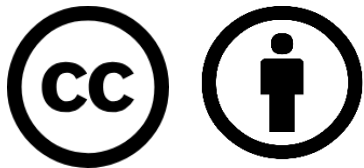


One-line Diagrams

Revision of 9 April 2026

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

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Essential Questions

What is a one-line diagram?

How is the one-line diagram used in an EPLA?

How does the level of detail depicted on a one-line diagram evolve during different stages of design?

What are the common symbols used in a one-line diagram?

Remember

Understand

Understand

Apply

Introduction

From U.S. Coast Guard Marine Safety Center Procedure E2-07:

“The purpose of an electrical one-line diagram is to provide an elementary schematic outlining connections from power sources (generators, shore power, battery banks) through a distribution system (switchboard, busbars, cables, feeders, and panels) to supply various power consuming loads.”

Introduction (continued)

- The one-line diagram may incorporate additional information such as that required by 46CFR110.25 to include:
 - Type and size of generators and prime movers.
 - Type and size of generator cables, bus-tie cables, feeders, and branch circuit cables.
 - Power and lighting panelboards with number of circuits and rating of energy consuming devices.
 - Type and capacity of storage batteries.
 - Rating of circuit breakers and switches, interrupting capacity of overcurrent devices, and rating or setting of overcurrent devices.
 - Location (machinery room) of electrical equipment.
- A one-line diagram may also be called a single-line diagram.

Introduction (continue)

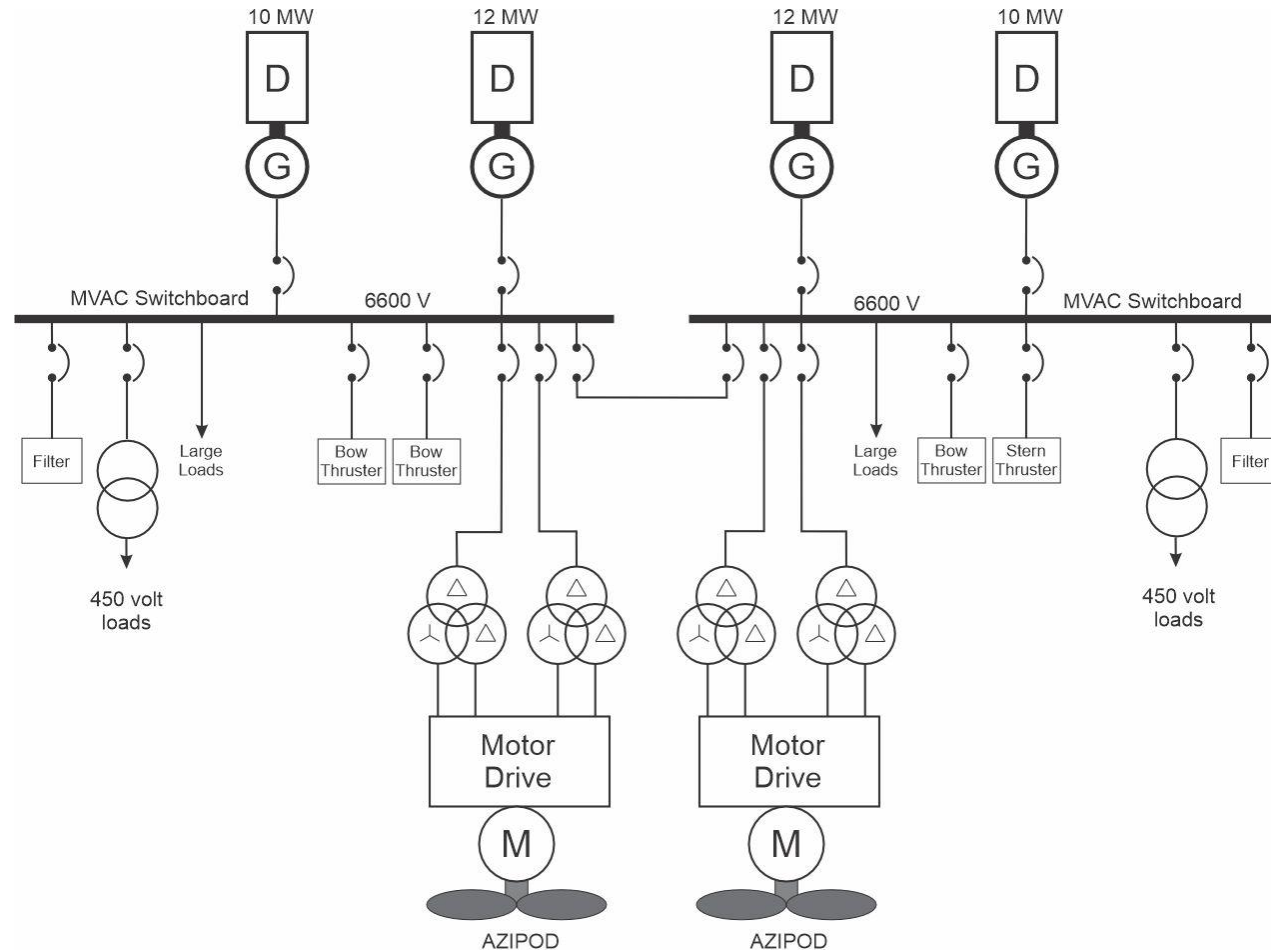
For detail design, ABS MVR for example, requires a one-line diagram of main and emergency power distribution systems that shows:

- “Generators: kW rating, voltage, rated current, frequency, number of phases, power factor.
- Motors: kW or hp rating, voltage and current rating, remote stops (when required).
- Motor controllers: type (direct-on-line, star-delta, etc.), disconnect devices, overload and under-voltage protections, remote stops, as applicable.
- Transformers: kVA rating, rated voltage and current, winding connection.
- Circuits: designations, type and size of cables, trip setting and rating of circuit protective devices, rated load of each branch circuit, emergency tripping and preferential tripping features.
- Batteries: type, voltage, rated capacity, conductor protection, charging and discharging boards.”

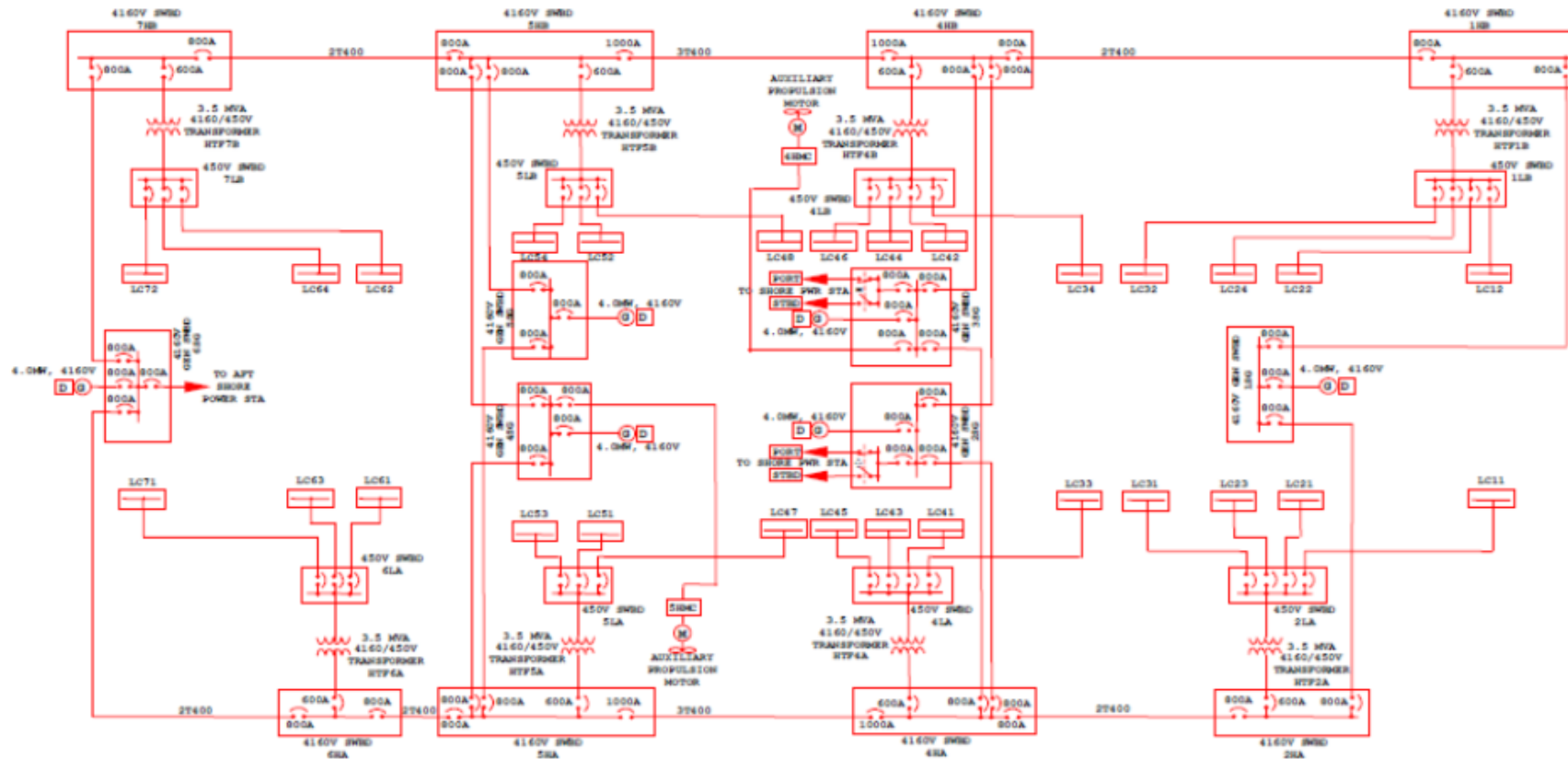
One-line diagram properties

- The lines representing the connections in a one-line diagram represent the power cables (or bus duct / bus pipe) connecting equipment
 - The cables can contain multiple conductors, and multiple cables may be paralleled.
 - A one-line diagram is more like a network diagram rather than a wiring diagram.
- The level of detail provided in a one-line diagram evolves during the design process.
 - Depends on the needs of analyses being conducted.
 - More detail is provided as the design matures.

Example: Cruise Ship (Concept Study)



Example: USS Makin Island (LHD 8) (Preliminary and Contract Design)

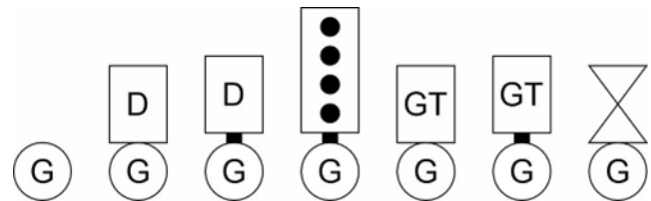


Dalton, Thomas, Abe Boughner, C. David Mako, and CDR Norbert Doerry, "LHD 8: A step Toward the All Electric Warship", presented at ASNE Day 2002.

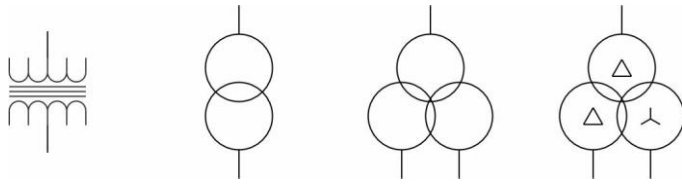
- NOTES: 1) ALL LOAD CENTERS ARE 2000A
 2) "⊕" / "⊖" / "⊕⊖" / "⊖⊕" = INTERLOCKED
 3) ALL 4160V CABLE TO BE TYPE LS5KV

Common Symbols

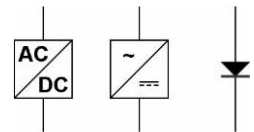
- Not standardized



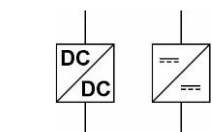
Generator sets



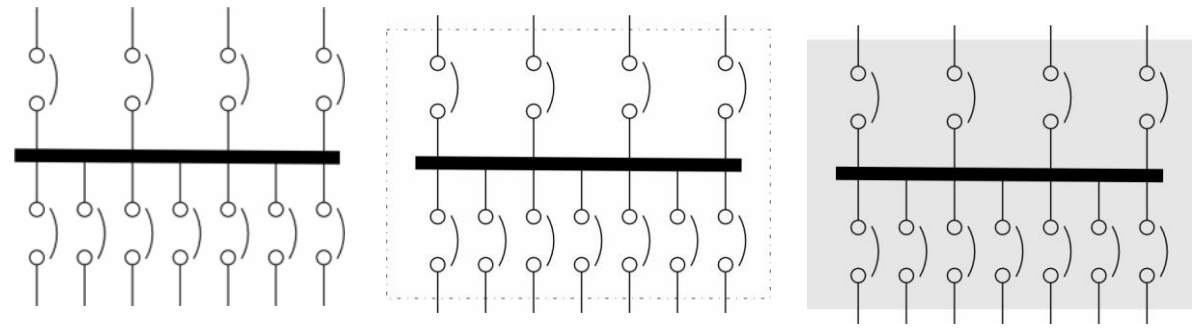
Transformers



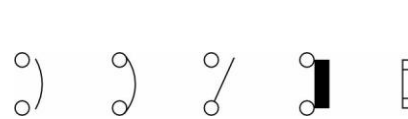
Rectifiers



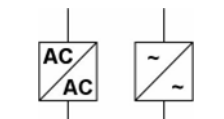
DC to DC converters



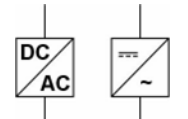
Switchboards (Load centers, Power panels)



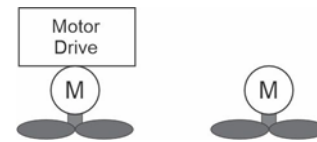
Circuit Interrupter



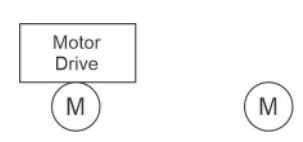
AC to AC Converter



Inverter



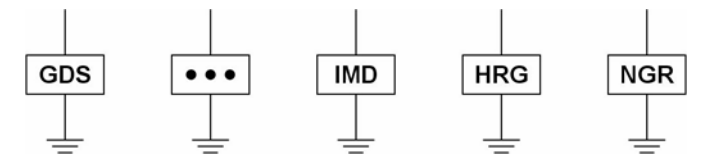
Propulsion Motor



Motor



Ground Symbols



Grounding Equipment

Layout

- Layout is not standardized; conventions commonly employed.
- Multiple sheets may be used.
- Traditional commercial power system (Cruise Ship Example).
 - Generator sets on top
 - Switchboards in middle
 - Loads at the bottom
 - Port switchboard on the left; Starboard switchboard on the right
 - Equipment in same space depicted near each other
 - Dotted or dashed lines may be used to depict space boundaries
- Zonal power system (LHD 8 Example).
 - Equipment arranged by zone
 - Forward most zone on right; aft most zone on left
 - Dotted or dashed lines may be used to depict zone boundaries
- If a line is intended to represent multiple connections to multiple loads (proxy load), then the connection to the switchboard may not include a circuit breaker; each load is understood to have its own circuit breaker.
- First sheet should include a legend describing symbols used.

Level of detail to support EPLA

- The electrical distribution system should be defined to the load center level (or the switchboard level if the design does not include load centers).
 - Facilitates assigning loads from the load list to the appropriate load center.
- All power system equipment should have a unique identifier.
 - The unique identifier helps ensure that the EPS-CONOPS refers to the appropriate electrical power system component.
- All bus-tie circuit breakers, generator circuit breakers, circuit breakers associated with energy storage, circuit breakers supplying large transformers / power conversion equipment, circuit breakers supplying switchboards and circuit breakers supplying load centers should have a unique identifier.
 - The trip rating for these circuit breakers should be depicted if known.
 - The unique identifier helps ensure that the EPS-CONOPS refers to the appropriate electrical power system component; the configuration of the electric plant for each operating condition can be defined without ambiguity.
 - Listing the trip rating can help ensure the circuit breakers are appropriately rated based on load flow analysis.
- The cable type, cable number, and ampacity should be depicted for all cables connecting generator sets to the power system, energy storage systems to the power system, bus-ties, large transformers and large power electronic converters, and large loads.
 - If known, one should consider depicting the length of the cable.
 - This information is useful for modeling the cables in a load flow analysis.

Level of detail to support EPLA (continued)

- For generator sets, the kW rating, kVA rating (or rated power factor), voltage, frequency, and number of phases should be depicted.
 - Helps ensure sufficient but not excessive generator set capacity is installed.
- For transformers, the kW rating, kVA rating (or rated power factor), primary voltage, secondary voltage should be depicted.
 - Helps ensure sufficient but not excessive transformer capacity is installed.
- For energy storage, the charge rate, discharge rate, voltage rating, and energy rating should be depicted.
 - Helps ensure sufficient but not excessive energy storage capacity is installed.
- All large loads should have a unique identifier and the one line diagram should depict the kW connected load, and the kVA connected load (or rated power factor).
 - The unique identifier helps to ensure the proper load configurations are specified in the EPLA for each operating condition.
 - The connected load helps ensure cables and other power system equipment have sufficient capacity to serve these loads.