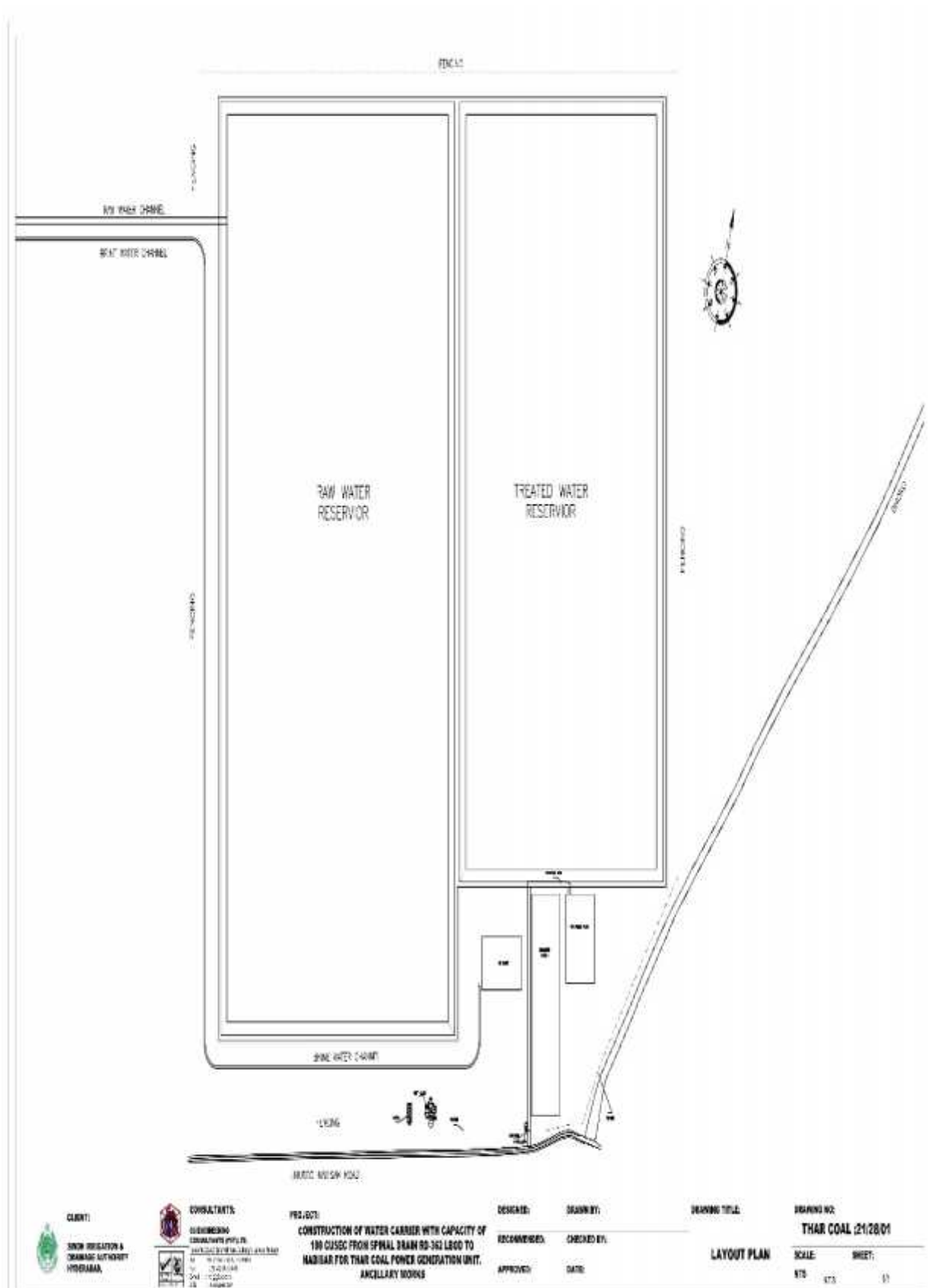
THAR COAL LOCATION



Appendix "C"



UTILITY RO PLANT LAYOUT



GPS Coordinates of THAR Coal Project

RO Plant

| S NO: | Easting | Northing | Remarks |
|-------|----------|----------|---------|
| 1 | 69.62636 | 25.06504 | |
| 2 | 69.62724 | 25.06532 | |
| 3 | 69.62708 | 25.06585 | |
| 4 | 69.62620 | 25.06554 | |

RES-TW

| S NO: | Easting | Northing | Remarks |
|-------|----------|----------|---------|
| 1 | 69.62541 | 25.06598 | |
| 2 | 69.62988 | 25.06727 | |
| 3 | 69.62686 | 25.07551 | |
| 4 | 69.62225 | 25.07403 | |

RES-RW

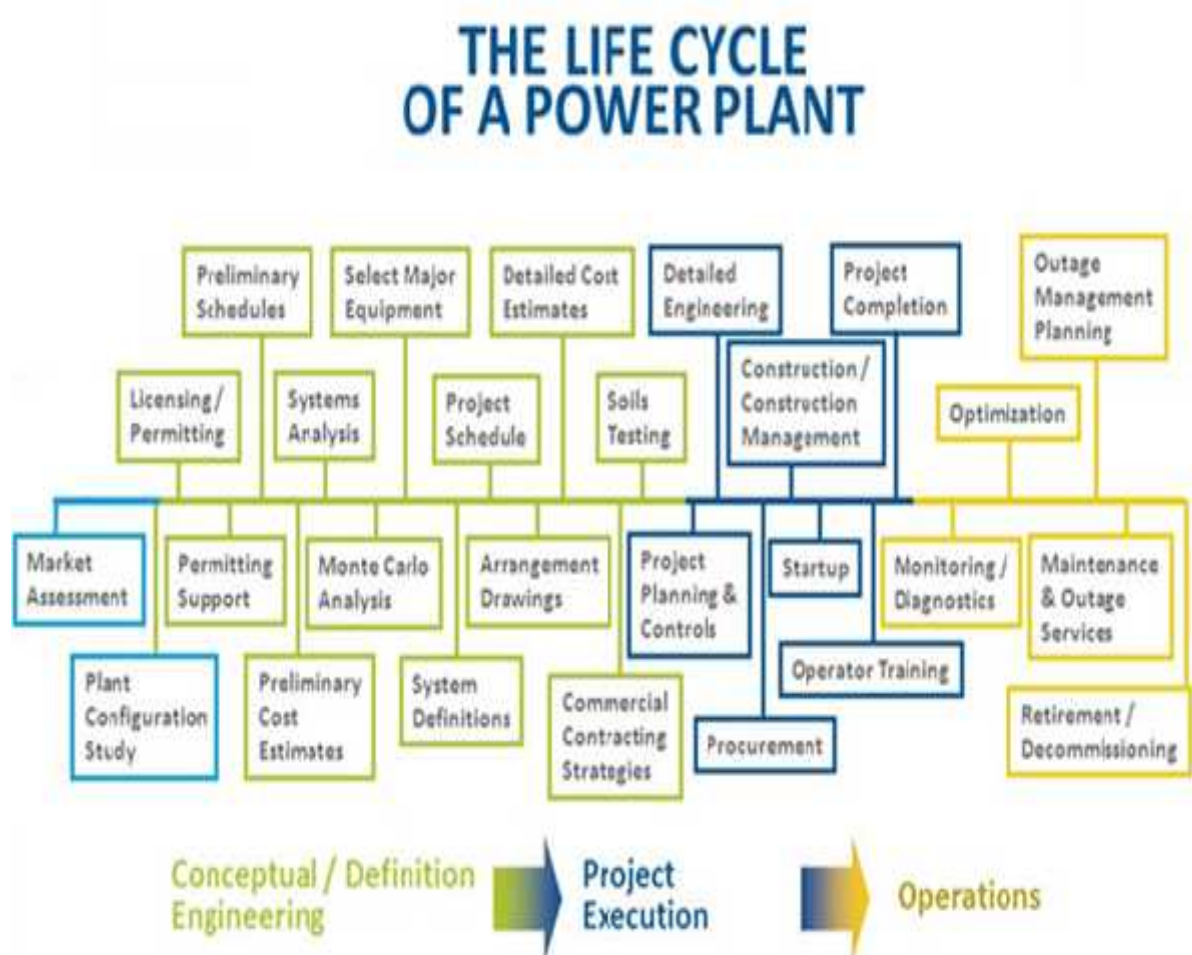
| | | | |
|---|----------|----------|--|
| 1 | 69.62043 | 25.06261 | |
| 2 | 69.62601 | 25.06433 | |
| 3 | 69.62225 | 25.07403 | |
| 4 | 69.61684 | 25.07231 | |

SITE APPROACH – THAR COAL ROAD

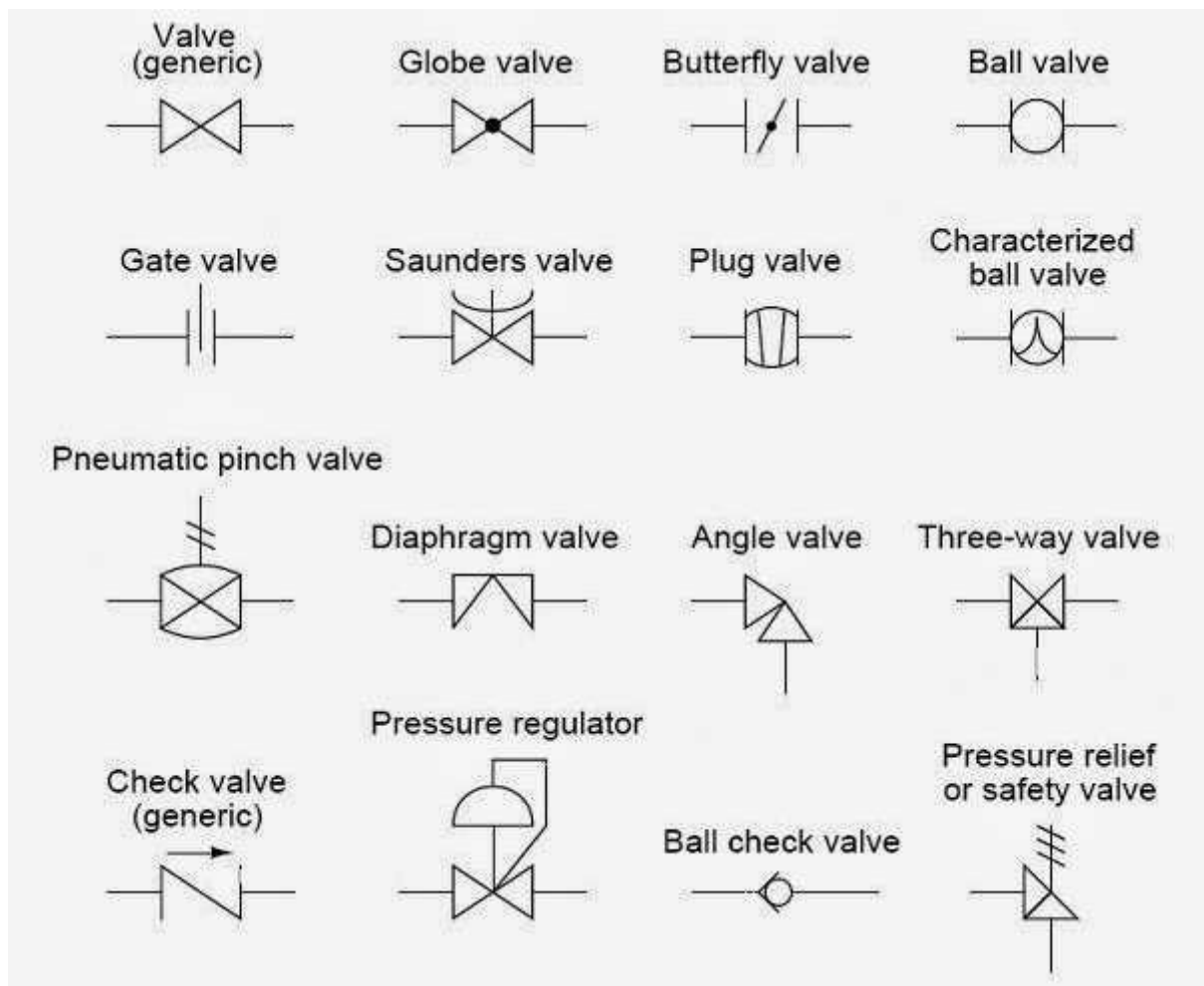
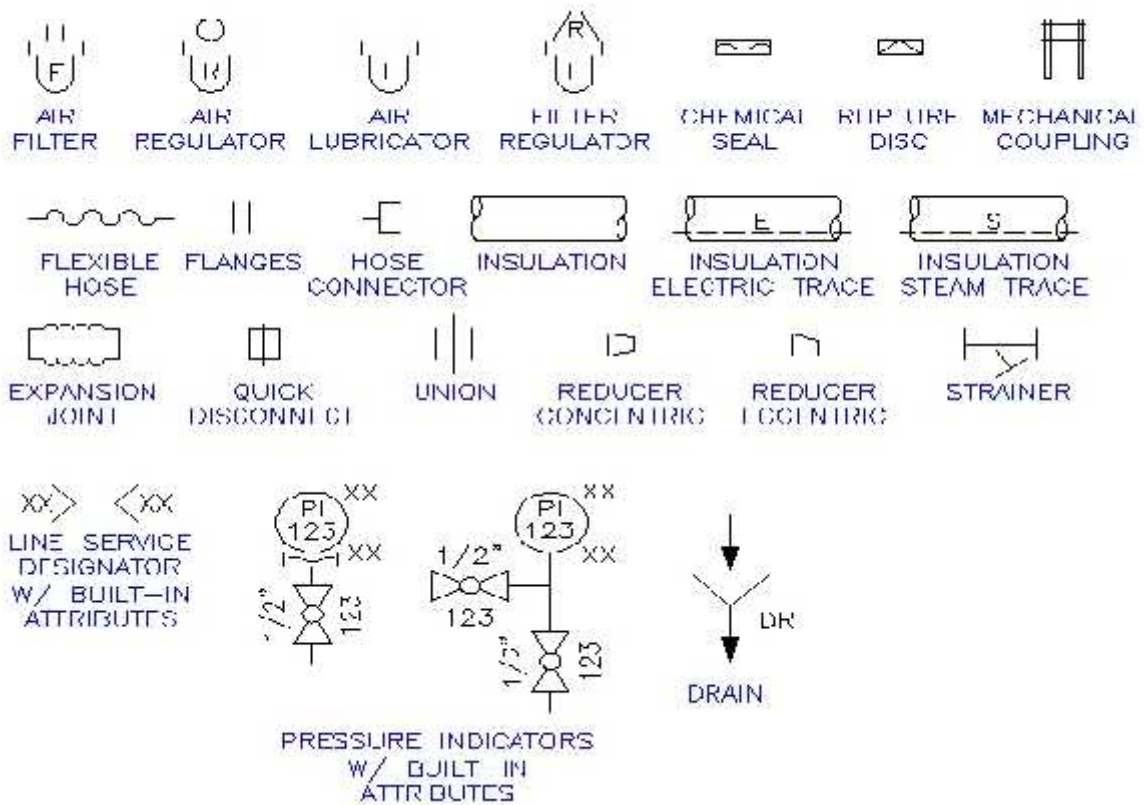


























PART B - Symbols & Main Layout

PROJECT LIFE CYCLE - EPC CONSIDERATIONS

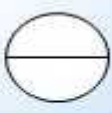
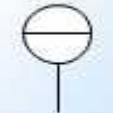



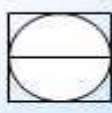
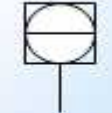
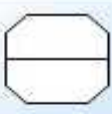













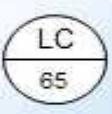

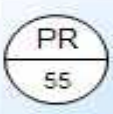
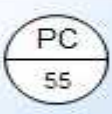
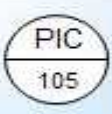
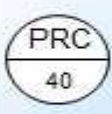






















































INLINE PIPING SYMBOLS INCLUDED WITH THE
P&ID SYMBOLS LIBRARY V1.1



| | | |
|---|--|--|
|  Temp Indicator |  Flow Indicator |  Transducer |
|  Temp Transmitter |  Flow Transmitter |  Pressure Indicating Controller |
|  Temp Recorder |  Flow Recorder |  Pressure Recording Controller |
|  Temp Controller |  Flow Controller |  Level Alarm |
|  Level Indicator |  Pressure Indicator |  Flow Element |
|  Level Transmitter |  Pressure Transmitter |  Temperature Element |
|  Level Recorder |  Pressure Recorder |  Level Gauge |
|  Level Controller |  Pressure Controller |  Analyzer Transmitter |

Instruments

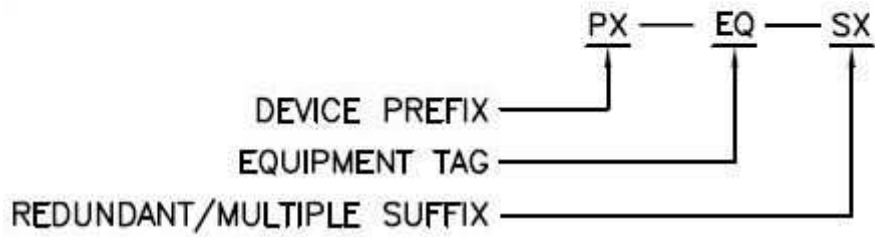
| | | | | | | |
|---|---|---|---|--|---|---|
|  |  |  |  |  |  |  |
| Indicator | Indicator 2 | Indicator 3 | Indicator 4 | Indicator 5 | Shared Indicator | Shared Indicator 2 |
|  |  |  |  |  |  |  |
| Computer Indicator | Programma... Indicator | Temp Indicator | Temp Transmitter | Temp Recorder | Temp Controller | Flow Indicator |
|  |  |  |  |  |  |  |
| Flow Transmitter | Flow Recorder | Flow Controller | Level Indicator | Pressure Indicator | Level Transmitter | Level Recorder |
|  |  |  |  |  |  |  |
| Level Controller | Pressure Transmitter | Pressure Recorder | Pressure Controller | Pressure Indicating | Pressure Recording | Level Alarm |

| | | | | | |
|--|--|--|--|--|--|
|  LOCALLY MOUNTED INSTRUMENT |  BOARD MOUNTED INSTRUMENT |  FLOW ALARM |  FLOW ELEMENT |  UNIT SHUT DOWN | |
|  PRESSURE CONTROLLER | |  FLOW INDICATOR | |  POSITION/ UNIT SWITCH CLOSED | |
|  PRESSURE INDICATOR | |  FLOW RECORDER | |  SHUT DOWN VALVE RELAY | |
|  PRESSURE RECORDER | |  FLOW RECORDING CONTROLLER | |  SHUT DOWN VALVE | |
|  PRESSURE INDICATING CONTROLLER | |  TEMPERATURE ALARM | |  POSITION/ LIMIT INDICATOR OPEN | |
|  PRESSURE RECORDING CONTROLLER | |  TEMPERATURE INDICATOR | |  TEMPERATURE RELAY | |
|  PRESSURE SAFETY VALVE | |  TEMPERATURE RECORDER | |  SPECTACLE BLIND OPEN | |
|  RELIEF VALVE | |  TEMPERATURE RECORDING CONTROLLER | |  SPECTACLE BLIND CLOSED | |
| | |  TEMPERATURE WELL | |  ORIFICE FLANGES | |
|  LEVEL ALARM | |  GATE VALVE | |  PIPING SPECIALITY ITEM | |
|  LEVEL ALARM HIGH | |  GLOBE VALVE | |  INSTRUMENT AIR LINE | |
|  LEVEL ALARM LOW | |  CHECK VALVE | |  INSTRUMENT ELECTRICAL | |
|  LEVEL CONTROLLER | |  CONTROL VALVE | |  INSTRUMENT CAPILLARY TUBING | |
|  LEVEL GLASS | |  PLUG VALVE | |  PIPE | |
|  LEVEL INDICATOR | |  BALL VALVE | |  TRANSMITTER (OR)  | |
|  LEVEL INDICATING CONTROLLER | |  BUTTERFLY VALVE | |  HAND CONTROL VALVE | |
|  LEVEL RECORDING CONTROLLER | | | | | |

ISA S5.1 Identification Letters

| | First-letter | | Succeeding- Letters | | |
|---|---------------------------------|--------------|---------------------|-----------------|----------|
| | Measured or Initiating variable | Modifier | Readout function | Output function | Modifier |
| A | Analysis | | | | |
| C | | | | Control | |
| D | | Differential | | | |
| F | Flow Rate | Ratio | | | |
| H | Hand | | | | High |
| I | Current | | Indicate | | |
| L | Level | | | | Low |
| P | Pressure, vacuum | | | | |
| Q | Quantity | Totalizer | | | |
| S | | Safety | | Switch | |
| T | Temperature | | | Transmit | |
| V | Vibration | | | Valve, Dampor | |
| Z | Position | | | Actuator | |

INSTRUMENT/DEVICE TAGS



NOTE: HYPHENS ARE NOT RQD BETWEEN PX AND EQ.

REDUNDANT/MULTIPLE SUFFIX RULES:

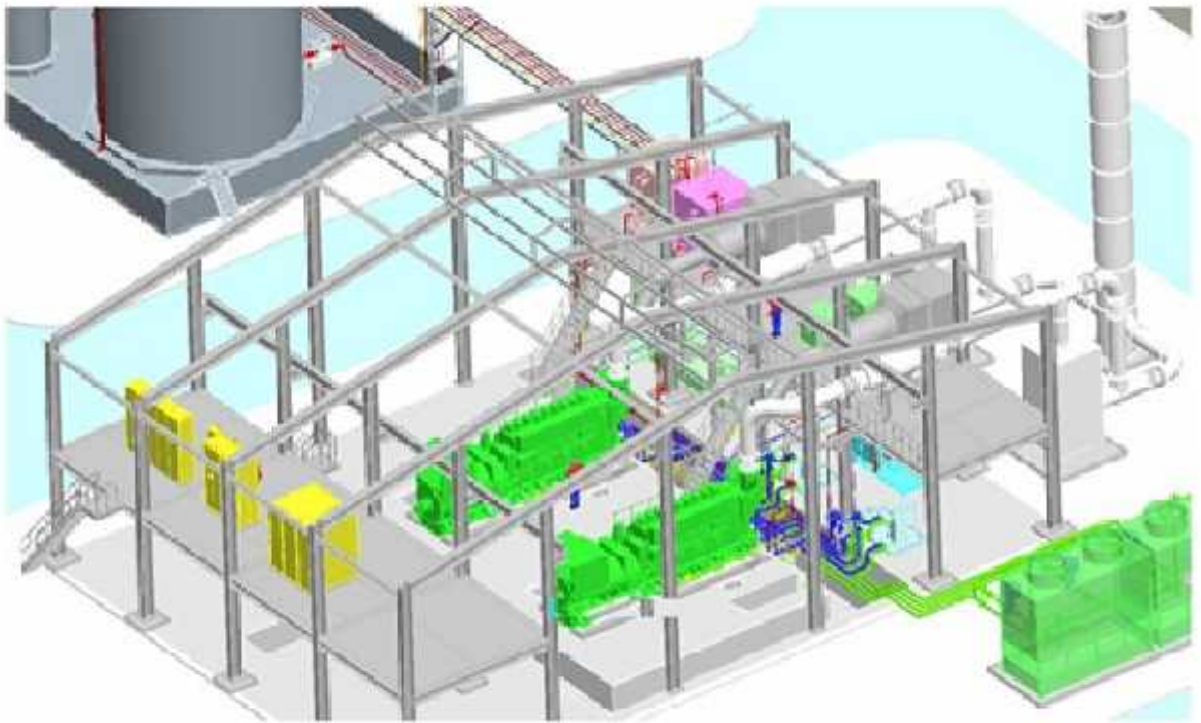
1. UTILIZE SEQUENTIAL NON-HYPHENATED ALPHABETIC SUFFIXES FOR REDUNDANT DEVICES.
2. FOR MULTIPLE ITEMS OF SAME TYPE, EMPLOY A SEQUENTIAL, HYPHENATED NUMERIC SUFFIX.

POWER PLANT CONCEPTUAL SET UP

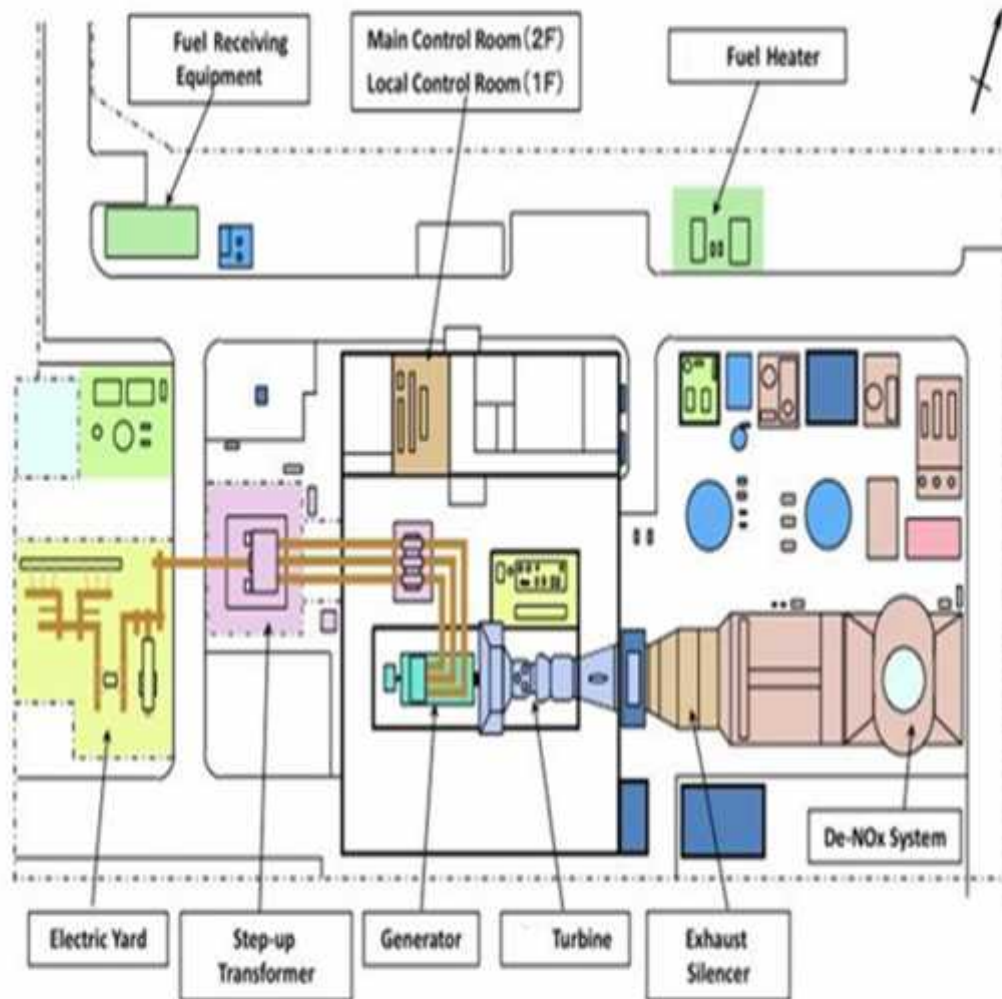


OVERFLOW + IGNITION
=
TANK FARM FIRE

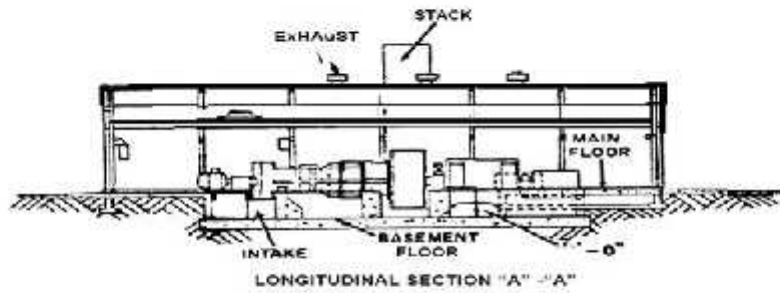




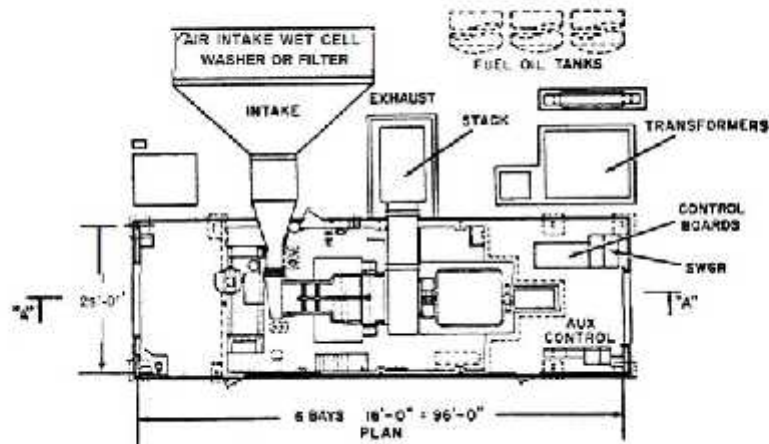
General Arrangement of Plant



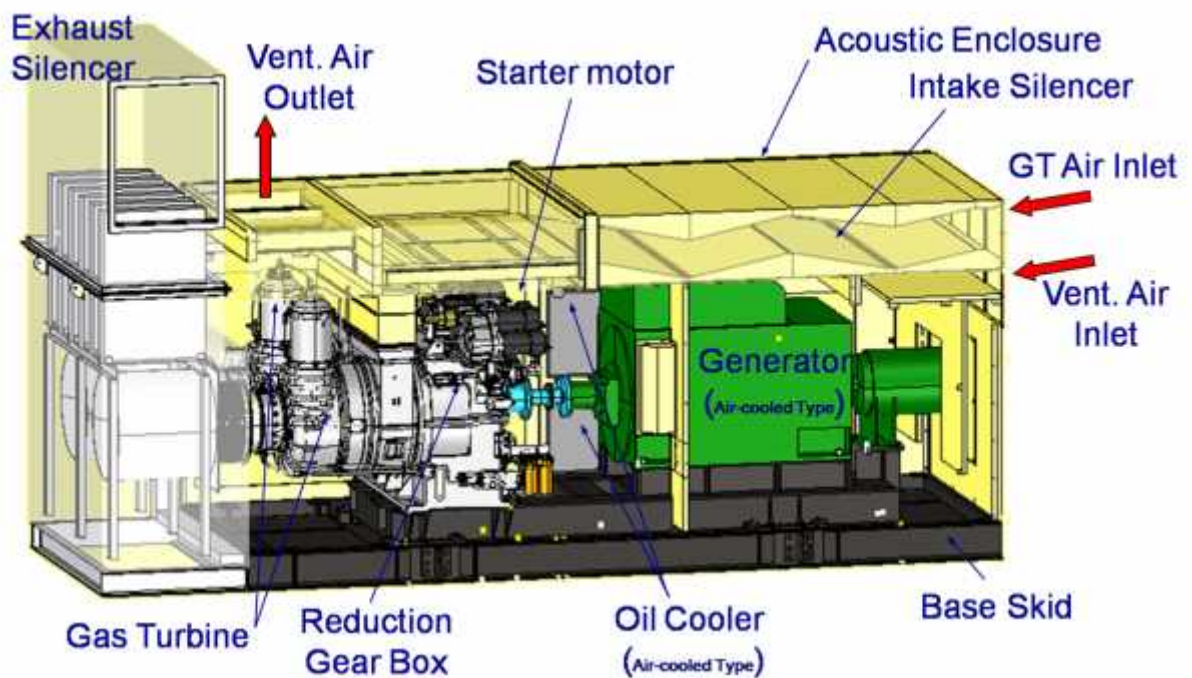
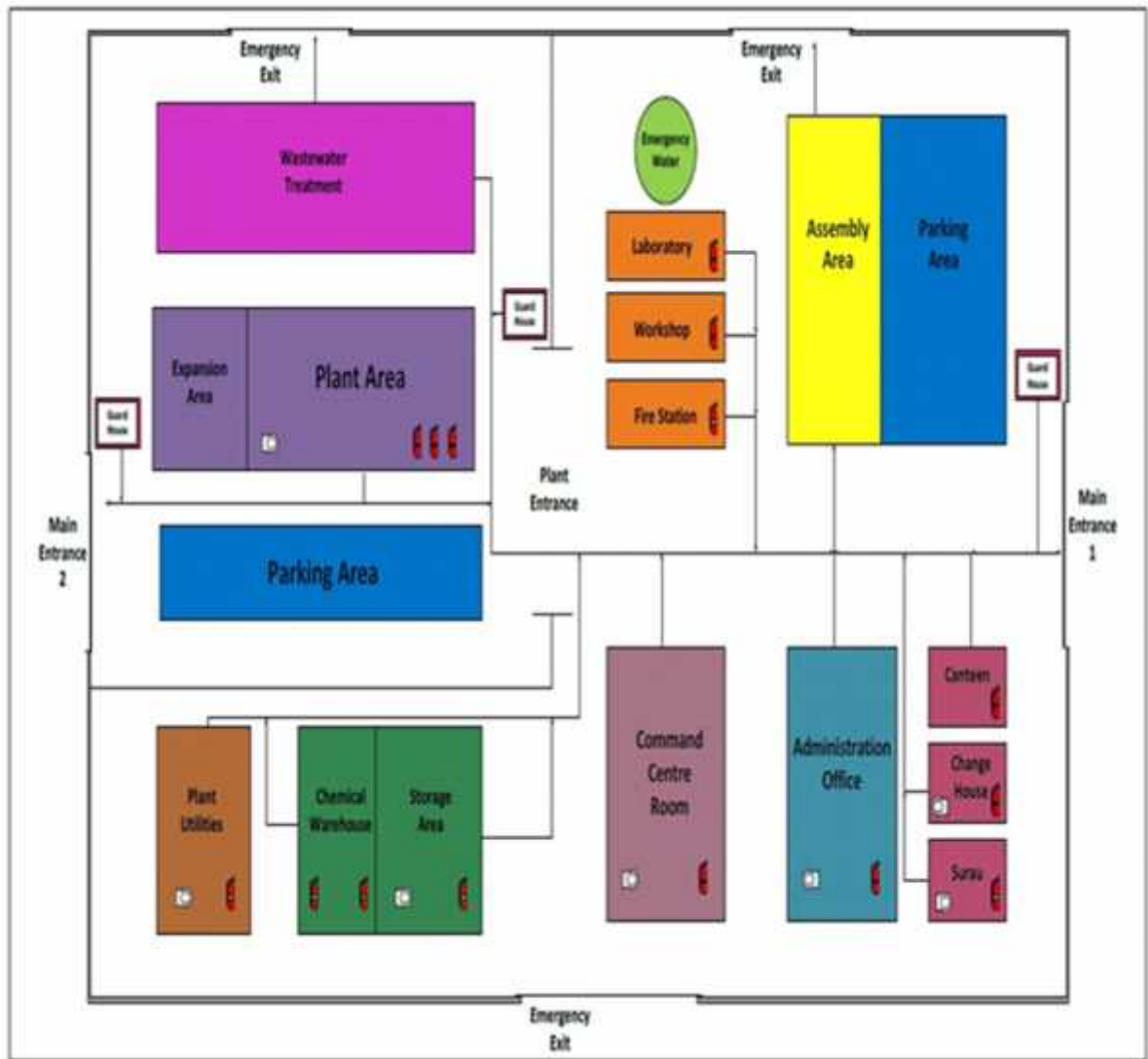
SIMPLE GAS TURBINE LAYOUT



FRONT VIEW



PART PLAN – CONCEPTUAL LAY OUT



CONTROL ROOM - CONCEPTUAL



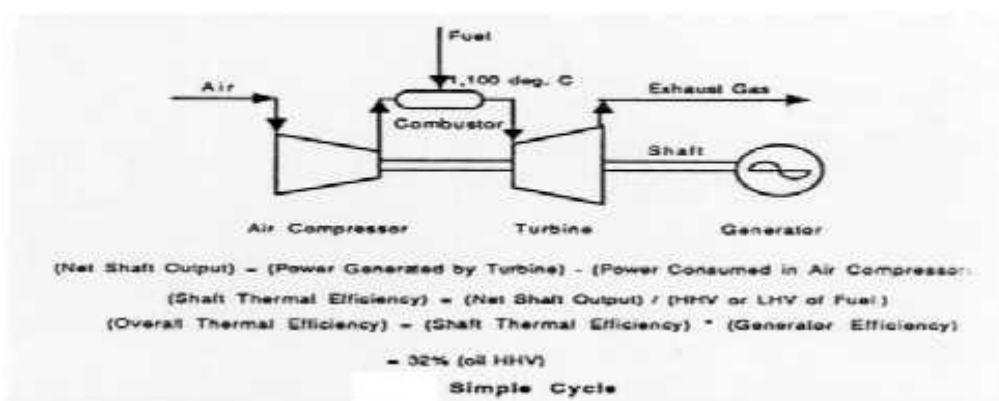
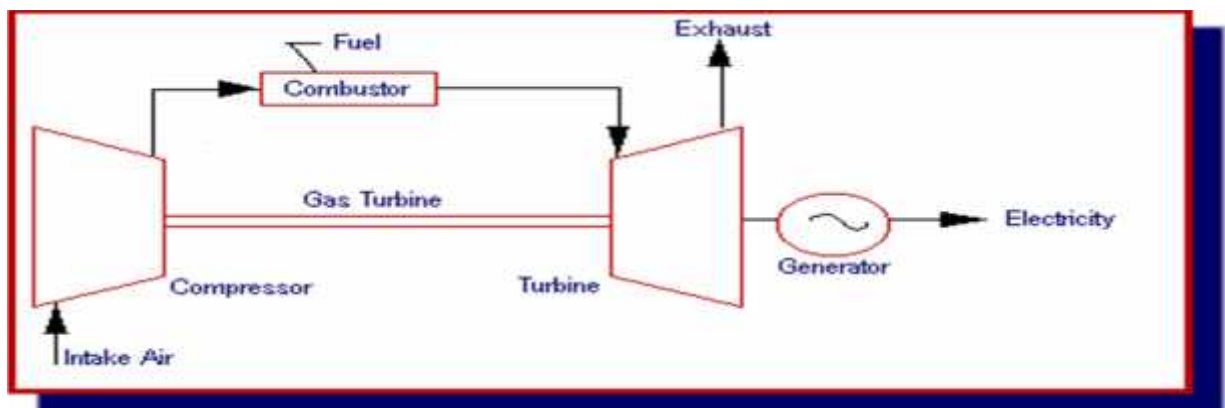
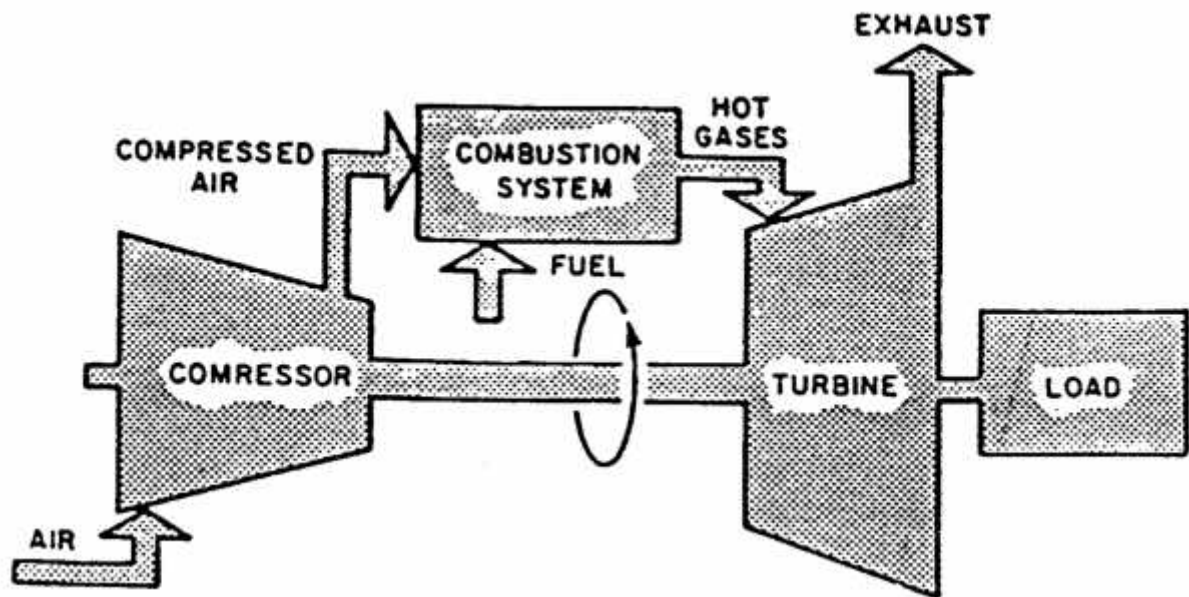
Power Plant C&I systems

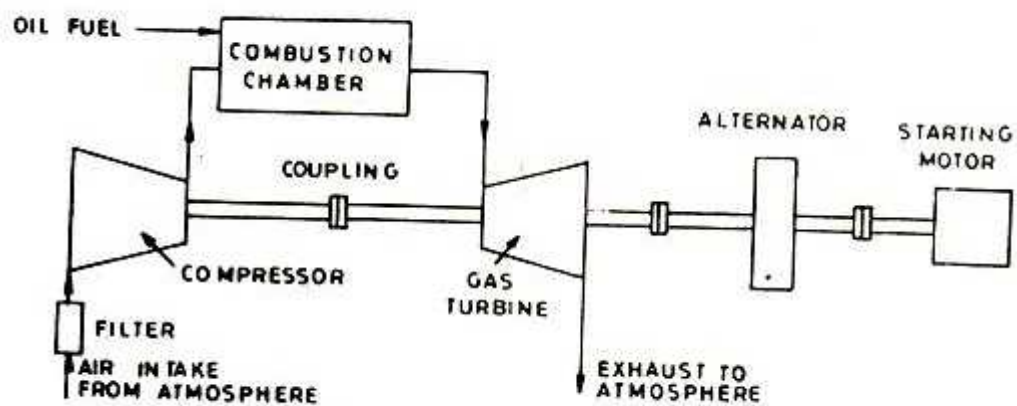
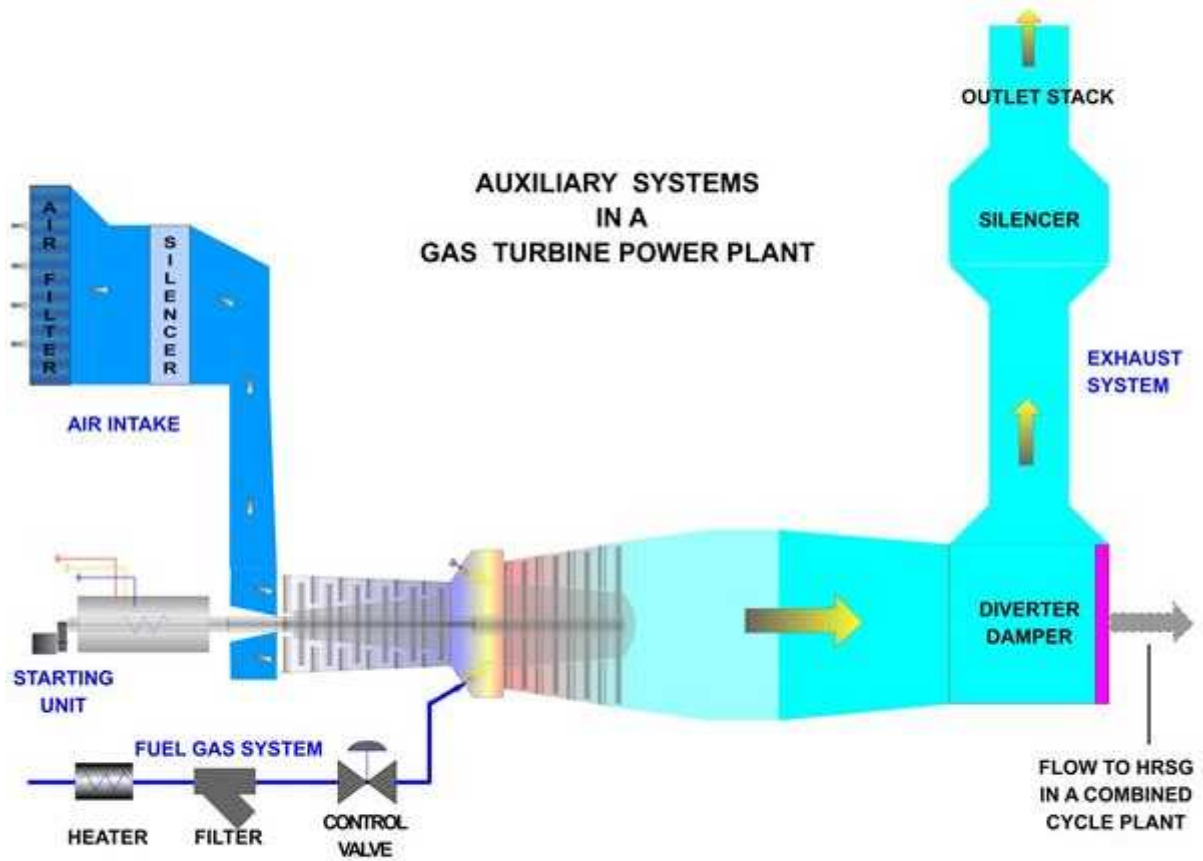
1. Field Instruments/ input & output instruments

- a) Various measuring instruments like Transmitters, RTD, Thermocouples, Pr. & temp. gauges, speed & vibration pick ups etc. (Analog inputs)
- b) Various Pr., Temp. & limit switches, for Interlock, protections & feedback of control element (Binary inputs)
- c) Output devices like solenoids, EP converters, Positioners etc. for controlling final control element
- d) Final control elements like Power cylinder, Pneumatic/ motorized actuators etc.

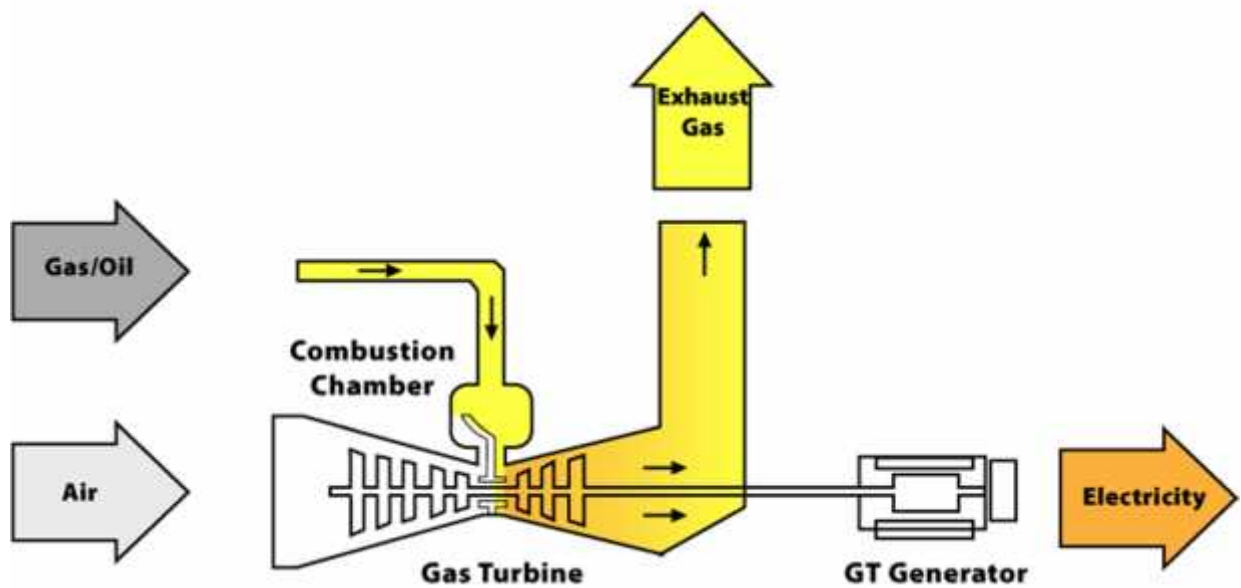
PART C - COMBUSTION TURBINE SET UP

MAIN PLANT CONCEPTUALS

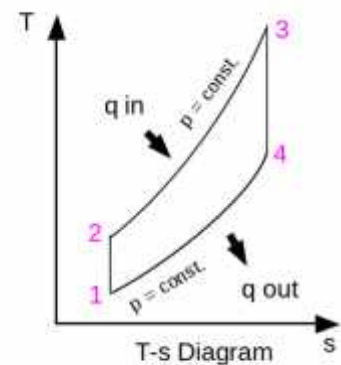
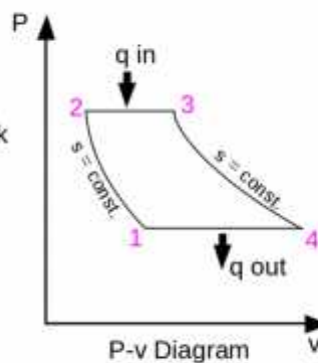
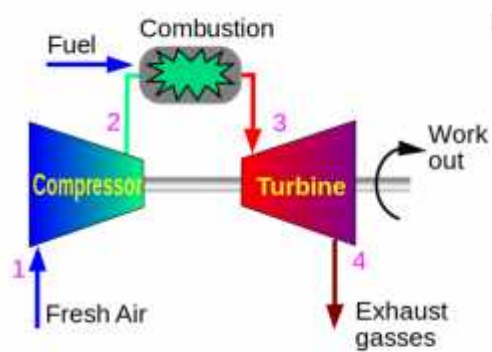
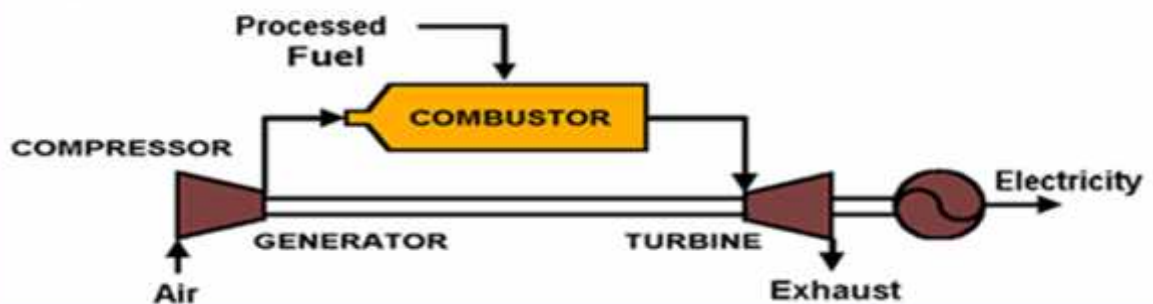




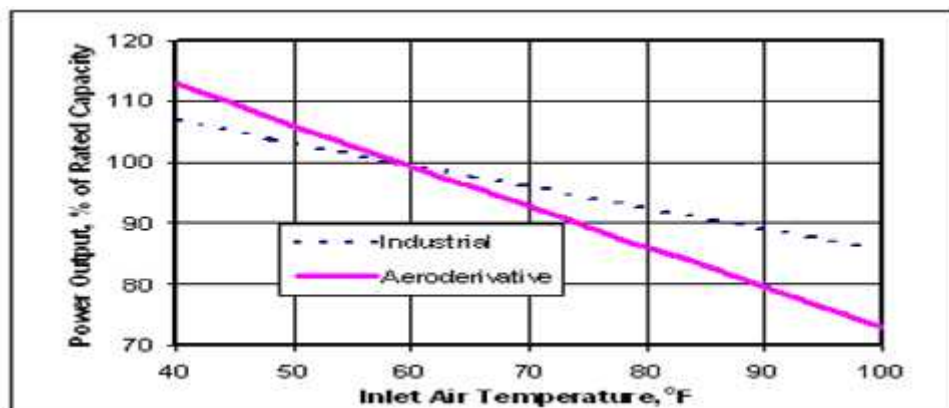
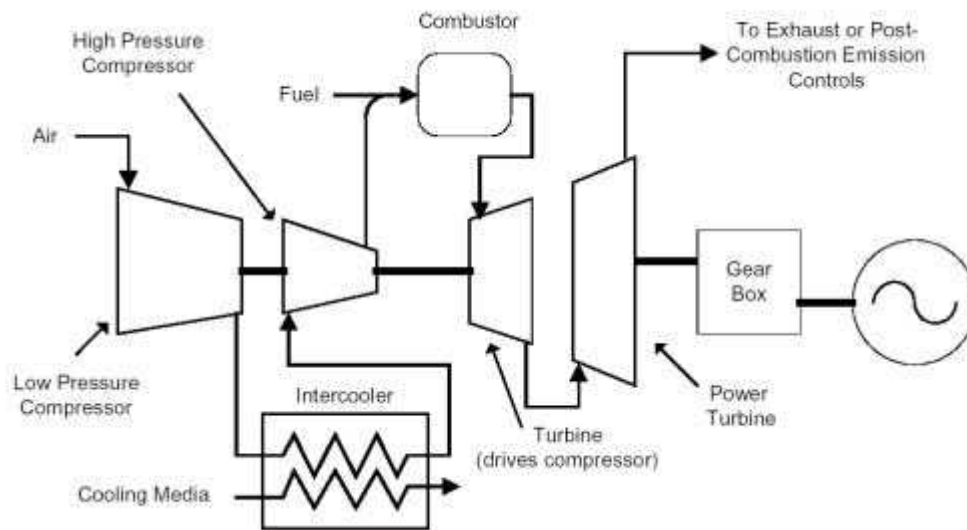
Simple Cycle Process



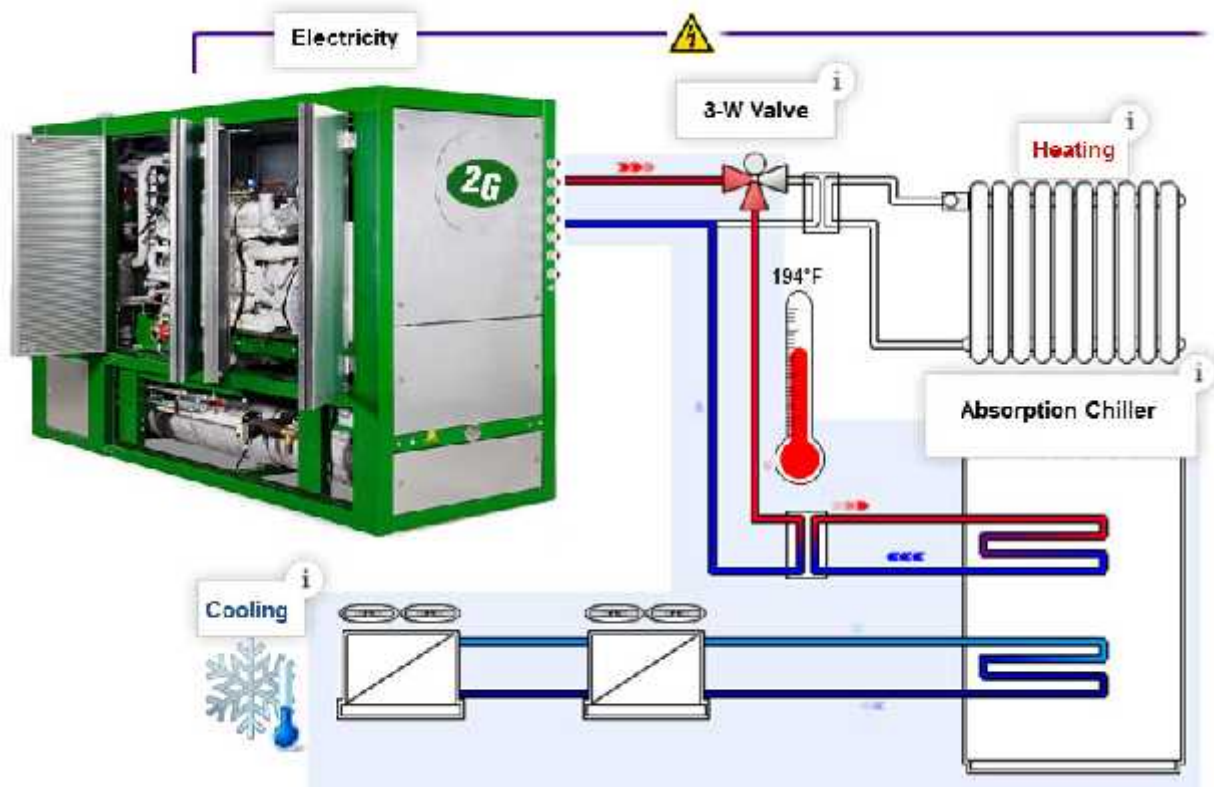
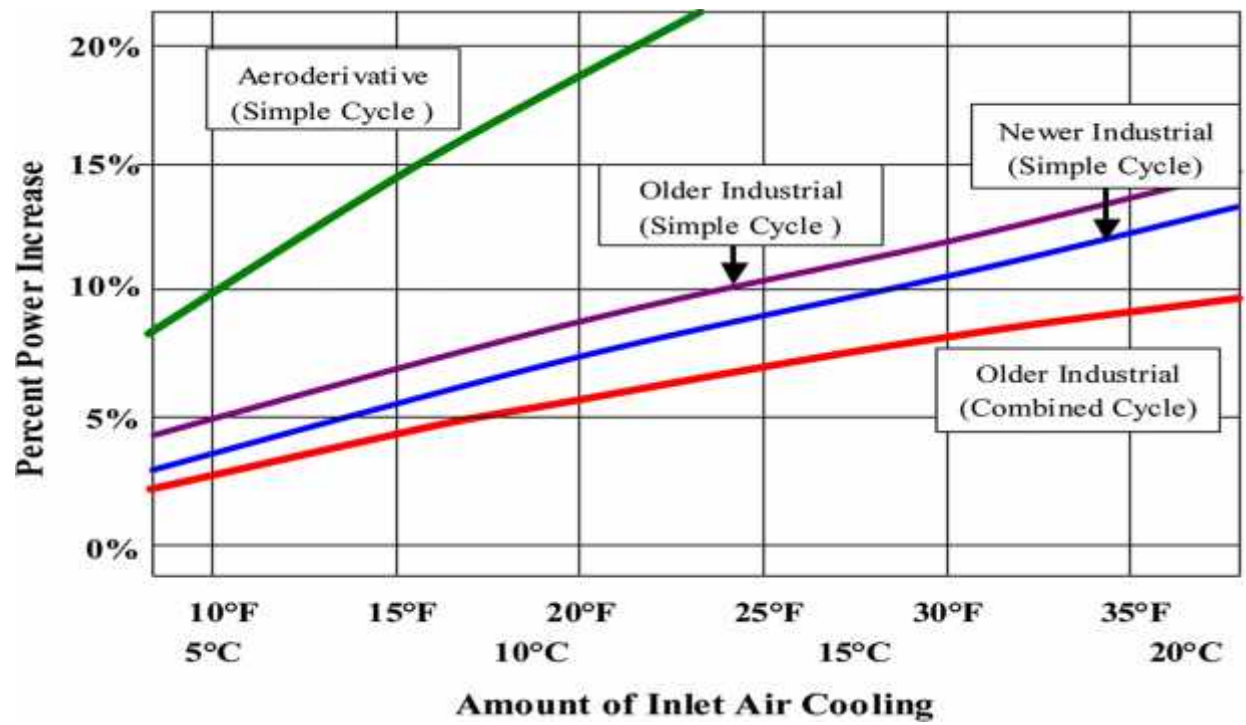
Simple Cycle Gas Turbine



AIR INLET COOLING CONCEPT



Effect of Ambient Temperature on the Output of CTs

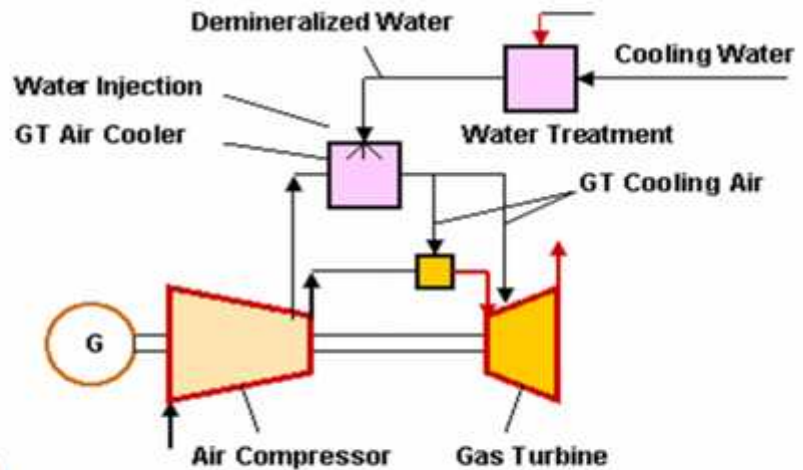


LUBE OIL COOLING COMCEPT / GT COOLING AIR COOLING CONCEPT

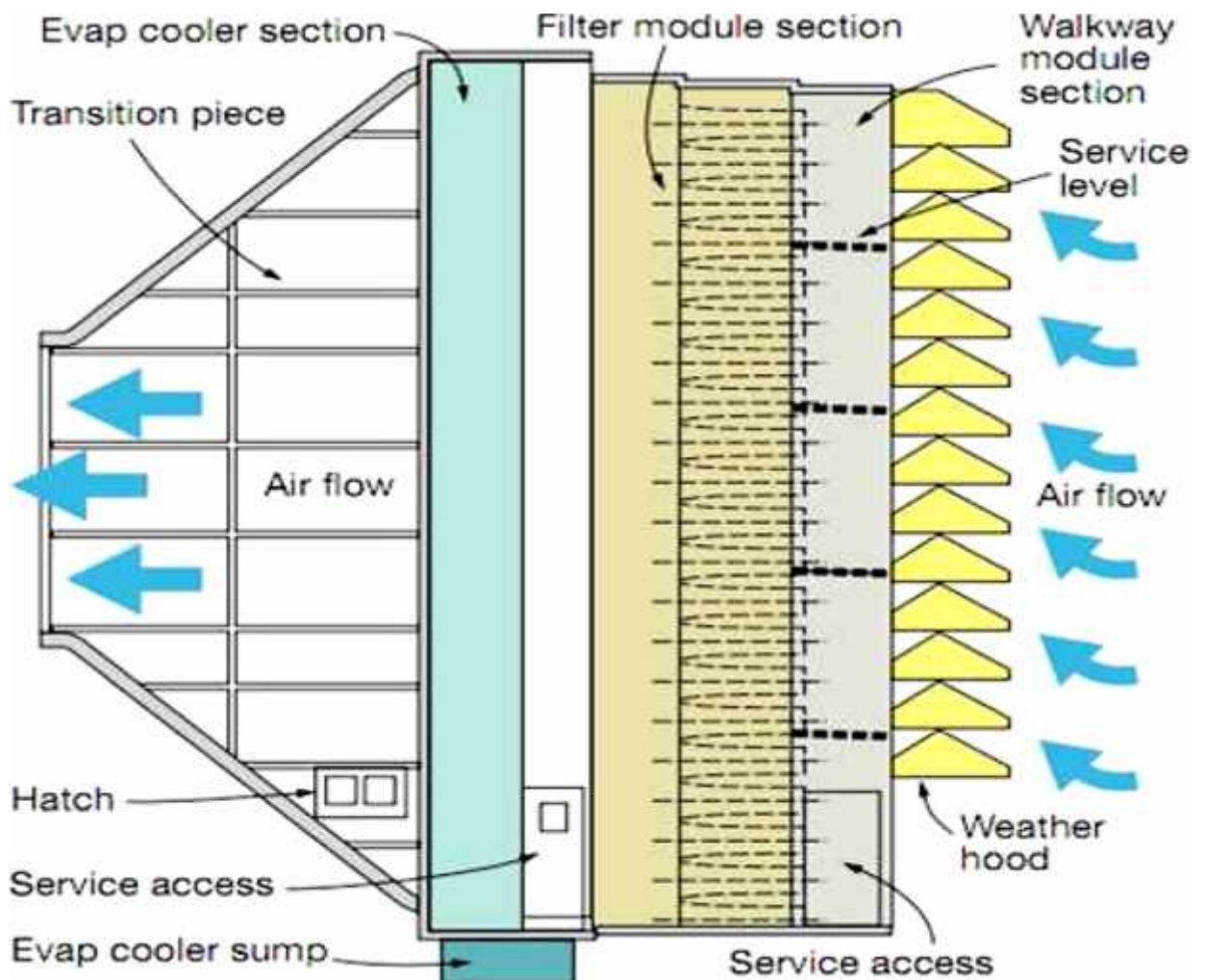
Gas Turbine Power Plant Cooling of GT Cooling Air by Water Injection (Quench Cooling)

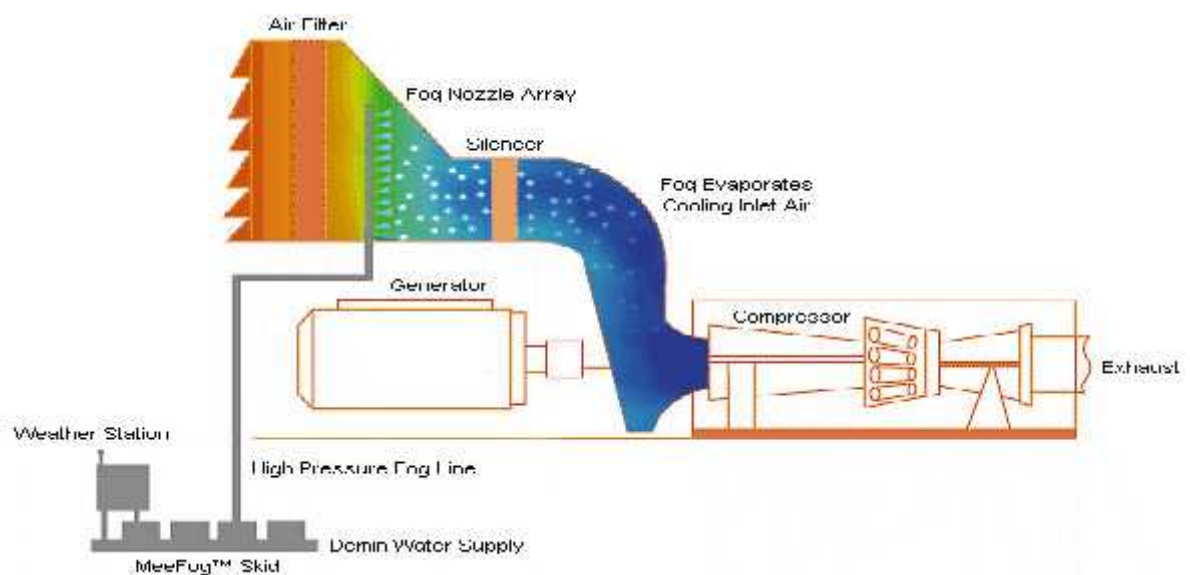
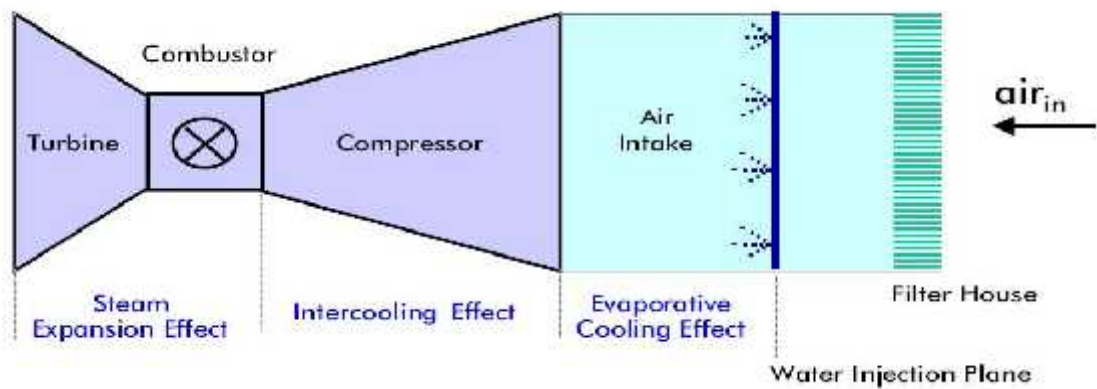
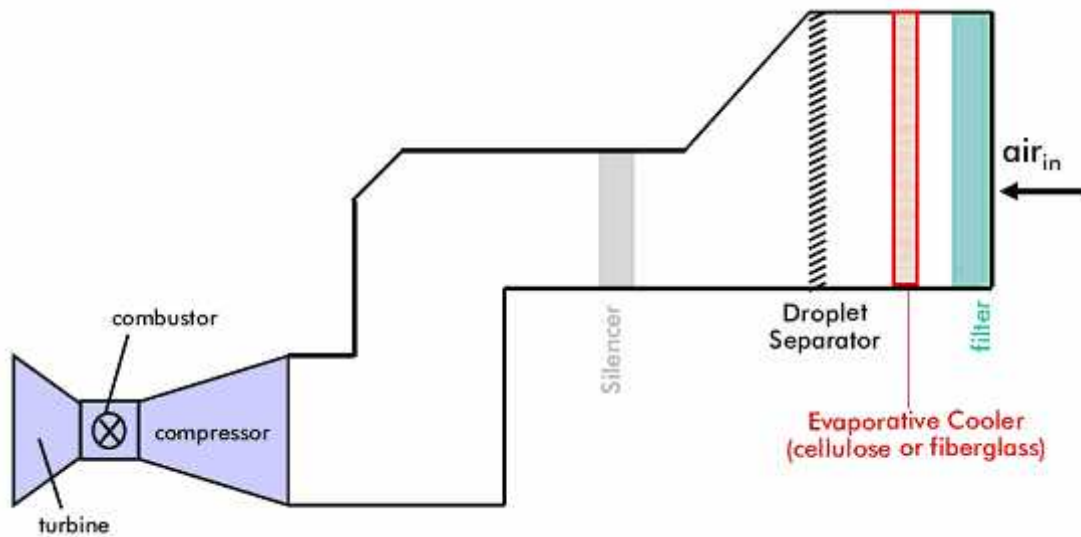
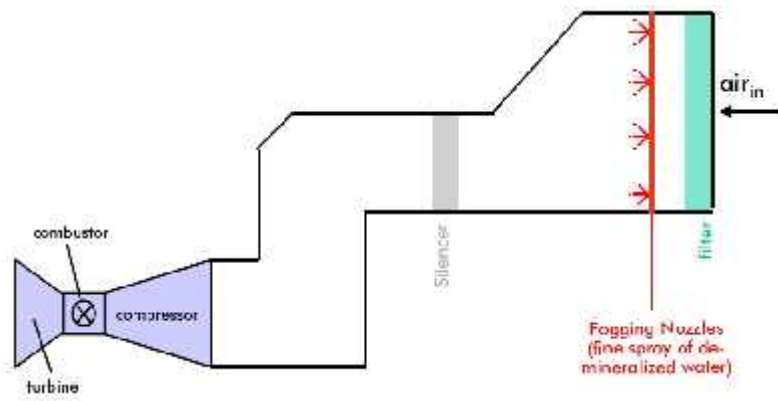
$$\eta^{th}_{net} \approx 0.38$$

© Thermal PowerTec 028

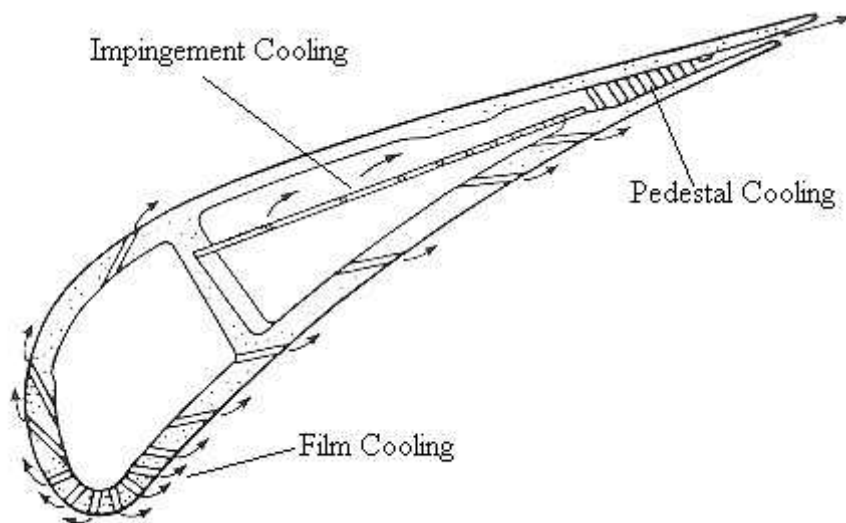


EVAP COOLING CONCEPT

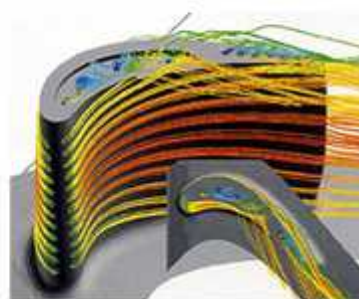
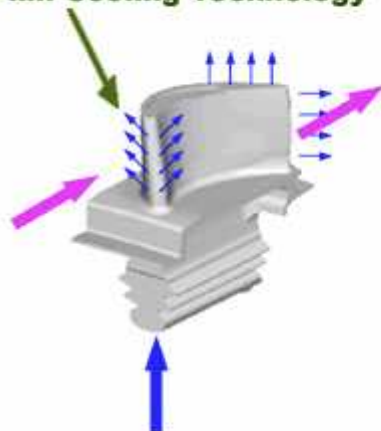




COOLING AIR CONCEPTS

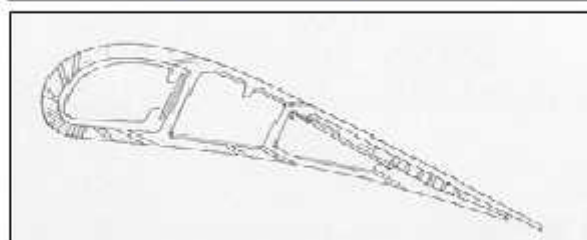
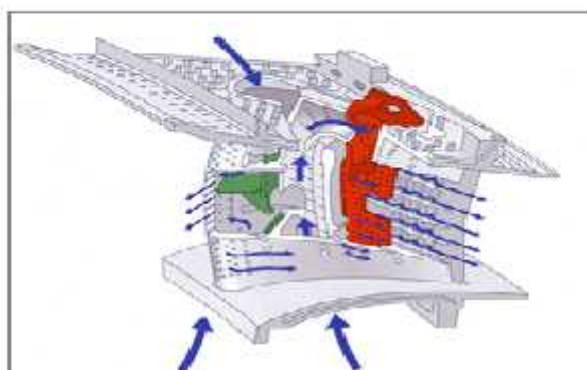


Film Cooling Technology

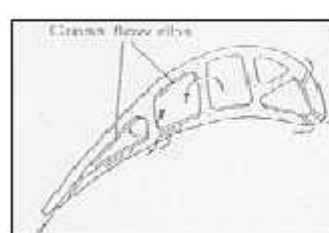
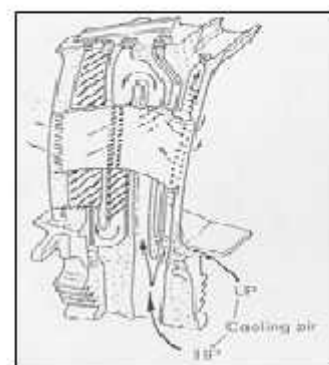


Control of low rate and pressure of cooling air

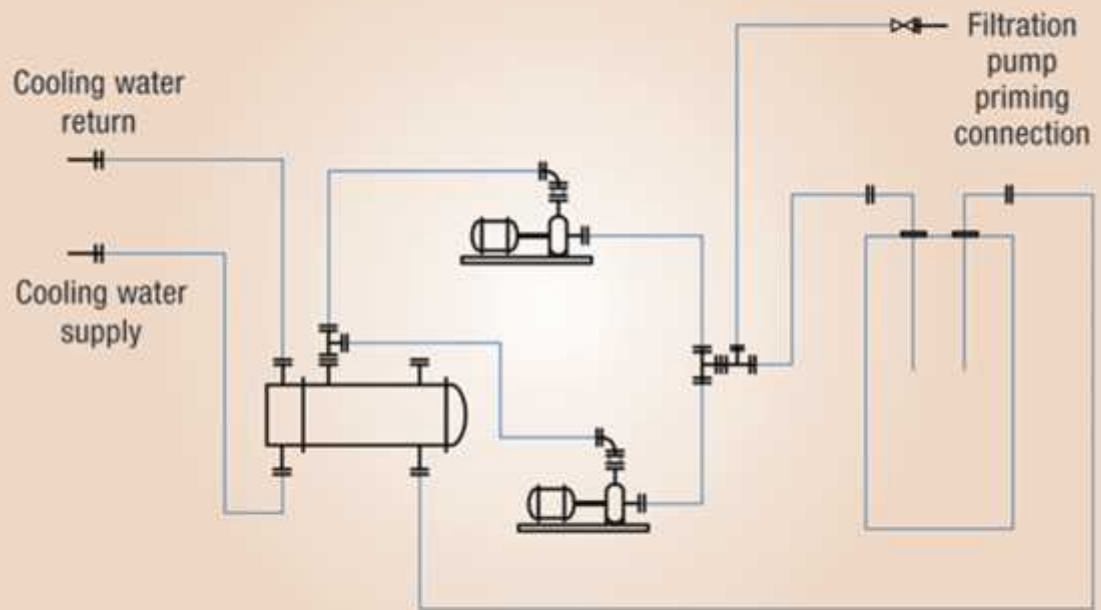
VANE

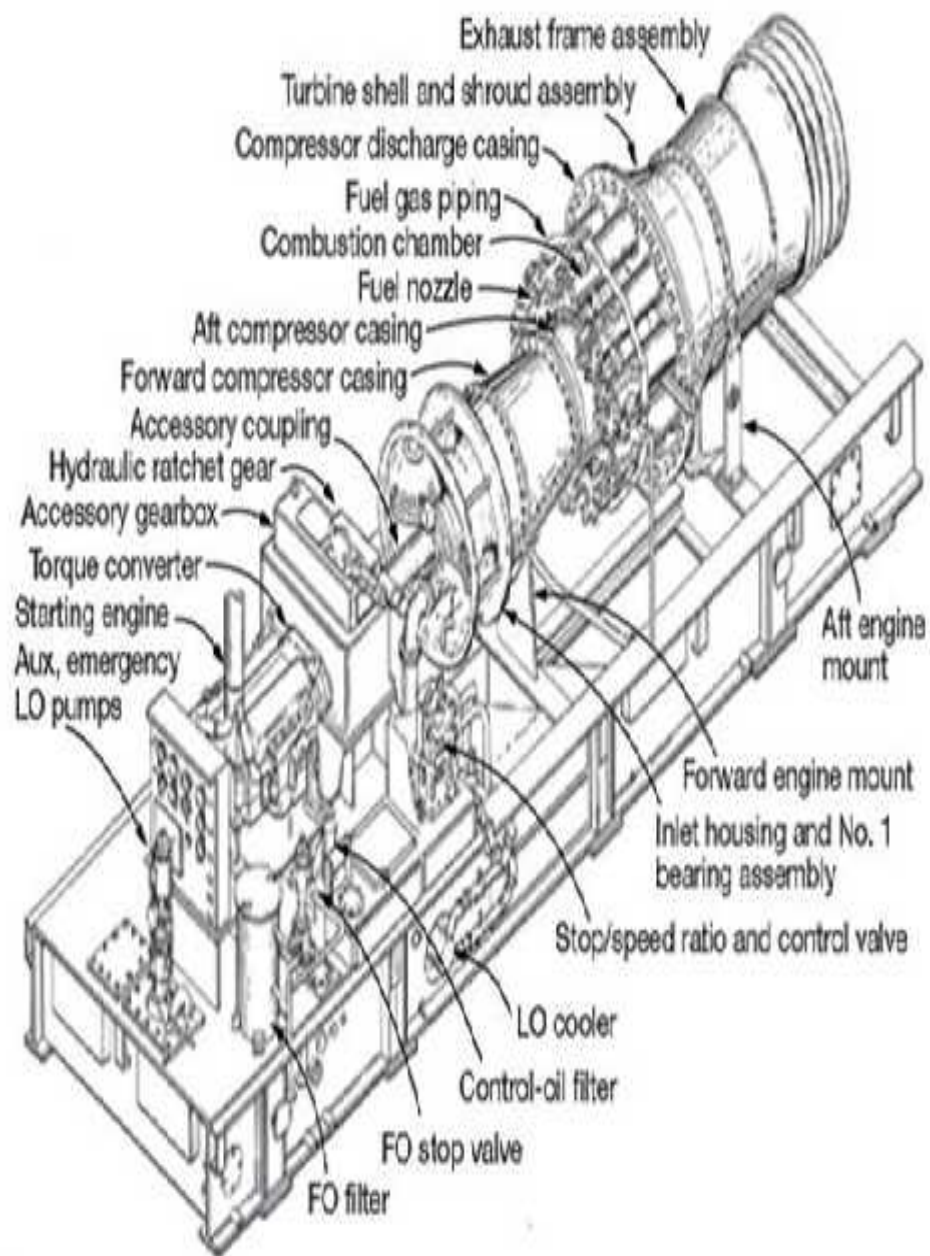


BLADE



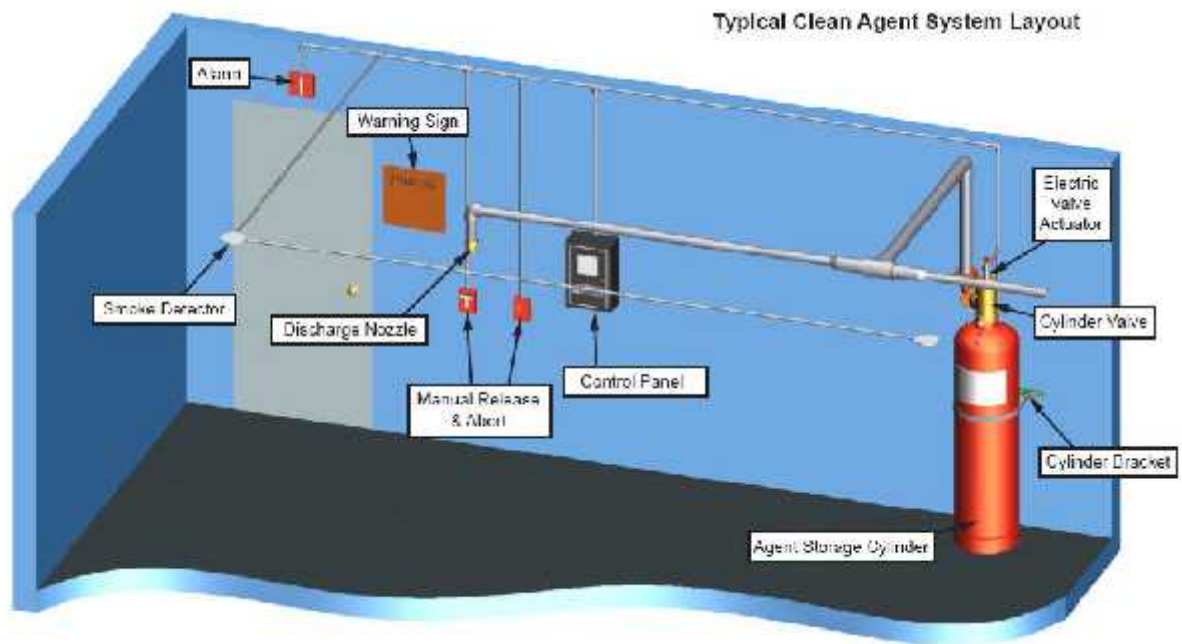
FLOW SKETCH FOR LUBE OIL RESERVOIR COOLING



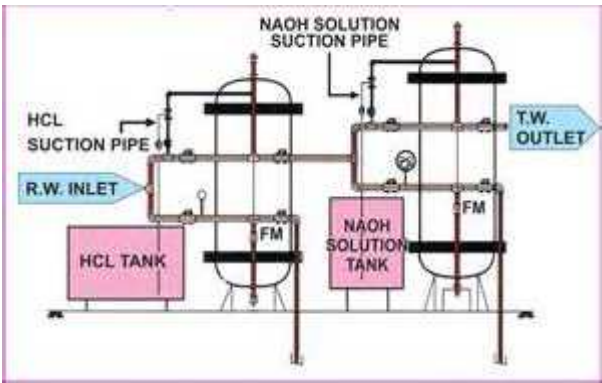
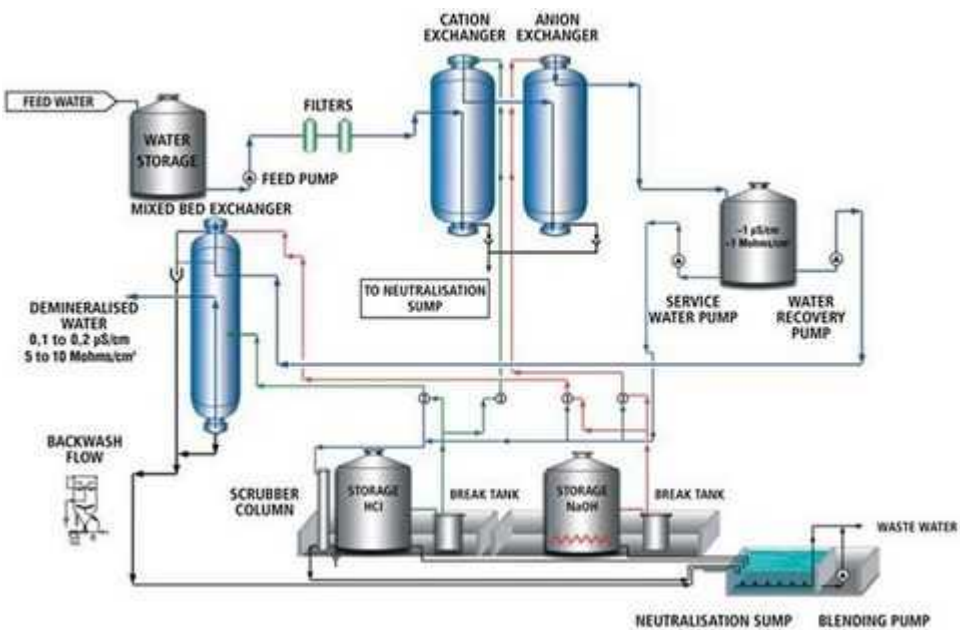
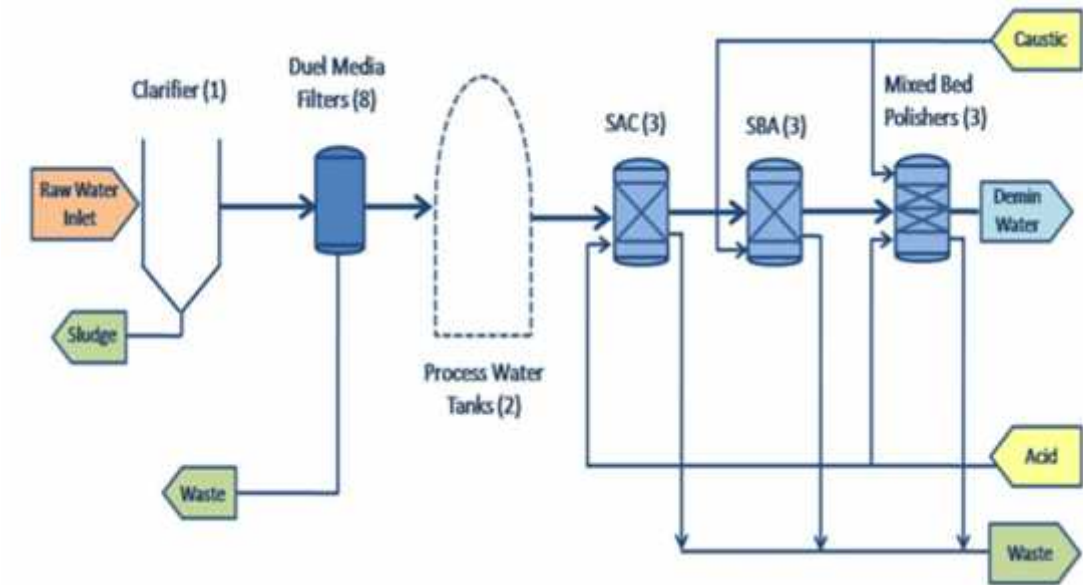


TYPICAL FRAME MOUNTED COMBUSTION TURBINE

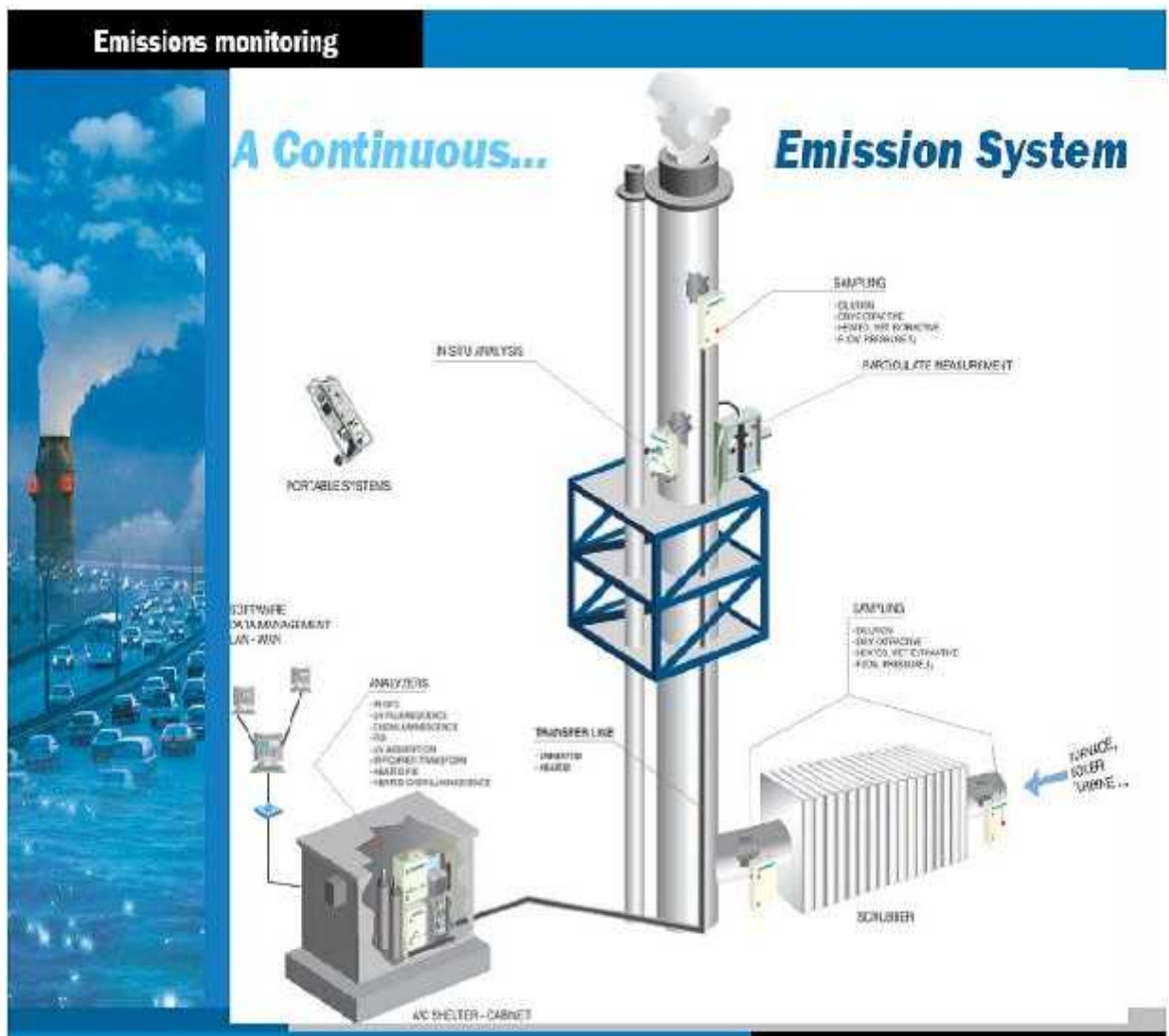
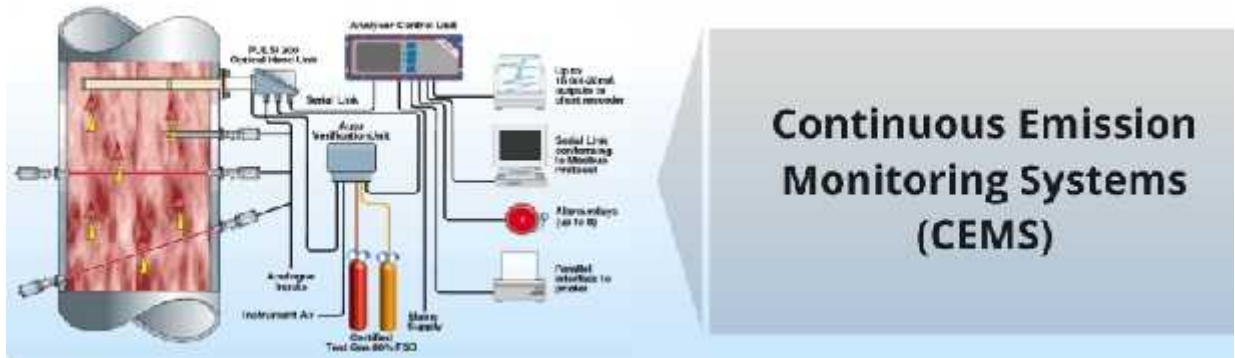
PART – D. BOP / AUXILARY SYSTEMS
ENCLOSURE FIRE DETECTION AND FIRE SUPPRESSION CONCEPT

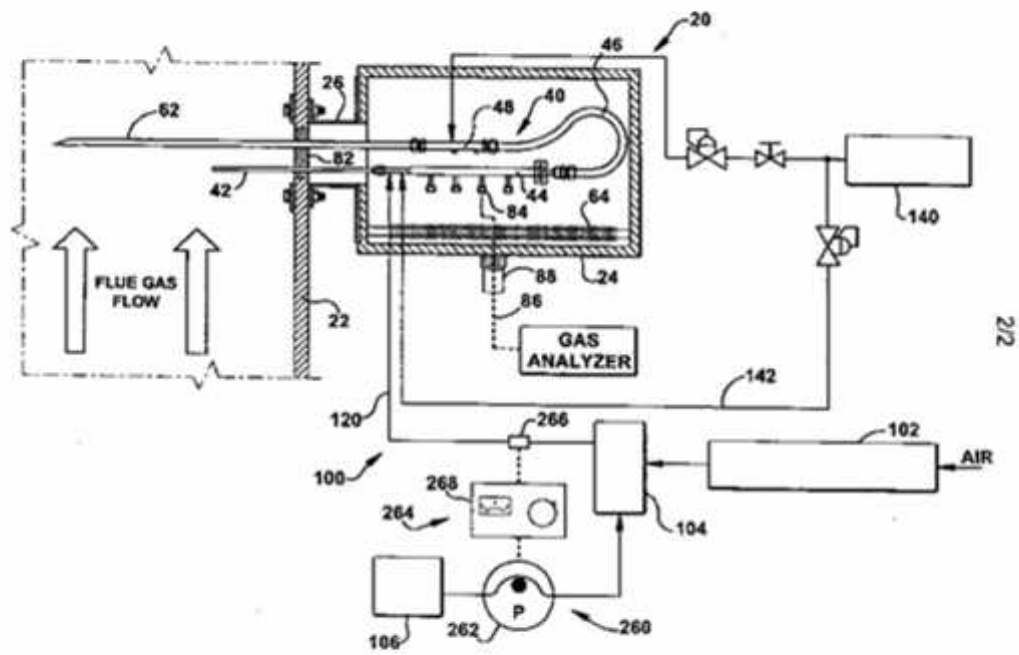


CONCEPTUAL LAYOUT OF WATER TREATMENT PLANT

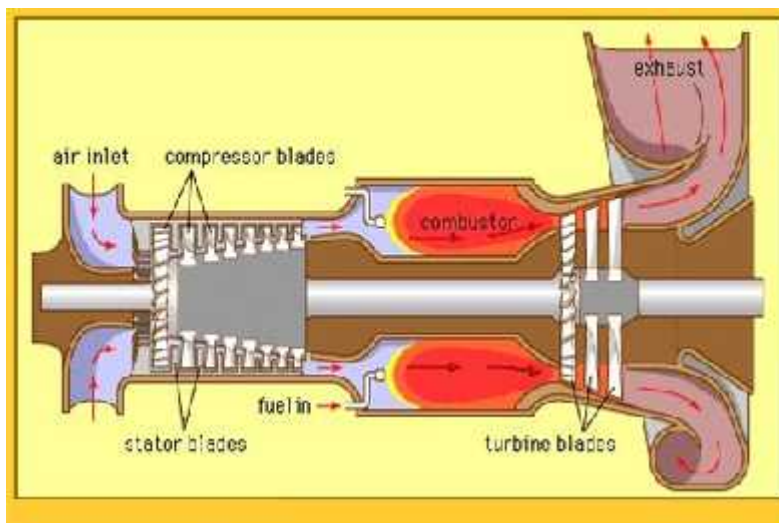


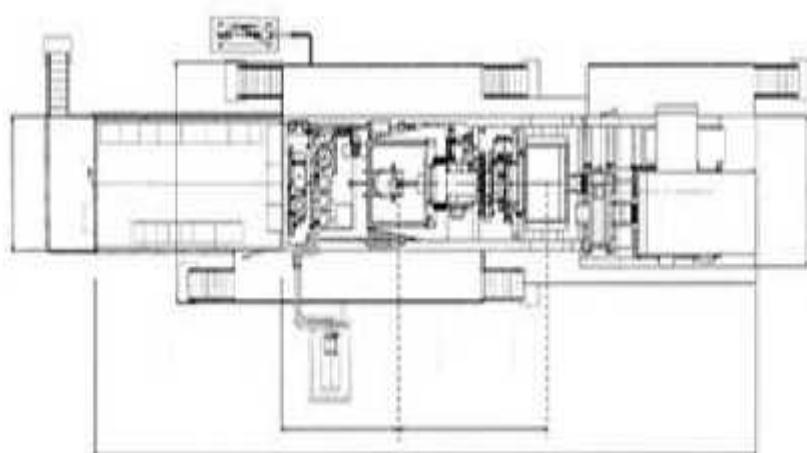
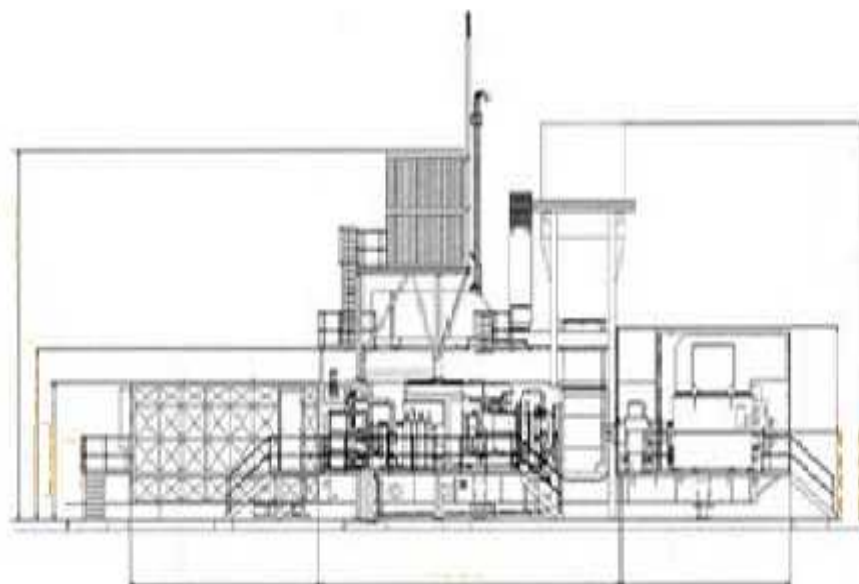
TYPICAL CONTINUOUS EMISSION MONITORING SYSTEM

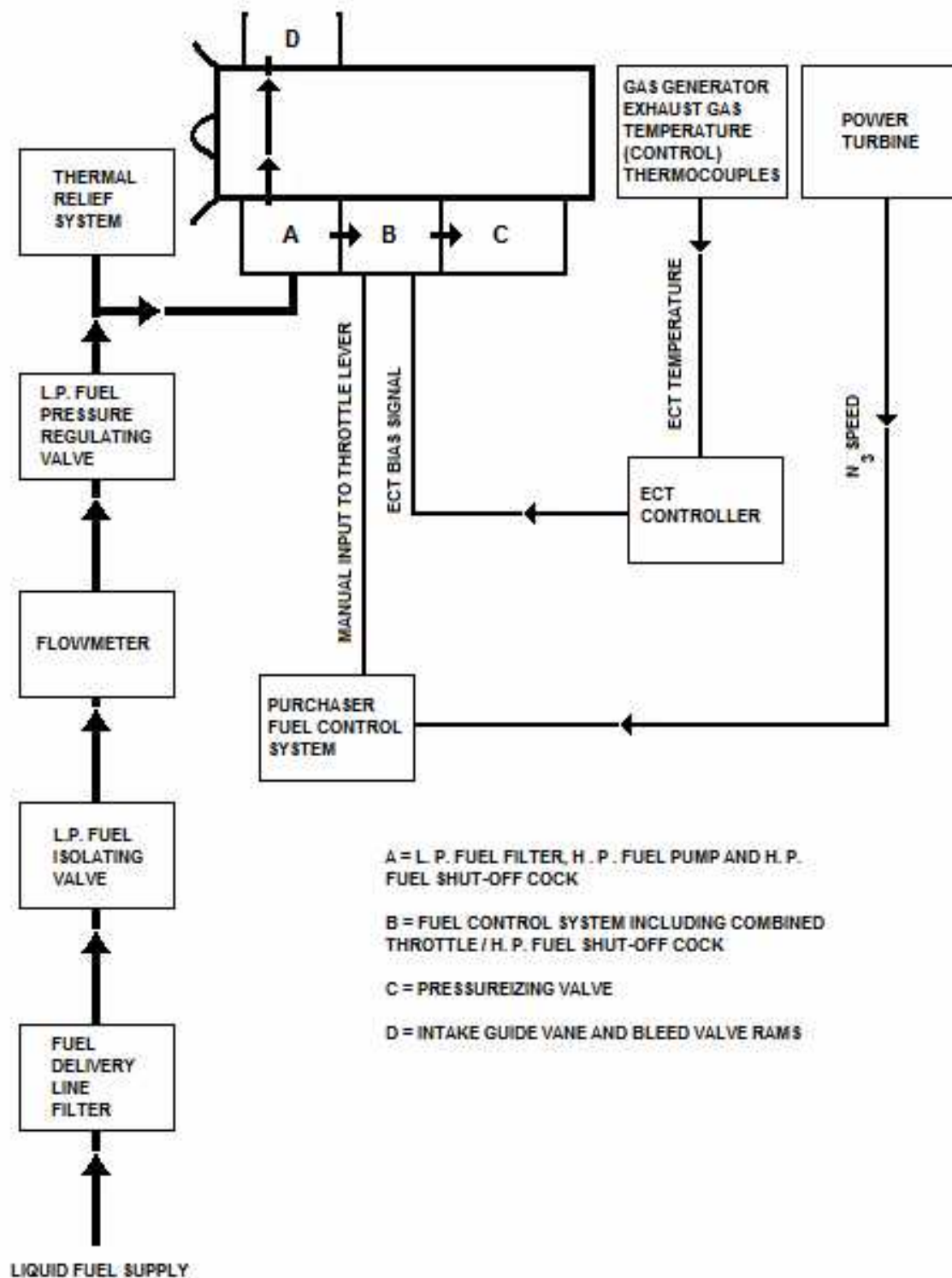




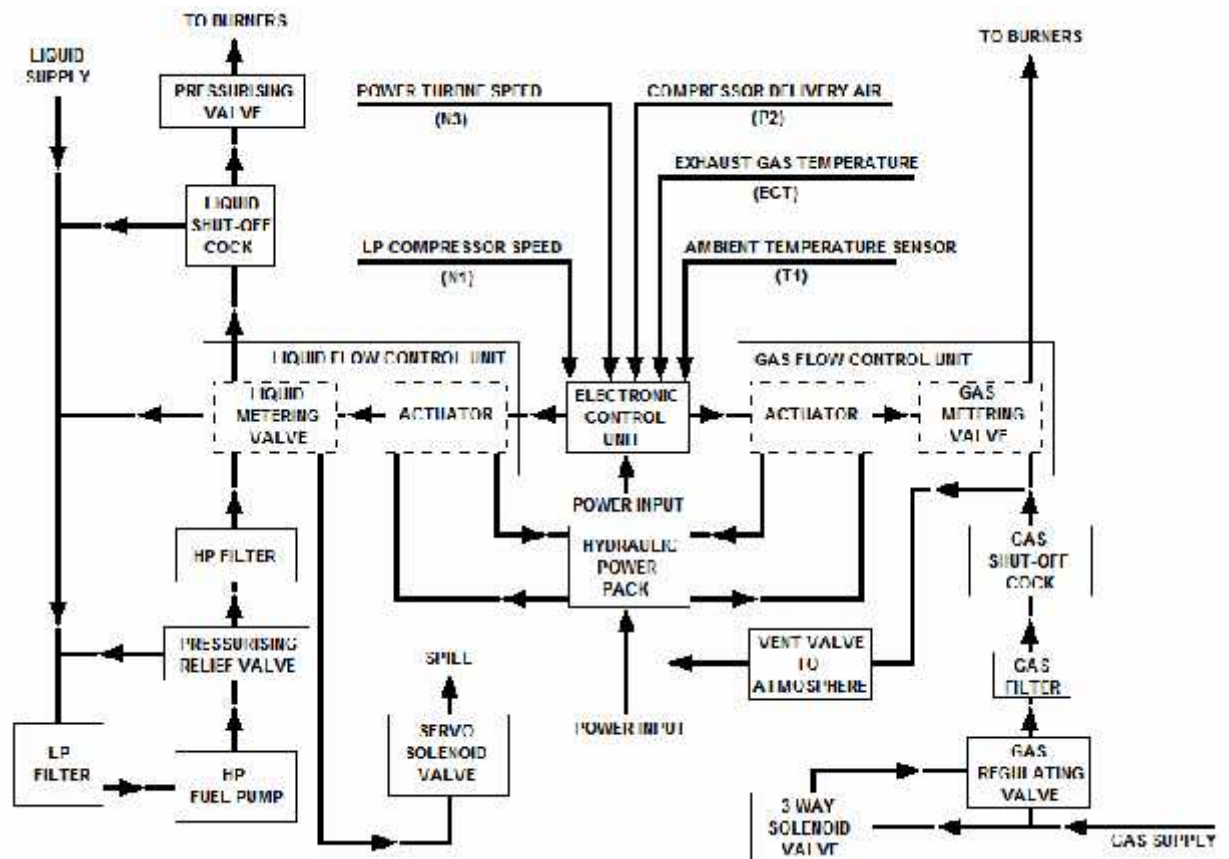
TYPICAL COMBUSTION CHAMBER





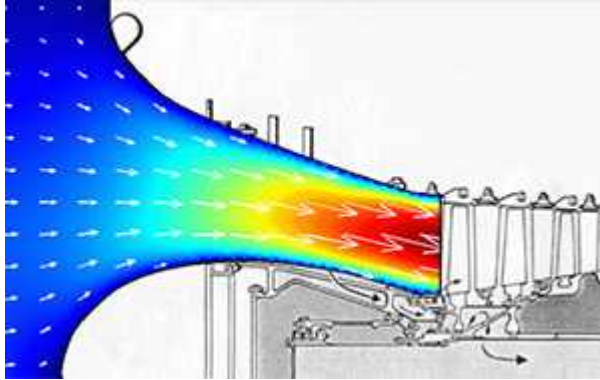


TYPICAL FUEL SUPPLY SYSTEM TO COMBUSTION TURBINE



TYPICAL DUAL FUEL SYSTEM OF COMBUSTION TURBINE

Turbine - Compressor Water Wash and Cleaning Systems



Typical water wash technology to clean industrial gas turbines, that rely on the volume and delivery pressure with full pressure drop across its spray nozzles. This provides the optimal droplet momentum for cleaning, while atomizing the water droplets.

Gas turbine compressors consume approximately 60% of the overall cycle energy during operation. This cycle consumes large quantities of air and although this air is filtered, small quantities of dust, aerosols and water pass through the filters and deposit on the blades. These deposits decrease the air flow of the compressor and the overall performance of the gas turbine.

Compressor cleanliness need be maintained using a routine program of water washing using both water wash methods performed on gas turbines: offline and online. Offline be conducted with the gas turbine in a cooled state using cranking speed, while the online process one be conducted with the machine at operating temperature using water only. Both operations shall use highly atomized water spray patterns designed to completely enter the compressor core. The offline process shall clean the entire core recovering lost performance, while the online cleans the early stages and extends the time to provide peak availability and higher average power output.

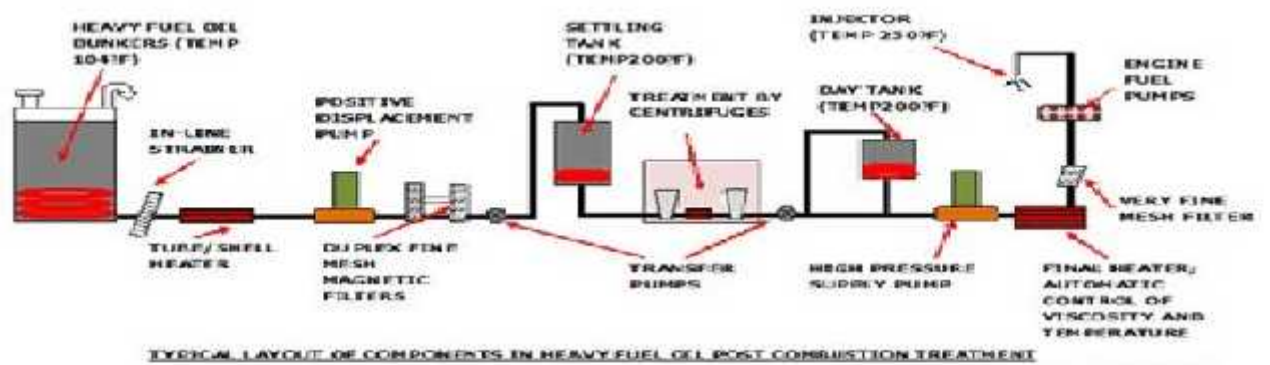
This highly atomized compressor wash system shall offer the gas turbine operator the following improvements:

-) **Availability: ~ 2 %**
-) **Performance/Output: ~ 3 %**
-) **Heat Rate: ~ 1 %**
-) **Payback: a few months**

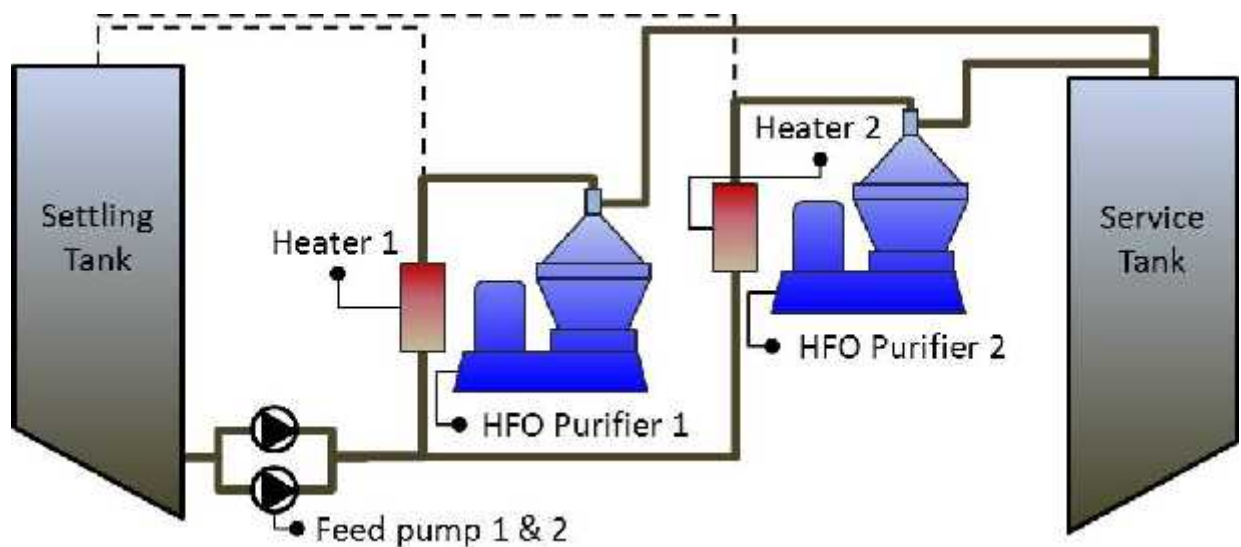
Typical Heavy fuel oil

| ISO 8217, ISO-F-RM | | | K700 |
|---|--------------------------|---------------------------------------|------------------------------------|
| Fuel-system related characteristics values | | | |
| Viscosity (at 50 °C) | mm ² /s (cSt) | max. | 700 |
| Viscosity (at 100 °C) | mm ² /s (cSt) | max. | 55 |
| Density (at 15 °C) | kg/m ³ | max. | 1,010 |
| Flash point | °C | min. | 60 |
| Pour point | °C | max. | 30 |
| Hydrogen sulfide | mg/kg | max. | 2 |
| Acid number | mg KOH/g | max. | 2.5 |
| Total sediment aged | mass % | max. | 0.10 |
| Engine-related characteristic values | | | |
| Carbon residues (Conradson) | m% | max. | 20 |
| Sulphur | m% | max. | 5 |
| Ash | m% | max. | 0.15 |
| Vanadium | mg/kg (=ppm) | max. | 450 |
| Water | Vol. % | max. | 0.5 |
| Additional parameters | | | |
| Aluminium and silicon | mg/kg | max. | 60 |
| Asphalts | m% | max. | 2/3 of carbon residues (Conradson) |
| Sodium | mg/kg | Sodium < 1/3 vanadium, sodium < 100 | |
| Used lubricating oil (ULO) | mg/kg | Ca >30 and Zn >15 or CA >30 and P >15 | |

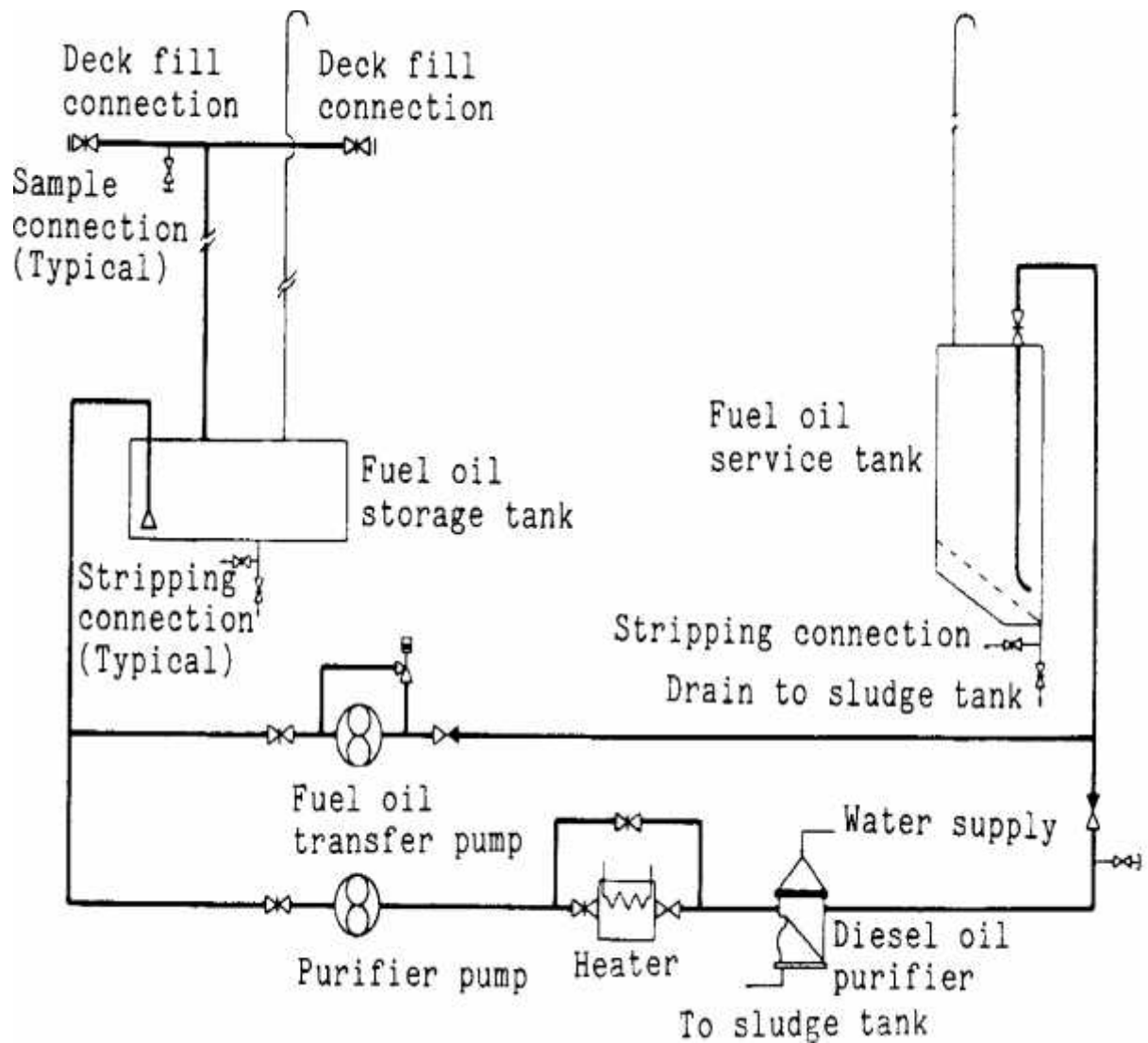
TYPICAL – HEAVY FUEL POST COMBUSTION TREATMENT



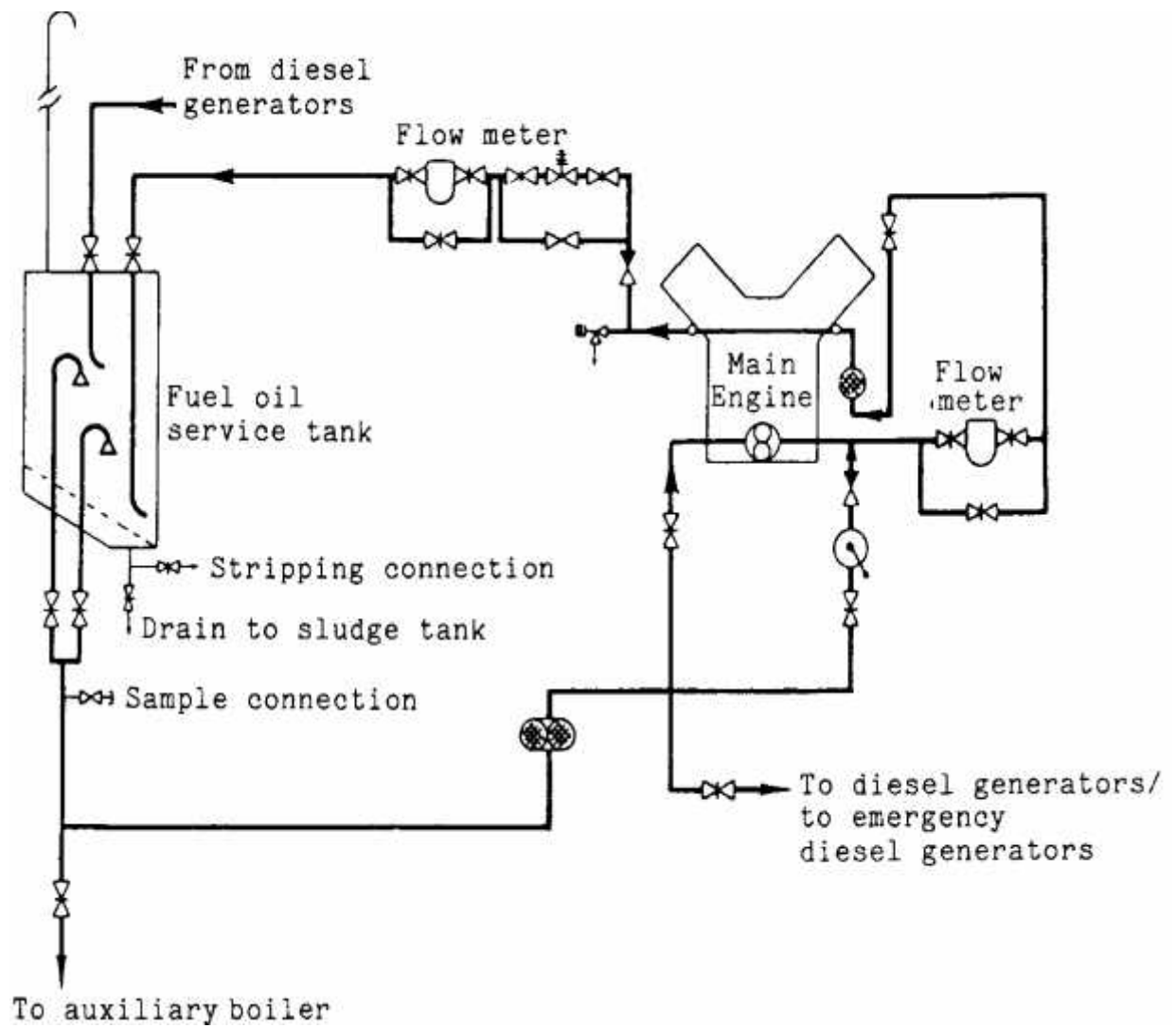
TYPICAL – HEAVY FUEL OIL PURIFIER



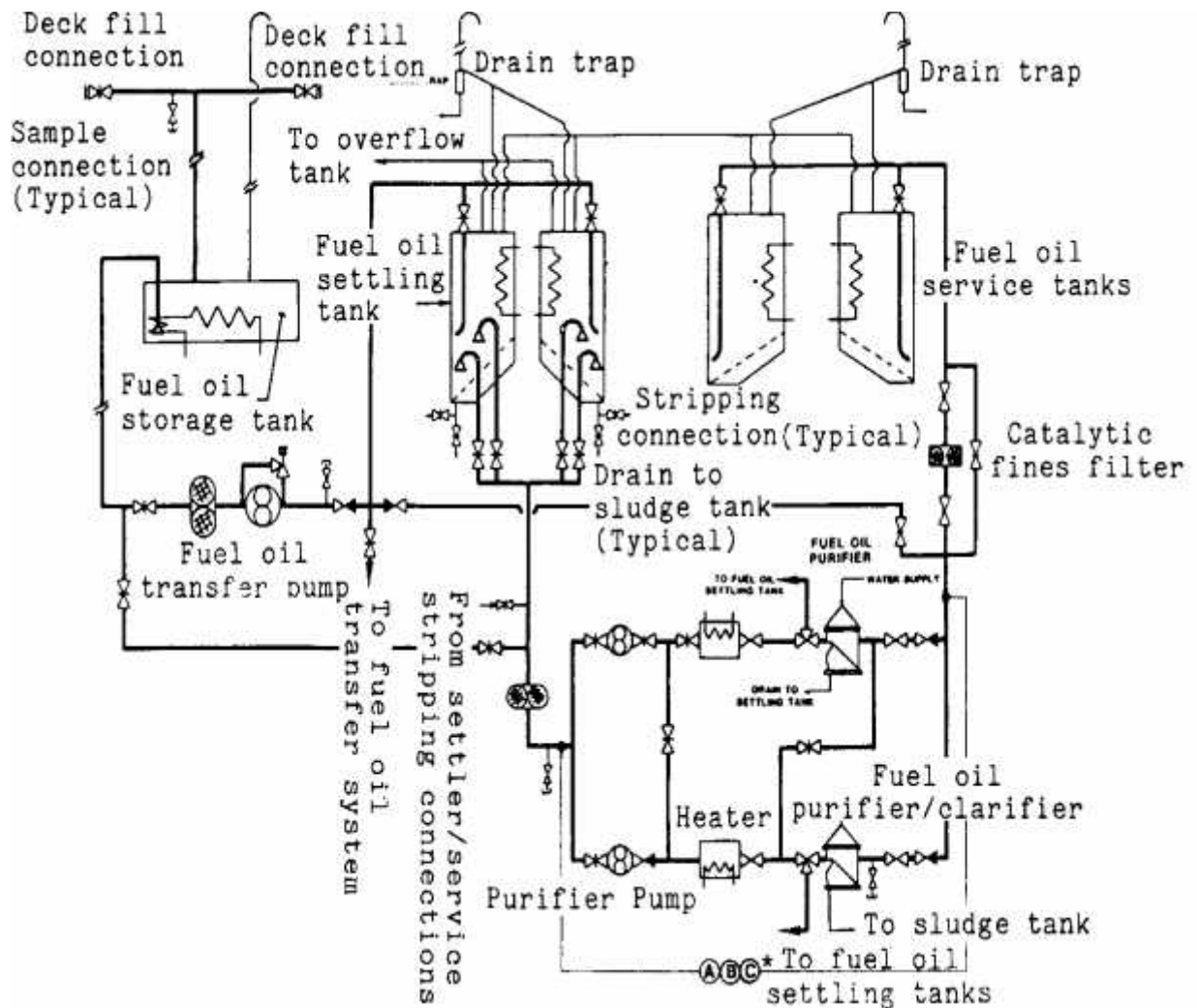
Typical Diesel Oil Fill, Transfer, Storage and Purification System



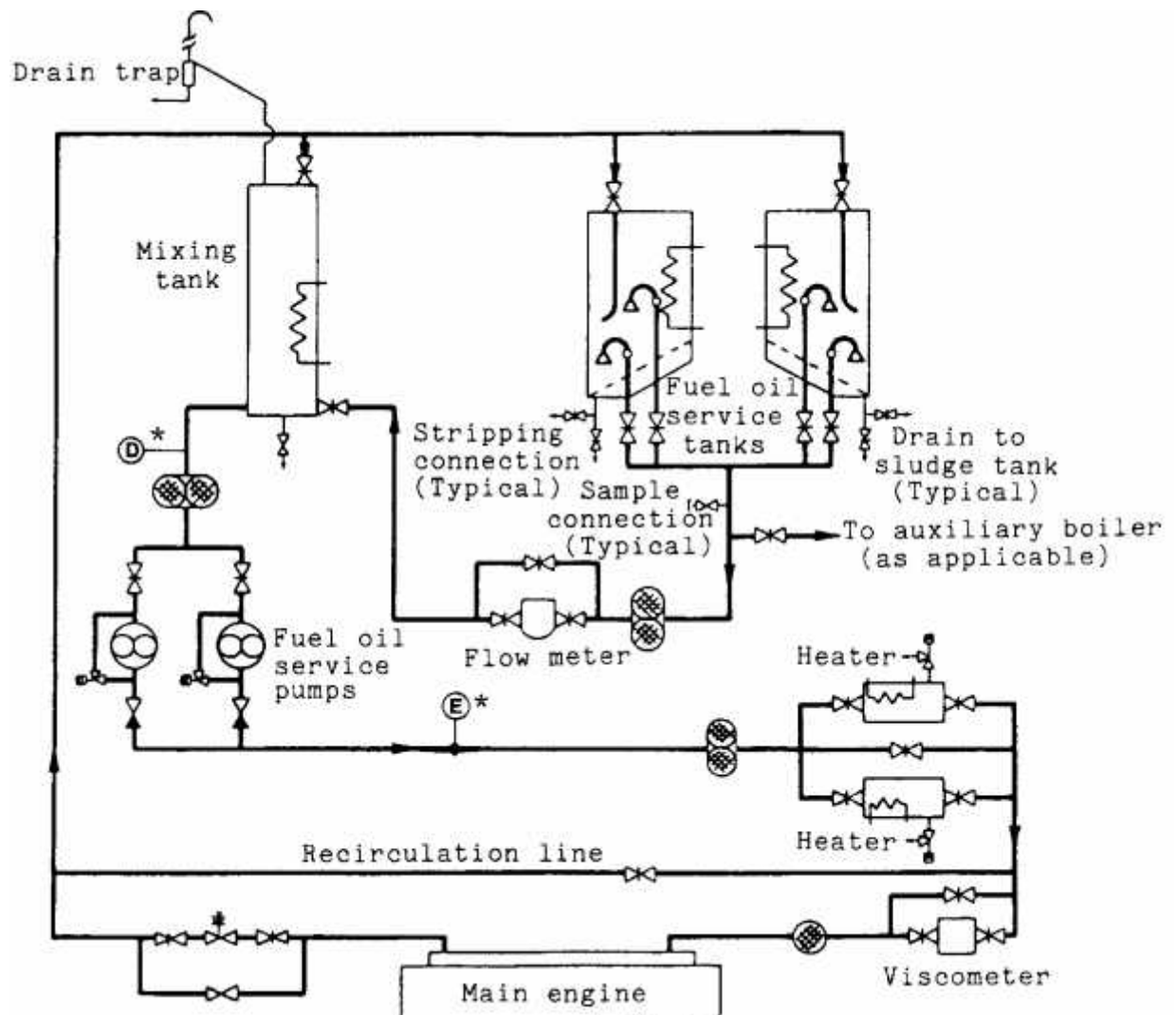
Typical Diesel Oil Service System



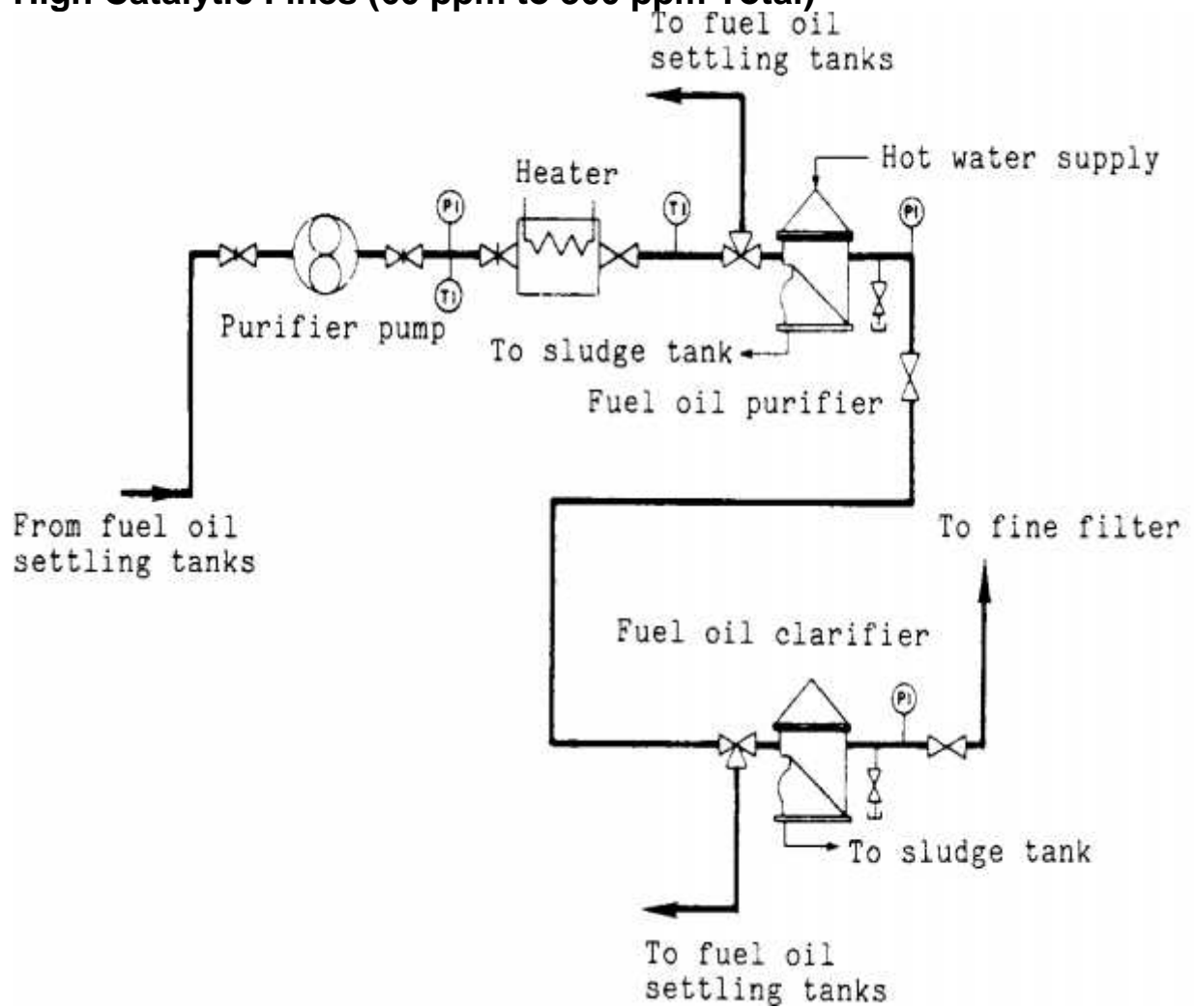
Typical Heavy Fuel Oil Fill, Transfer, Storage, and Purification System



Typical Heavy Fuel Oil Service System

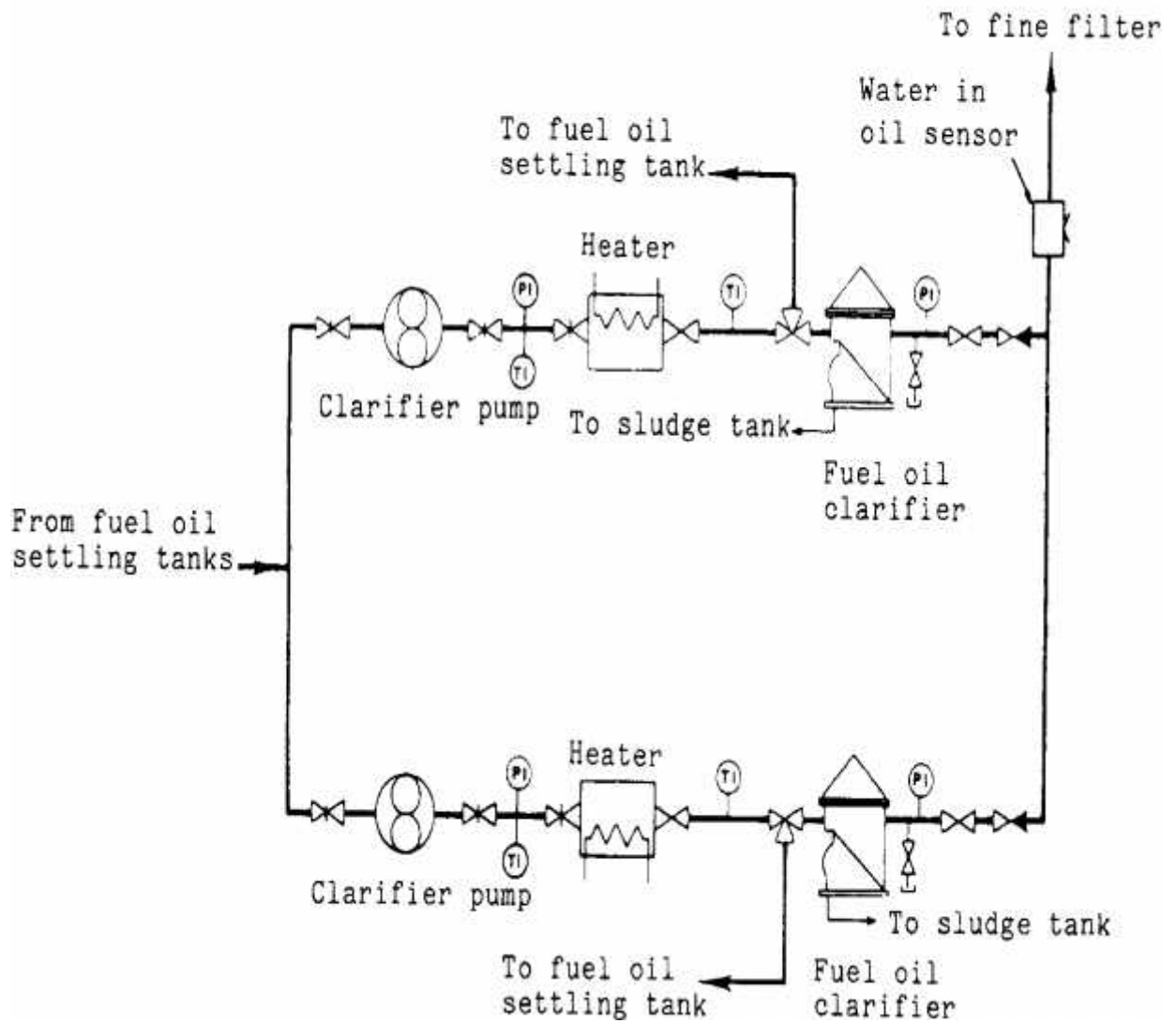


**Typical Centrifuge Configuration for High Ash (0.20 to 0.50% wt.)
High Catalytic Fines (60 ppm to 300 ppm Total)**

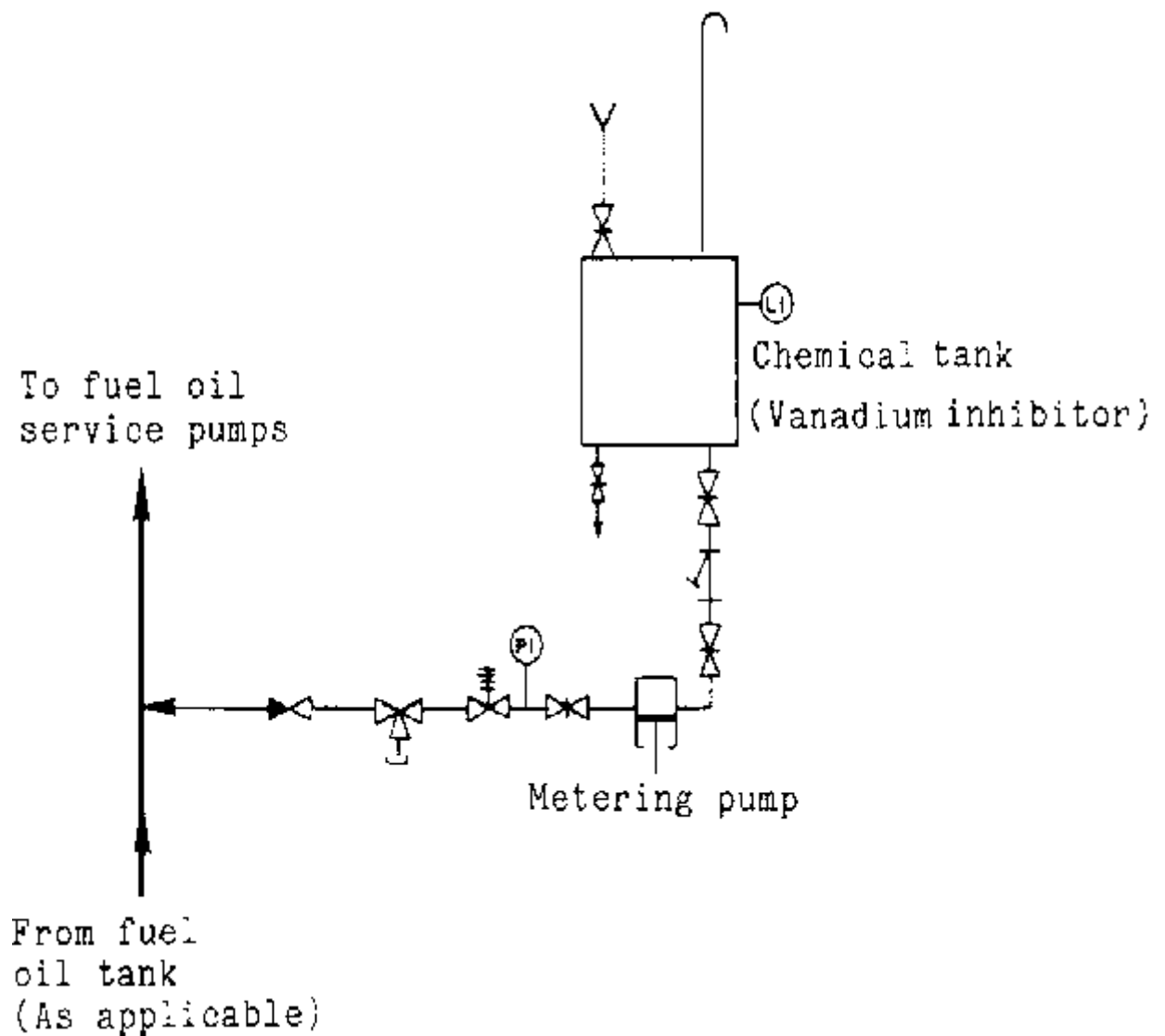


Typical Clarifier/Clarifier System for High Specific Gravity (0.991 to 1.006) Fuel Oils

Subsystem - C

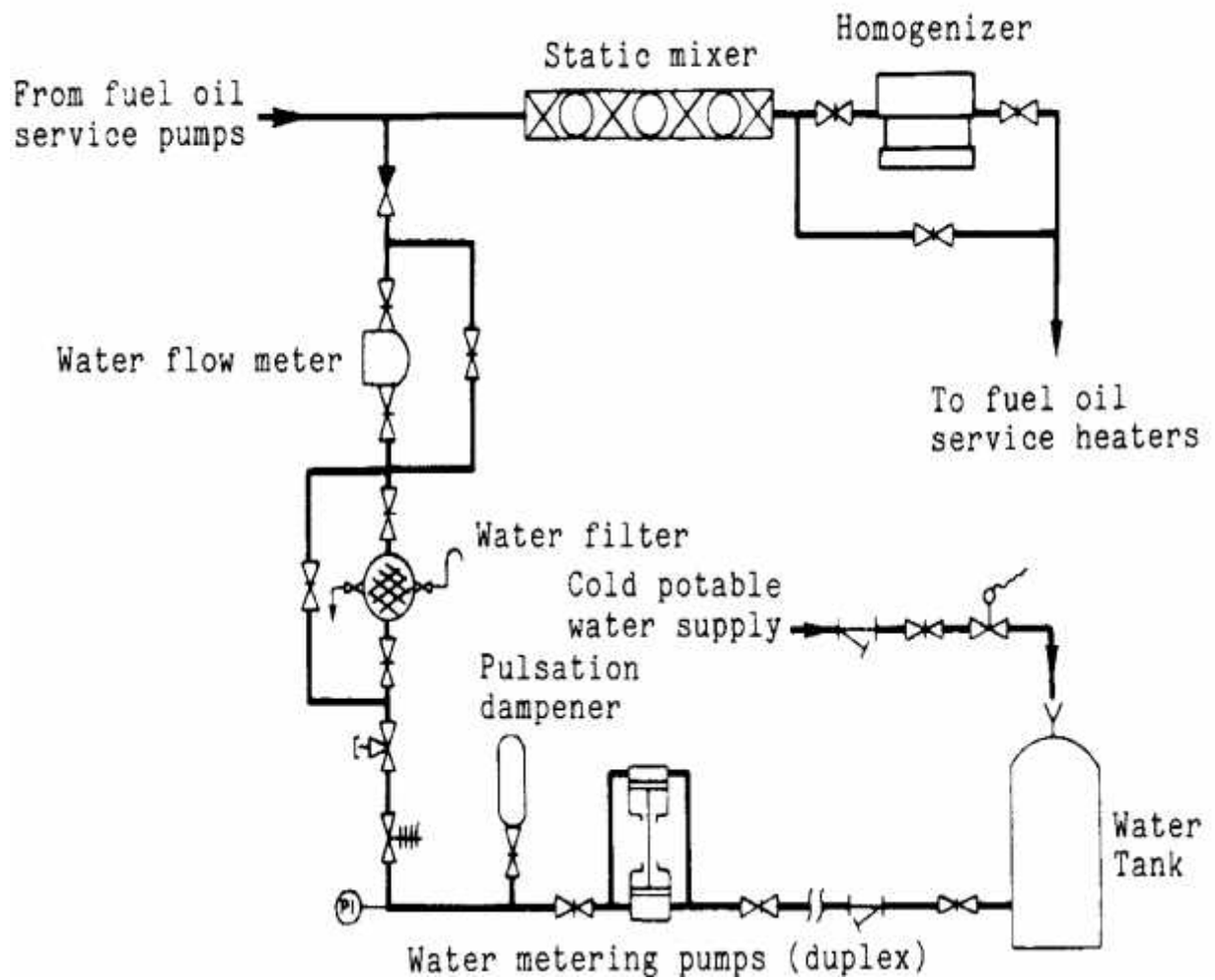


Typical Additive Injection System for High Concentrations of Oil Soluble Heavy Metals
Subsystem - D

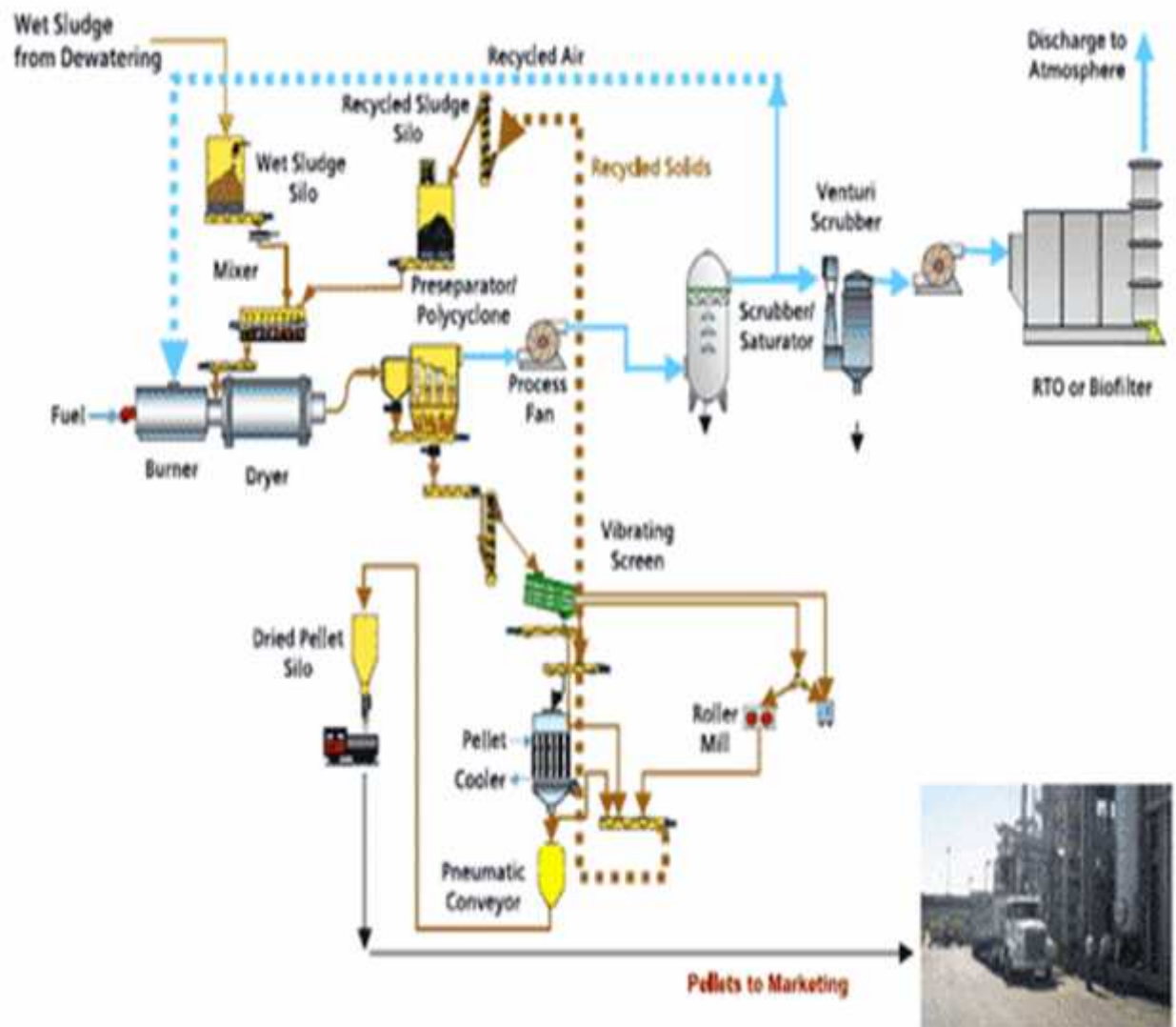


Typical Water in Oil Emulsification/Homogenization for High Conradson Carbon Content Fuels (15 to 22% wt.)

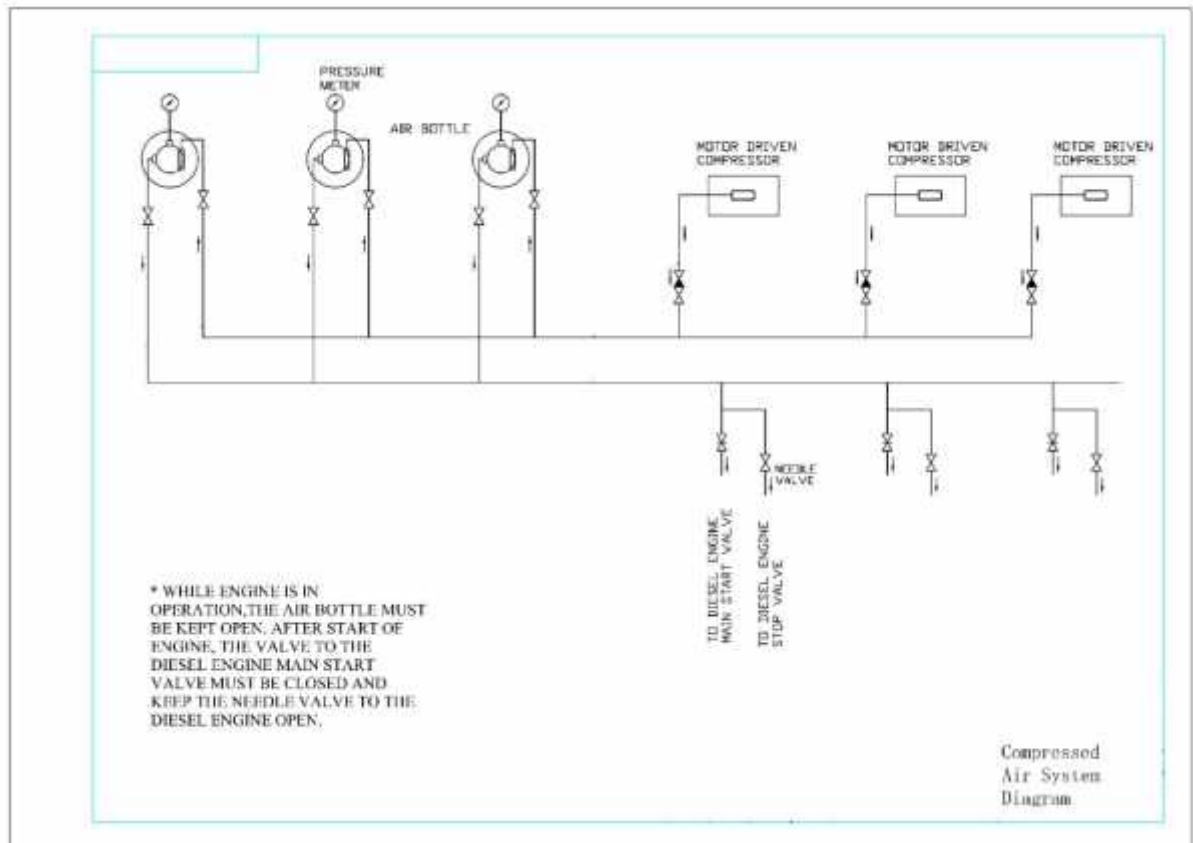
Subsystem - E

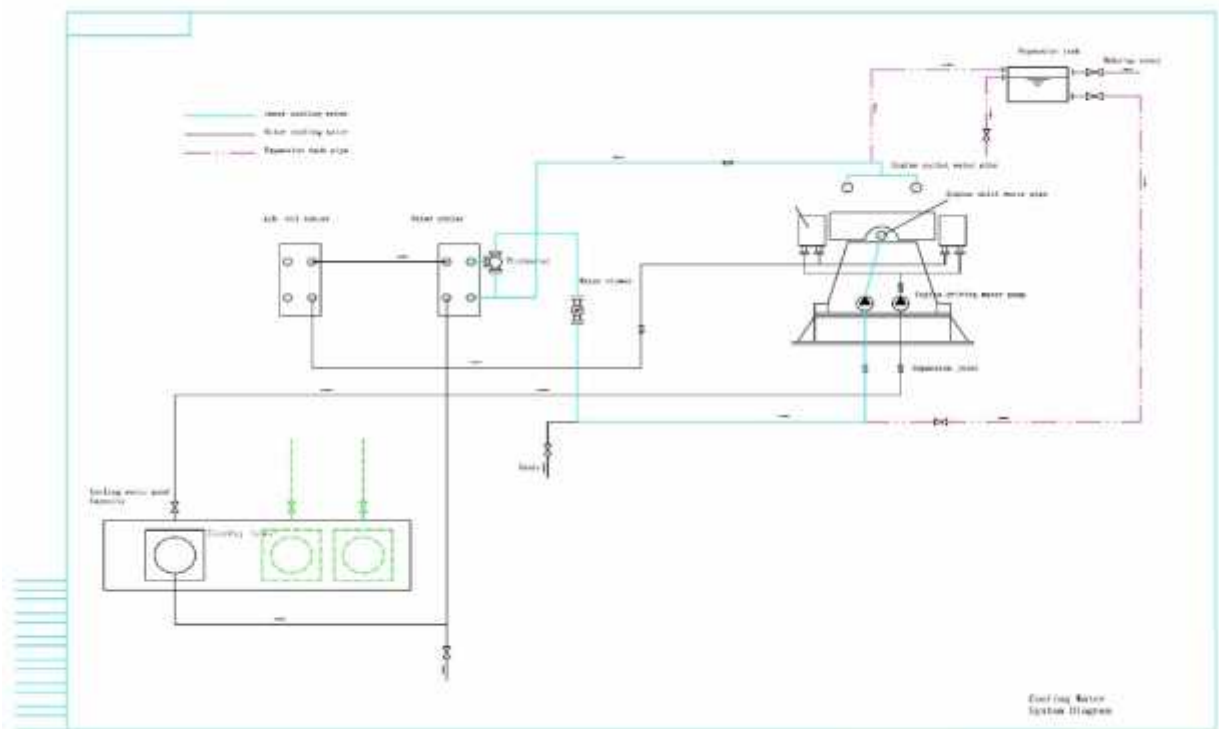


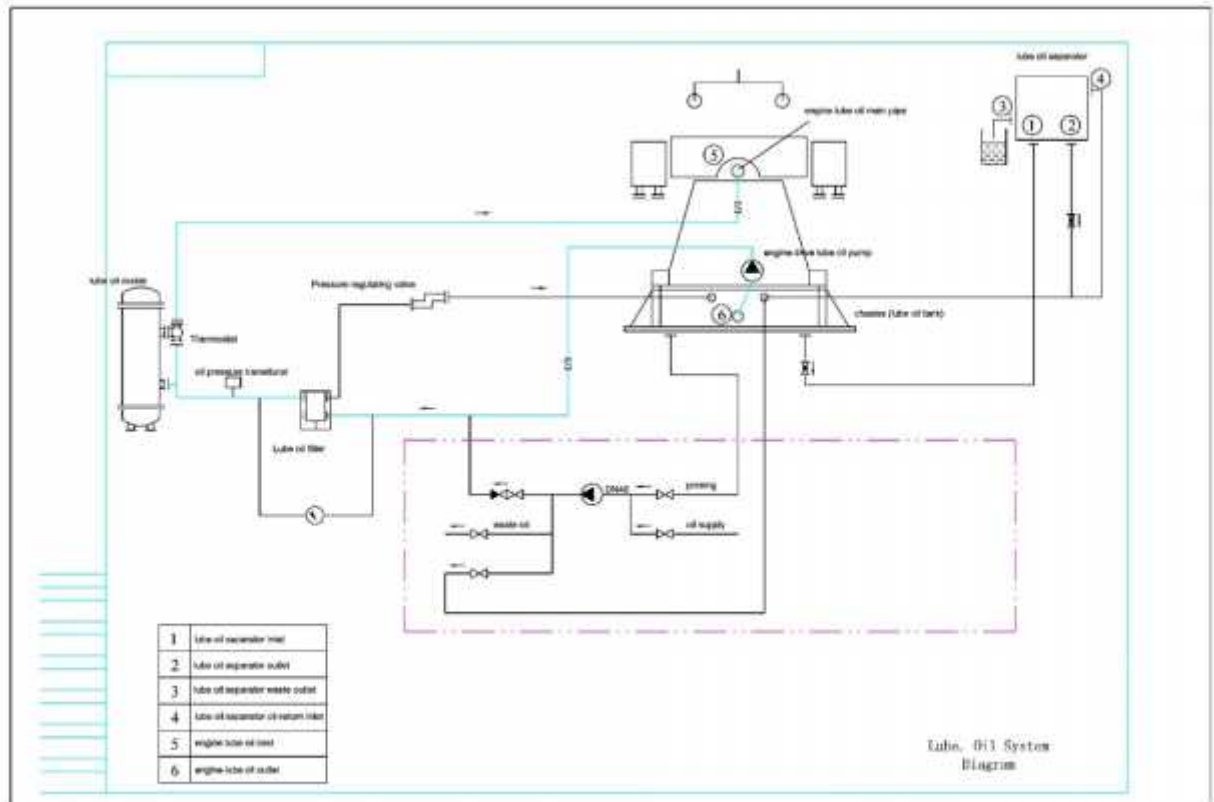
TYPICAL - WASTE / SLUDGE HANDLING



BSDG-COMPRESSED AIR / COOLING WATER / LUBE OIL CONCEPTUAL

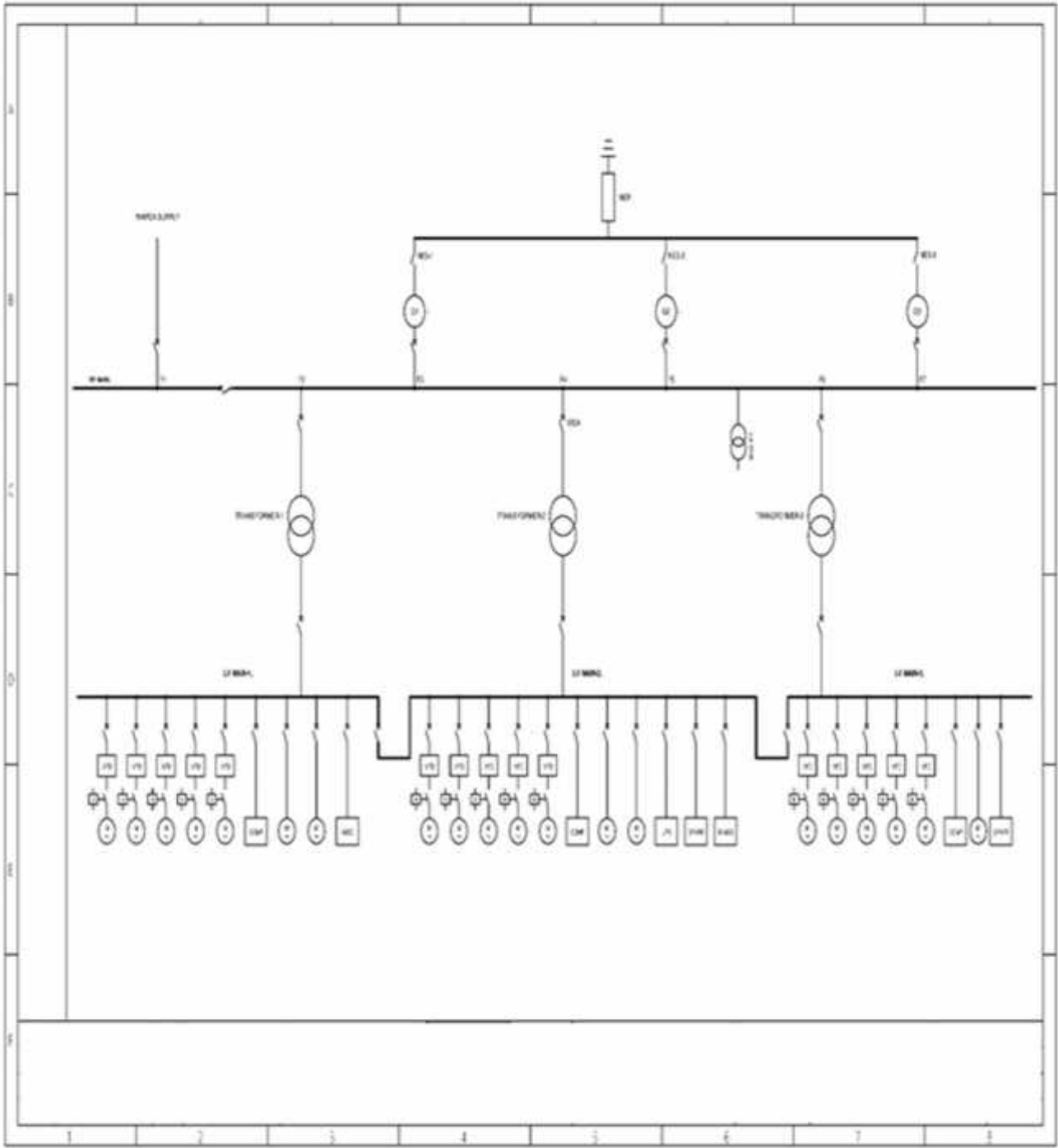






PART E. ELECTRICAL SYSTEMS

ELECTRICAL MAINS – SINGLE LINE DIAGRAM



Synchronizing Typical.

Closing a circuit breaker between two energized parts of the power system, crucial be to match voltages on both sides of the circuit breaker before closing. **If this matching or "synchronizing" process is not done correctly, a power system disturbance will result and equipment (including generators) can be damaged.** In order to synchronize properly, three different aspects of the voltage across the circuit breaker must be closely monitored. The three aspects of the voltage are called the synchronizing variables and are:

1. The voltage magnitudes
2. The frequency of the voltages
3. The phase angle difference between the voltages

Synchronizing Scenarios

The importance of synchronizing cannot be overstated. All system operators should understand the theory and practice of synchronizing. If two power systems are synchronized via an open circuit breaker, and the synchronizing process is not done correctly, generators can be severely damaged. Two scenarios for synchronizing follow to further describe the synchronizing process.

Scenario #1: Synchronizing Two Islands

The first scenario assumes that two islands are about to be connected together using the open circuit breaker as illustrated in Figure 1. The two islands, since they are independent electrical systems, will have different frequencies so all three of the synchronizing variables must be monitored to ensure they are within acceptable limits prior to closing the open circuit breaker.

The system operators for the two islands will likely have to adjust generator MW output levels (or adjust island load magnitudes) in one or both islands to achieve the desired adjustment in frequencies and phase angles. Voltage control equipment (reactors, capacitors, etc.) may also be used as necessary to change voltage magnitudes to within acceptable levels.

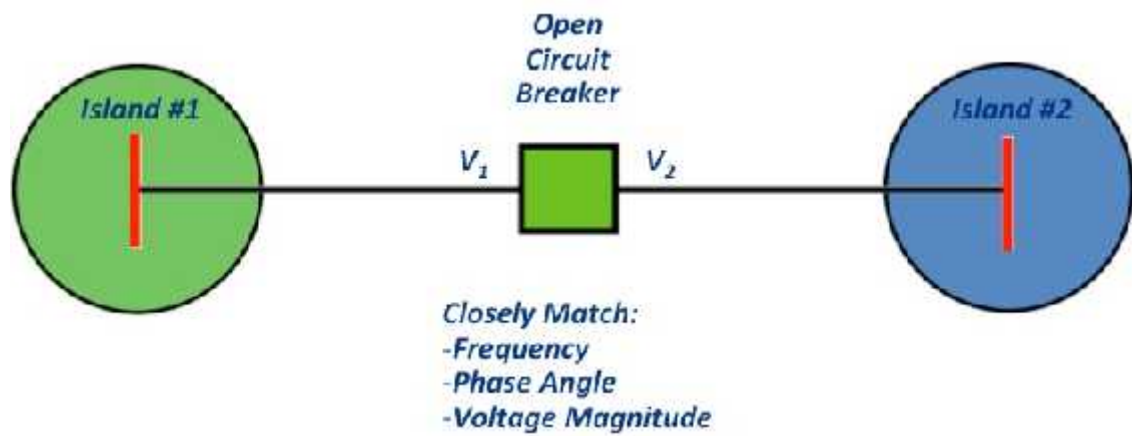


Fig. Synchronizing Two Islands

Scenario #2: Establishing the Second Tie

Once the first transmission line is closed interconnecting the two islands, the frequency will be the same in the two areas. Therefore, one of the three synchronizing variables (the frequency) is no longer a factor. However, as illustrated in Figure, the other two synchronizing variables must still be monitored. Generation and/or voltage control equipment may be to be utilized to ensure the phase angle and voltage magnitude differences are within acceptable limits prior to closing the second circuit breaker. This process should be easier than closing the first transmission line (Scenario #1) as frequency is no longer a factor.

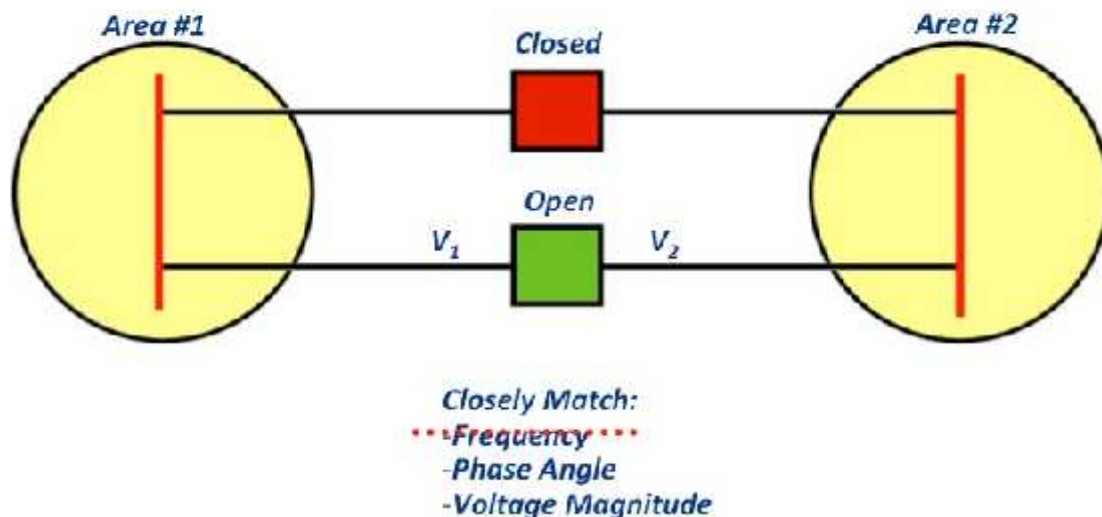


Fig. Establishing the Second Transmission Tie

Synchronizing Equipment

1.3.1 Synchroscope

A synchroscope is a simple piece of equipment that is used to monitor the three synchronizing variables. A basic synchroscope (illustrated in Figure below) inputs voltage waveforms from the two sides of the open circuit breaker. If the voltage waveforms are at

the same frequency, the synchroscope does not rotate. If the voltage waveforms are at a different frequency, the synchroscope rotates in proportion to the frequency difference. The synchroscope needle always points to the voltage phase angle difference.

A synchroscope is a manual device in that an operator must be watching the "scope" to ensure they close the circuit breaker at the correct time. The synchroscope is normally mounted above eye level on a "synch panel". The synch panel also contains two voltmeters so that the voltage magnitudes can be simultaneously compared.

The synchroscope in Figure below reflects a slight voltage magnitude mismatch, and a stationary synchroscope with a phase angle of approximately 35° . The fact that the synchroscope needle is not rotating indicates frequency is the same on either side of the circuit breaker.

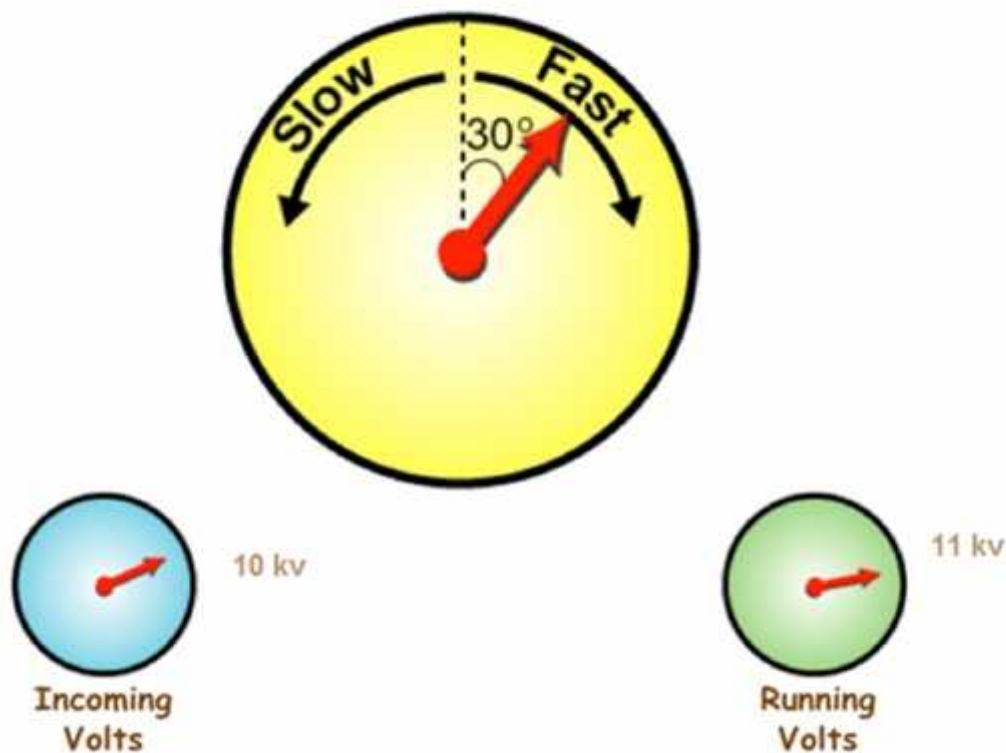


Fig. Synchroscope in a Synch Panel

Synchro-Check Relays

A synchro-check or synch-check relay electrically determines if the difference in voltage magnitude, frequency and phase angle falls within allowable limits. The allowable limits will vary with the location on the power system. Typically, the further away from generation and load, the more phase angle difference can be tolerated. Synch-check relays typically do not provide indication of the voltage magnitude, frequency or phase angle. A synch-check relay decides internally whether its conditions for closing are satisfied. The synch-check relay will either allow or prevent closing depending on its settings. A typical synch-check relay may allow closing if the voltage angle across the breaker is less than 30° .

Application of Synchronizing Equipment

At power plants, synchrosopes are routinely installed to permit manual closing of a circuit breaker. In addition, synch-check relays can be used to "supervise" the closing of the circuit breaker and prevent distracted or inexperienced operator from initiating a bad close.

Modern power plants typically utilize automatic synchronizers. Automatic synchronizers send pulses to the generator exciter and governor to change the voltage and frequency of the unit. The synchronizer will automatically close the breaker when it is within an allowable window.

Substations on the transmission system have traditionally had synchrosopes installed. However, few substations are now manned due to the availability of powerful SCADA systems. Because of this development, newer substations may or may not have a synch panel, depending on the transmission company procedures. Since most circuit breaker operations are done remotely, transmission companies often rely on synch-check relays to supervise closing of breakers.

Figure below illustrates a possible synchronizing system for substation breakers. Note the use of a synch scope and a synch-check relay. Electrical contacts can be opened or closed to rearrange the synchronizing system as desired.

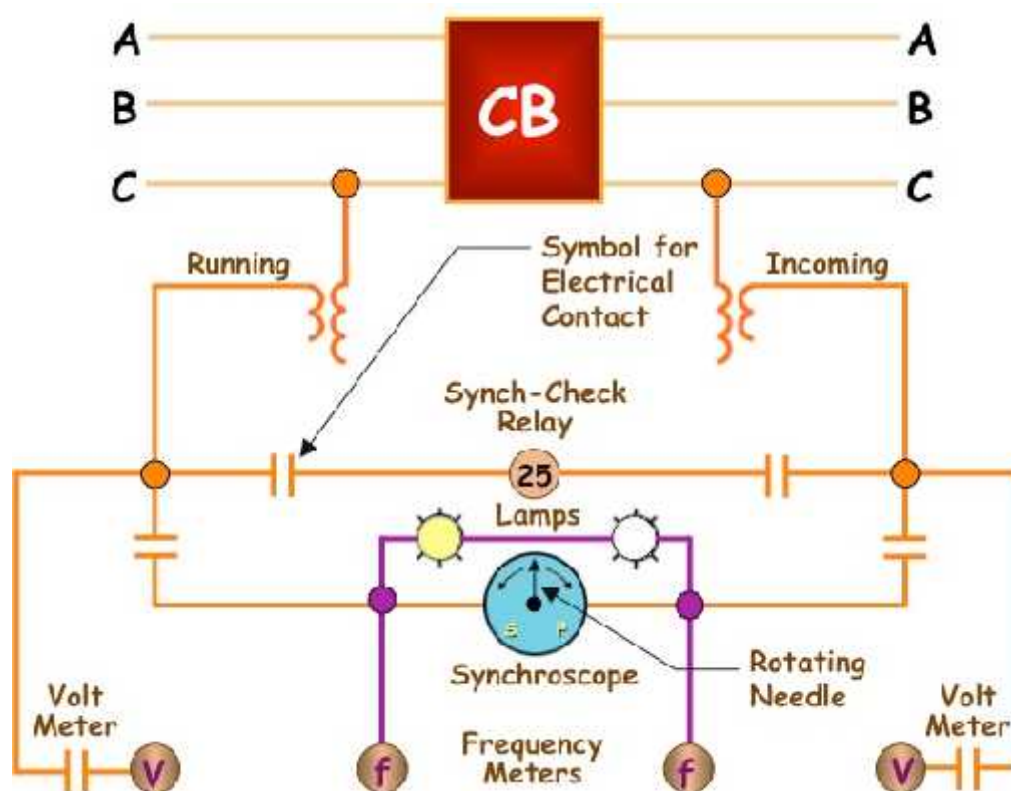


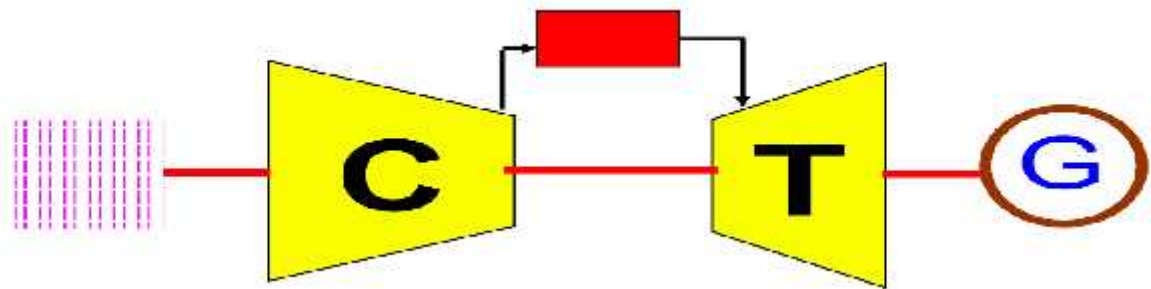
Fig. Synchronizing System for a Substation Breaker

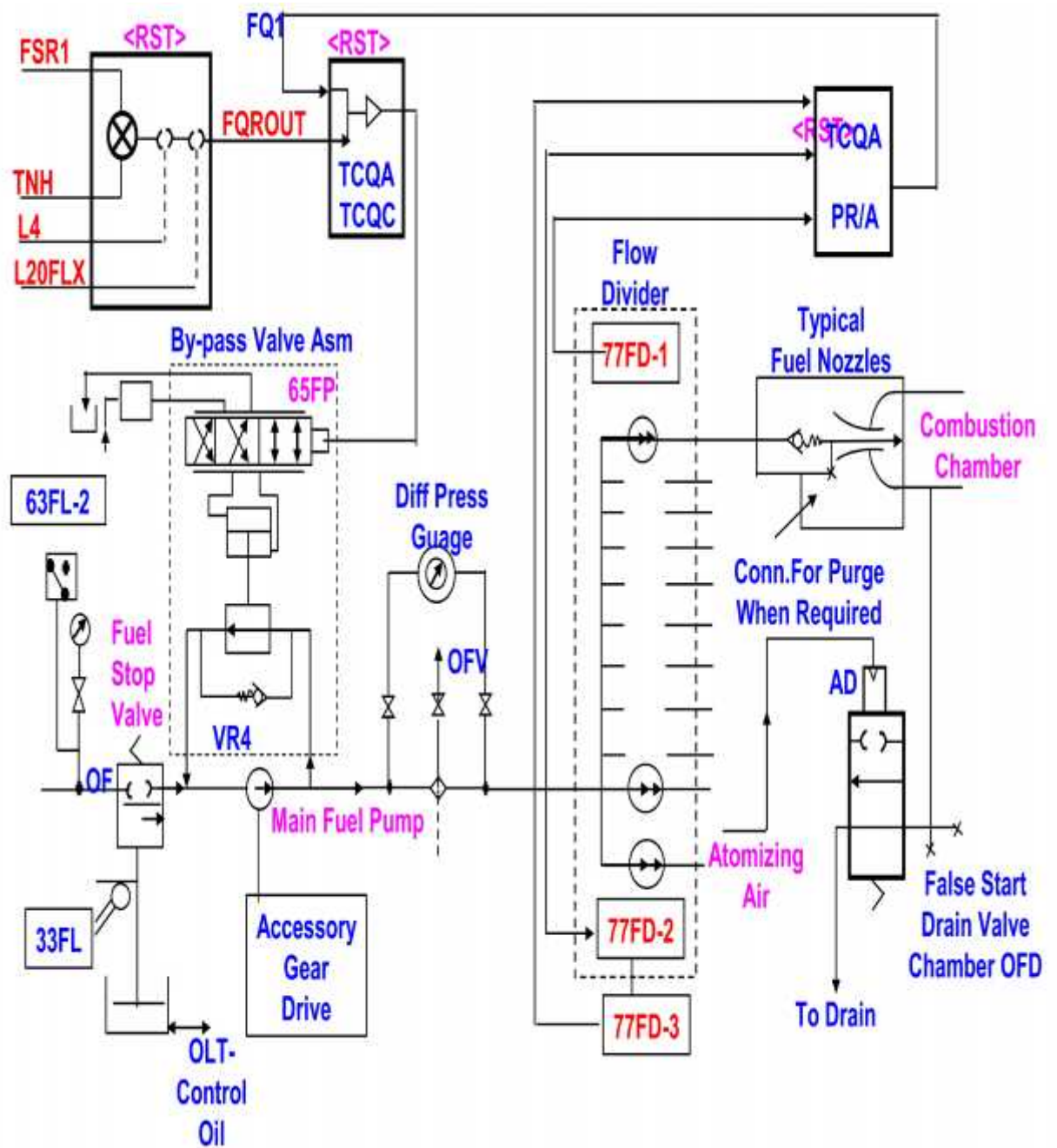
Operating states need be implemented in an E/M
fool proof and errorless Synchronizing Scheme.

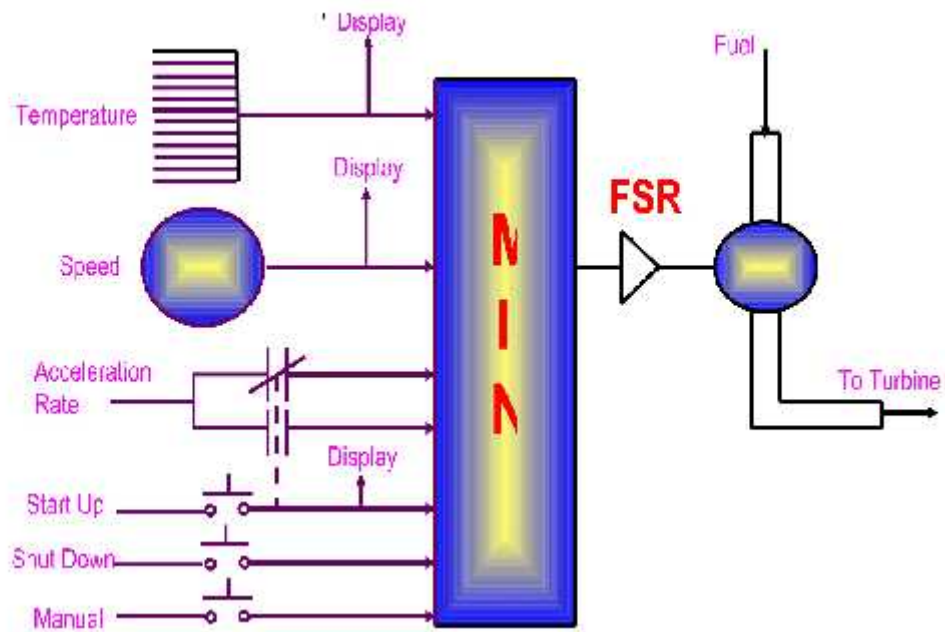
| Site Scenario # | Main Plant Units | GTG-1/2 Operating Status | WAPDA BACK UP Status | BLACK START Status | Auto Action |
|-----------------|-------------------|--|--|---|--|
| 1 | GTG-1/2 | Operating at FSNL | Available and 11 KV Mains Energized | Ready Shut Down State | GTG-1/2 Synchronize one after one on 11 KV Main with WAPDA |
| 2 | GTG-1/2 | Both or one Tripped | Available and 11 KV Mains Energized | Ready Shut Down State | WAPDA Supplies 5 MW back Up Load - Load sharing to be indicated in Control Room and locally |
| 3 | GTG-1/2 | Both or One available and on FSNL | Not Available | In Operation and feed GTG Essential Load through a load sequencer | BS synchronized using Ref Bus. GTG-1/2 Synchronize one after one on 11 KV Main with BS DG to receive incoming WAPDA synchronizing automatic or manual as selected. |
| 4 | GTG-1/2 | One Unit Operating and connected at 11 KV Mains | WAPDA Resumes, not synchronized on 11 KV Mains | Back on Auto Standby Mode | GTG-1/2 synchronized using Ref Bus. WAPDA be synchronized as incomer back up available, |
| 5 | GTG-1/2 | Both Units Operating and Synchronized at 11 KV Mains | Available and synchronized at 11 KV mains | Auto-Standby Mode | Demonstrate Operator actions to test various scenarios of switch-in/out |
| 6 | GTG-1/2 in Outage | Unavailable | On / Off Frequently | Feeding Essential Load through a load sequencer | Advise optimum action how to synch WAPDA and how to share the load |

PART F. CONTROL SYSTEMS

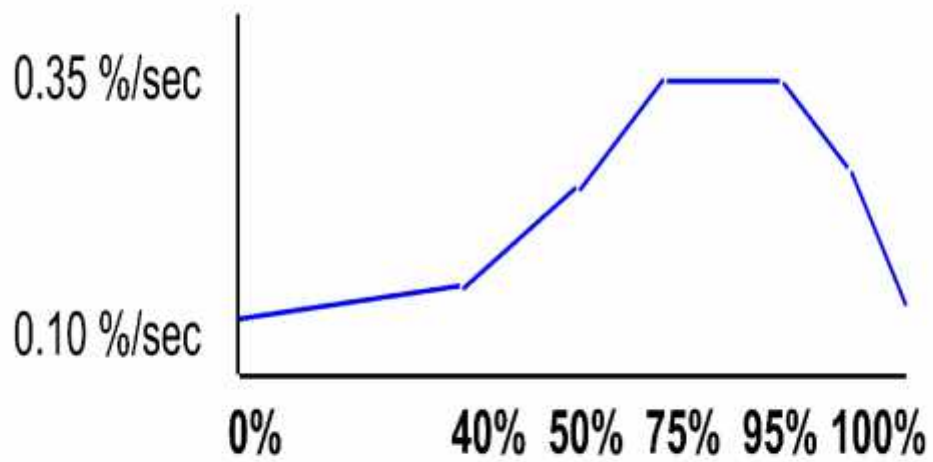
CONTROL CONCEPTUALS







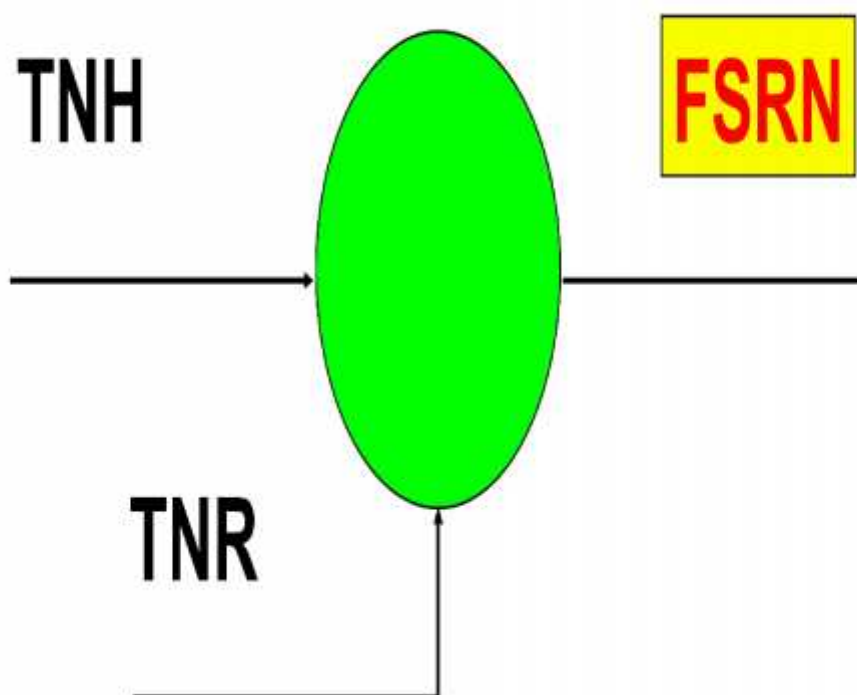
Typical

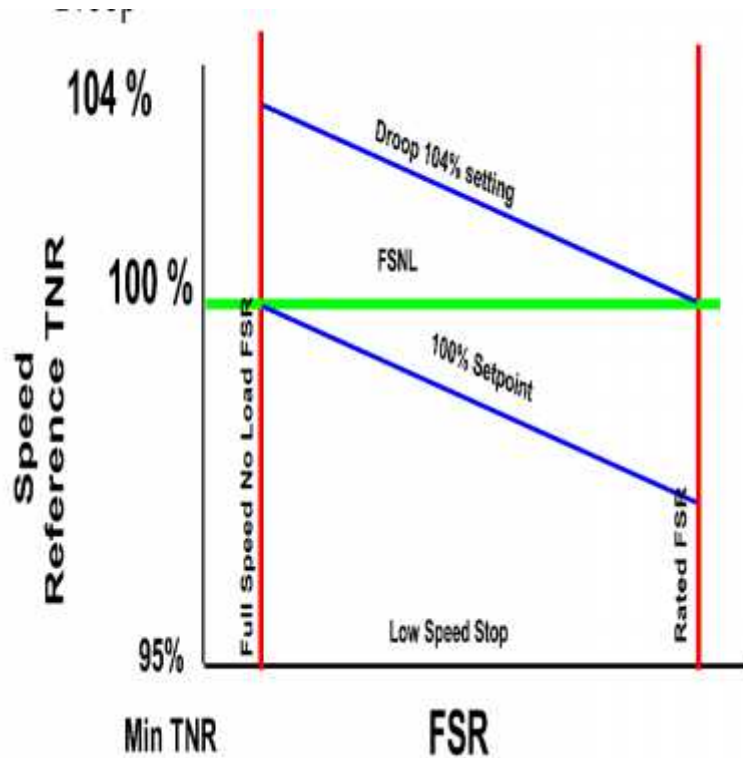
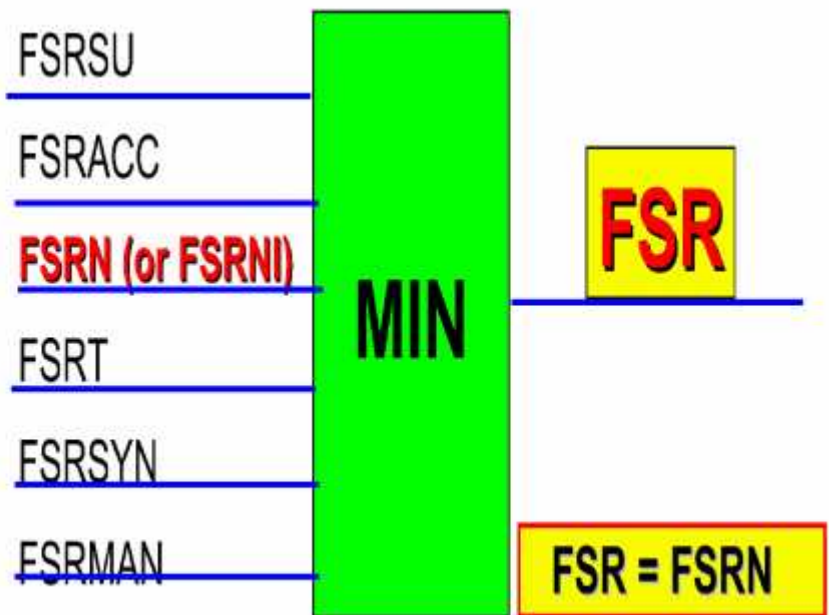
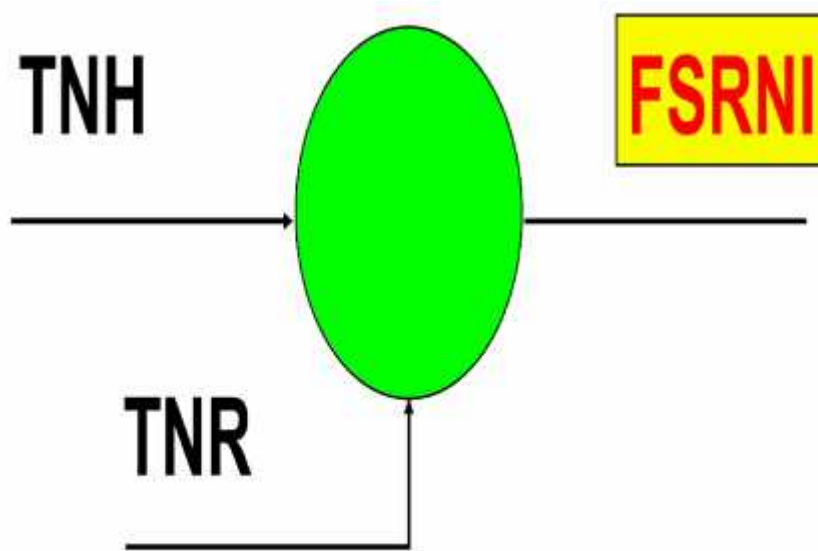


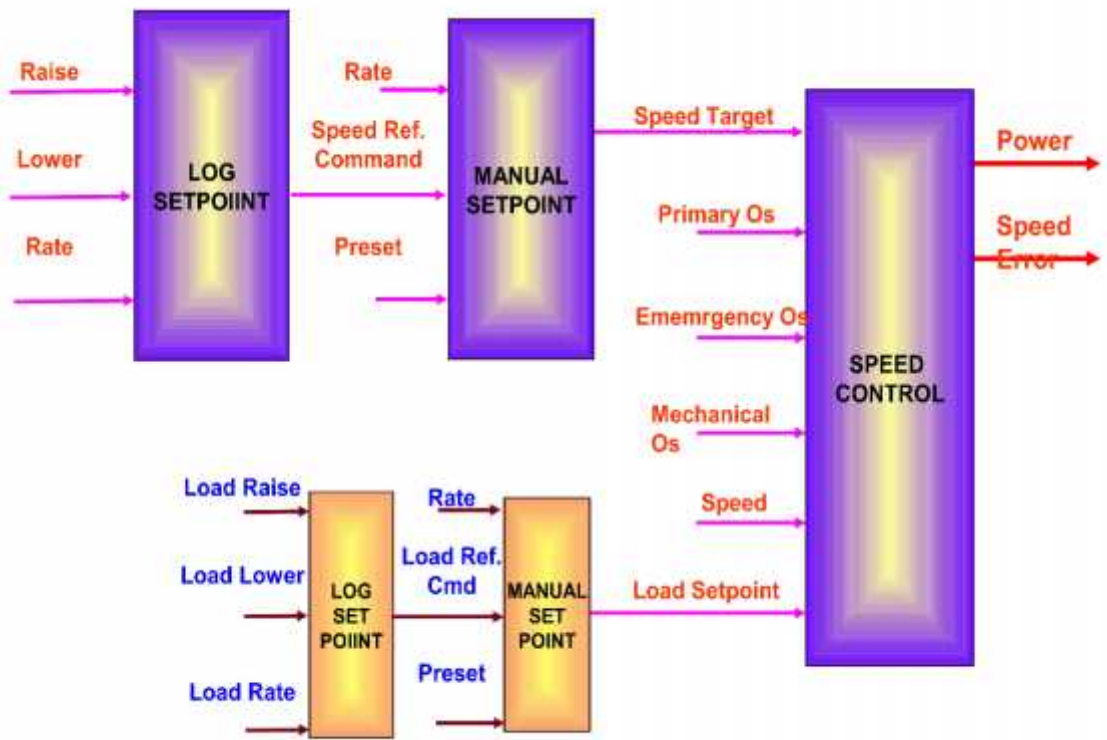
TNH

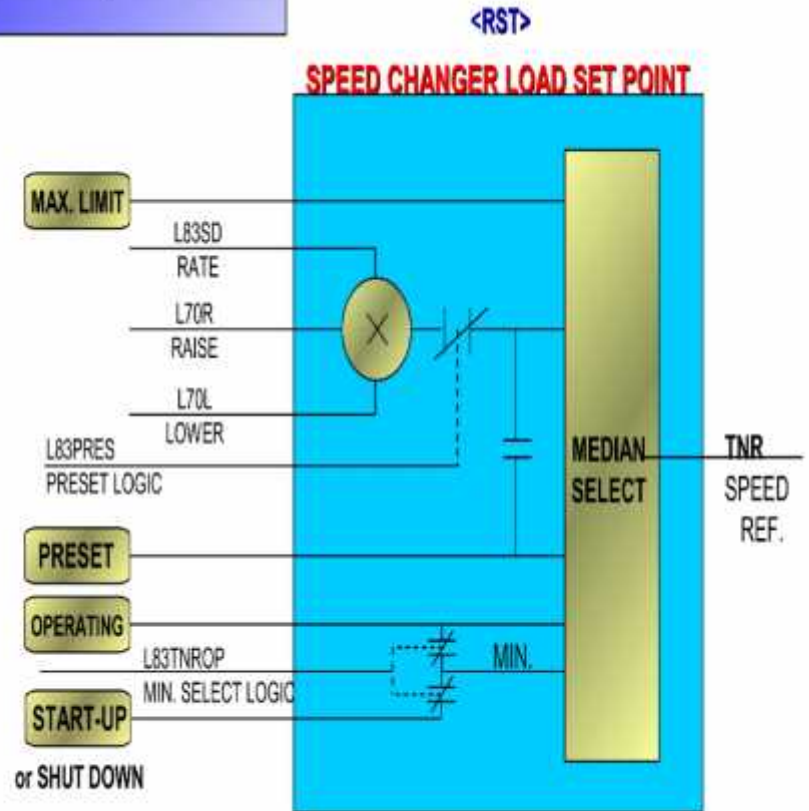
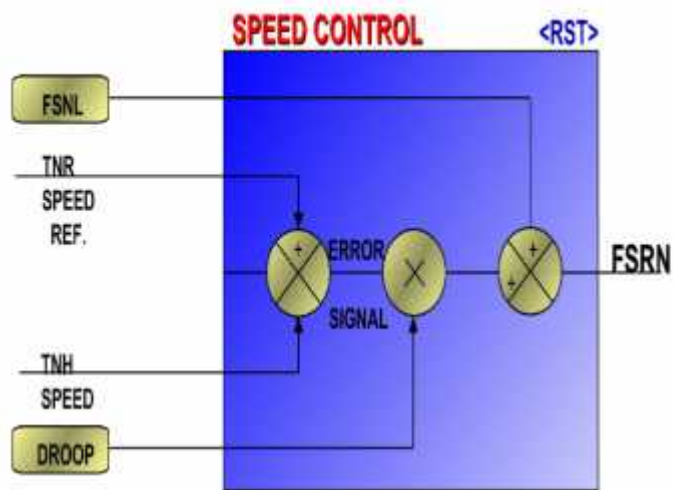


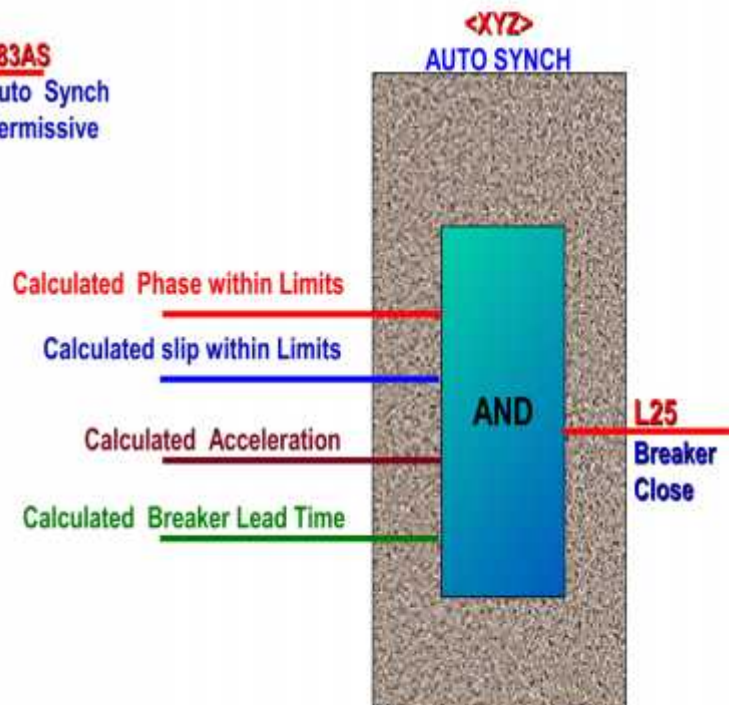
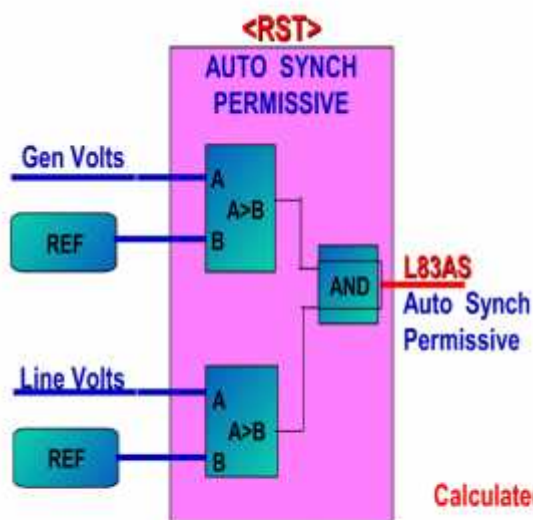
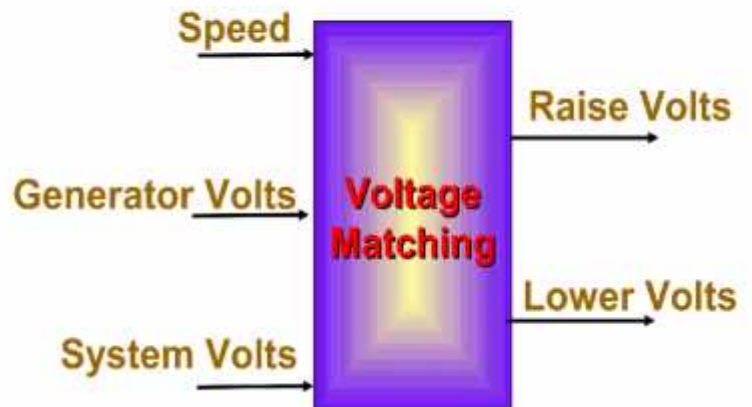
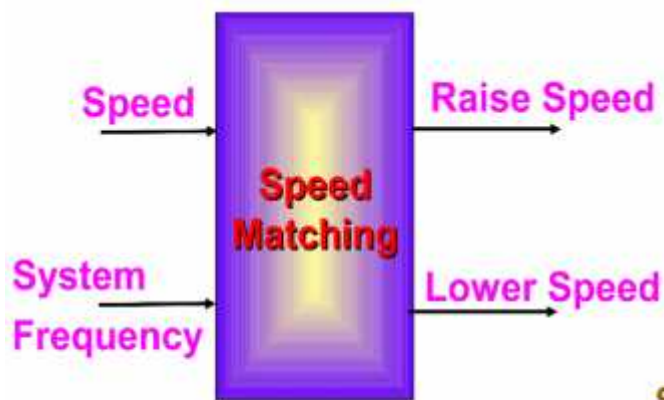
$$\text{FSR} = \text{FSRACC}$$

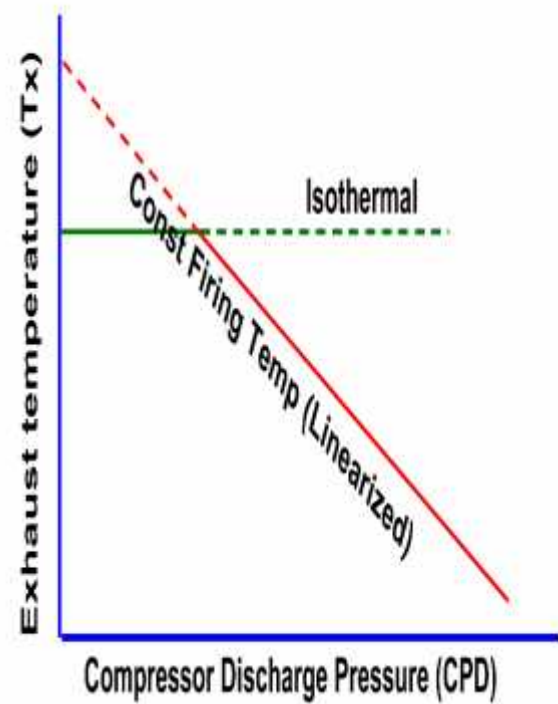
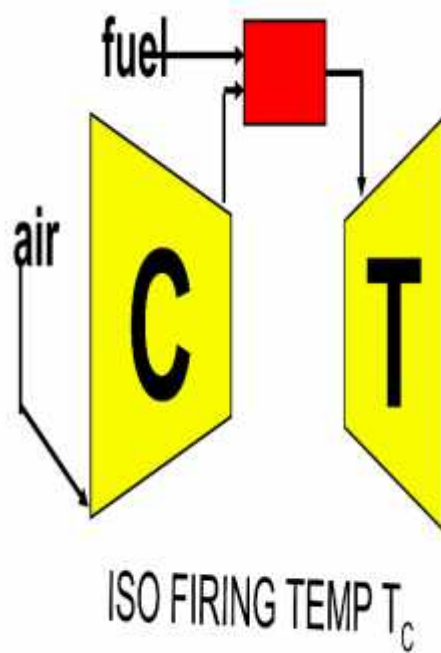
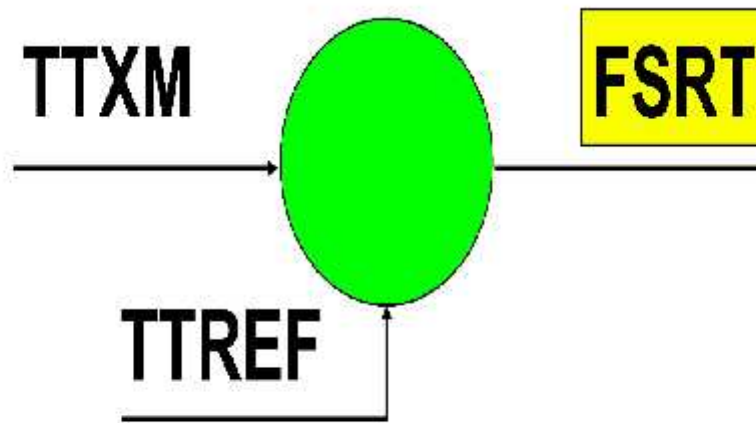


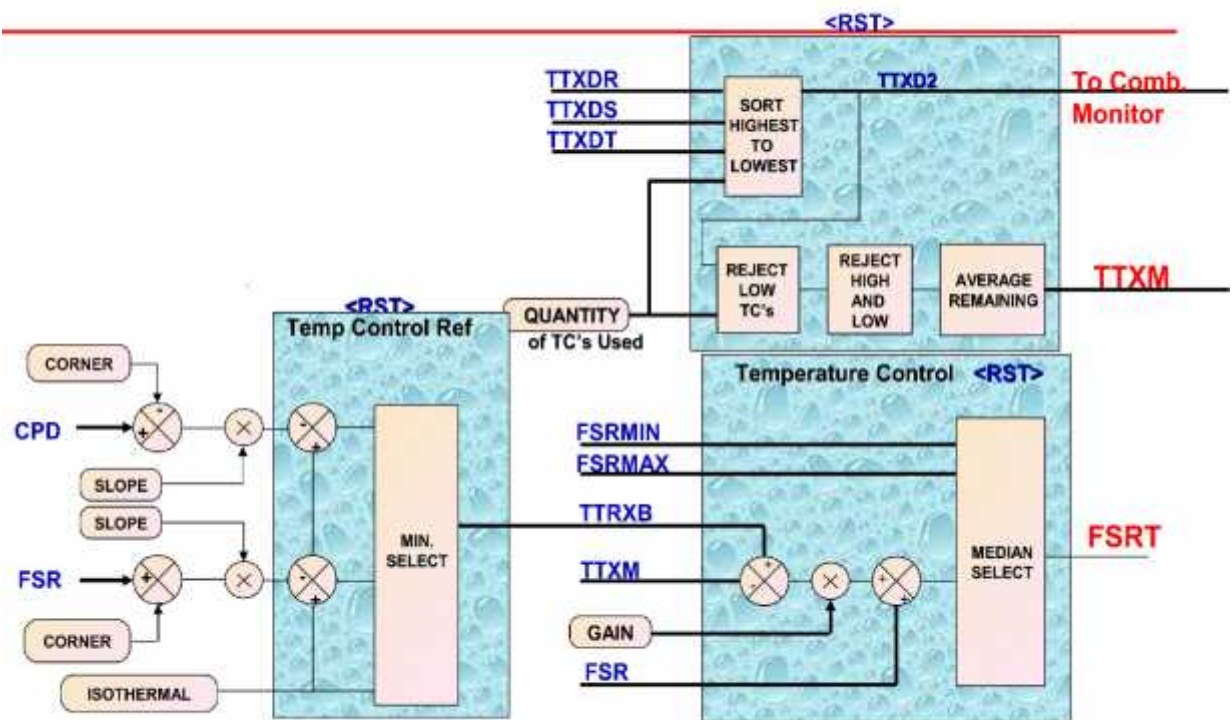
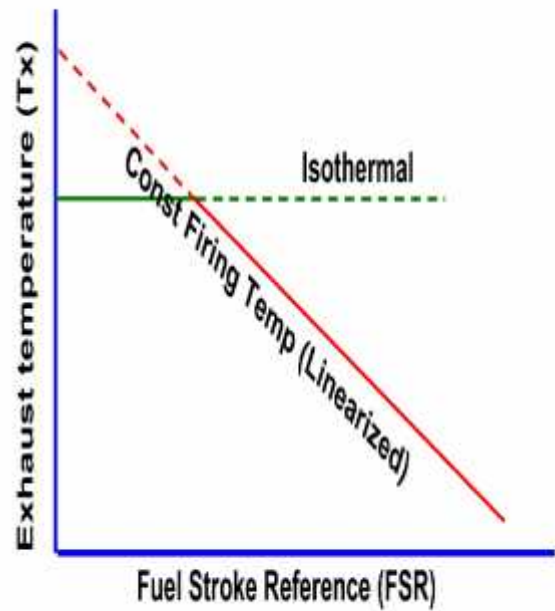
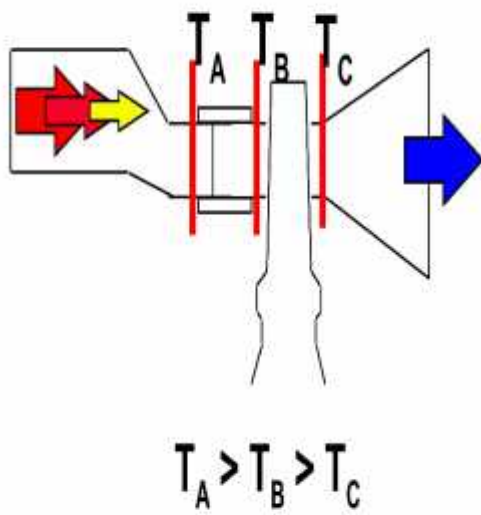


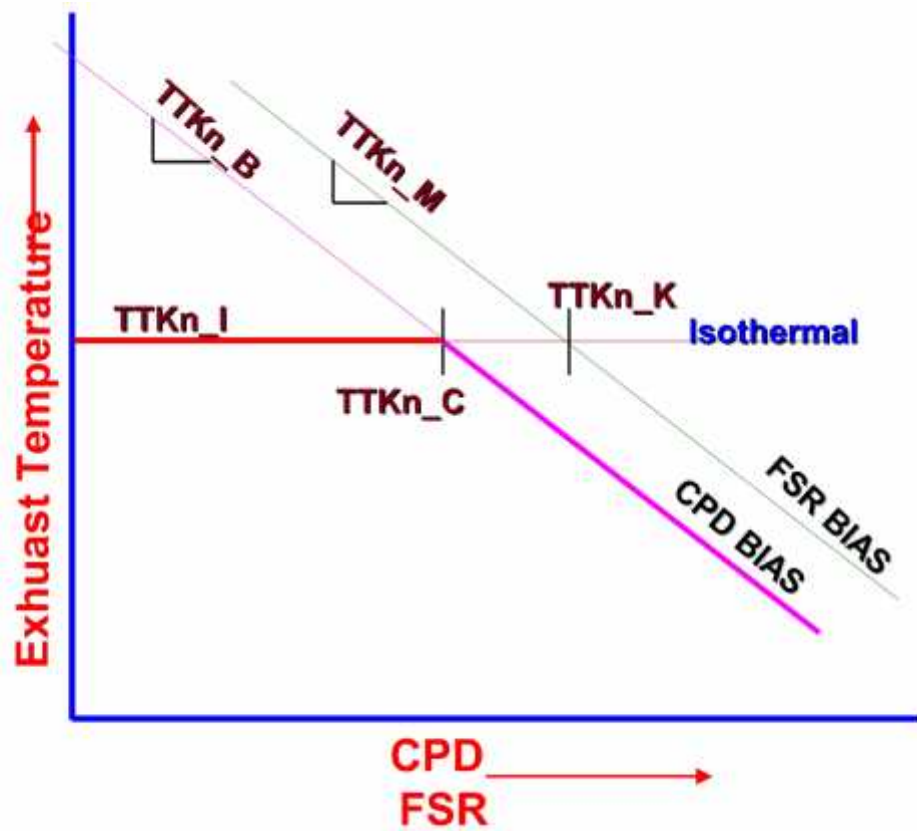
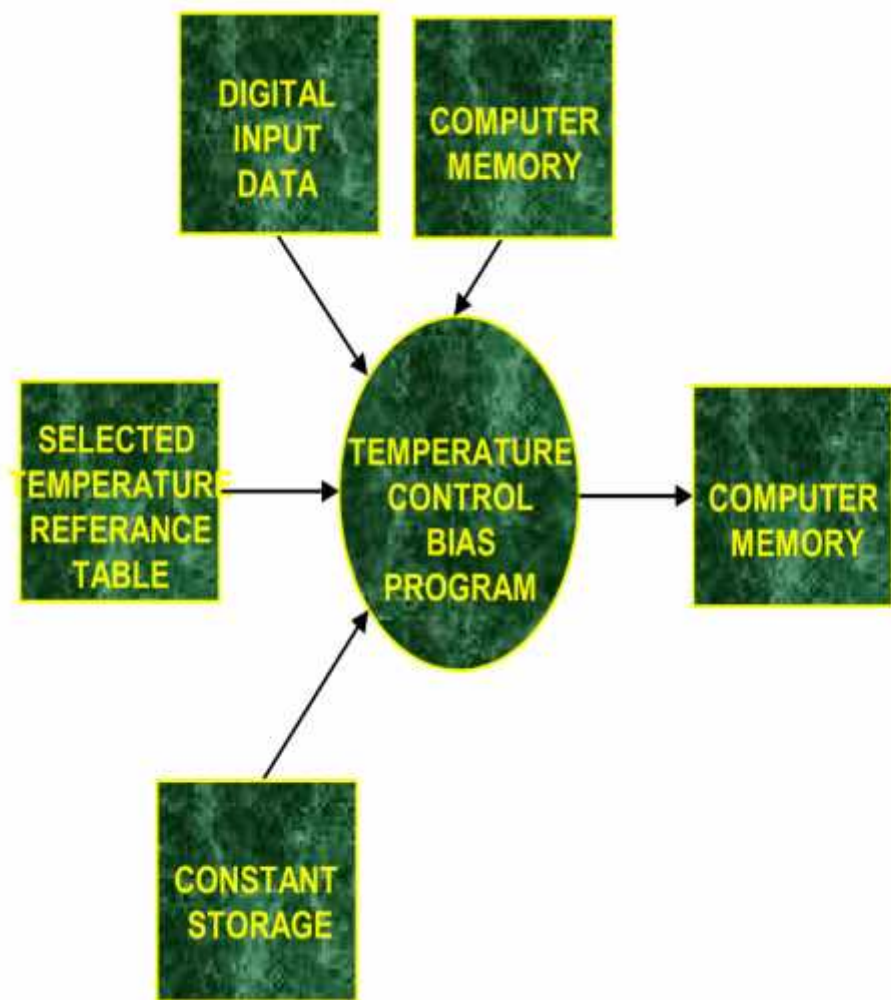


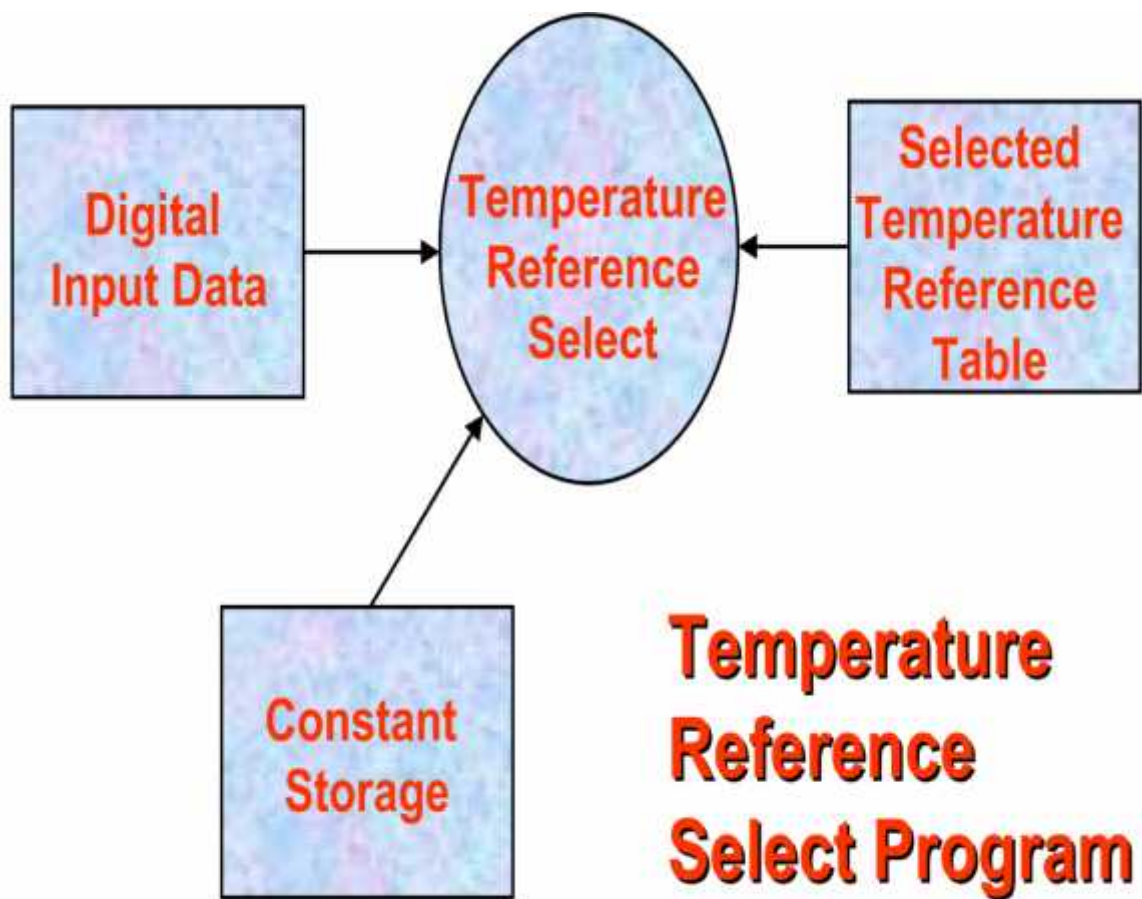




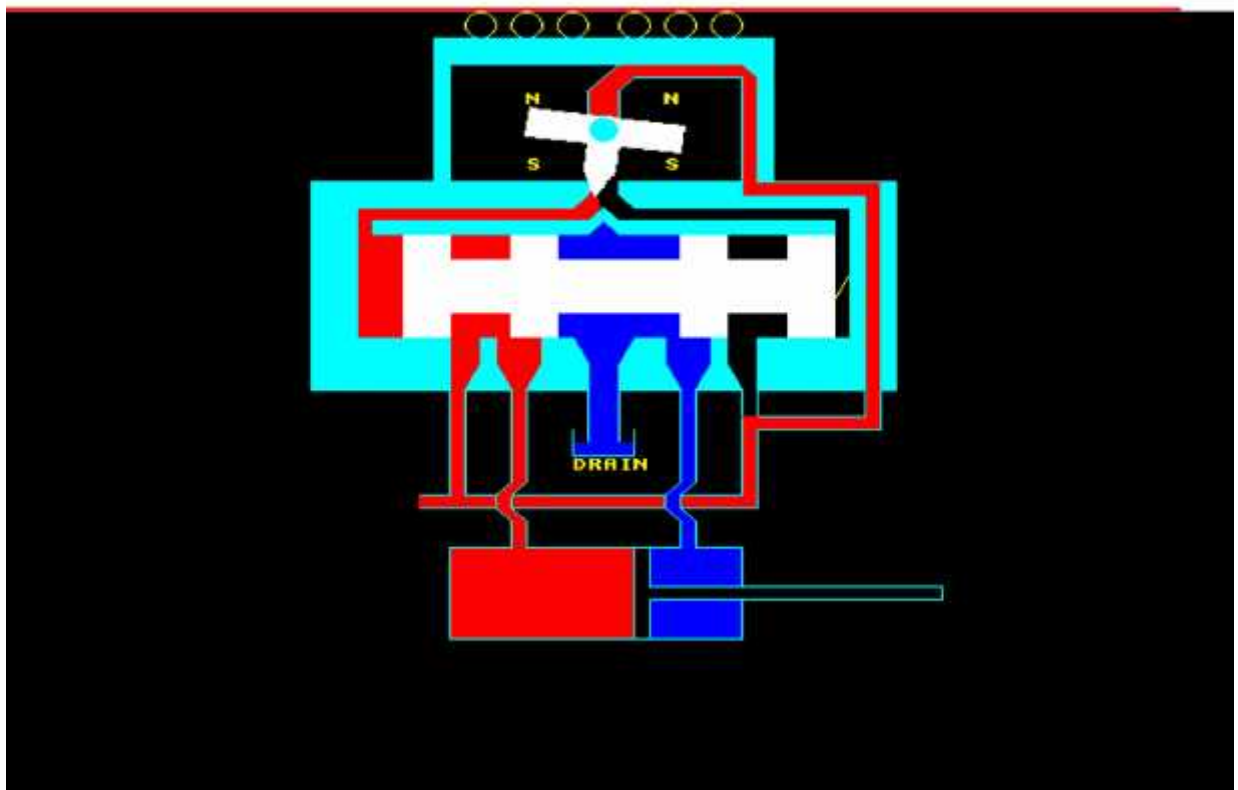




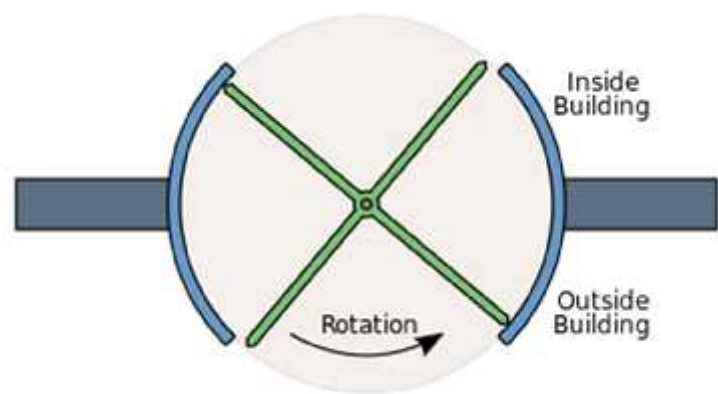




Servo Drive System



Rotating Doors





PART G. TYPICAL P&IDs (Available on Request)

