

## NSRP - Combat Systems Standard Foundation Qualification & Optimization July 16, 2024



**Newport News  
Shipbuilding**

A Division of HII



NATIONAL SHIPBUILDING RESEARCH PROGRAM™

*Taking Shipbuilding and Repair to the Next Level*

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# Combat Systems Standard Foundations Qualification and Optimization

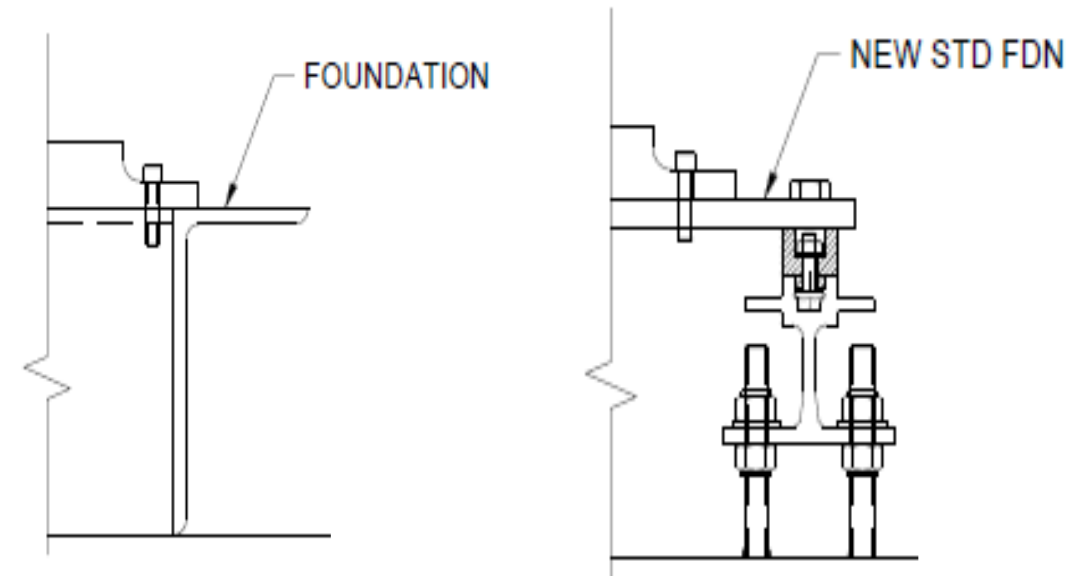
- Integrated Project Team:
  - Lead – Newport News Shipbuilding:
    - Harold Howard
    - Ify Amene
    - Mackenzie Wilson
    - Daniel Kissinger
  - Participants - Ingalls Shipbuilding:
    - James Breakfield
    - Davida Cunningham
  - NAVSEA O5P1
    - Sloan Burns
    - Robert Heyburn
  - Program Technical Representative
    - Shawn Wilbur – AUSTAL USA

# Project Background/ Purpose

- The standard foundation effort was initiated from the National Shipbuilding Research Program (NSRP) Common Interface Pilot Project (CIPP) with its purpose being to develop common interface standards for the integration of combat systems Enterprise Air Surveillance Radar (EASR) on multiple surface ships
- Multiple shipyards were surveyed to identify the major cost & schedule drivers in the Combat Systems (CS) equipment installation process which included:
  - Impact to schedule caused by late/ changing GFI
  - Impact to adjacent spaces due to performing work out-of-sequence
  - Achieving required installation tolerance of CS equipment

# Background/ Purpose (Cont.)

- Therefore, the following objectives were established:
  - Provide flexibility to suit changing equipment/ late technology insertion
  - Develop a foundation that utilizes studs to reduce installation cost & schedule
  - Develop an analysis process that satisfies shock and vibration requirements
- The project approach for the optimization of a standard foundation design was to utilize the Flexible Infrastructure (FI) Deck Track System



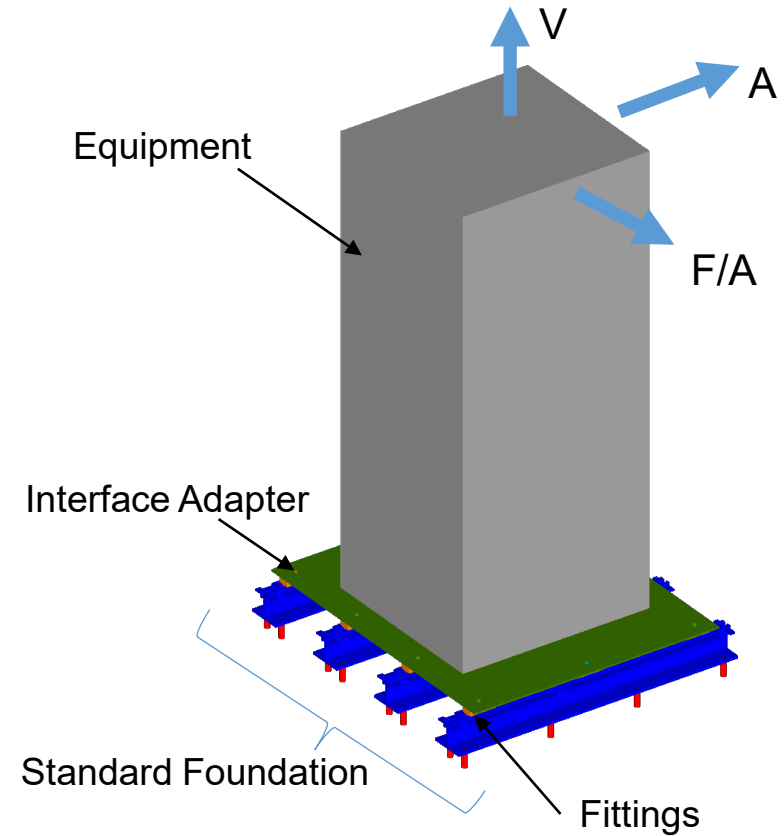
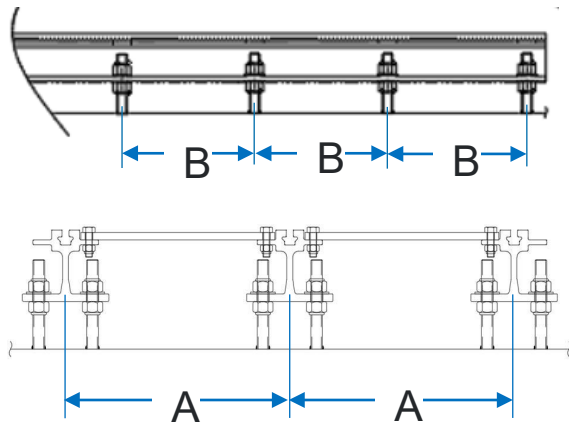
Typical Legacy Foundation vs FI  
Low Deck Track Concept

# Project Status

- Current Status:
  - The project status has advanced to the development of an excel Analysis Tool to evaluate each standard foundation design under shock loading. Also the Standard Foundation Guidance Drawing has progressed to the point of informing the Design Agent how to proceed in designing a standard foundation, and providing the manufacturing and installation details to ensure standardization in the component and installation process when used in conjunction with the excel Analysis Tool.
- Project Tasks:
  - Collaborate with the Government Technical Community to determine the OQE required for cross-platform approval of the chosen standard foundation solution, and implement this process as part of the design and analysis tool to be developed
  - Develop an analysis process that satisfies shock and vibration requirements specific to CS Standard Foundations
  - Develop a Standard Foundation Guidance Drawing that specifies the materials and details for the chosen standard foundation solution

# Standard Foundation Concept

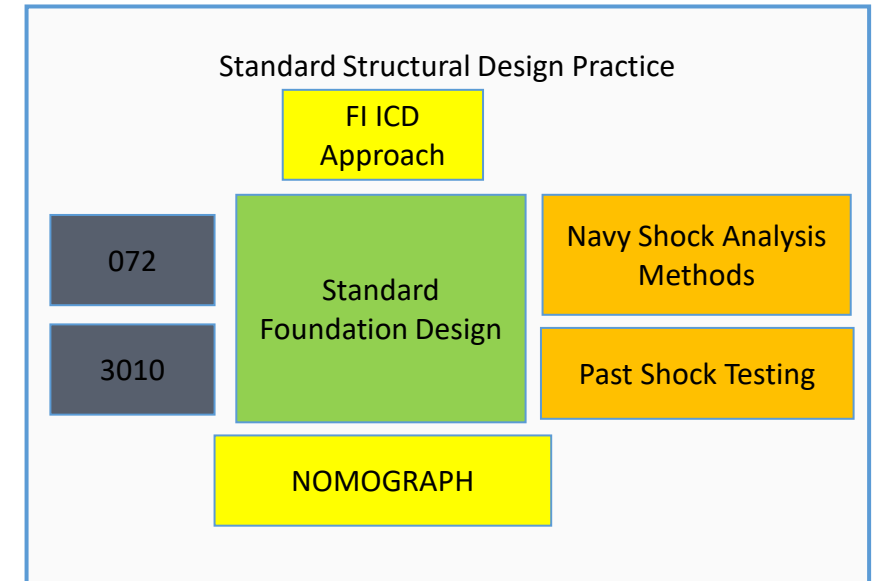
- FI based standard foundation design will include:
  - Standardized stud and track spacing
  - Method for foundation arrangement
    - Number of tracks, type of fitting, number of fittings, etc.



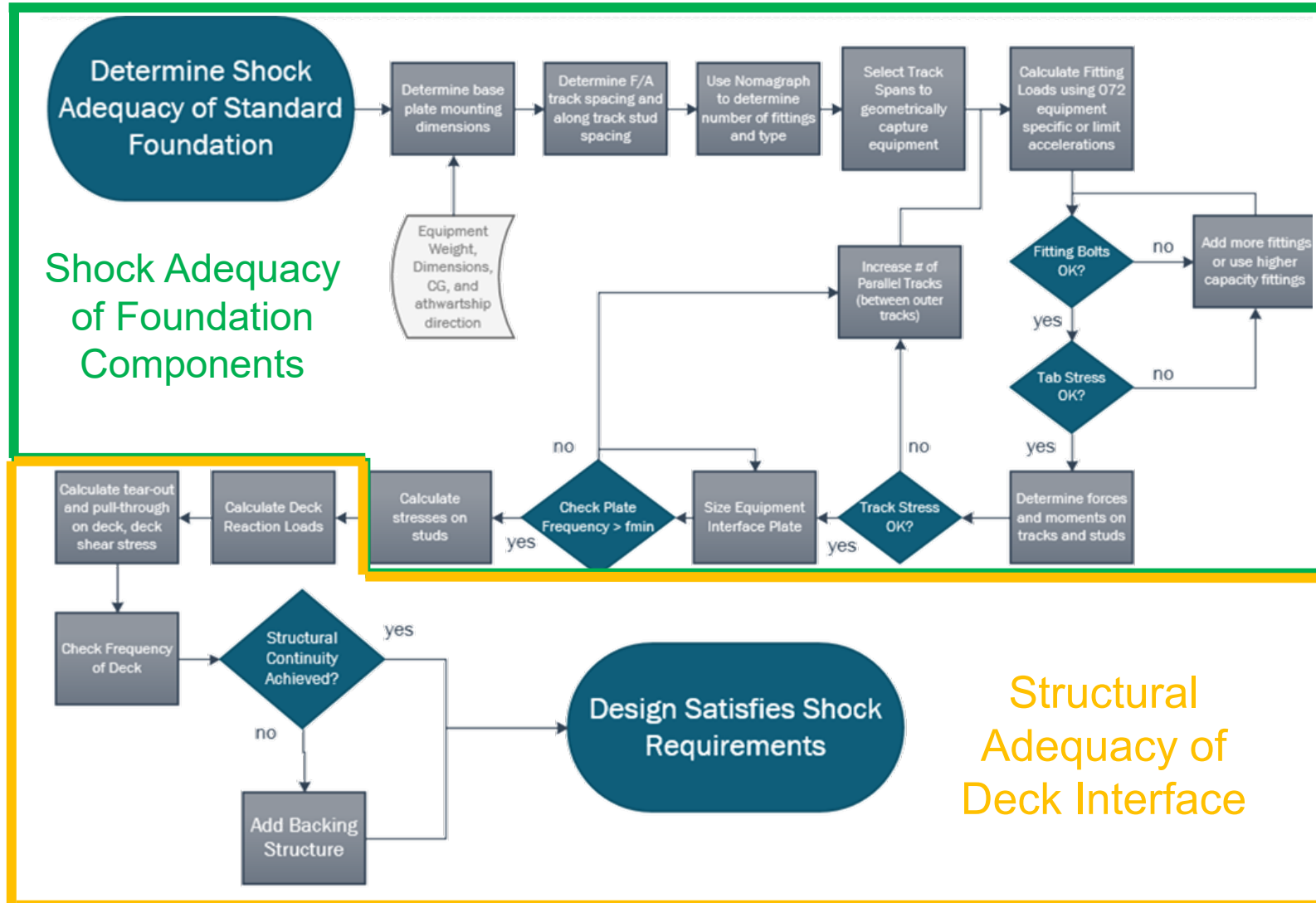
Standard Foundation - Stud Mounted & Scalable

# Standard Foundation Overall Approach

- Stay within the confines of shock approved methods and processes
  - Augment when necessary using standard engineering practice
- Utilize past shot stud efforts and standard design practices
- Establish Standard Foundation shock evaluation process
- Assess a large parameter space to determine what design and setup will meet process



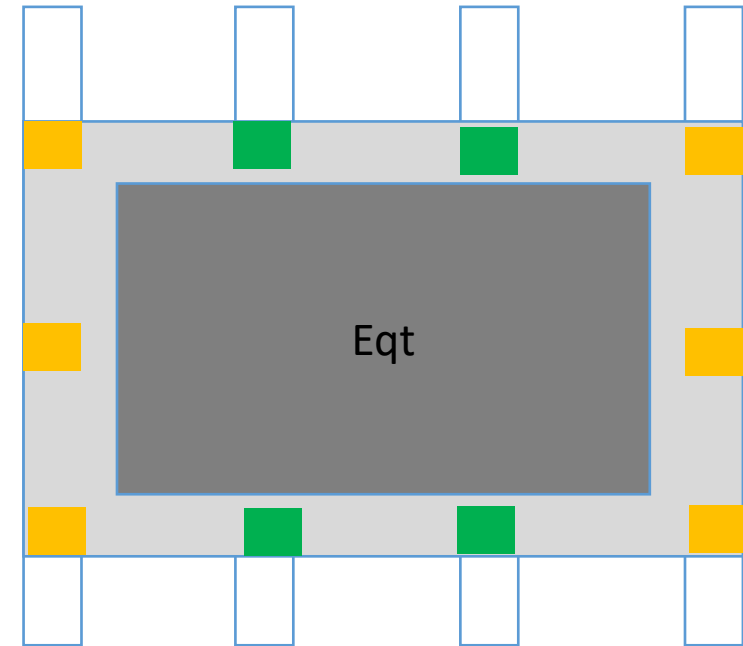
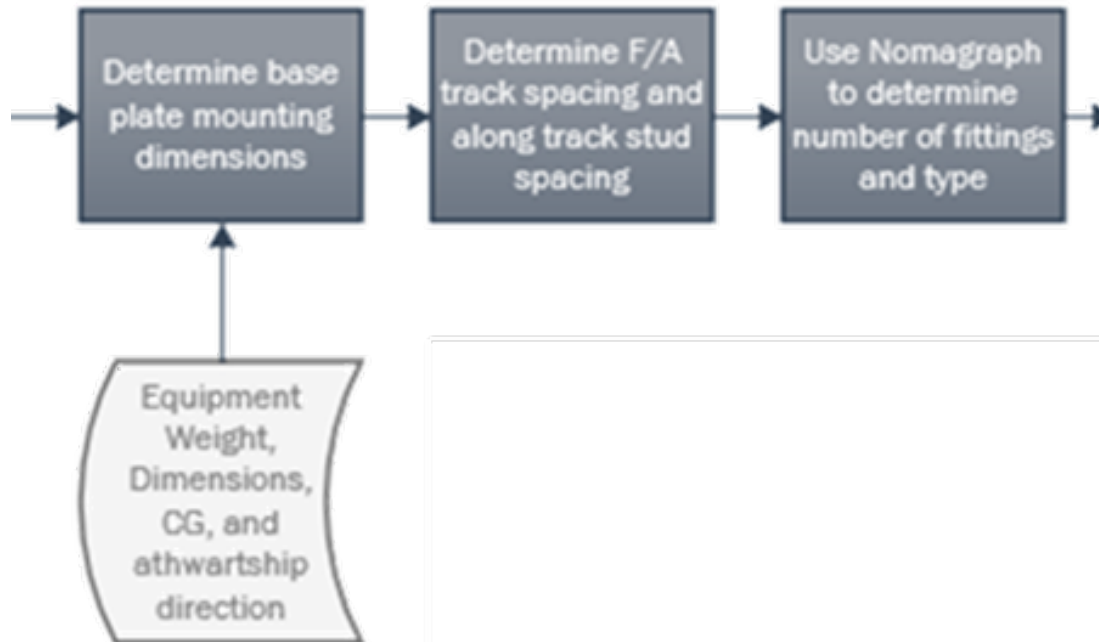
# Proposed Process Flow Chart for Design Evaluation





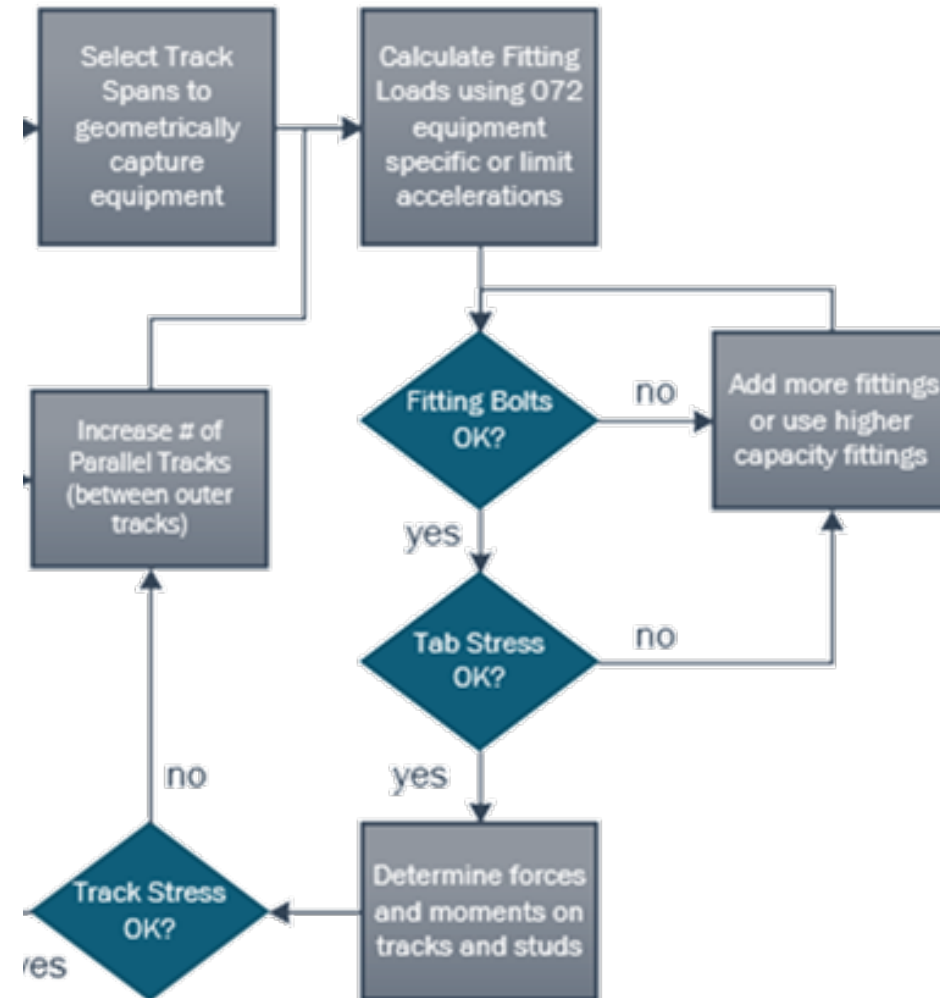
# Fitting Selection and Arrangement

- Number of fittings on outer tracks chosen via Nomograph
  - Fittings added to all the inner tracks at perimeter of adapter plate
    - Additional stiffness
    - Better load distribution



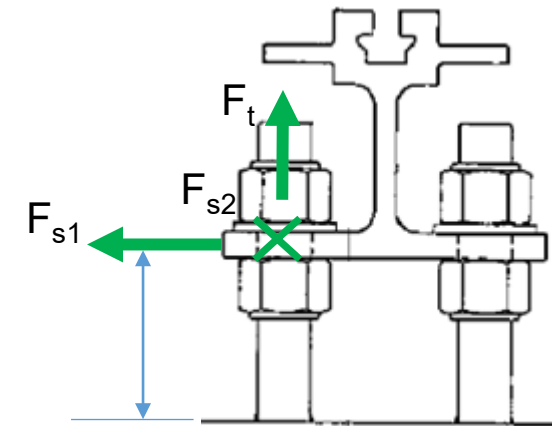
# Component Analysis

- Foundation arrangement designed to DDS-072 limit accelerations for surface ship decks
- All FI components are required to stay within elastic material allowables or established allowables from prior shock tests
  - Fitting bolt stresses
  - FI deck track tab shear stresses
  - Deck track stresses
  - Track stiffener stresses



# Stud Analysis

- Shot stud stresses evaluated for worst-case jacking nut condition
  - Guided cantilever assumption
- Forces reacted to deck at base of stud
- NNS proposes that this assessment is sufficient foundation design criteria to address all potential shock concerns with the Standard Foundation components



# Analysis Tool

- To assess this standard foundation, an Excel spreadsheet tool was developed to automate the process of evaluating the standard foundation for all Class I equipment. The core analysis process of the tool is as follows:
  - Accepts user inputs (Equipment size, weight, and center of gravity (CG) information at minimum)
  - Determines a fitting layout configuration based on the inputs (fitting type, number, and locations)
  - Builds the track system under the equipment fitting layout and applies constraints at the stud locations
  - Runs static analyses using fitting loads from vertical, athwartship, and fore/aft shock load cases and outputs both load and stress results for the foundation (tracks, stiffeners and studs) for each load case
- Utilizing the core analysis process as a base, several functions were created to facilitate the tool's capabilities. These functions are:
  1. Utilize inputs to analyze and evaluate a specific foundation configuration
  2. Utilize necessary/known input parameters to determine an acceptable foundation configuration by iterating track and stud spacing
  3. Creation and evaluation of foundation configuration permutations based on input ranges

# Tool – Input & Output

## Combat System Standard Foundation Tool

Permutation, Check, or Iterate?

Insert the Following Configuration Values:

Equipment Weight (lbs)	Depth (in)	Width (in)	Vertical CG (in)	Track Spacing (in)	Stud Spacing (in)
Max # of Tracks	Final # of Fittings	Max Possible # of Fittings Along Outer	Track Stud Diameter	Type of Fitting	Fitting Bolt Grade

After Choosing and Filling Inputs, Click This Button to Run Analysis

Multiple Equipment Check? (I.e. Same Footprint)

To Set/Reset Permutations, Insert the Following Values:

	Equipment Weight (lbs)	Depth (in)	Width (in)	Vertical CG (in)	Track Spacing (in)	Stud Spacing (in)
Range Start						
Range End						
Interval Size						
Exceed # of Range Data Points?						

#1 Calculate Permutations

#2 Run Analysis for Permutations

Check Input Configuration:

Attachment to Track Acceptable?	<input type="text"/>
Does Configuration Work?	<input type="text"/>

Permutation Results:	Number of Configurations:	<input type="text"/>
Track Stud Diameter Used:	Passing Configurations:	<input type="text"/>
Passing Configuration Weights:		<input type="text"/>

Iterate Optimal Config (Less Tracks Prioritized):

Equipment Weight (lbs)	Depth (in)	Width (in)	Vertical CG (in)	Track Spacing (in)	Stud Spacing (in)	# of Tracks	# of Fittings	Max Possible # of Fittings Along Outer Tracks	Type of Fitting	Fitting Bolt Grade

User Input Flow Chart

General Configuration

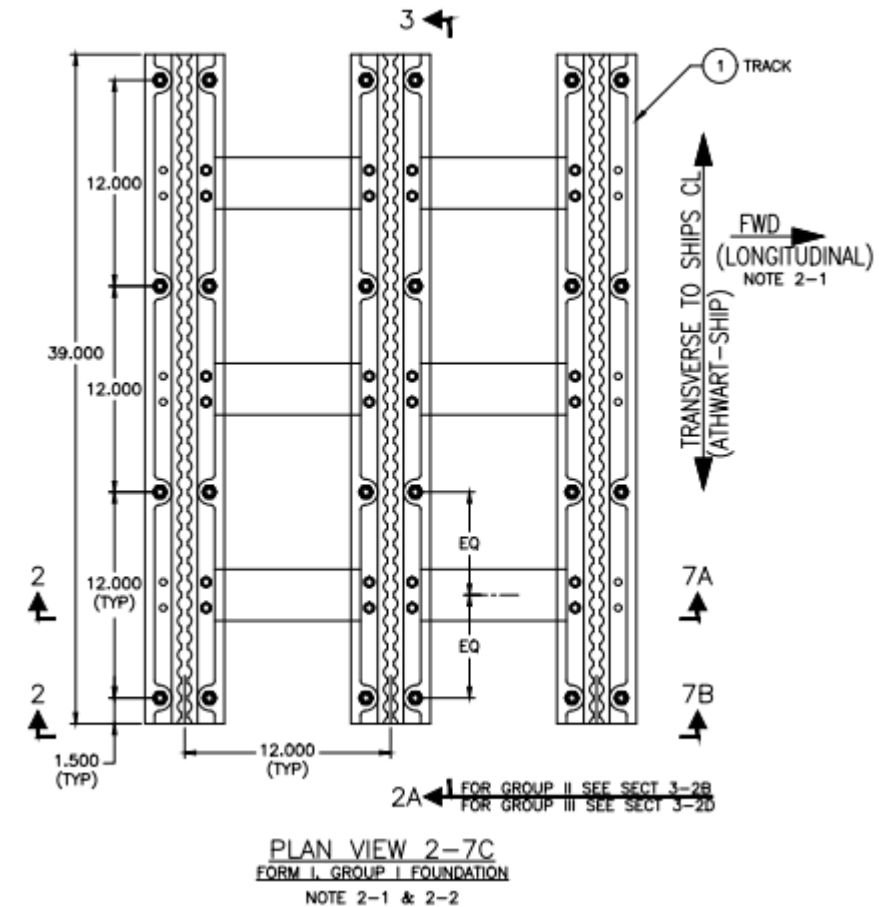
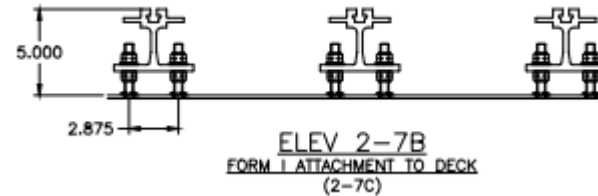
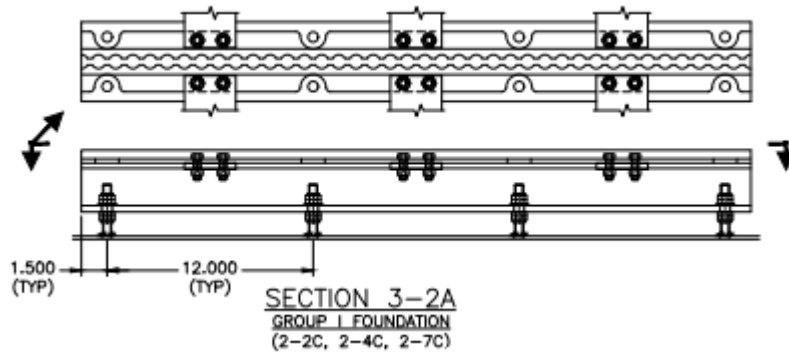
# **Standard Foundation Guidance Drawing**

# Standard Foundation Guidance Drawing

- Purpose:
  - The purpose of the Standard Foundation Guidance Drawing is to provide guidance to Design Agents developing standard foundations in accordance with this NSRP project. This drawing provides manufacturing details for standard foundation components as well as configuration guidance to ensure all previous approvals are maintained in the design process
- Approach:
  - Configure the Standard Foundation Guidance Drawing to reflect the established design criteria of the Analysis Tool for standard foundations:
    - Deck Track profile to profile spacing defined as = 12", 9" or 6" and reflected on drawing as Form I, Form II or Form III foundation respectively
    - Deck Track mounting stud to stud spacing defined as 12", 9" or 6" and reflected on the drawing as Group I, Group II or Group III deck track respectively
    - Deck Track mounting stud diameter defined as  $\frac{3}{4}$ " Dia. or  $\frac{9}{16}$ " Dia.
    - Deck Track Stiffener size determined by Track Form and defined in Deck Track Stiffener Table 5-4F

# Standard Foundation Guidance Drawing

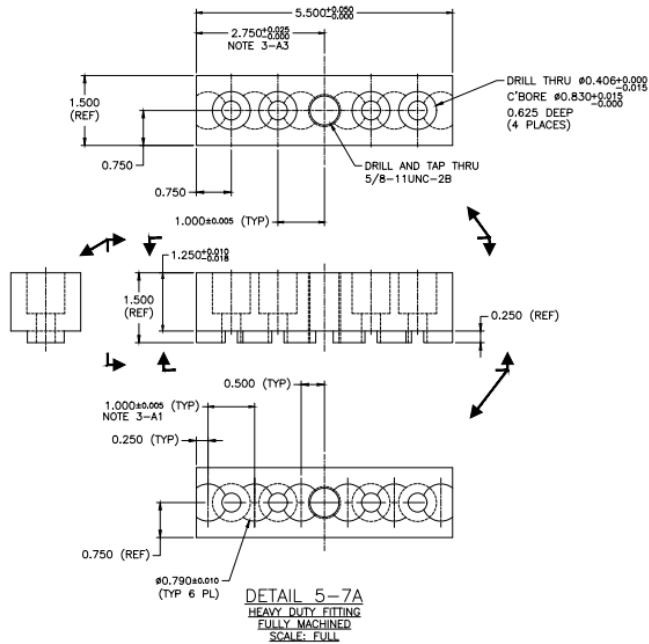
- Configuration: Form I Group I Standard Foundation
  - Deck Track configured in the athwart ship direction
  - Deck Track spaced 12" apart profile to profile
  - Deck Track mounting studs spaced 12" apart
  - Deck Track Stiffeners centered between mounting studs
  - Deck Track manufacturing details included in drawing



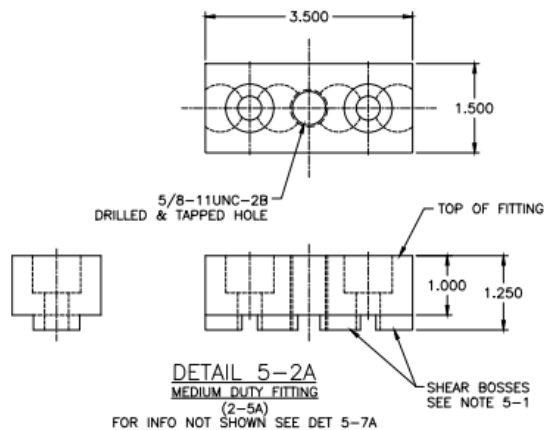


# Standard Foundation Guidance Drawing

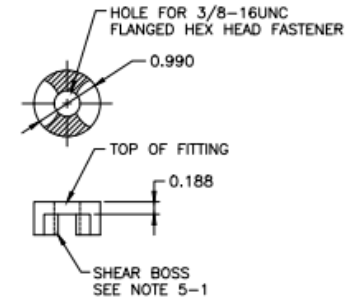
- Standard Foundation Components:



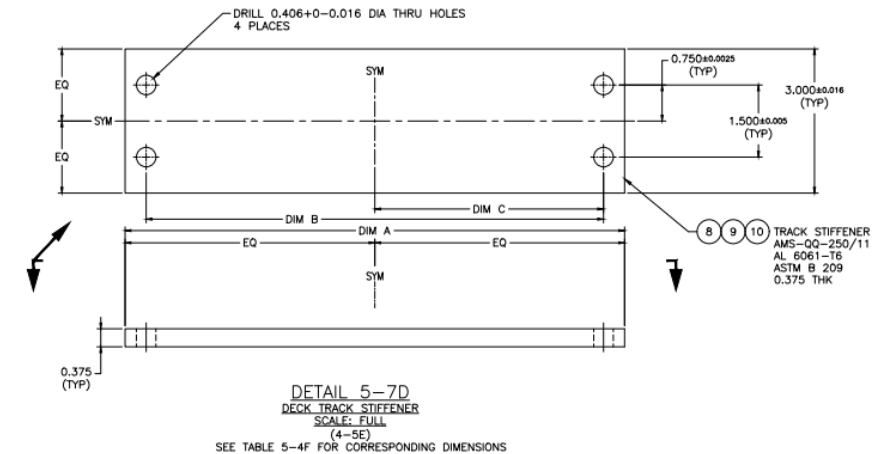
Heavy Duty Fitting



Medium Duty Fitting



Light Duty Fitting



Deck Track Stiffener

# Standard Foundation Project Tasks

- Conduct structural and shock analyses on various combat systems standard foundation solutions (Complete)
- Down-select a combat systems standard foundation solution based on the analyses results and define its not-to exceed parameters (Complete)
- Collaborate with the Government Technical Community to determine the Objective Quality Evidence (OQE) required for cross-platform approval of the chosen standard foundation solution, and implement this process as part of the design and analysis tool to be developed (In progress)

# Standard Foundation Project Tasks (cont'd)

- Develop a user-friendly tool for the Design Agents that defines the optimal standard foundation layout for each piece of equipment and associated materials that meet the applicable shipboard foundation requirements  
(Complete)
- Develop a standard foundation guidance drawing that optimize the materials and details for the chosen standard foundation solution  
(Complete)
- Report results to NSRP members (In Progress)

# Discussion / Questions

