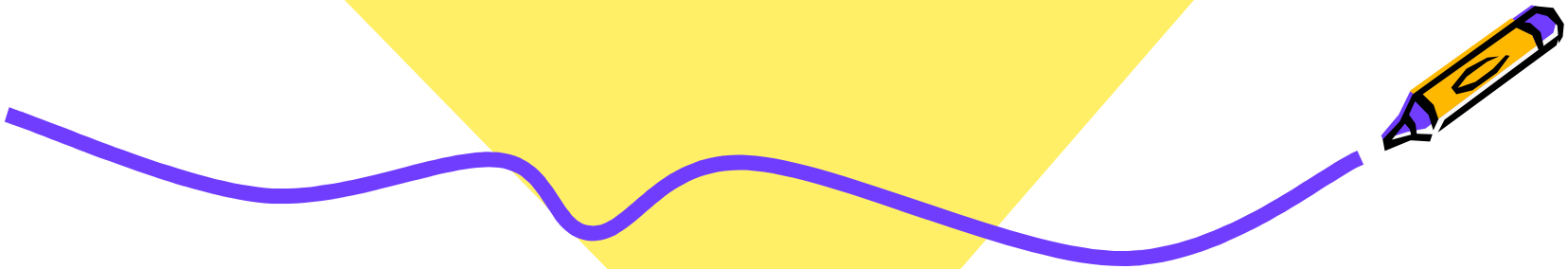
Cooling Water System



OBJECTIVE

To understand about

- the need for cooling system in a diesel engine
- the benefit of water cooling system
- Schematic diagram of water cooling system of WDM2 Locomotive
- Failures of water cooling system
- To avoid hot engine failure

Need for cooling system in a diesel engine

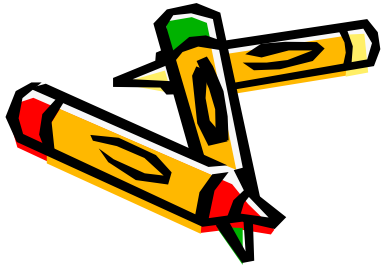
All **I.C. engines** are provided with a cooling system to cool the hot components to maintain uniform temp. throughout the engine.

- About 25-30 % of heat produced inside the cylinder is absorbed by the components surrounding the combustion chamber like piston, cylinder, cylinder head etc.
- Finally dissipate the excess heat to atmosphere to keep the engine temperature within suitable limits.

- Different cooling systems, like air cooling, water cooling are adopted, depending on the engine design, working conditions and service etc.

Benefit of water cooling system

- Different cooling systems, like air cooling, water cooling are adopted, depending on the engine design, working conditions and service etc.
- The advantage of having a water cooling system is that it maintains a uniform level of temperature throughout the engine.
- By controlling the water temperature, the engine temperature can be controlled effectively



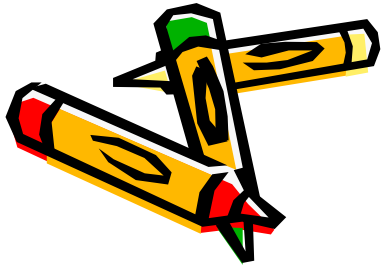
COOLING WATER AND ITS TREATMENT

Although natural water can meet the basic requirement its use is prohibited for the cooling of the engine because

- It contains many dissolved solids and corrosive elements.
- Dissolved solids may form scales on the heat exchanger surface and reduce the heat transfer coefficient.
- It also accelerates corrosion.
- Other minerals get collected in the form off sludge at an elevated temperature.
- This sludge may get deposited at the low-pressure zone and choke the passage of circulation.

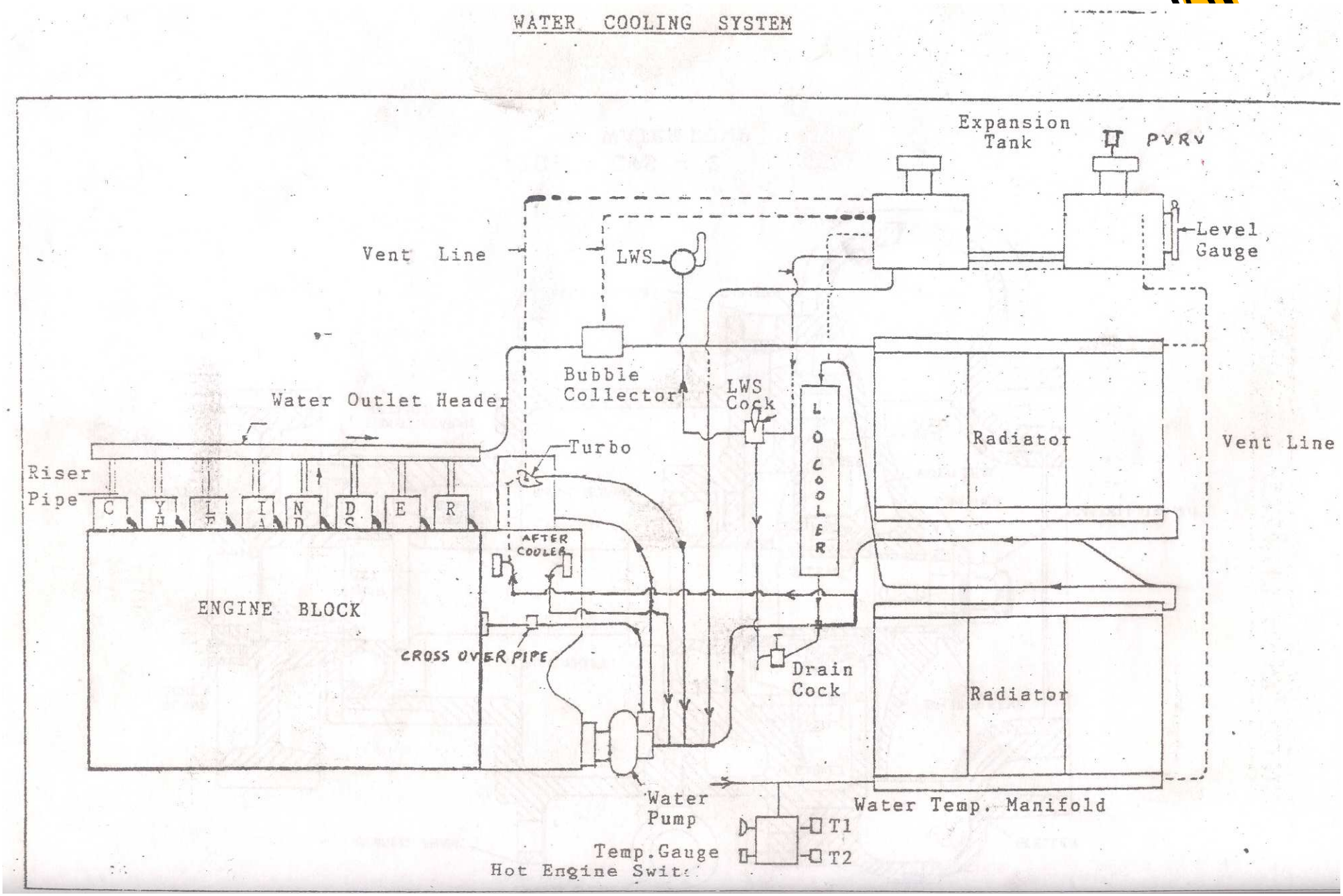
- The insulation caused by the scale deposits results in unequal expansion and localized stress, which may eventually rupture the engine block, cylinder block, cylinder heads etc.

- To eliminate all of these, distilled or de-mineralized water is used in the cooling system of the diesel locomotive.

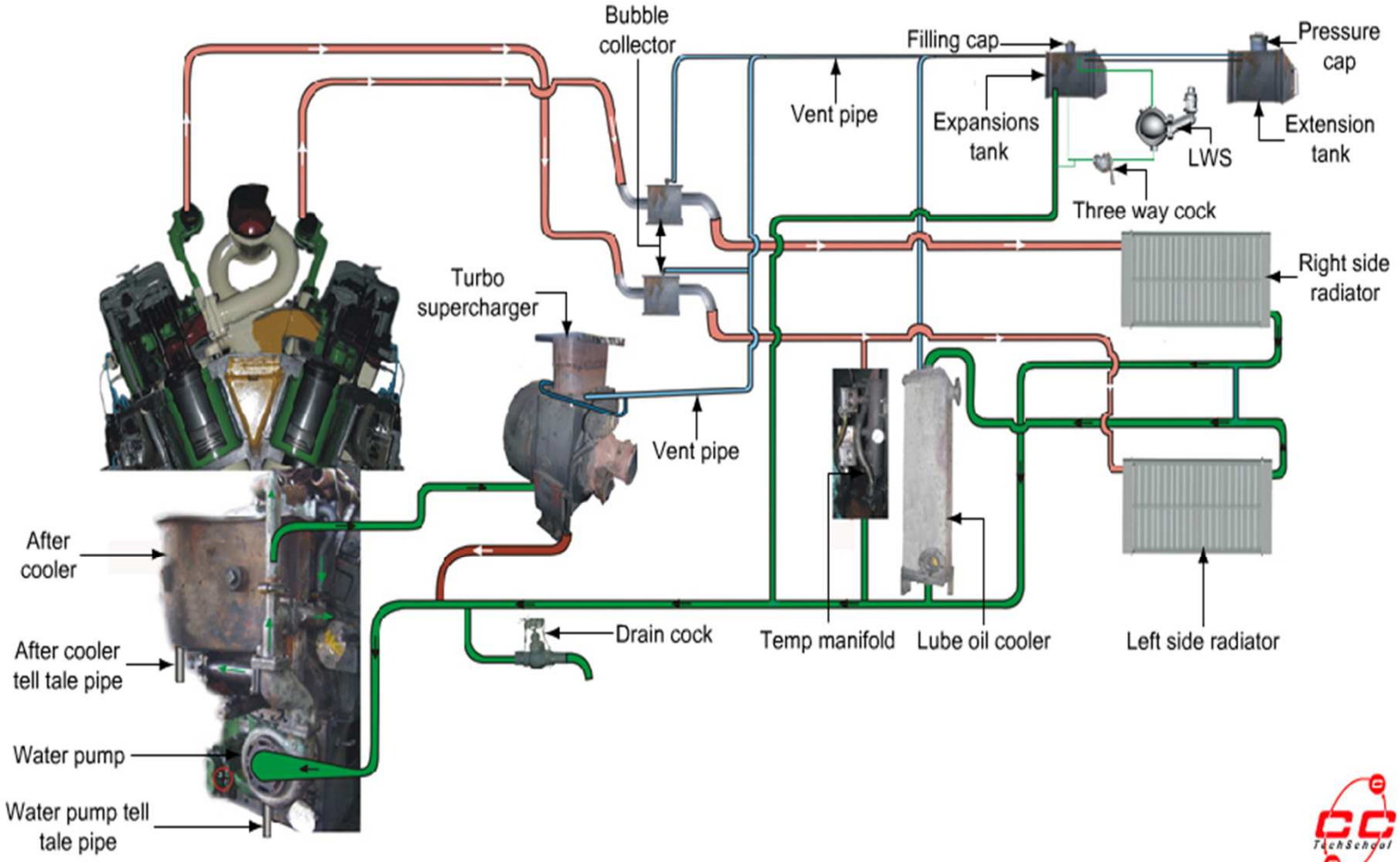


- The water sample is tested for hardness, pH value, and chloride content.
- Water is changed if hardness and chloride is higher than the recommended limit.
- Water is also changed if found contaminated with oil etc.
- When water is changed due to contamination etc. the system is cleaned by adding (TSP)Tri-Sodium Phosphate, and circulating water for 45min, this water is drained out, and fresh distilled water is filled in the locomotive.

Schematic Diagram of Cooling System



Cooling Water Circuit Diagram



water cooling system of WDM2 Locomotive

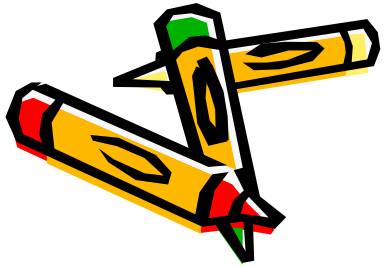
- The WDM2 class locomotives have a closed circuit pressurised water cooling system for the engine.

- The system is filled in by 1210 ltrs. Of distilled water or demineralised water treated with nonchromate corrosion inhibitor (Borate nitrite treatment) to maintain a con. of 4000 PPM.
- The pH value is '8.5-9.5'.

- The water circuit has two storage tanks in two segments known as expansion tanks on top of the locomotive.

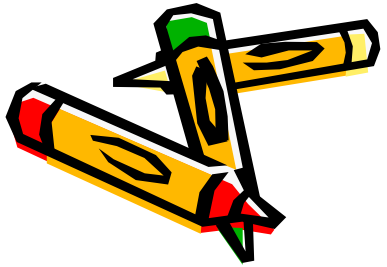
Main components for WCS

- 1. Water Pump
- 2. Right & Left Water jackets
- 3. Cylinder head, jumper & Riserpipes
- 4. TSC & Aftercooler
- 5. Right & Left Water header
- 6. Bubble Collector
- 7. Radiater cores
- 8. LUBE OIL COOLER
- 9. Water Tank
- 10. LWS



- A centrifugal pump driven by the engine crankshaft through a gear sucks water from the system and delivers it through outlet under pressure.

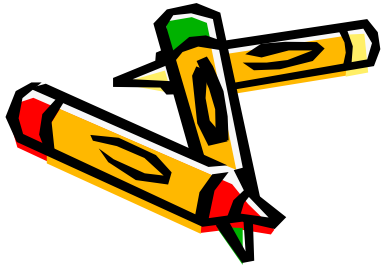
- The outlet of the pump has three branch lines from a three-way elbow



The branching off leads water to the different places as follows-

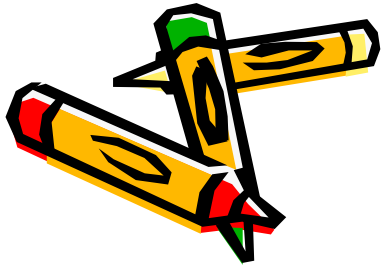
- First to the turbo-supercharger through a flexible pipe to cool the intermediate casing, bearings on both sides of the rotor and the turbine casing.

- After cooling the components in the turbo-supercharger, water return to the inlet side of the pump through a bubble collector, so that they cannot cause air lock in the water circulatory system.



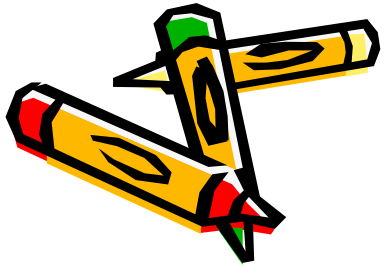
- The second line leads to the left bank of the cylinder block and water enter the engine block and circulates around the cylinder liners, cylinder heads on the left bank of the engine, and then passes onto the water outlet header.

- Individual inlet connections with water jumper pipes and outlet water riser pipes are provided to each cylinder head for entry and outlet of water from cylinder head to the water outlet header.



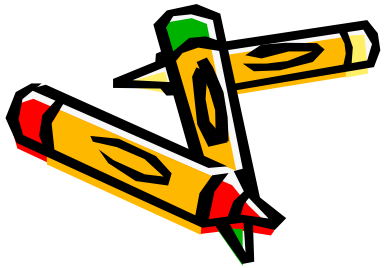
- Cooling of cylinder liners, piston rings, cylinder heads, valves, and fuel injection nozzles are done in this process.

- Water then proceeds the left side radiator for circulation through it, and releases its heat into the atmosphere to cool itself.

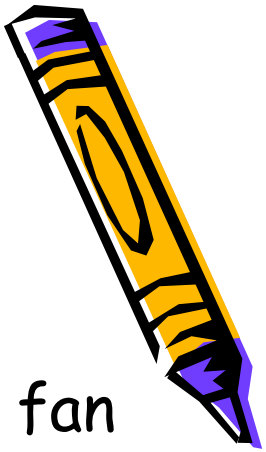


- The third connection from the three-way elbow leads to the right side of the cylinder block. After cooling the cylinder liners, heads etc.

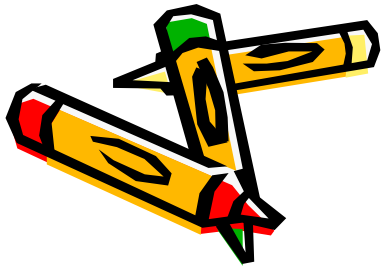
- Before it enters the radiator, a connection is taken to the water temperature manifold where a thermometer is fitted to indicate the water temperature.



Three temperature switches are also provided here, out of which

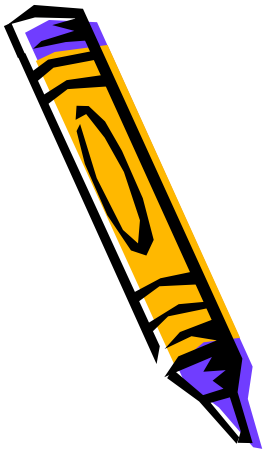


- **ETS1** is for starting the movement of radiator fan at 60O C slowly.
- **ETS2** picks up at a water temperature of 64O C and accelerates the radiator fan to full speed.
- **ETS3** (Engine Temperature Switch),set at 90 degree protection against hot engine, which gives bell alarm, red lamp indication & back to the idling speed and power cutoff also takes place to reduce load on the engine.



- 10. Cooling water from the left side radiator passes through the lube oil cooler and cooling the lube oil.
- 11. Cooling water from right side radiator passes through after cooler, where water circulates inside a bunch of element tubes and cooling the charge air.
- 12. Apart from hot engine protection, another safety is also provided by way of low water switch (LWS). In the event of cooling water level falling below one inch from the bottom of the tank, the LWS shuts down the engine.

MODIFICATIONS PERTAINING TO COOLING WATER SYSTEM OF WDM2 LOOMOTIVE



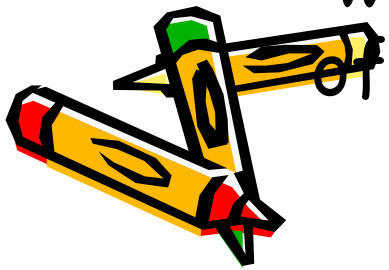
1. Louvred fin radiator
2. High efficiency turbochargers
3. Large after cooler & water connection
4. Revision of ETS setting
5. Pressurisation of cooling water system
6. Flexible water inlet elbow
7. Digital water temp.indicator cum switch
8. Electronic water level indicator cum switch
9. Improved type pipe joints

1. Louvred fin radiator: -

The radiator core has been redesigned by providing louvred fins thereby increasing the cooling capacity by 14% due to improved air flow pattern through the radiator.

2. High efficiency turbochargers:-

High efficiency turbochargers has been provided on the fuel efficient version of wdm2 locos. This has resulted in lowering of the exhaust gas temperature by around 15% with modified after cooler.



3.Large after cooler & water connection:- Large after cooler & water connection has been provided on the fuel efficient locos. This has reduced the heat input to the cooling system.

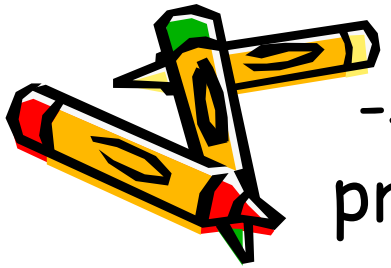
4.Revision of ETS setting :- The setting of ETS3 is raised to 90 deg.C from 85 deg.C in order to avoid frequent hot engine alarms. (One more ETS is added with the idea of providing only hot engine alarm through ETS3 at 90 deg. C and bringing the engine to idle by ETS4 at 95 deg. C.)

This change not only reduces the occurrences of hot engine alarm but also increases the heat transfer potential of the radiator at high temperature.

5. Pressurisation of cooling water system:- The cooling water circuit has been pressurised upto 7 psi thereby increasing the boiling point by 11 deg. C.

-> This has not only increased the margin before the cooling water gets converted to steam but has also increased the temperature differential acrossed the radiators at peak engine temperature, thereby increasing the rate of cooling in radiators.

-> This has been achieved by providing a pressure cap assembly on the water tank.



6. Flexible water inlet elbow:-

Rubber hose type flexible water inlet elbow has been developed in place of the rigid one piece metallic water inlet elbow for obtaining better leakproofness even in face of mislignments between the engine block and the cylinder head.

7. Electronic water level indicator cum switch:-

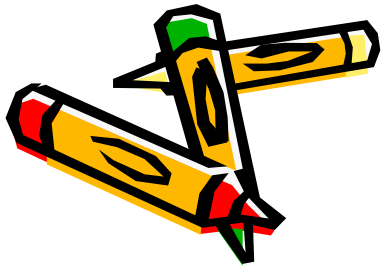
This has been developed to replaced the existing water level gauge as well as the low water switch.

8. Digital water temperature indicator cum switch:-

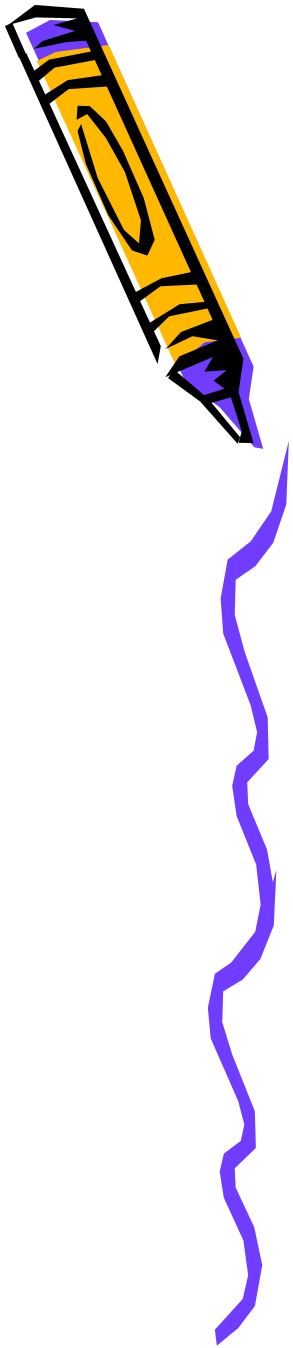
This has been developed to replace the existing water temperature gauge.

9. Improved type pipe joints:-

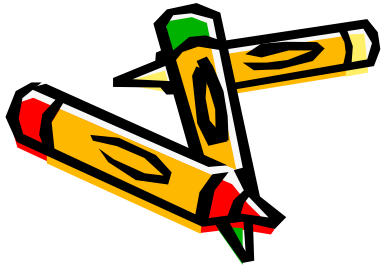
This has been improved to replace the existing pipe joints viz. dressers victaulics by superior rubber hoses along with double wire stainless steel clamps and by stainless steel bellows.



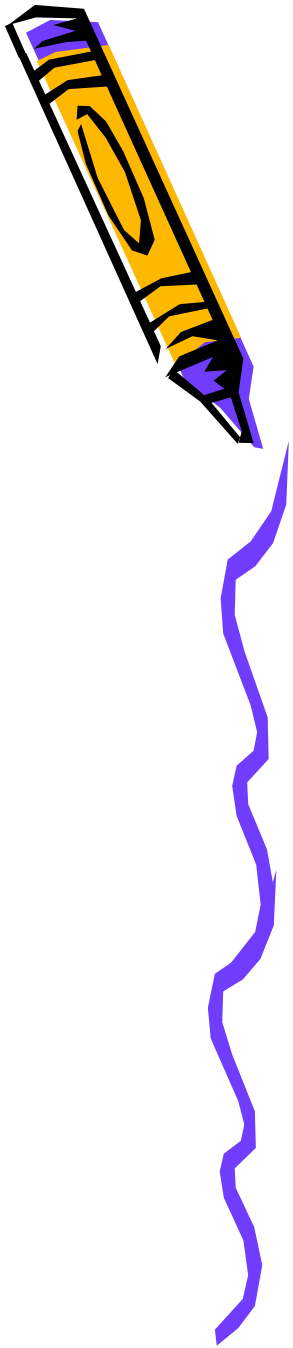
Failures of water cooling system



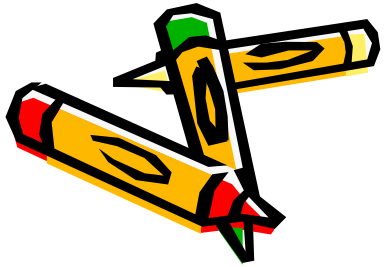
- 1. Defective of Water Pump
- 2. Water leakage through joints
- 3. RADIATORS Tubes brust
- 4. RADIATOR FAN assembly
- 5. Low Water Switch
- 6. Water Tank & Pressurization cap
- 7. Water Jumper Pipe Cap Screws
- 8.Thermal Loading
- 9. Water Overflow



To avoid hot engine failure



- 1. TSP Treatment
- 2. ETS Settings
- 3. RADIATORS CLEANING
- 4. Water pressurisation system
- 5. RADIATOR FAN and ECC
- 6. RADIATOR efficiency



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