Dynamic Limiter Function (DLF)

- Description of Dynamic Limiter Function
- Example of DLF Effects
- Conclusions
Dynamic Limiter Function (DLF)

What is purpose of DLF?
Utilize flexibility of MEC engine, to maximize heavy running capabilities!

What does DLF consist of?
DLF is the common name for a number of control system (ECS-SW) changes!

Where is DLF Applicable?
DLF will be standard part of ECS for any MEC engine!

What are the ECS-SW Changes?
The changes consist of 4 parts:
1. New ‘Scavenge Air Limiter’
2. New ‘Torque Limiter’
3. Support for special engine tuning during transients
4. Support for reduction of shaft stresses in Barred Speed Range (BSR)
Dynamic Limiter Function (DLF)
Part 1: New Scavenge Air Limiter

Existing Limiter:
Sets upper limit on fuel index, depending on scavenging air pressure

Existing Challenge:
Lacks compensation for differences in exhaust valve close timing, or other process changes which affects ‘captured air mass’

New Limiter:
Continuously estimates air available in cylinder, and sets fuel limit accordingly. For instance, any change in ExhV timing, will directly affect limiter value
Dynamic Limiter Function (DLF)
Part 2: New Torque Limiter

Existing Limiter:
Sets upper limit on fuel index, depending on engine speed (load diagram)

Existing Challenge:
Requires action by crew for temporary overload (Cancel Limit).

New Limiter:
Automatically accepts temporary overload, while preventing it stationary
Existing Situation:
• Engine tuning is calibrated during shop test under stationary conditions
• During transient, the control system tries to keep similar tuning

Existing Challenge:
Optimum tuning during stationary running is not optimum during transient.

New Function:
• Active engine tuning is deliberately modified during transient
• Focus is primarily on load up ability, instead of NOx and SFOC
**Existing Situation:**
- Engine tuning is calibrated during shop test under stationary conditions
- During transient, the control system tries to keep similar tuning

**Existing Challenge:**
Optimum tuning during stationary running is **not** optimum in the barred speed range (BSR).

**New Function:**
- Fuel Injection timing is modified when accelerating up through BSR
- Modified speed set handling when accelerating up through BSR
- Exh Valve timing is modified when wind milling down through BSR
### Example

<table>
<thead>
<tr>
<th>Ship Type</th>
<th>250,000 DWT Ore Carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length, Breath, Draught</td>
<td>321m, 57m, 18m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engine Type</th>
<th>6G80MEC9.2 Tier 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layout</td>
<td>18240kW @ 58RPM (L4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Propeller Type</th>
<th>4 blade fixed pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propeller Diameter</td>
<td>10.3m</td>
</tr>
<tr>
<td>Propeller Mean Pitch</td>
<td>81% (resulting in LRM of ~1%)</td>
</tr>
</tbody>
</table>

| Barred Speed Range         | 25-35RPM                |

**Simulate Propulsion System, when ordering DeadSlow to Full, Starting from Bollard Pull Situation!**
Dynamic Propulsion Simulation

- Previous internal performance layout tools focus on stationary running.

- Ambitions with ‘Dynamic Propulsion Simulation’ are to predict:
  - Stationary performance with ‘high’ precision
  - Transient performance with ‘fair’ precision

- As consequence ‘Dynamic Propulsion Simulation’ includes:
  - Combustion chamber and turbocharging system
  - Main control algorithms of engine control system (ECS)
  - Shop test commissioning of engine control system
  - Propeller and shaft *
  - Vessel **

* Propeller: Based on Wagening B-Screw Series (1 and 4 Quadrant)
** Vessel: Based on ‘J.Holtrop And G.G.J. Mennen’ Power Prediction Method
Dynamic Propulsion Simulation Example

Reference

Increased Limiters

Increasing limiters help!
Dynamic Propulsion Simulation
DLF Example

- Significant improvement over reference situation is expected.
- Some improvement over increased limiters is expected.
Dynamic Propulsion Simulation

DLF Example

- DLF offers relative improvement
- ‘Size’ of improvement in terms of power margin, will depend on complete propulsion system
- DLF represent the first ‘major step’ of optimizing engine independently in stationary and transient conditions

Barred speed range at high speed will remain difficult
Reduction of Shaft Stresses ‘Quick Passing Through’

- Original QPT from MAN, was intended for CPP only
- Today ECS include barred speed range speed set handling
- Now lower barred speed set is kept for certain time delay, or until governor has index margin
- The delay can always be overruled by ‘Cancel Limit’
Conclusions

- ‘DLF’ represents a number of ECS-SW modifications
- Aim is to maximize temporary heavy running capabilities on MEC
- Existing governor limiters will be changed
- DLF allows engine tuning to be optimized independently in stationary and transient situations

- ‘Dynamic Propulsion Simulator’ predicts relative improvement by DLF
- High BSR will remain very difficult to run through quickly, and DLF will not change LRM recommendation

- DLF affects propeller shaft excitations
- DLF includes potential for reducing shaft stresses
- Procedure for verifying stress levels in the future must be decided
- Specific ‘roll out’ of DLF will depend on handling of shaft stresses

DLF is expected to go into service test October 2015