

**Ingalls Shipbuilding**

A Division of Huntington Ingalls Industries



# Standardized Foundations Database for Combat Systems

**Planning, Production Processes, and Facilities Panel Meeting**  
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# Introduction



- Customer requirements in shipboard operations have driven complexity into both design and construction
  - Mission requirements have increased with smaller operational crew size
  - Increased use of automated systems with higher operational loading
  - Longer service fatigue life expectancy in design requirements
- Increased use of higher strength steels has been incorporated to leverage lighter weight required in ship design using thinner steels
- All of the changes have driven schedule, cost and weight upwards in shipboard foundation design and construction
- The foundations represent a small percentage, about 10% of the overall steel weight of navy ships, but the relative cost is very high, which represents about 50% of the steel construction costs\*
- The cutting, fit-up, and welding operations necessary for shipboard foundation fabrication are among the most costly process in hull structural construction. The design standardization of foundations will significantly reduce ship production cost.



\* Ref. "A Common Sense Design Manual for Producibility of Hull Foundations", by the US Navy NSWC-Carderock Div., and Newport News Shipbuilding, June 1996

# Foundation Design Requirements



- Shipboard foundations are typically uniquely designed to provide adequate structural support for all shipboard equipment, including electrical, mechanical, HVAC, mooring, and combat systems, to resist ship's motion acceleration and other operational and environmental loading. In cases of naval surface combatants, shock acceleration resistance is the most critical requirement.
- All equipment foundations and combat systems are typically mounted on decks, bulkheads, or shells and are designed to meet the following requirements:
  - Structural adequacy
  - Vibrational and acoustical limitation
  - Fatigue life expectancy
  - Producibility, weight and cost limitation
  - Operational and maintenance space limitation
- In case of combatants, depending on the criticality of the equipment in the event of an impact loading situation, foundations have to be qualified to various shock grades based on the design specification



# Current Foundation Design Processes



1. Cognizant engineers identify need for equipment, then send vendor drawings and Request For Service (RFS) to the responsible engineering group
2. The responsible engineering group identifies locations for equipment and sends a request to Hull or Outfitting Design for foundation drafting development
3. Hull and outfitting designers develop preliminary foundation design drawings with approximated scantlings based on existing design experiences, send drawings to Hull Technical Engineers for verification
4. Hull Tech structural engineers validate preliminary design scantlings developed by designers and perform structural analyses for strength and ship specification requirements
5. After validation, the engineers return the drawings to the designers with any necessary modifications or approval as submitted notifications
6. Fabrication documents and material bills are generated





# Typical Foundation Examples



Seawater Pump



HVAC Fan Motor



Electrical Transformer



57 mm Turret



Main Engine Foundation

# Foundation Focus Areas on Ship



- Foundation breakdown for LHA and DDG Contracts:

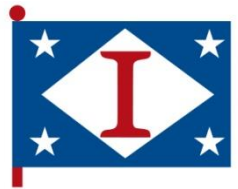
	LHA	DDG
Shipboard Foundations (#)	2,560	590
Electrical (%)	51%	50%
Pump/Machinery (%)	24%	20%
HVAC (%)	16%	14%
Armament/Other (%)	9%	16%

- Most common mounting areas, based on sampling of LHA FDN's

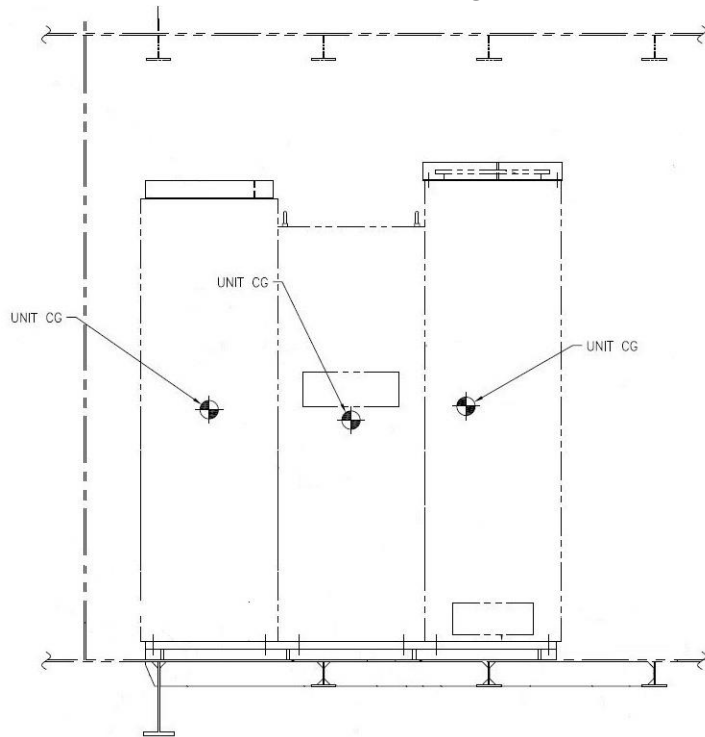
- Bulkheads, Stiffener Side (31%)
- Bulkheads, Smooth Side (24%)
- Decks (16%)
- Banked, Stiffener Side BHD (11%)
- Banked, Smooth Side BHD (9%)
- Overhead (6%)
- Other (3%)



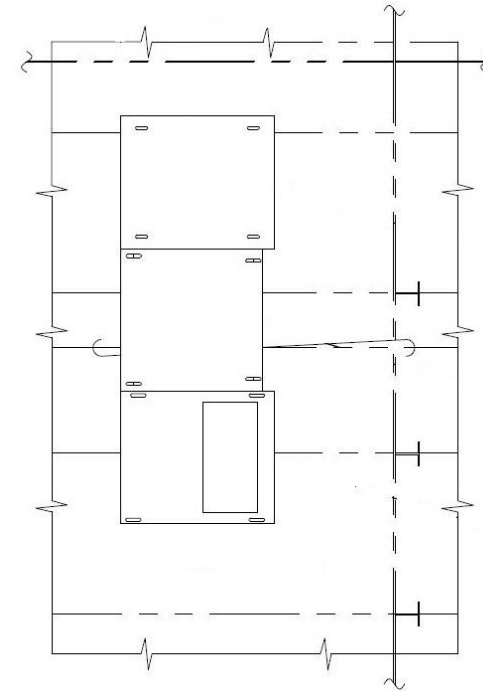
# Equipment Foundation Designs



Section View (Lkg FWD)



Plan View



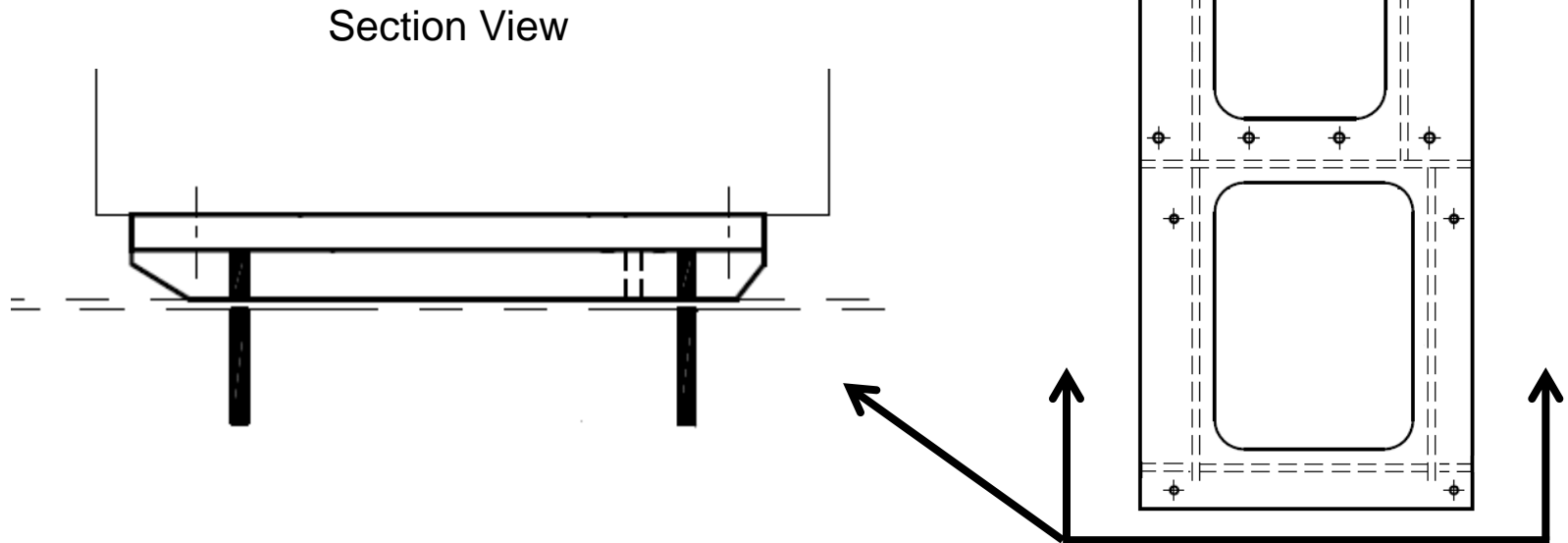
- 3 Pieces of different combat systems equipment, with given CG's, weights, and footprints
- A single “rack” foundation was chosen to support all three pieces, mounted to the deck



# Foundation Design Variances



- Designer chose to use a Plate base for bolting with flat bar for the connection to the deck
- Another designer may have chosen an angle bracket base, or a structural tee base



# Foundation Design Issues



- Foundations are almost always “uniquely” designed and analyzed, and can vary based on the designer’s and/or engineer’s preferred methods of equipment attachment and locations in the ship
- Environmental or operational differences between various contracts can cause variations in foundation designs for identical equipment mountings
- Late updates to equipment and technologies can drive late changes to foundation designs



Two electrical transformers, installed on the same ship in different locations with drastically different foundation designs



# Foundation Production Issues



- Each foundation has many parts that must be fabricated, tagged, stored, and later retrieved during the outfitting stage. Material tracking and handling become significant cost drivers.
- Designers do not always design using shapes that are available off-the-shelf and must be uniquely manufactured in the shop to meet size specifications
- In many instances, unbudgeted rework is caused by:
  - Foundation built incorrectly
  - Discrepancies between drawings
  - Incorrect vendor drawings
- “Leave loose” parts are frequently lost during blasting, painting, and moving resulting in rework and delays in equipment installation



# Why is Foundation Standardization Needed?



Equipment Label	S=SWAY BRACE U= UPPER FDN N= NONE	HARD MOUNTED / SHOCK MOUNTED	FOUNDATION BOLTING SURFACE	FALSE DECK COMP YES/NO	SHOCK GRADE	SHIP'S ORIENTATION	Weight
ER-14	N	SHOCK MOUNT	ANGLE	NO	A	Transv	330#
ER-01	N	SHOCK MOUNT	TEE	NO	A	Long	330#
ER-01	N	SHOCK MOUNT	PLATE	NO	A	Long	330#
ER-01	N	SHOCK MOUNT	TEE	NO	A	Long	330#
ER-01	N	SHOCK MOUNT	ANGLE	NO	A	Long	330#
ER-01	N	SHOCK MOUNT	TEE	NO	A	Transv	330#
ER-02	N	SHOCK MOUNT	ANGLE	NO	A	Transv	330#
ER-01	N	SHOCK MOUNT	ANGLE	NO	A	Transv	330#
ER-01	N	SHOCK MOUNT	ANGLE	NO	A	Long	330#

- Group of nine foundations taken from an LHA sample group
- Seven foundations support identical equipment, two foundations support equipment with only minor differences
- A need to standardize foundations scantlings and design configurations to be consistent with equipments weight and geometry

# Benefits of Standardized Foundations



- Eliminate cross-contract duplication of engineering labor costs in foundation analysis and design
- Improve productivity by reducing the numbers of unique parts and materials that must be designed, marked, fabricated, stored, tracked, and retrieved later
- Simplify production by having many foundations using the same footprints in volumetric production, rather than crafting unique foundations for every application
- Provide consistent information to government customers and vendors to guide equipment design by utilizing existing database information in earlier stages of design and construction



# Summary



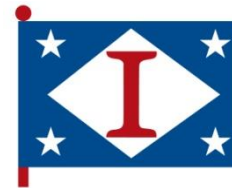
- Project kickoff meeting held on February 7, 2014 at Ingalls Shipbuilding, Pascagoula, MS
  - Scope of the database was selected as Government-Furnished Equipment (GFE) foundations that are deck-mounted
  - There are 114 foundations out of 2,560 on LHA that belong in this group
- Held a series of user-requirements meetings with Ingalls' IT group to define the requirements of the database
- Generated spreadsheet of critical foundation parameters for all 114 foundations within the scope of the project
- The preliminary database of foundations based on the above spreadsheet for the LHA class has been developed
- The database will be finalized, including a cost-benefit analysis, by the end of the project.

# Acknowledgements



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- Virgel Smith – Information Technology
- Tim Warren – Production Engineering
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Thank You



Questions?