

# Shipboard Experiences with Low Sulfur Distillate Fuel Oil



## Unintended Consequences

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# ARB Fuel Rules

## Effective July 1, 2009

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- 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)

<i>Port</i>	<i>2004</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>
<b>San Francisco</b>	15	11	10	10	12	37	17
<b>Los Angeles / Long Beach</b>	8	12	6	14	14	28	10
<b>San Diego</b>	0	1	3	0	0	0	2
<b>Santa Barbara</b>	0	1	0	0	0	2	1
<b>Humboldt</b>	0	0	1	0	0	0	0
<i>Total per year</i>	23	25	20	24	26	67	30

# LOSS OF PROPULSION INCIDENTS

## *Monthly Totals in 2009*

Month	Total LOPs	Fuel Switching Related
Jan – June 2009	21	9
Jul-09	13	6
Aug-09	8	4
Sep-09	9	5
Oct-09	8	3
Nov-09	3	2
Dec-09	5	4
<b><i>Totals</i></b>	<b><u>67</u></b>	<b><u>33</u></b>

# LOSS OF PROPULSION INCIDENTS

## *Monthly Totals in 2010*

	Total Loss of Propulsion Incidents	Loss of Propulsion - Fuel Switching Related
Jan-10	5	1
Feb-10	3	0
Mar-10	3	2
Apr-10	2	0
May-10	4	0
Jun-10	2	0
Jul-10	3	2
Aug-10	1	0
Sep-10	7	1
<i>Totals</i>	<i>30</i>	<i>6</i>

# LOP - LSDFO Related Engine Effects

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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

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## ➤ **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

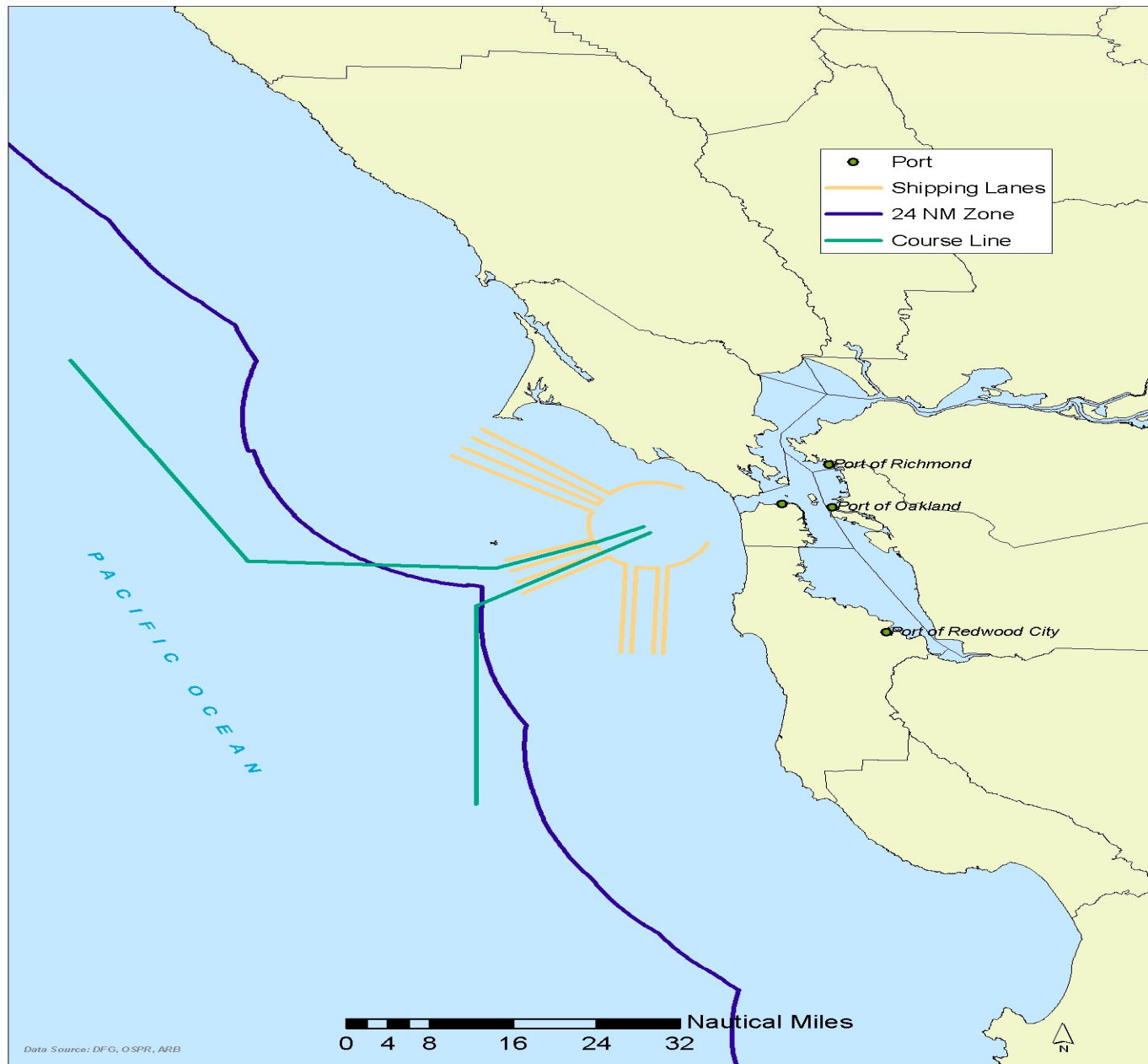


# Engine Problems with LSFDO

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- Difficulty finding fuel with sufficient viscosity.
  - Heat effects viscosity.
  - Marine Gas Oil (MGO) 2cst @ 40C(104F) = 1.7cst@50C(122F).
  - Minimum engine viscosity specs 2cst.
- Long term engine deterioration.
- Complex switching procedures.
- Ships not responding to speed or failing to start.



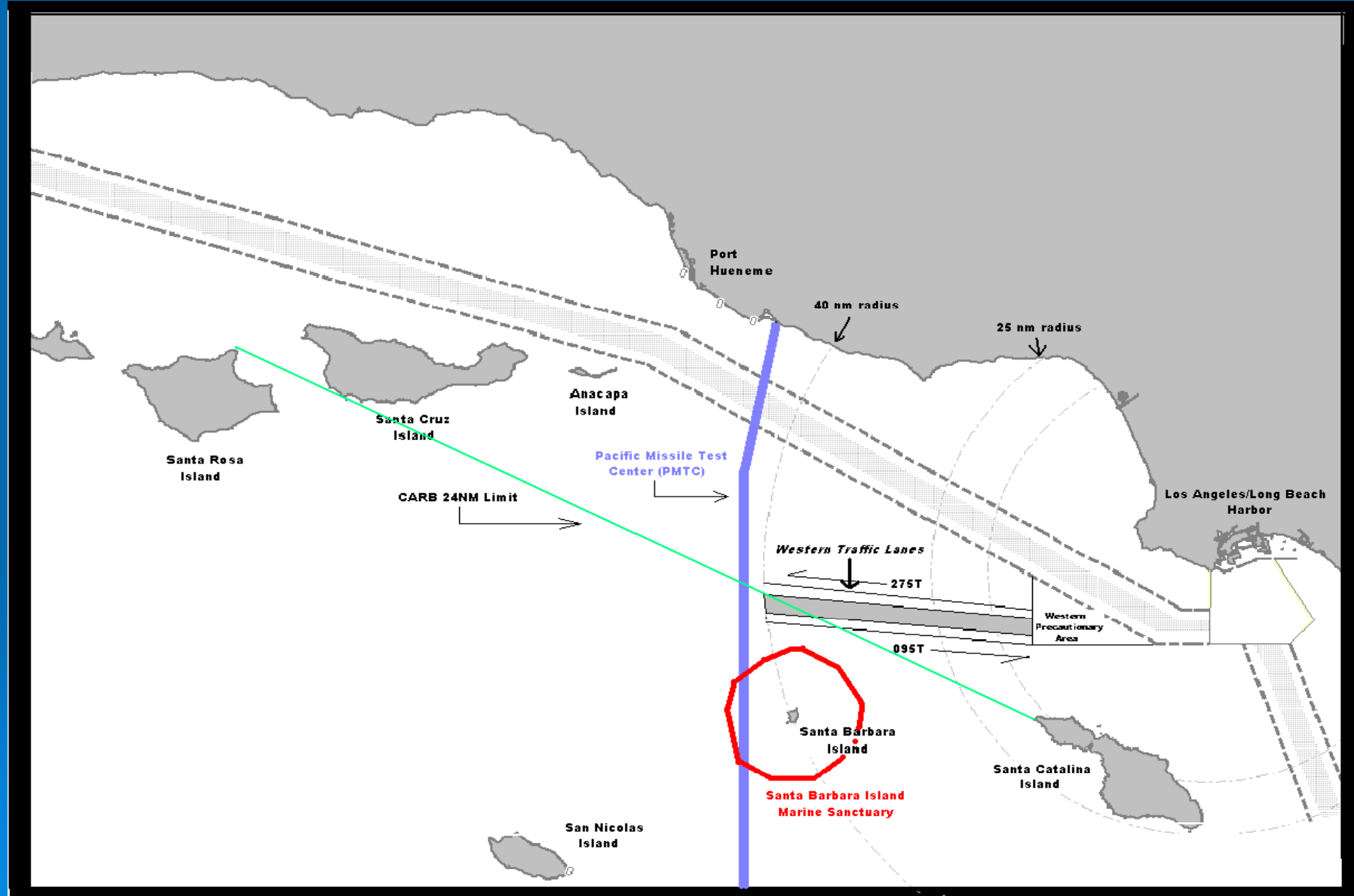


# San Francisco Bay Area Concerns

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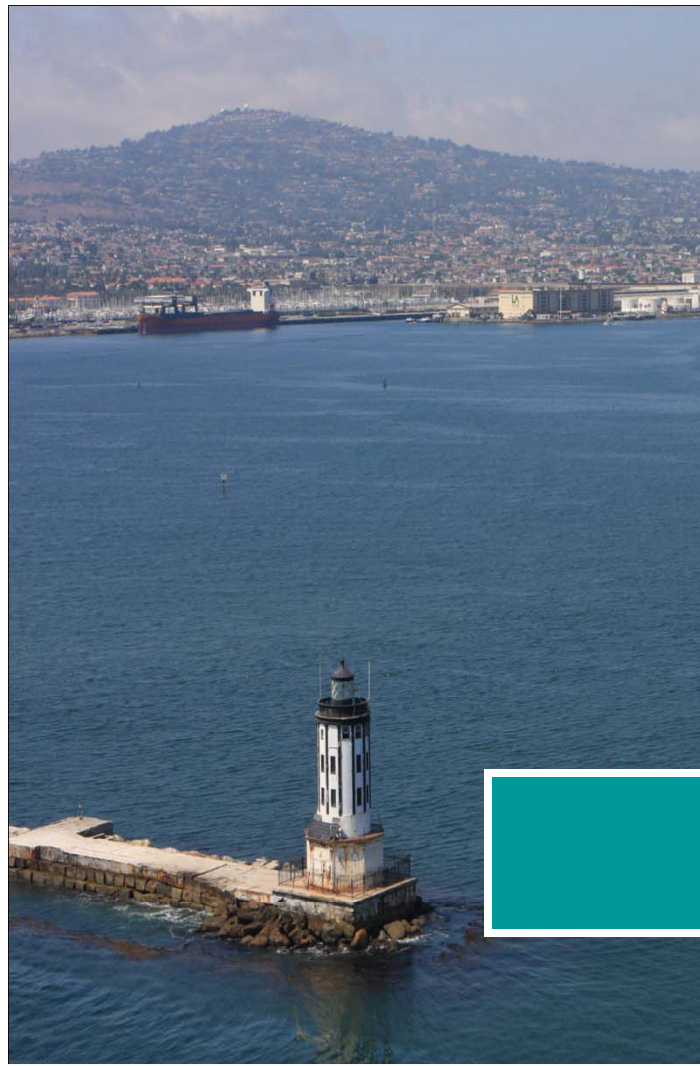
- An LOP could result in a marine accident
  - Discharge of oil from a ship allision with a bridge, collision with another ship or grounding.
- Ecologically and politically sensitive region
  - Environmentally sensitive estuary system
  - Three National Marine Sanctuaries offshore
  - Key part of the Pacific Flyway
  - 2007 “COSCO BUSAN” oil spill
  - 2009 “DUBAI STAR” bunker oil spill

# New Voluntary Western Traffic Lanes for LALB HARBOR





# Long Beach



# Los Angeles

# LA/LB Concerns

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- 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





A map showing the 2012 ECA 200 Mile Limit. The map features a light blue shaded area representing the Exclusive Control Area (ECA) and a red line representing the 200-mile limit. A black line with two dots and an arrow points to the red line, labeled 'Course Line, Arrival LALB'. A teal oval with a black border contains the text '2012 ECA 200 Mile Limit' and a teal arrow points from it to the red line. The map is framed by a thick blue border.

**2012 ECA  
200 Mile Limit**

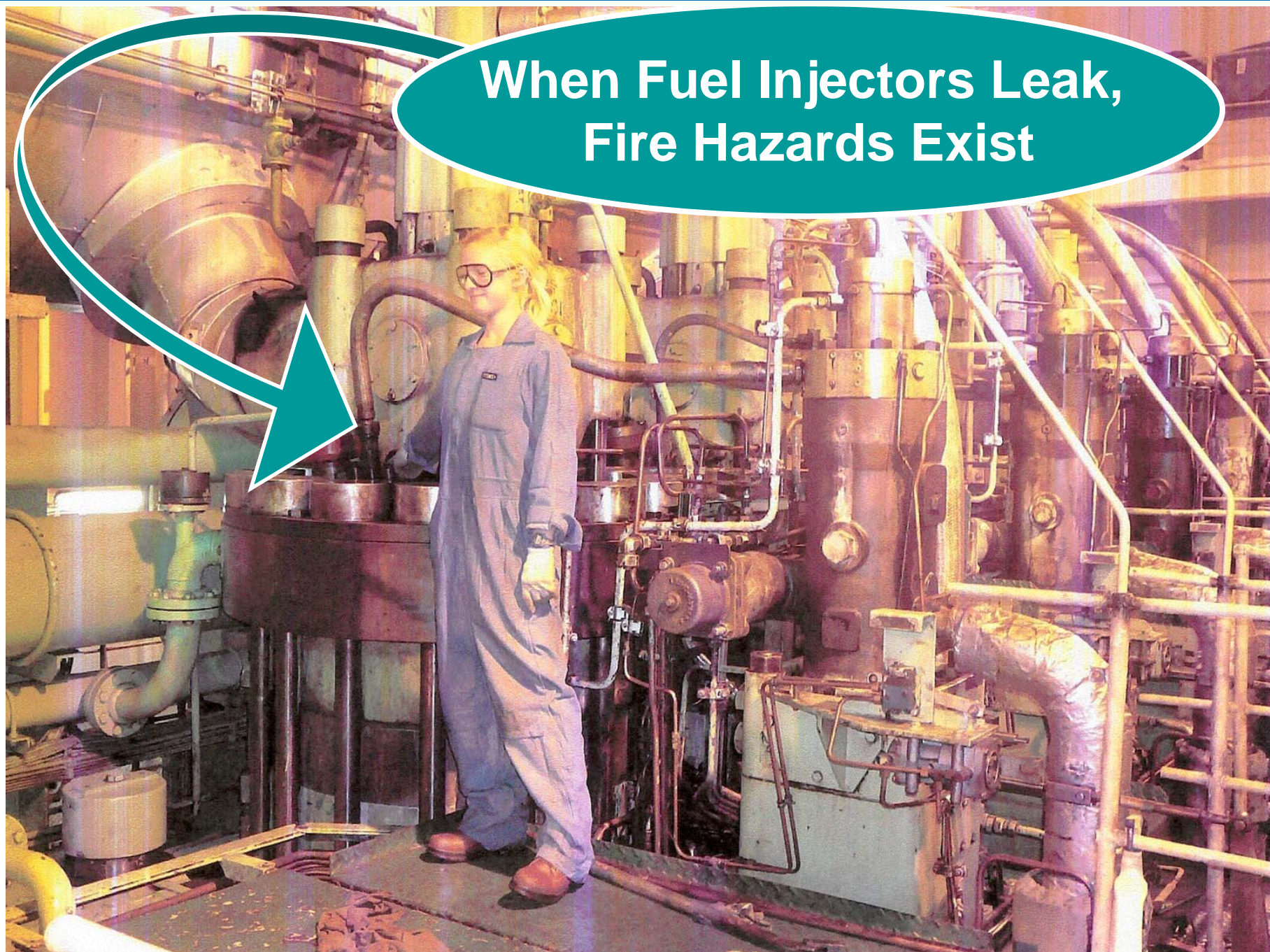
**Course Line, Arrival LALB**

# What We Don't Want!



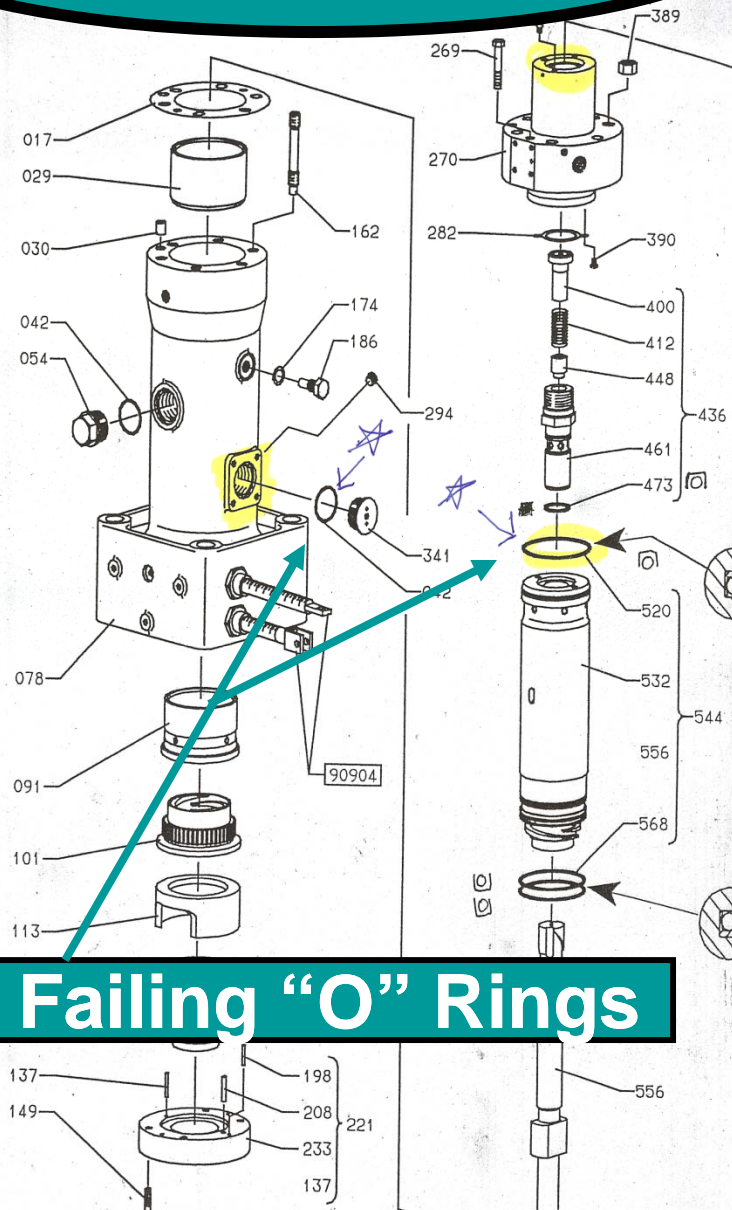


**When Fuel Injectors Leak,  
Fire Hazards Exist**



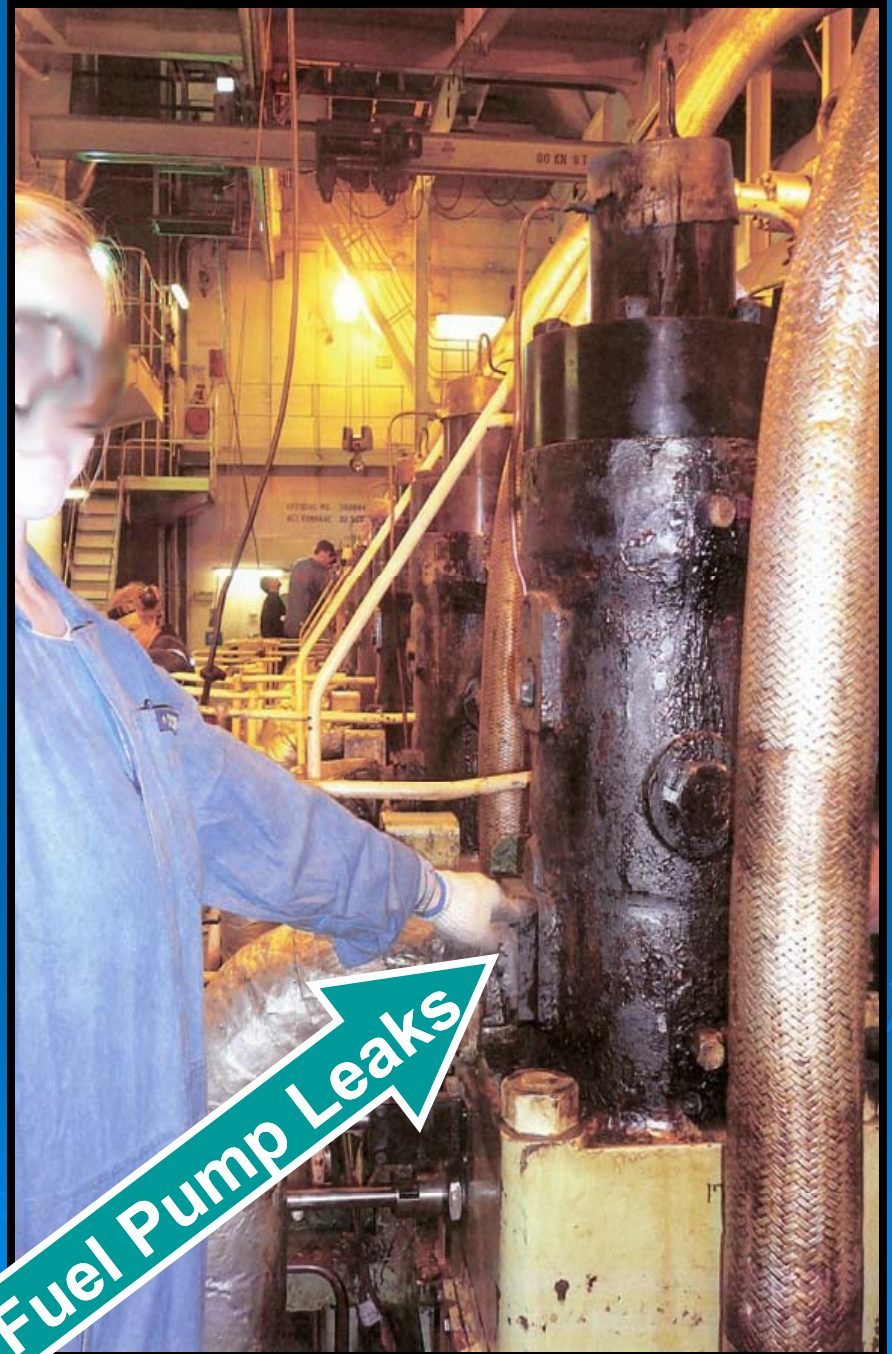


# Fuel Pump Diagram



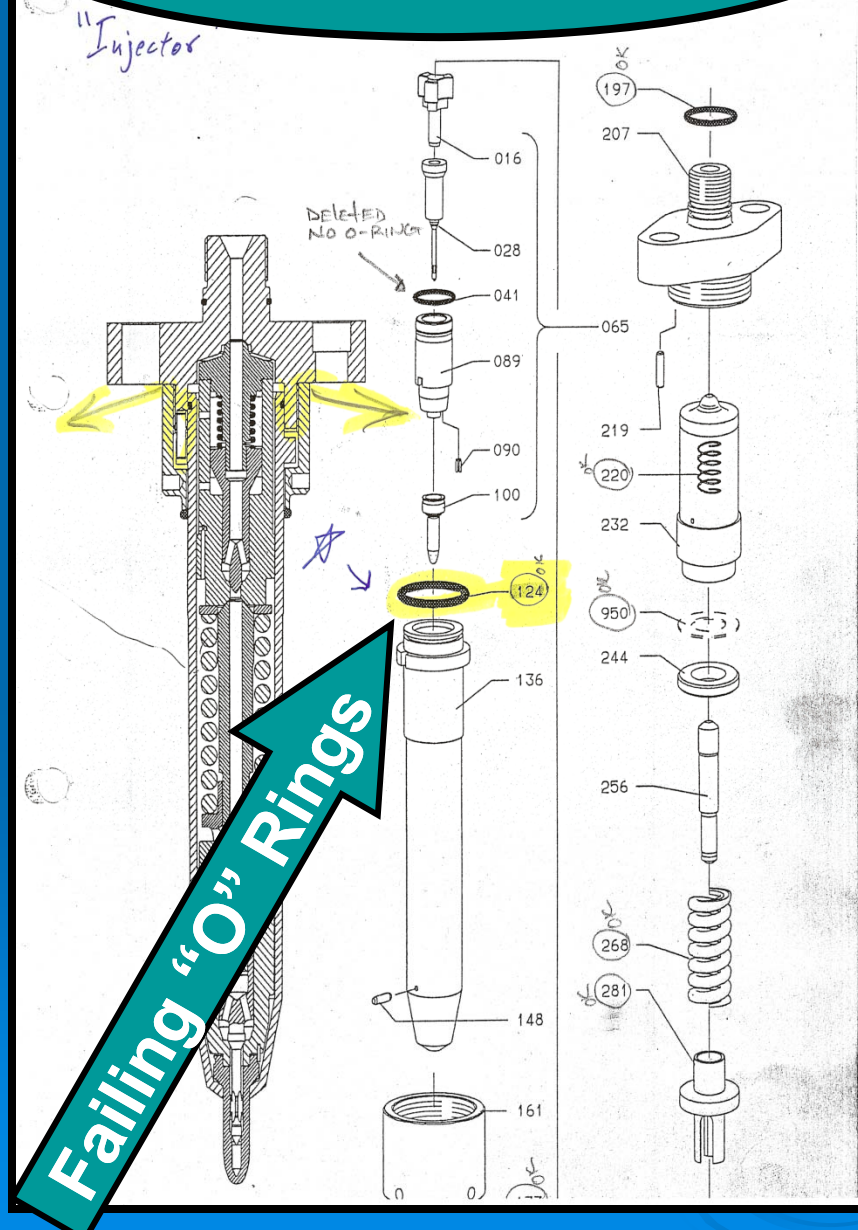
Failing "O" Rings

Fuel Pump Leaks



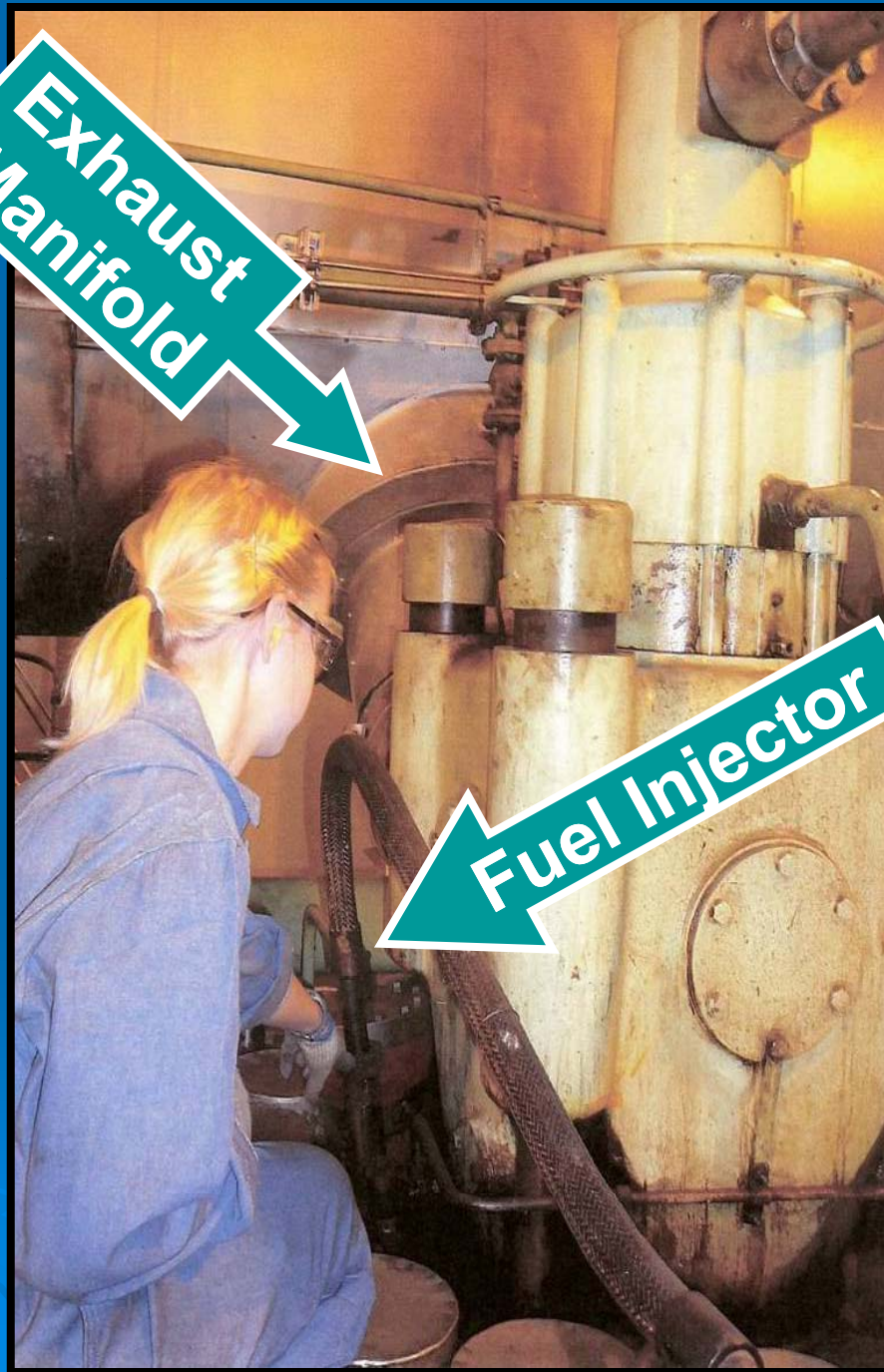


# Fuel Injector Diagram



**Exhaust Manifold**

**Fuel Injector**





# Engine Damage / Limitations



**Close Up View Of Piston Damage**

# Fuel Pump Plungers



Note The  
Lacquering

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



# Normal Healthy Piston







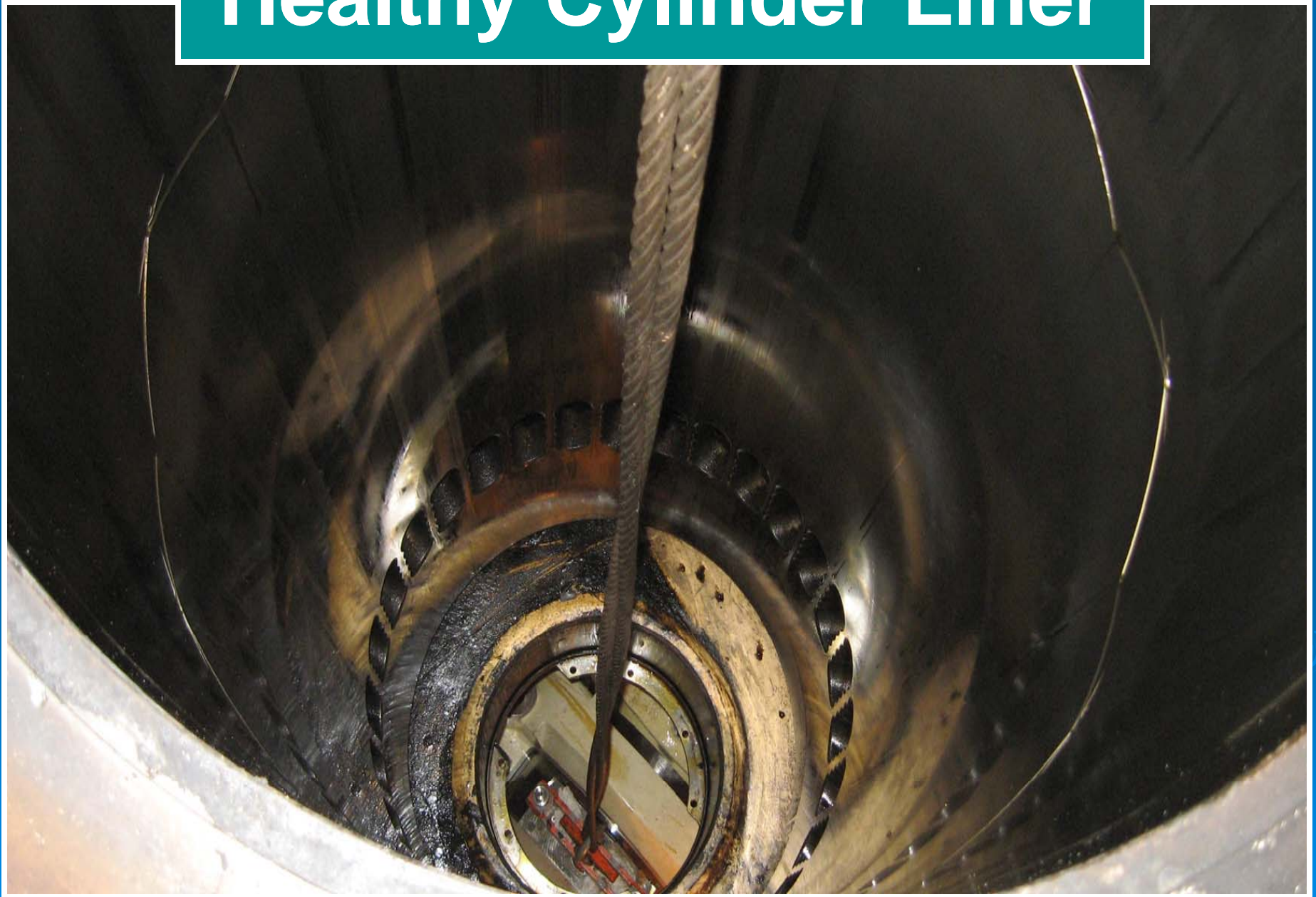
Calcium build up due to LSDFO  
from additive in cylinder lube oil

#1E

**Cylinder Liner Damage  
“Stepping”**



# Healthy Cylinder Liner

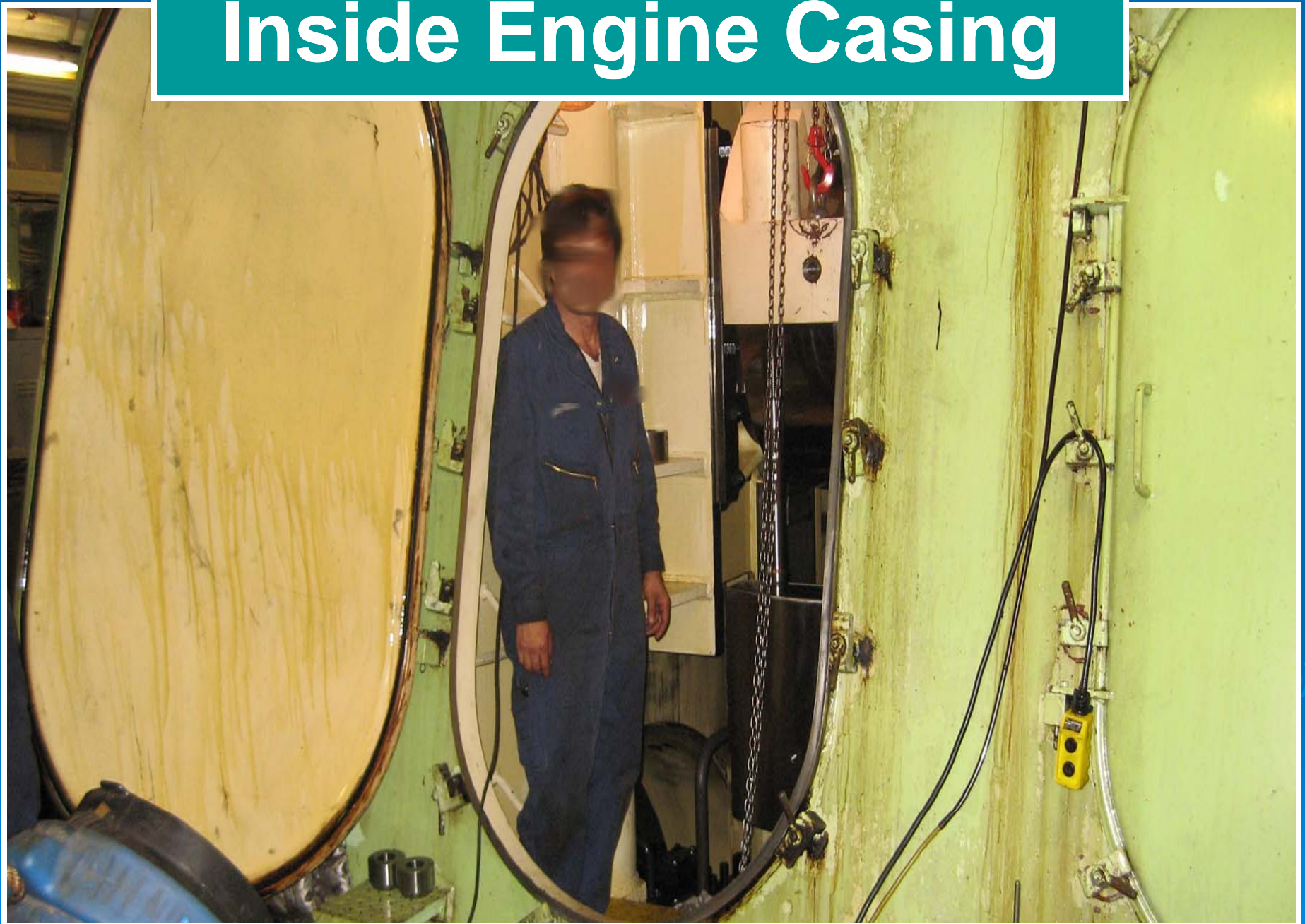




# Crankcase Doors



# Inside Engine Casing





# Findings / Solutions - Recommendations

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- 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

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- 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

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- 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

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- 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

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- 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

# ILO Convention (No. 180) Seafarers' Hours of Work & the Manning of Ships

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- 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

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- 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