PROPULSION CONFIGURATION ANALYSIS of GREAT LAKES BULK CARRIER

Configuration Analysis

- ☑ Flexible Configuration
- ☑ Low Running Costs & Maintenance
- ☑ Great Lakes Optimised
- ☑ Convertible to Self Unloader
- ☑ Minimal Environmental Footprint
- ☑ Simple Arrangement
- ☑ Familiar Hardware
- ☑ Supportable Locally

Flexible Configuration

- ☑ High Redundancy
- ☑ Safety during Close Navigation
- ☑ Great Lakes Optimised
- ☑ Proven Design
- ☑ Convertible to Self Unloader - No Modification
- ☑ Improved Asset Utilization
- ☑ Conventional Electrics – Intuitive Operation

High Redundancy

- ☑ Twin MAK 8M32C Propulsion Diesels
- ☑ 2 x F.O. Purifiers – 100% capacity
- ☑ Dedicated L.O. purifier per engine
- ☑ Twin 2,500 kW P.T.O. Generators
- ☑ Twin Economisers for Steam or Thermal Fluid
- ☑ Heavy Fuel Oil Fired Backup/Layup Boiler
- ☑ Two CAT C18 550kW Ship Service Generators
- ☑ CAT C9 200kW Emergency Generator

Low Running Costs & Maintenance

- ☑ Great Lakes Optimised Power Output.
- ☑ Single Engine Running for Economy.
- ☑ Minimal O.F. boiler use.
- ☑ Engines share reduced annual operating hours due to single engine operation.
- ☑ Minimal annual ship service generator set use.
- ☑ Low Speed optimal engine loading.
- ☑ Lighter, easily managed, maintenance components.
- ☑ Proven, familiar hardware.
- ☑ All supported globally and locally through

MaK TOROMONT Marine Power CAT

Great Lakes Optimised

- ☑ **2 x Medium Speed Propulsion Engines**
  Propulsion power redundancy
  Approx. 100T less than typical 2 stroke with spares
  ¢ loop belt arrangement with gearbox fwd - “Collingwood Config.”
- ☑ **2 x PTO 2,500kW Alternators**
  Providing fully redundant ship service power underway as well as BTU, unloading and ballasting power at the lowest cost per kW.
- ☑ **2 x Exhaust Gas Economisers**
  Provide ships steam/thermal oil requirements under most operations. (A backup/layup/cold start heavy fuel fired boiler is provided).
- ☑ **Reduced Annual Engine Operating Hours.**
  All power: Propulsion, Electrical & Steam from propulsion engines
- ☑ **Controllable Pitch Propeller In Steering Nozzle**
  High manoeuvrability, Low stress Docking and Locking.
  Minimized E.R. length.

Improved Asset Utilization

- ☑ **Twin propulsion engines with engine driven pumps**
  Electric standby pumps not required for Class - possible reduced installation costs, survey items, engine room clutter & weight.
  Smaller engine physical envelope – maximize ‘lay down’ space.
- ☑ **Minimize parasitic loads**
  No ME auxiliary blowers, FW & LO pumps – reduced switchgear.
- ☑ **2 x PTO 2,500kW Alternators**
  Minimizes the use of ship service generator set use to ‘harbour’ use.
- ☑ **2 x Economisers**
  Provide ‘free’ ships steam/thermal oil heating requirements under most operations from exhaust gas waste heat.
- ☑ **Controllable Pitch Propeller**
  Both main engines operate in ‘combinator’ or ‘isochronous’ engine speeds for best fuel economy.

Minimal Environmental Footprint

- ☑ **Twin propulsion engines with engine driven pumps**
  Most efficient propulsion, steam and electric power production - Extremely low ‘tier 2’ emissions.
- ☑ **Environmentally Sensitive Engine Design**
  High reliability, Fewer parts, Long time between overhaul, One piece dry engine block.
- ☑ **Exhaust Emission Reduction**
  Smaller silencers provide space for future SCR or exhaust scrubber
- ☑ **2 x PTO 2,500kW Alternators**
  Ample power for Hotel, Ballast, Invasive Species Protection, Self Unloading, Bow Thruster, Stern Thruster and system growth.
- ☑ **2 x Economisers**
  Provide ‘free’ ships steam/thermal oil heating from exhaust gas waste heat and add to the exhaust silencing.
- ☑ **Controllable Pitch Propeller**
  Minimal compressed air requirements – Low start air demand, No reversing.

VOYAGE ANALYSIS

Typical Lakes
Long Haul Trip

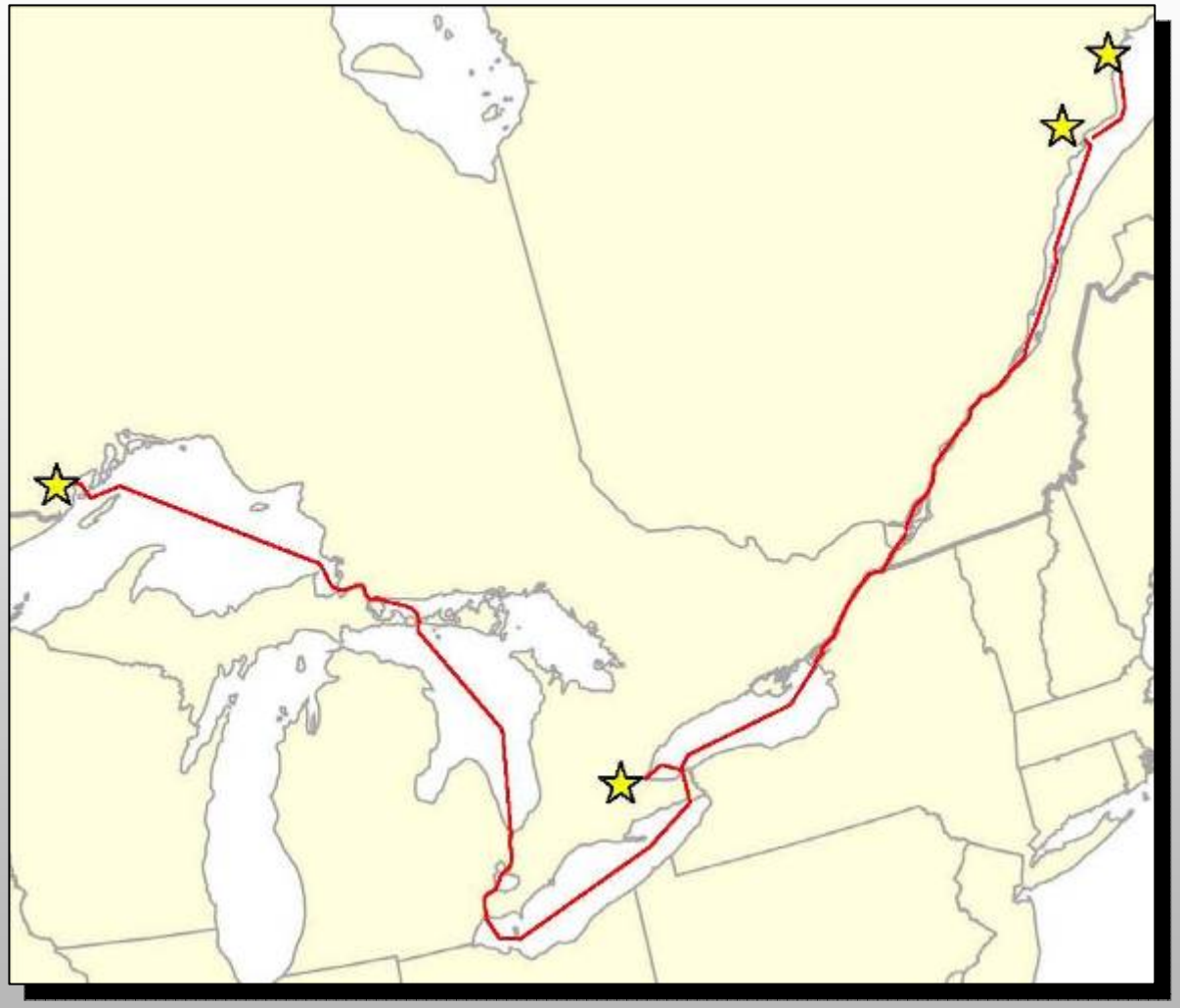
Typical Trip

- **Thunder Bay**
  Load Grain to
- **Baie Comeau**

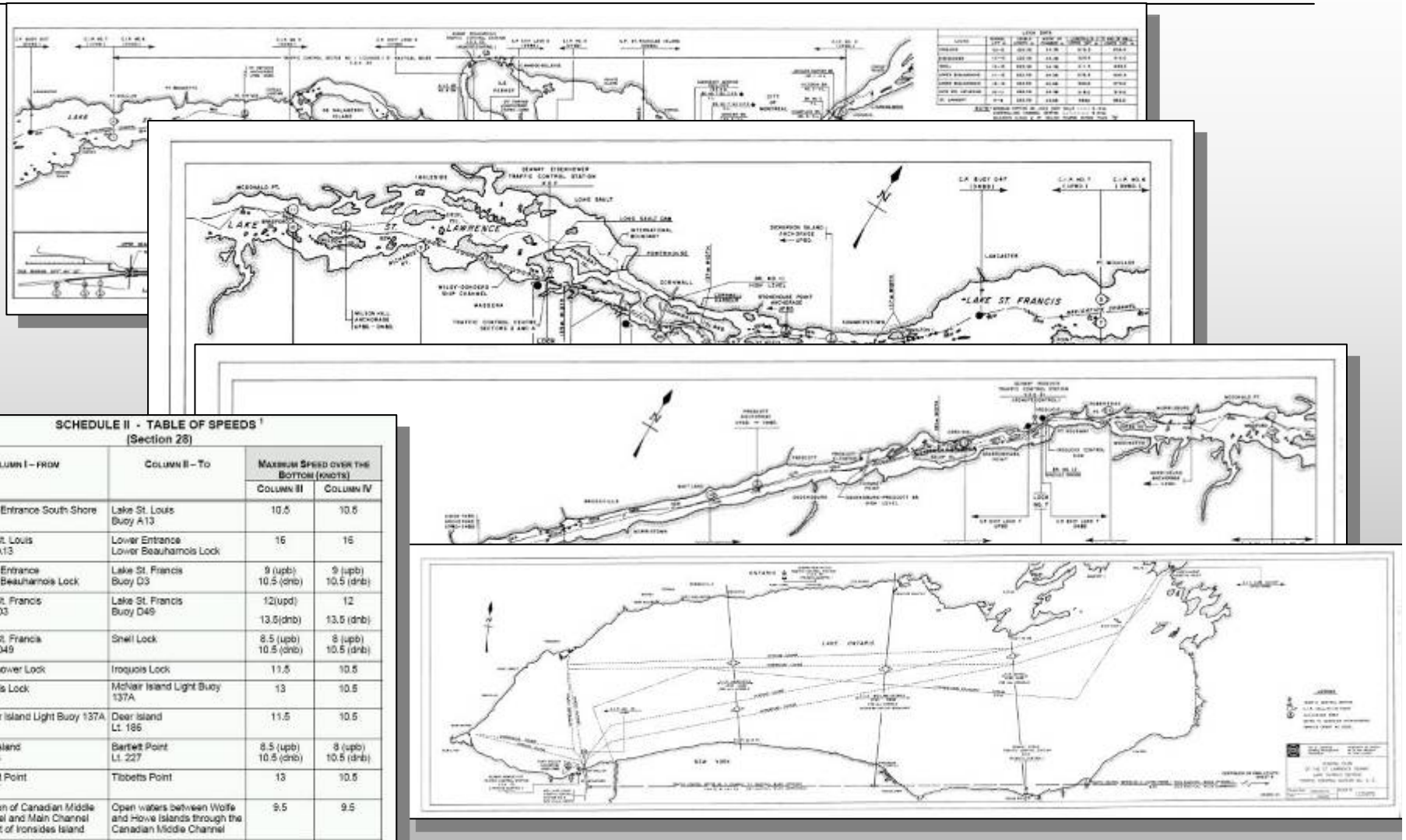
  Discharge Grain

  Ballast to
- **Port Cartier**
  Load Iron Ore to
- **Hamilton**
  Discharge Iron Ore

  Ballast to
- **Thunder Bay**



Research



SCHEDULE II - TABLE OF SPEEDS [1]
(Section 28)

	Column I – From	Column II – To	Maximum Speed over the Bottom (knots)	
			Column III	Column IV
1.	Upper Entrance South Shore Canal	Lake St. Louis Buoy A13	10.5	10.5
2.	Lake St. Louis Buoy A13	Lower Entrance Lower Beauharnois Lock	16	16
3.	Upper Entrance Upper Beauharnois Lock	Lake St. Francis Buoy D3	9 (upb) 10.5 (dnb)	9 (upb) 10.5 (dnb)
4.	Lake St. Francis Buoy D3	Lake St. Francis Buoy D49	12(upd) 13.5(dnb)	12 13.5 (dnb)
5.	Lake St. Francis Buoy D49	Snell Lock	8.5 (upb) 10.5 (dnb)	8 (upb) 10.5 (dnb)
6.	Eisenhower Lock	Iroquois Lock	11.5	10.5
7.	Iroquois Lock	McNair Island Light Buoy 137A	13	10.5
8.	McNair Island Light Buoy 137A	Deer Island Lt. 186	11.5	10.5
9.	Deer Island Lt. 186	Bartlett Point Lt. 227	8.5 (upb) 10.5 (dnb)	8 (upb) 10.5 (dnb)
10.	Bartlett Point Lt. 227	Tibbetts Point	13	10.5
11.	Junction of Canadian Middle Channel and Main Channel abreast of Ironsides Island	Open waters between Wolfe and Howe Islands through the Canadian Middle Channel	9.5	9.5
12.	Port Robinson	Ramey's Bend through the Welland By-Pass	8	8
13.	All other canals		6	6

[1] *Maximum speeds at which a ship may travel in the identified area in both normal and high water conditions are set out in this schedule. The Manager and the Corporation will, from time to time, designate the set of speed limits that is in effect.*

VOYAGE ANALYSIS

Way Point	Time (Hours)	Vessel Speed (Knots)	Propulsion Load	Hotel Load	Comments	Distance N.Miles	Propulsion kWm	Propulsion g/kWh	HFO used (Tonnes)	Propulsion kWh	PTO Gen (Y/N)	S.S. Gen g/kWeh	MDO used (Tonnes)
BALLAST TRIP													
1. Hamilton to Port Weller Piers	3.25	13	100%	400 KW	Transit Lake Ontario to Welland Canal	30							
					Check Distance:	29.4							
Idling	0.55	0	5%	400		0	373	369	0.08	205	N	236	0.06
Hamilton Harbour	0.75	4	12%	400		3	1,000	311	0.23	750	N	236	0.08
Ham. to Pt Weller	1.8	13	82%	400		23.4	6,546	191	2.3	11,783	Y		
CIP 15 to Pt Weller	0.75	4	12%	400		3	1,000	311	0.23	750	N	236	0.08
		0-5 Knots	25%-40%										
2. Transit Welland Canal	11	2.1	20%	400 KW-1,500 KW	Continual maneuvering into locks and use of bowthruster	23.1	1,600						
					Check Distance:	24							
Idling	5	0	5%	400		0	373	369	0.7	1,865	N	236	0.50
Lock to Lock	6	4	12%	1200		24	1,000	311	1.87	5,998	N	236	1.80
		12-13 Knots		400 KW									
3. Transit Lake Erie	16	13	82%	400 KW	Full speed run across the lake	208	6,546	191	20.0	104,742	Y		
		6-12 Knots	40%-100%	400 KW									
4. Transit: Detroit River Lake St. Clair St. Clair River	8	8	40%-100%	400 KW	River transit, various speeds, possible docking for fuel	64							
Check (8hrs - 73Nm):	8		5%			73							
Detroit River (34)	4	9	30%			36	2,436	222	2.2	9,745	N	236	0.00
Lake St. Clair (14.5)	1	13	82%			13	6,546	191	1.3	6,546	Y		
St. Clair River (24.5)	3	8	25%			24	1,964	253	1.5	5,892	N	236	0.00
5. Transit Lake Huron	14.5	13	82%	400 KW	Full speed across lake	188.5	6,546	191	18.1	94,923	Y		
6. Transit: St. Mary's River (56Nm)	7.5	0-12 Knots	25%-90%	400 KW-1,500 KW	River transit with one lock to pass at Sault Ste Marie								
	7.5					55							
Open River	4	10	38%	400		40	3,068	222	2.7	12,271	N	236	0.40
Soo Lock	0.5	0	5%	400		0	373	369	0.07	187	N	236	0.05
Close Navigation	3	5	14%	400		15	1,148	311	1.1	3,444	N	236	0.30
		13 Knots	100%	400 KW									
7. Transit Lake Superior	18	13	82%	400	Full speed run across lake	234	6,546	191	22.5	117,835	Y		

VOYAGE ANALYSIS

2x MAK 8M32C

Total Voyage Hours :	397	Total Voyage Time at less than 10 knots :	86hrs	or 22% of voyage

TOTAL				MCR	CSR
Days:	16	Total days:	16.54	**100%**	**85%**
Hours:	13	Steaming Days:	12.42		
Minutes:	0	Operating Hrs/Yr:	6,352		
Season Start	**1-Apr-09**		Bunker Capacity :	**600 Tonnes**	600 Tonnes
Season End	**1-Jan-10**		Power :	8,000 kW	6,800 kW
Season Days:	275		Speed :	**13.85 knots**	**13.00 knots**
Lay Days:	10		Consumption :	188 g/kWh	187 g/kWh
Return Trips per Season:	16		Endurance :	5,531 N.Miles	6,143 N.Miles

MAK 8M43C

TOTAL				MCR	CSR
Days:	16	Total days:	16.54	100%	85%
Hours:	13	Steaming Days:	12.42		
Minutes:	0	Operating Hrs/Yr:	6,352		
Season Start	1-Apr-09		Bunker Capacity :	600 Tonnes	600 Tonnes
Season End	1-Jan-10		Power :	8,000 kW	6,800 kW
Season Days:	275		Speed :	13.85 knots	13.00 knots
Lay Days:	10		Consumption :	186 g/kWh	185 g/kWh
Return Trips per Season:	16		Endurance :	5,594 N.Miles	6,213 N.Miles

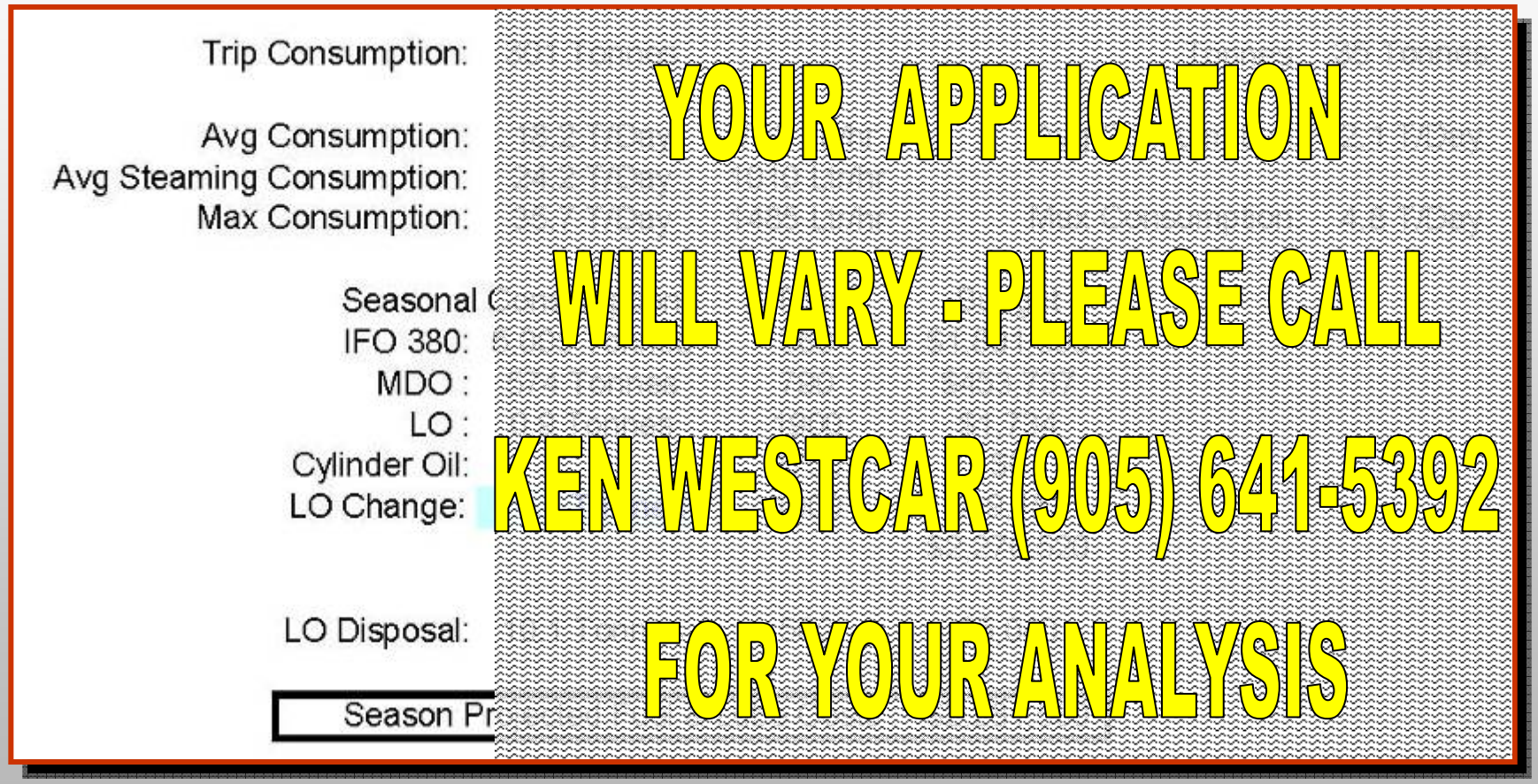
VOYAGE ANALYSIS

2x MAK 8M32C

Voyage Total Propulsion kWh:	
Trip Consumption:	YOUR APPLICATION
Avg Consumption:	
Avg Steaming Consumption:	WILL VARY - PLEASE CALL
Max Consumption:	
Seasona	KEN WESTCAR (905) 641-5392
IFO 380:	
MDO :	FOR YOUR ANALYSIS
LO :	
Cylinder Oil:	
LO Change:	
LO Disposal:	
Season Projected Fuel & Lube Costs :	

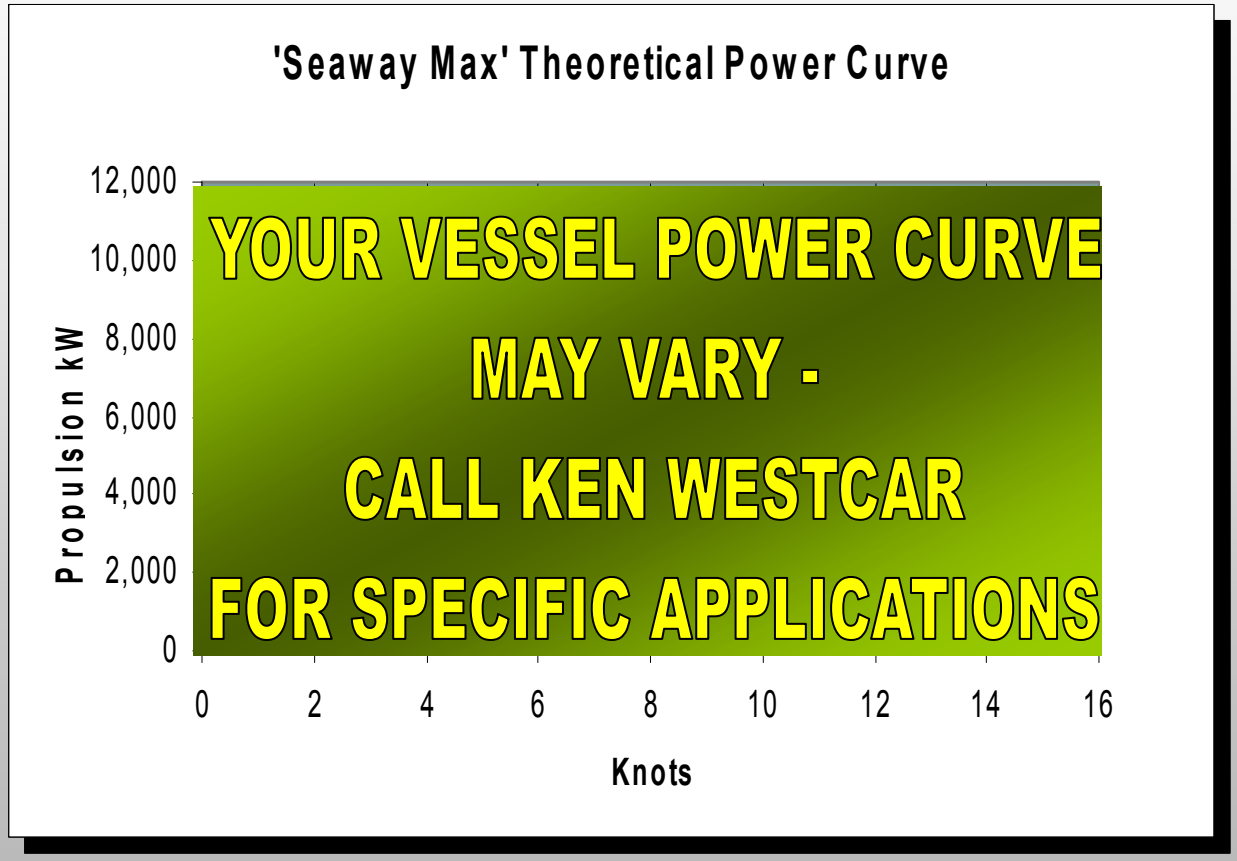
VOYAGE ANALYSIS

MAK 8M43C

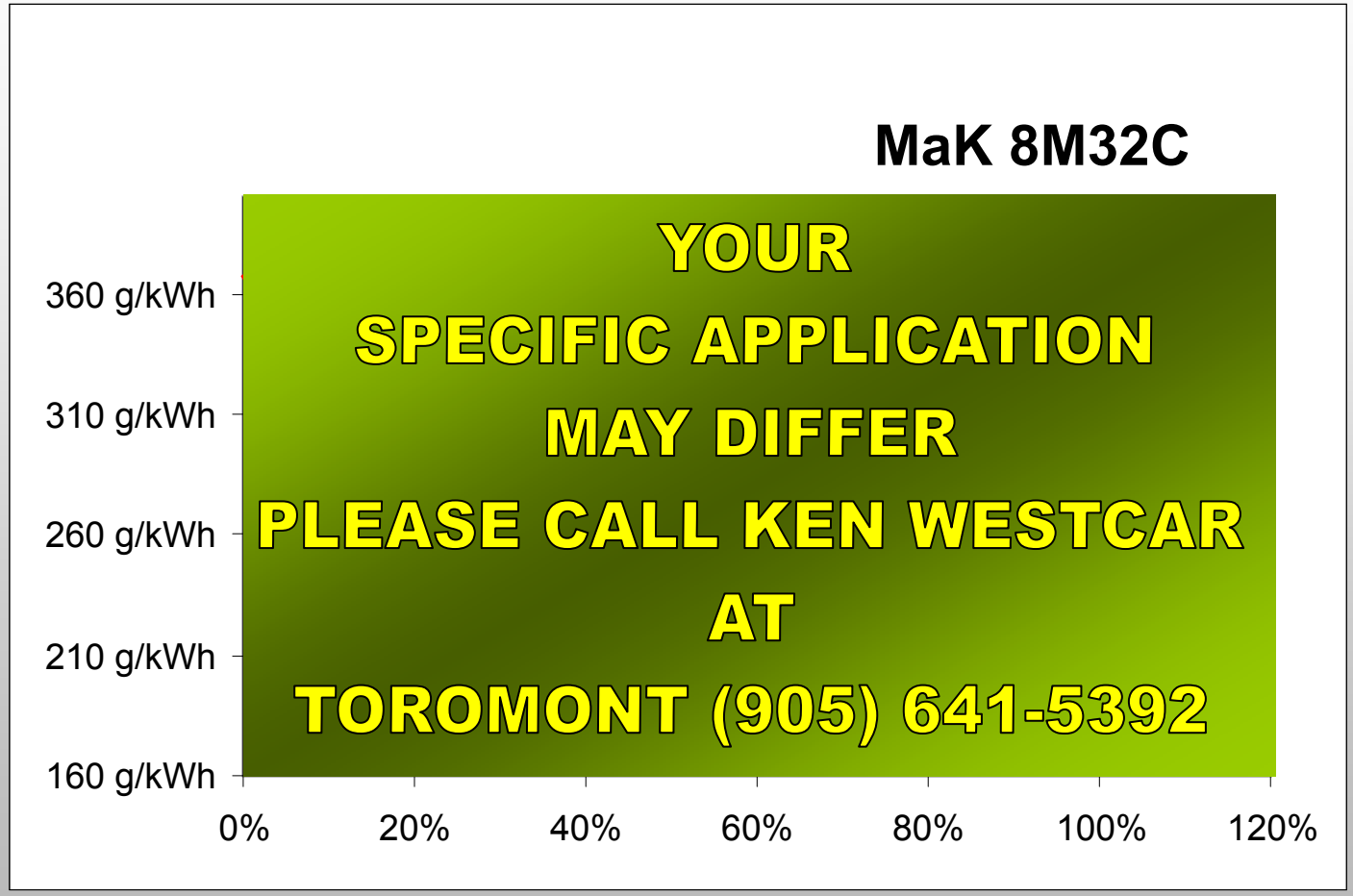


PROPULSIVE PLANT OPTIMIZATION

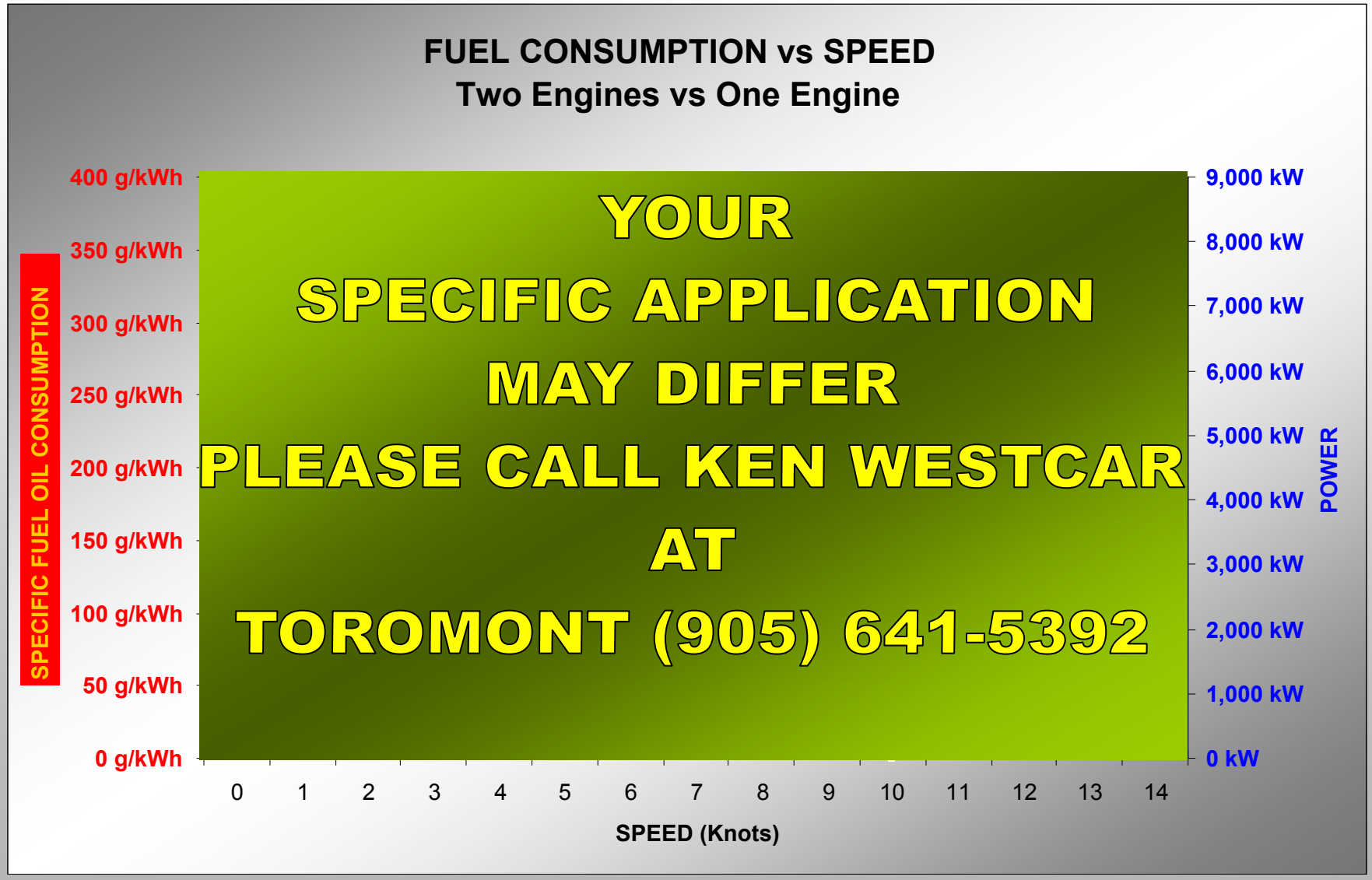
SEAWAY MAX LAKER
THEORETICAL POWER CURVE



MAK 8M32C
FUEL CONSUMPTION CURVE

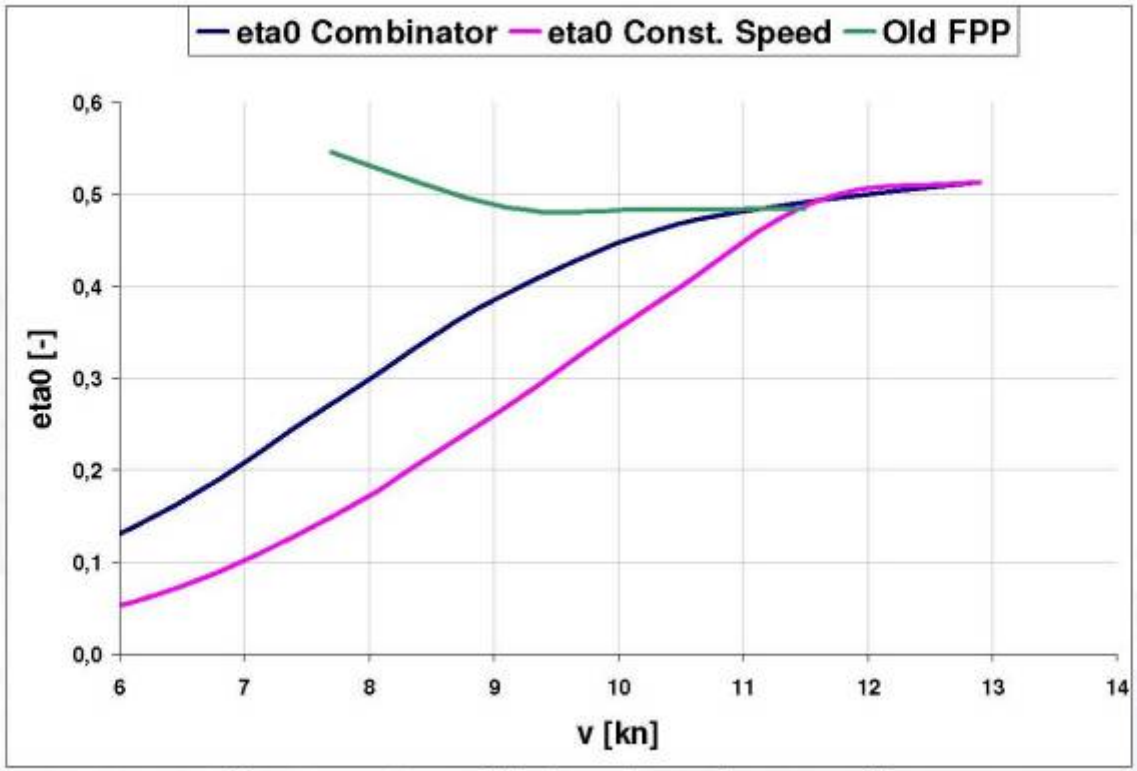


FUEL CONSUMPTION CURVES



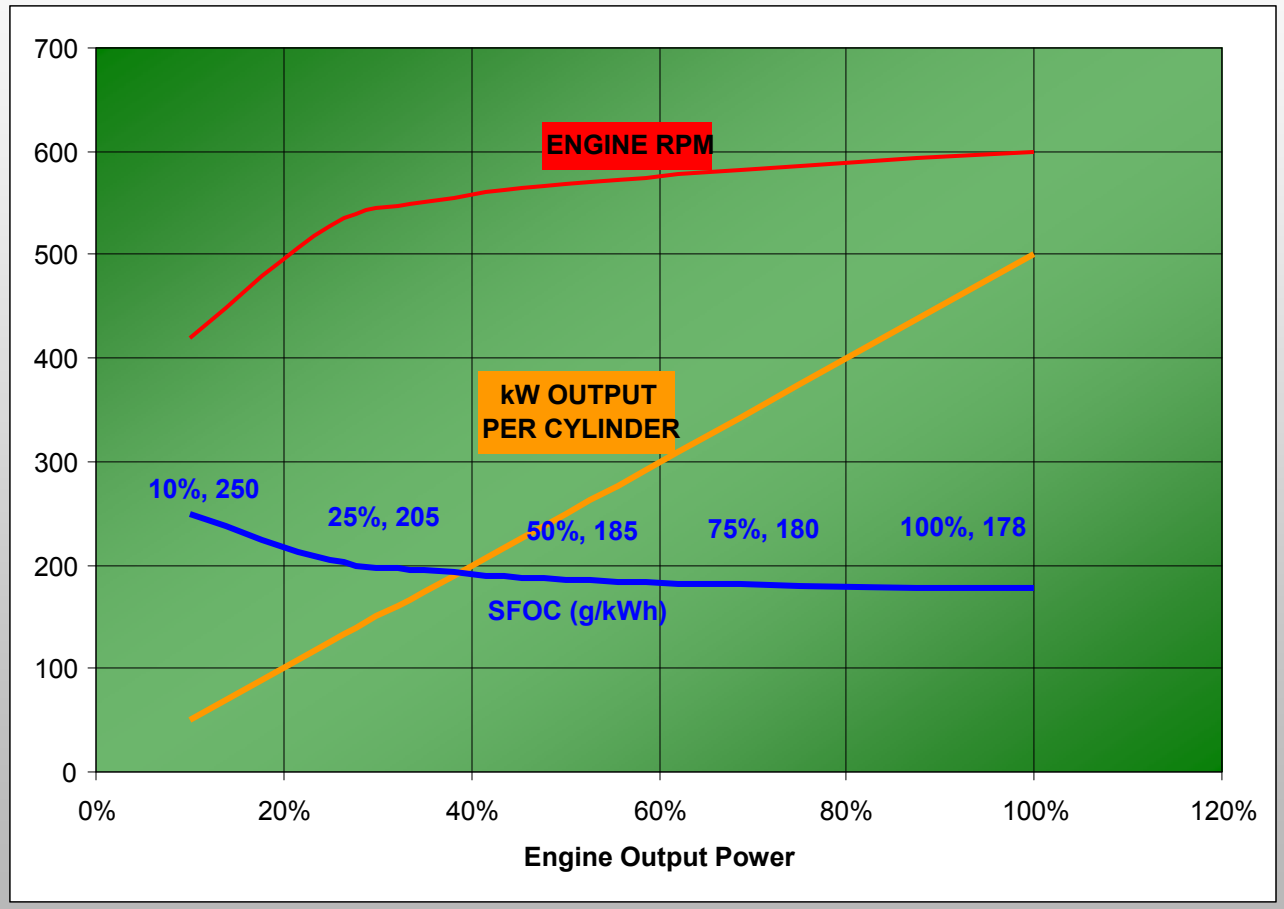
PROPELLER CURVES

Great Lakes Application

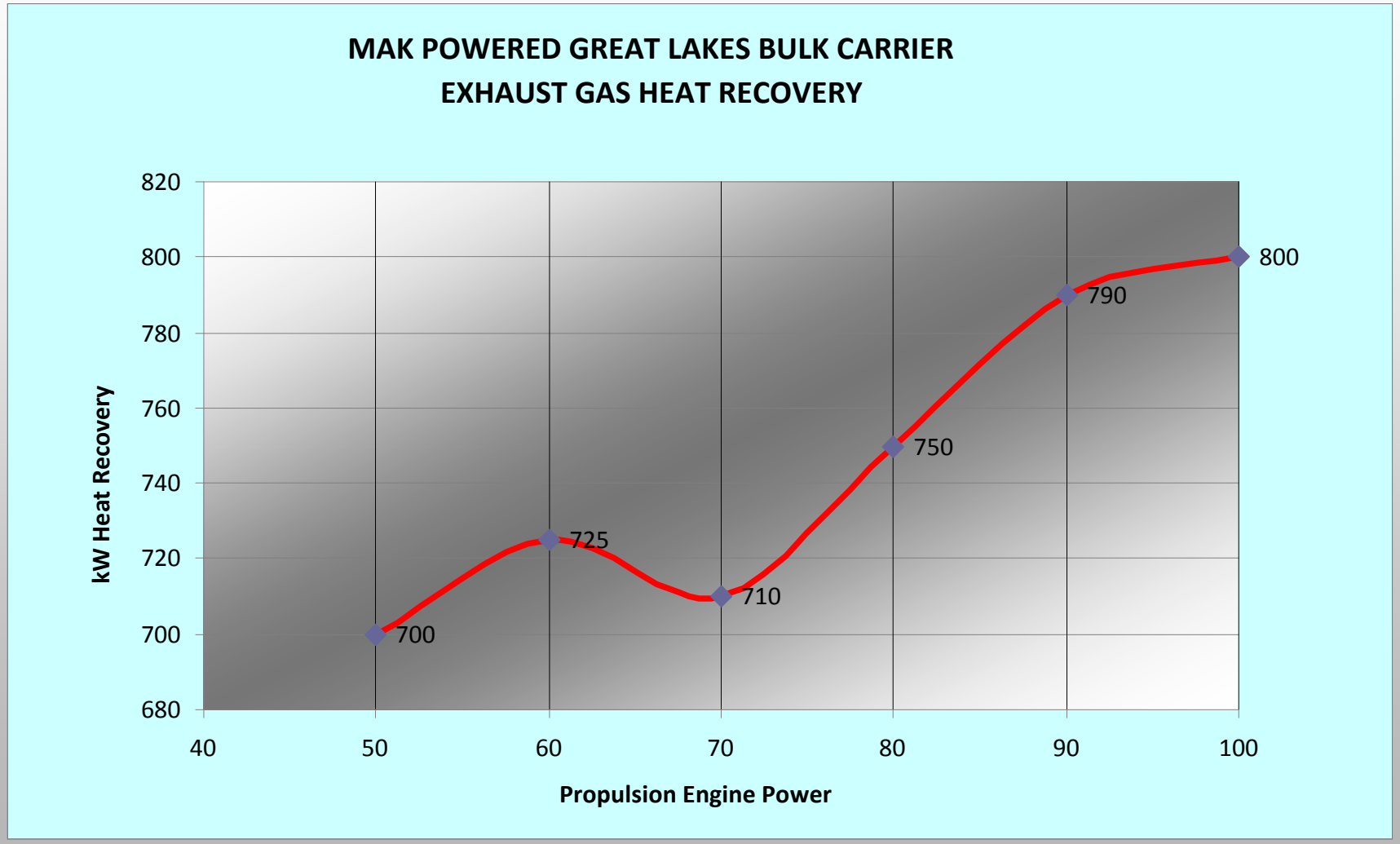


Open water efficiencies of propeller
Assumption: Power proportional to v^3

MAK 8M32C CURVES



HEAT RECOVERY CURVES



Heat Recovery Analysis

GESAB

2009.02.05

1 x Engine type - MaK 8M43C

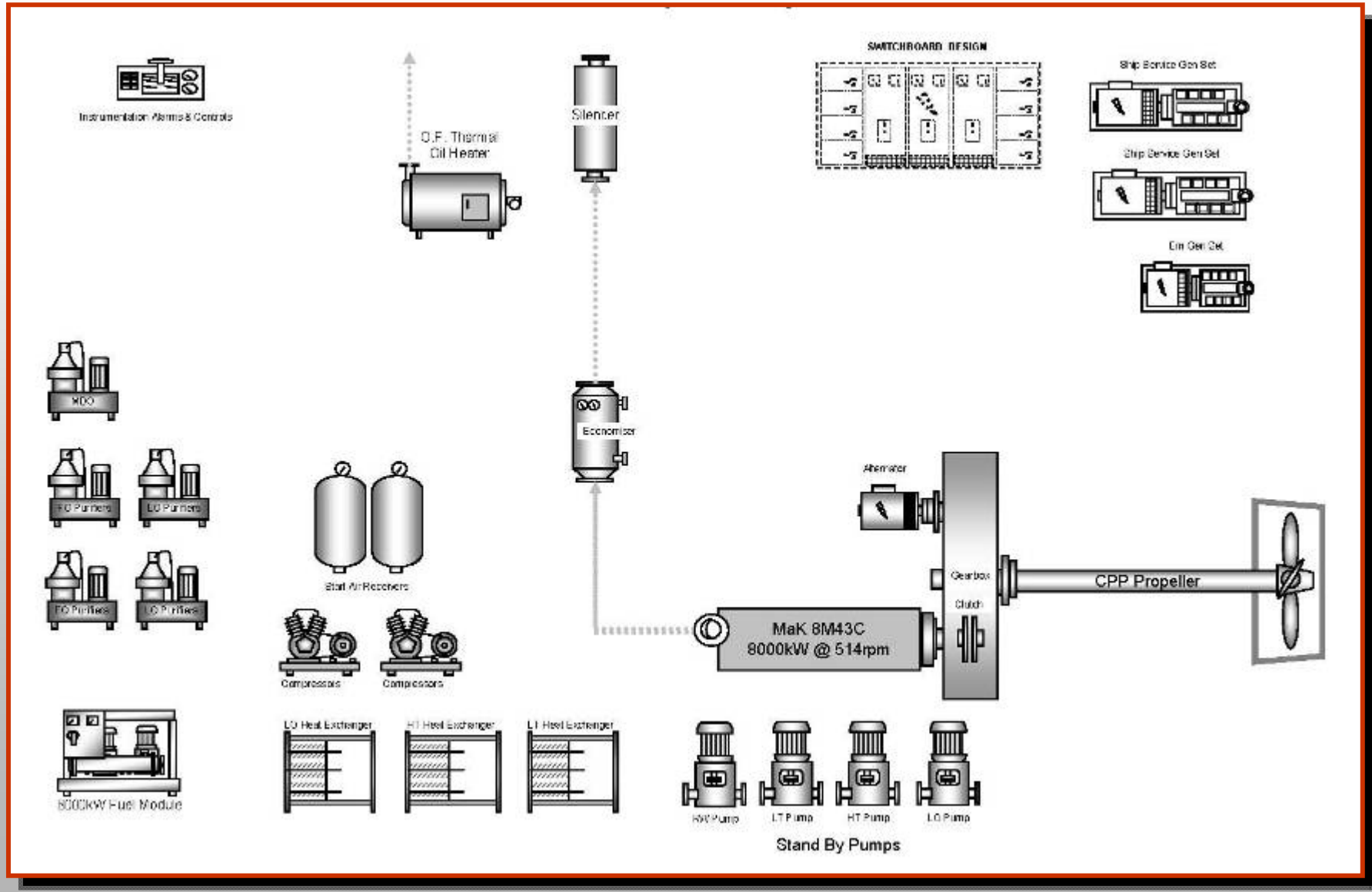
Engine load in [%]	EGH produced heat [kW]	Oil Fired Heater Oil cons. [kg/h]
100	1000	21
90	950	26
80	887	33
70	855	36
60	860	35
50	855	36
25	670	56

2 x Engine type - MaK 8M32C

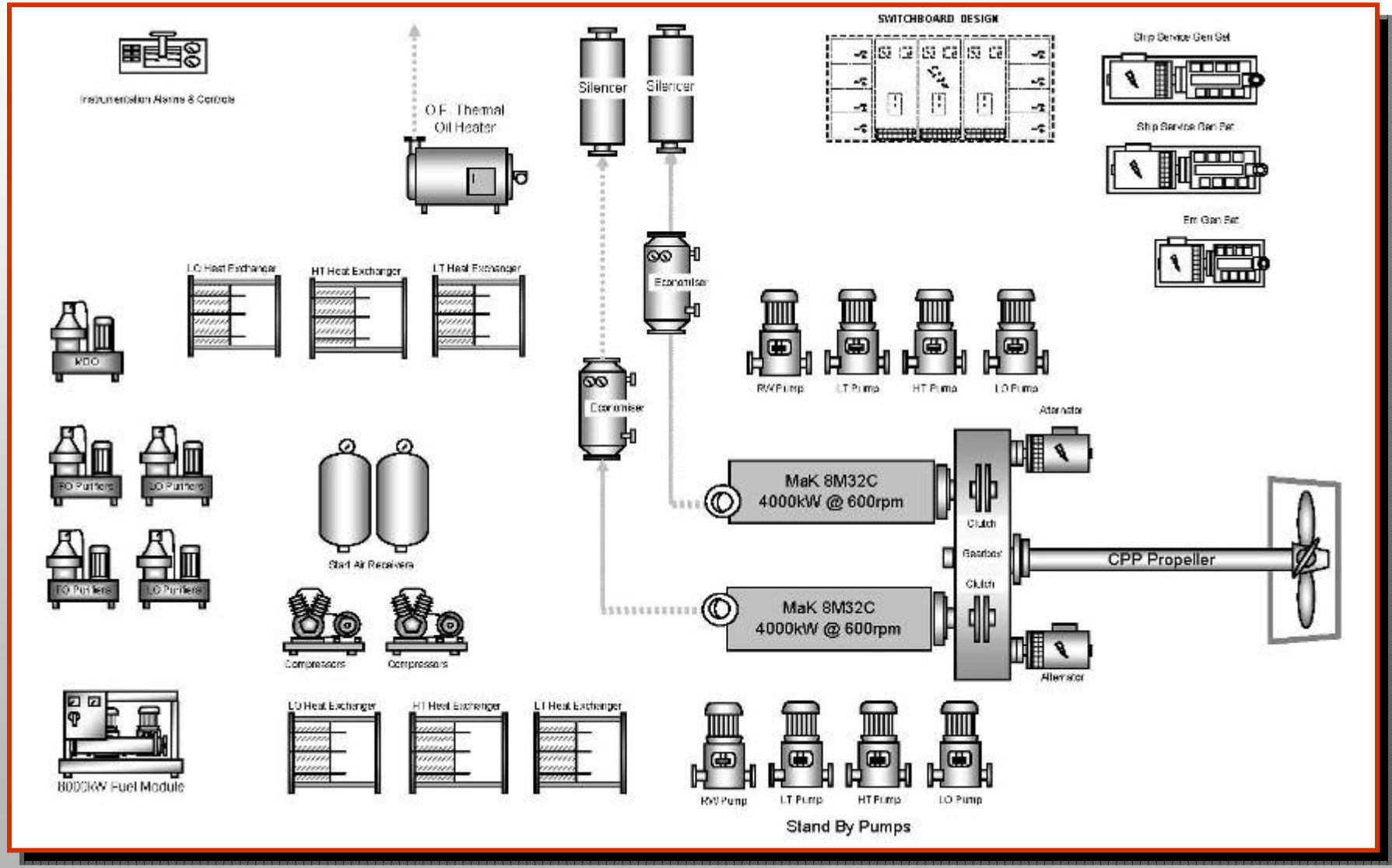
Engine load in [%]	EGH produced heat [kW]	Oil Fired Heater Oil cons. [kg/h]
100	2 x 800 = 1600	No
90	2 x 790 = 1580	No
80	2 x 750 = 1500	No
70	2 x 710 = 1420	No
60	2 x 725 = 1450	No
50	2 x 700 = 1400	No
25	3 x 350 = 700 (estimated)	53

PROPOSED PACKAGES

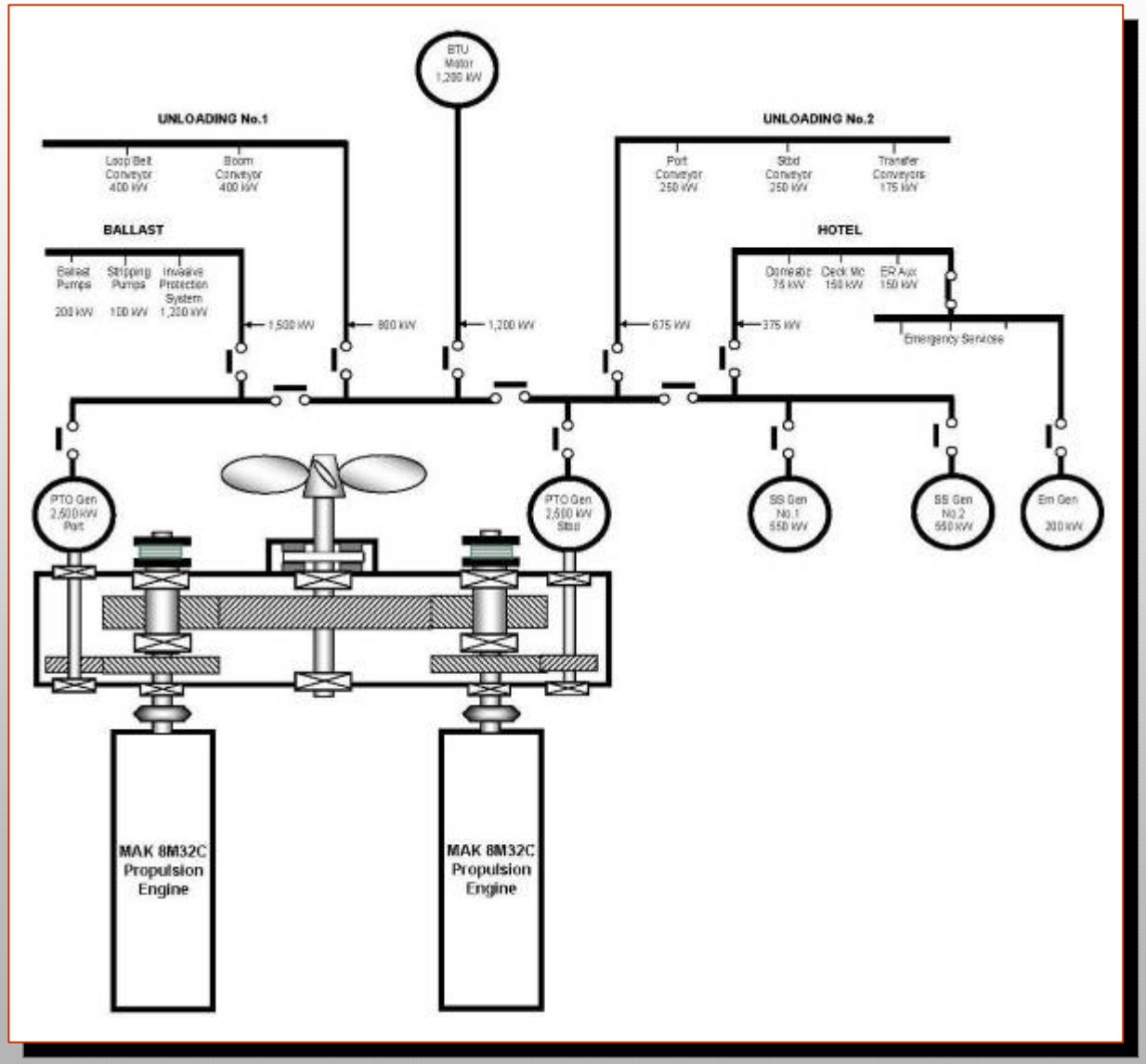
MAK 8M43C PACKAGE



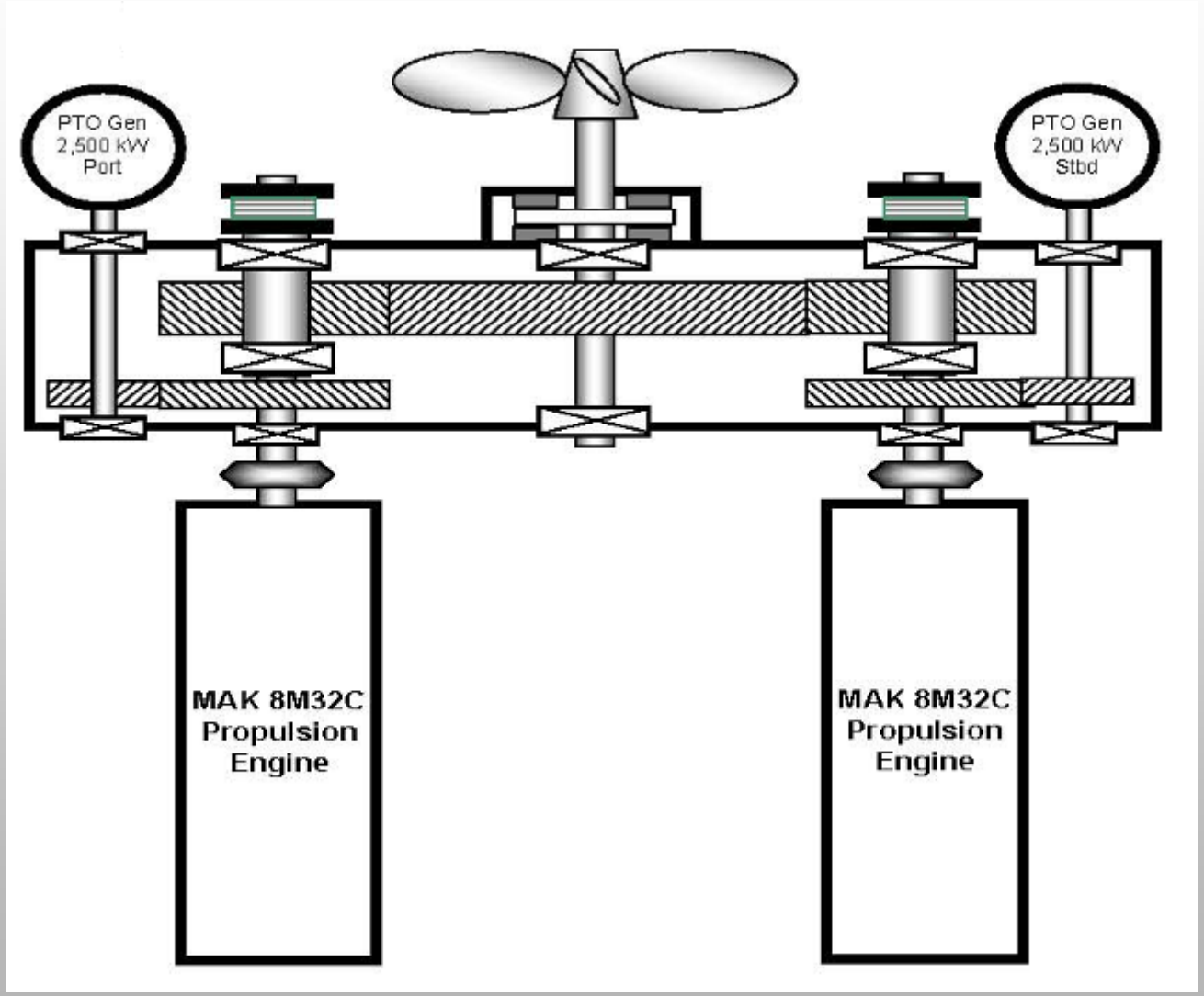
2x MAK 8M32C PACKAGE



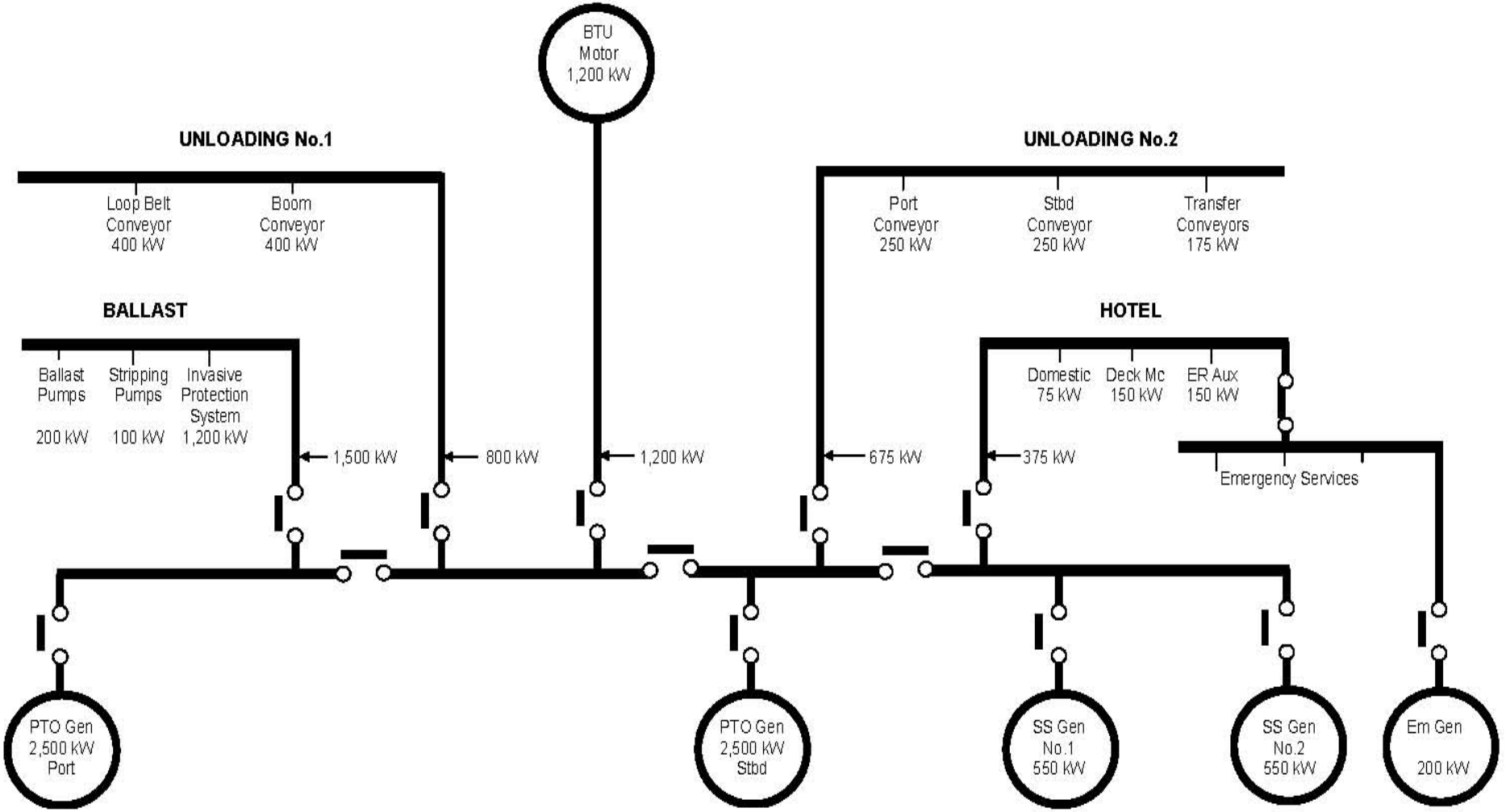
TWIN ENGINE OVERVIEW



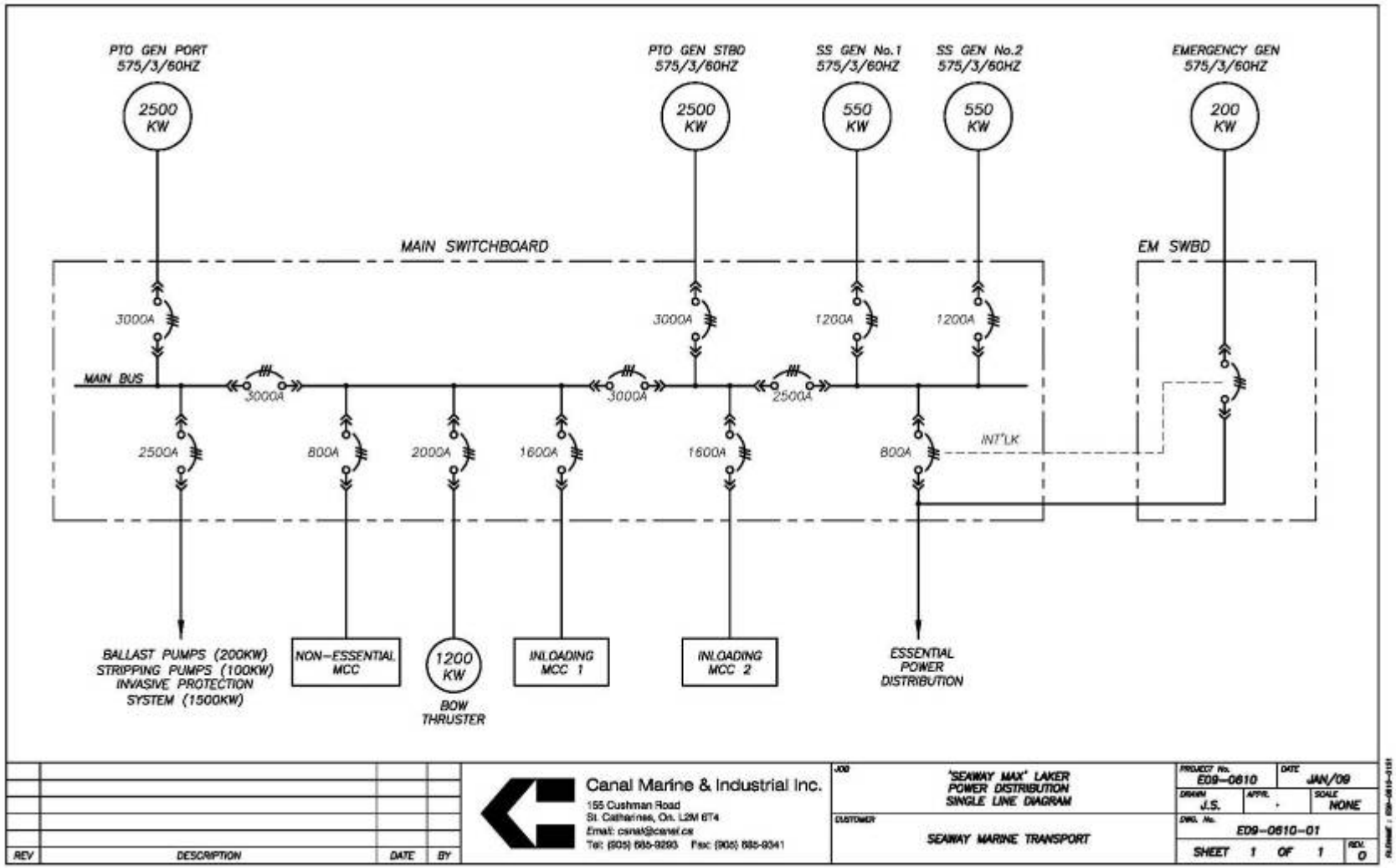
PROPULSION CONFIG.



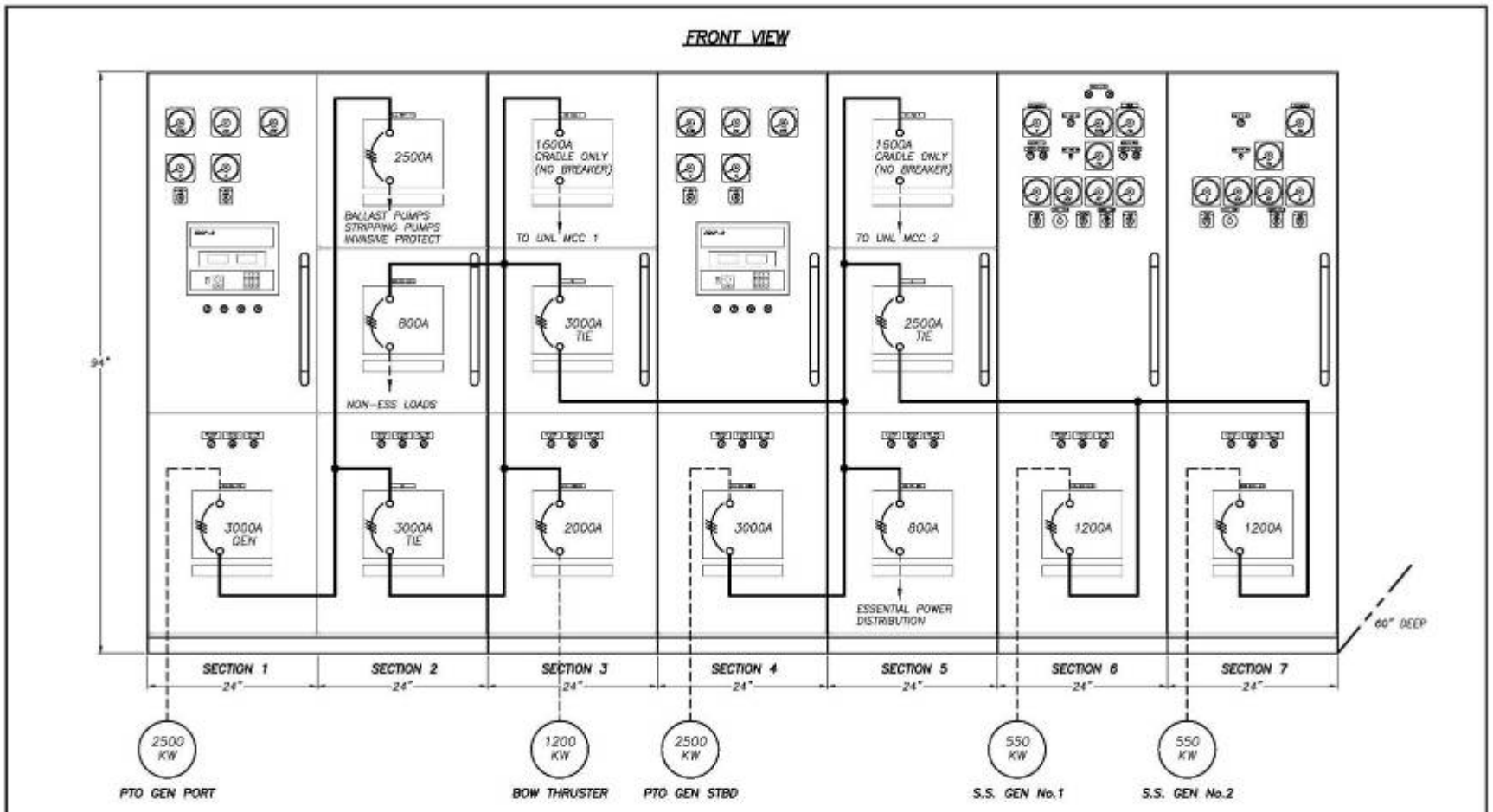
SWITCHBOARD CONFIG.



SWITCHBOARD DESIGN



SWITCHBOARD ARRANGEMENT



PROPULSION DRIVE DIMENSIONAL & MASS ANALYSIS

PHYSICAL ANALYSIS

	Engine	kW	rpm	Cyl	L.O.A	Crank L	Gear	Width	Height	Envelope	Min ER Length
MAK	MaK 8M43C	8000	514	8	9,798	8,215	3,000	2,904	5,501	157	17215
MAK	2x MaK 8M32C	8000	600	16	7,061	5,876	3,000	7,154	4,498	227	14876
MAN B&W	B&W S46 MC-B8										
MAN B&W	MAN 7L48/60CR										
MAN B&W	MAN 6L58/64CR										
WARTSILA	W RTA flex48T										
WARTSILA	W 7L46F										
WARTSILA	W 6RTflex50B										
WARTSILA	W 6+8L38										
WARTSILA	W 8L46F										

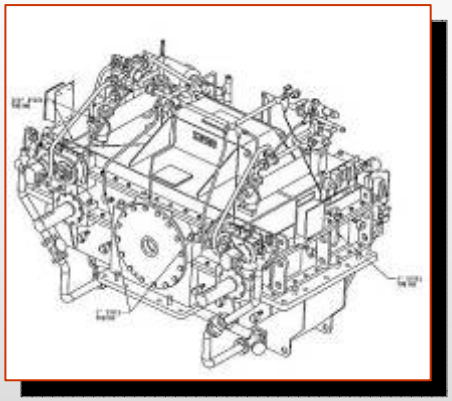
YOUR SPECIFIC APPLICATION MAY DIFFER

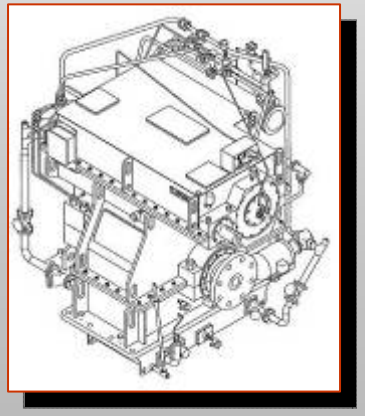
PLEASE CALL KEN WESTCAR AT TOROMONT (905) 641-5392

DIMENSIONAL & MASS ANALYSIS BASIS

GLOBAL Assumed Values

Single input Gearbox Length:	3,000mm
Twin input Gearbox Length:	3,000mm
ME to Fwd ER Bhd:	3,000mm
Aft bhd to Coupling:	3,000mm
Single Engine Gear Mass:	39 T
Twin Input Gear Mass:	40 T
Avg Elect Stby Pump Mass:	1.2 T





DIMENSIONAL ANALYSIS

Sort by ER Length

Engine	kW	rpm	Cyl	L.O.A	Crank L	Gear	Width	Height	Envelope	Min ER Length
W RTA flex48T										
B&W S46 MC-B8										
W 6RTflex50B										
2x MaK 8M32C	**8000**	**600**	**16**	**7,061**	**5,876**	**3,000**	**7,154**	**4,498**	**227**	**14876**
W 6+8L38										
W 7L46F										
MAN 6L58/64CR										
MAN 7L48/60CR										
MaK 8M43C										
W 8L46F										

YOUR SPECIFIC APPLICATION MAY DIFFER

PLEASE CALL KEN WESTCAR AT TOROMONT (905) 641-5392

MASS COMPARISON

Sort by Total Mass

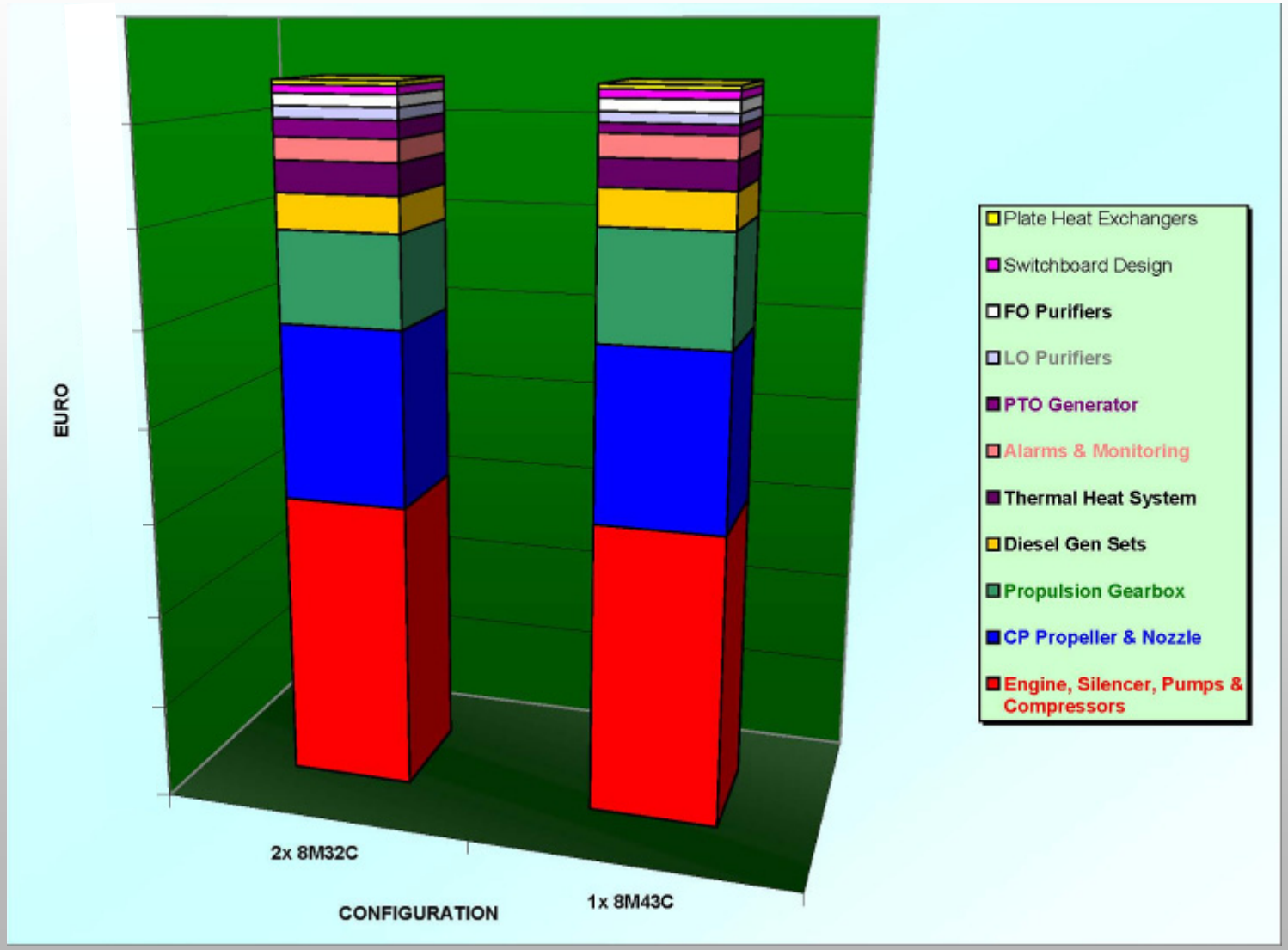
Engine	kW	rpm	Cyl	Engine Mass	Gearbox Mass	No of Aux	Aux Mass	Total Mass
2x MaK 8M32C	**8000**	**600**	**16**	**92.8**	**36 T**	**0**	**0**	**128.8**
W 7L46F								
MAN 7L48/60CR								
W 6+8L38								
W 8L46F								
B&W S46 MC-B8								
MAN 6L58/64CR								
MaK 8M43C								
W RTA flex48T								
W 6RTflex50B								

YOUR SPECIFIC APPLICATION MAY DIFFER

PLEASE CALL KEN WESTCAR AT TOROMONT (905) 641-5392

PACKAGE
COST BREAKDOWN

8000kW MAK
Propulsion Comparison



MAINTENANCE COMPARISON

MAINTENANCE COSTS

Basis: 6000 Operating Hours over 15 Years

MAK 8M32C

Engine Hours	Start Usage	0	6,000	12,000	18,000	24,000	30,000	36,000	42,000	48,000	54,000	60,000	66,000	72,000	78,000	84,000
	End Usage	6,000	12,000	18,000	24,000	30,000	36,000	42,000	48,000	54,000	60,000	66,000	72,000	78,000	84,000	90,000
CORE ENGINE																
1063 AFTERCOOLER																
1100 CYLINDER HEAD ASSEMBLY																
1200(IC) SHORT BLOCK																
1205 CRANKSHAFT DAMPER/PULLEY																
1239 CYLINDER PACK																
1250 FUEL SYSTEM																
1361 WATER PUMP																
1450 STARTING SYSTEM																
FUEL SYSTEM																
126D DUPLEX FUEL FILTER																
LUBE SYSTEM																
1304 ENGINE OIL PUMP																
131D DUPLEX OIL FILTER																
1336 OIL MIST DETECTOR																
MAINTENANCE																
7502 PM 2																
7503 PM 3																
TOTAL																
TOTAL/SMU																
Cumulative Parts Costs :																
Cost Per Hour Run since new :																
Cum. Maintenance Part Cost/Year :																
Annual Cre																
Annual E																
Annual E																
Annual En																

15 Y

PLEASE CALL KEN WESTCAR AT TOROMONT (905) 641-5392 FOR YOUR SPECIFIC APPLICATION

ALL VALUES ARE PER ENGINE

Printed: 09/02/2009

MAINTENANCE COSTS

Basis: 6000 Operating Hours over 15 Years

MAK 8M43C

Engine Hours															
Start Usage	0	6,000	12,000	18,000	24,000	30,000	36,000	42,000	48,000	54,000	60,000	66,000	72,000	78,000	84,000
End Usage	6,000	12,000	18,000	24,000	30,000	36,000	42,000	48,000	54,000	60,000	66,000	72,000	78,000	84,000	90,000

CORE ENGINE
1083 AFTERCOOLER
1100 CYLINDER HEAD ASSEMBLY
1200(IC) 'SHORT BLOCK' COMPONENTS
1205 CRANKSHAFT DAMPER/PULL
1239 CYLINDER PACK
1250 FUEL SYSTEM
1450 STARTING SYSTEM
Total

FUEL SYSTEM
126D DUPLEX FUEL FILTER
Total

LUBE SYSTEM
1304 ENGINE OIL PUMP
131D DUPLEX OIL FILTER
1336 OIL MIST DETECTOR
Total

MAINTENANCE
7502 PM 2
7503 PM 3
Total

TOTAL EURO
TOTAL/SMU EURO Per Hr Run this period

Cumulative Parts Costs : EURO
SMU Cost Per Hour Run since new :
Cum. Maintenance Part Cost/Year : EURO

Annual Crew Maintenance Manhours
Annual Engine Downtime (Hours)

PLEASE CALL KEN WESTCAR AT TOROMONT (905) 641-5392 FOR YOUR SPECIFIC APPLICATION

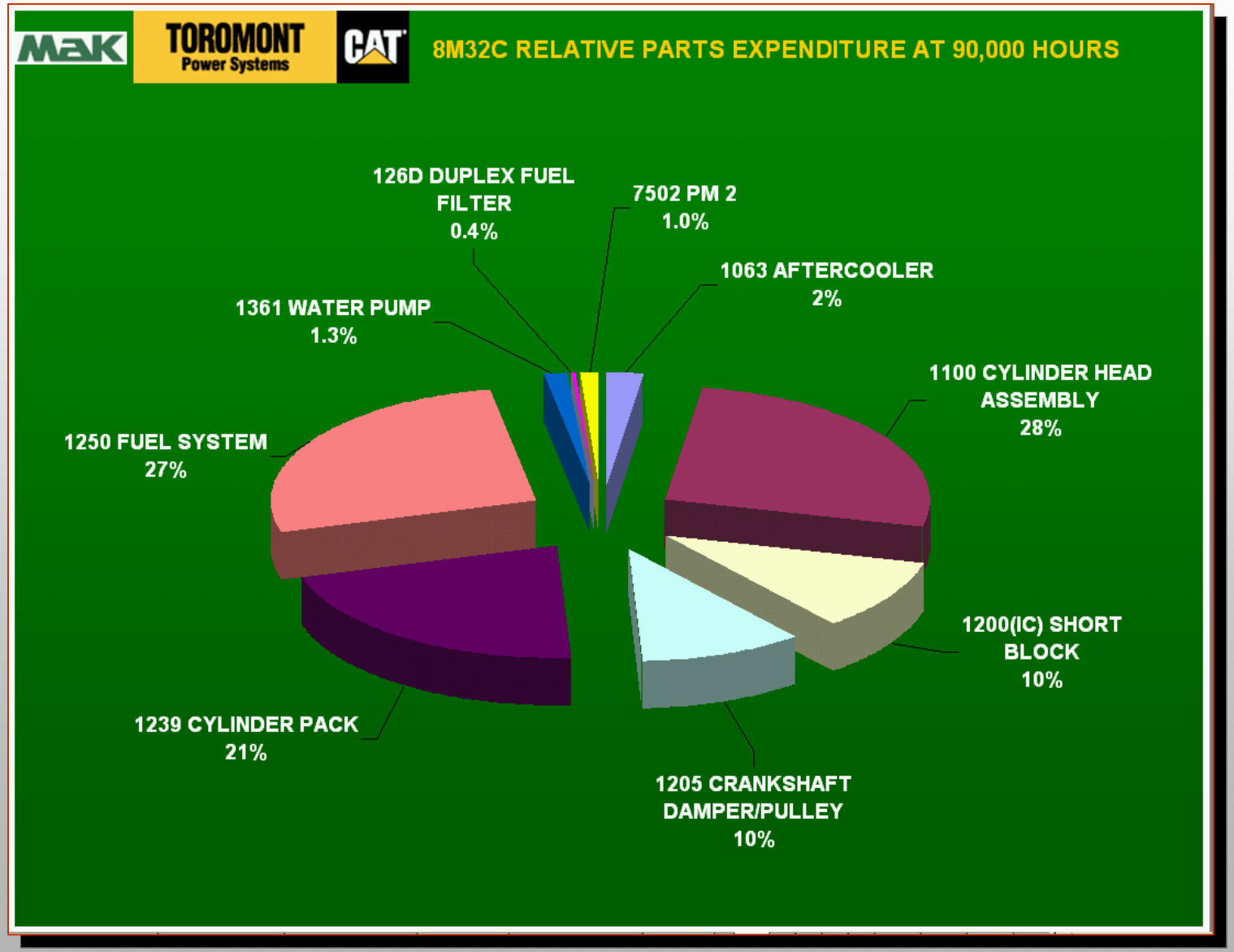
8M43C MAINTENANCE

Basis: 6000 Operating Hours over 15 Years

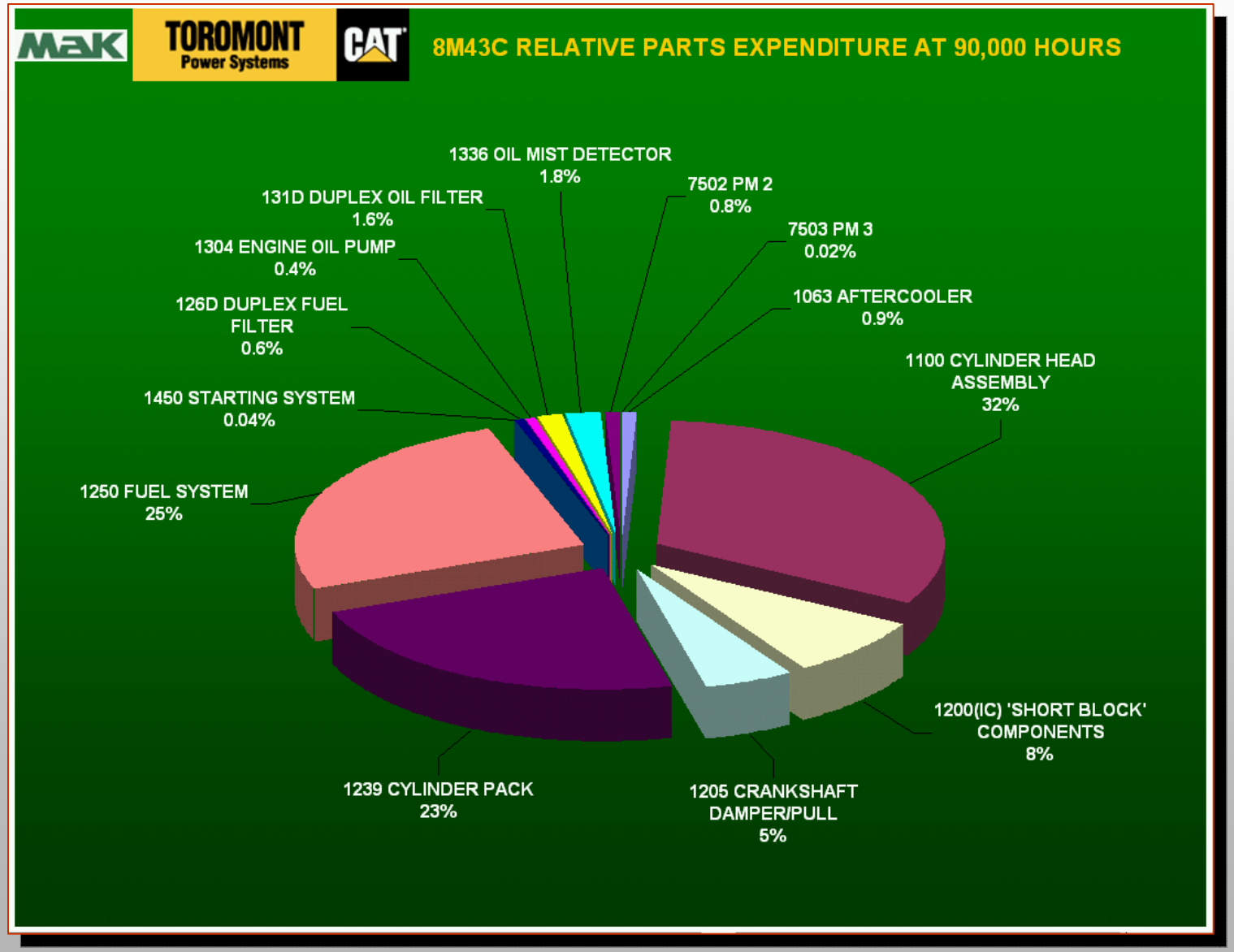
8M32C MAINTENANCE

Basis: 6000 Operating Hours over 15 Years

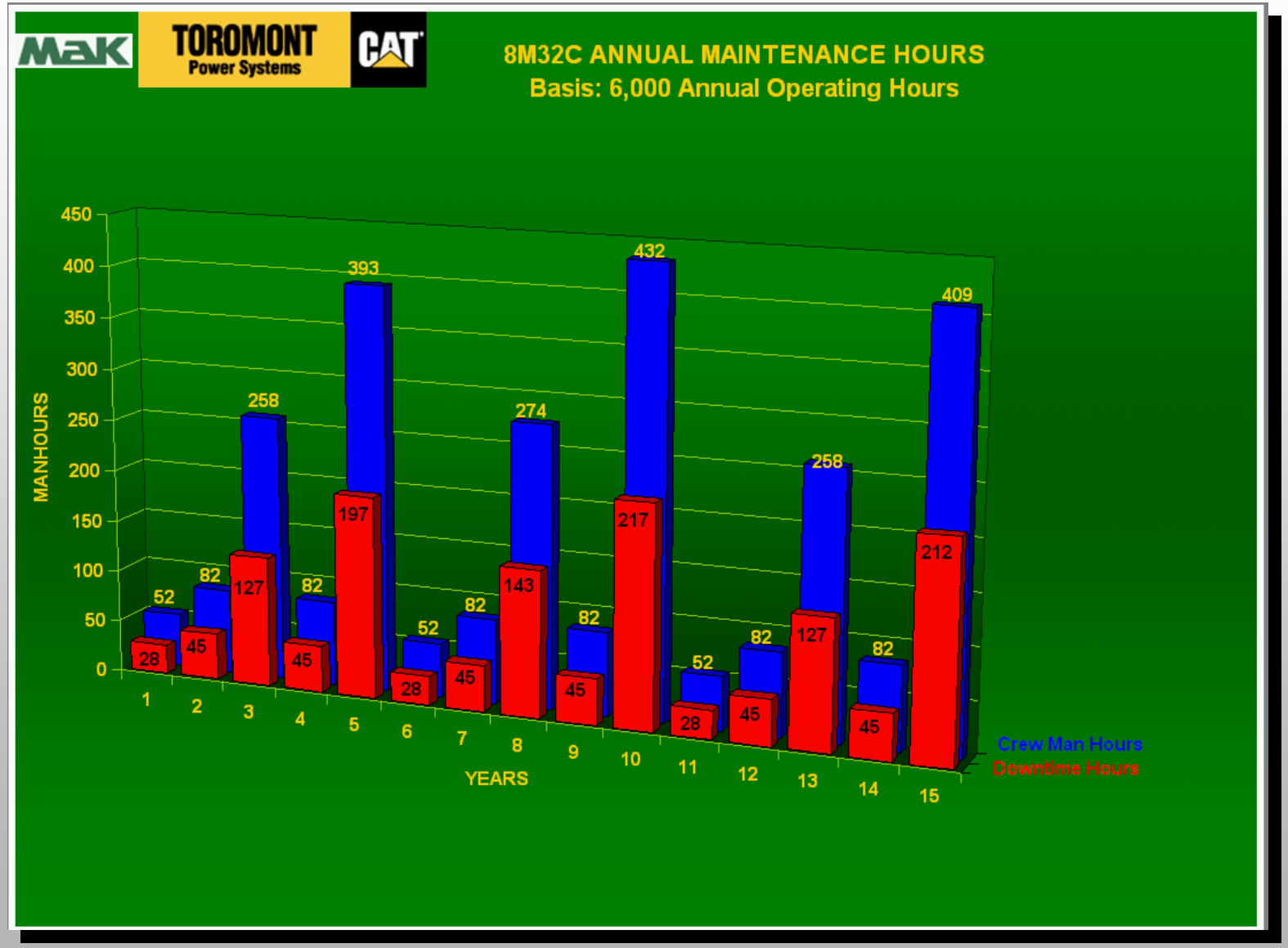
8M32C MAINTENANCE



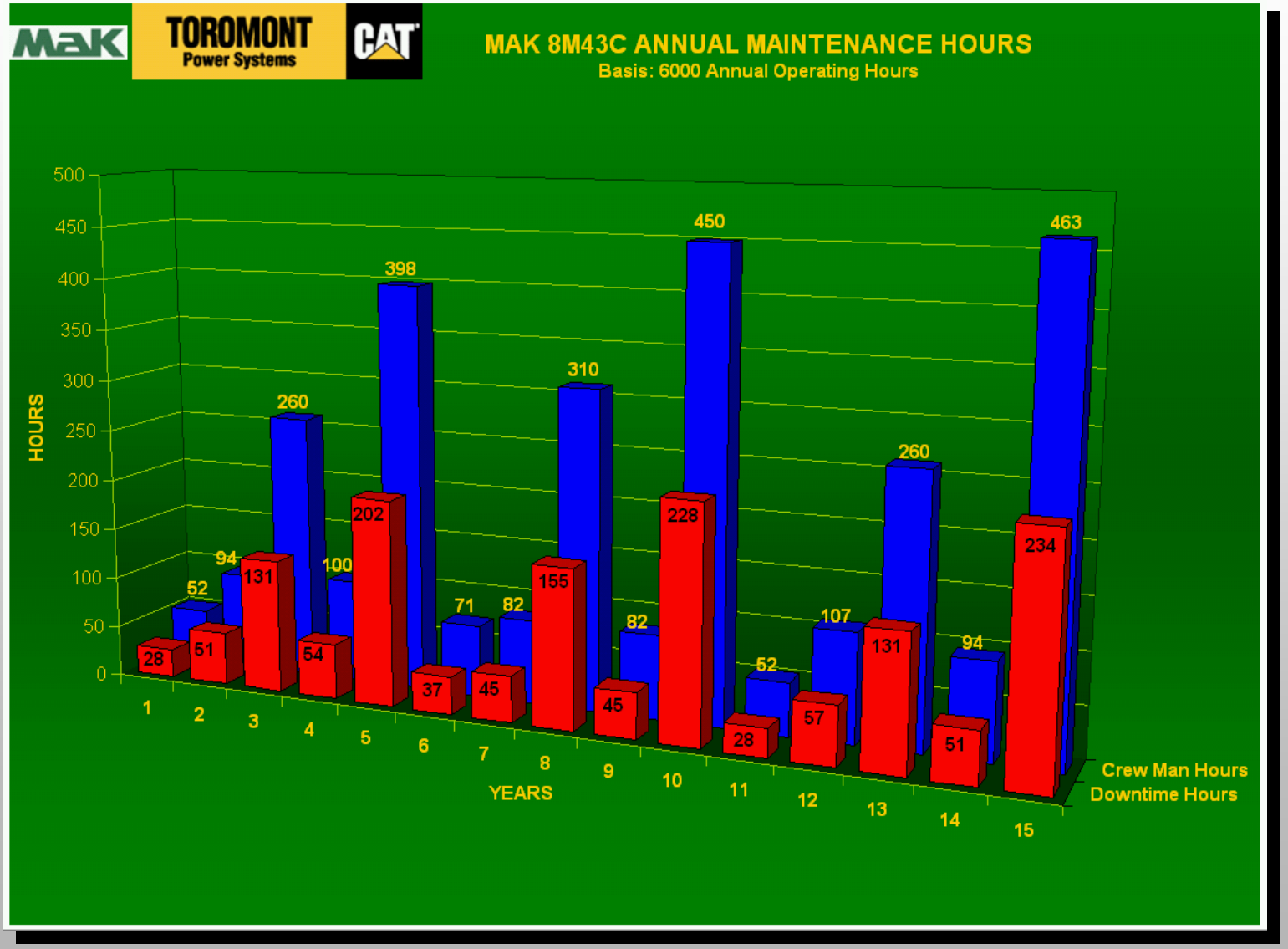
8M43C MAINTENANCE



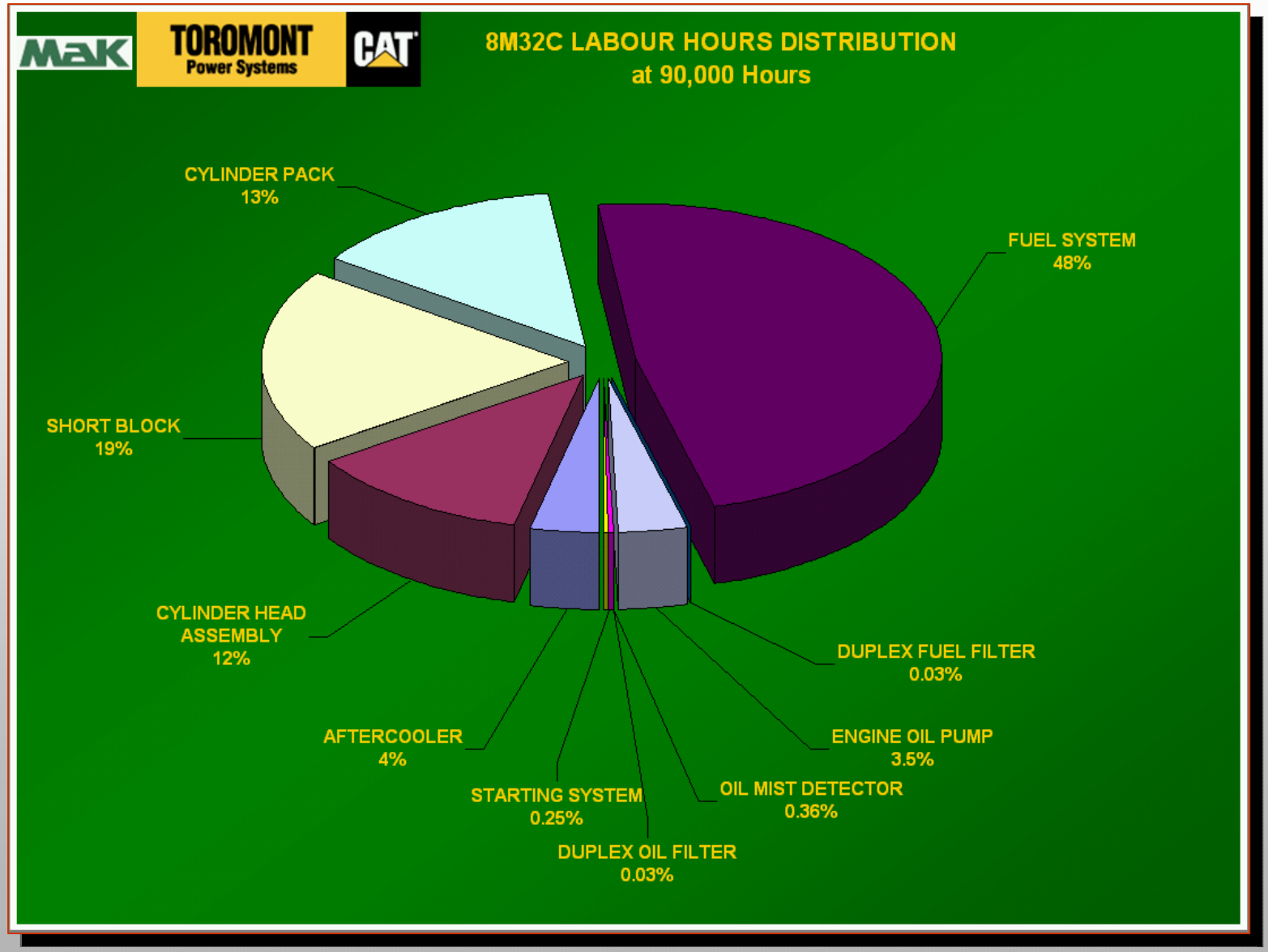
8M32C MAINTENANCE



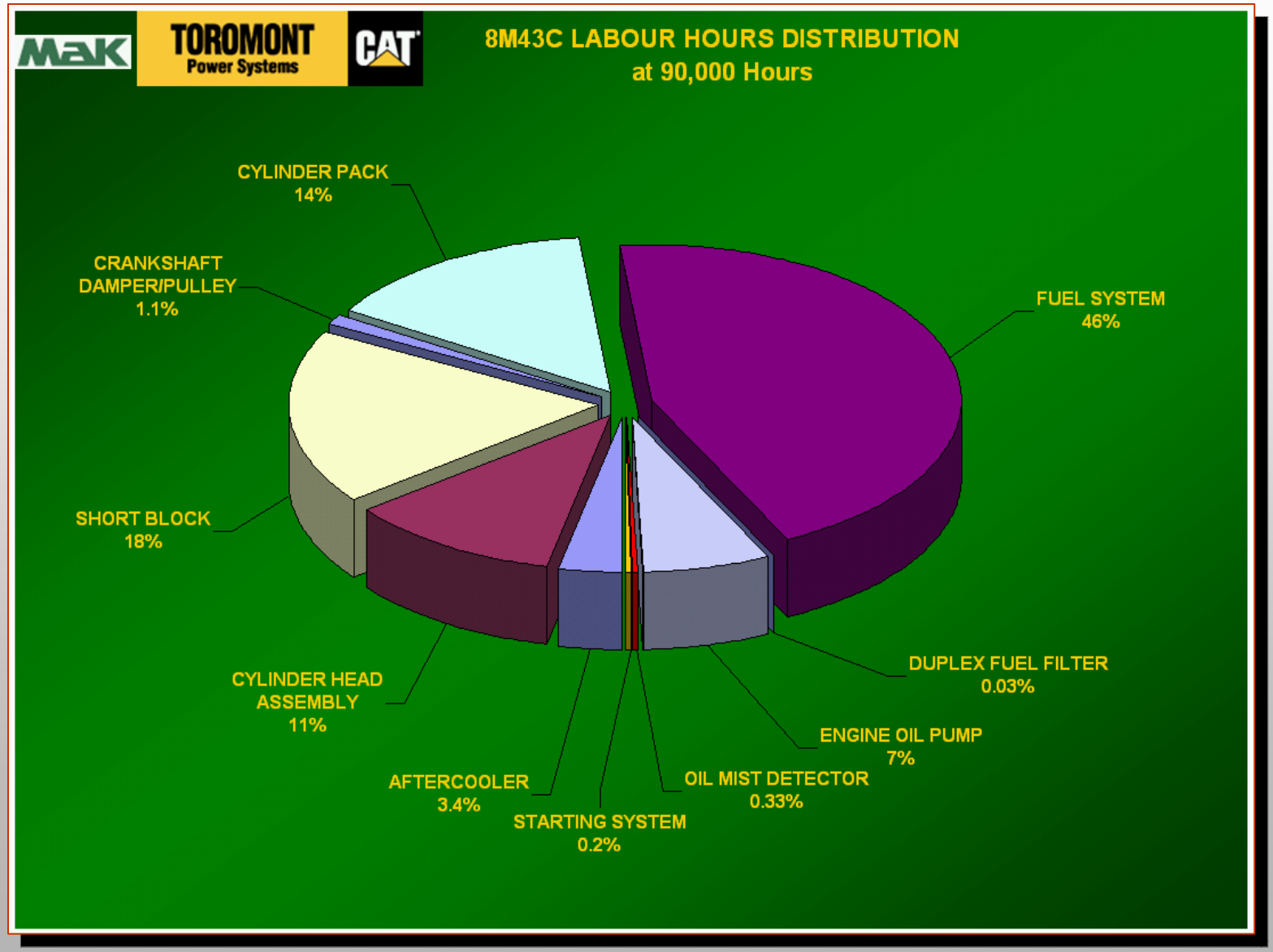
8M43C MAINTENANCE



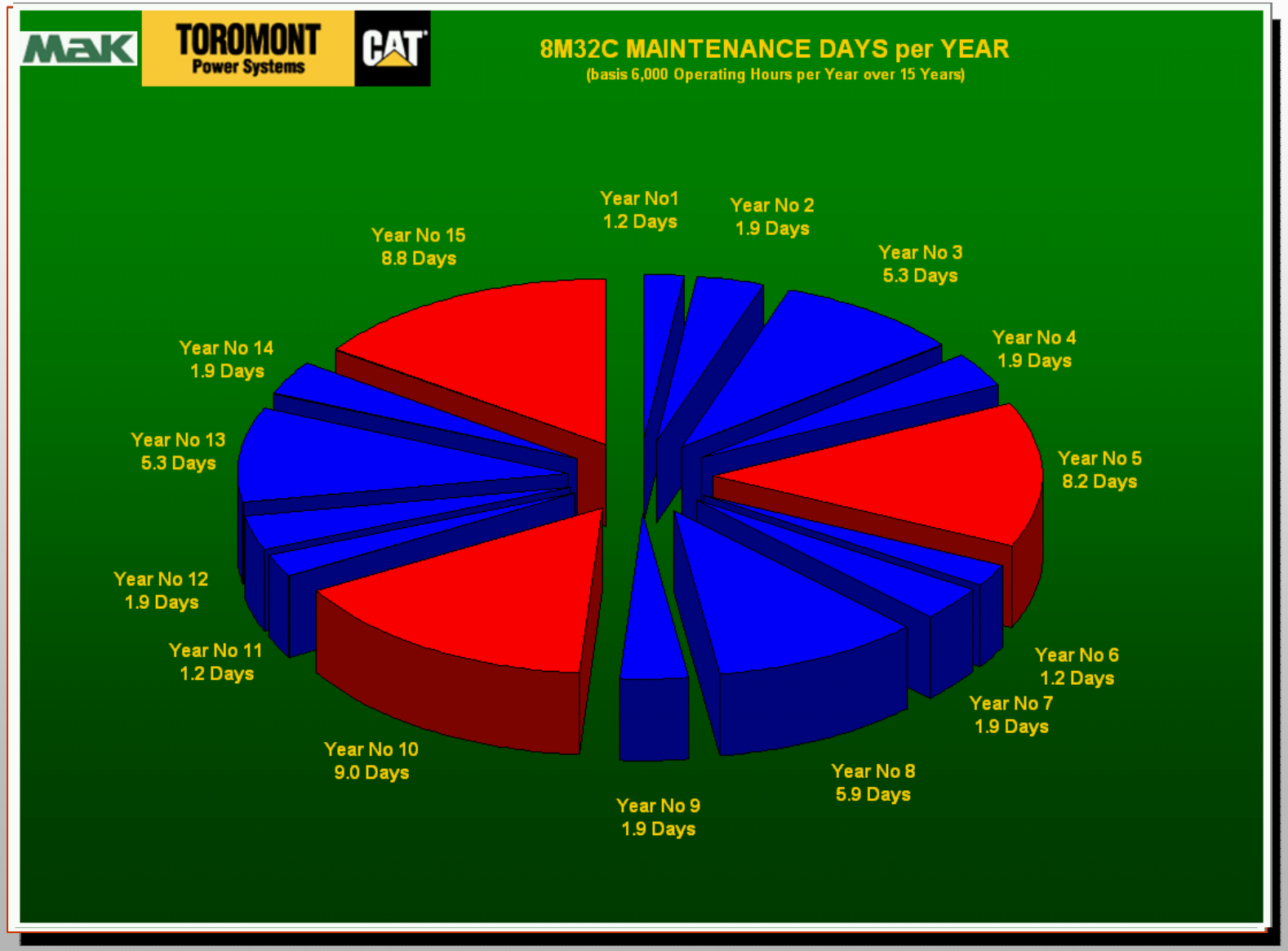
8M32C MAINTENANCE



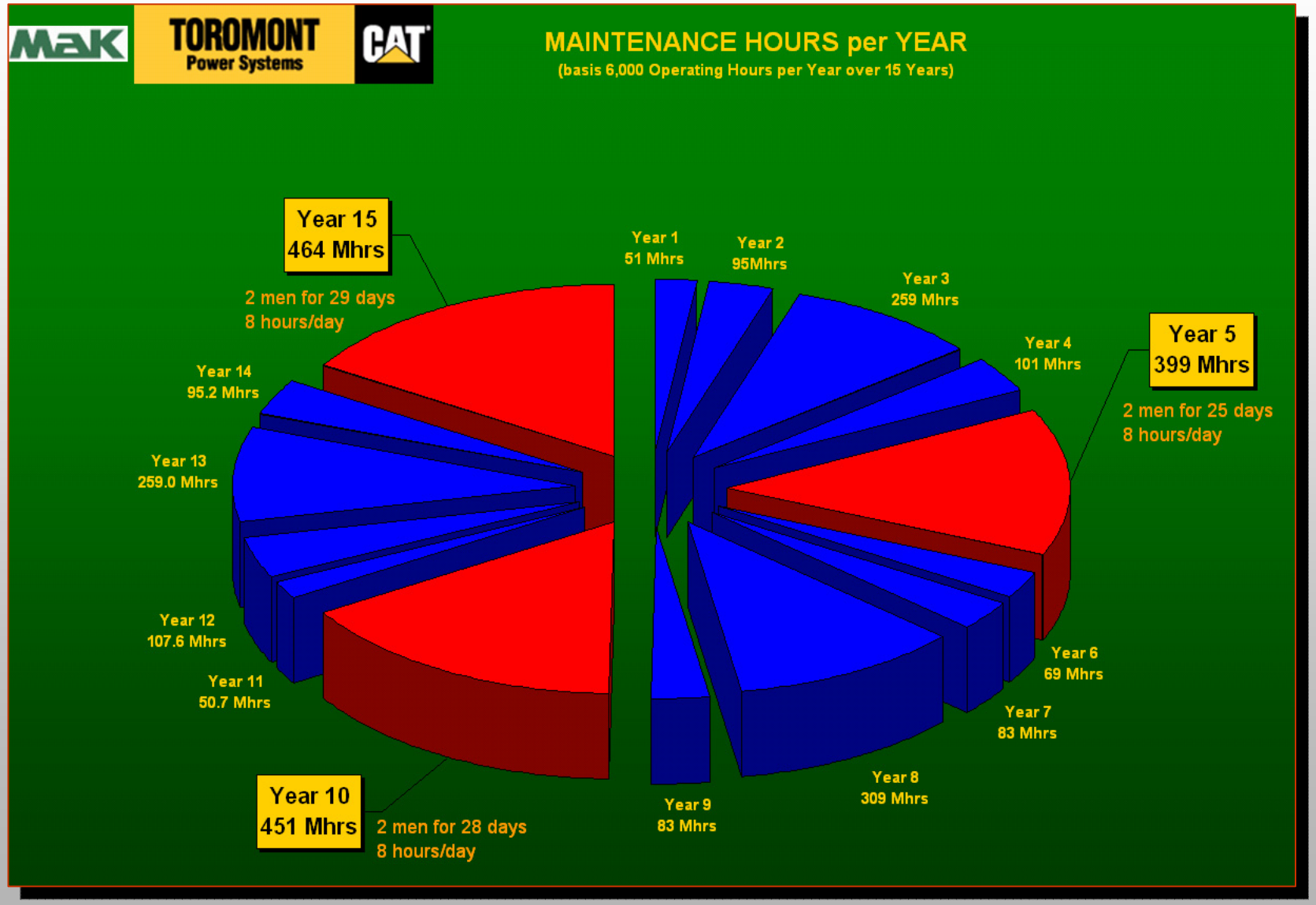
8M43C MAINTENANCE



8M32C MAINTENANCE



8M43C MAINTENANCE



CLICK HERE TO SEE POWER REPORTS OF TOROMONT MARINE APPLICATIONS

THANK YOU

WE'RE HERE FOR YOU

Marine Contacts:

For MAK :-	Ken Westcar	(905) 641-5392	email: KWestcar@toromont.com
For CAT :-	Kiet Mach	(416) 458-2116	email: KMach@toromont.com
Customer Support:-	Sean Goodman	(416) 427-7159	email: SGoodman@toromont.com

Toromont CAT, 3131 Highway 7 West, P.O. Box 5511, Concord, Ontario L4K 1B7 Tel: (416) 667 5833