Shipboard Experiences with Low Sulfur Distillate Fuel Oil

Unintended Consequences

PREPARED BY:
Maritime Safety Unit
Jeff Cowan
Mike Coyne
ARB Fuel Rules
Effective July 1, 2009

- Fuel required for ship’s main and auxiliary diesel engines, & auxiliary boilers
  - Marine Gas Oil (MGO) at or below 1.5% Sulfur
  - Marine Diesel Oil (MDO) at or below 0.5% Sulfur
- When operating within 24 miles of CA coastline
Summary

Loss of Propulsion (LOP) Incidents
# LOSS OF PROPULSION INCIDENTS

**2004 – 2010**

*(as of Oct 1, 2010)*

<table>
<thead>
<tr>
<th>Port</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
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<tbody>
<tr>
<td>San Francisco</td>
<td>15</td>
<td>11</td>
<td>10</td>
<td>10</td>
<td>12</td>
<td>37</td>
<td>17</td>
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<tr>
<td>Los Angeles / Long Beach</td>
<td>8</td>
<td>12</td>
<td>6</td>
<td>14</td>
<td>14</td>
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<td>San Diego</td>
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<td><strong>Total per year</strong></td>
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<td><strong>25</strong></td>
<td><strong>20</strong></td>
<td><strong>24</strong></td>
<td><strong>26</strong></td>
<td><strong>67</strong></td>
<td><strong>30</strong></td>
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### Monthly Totals in 2009

<table>
<thead>
<tr>
<th>Month</th>
<th>Total LOPs</th>
<th>Fuel Switching Related</th>
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<tbody>
<tr>
<td>Jan – June 2009</td>
<td>21</td>
<td>9</td>
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<tr>
<td>Jul-09</td>
<td>13</td>
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<td>Sep-09</td>
<td>9</td>
<td>5</td>
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<tr>
<td>Oct-09</td>
<td>8</td>
<td>3</td>
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<tr>
<td>Nov-09</td>
<td>3</td>
<td>2</td>
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<tr>
<td>Dec-09</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>67</strong></td>
<td><strong>33</strong></td>
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</table>
## LOSS OF PROPULSION INCIDENTS

### Monthly Totals in 2010

<table>
<thead>
<tr>
<th></th>
<th>Total Loss of Propulsion Incidents</th>
<th>Loss of Propulsion - Fuel Switching Related</th>
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</thead>
<tbody>
<tr>
<td>Jan-10</td>
<td>5</td>
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<tr>
<td>Feb-10</td>
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<td>Mar-10</td>
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<tr>
<td>Apr-10</td>
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<tr>
<td>May-10</td>
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<tr>
<td>Jun-10</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Jul-10</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Aug-10</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Sep-10</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>30</td>
<td>6</td>
</tr>
</tbody>
</table>
LOP - LSDFO Related Engine Effects

1. LSDFO Inherent lower viscosity
2. Low sulfur content (lower lubricity)
3. Temperature variance between fuels {HFO 150C (302F) vs. LSDFO 40C (104F)}
LOP – LSDFO Related

LOP Preliminary Common Threads

- Engine temperature increase (pistons/cylinder)
- Poor engine performance / stall outs at low RPM
- Insufficient fuel oil pump pressure
- Fuel system leaks (internal/external)
- Fuel pump malfunctions and wear
- Poor / failure of engine to operate in astern mode
Engine Issues
Engine Problems with LSFDO

- Difficulty finding fuel with sufficient viscosity.
  - Heat effects viscosity.
  - Marine Gas Oil (MGO) 2cst @ 40°C (104°F) = 1.7cst @ 50°C (122°F).
  - Minimum engine viscosity specs 2cst.

- Long term engine deterioration.
- Complex switching procedures.
- Ships not responding to speed or failing to start.
San Francisco Bay Area Concerns

- An LOP could result in a marine accident
  - Discharge of oil from a ship allision with a bridge, collision with another ship or grounding.

- Ecologically and politically sensitive region
  - Environmentally sensitive estuary system
  - Three National Marine Sanctuaries offshore
  - Key part of the Pacific Flyway
  - 2007 “COSCO BUSAN” oil spill
  - 2009 “DUBAI STAR” bunker oil spill
New Voluntary Western Traffic Lanes for LALB HARBOR
LA/LB Concerns

- Vessel traffic congestion south of Channel Islands
  - Vessels opting to transit west/south of the Channel Islands and not via Santa Barbara Channel to/from LALB

- US Navy concerned with increased traffic through the pacific missile test range west of Channel Islands
2012 ECA
200 Mile Limit

Course Line, Arrival LALB
What We Don’t Want!
When Fuel Injectors Leak, Fire Hazards Exist
Fuel Pump Diagram

Failing “O” Rings

Fuel Pump Leaks
Engine Damage / Limitations

Close Up View Of Piston Damage
Fuel Pump Plungers

Causes problems on 4-st engines as the clearance inside the pumps are much smaller.

Note The Lacquering
Normal Healthy Piston
Calcium build up due to LSDFO from additive in cylinder lube oil
Cylinder Liner Damage

"Stepping"
Crankcase Doors
Findings / Solutions - Recommendations

- Improper Governor Pre-set Speed
- Setting or Binding of the Fuel Rack
- Check pre-set governor speed setting
  - Pressure may be set too low or for too short a time period.
Findings / Solutions - Recommendations

- Insure no binding in the fuel pumps, rod connections, or bearings.
- Failure to start may be associated with insufficient fuel delivery.
- If engine fails to start on Bridge Control:
  - Switch to the Engine Control Room
Switching to Engine Control Room or Engine Side

- May allow the engine to start in some instances

- Until the starting characteristics of the engine on MGO (light distillate) are proven:
  - When going astern, transfer control to the engine control room.
  - Engineers can increase the starting fuel setting if the engine does not start on the first attempt.
FATIGUE!
Arrival San Francisco – Rest Periods

20 hr work day for the Chief Engineer

- **0500 Hrs - ETA San Francisco Pilot Station (SFPS)**
- 2200 Hrs - Call CE & Duty Eng. Prepare for Fuel Switch
- 0000 Hrs - Fuel switch starts
  - 150°C to 40°C Temp reduction at 2°C per minute
- **0110 Hrs - Fuel Switch complete, CPA CA 24 NM**
  - Enters ARB zone proceeding at reduced RPM.
- **0500 Hrs - Arrival - SFPS**
Part II  Arrival San Francisco – Rest Periods

20 hr work day for the Chief Engineer

- 0730 Hrs - All Fast to berth
- 0800 Hrs - Cargo commences. Bunker barge alongside
- 0900 Hrs - Commence taking bunkers
- 1700 Hrs - Bunkers complete
- 1800 Hrs - Sign off bunkering paperwork
- ETD – 0500 Hrs
Article 5

1. The limits on hours of work or rest shall be as follows:
   - (a) maximum hours of work shall not exceed:
     - (i) 14 hours in any 24-hour period; and
     - (ii) 72 hours in any seven-day period or;
   - (b) minimum hrs of rest shall not be less than:
     - (i) ten hours in any 24-hour period; and
     - (ii) 77 hours in any seven-day period.
OSPR’s Concern
Increase risk for an oil spill
due to higher rates of
Loss of Propulsions incidents
Data Sources

- USCG District 11
- USCG Sector San Francisco
- USCG Sector Los Angeles / Long Beach
- USCG San Diego
- The Marine Exchange of Southern California
  - VTS LA/LB
- Wartsila
- MAN B&W
- Larry Korwatch, CE Ret. MEBA
- Pilot organizations of San Francisco, Los Angeles & Long Beach
- Rob Jackson, CE Ret. California Maritime Academy
- APL Maritime, LTD
- Hans Mueller, MTD