IMCA Safety Flash 10/14

June 2014

This safety flash concentrates on one single issue - fires in engine room spaces – as there have been several such incidents reported recently.

1 Serious Engine Room Fire Whilst Divers in Saturation

A member has reported a very serious incident in which there was a fire in the engine room of an offshore vessel. The incident occurred whilst the vessel was alongside, but there were divers in saturation at the time. The incident happened when a leak of diesel fuel, under pressure, ignited at the secondary duplex fuel filter on an engine. Only one engine - main engine 1 on the port side was running at the time, supplying all vessel systems.

During routine maintenance work, the engineers became aware of flames near the exhaust or waste gate and at secondary fuel filter of the main engine that was running. An engineer attempted to get to an emergency stop location, but that moment the fire expanded explosively and within seconds engulfed the forward section of the engine in a ball of fire, and he was driven back, but managed to escape. Emergency procedures were followed including closing of valves, stopping of fans and engines and shutting of all watertight doors. The Hi-Fog Mist system was activated, and the fire was extinguished.

When the general fire alarm sounded, the Diving Superintendent was informed and all diving personnel were mustered. All the divers in saturation were transferred to the Hyperbaric Rescue Craft (HRC) and the transfer trunking was brought to surface. The seal on the HRC was confirmed. The dive system was switched to emergency power supply and the HRC made ready to launch. The crane was made ready to lift the HRC from the vessel if required. Once the situation was contained, the divers were able to return to the saturation complex to continue decompression. All divers completed their decompression without further issue.

Everyone escaped safely; no-one was injured. The fire had the potential to have caused multiple fatalities. There was serious fire damage to the port engine room and mezzanine deck level equipment and service wiring.

Our member wished to record that:

- The conduct and actions of the Chief Engineer, 1st Engineer and both 2nd Engineers were carried out quickly, professionally and as safely as possible, their actions and the speed of their response greatly reduced the significant potential of this very serious incident;
- The emergency response and swift actions of the Diving Superintendent, Diving Supervisors, Life Support Technicians and Divers demonstrated a professional and very competent response;
- The Vessel Master, Chief Mate, Offshore Manager and Client Site Representative all contributed professionally and very competently during this incident.

Figure 1: Typical fuel filter of the sort that failed

Figure 2: Failed fuel filter unit

Figure 3: Top of filter showing bolt hole and extruded O ring

Figure 4: Sheared bolt

Figures 5 and 6: Failed stud

Our members' investigation noted the following:

- With regard to the vessel and its crew:
  - The engine room personnel were very experienced, qualified and competent in the engineering processes and systems on-board the vessel
  - The vessel preventative maintenance system was well applied, actioned and documented and in many cases over and above scheduled requirements
  - The starboard engine room (undamaged) was found to be clean and very well maintained which provides an indication of the professionalism of the vessel engineers
  - The vessel had been in operation for four years. Fuel filter maintenance has been carried out in excess of stated requirements in order to cater for extended dynamic positioning (DP) operations.
- With regard to the failed equipment that was found to be the cause of the fire:
  - The Bollfilter Duplex Filter units had been in service since the vessel was commissioned in 2010
  - Detailed analysis of the failed stud showed that:
    - One of the three studs broke by high cycle low stress fatigue
    - One stud contained a short fatigue crack
    - The primary cause of cracking was insufficient preload tension in the studs due to insufficient tightening of the nuts
    - The stud was manufactured from good quality creep resistant steel;
- With regard to the fire itself:
  - Activation of the fuel quick closing valve(s) was undertaken but main engine 4 (which had been started as the burning engine was shut down) continued running;
- The **immediate cause** of the incident was found to be:
  - One of the three filter housing cover stud bolts failed by high cycle, low stress fatigue as a result of insufficient pre-load tension in the studs due to insufficient tightening. This led to a loss of pressure integrity of the filter housing and the 'O' ring seal was extruded through the housing/lid interface. This allowed fuel at pressure to spray onto a turbo charger exhaust manifold, causing a fire;
- The **underlying causes** of the incident were found to be:
  - Filter unit in line and in close proximity to the engine turbo charger exhaust (750mm)
  - Failed stud in direct line of engine turbo charger exhaust
  - No physical barrier between the fuel filter and the potential ignition source of the engine turbo charger exhaust. The cladding around the exhaust does not provide 100% cover

- No local fuel shut off valve in close proximity to the forward engine space and areas where personnel may be present or at access/exit location
- No local Hi-Fog Water Mist activation facility in the forward engine bay in the vicinity of the access way to the engine room
- Fuel shut off valve was a considerable distance from the engine bay and the vicinity of the fuel supply;

- The **root causes** of the incident were found to be:
  - Lack of stud bolt torque information available from either the vessel planned maintenance system or the filter manufacturers documentation
  - Vessel design: Fuel system location in close proximity to systems at auto-ignition temperatures
  - Vessel design: limited mitigation and recovery systems in the event of a fuel related event with personnel working in the engine room.

Our member took the following actions:

- Immediate full visual inspection of all stud bolts in all other fuel filter units;
- Replaced all studs in filter assemblies and tightened sufficiently to attain pre-load tension. Supplied information back to the fuel filter manufacturer such that torque settings were provided and included in the manual;
- Fire retardant blankets were placed over remaining in-service filter housing in an attempt to prevent a similar event from occurring.

Our member took the following recommendations:

- Fuel supply system:
  - Review the design of the secondary duplex fuel filter locations to assess if the filter housings could be re-located away from the vicinity of the turbo changer exhaust manifolds for each engine. If the filters were able to be re-located in compliance with technical considerations, relocate to a position away from the engine exhaust manifolds and other extreme heat sources
  - There were no physical barriers between the secondary duplex fuel filter housing and the engine turbo charger exhaust manifold. Provide physical barrier between the filter housing and all surfaces with a potential temperature at or above auto-ignition temperature to prevent fuel being sprayed towards the auto-ignition heat source;
- Response to an engine room fire;
- Provide for local fuel shut-off facility at the forward end of each engine if technically feasible. Position should be at, or close to the exit of the engine room:
  - Provide for Hi-Fog Water Mist activation in each access way of the port and starboard engine room exit area if technically feasible. Position should be at, or close to the exit of the engine room
  - Fuel Emergency Shut-off systems - Investigate further the action of the Quick Closing fuel shut-off valves, as the activation of the quick closing shut-off valves did not starve all engines of fuel. When activated, main engine 4 continued to run.

This incident forms part of an IMCA Safety Flash dealing solely with incidents concerning fires in engine room spaces. However, members may wish to refer to the following incident, reported by the Marine Safety Forum, which had the exact same cause – shearing of bolts allowing fuel to leak onto a hot surface, causing a fire. (key words: *bolt, sheared, fire*).

- IMCA SF 12/11 – Incident 8: *Engine Room Fire on Offshore Vessel*

2 Fire in Engine Room on Platform Supply Vessel

A member has reported an incident in which there was a fire in the engine room on a platform supply vessel. The vessel was on its way to port from an oil platform, when it was decided on board to run a full power test on the propulsion system which included running all five diesel generators. This is a normal routine conducted on board approximately every month according to the vessel's planned maintenance system.

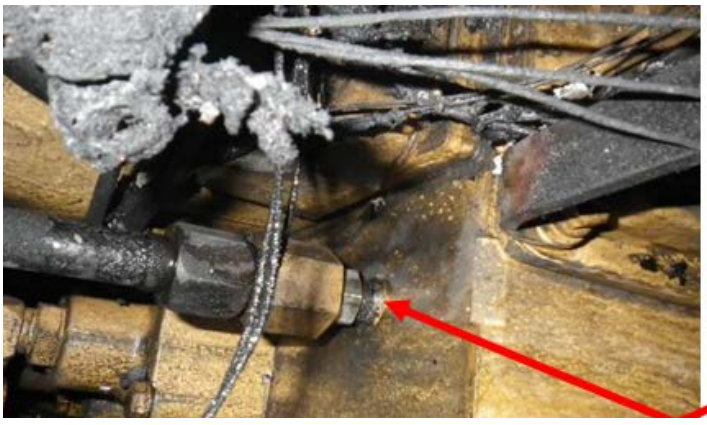
Subsequently the fire alarm was sounded on the bridge. The bridge called the engine control room. The chief engineer was in the engine control room where he already had started to prepare for the full power test. When the bridge called, he had already detected a fire located at diesel generator number 5 and confirmed this to the bridge. At the same moment he manually released the 'flexi fog' fire extinguishing system above the generator and started to shut down the propulsion

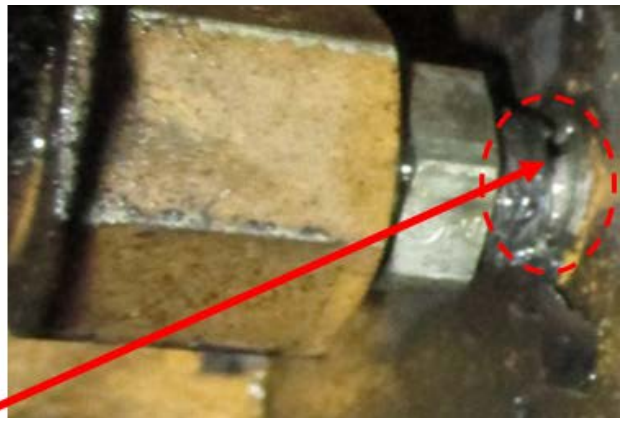
engines. In the meantime the crew attended their muster stations and prepared themselves according to the vessel's Emergency Plan.

After a short time the fire appeared to be extinguished by the 'flexi fog' fire extinguishing system. The Master decided to send down members of the crew wearing breathing apparatus (BA) sets. Initially this was not possible owing to smoke and fumes, but once the smoke and fumes had cleared they were able to enter. When they arrived at the fire area they discovered small flames above the generator which were rapidly extinguished using a fire hose.

Whilst there were no injuries, there was significant damage caused by the fire. A lot of power and signalling cabling was destroyed, resulting in the vessel losing propulsion and manoeuvring ability. A tug boat was ordered and the vessel was towed to a shipyard for repairs. This resulted in six weeks off hire for the vessel.

Figures 7 and 8: showing damage to the engine room following the fire





Figures 9 and 10: showing the broken nipple on the lubrication oil pipe which led to the oil leakage

Our members' investigation revealed the following:

- The **direct cause** of the fire was discovered to be a broken lubrication oil pipe fitting leading from the generator's engine block to a lubricating oil cyclone filter. This had resulted into an oil mist spraying out from the broken pipe. This oil mist was ignited by a source on the diesel generator or near by the generator;

- The **root causes** of the fire were determined to be:
  - **Design weakness** - The piping arrangement of the lubrication system had a weakness on a pipe nipple which resulted in to an oil leakage
  - **Location of the smoke/fire detectors** – When two of the fire detectors were activated the 'flexi fog' should automatically be released. It was considered that this did not occur because the fire was not detected by one of detectors above the generator - due to a poor location.

Our member took the following corrective actions:

- The oil cyclone filter and associated piping was removed and the lubrication oil pipe connection on the engine block permanently blanked off. This was done after the manufacturer of the engine was consulted about the necessity of the lubrication oil cyclone filter;
- The location and direction of the existing fire detectors was adjusted;
- Additional fire detectors were installed in the engine room to ensure enhanced fire monitoring and detection.

Engine room fires form a recurring theme in IMCA safety flashes. Typically the root causes of such fires are failures in house-keeping or planned maintenance, or failure to recognise fire hazards and address risks. Members may wish to refer to the following similar incidents (key words: *engine, room, fire):*

- IMCA SF 08/03 – Incident 4: *Cracked fuel line results in engine room fire*;
- IMCA SF 10/05 – Incident 2: *Engine room fire*;
- IMCA SF 12/11 – Incident 8: *Engine room fire on offshore vessel*;
- IMCA SF 05/13 – Incident 6: *Pressure switch location: fixed fire suppression systems.*

3 Fire in Engine Space on CTV (Crew Transfer Vessel)

An incident has been bought to IMCA's attention in which there was a small fire in the starboard engine space on a crew transfer vessel used in the offshore wind farm sector. The incident occurred when on passage to an offshore wind farm. Shortly after leaving port, the fire alarm was activated in the starboard engine. Dark smoke was observed coming from the drain hole in the after inspection hatch of the starboard engine. On the CCTV into the engine space there was no indication of flames.

The starboard engine was shut down and full fire procedures were carried out. The CO_2 system was also used, however on inspection after the incident it was found that the system had not deployed. Shore authorities were alerted and the vessel returned to port on one engine. All staff were safely landed ashore and the fire confirmed to be extinguished.

Investigation of the **fire** revealed the following:

- Normal checks on the engines and inspection of the engine and jet spaces had been carried out before the voyage, and all was found to be in order;
- The **immediate cause** of the fire was a rubber drain hose from a hatch combing catching fire as it was in contact with the exhaust system;
- Although the drain pipe was heat resistant and the main engine exhaust was covered in thermal insulation, the drain pipe was badly positioned, crossing over the exhaust system;
- The flames from the burning pipe were extinguished by oxygen starvation as a result of the shutdown of the engine fans and ventilators. The CO_2 smothering system was not actually deployed.

The following actions were taken with regard to the fire:

- Drain pipe on both engines replaced with a suitable thermally protected pipe which was run clear of any possible exposure to damage from the exhaust system;
- A general focus on pipe inspections was produced and circulated;
- Fire drills and specific vessel training to be updated to reflect lessons learnt from this incident.

Investigation of why the **CO_2 system** did not deploy revealed the following:

- The valve to the engine space had not been opened;
- The pin had not been removed from the valve head;

- A brass lever had been forced in the wrong direction causing it to shear;
- The instructions for the activation and effective use of the CO_2 system were not adequate to purpose;
- They were located on the external surface of the drop down access door;
- They are not readily visible to crew operating the system;
- They did not highlight the need to remove the safety pin on the activation lever of the cylinder;

The following actions were taken with regard to the failure to deploy the CO_2 smothering system:

- Better and more detailed operating instructions issued to vessels with similar CO_2 smothering systems – including pictorial instructions for use;
- Ensured that all crew members were fully conversant with the fixed fire fighting system fitted to the vessel and how to operate that fire fighting system.

Figure 11: Drain hole from which smoke was sighted

Figure 12: Scorched drain pipe which was immediate cause of fire

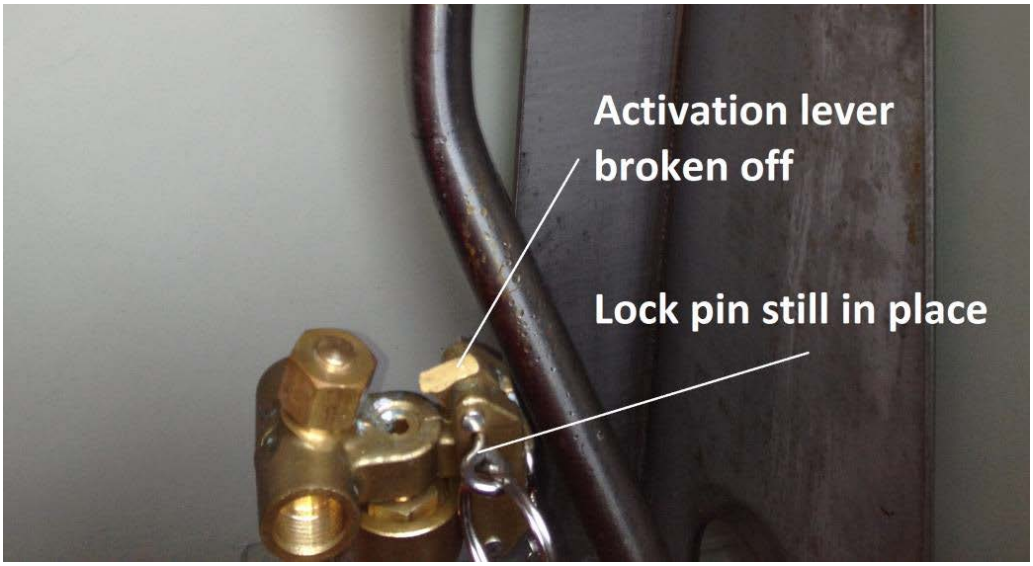


Figure 13: The activation lever on the starboard cylinder was broken off but the cylinder had not been activated

Figure 14: Both selector valves to the port and starboard engine were in the closed position

Members may wish to refer to the following similar incidents (key words: engine, space, fire):

- IMCA SF 08/03 – Incident 4: *Cracked fuel line results in engine room fire;*
- IMCA SF 10/05 – Incident 2: *Engine room fire*;
- IMCA SF 05/13 – Incident 6: *Pressure switch location: fixed fire suppression* systems.

4 Engine Room Fire

The Marine Safety Forum has published the following safety flash regarding an incident in which a fire occurred in an engine room space. The result was a blackout situation, a temporary loss of propulsion and damage to engine room equipment, wiring etc. There were no injuries or environmental impact sustained due to this incident, however the potential for a less favourable outcome was present.

The safety flash can be downloaded from www.marinesafetyforum.org/upload-files//safetyalerts/msf-safety-flash-14.28.pdf.

This incident forms one of a number which have occurred recently which have been collected together and issued as one single IMCA Safety Flash.

Members may wish to refer to the following similar incidents (key words: *engine, fire*):

- IMCA SF 08/03 – Incident 4: *Cracked Fuel Line Results in an Engine Fire*;
- IMCA SF 10/05 – Incident 2: *Engine room fire;*
- IMCA SF 12/11 – Incident 8: *Engine room fire on offshore vessel.*