

Automatic Engine Shutdown with AUXILIARY POWER UNIT

LD - III



Locomotive Idling

- When do we call a locomotive is idling ?
 - Locomotive speed is zero.
 - Engine is running between 350 to 400 RPM
 - Loco brakes are applied i.e. $BCP > 2.0\text{Kgs/Cm}^2$
- Most of the goods trains are waiting for long periods in station yards,
- Indian Railway statistics says almost 40% of the total run time of a diesel locomotive is IDLE only.



Why not shutdown

- The drivers can switch off the the locomotive and save fuel instead of running at IDLE.
- But they don't do – because
 - The crew does not have confidence that loco can re-cranked.
 - BP pressure reduces in the formation due to leakages.
 - It takes longer time to charge the BP again.
 - Driver cannot start the train immediately.
 - Lastly crew is not paying for the fuel oil.
- So They continue to run the engine at IDLE



What & How much is wasted when idling ?

- The fuel consumed per hour on Alco locomotives is around 25 liters / Hour.
- If you take Rs.60/- per liter, the cost per idle hour running is Rs. 1500/-.
- Average 10 hours per day idling means Rs.15000/- per day.
- 330 days of loco working means Rs. 49,50,000 /- per year.
- If a home shed is having 100 locos, almost all **49.5 crores** worth of fuel is wasted in an year.



Can we save that money ?

- Yes We can save that oil / money.
- It is a saving to individual and to nation by conserving the Diesel oil
- But How ?
 - Create confidence in the driver that engine can crank every time he shuts down the engine.
 - This is possible only if Shed maintains good healthy batteries and
 - There is no hard starting of the engine.



What more ?

- But what about the reduction of BP pressure ?
 - This cannot be sorted out in the existing system unless and until leak proof train formation is maintained. .
- After a long period of waiting, the driver cannot start the train immediately he is on green signal.



What Next ?

- How to reduce the starting time ?
 - This is possible through Automatic engine stop and start by installing

Auxiliary Power Unit..



What locomotive is doing while in IDLE state.

Locomotive does two jobs:

1. Maintains MR pressure between 8 to 10 Kgs/cm²
2. Charging loco batteries and Providing supply to control system.

So,

- There is no reduction of BP pressure.
- Train can be started immediately



ALTERNATIVELY

- If these two jobs are met by a small engine,
 - Main engine can be shut down.
 - Fuel oil can be saved to a major extent.
 - Absolutely there is no delay in traffic needs.



AES with APU

Concept

- While main engine is working, it is delivering power of around 250 HP.
- This power is consumed by the Auxiliaries.
 - TM blowers
 - Radiator fan
 - Exciter Generator
 - Auxiliary generator
 - Compressor
- Out of this only compressor and Auxiliary generator are performing useful job Remaining are simply consuming power.



AES with APU Concept

- If a smaller engine having low SFC can perform the required functions of idling locomotive, lot of diesel oil can be saved on Indian Railways and to nation.
- With this concept AES with APU is designed..



AES with APU

- AES: Auto Engine Shutdown
 - The system continuously monitors the following parameters:
 - Idling state of the locomotive.
 - Health status of the battery and compressor.
 - Safety parameters of the engine.
 - Automatically shuts down the main engine if all the above parameters are within limits.
 - automatically starts the main engine whenever the driver requires to start the train.



AES with APU

- APU: Auxiliary Power Unit

A small engine coupled to a baby compressor and an alternator along with control circuitry is called APU.

- Smaller engine having low SFC produces required limited HP power.
 - Required fuel is only consumed
- Baby compressor maintains BP pressure.
 - No reduction of BP pressure and the train can be started as and when required.
- Alternator along with rectifier generates 72V DC and charge locomotive batteries while the main engine is shut down.
 - Ensures engine cranking without failure.
- Control circuitry:
 - Provides automatic change over.



AES with APU

Added advantages

- Reduction in fuel oil consumption.
- Reduction in lube oil consumption.
- Reduction in emissions
- Extended engine life
- No dependancy on driver.
 - Active 365 days a year, 24 hours a day. Automatic changeover.
 - Continuous monitoring of parameters before and after shutdown.
- No stress to driver.



AES with APU

Added advantages

- Extended fuel saving through load shredding.
 - Dust exhaust motors, CCEM, FPM are not required when engine is shutdown. Unnecessarily they consume power.
 - These motors are switched OFF and save fuel further.
- Provides documentation and verification of fuel savings.
 - APU run hours are recorded in life time counters and trip run hours.



LOCO IDLING

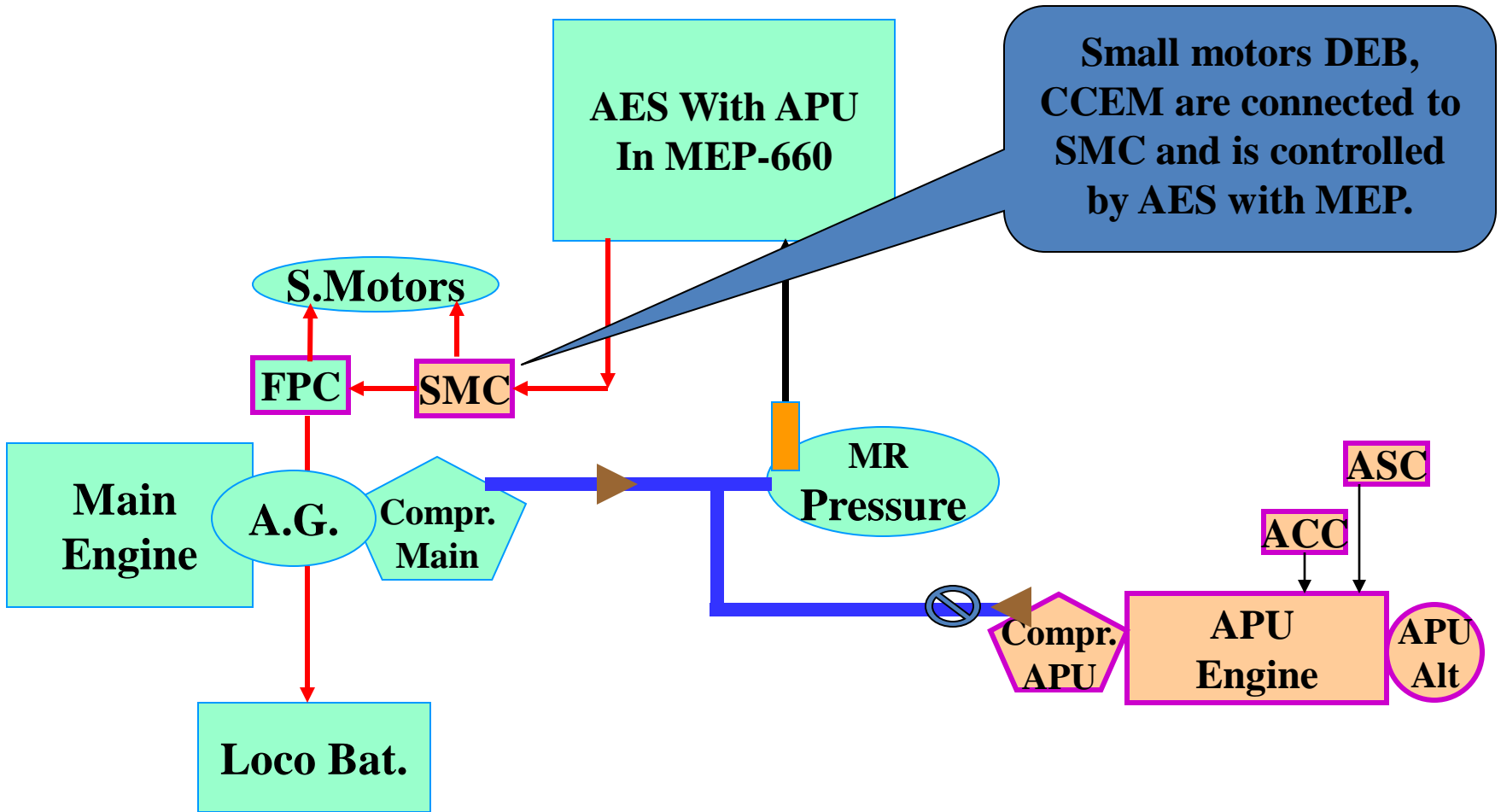
- AES with APU assumes that the loco is Idling when:
 - Engine runs between 350 to 400 RPM.
 - Loco Speed is zero
 - Loco brakes are applied (BCP is > 1.5Kgs./Cm²)



When AES with APU save Fuel

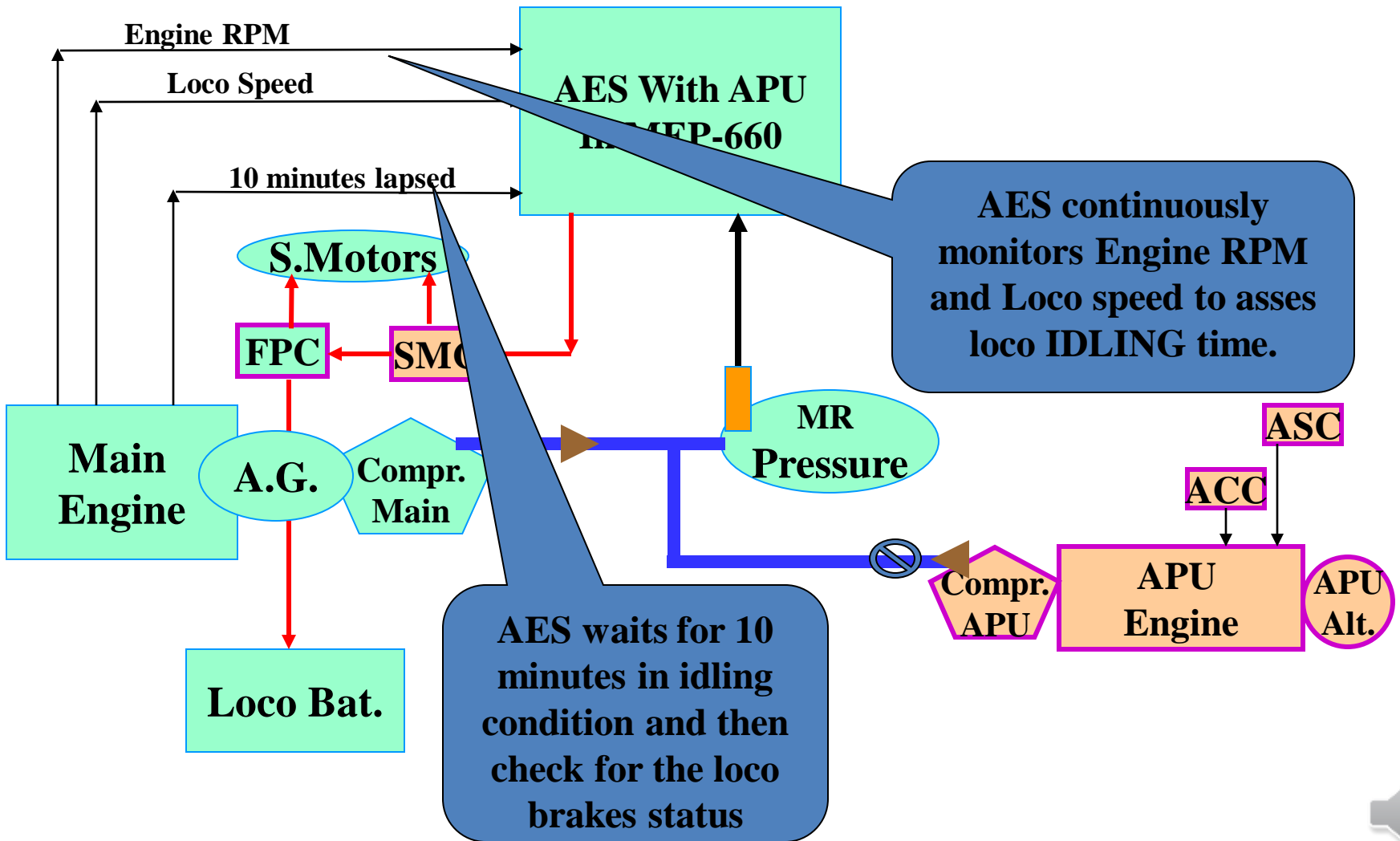
- Loco is idling for more than 10 minutes.
- AES with APU checks the following conditions:.
 - Driver acceptance – AES switch is in ON.
 - Engine Idling
 - Loco is not set for load test
 - Loco is set to lead position (MCB1 and 2 are switched ON)
 - APU status is healthy – Water level, fuel oil level etc.
 - Water and lube oil Temperature sensors are healthy and the temperature is $>30^{\circ}\text{C}$.
 - Battery charging current is below 10 Amps.
 - MRPR is $>$ than $7.5 \text{ Kgs}/\text{Cm}^2$
 - Reverser Handle is in neutral position.
- Then AES with APU goes into FUEL SAVE Mode.

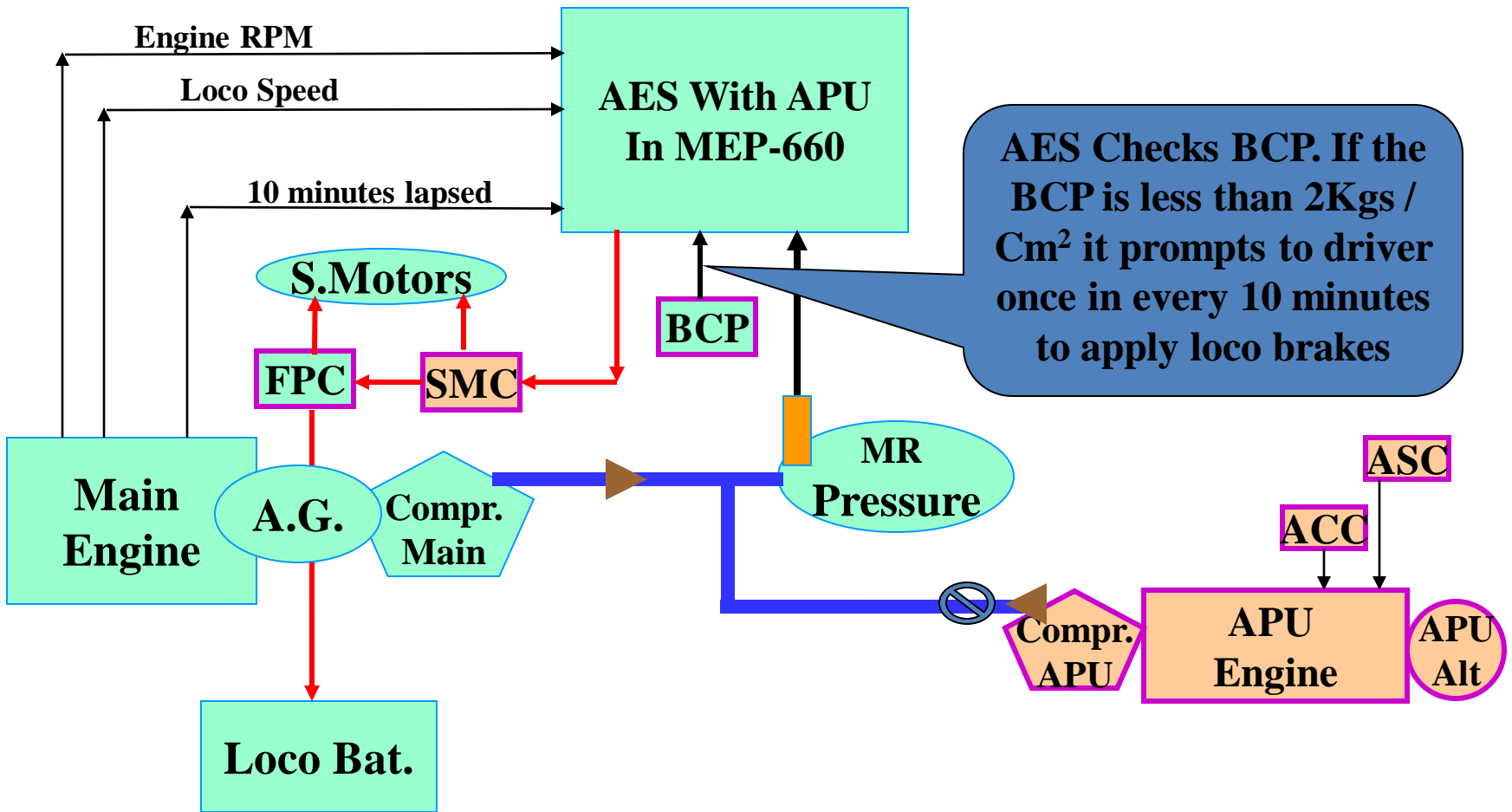


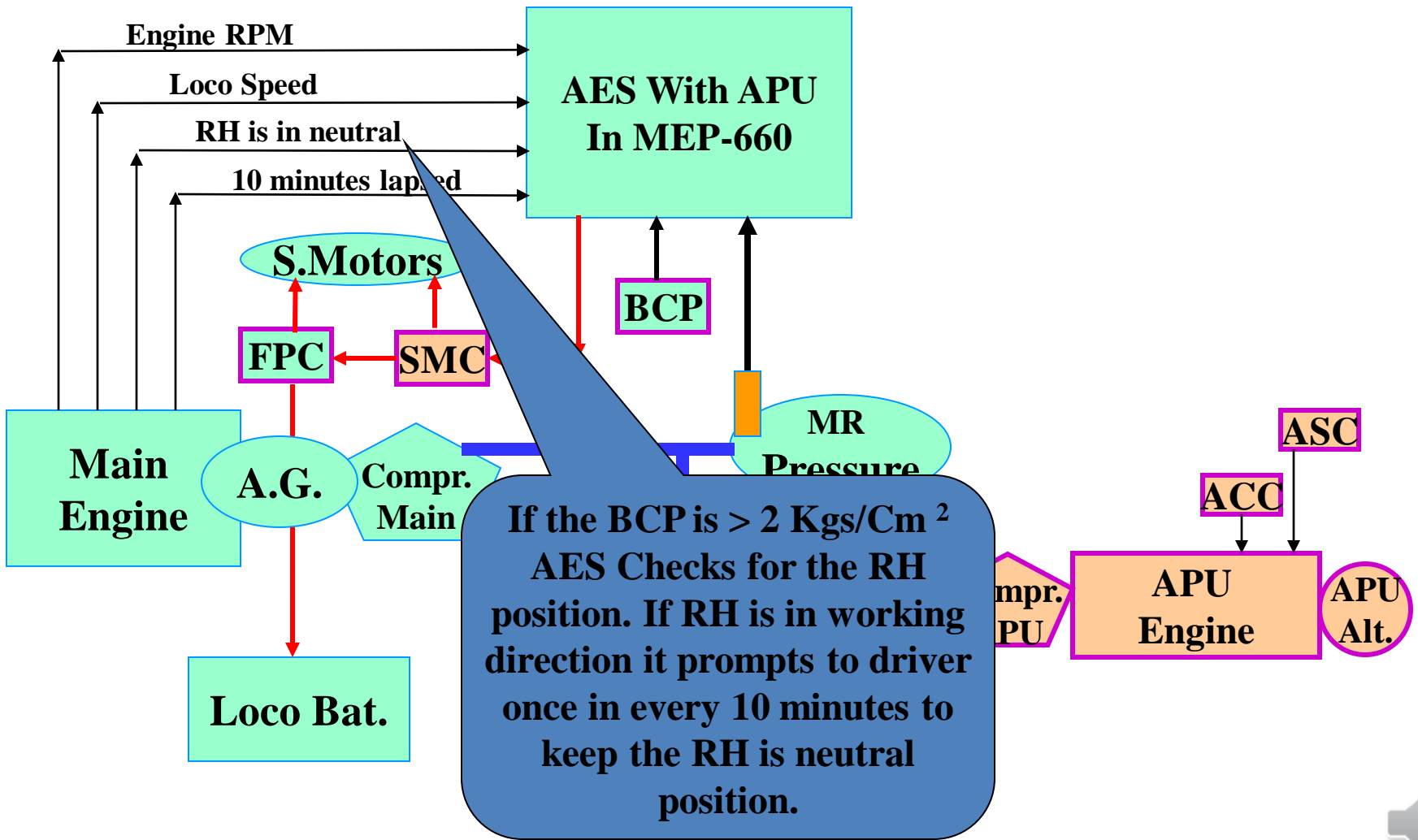


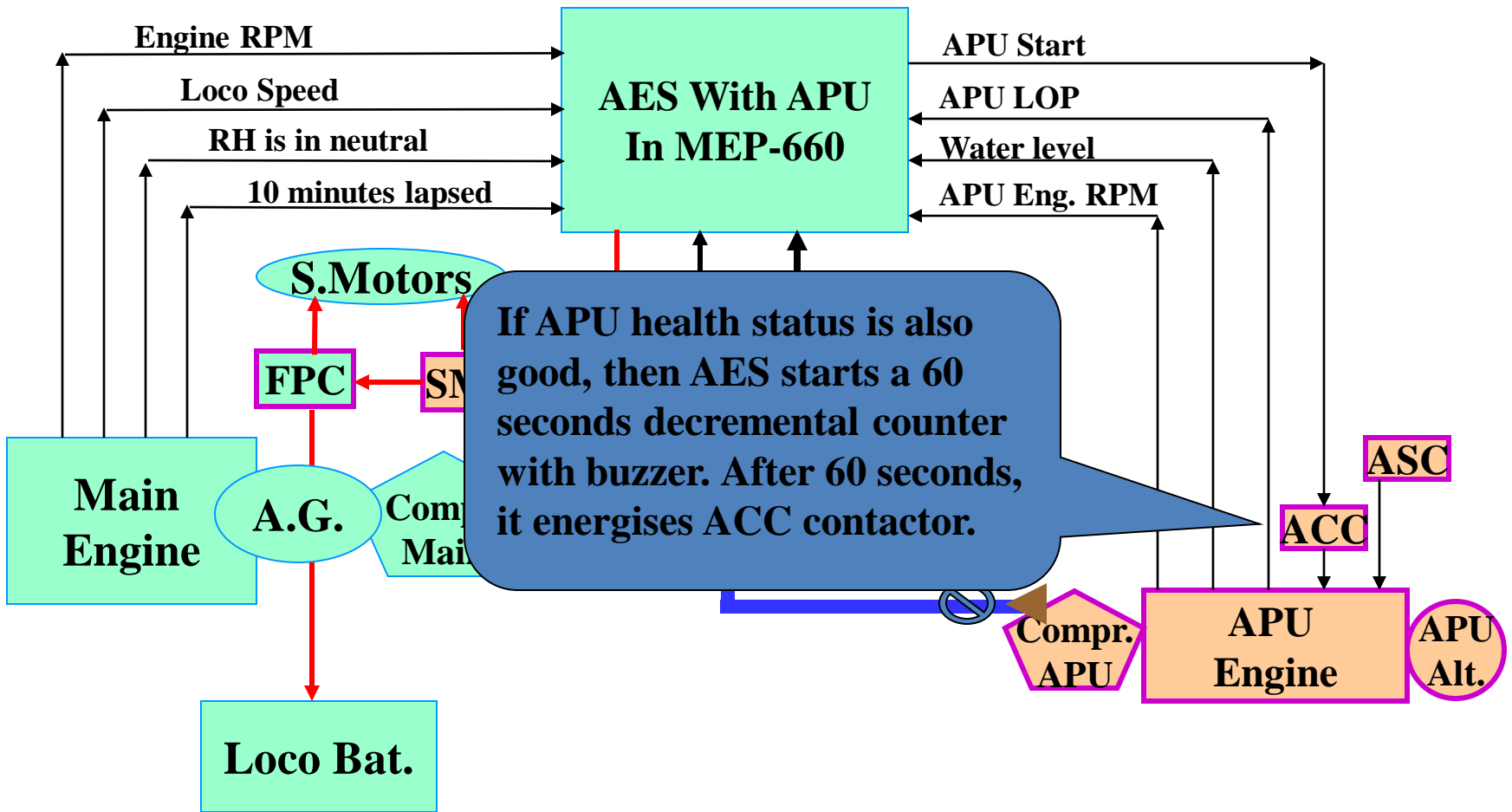
Small motors DEB, CCEM are connected to SMC and is controlled by AES with MEP.







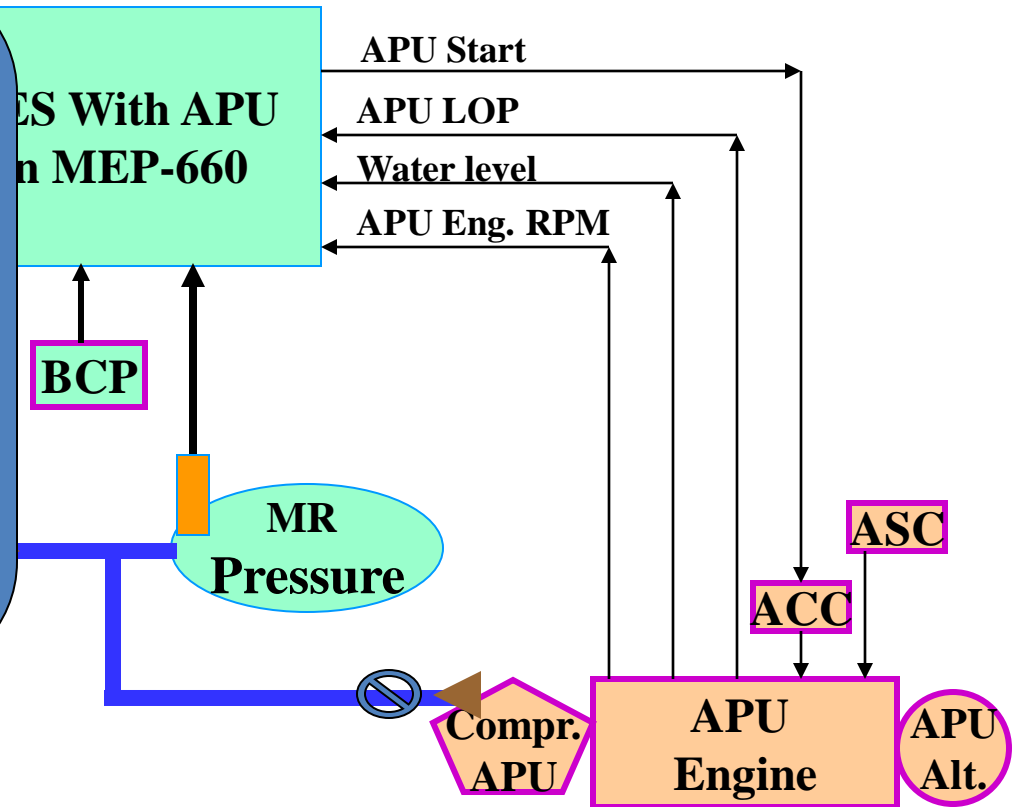




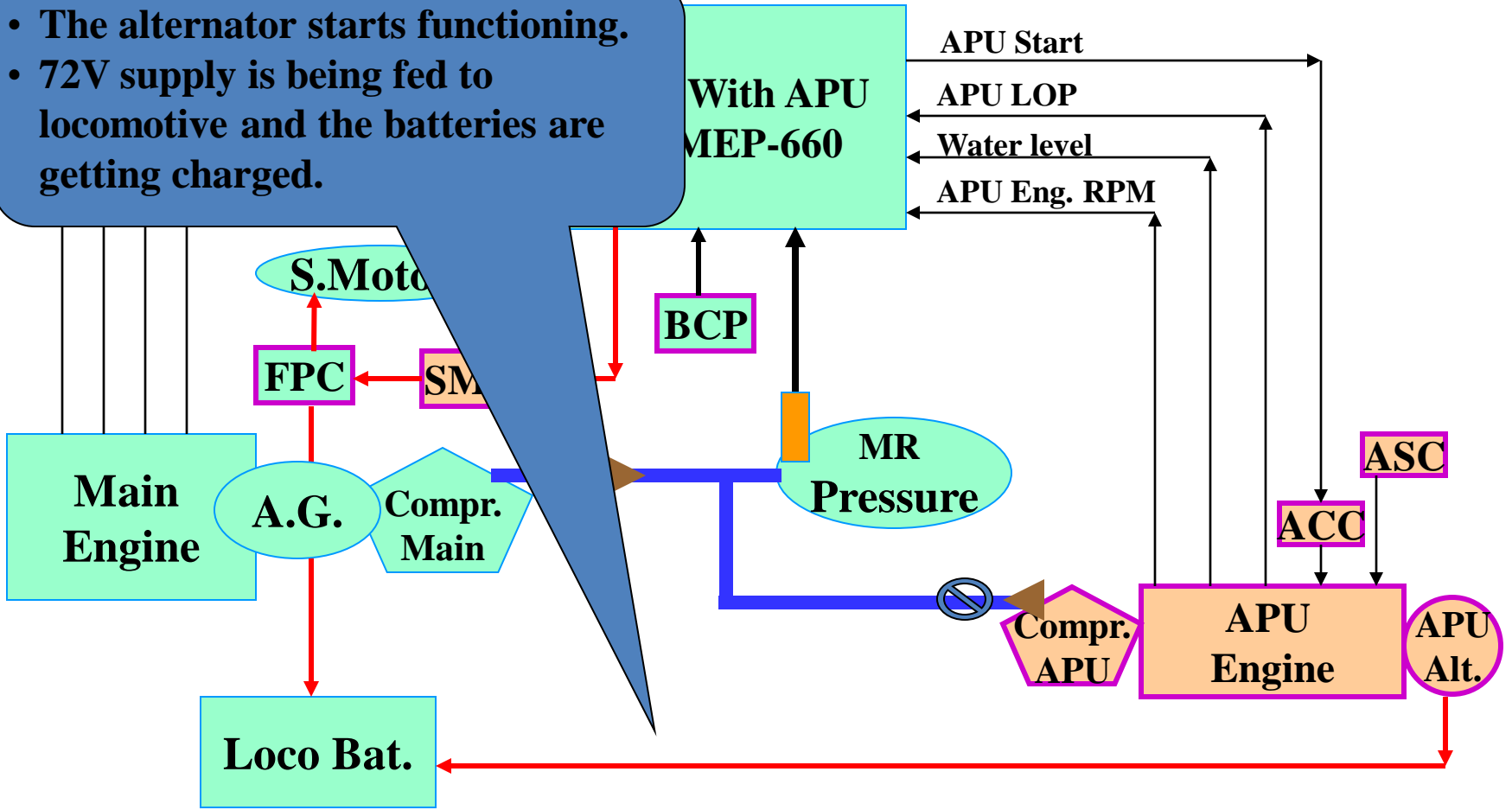
The following sequence follows:

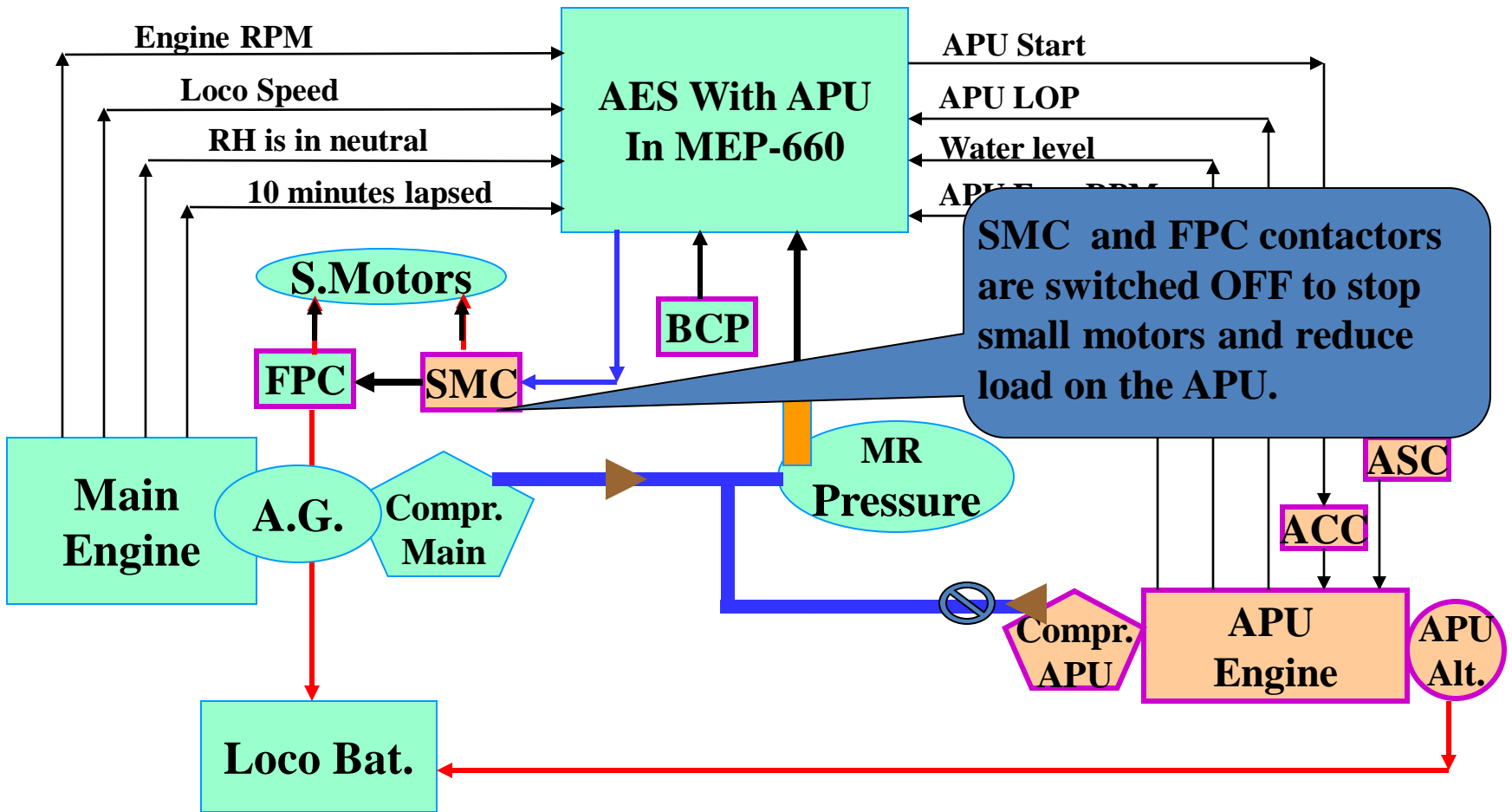
- Internal 12V supply is connected to starter motor of diesel engine.
- Engine runs at 1500 RPM.
- Compressor starts functioning.
- MR tank is getting charged with compressed air.
- MR is maintained above 9 Kgs. / Cm².
- Main engine is shutdown

Loco Bat.



- The alternator starts functioning.
- 72V supply is being fed to locomotive and the batteries are getting charged.



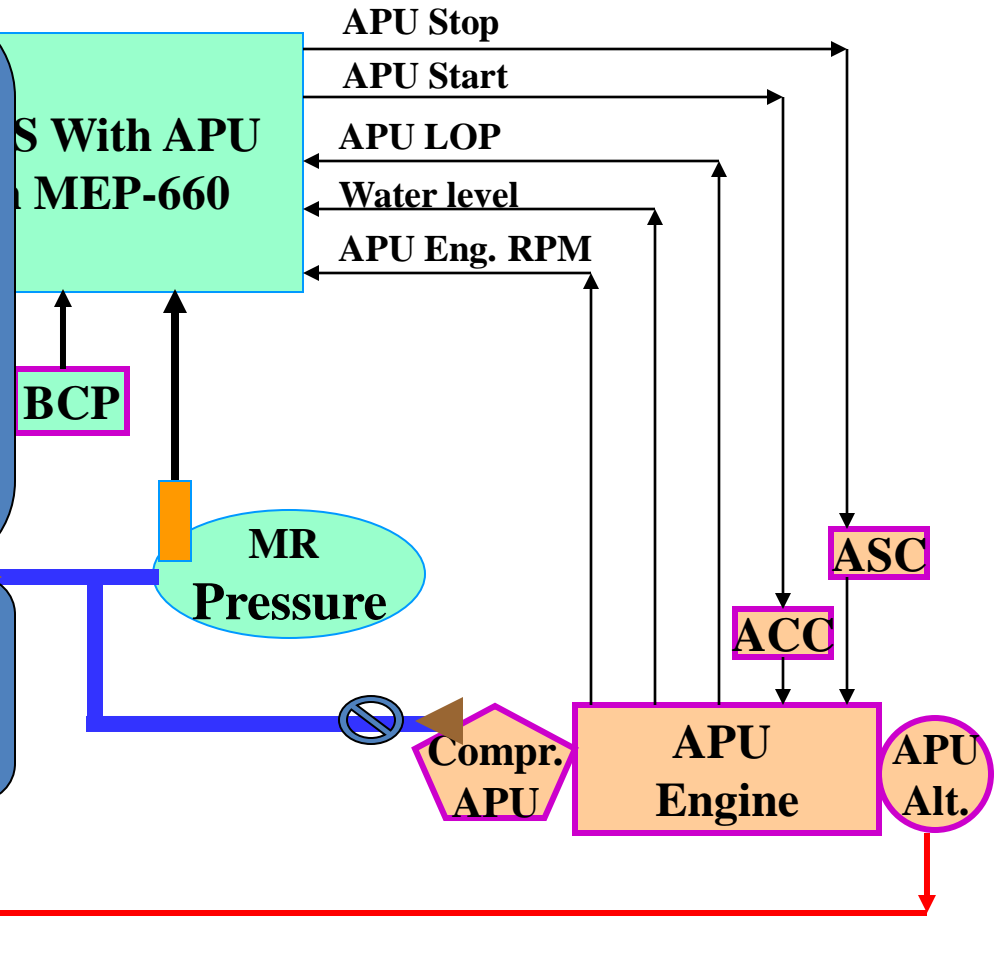


APU will be running as long as:

- MR is above 6Kgs/Cm².
- Batteries are charging.
- Safety devices in APU not operated.
- Driver did not switch OFF AES switch.
- Driver did not keep RH in working Direction.

If any of the above is happened, AES energises APU shut down contactors ASC.

Loco Bat.

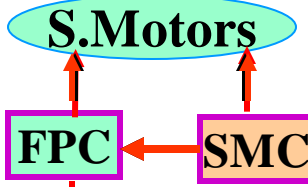


- SMC & FPC are switched ON.
- Main engine is cranked.
- Loco works normally.

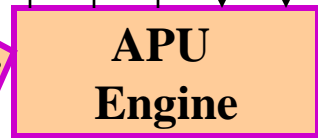
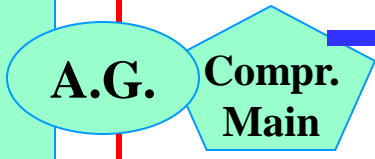
**ES With APU
In MEP-660**

- APU Stop
- APU Start
- APU LOP
- Water level
- APU Eng. RPM

10 minutes lapsed



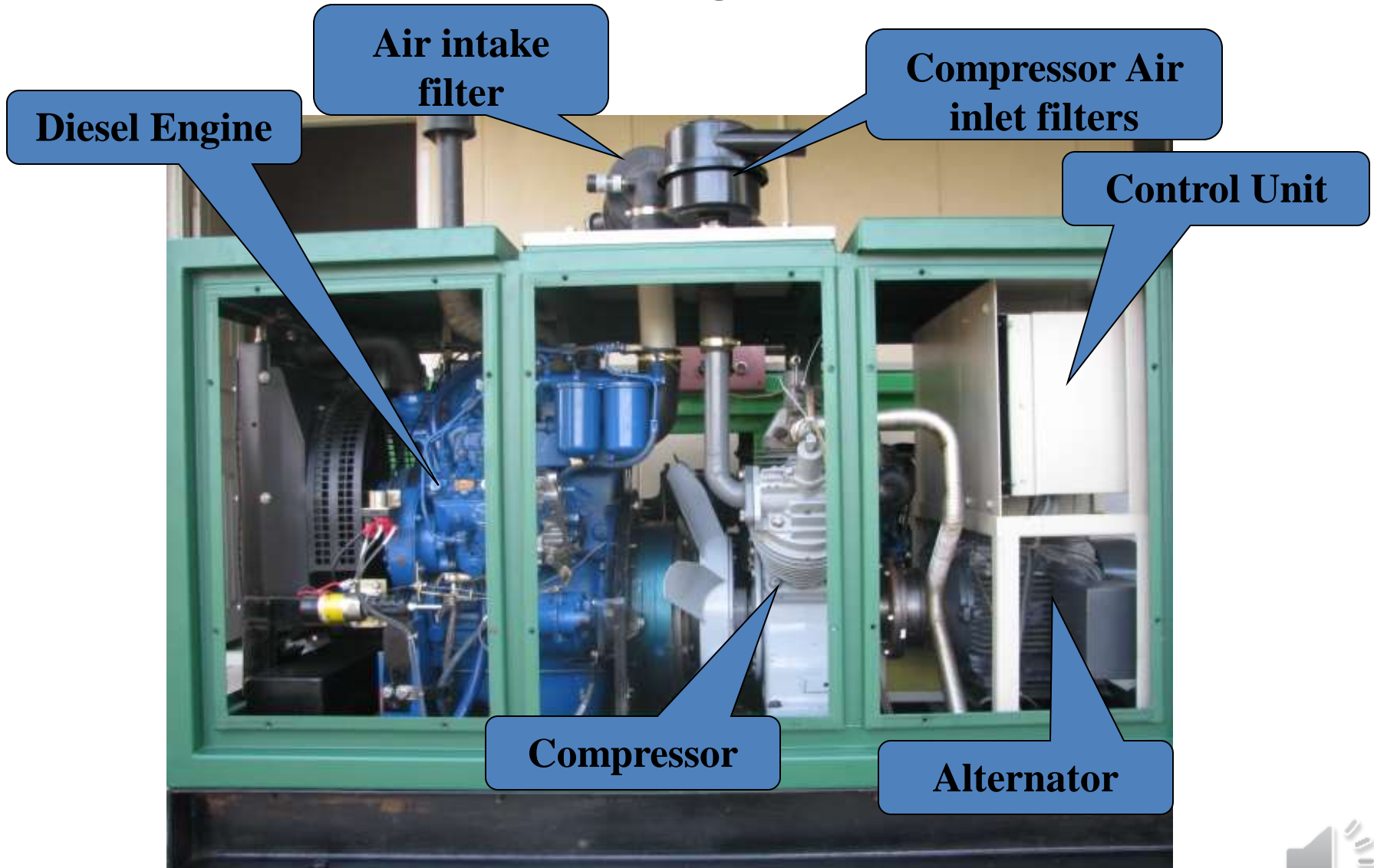
BCP



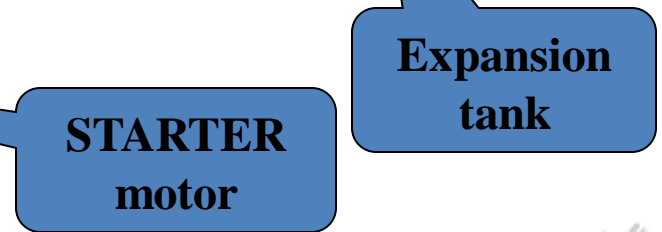
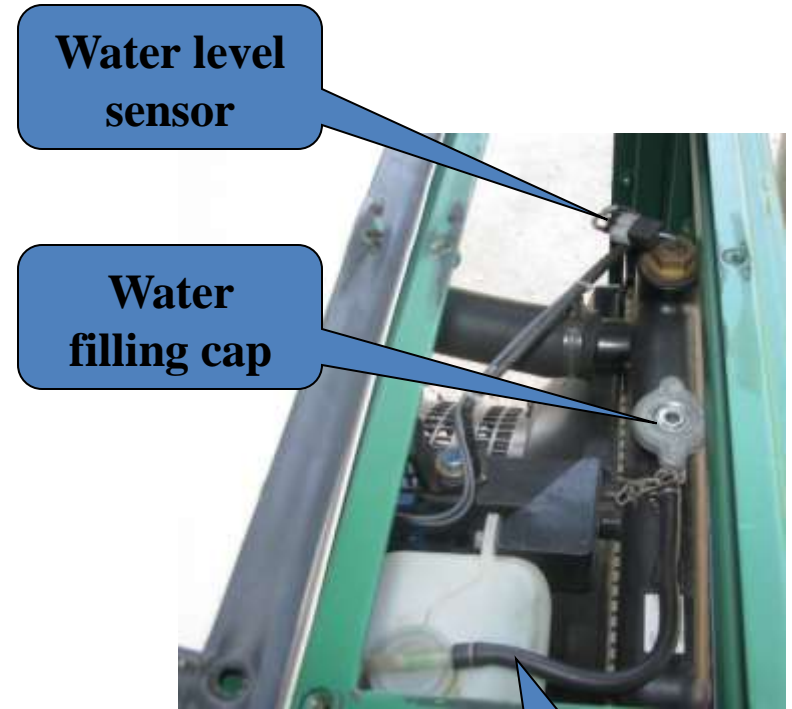
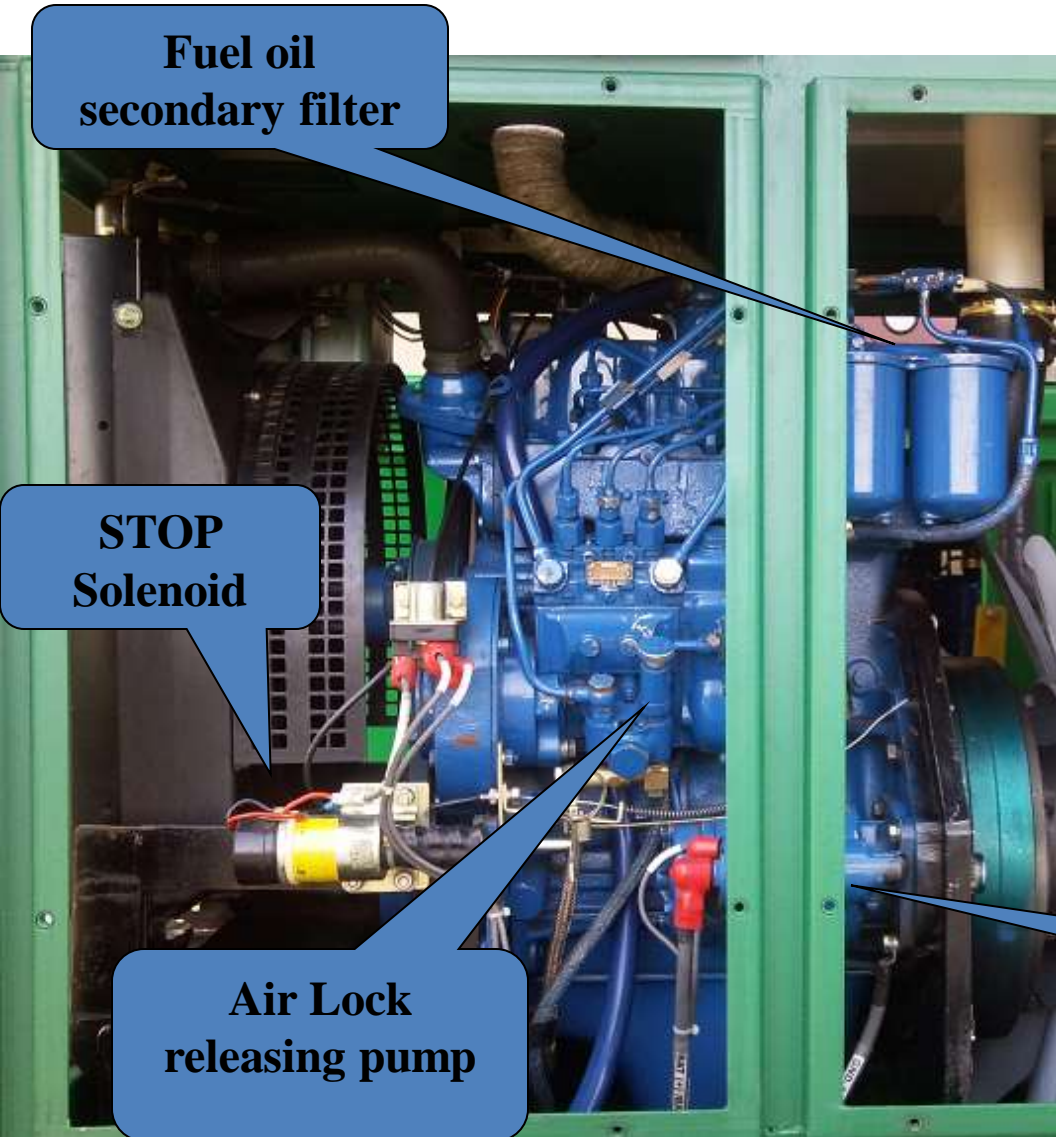
- The following sequence happens:
- Internal 12V supply is connected to STOP solenoid.
 - APU engine is shut down.



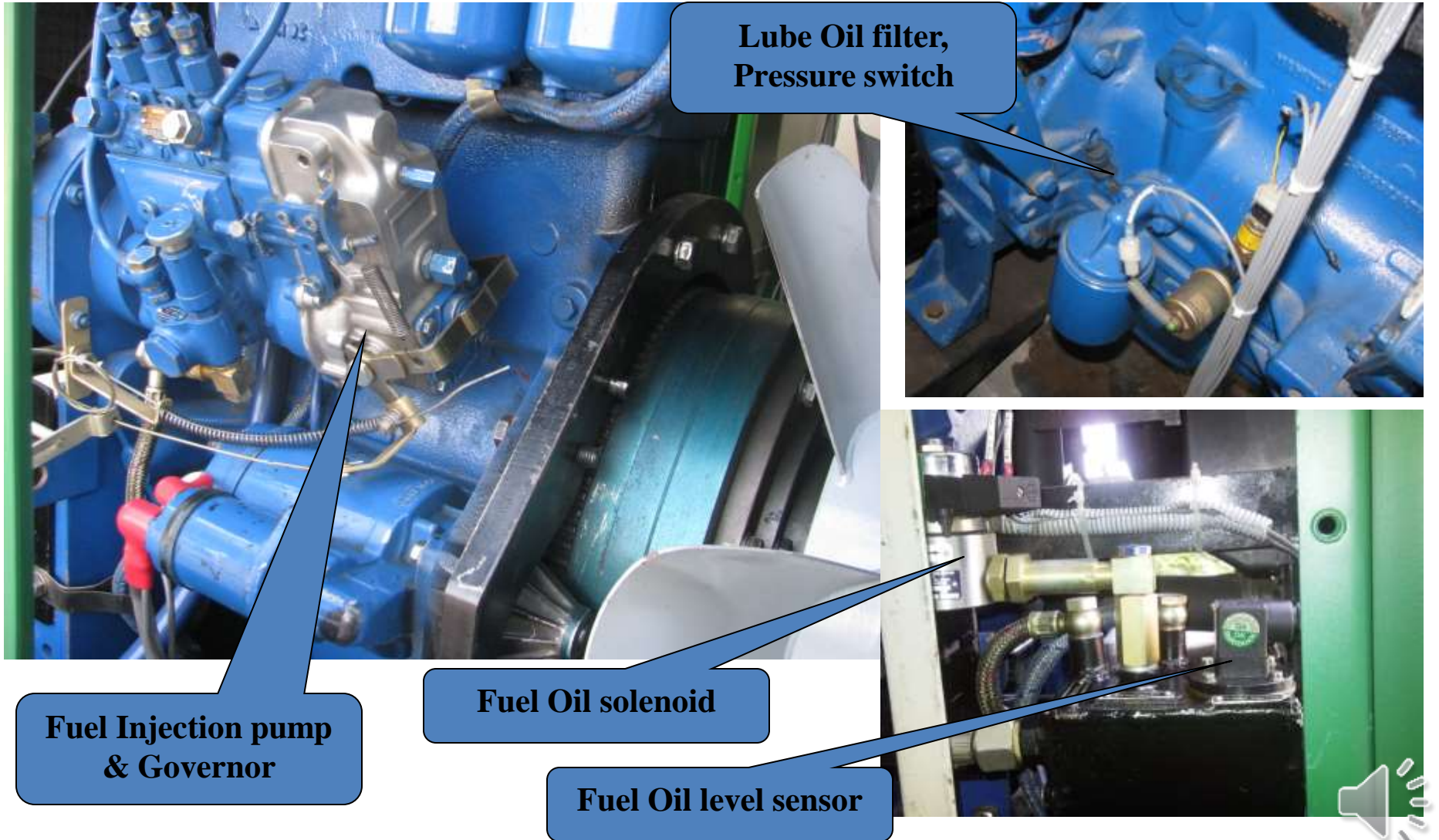
APU



Diesel Engine



Diesel Engine



**Lube Oil filter,
Pressure switch**

**Fuel Injection pump
& Governor**

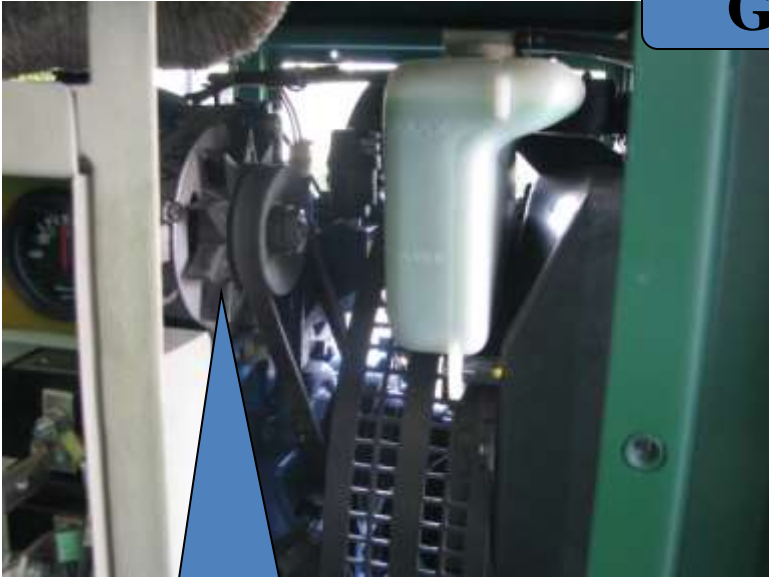
Fuel Oil solenoid

Fuel Oil level sensor



Diesel Engine

Gauge panel



12V Alternator



12V Battery



COMPRESSOR

Breather Valve

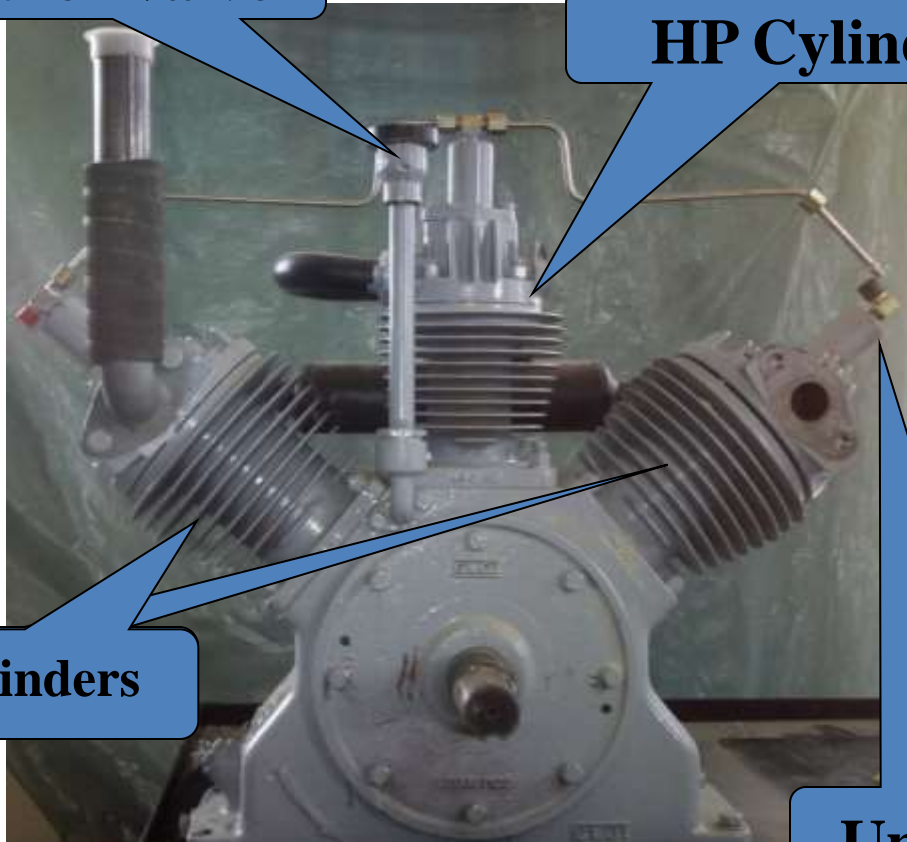
HP Cylinder

LP Cylinders

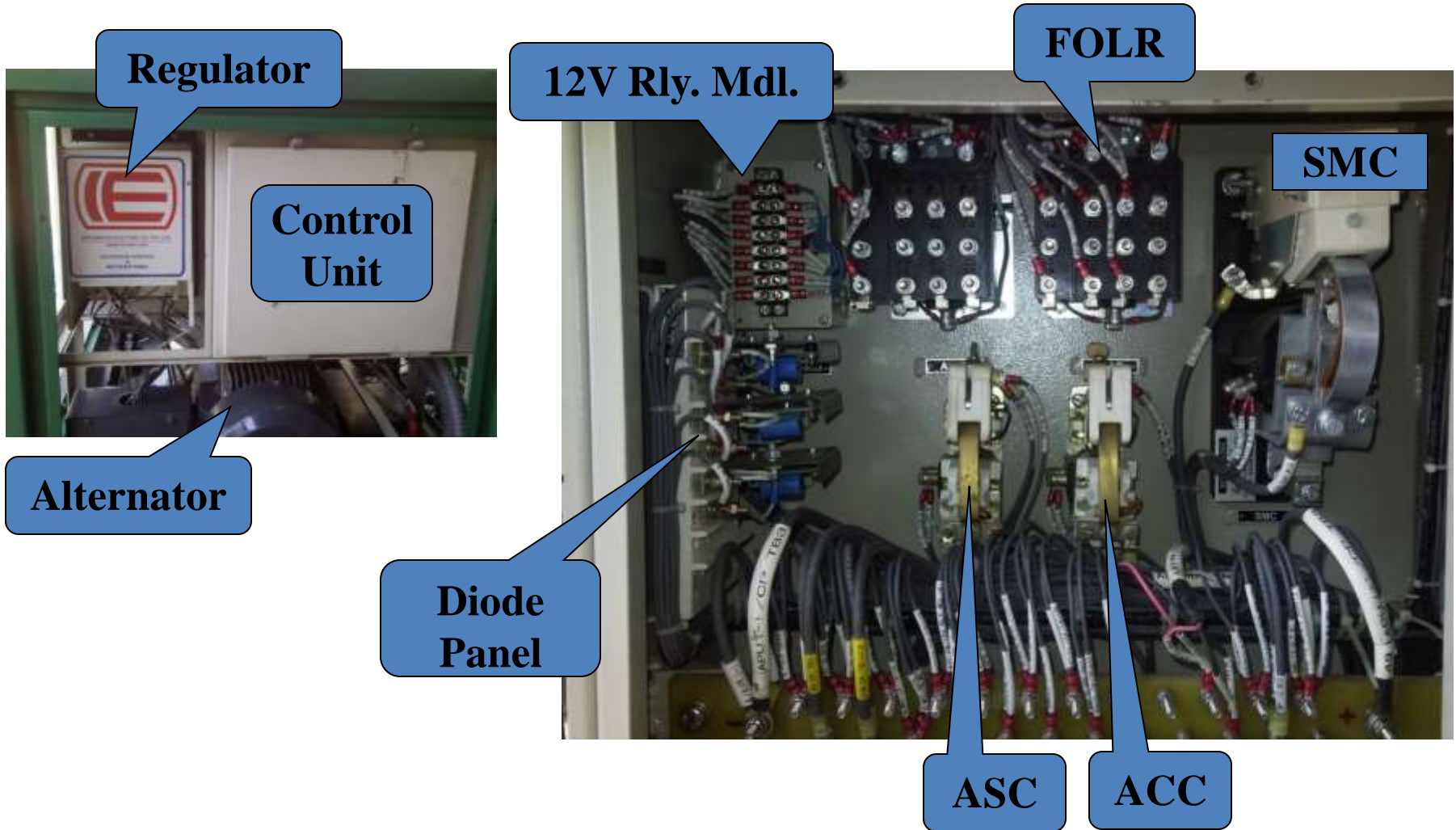
Oil sight glass

Oil Fill Cap.

Unloader Valves



Control unit





APU Enable switch

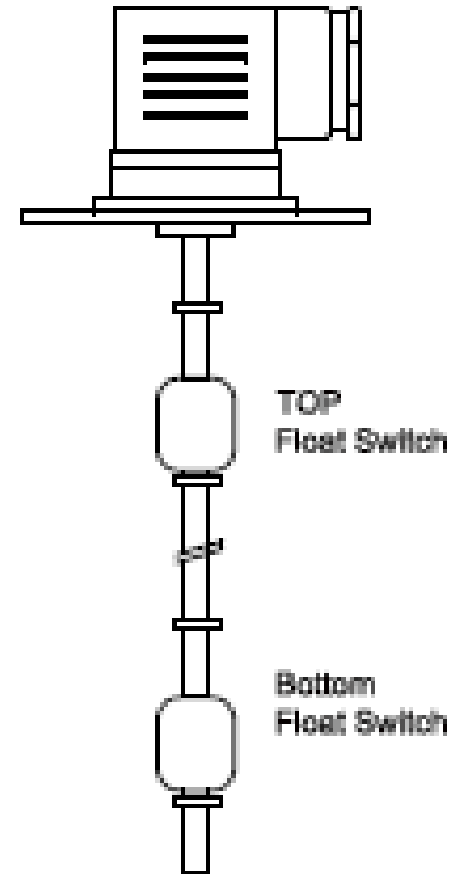


FUEL OIL SOLENOID





APU FUEL OIL LEVEL SWITCH



New Faults Added

Code	Message
1700	Operator enabled APU
1701	Operator disabled APU
1277	APU cranking contactor circuit open fault.
1278	APU Cranking contactor stuck closed.
1287	APU shut down contactor circuit open fault
1284	APU shut down contactor stuck closed fault
1286	SMC contactor circuit open fault
1285	SMC contactor stuck closed
1293	FPC contactor circuit open
1292	FPC contactor stuck closed



New Faults Added

Code	Message
1279	APU fuel oil level low fault
1280	APU water level low / Temperature High fault
1281	APU lube oil pressure low fault
1290	APU Engine failed Engine RPM low
1291	APU Engine failed Engine over speed
1276	APU Engine shut down unexpectedly.
1282	APU battery charging faulty
1283	APU Air compressor faulty
1289	No APU Generator output
1288	Main Engine failed to crank while rereturning from APU mode.

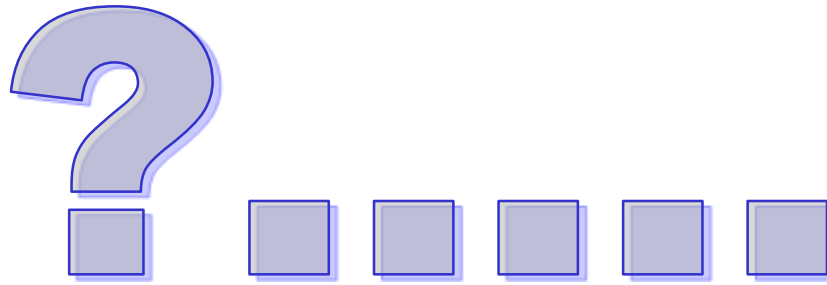


New Faults Added

Code	Message
2075	Keep REV handle to neutral to enter into FUEL SAVE mode.
2076	APU Enable switch is in OFF position
2077	System returning from FUEL SAVE mode
2078	APU shutdown contactor failed. Manually pull the emergency shut down lever to shutdown APU Engine.
2079	Loco brakes are not applied. May not enter into FUEL SAVE mode
2606	BAT/EWT?EOT/MRPR are not full filled. Fuel save mode prohibited.



Question Hour



Thank You