Standardizing Electrical Analysis for Vessel Life Extension and Modernization

Ottawa

24 April 2019

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Overview

BMT Group

- BMT is an international design, engineering and risk management consultancy, working principally in the defence, energy and environment and maritime transport sectors.
- 1544 staff in 26 subsidiary companies in Europe, South America, North America and Asia

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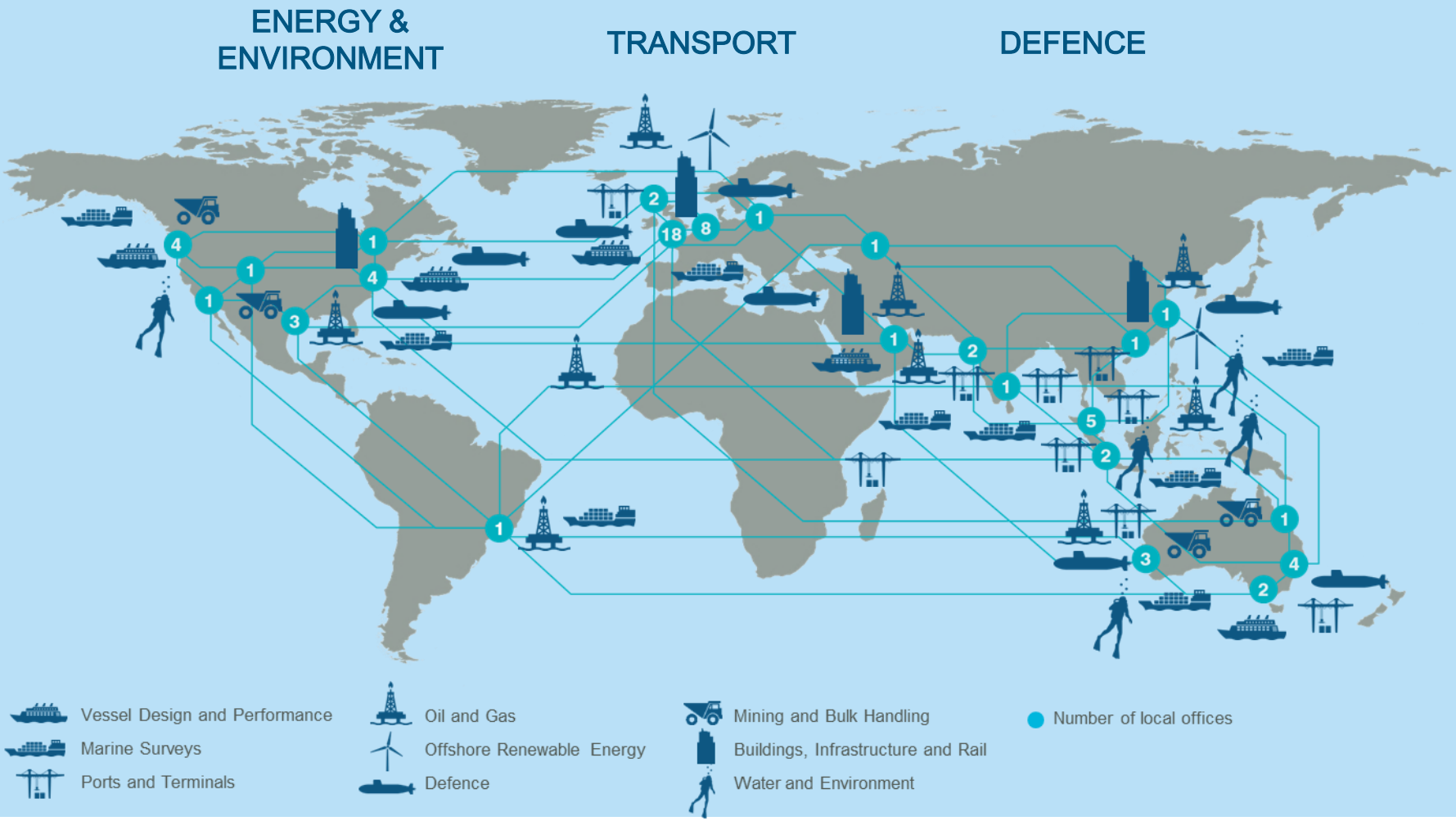
A network of knowledge and resources



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BMT Canada

Overview

BMT Canada

- BMT in Canada provides specialist engineering and program advice and support, both as a design agent and engineering support contractor. Recognized as one of Canada's leading suppliers of design, acquisition, in service, modernization and program support in the maritime sectors.

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About the Presenters

Mark Butler, P.Eng. Electrical Engineering Manager

- 25 Years Marine Electrical Engineering Experience
- New build and refit design on marine platforms including submarines, yachts, RAS tankers, OPVs, surface combat ships, commercial ships, and aircraft carriers
- Standards author and reviewer for Lloyds, Def Stan and IEC

Graeme Thompson, P.Eng. Intermediate Electrical Engineer

- 3 Years Marine Electrical Engineering Experience
- 9 Years Total Electrical Engineering Experience
- Life Extension Studies, Electrical Load Analysis, Arc Flash Studies, Engineering Changes

Bottom Photo: Libertee Muzyka

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Background

Why Extend the Life of a Vessel?

- Lower cost than new build program
- Delays in replacement ship build
- Difficulties in replacing a specialized vessel
- Change in capabilities of a vessel
- Lower vessel utilization than expected
- Etc.

Photos: DND

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Electrical Life Extension

Why do electrical life extension?

- Electrical changes can result in overloading equipment and cause nuisance circuit breaker tripping
- Ageing equipment
- Ageing cables
- Changing electrical requirements
- Knowledge of present or future margins should be an input to the decision to extend the life of the vessel

Electrical Life Extension Standards

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Proposed Electrical Life Extension Standard

Procedure for carrying out electrical life extension

- Understand Status Quo
  - Perform margins analysis for baseline
- Know the desired end state
  - Understand the impact of change on the electrical system

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What is Electrical Margins Analysis?

The electrical load compared with system capacity

- All of the electrical loads – pumps, bow thrusters, lights, galley equipment, steering, etc.
- Capacity needs to be assessed at each part of the system
- Each piece of distribution equipment has a capacity limitation, not just the generators:
  - Switchboards
  - Transformers
  - Motor Generators
  - Panelboards
  - Circuit Breakers
- Typically completed at the design phase

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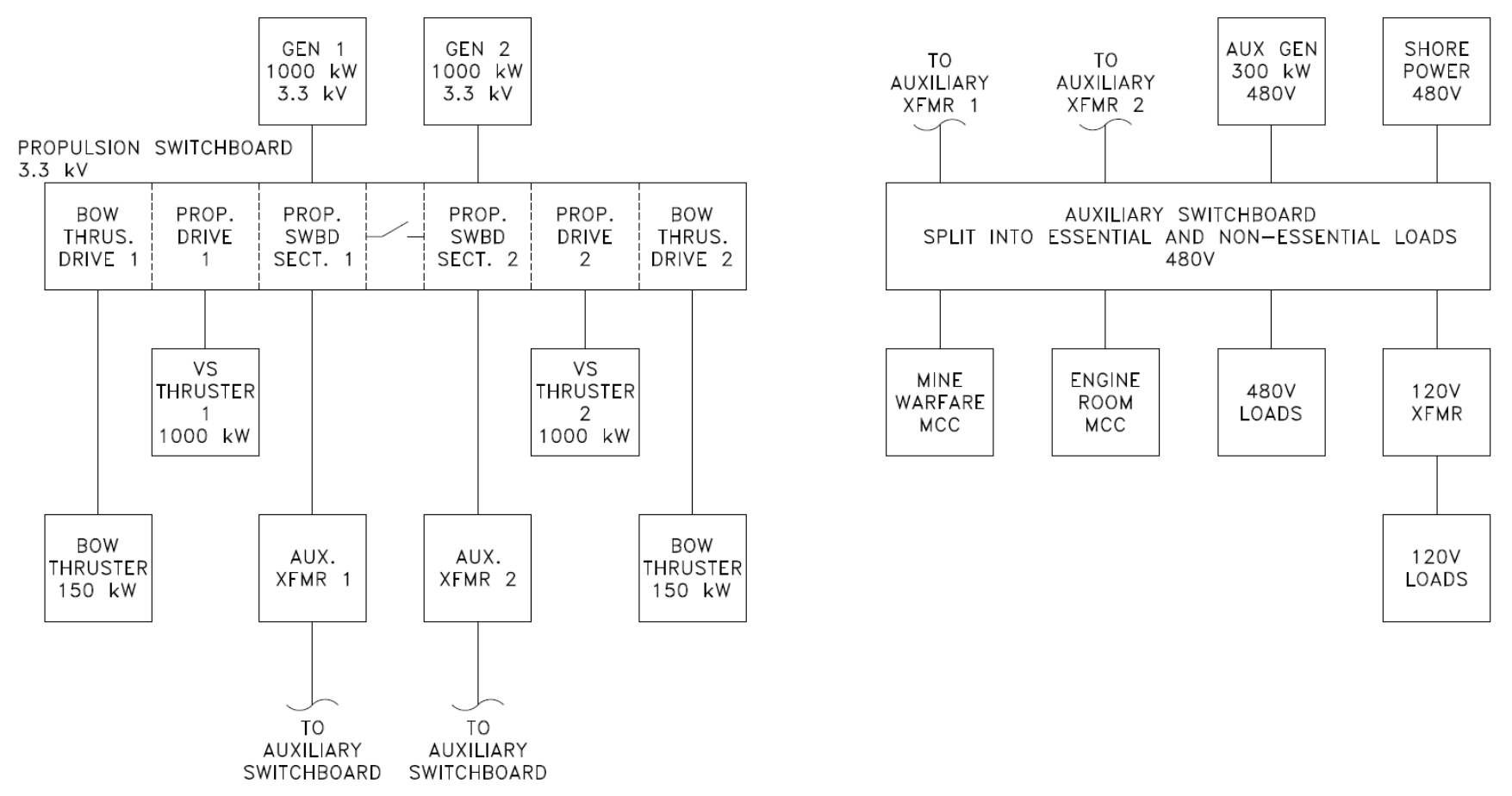
Sample Electrical Distribution System



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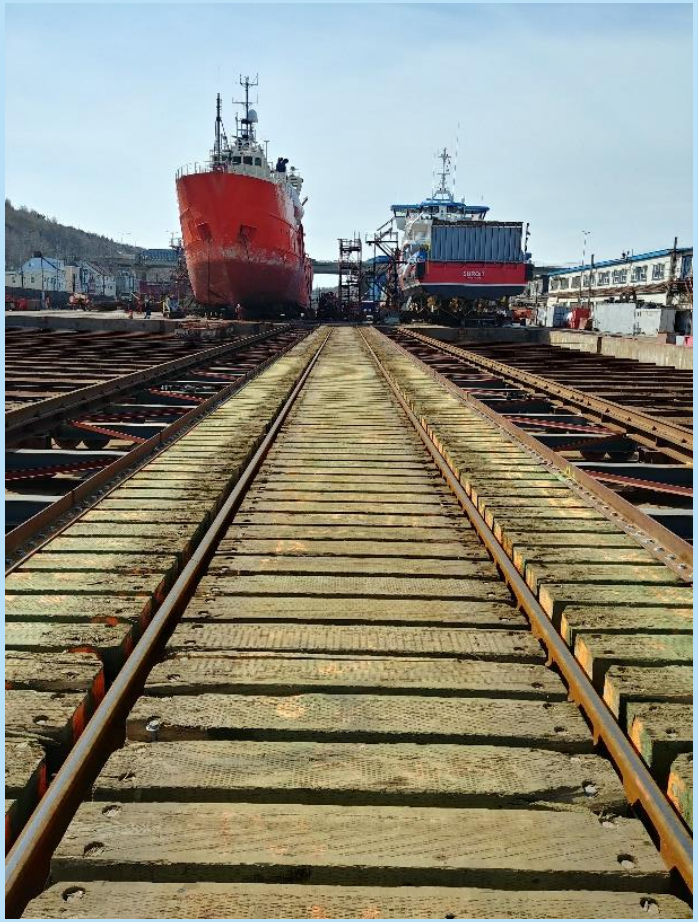
Challenges

Vessels are typically in operation for decades

- The electrical loads on a vessel are continuously evolving
- Modifications are typically completed in a piecemeal fashion without full consideration of the impact on the overall electrical system
- The design margins are frequently not updated



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Misconception: New Equipment Decreases Electrical Loads

Electrical loads often increase over time

- New capabilities are added
- Ships are operated in different ways or in different locations (ie. different weather and heating / cooling)
- Worn out equipment is replaced
- Increased cooling capacity for electronics
- Some examples:
  - Naval: Upgraded radar and weapons systems
  - Ferry: Route change
  - Commercial Fishery: Upsize refrigeration plant
  - Cargo: Replace self unloading equipment
  - Coast Guard: Larger deck crane

Establish Electrical Margins

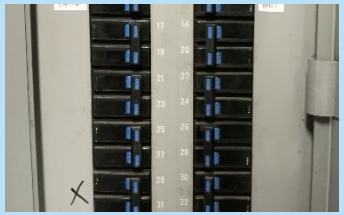
Create a margins management tool

- Use the existing margins management tool if available
- Can be created in Excel or using commercial electrical analysis software such as ETAP, SKM, or EasyPower
- Margins tool should account for:
  - All loads
  - Grouped by switchboards and panelboards
  - Utilization factors – (can be IEEE 45.1 Annex B)
  - Operating scenarios
  - Phase current, line currents, current imbalance, power, apparent power, percent loading, power factor, and circuit breaker ratings

Determine Baseline Capacity

Determine Capacity of Electrical System to Supply Loads

- Conduct data mining
- Conduct survey
- Collect capacities of generators, switchboards, panelboards, circuit breakers, transformers, etc.
- Consult with crew to determine:
  - What loads are typical at the generators and switchboards
  - If any equipment is overloaded and tripping
- If available, system logs can show electrical current draw at different parts of the system.
- Note that electrical systems are designed for the maximum load situations, so day to day loads will usually be lower.



Assess Baseline Capacity

Assess Capacity of Electrical System to Supply Loads

- Populate margins management tool with collected data
- The load on each voltage level should be assessed with each of the operating scenarios
- Determine the highest load scenario for each voltage system
- Assess each piece of equipment with respect to the highest load
- Assess phase imbalances on the system

Photo: DND

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Gather Data on Potential Load Growth

How much additional electrical load will be added?

- Assess planned changes to the vessel
- Changes could include operational changes, equipment changes, and operating environment
- Estimate timing of changes in 5 year increments (or as desired)
- Extrapolate historical load growth if future load changes are unknown

Assess Capacity of System to Handle Projected Load Growth

Can the electrical system handle the future load?

- Populate the margins management tool with new data
- Determine if there will be changes in capacity.
- Assess the capacity for each of the extension periods.
- Utilize the highest load scenario as was done for the baseline assessment.

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Assess Condition of Existing Equipment and Cables

Can the existing electrical equipment survive the extension period?

- Understand age and condition of equipment
- Assess equipment for exceeding MTBFs or MTTFs
- Assess cables for damage and degradation
- Review maintenance program

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Prepare Recommendations

Determine solutions to identified capacity issues

- Make recommendations to replace ageing equipment or increase planned maintenance schedules
- Proactively plan for all changes during docking periods
- Identify equipment that will be at or near capacity either now or in the future.
- Make recommendations to improve margins:
  - Upsize generators or distribution equipment
  - Moving loads
  - Energy efficiency
  - Operational changes

Photo: CCG

Final Notes

Summary

- The electrical margins analysis should be an input to the life extension decision
- An electrical margins management process needs to be put in place to ensure up-to-date data is available at all times
- BMT Canada has the capacity to perform life extension studies

Photo: DND