DIESEL INJECTION
SALES AND SERVICE

Engine / Generator Control Upgrades

CCGS Louis S. St-Laurent

MV Caribou

DIESEL INJECTION
SALES AND SERVICE

CCGS Louis S. St-Laurent

DIESEL INJECTION
SALES AND SERVICE

CCGS Louis S. St-Laurent

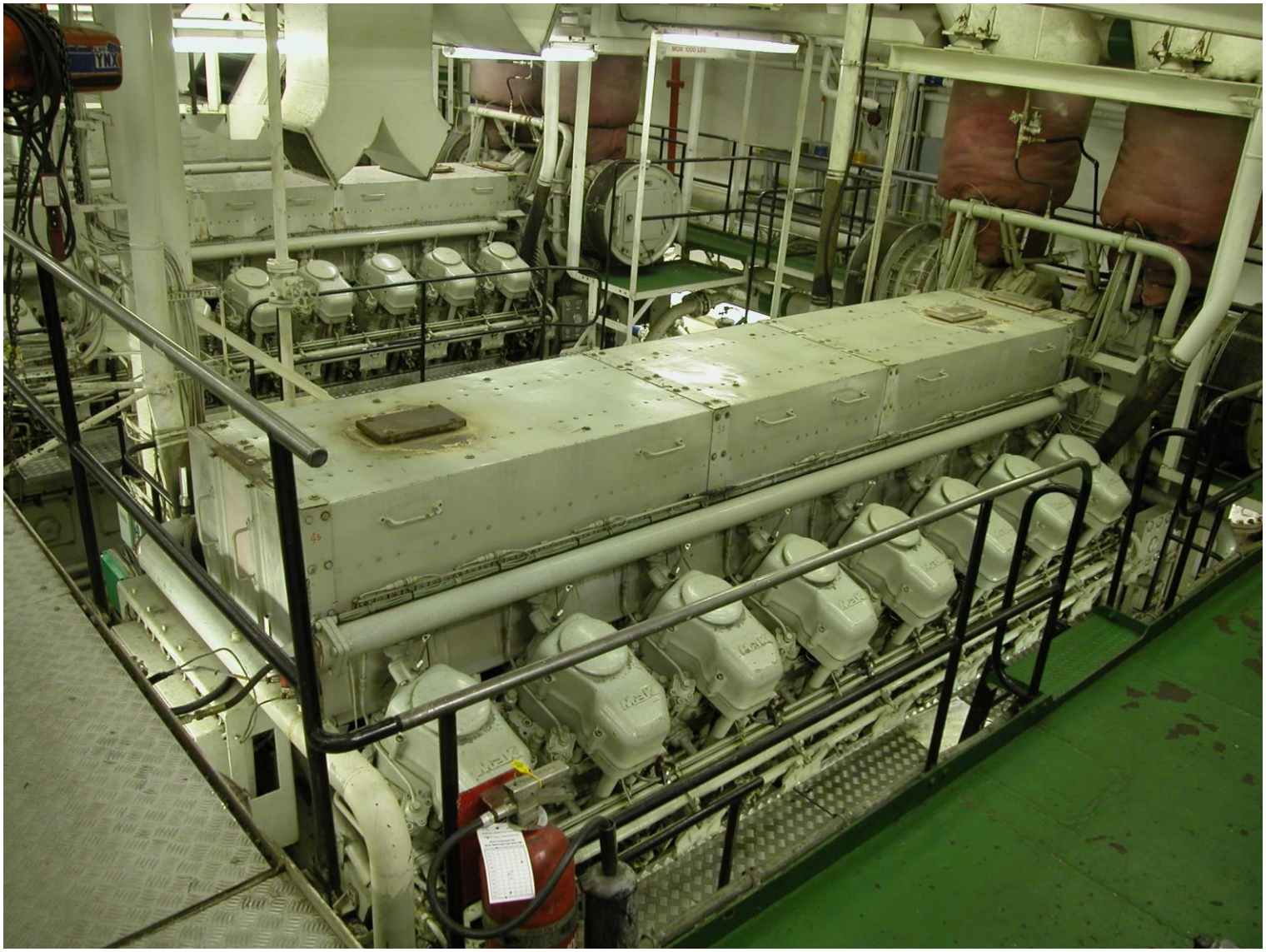
- Flagship of the CCG Fleet
- Built at Canadian Vickers, Montreal, PQ
- In service 1969 & modernized 1988
- Heavy Icebreaker - Ice Class 100A

DIESEL INJECTION
SALES AND SERVICE

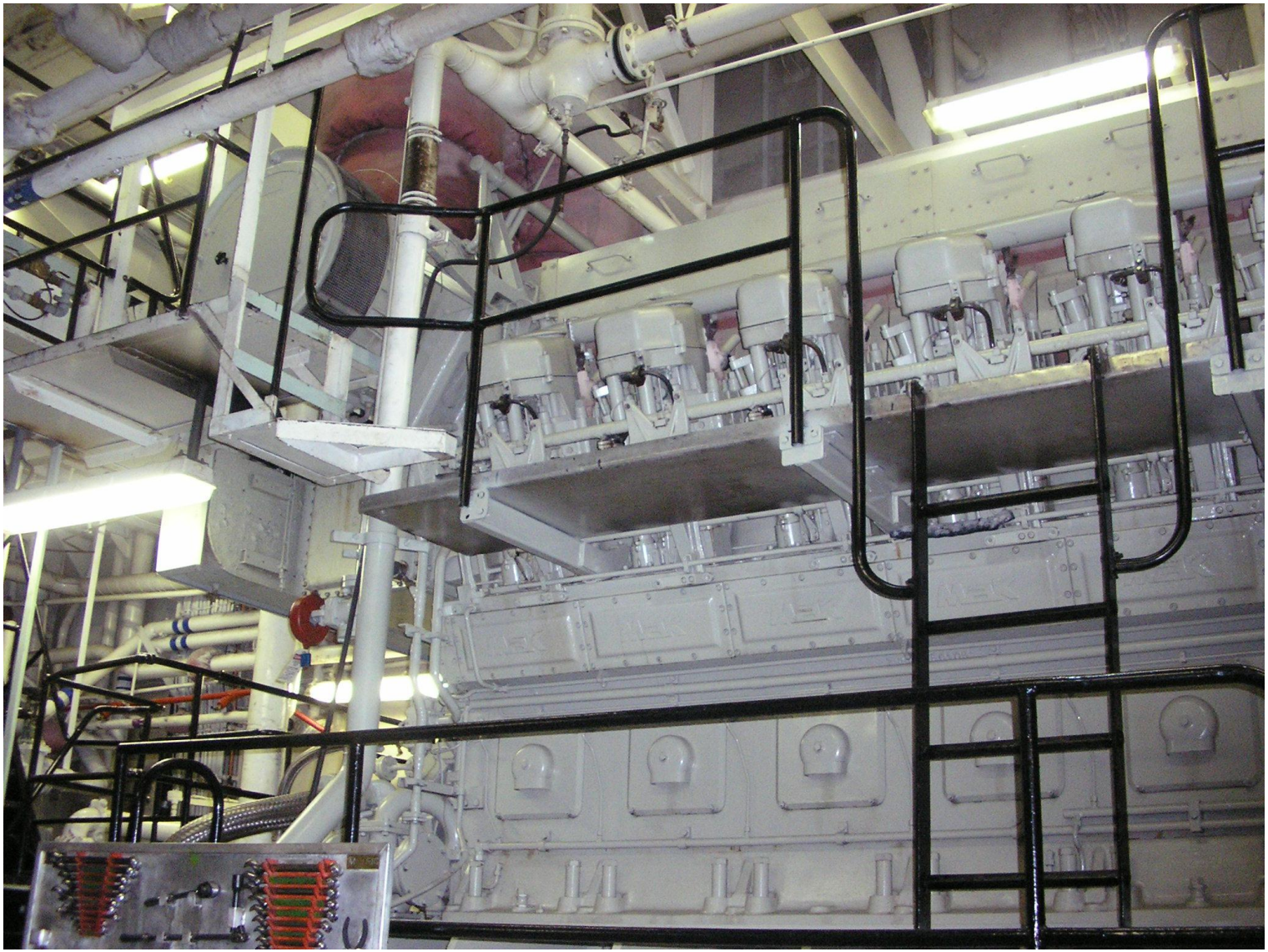
CCGS Louis S. St-Laurent

- Diesel electric AC/DC
- Triple screw – fixed pitch
- 5 Krupp Mak 16M453C main engines
- 3 General Electric DC motors
- Total propulsive power 20,142 kw
- Propulsion bus 6.6Kv and 560A

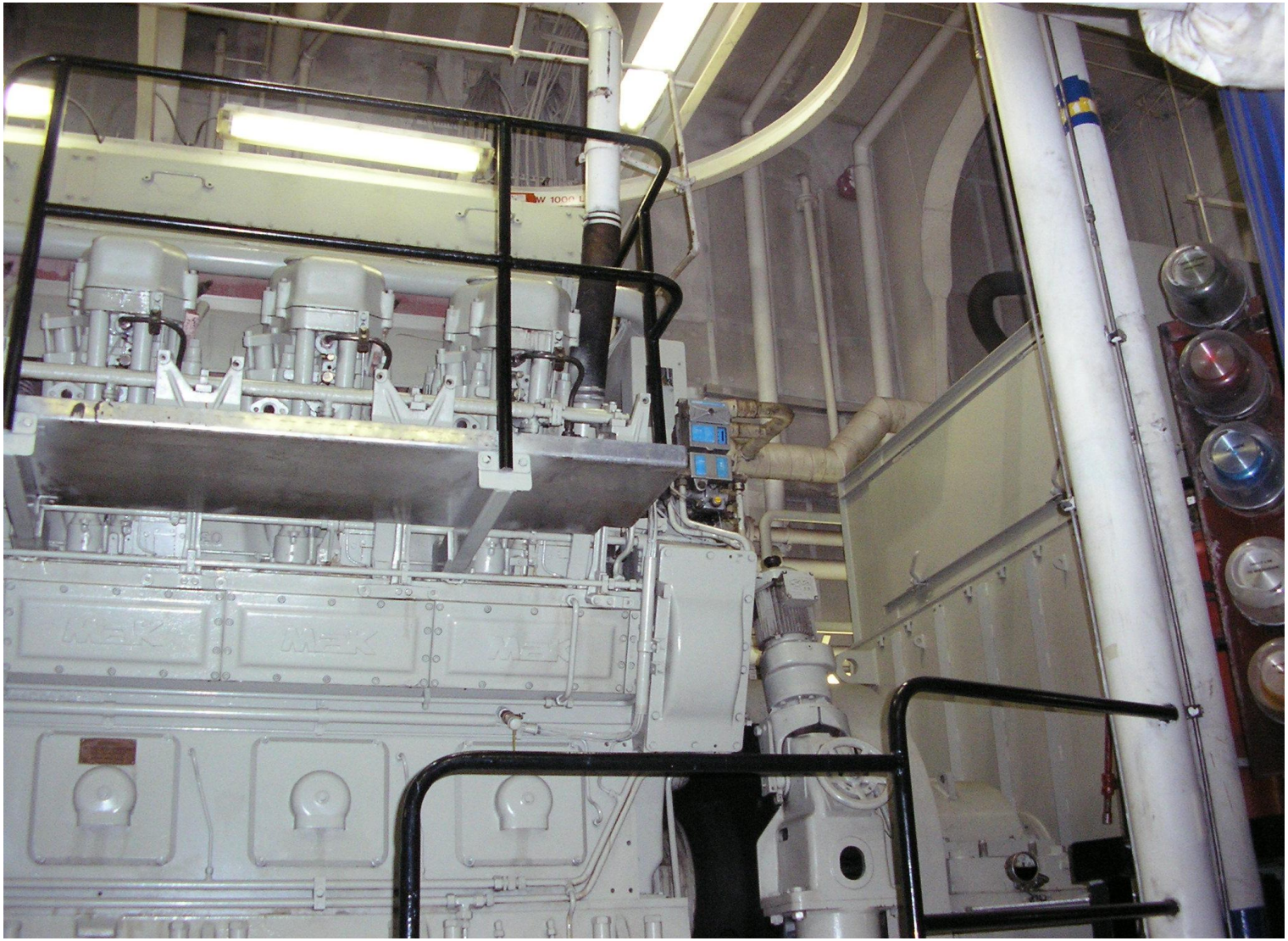
DIESEL INJECTION
SALES AND SERVICE



DIESEL INJECTION
SALES AND SERVICE



DIESEL INJECTION
SALES AND SERVICE



DIESEL INJECTION
SALES AND SERVICE

CCGS Louis S. St-Laurent Concerns

- Load control and sharing units, synchronizing units and governors suffering from many age related dynamic problems
  - Hunting
  - Instability - ramping
  - Operating outside control window
- Difficult to set up and retain settings
- Units obsolete and parts availability an issue

CCGS Louis S. St-Laurent

- Removed
  - Speed & phase matching synchronizers
    - provided frequency & phase matching
  - Automatic generator loading control units
    - to soft load machines in and out of the load sharing loop
  - Generator load sensors
  - Woodward 1000 Series speed controllers
    - Prototype dual dynamics

CCGS Louis S. St-Laurent

- Installed
  - Woodward EGCP-3 Load Managers
    - Replaced speed & phase matching units, load sensing units, and loading control units
    - Reserve functionality for further modifications
  - Woodward 828 electronic speed controllers

DIESEL INJECTION
SALES AND SERVICE

Woodward EGCP - 3

WOODWARD

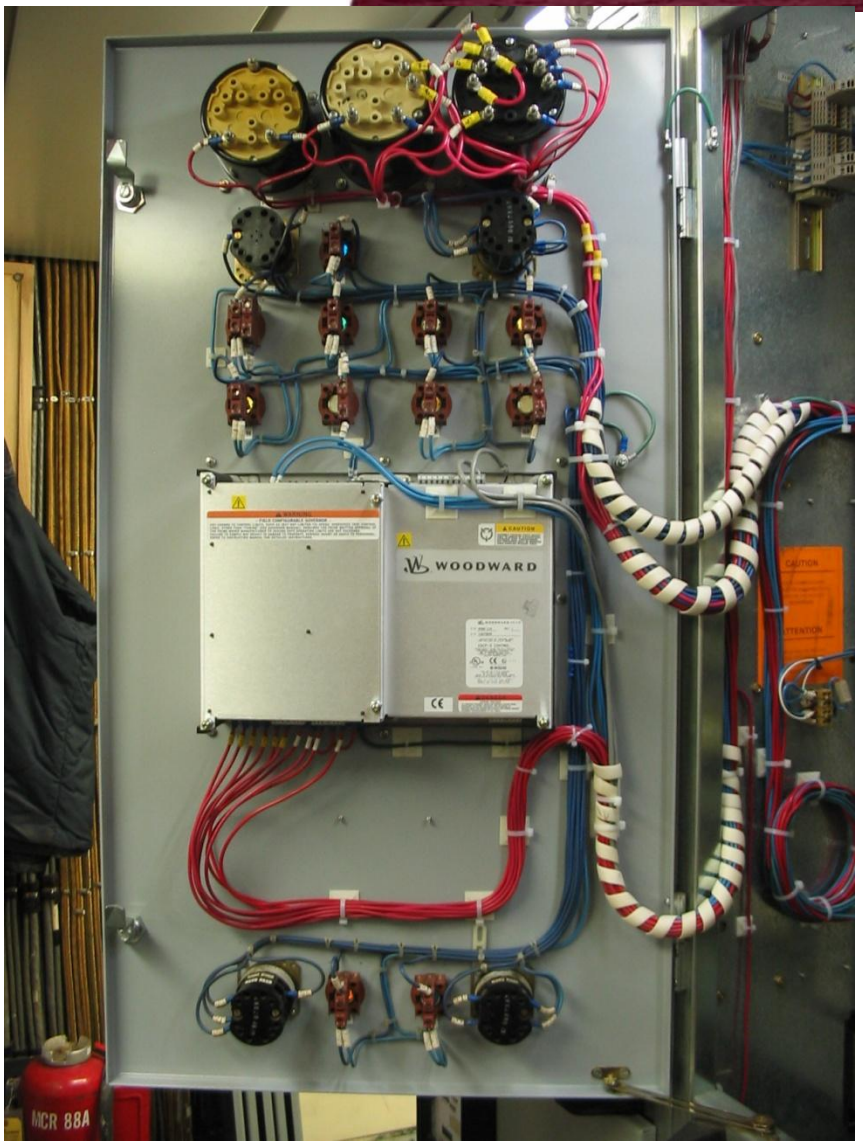
Woodward EGCP 3

- In this application it handles:
  - Load sharing
  - Power factor
  - Synchronization
  - Sequencing

DIESEL INJECTION
SALES AND SERVICE

Before & After

DIESEL INJECTION
SALES AND SERVICE



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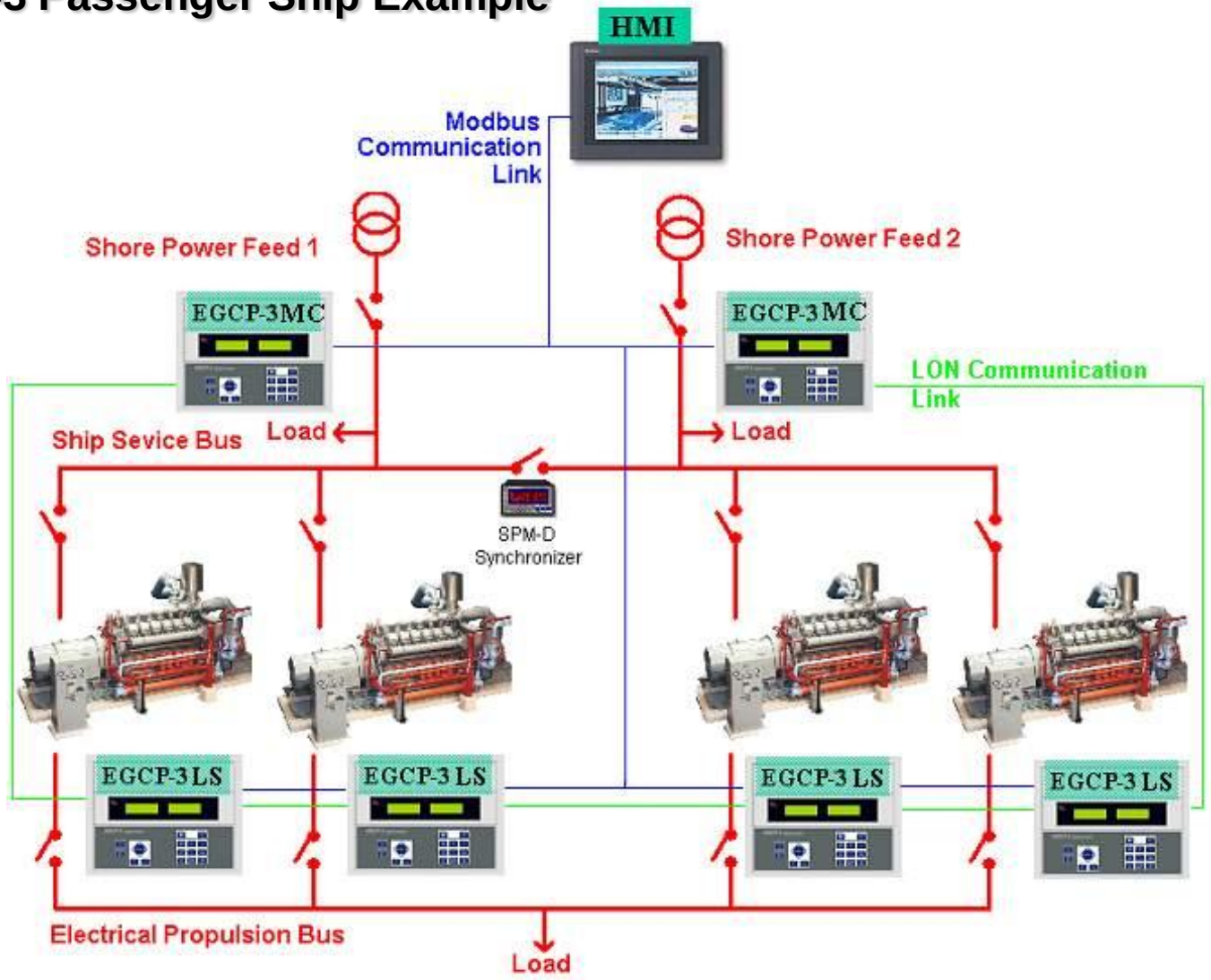
EGCP-3 Louis St. Laurent

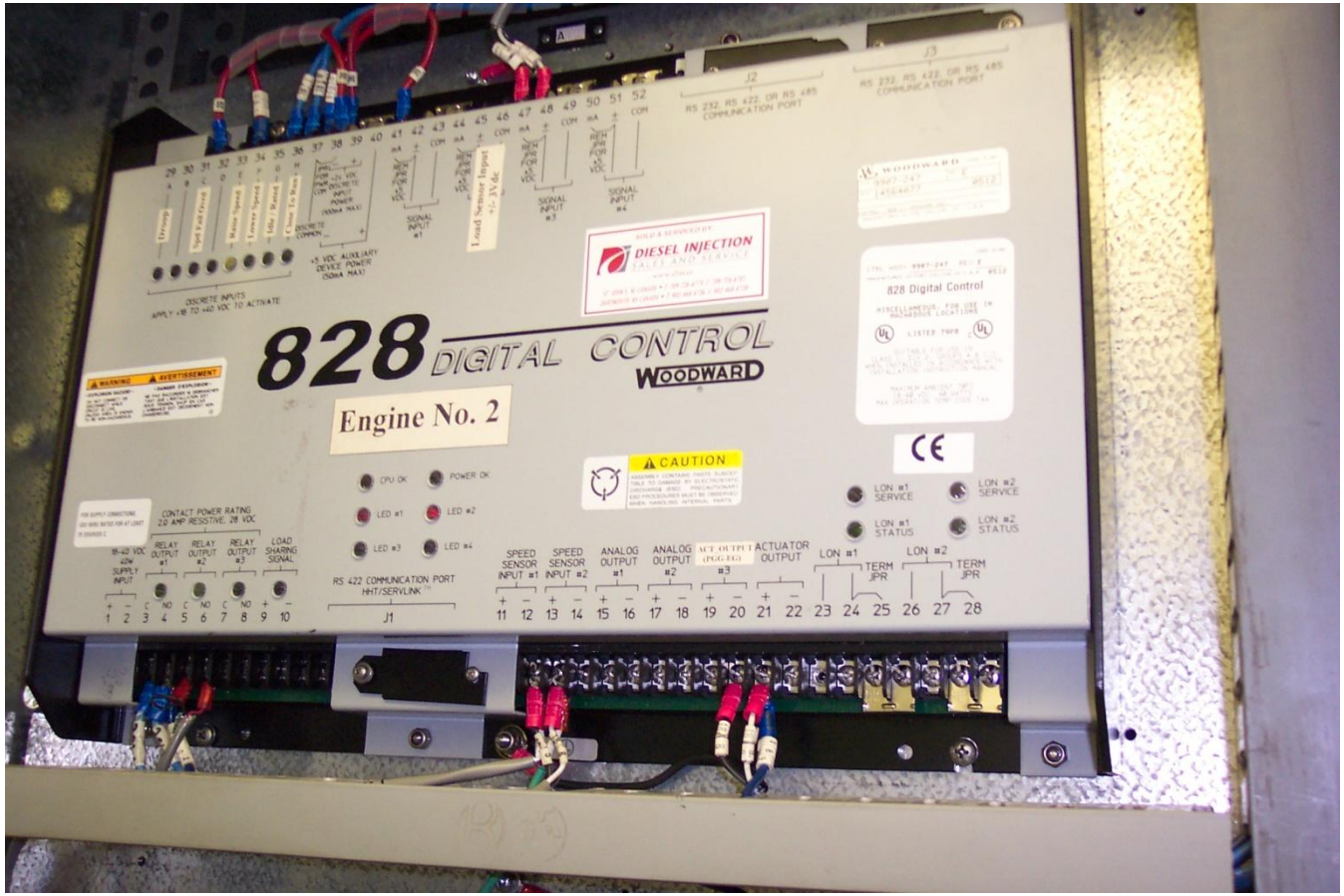
EGCP-3 Passenger Ship Example



- The EGCP 3 is capable of much more:
  - Generator/engine protection
  - bus protection
  - reverse power
  - start/stop, etc
  - see handout

DIESEL INJECTION
SALES AND SERVICE

Woodward 828



Woodward 828

- Designed for controlling load and speed of engines in generating set service
- Has internal circuitry and connections designed for use in load sharing systems
- Two speed inputs
- Four analog inputs, three analog outputs
- Eight discrete inputs, three discrete outputs

Two Speed Inputs?

- Systems with low frequency oscillatory modes due to engine and driven load inertias and flexible couplings are difficult to control.
- In some instances a coupling by itself can produce torsional frequencies. We don't want the actuator to respond to speed sensor changes it cannot control with the fuel.
- The two speed inputs permit dynamic filtering.
- *Or* the two speed inputs can be used for redundancy reasons

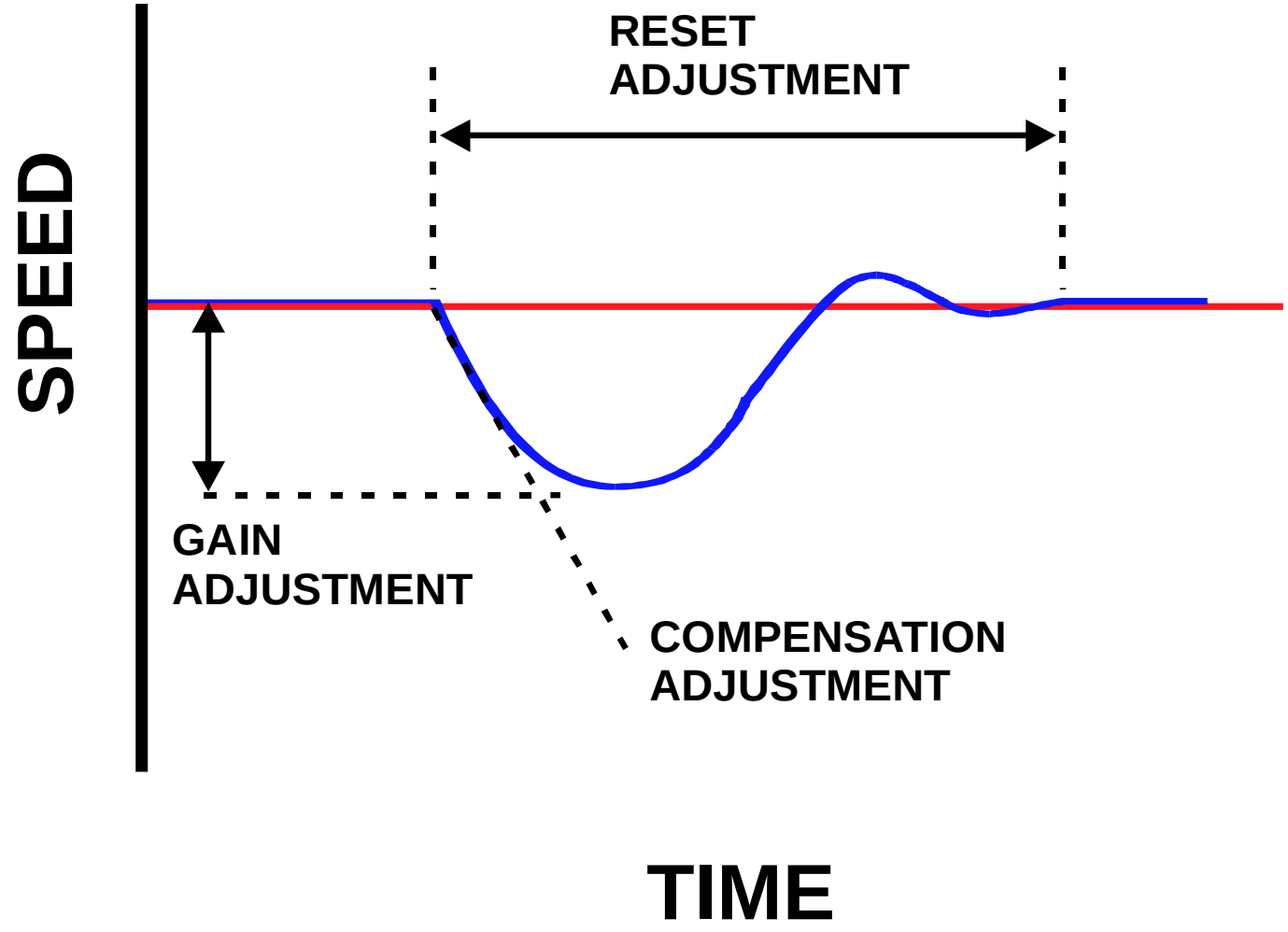
Dual Dynamics?

In a marine application

- Main engine clutch: out vs engaged
- SS Gen circuit breaker: open vs closed

In other applications

- Idle speed vs rated speed
- Diesel fuel vs natural gas


RESET
ADJUSTMENT
SPEED
GAIN
ADJUSTMENT
COMPENSATION
ADJUSTMENT
TIME

Externally Switchable Dynamics

- 1st Dynamics
  - Gain1
  - Reset 1
  - Compensation 1
  - Gain Ratio 1
  - Window Width 1
  - Gain Slope Bk Pnt 1
  - Gain Slope 1
  - Speed Filter Freq 1
- 2nd Dynamics
  - Gain 2
  - Reset 2
  - Compensation 2
  - Gain Ratio 2
  - Window Width 2
  - Gain Slope Bk Pnt 2
  - Gain Slope 2
  - Speed Filter Freq 2

CCGS Louis S. St-Laurent

- Upon installation of 828's and EGCP 3's the units were tuned/calibrated to interact with Siemens.
  - PT's & CT's correct, phasing, synchronization, load control, load sharing etc.
- Operational trials alongside & at sea
  - Stability tests and adjustments
  - 100% load, response times, load sharing etc
- Sea trials 4 days (in conjunction with Siemens trials)
- Arctic trials – conducted several weeks after open water trials (looking for ice for loading purposes)

CCGS Louis S. St-Laurent

- Upgraded system
  - responsive
  - stable
  - reliable
- TCMS witnessed test, trials and approved installation
- Crew given formal training on new controls

DIESEL INJECTION
SALES AND SERVICE

CCGS Louis S. St-Laurent Issues

- Project done in two main phases
  - Continuity of staff afloat and ashore
  - Re-familiarization with project
  - Documentation and parts
- Final adjustments, tuning and trials done while ship operational en-route Arctic
- As Fitted drawings are NEVER “as fitted”

DIESEL INJECTION
SALES AND SERVICE

MV Caribou

DIESEL INJECTION
SALES AND SERVICE

MV Caribou

- Flagship of the Marine Atlantic fleet
- Built at Versatile Davie Inc, Lauzon PQ
- In service in 1986 – (22 years ago!)
- Class: Lloyd's 100A1
- Ice class: Northern Baltic 1A Super
- 15 knot economical cruising, 22 knot max

DIESEL INJECTION
SALES AND SERVICE

MV Caribou

- ASEA propulsion system
- Twin screw – Kamewa CPP
- 4 MaK 8M552 main engines – 7000 bhp ea.

DIESEL INJECTION
SALES AND SERVICE

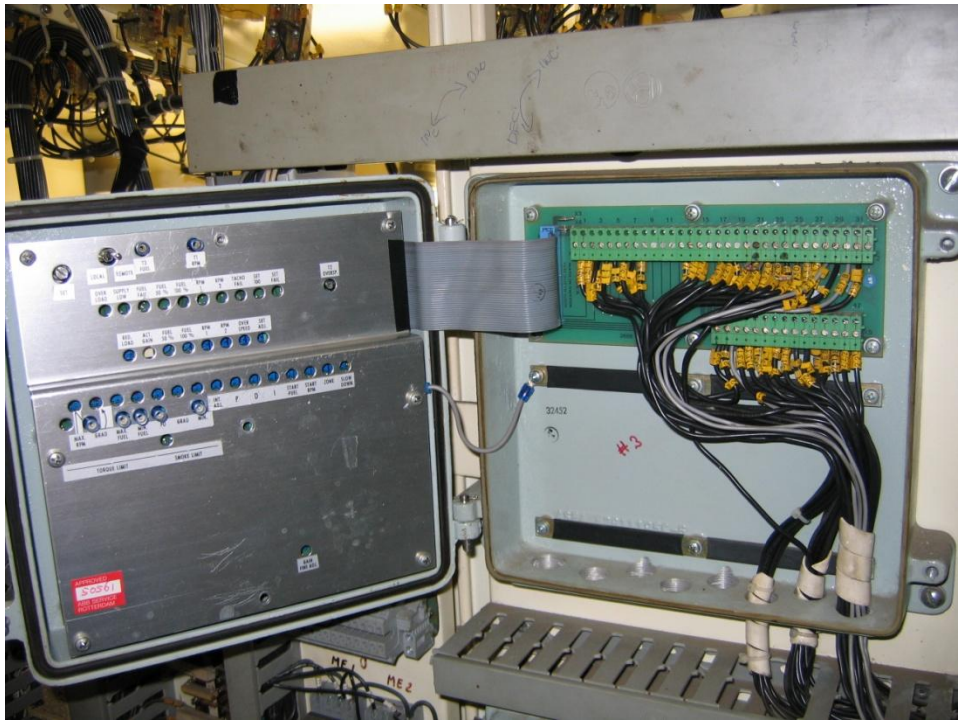
MV Caribou Concerns

- ASEA propulsion controls inputting to DEGO governor in turn controlling PGTM actuators
- Instability - hunting
- Frequent over speeds when manoeuvring
- Harbour entry a risky proposition
- DEGO unit obsolete and superseded
- Finger trouble

DIESEL INJECTION
SALES AND SERVICE

MV Caribou

- Removed DEGO governors
- Removed Kamewa rack feedback transmitters



DIESEL INJECTION
SALES AND SERVICE

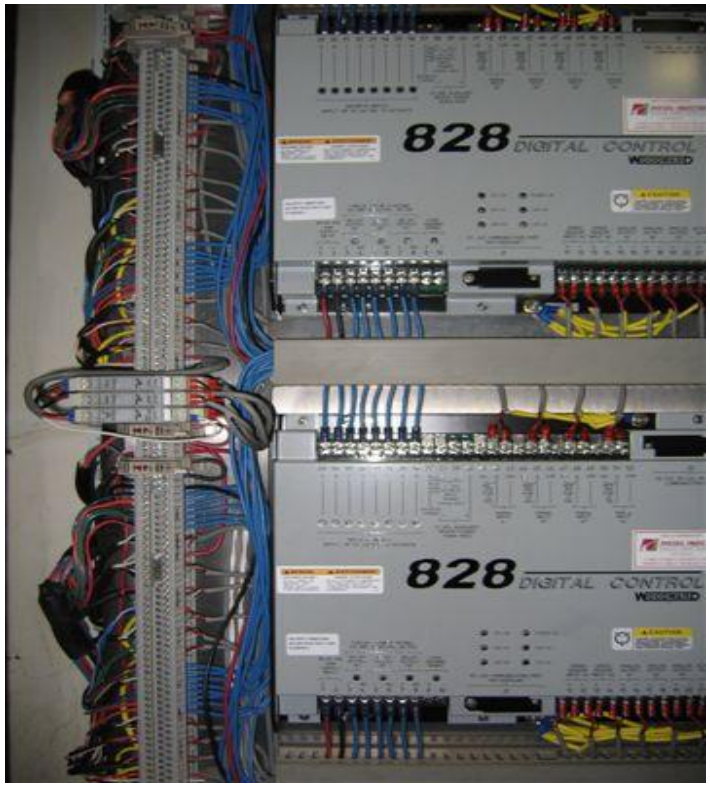
MV Caribou

DEGO Governors

DIESEL INJECTION
SALES AND SERVICE

MV Caribou

- Installed Woodward 828 electronic governors
- Installed Woodward PG-EG actuators
- Installed PMC rack feedback transmitters



DIESEL INJECTION
SALES AND SERVICE

MV Caribou

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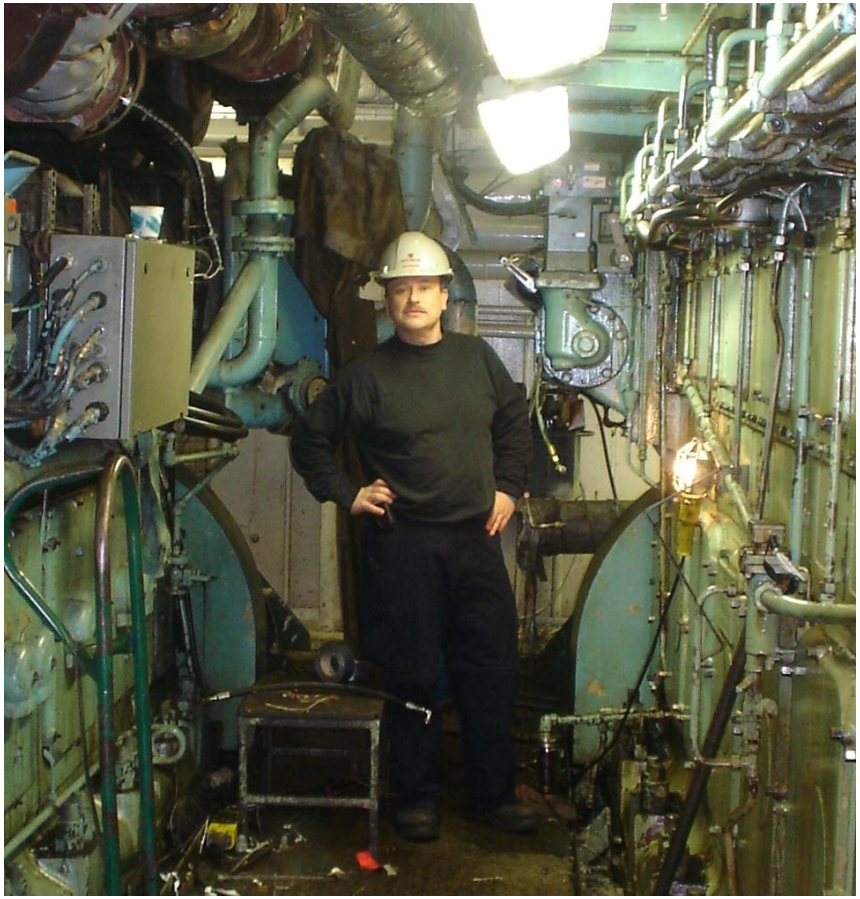
MV Caribou



MV Caribou

- Stability tests and adjustments
  - Individual diesels
    - response at 25, 50, 75 and 100% load
    - response with sudden removal of 100% load
    - crash stops and manoeuvres at 100% load
  - Paralleled diesels
    - at 25, 50, 75 and 100% load
    - sudden load removal
    - crash stops and manoeuvres at 100% load

DIESEL INJECTION
SALES AND SERVICE

MV Caribou

- Upgraded system
  - responsive
  - stable
  - reliable
- Lloyds and TCMS approved installation and witnessed tests and trials

DIESEL INJECTION
SALES AND SERVICE

MV Caribou Issues

- Ship departed port immediately after undocking and trials carried out while underway and in service
- Blockage at turbo aftercoolers
- Finger trouble with original installation
  - Woodward is programmable via hand held of lap top
    - No individual pots providing idle temptation
- “As Fitted” drawings are NEVER “as fitted”

DIESEL INJECTION
SALES AND SERVICE

Marine Type Approval

ABS
TYPE APPROVAL PROGRAM

Lloyd's Register

DNV

BUREAU VERITAS

DIESEL INJECTION
SALES AND SERVICE

Thank you!