Load Factor Analysis

Electric Power Load Analysis (EPLA)

Revision of 25 May 2026

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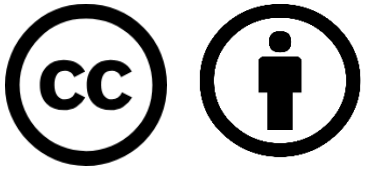


http://doerry.org/norbert/MarineElectricalPowerSystems/index.htm

Essential Questions

What is Load Factor Analysis?	Remember
How is a load factor determined?	Apply
How should load factors be assigned for cycling loads?	Understand
How should load factors from a parent design be adjusted?	Understand
How should load factors be determined from measured data?	Understand

Load Factor Analysis

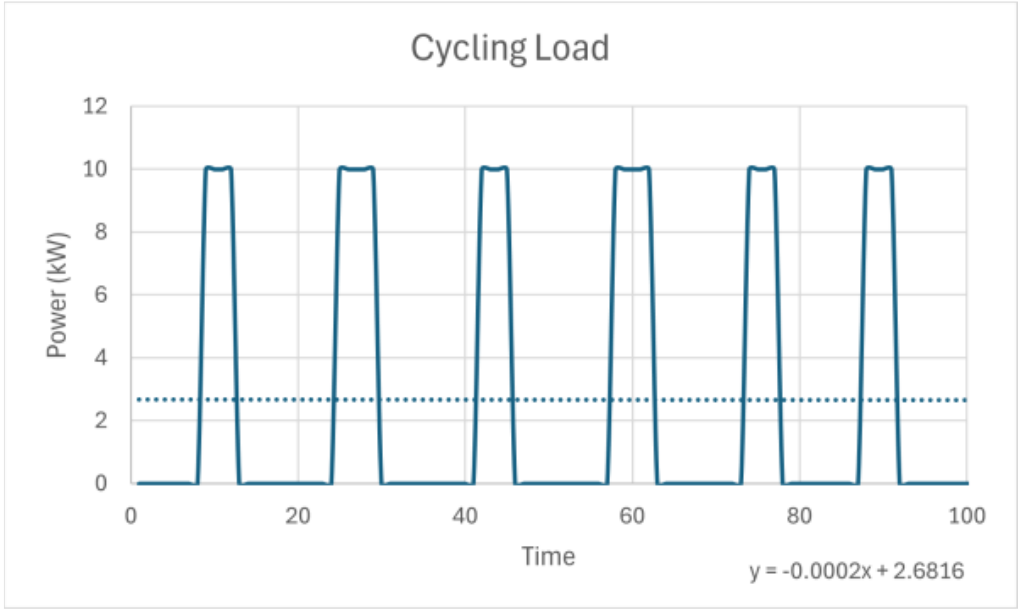
- Bottoms up estimate of the electrical load for different operating conditions and different ambient conditions.
- Multiple purposes
  - 24-hour average load for fuel consumption calculations
  - Determine if electrical system equipment has adequate power rating
    - Cycling loads may result in temporary increases in total operating load over the long-term average.
    - The duration and magnitude of the increase in total operating load may require the equipment to have a higher power rating than an estimate based on 24-hour averages.
    - Power electronic sources typically have less capability to supply an overload magnitude and duration as comparted to a synchronous generator.

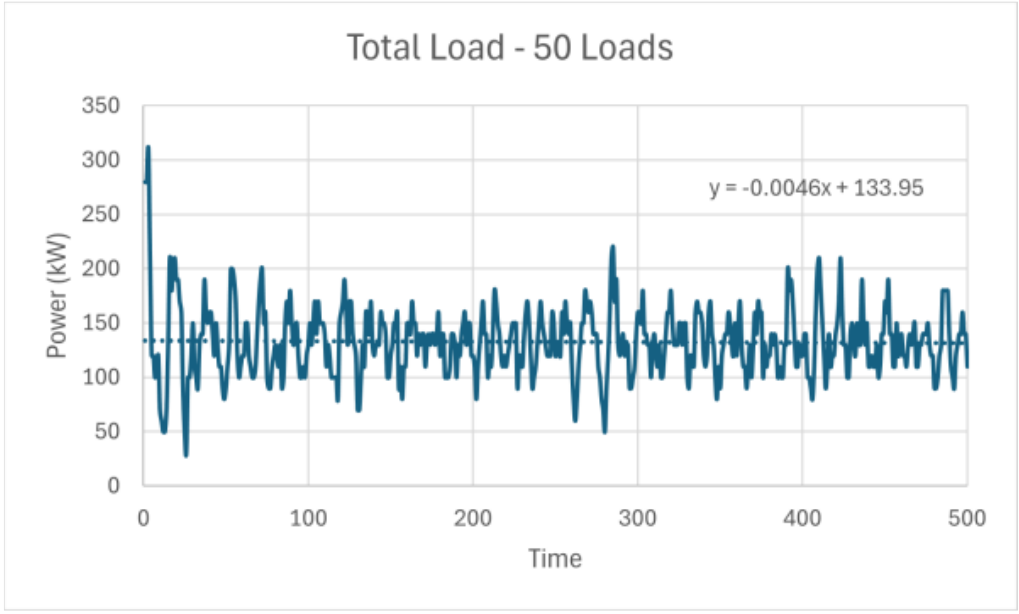
Load Factor Analysis - process

- Load List
  - Identifies all loads onboard ship
  - Identifies the connected load of each load
  - Identifies the load's connections to the power system
- Load factors assigned to each load
  - Possibly different load factors for each combination of operating condition and ambient condition
  - Load factors for 24-hour averages and equipment power rating may differ
    - Equipment power rating may need to account for cycling loads
- Total Operating Load
  - Sum the products of the load factor and connected load for all the loads
  - Calculated separately for each combination of operating condition and ambient condition
- Ship Demand Power
  - Apply margin and service life allowance to the total operating load

Cycling Loads

- Cycling loads are on for a period of time, and off for a period of time
  - On periods and off periods may vary
  - The load when on may vary
- For 24-hour average computations
  - Load factor is the average power over the connected load
- For equipment sizing
  - 24-hour average-based load factor is likely too low
  - Peak value-based load factor is likely too high
  - The appropriate load factor depends on the magnitude and type of other loads online



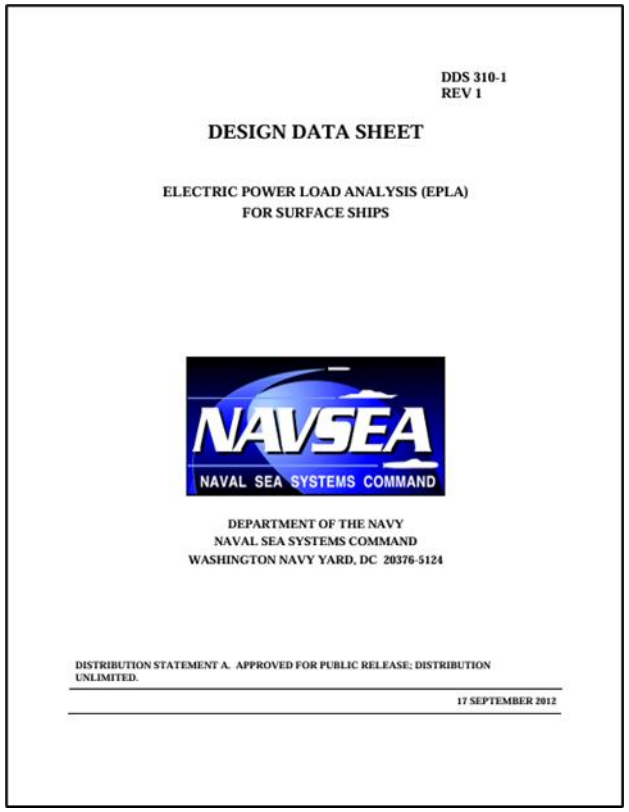


Calculating Load Factors

- Load analysis
- Scaling from parent design
- Using default values
- Measured data
- Modeling and simulation

Load analysis

- Assign load factors based on an investigation of the load behavior
- From DPC 310-1
  - Zero load factors assigned to seldom used equipment
  - Motor operating at full load for an extended period of time
    - Use 0.9 for ship electrical equipment rating,
    - Use the long-term average load for 24-hour average calculations.
  - All standby units are assigned zero load factors except when the standby unit is actually kept running or is based on percent of power used while idling.
  - Mutually exclusive loads
    - Assign 0 for the load with the lower operating load for determining ship electrical equipment rating
    - Assign each load with their average load divided by their connected load for 24-hour average calculations
  - In some cases, calculating and tabulating actual kW instead of using load factors is warranted
    - Power conversion equipment
    - Losses associated with power distribution equipment efficiencies
  - Consider using zonal load factor method for cycling loads



DDS 310-1
REV 1

DESIGN DATA SHEET

ELECTRIC POWER LOAD ANALYSIS (EPLA)
FOR SURFACE SHIPS

NAVSEA
NAVAL SEA SYSTEMS COMMAND

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
WASHINGTON NAVY YARD, DC 20376-5124

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Using Zonal Load Factor process for estimating load factor for cycling load

- Used for converting load factor calculated for 24-hour averages to load factor for determining equipment rating.
- Based on relative magnitudes of other loads powered by the electrical system equipment

$$L_{fz_j} = L_{f_j} + \left(\frac{P_{P_j}}{P_{L_j}} - L_{f_j}\right)\left(\frac{P_{P_j}}{\sum_{i=1}^{n} L_{f_i} P_{L_i}}\right) \text{ for } \frac{P_{P_j}}{\sum_{i=1}^{n} L_{f_i} P_{L_i}} < 1.0$$

$$L_{fz_j} = \frac{P_{P_j}}{P_{L_j}} \text{ for } \frac{P_{P_j}}{\sum_{i=1}^{n} L_{f_i} P_{L_i}} \geq 1.0$$

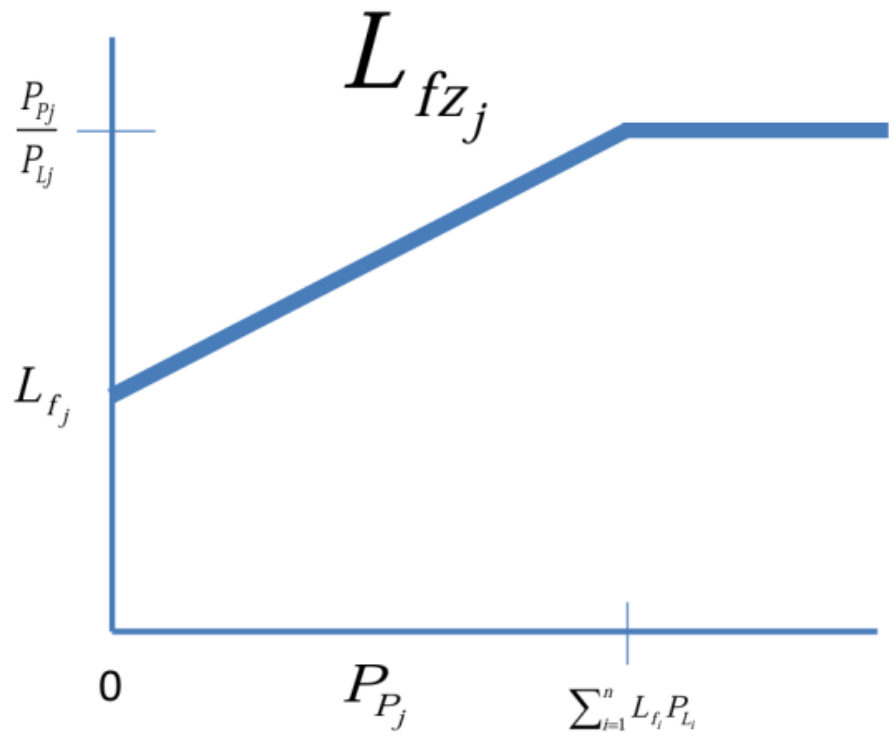
L_{fz_j} = Zonal load factor for load j

L_{f_j} = Load factor for load j for 24-hour average calculations

P_{L_j} = Connected Load (kW) for load j

P_{P_j} = Peak Load (kW) for load j

n = Number of loads

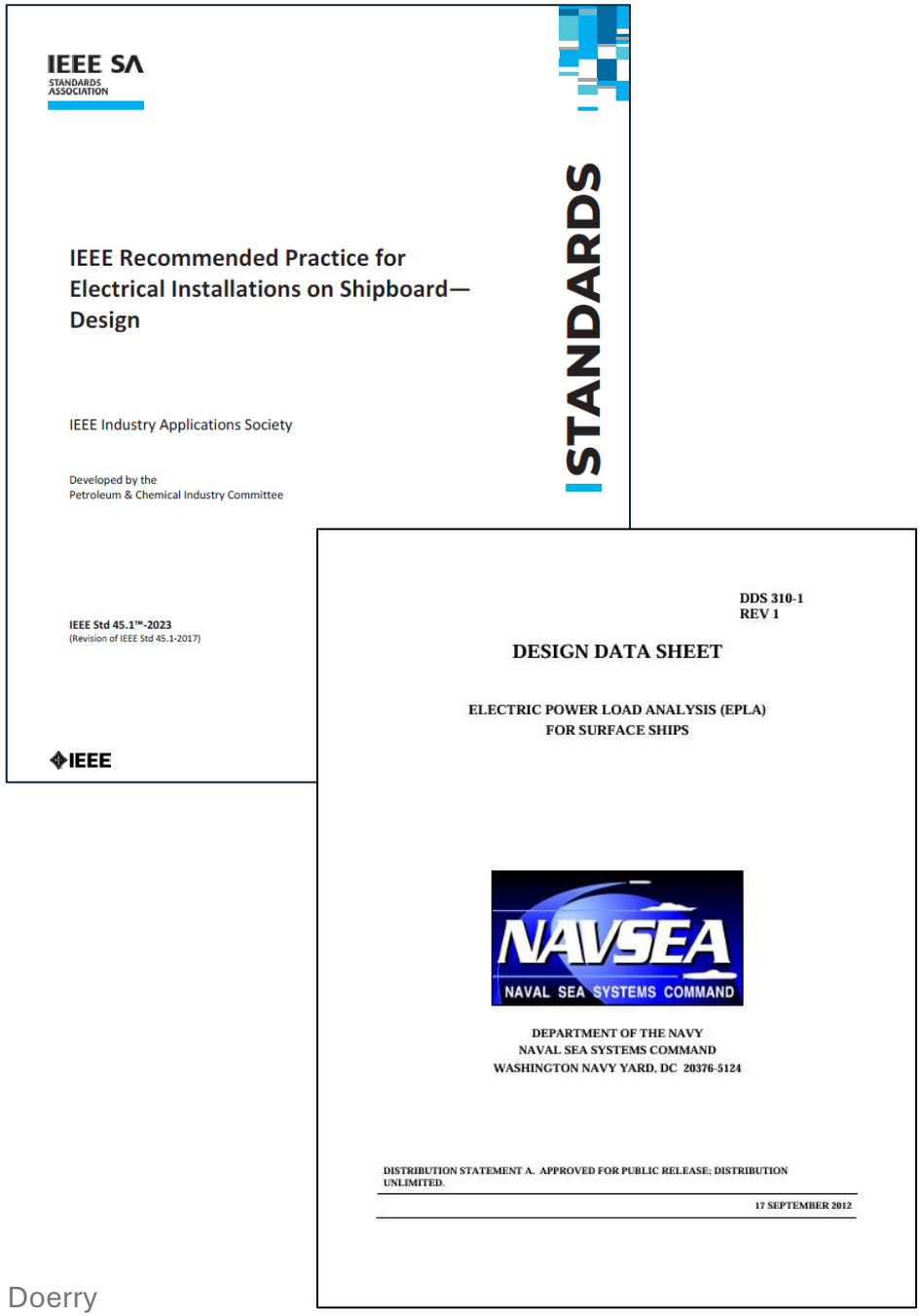


Scaling from parent design

- Using a parent design for developing the load list is a normal practice
  - Load list is modified to reflect differences from the parent design
- Load factors from a parent design should not be blindly used
  - Should review each load factor and adjust based on differences in
    - Equipment
    - Concepts of Operation

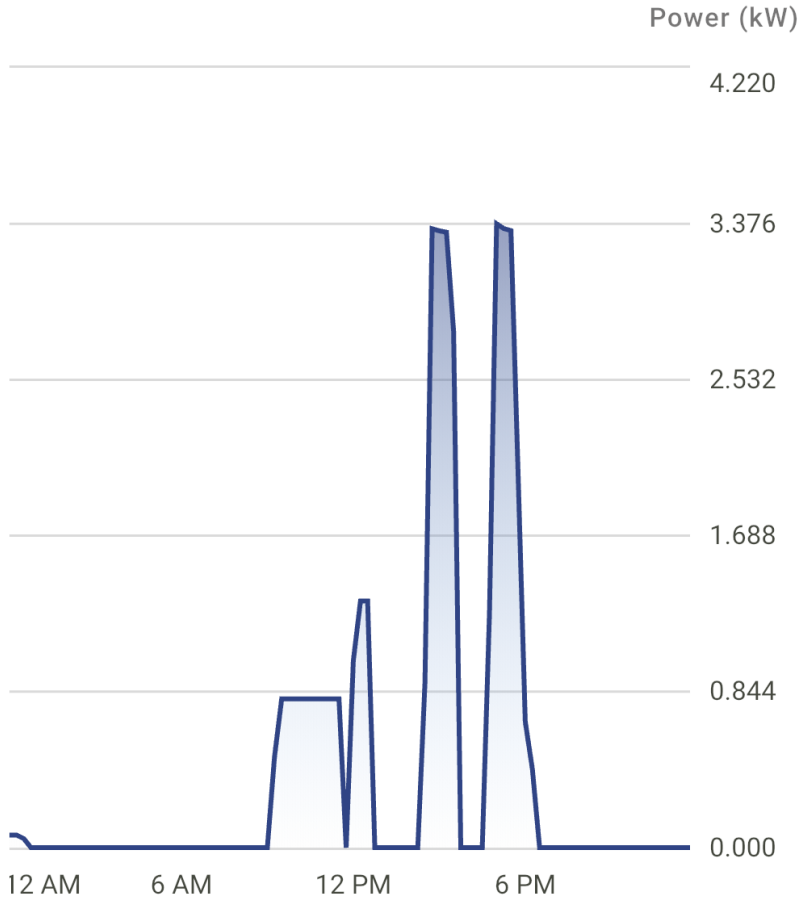
Using default values

- Default values are available from
  - DPC 310-1
  - IEEE Std 45.1
- Should only be used if cannot obtain better data elsewhere



Measured Data

- Measure electrical load of a particular load for an extended period of time on an existing ship
- Use the average value of the power for the 24-hour average load factor
- Load factor for cycling loads
  - Measure the total load for the corresponding group of loads
  - Identify the peak value in the measured data that the power system equipment should handle
  - Apportion difference between peak value and average value to the various cycling loads
- Alternate method for load factor for cycling loads
  - Use the zonal load factor method to adjust the 24-hour average load factor for a given set of loads supplied by the power system equipment



Modeling and Simulation

- Perform a time-based simulation of the power system to develop a substitute for measured data
  - Employ same calculation methods as for the measured data
- Quasi-steady-state analysis is likely sufficient