



Ingalls Shipbuilding
A Division of Huntington Ingalls Industries



STANDARDIZED WELDING CURRICULUM AND TESTING FOR SHIPYARDS

Technology Investment Agreement 2005-337

Deliverable for Task 2

DRAFT STANDARDIZED WELDING CURRICULUM

Revision 1

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Introduction

The National Shipbuilding Research Program (NSRP) project entitled “**Standardized Welding Curriculum and Testing for Shipyards**” is a collaborative and sustainable optimization process on weld size control and production process improvement. Ingalls Shipbuilding (Ingalls), a company element of Huntington Ingalls Incorporated (HII), is pleased to provide leadership for this project. It is intended to significantly reduce the cost of lightweight steel production across the U.S. shipbuilding and ship repair industries. This project is applicable to a major labor cost driver across all shipbuilding and ship repair programs. The team expects the results of the project to be applied to Ingalls programs such as the DDG 113, LHA, LPD, and USCG NSC Programs, and to be transferred to all Navy, Coast Guard, and Repair Programs upon completion of the project.

In recent years, ship designers have been forced to incorporate lighter, thinner steel structures to reduce topside weight, improve fuel economy, and enhance mission capability. Over the past decade, the production ratio of thin-steel (10 mm or less) to thick-plate structures for some vessels built at Ingalls has risen up to 90% per ship. At the same time, military and commercial customers have tightened the design requirements in strength, stiffness, and fitness to meet more stringent performance specifications.

Understandably, the development of technology, facilities, and processes to build thin steel ships efficiently has not kept pace with the rate of change in the designs. Shipbuilding facilities and equipment are large, costly, and expected to have a long service life. Thin steel requirements affect facility issues from the spacing of conveyor rollers, to the type of magnet cranes used, to the way steel is stored, cut, moved, welded, and assembled. The heavy machinery and support structures that are part of the steel fabrication facility cannot be changed overnight. The rapid shift in the use of thin steels from small percentages a decade ago to the high levels of today poses a major cost challenge to the U.S. Navy, to Ingalls, and to other U.S. shipyards that build these ships.

Project Background

Shipyards training programs are varied in their methods and in the metrics they use to qualify welders, and welders are not always trained on each type of weld (butt, fillet, lap, etc.) before going out into the field and performing them. As naval ship designs continue to incorporate a rising amount of thin steel, the demand for a standardized training program to address the requirements for welding this thinner material is increasingly apparent. In many programs, little attention is given to distortion-reducing practices, including welding to design sizes in an effort to reduce overwelding.

Funded by NSRP in October 2012, this project will investigate what is currently taught in the U.S. shipyard training programs in order to determine where change is most-needed. Then, working with shipyard instructors, a new program will be drafted and tested at shipyards with the goal of training welders who are able to make sound welds to design sizes and who are capable of performing welding procedures needed for thin steel designs in order to reduce rework and downstream costs. An “as-is” analysis of the current state of weld training and curriculum given to new hire welders and re-training for current welders employed at Ingalls has been performed. Investigation of the current state at Ingalls



and other US shipyards has led to affirmation of the need to fully develop and implement a new training strategy to address the issues faced by welders in today's ship designs and production limitations. A preliminary new training database is currently being developed. It's expected that the benefits the standardized weld curriculum will bring to cost savings at Ingalls Shipbuilding and across all other U.S. shipbuilders will be substantial.

Deliverable Overview

HII-Ingalls has completed the initial draft of the Standardized Welding Curriculum. The curriculum topics and modules were chosen based on current thin steel production needs. Ingalls surveyed the current new hire and recertification training program for fitters and welders and identified areas where key information pertaining to welding thin steel ship designs was neglected. Those topics as well as training information gathered from surveying other major US Shipyards allowed the team to set an outline for topics to be covered in the curriculum.

The topics that need to be covered fell into 4 major categories: First Time Quality, Welding, Shipfitting Plates and Inserts, and Quality Inspection. These categories formed the foundation of each module and in all, the curriculum contains 4 modules targeted at 2 to 4 hour training sessions each. Information critical to thin steel production and distortion mitigation for each of the 4 modules was obtained through extensive research, process review, discussions with subject matter experts, and on-site observations. Each module was thoroughly developed based on the information gathered and course material was put into PowerPoint format.

Much of the subject matter pertinent to the modules is advanced and highly technical. Realizing the curriculum needs to be comprehensible to a wide range of education levels, the subject matter was broken down to verbiage that could be easily understood and applied. A focus was made to reinforce abstract concepts with plenty of visuals and production examples. The project team generated graphics, inserted pictures, developed animation and provided videos to ensure the material was easily conveyed to the target audience. At numerous points throughout the curriculum, there is a knowledge check where the students are asked to recall important information from the module. The team made great efforts to re-emphasize key concepts due to the complexity and quantity of new information being presented.

A course workbook was created and will be distributed to each student to help maintain focus and enhance learning ability. The workbooks contain information and visual aids that follow along with the curriculum PowerPoint as the course is presented. Select items are intentionally left blank with room for the welder to fill in as they go along and there are designated areas to jot down notes or questions. These workbooks will be given to the welders and taken with them as they transition into production to help reinforce concepts learned and access critical information needed to produce quality work. Welders will also receive a laminated card to place with their badge. This card contains recommended fillet weld settings for multiple welding processes to help them produce the smaller design welds that may otherwise be difficult to achieve with acceptable quality.



Testing the welders' understanding of concepts learned throughout the course will commence upon the completion of module 4 instruction. A welding mock-up practical has been produced to give hands-on visual testing while exposing the welders to physical examples of defects and principles discussed in the course. The mock-up stands 5 feet tall and has divided sections to allow for up to 4 welders to be tested at a time. Each section contains different welded samples that demonstrate important items discussed in the course modules. The welder will be given the test that corresponds to the section they are inspecting and asked to identify the defect or problem with the sample as well as provide a brief description of probable cause and prevention measures.

A pilot training session has been planned and a sample of current welders will be trained on the curriculum by a shipyard instructor who is thoroughly briefed on the course. The project team will be present during the training and will interact with trainees to gather information and make observations about the effectiveness of the curriculum in its current state. Feedback forms will be given to the pilot trainees and the curriculum will be adjusted based on the information gathered.

The preliminary draft of the welding curriculum is shown in the next section. Some of the slides shown have blank areas that contain animation or videos which do not appear when converted to PDF format. This draft will be revised as needed and the final version will be delivered to NSRP as a PowerPoint with all applicable video links embedded. This draft is not authorized for distribution outside of the project team and NSRP ASE program representatives but the final version will be modified to eliminate any items deemed unfit for circulation and will be available to other US Shipyards upon request.

