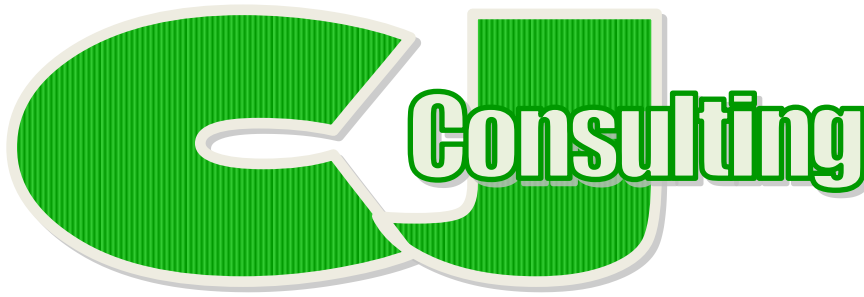


Appendix 4.7

Mirrlees Assessment Report



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Yukon Energy KV-16 August 2016 Inspection

Overview

Inspections were completed on WD3 and FD1.

Since the BC Hydro report of 2004, the two engines have been overhauled. Although in better condition, the engines still do not meet Yukon Energy's criteria for emergency standby and peaking. These engines are intended to run for longer periods of time at base load operation; not the present mode of operation. Testing the engines for one hour a month causes more wear and tear, thus requiring more maintenance than a continuous running engine.

These engines are over 45 years old and do not meet today's environmental emission standards. In the future, this may cost Yukon Energy a major capital investment to upgrade the exhaust system to meet today's standards.

WD3 KV-16

S/N 6444-1

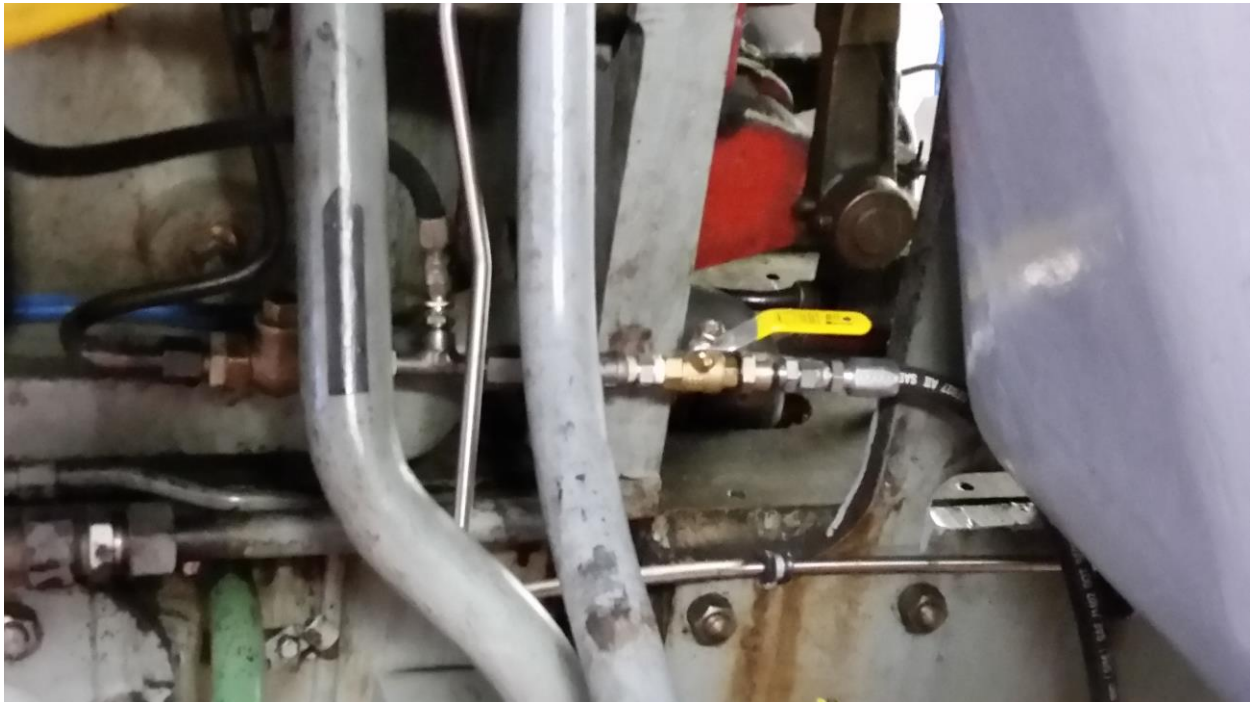
Engine Hours

Last Major Overhaul Completed: Sept 2008

Last Overhaul Hours 39040

Engine Test

The lubricating rocker pressure regulator was removed from WD2 to replace the manual valve that was installed at the last overhaul. This valve was found to be defective and the manual valve was reinstalled. (This regulator valve could not be sourced by MAN at the last overhaul.)



The engine did not start at first attempt; some fuel pumps were sticking.

All fuel pumps and linkage were oiled and racks freed.

All three engine air tank valves were opened to make one system (Operations say this is a common problem on starting).

Engine was started and ran on line up to 3.7 MW for one hour.

Engine started to overheat, jacket water cooling system was up to 200° F.

No alarm came on; **needs to checked.**

Aftercooler outlet temperature should be between 110° and 120° F with a maximum temperature of 125° F.

‘A’ bank was up to 150° F and the alarm came on.

‘B’ bank was running at 138° F with no alarm.

Concerns

The secondary cooling system uses untreated river water and the engine pipe work and valves look original and could be over 45 years old.

The overheating problem could also be restrictions in the pipe work due to 45 years of scale build up. The scale could also be blocking the plate type heat exchangers. Cleaning and inspections of the plate heat exchangers is a one to two-week job with parts.

The raw water pump may not be operating properly. There is also a possibility of a closed valve in the system due to WD1 and WD2 taken out of service.

There are only two pumps installed for cooling of engines, which are fed from the hydro plant. After the unit was taken off line, the operator switched over to the other pump.

The pump taken out of service should be checked to make sure it is operational.

The engine jacket water and valve cage cooling system ran on river water from installation until the last overhaul in 2006 when the engine cooling system was changed to anti-freeze.

Some erosion of both the block and liner lands was observed at the last overhaul due to the river water. The liner lands were filled with plastic steel.

Engine Internal Inspection

A visual inspection completed on the outside of the engine.

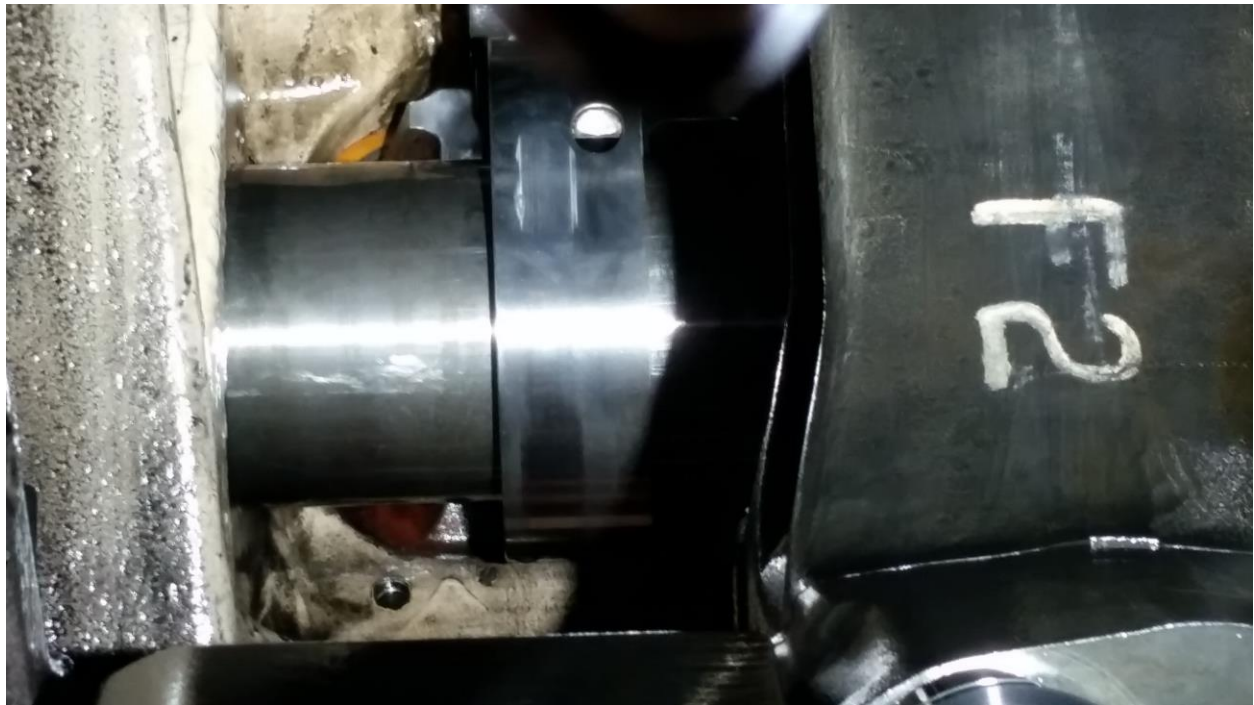
Doors 2, 4, 6 and 8 removed from 'A' bank side

Doors 1, 3, 5 and 7 removed from 'B' bank side.

Visual signs of B6 exhaust cam (K22448) picking up. B6 crankcase door was removed.

Unable to inspect further due to type of clearance on the unit.

Recommend removal of cam door for more detailed inspection. If the cam needs to be replaced, this job could take up to a month after the parts are sourced.



Bottom of cylinder liners that could be seen are showing signs of polishing.

The piston oil return still has the spay type return plugs installed.

The extent of the polishing is not known and can be caused by the short runs or the liners not properly honed at the time of the last overhaul.



If a piston needs to be removed, it could take anywhere from a week to a month after the parts are sourced depending on what is found.

Operations noted that the gear train is extremely noisy in the winter months, which could be caused by engine foundation movement. The original grout that is installed is prone to crumbling due to the type used at the time of installation.

Replacing the grout requires the complete strip down of the engine and removal of the generator to jack up the bed plate; this would run into millions of dollars and the engine out of service for a year or more and that's if all the parts can be sourced.

Recommend that crankshaft deflections be taken in beginning of spring, the middle of summer, fall, and the middle of winter to see if there is crankshaft and bedplate movement. Inter-gear clearances should be checked at the same time.
This job is about one week.

If a failure occurs of any the gears or inter-gear brackets, the engine will be out of commission for an extremely long time until the parts are made.

There was no overhaul report submitted to Yukon Energy from DEAS, so there is no record of tolerances (liners, piston grove clearances, gear backlash). This could have a major impact on future parts requirements, down time, and costs.

This engine has been down rated due to the generator having one coil isolated. Max load is 4.5 MW. Estimated cost to repair the generator is \$1 to 1.5 million with a down time of over six months.

Faro

Plant is kept in a clean and orderly manner.

FD1 KV-16

S/N 6451-1

Engine Hours: 247.5 on the hour meter

Last Major Overhaul Completed: Oct 2009

Hours at last Overhaul: 22277



Engine Internal Inspection

A visual inspection completed on the outside of the engine.

Doors 2 and 8 removed from 'A' bank side.

Doors 3 and 7 removed from 'B' bank side.

Engine inside was clean.

Liners that could be seen still had the cross hatch.

Engine Test

Engine remote started from Whitehorse and started first time.

Engine was loaded to 2 MW

Large amount of oil is getting into the exhaust system due to the wrong Fairchild Valves install. MAN supplied these valves, and were installed at the last overhaul.

The lubricating rocker pressure regulator was replaced with a manual valve at the last overhaul (this regulator valve could not be sourced at the last overhaul). With the engine being in auto start, the valve is left open causing oil to enter the cylinder liners through the valves.

Engine Concerns

Mechanical emergency over-speed and low lube oil pressure trip shutdown blocked with a wedge. It was found that the unit trips off when running.

This could have a catastrophic failure if there is a governor failure.

Misalignment of the tripping lever mechanism is caused by movement of the cylinder block.

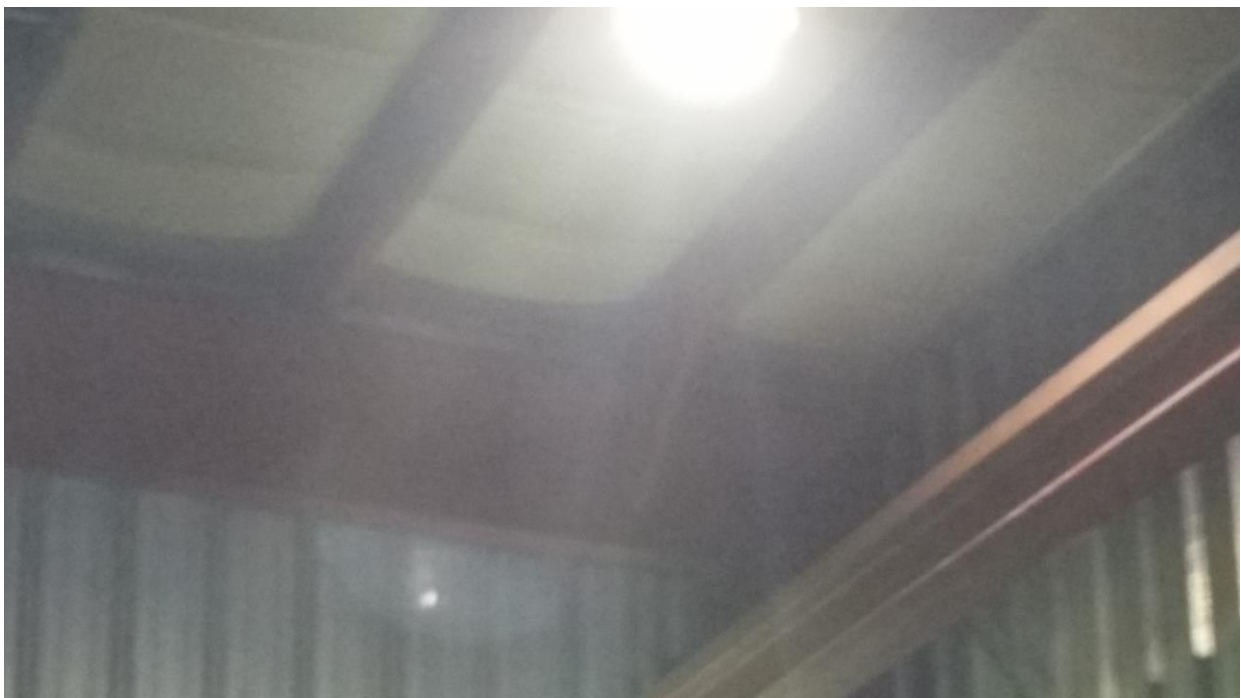
The mechanical overspeed trip and low lube pressure is now not operational and is relying on the electrical shut downs

Realignment of the tripping mechanism is needed; this could take up to a month to correct.



Heavy exhaust smoke fills the plant from oil in the exhaust pipes when starting the engine requiring operator evacuation.

Large amounts of smoke from the stacks drifts over the town on start up.



Recommendation

The cylinder head rocker lubrication valve should be closed when the engine is not running, requiring someone to be at site when starting the engine.

Fairchild valves for valve guide lubrication need changing to the correct ones. (WD2 valves checked for use on FD1, but they are also the wrong ones.)

Next Maintenance PM

Valves need resetting, exhaust has some blown gaskets need replacing, water manifold pipe needs the supports fixing,

Engine Common Failures

Jacket water leaks from the liner "O" rings. This is a minimum two-week job with the parts

Valve cage cooling water leaks. This is up to a week with parts

Catastrophic failures

Inter-gear brackets cracking, if this is not found will destroy the gear chain and possibly the engine. The problem is these brackets are no longer made and would be a special order or find a second hand one. (engine could be out of service could be over a year).

A failure to the piston crown will have the engine out of service for a long period, it could take more than a year to source parts to repair or it could destroy the engine beyond repair.

Conclusions

Mirrlees no longer exists as an engine manufacturer and is owned by MAN Diesel.

MAN, never informed Yukon Energy of the closure of the Ontario office or any procedure for purchasing parts.

These engines are over 45 years of age and Mirrlees-experienced service engineers are not stationed in Canada. This will have a higher cost to provide service engineers in the future.

Stocking of parts are no longer in Canada and delivery of parts in a timely manner and cost are a major concern.

Brown Boveri VTR turbo chargers for these engines are no longer made and no parts are stored in Canada. The only supplier I could find on line was aftermarket parts in Europe.

NTPC in Yellowknife had to salvage parts from Yukon Energy to finish their overhaul. Exhaust valve cages loaned to NTPC in Yellowknife took over three years to replace.

The use of aftermarket parts is not recommended, Yukon Energy tried this already and cost a lot of money for parts that did not meet Mirrlees specifications.

We tried to phone the Ontario service office for a time estimate for delivery of parts, only to find the office was closed

This is the contact information we were given for MAN was from NTPC:

Vancouver:

Najibul Ansari 1-604-365-4023 email: najibul.ansari@ca.man.eu

Riseley D'Souza [<mailto:Riseley.DSouza@ca.man.eu>]

Halifax:

Charlie Balogh 1-902-402-6445 email: charlie.balogh@ca.man.eu

24/7 emergency contacts:

Spare parts AUG engines: +49 821 322 1799

Spare parts TC: +49-821-322-4030

Spare parts 2 stroke engines: +45 4019 3501

Spare parts Holeby engines: +45 4014 4045

Technical Service AUG engines: +49 821 322 1499

Technical Service 2 Stroke engines: +45 2048 9440

Technical Service Holeby engines: +45 4014 4045

Technical Service TC (radial type): +49 821 322 4020

Technical Service TC (Axial type): +49 821 322 4010

Due to the age of the units, FD1 and WD3 are considered to be “end of life” and would require major work and operating methods to extend life. Even if this work is carried out equipment obsolescence will result in difficulty of obtaining parts at reasonable cost. The loss of OEM technical support compromises the life extension of these units. A major failure would result in an extended outage on the unit, and a cost prohibitive repair. YEC should replace the units.