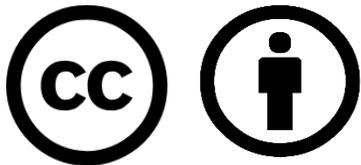


Margin and Service Life Allowance

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<http://doerry.org/norbert/MarineElectricalPowerSystems/index.htm>

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Essential Questions

What is margin and what is it used for?

Understand

What is service life allowance and what is it used for?

Understand

Who controls margin and who controls service life allowance?

Remember

How are margins and service life allowance applied in new designs?

Apply

How are margins and service life allowance applied in conversions and modified repeat designs?

Apply

Introduction

- Margin and Service Life Allowance (SLA)
 - Extra capacity required of power system components beyond the maximum estimated operating load.
- Margin (Acquisition Margin)
 - Employed during design and construction
 - Accounts for uncertainty due to
 - Modeling individual loads
 - Possible omission of loads in the Load List
 - Controlled by the Ship Design Manager (SDM)
- Service Life Allowance (SLA) (Service Life Margin)
 - Employed when in-service
 - Accounts for
 - Increased energy use as equipment degrades with time
 - Increased energy use of other systems due growth in their loads
 - Installation of replacement or additional equipment to keep the ship operationally relevant
 - Controlled by the customer

Margin and Service Life Allowance policy

- Typically documented in the electrical power system concept of operations.
- Specifies margin
 - Usually allocates to different stages.
 - Preliminary and contract design (Design Margin)
 - Detail design and construction (Build Margin)
 - Values typically a percentage of maximum estimated operating load.
- Specifies SLA
 - Values typically a percentage of maximum estimated operating load.
 - For conversion designs, may be specified as a percentage of maximum estimated operating load per year of remaining service life.
 - May have a component that is a fixed value for equipment anticipated to be installed while the ship is in-service.

Considerations for establishing margins

- The completeness of the load list
 - Probability that additional loads will be added to the load list, or loads on the load list will be replaced with other loads.
- The accuracy of the connected load (validated?)
- The accuracy of load models (validated?)
- If a power system component is discovered to be undersized, how difficult is it to replace it with a component having a higher rating?
- Are specific load equipment specified, or is the shipbuilder allowed to choose equipment during detail design based on performance requirements?
- The type of load models employed.
 - Most margins are specified based on load factor analysis.
 - Smaller margins may be warranted with stochastic load analysis or modeling and simulation load analysis.
- The overall design method employed.
 - Most margins are specified based on a point-based design method using the design spiral.
 - Smaller margins may be warranted if set-based design is employed.
- Whether the design is a clean-sheet design, a modified repeat design, or a conversion design.

Margin

- New Design
 - Preliminary and contract design (Design margin)
 - Usually on the order of 10% of the maximum estimated operating load
 - Detail design and construction (Build margin)
 - Usually on the order of 10% of the maximum estimated operating load
 - At the conclusion of construction contract, unused margin converted to SLA
- Modified Repeat and Conversion design.
 - If changes are extensive use new design guidance
 - Otherwise
 - Margin should be a percentage of the sum of the loads removed and added.
 - If validated models of loads removed used, may not need to margin the loads removed.
 - Typically, 10% for design margin and 10% for build margin
 - Example
 - 100 kW of non-validated load removed, 150 kW of load is added with 10% design margin and 10% build margin
 - 10% of (100 kW + 150 kW) = 25 kW for design margin and 25 kW for build margin
 - Total load added to the maximum estimated operating load is $150 \text{ kW} - 100 \text{ kW} + 25 \text{ kW} + 25 \text{ kW} = 100 \text{ kW}$

Considerations for establishing SLA

- The degree to which equipment aging results in increased load.
- Whether installation of specific additional equipment is planned while the ship is in-service.
- The probability that new regulations will require the installation of additional equipment that has not been specifically identified.
 - IMO MARPOL and SOLAS may be sources of new regulations
- The probability that equipment related to the function of the ship will require replacement during the service life of the ship.
- If power system equipment is discovered to be undersized, how difficult is it to replace the equipment with equipment having a higher rating?
- If the design is severely weight or volume constrained, the impact of adding additional capacity on the overall ship design.
 - High speed craft may have less SLA than a comparable low speed displacement vessel.

Service Life Allowance

- SLA may be split into
 - In-Service Growth Margin
 - Increase in load due to equipment degradation
 - Capability Upgrade Margin
 - Increase in load due to addition, modification, or modernization of systems
- SLA value should depend on expected growth in load
 - Some commercial ships may not have any SLA.
 - An SLA of 30% of maximum estimated operating load may be appropriate for ships expecting a considerable growth in load.
 - Internationally, naval ships typically have an SLA between 10% and 20%
 - Conversions may specify a % of maximum estimated operating load per remaining years of service life.
 - Typically established as between 0.5% and 1.0% per year.

Management of margin

- Usually the responsibility of:
 - Design Margin: Ship design manager
 - Build Margin: Shipbuilder
- Design margin typically not consumed until the power distribution system is placed under configuration control
 - Typically, during preliminary design.
 - Ratings of generators sets and other power system components adjusted to provide necessary margin and service life allowance prior to establishing configuration control.
 - Configuration management should typically not be established until load models shift from parametric equations to specific loads based on system design.
 - Set-based design enables placing the power distribution system design under configuration control later than point-based design using a design spiral.
- Consumption of margin often used as a measure of design convergence.

Management of SLA

- Customer should maintain the EPLA
 - Periodic update and validation of EPLA based on measured data
 - Instrument 50 to 100 largest loads
 - Instrument load centers / switchboards
 - Validate models based on measurements in various operational conditions
 - Updated EPLA becomes the basis for modernization planning
- Reality is that the EPLA is typically not updated or validated
 - Modernization planning based on questionable load models
 - May result in increased costs and lost operational capability