

**Project Number:** STIN-0153  
**Project Title:** Effect of Ferrite Content on Material Properties and Embrittlement of Duplex Stainless Steel Weld Metals  
**Solicitation Date:** March 21, 2016  
**Proposal Due Date:** April 29, 2016

## 1 Summary

ASME Standards Technology, LLC (ASME ST-LLC) is soliciting proposals for the referenced project. The project results from a comprehensive report that will include the results of weld metal characterization and mechanical testing, recommendations on acceptable weld metal ferrite levels to achieve mechanical properties (strength and toughness) and maximum elevated temperature and exposed temperatures/times to avoid embrittlement for this project

This Request-for-Proposal (“RFP”) and all open RFPs are posted on the ASME ST-LLC webpage: ([http://stllc.asme.org/ST-LLC\\_RequestsProposals.html](http://stllc.asme.org/ST-LLC_RequestsProposals.html))

## 2 Background

The use of duplex alloys is becoming more common in industry practice. A better understanding the deposited welds and exposure of duplex alloy welds will provide better guidance to users of these alloys from a construction perspective and a system integrity aspect. For example, two industry areas that would likely benefit from this topic are suppliers of duplex alloy base materials and manufacturers of duplex alloy filler metal.

## 3 Scope of Work

### 3.1 Summary

This project will validate the common industry practice of ferrite content between 30 to 65 percent acceptable and determine the operating temperature effect on the mechanical properties of completed duplex alloy weldments. The Independent Consultant shall perform two primary objectives:

1. Compile and gather already published industry data that address the ferrite content and exposure limits concerns for duplex alloy welds and perform a gap analysis on the data that was collected.
2. Generate weld test data (based on the first primary objective findings) to close the gaps in the reported data.

The Independent Consultant shall develop a comprehensive report that includes the results of weld metal characterization and mechanical testing, recommendations on acceptable weld metal ferrite levels to achieve mechanical properties (strength and toughness) and the maximum elevated temperature and exposed temperatures/times to avoid embrittlement.

The two primary objectives have been divided into three (3) phases, with tasks associated within each phase.

- **Phase 1:** Task 1 - Gap Analysis
- **Phase 2:** Task 2 - Weld Metal Ferrite Content Range Verification & Task 3 - Elevated Temperature Exposure Verification
- **Phase 3:** Task 4 – Reporting

Task 1 of the project scope is to gather the industry data on duplex alloy welds. The results of Task 1 will dictate whether Task 2 and/or Task 3 are funded since the goals of Task 2 and Task 3 are to generate weld test data to fill in the gaps discovered by the gap analysis performed in Task 1. For the purpose of this work, the independent consultant shall be responsible for completion of Phase 1 along with the mapping out in detail the rest of the project. The details for the various tasks are shown below:

### **Task 1 – Gap Analysis**

This task will include a review of available research performed on duplex alloys. The base metals that will be the target of the review will include 2101, 2205 and 2507 grades of this duplex alloys. These three duplex alloys are the most common alloys in the lean, standard and super duplex alloy groups. The hyperduplex grades were not included since they have seen limited used in welded construction. The filler metals that will be the target of the review will include but not limited to ER2209 and ER2594 which are the most common filler metals used when welding these three base metals.

The research to be reviewed may include published research as well as private industry reports. The goal of the literature review is to compile data on two different aspects of the duplex alloys. The first aspect is the compilation of mechanical testing data compared to ferrite content which can be used to verify the common industry understanding of the 30 to 65 percent ferrite content requirement when welding these materials. The second aspect is the comparison of service exposure temperatures to mechanical testing data to determine if the typical maximum operating temperature of 600°F still is appropriate.

### **Task 2 – Weld Metal Ferrite Content Range Verification**

#### **Task 2.1 – Welding**

The mechanized gas metal welding (GMAW) process using the filler metals listed in Table 1 will be used to deposit the test welds. Both single pass and multi-pass welds will be performed. The single pass welds will be deposited in approximately 0.25 inch thick plate using a suitable joint

design to ensure full penetration. Single pass welds will yield the highest weld metal ferrite content since no secondary austenite can form as a result of reheating from subsequent passes. Multi-pass welds will be made in approximately 0.5 inch thick plate using a suitable joint design to accommodate 4-5 passes in order to insure formation of secondary austenite during reheating by the fill passes. The goal of producing welds of two different thicknesses is to produce welds that have ferrite content between 25 to 75 percent to supplement the compilation of data gather during Task 1. It is anticipated that nitrogen will be added to the shielding gas in order to drive weld metal ferrite content to lower levels.

**Table 1. Base and Filler Metals**

Base Metal	Filler Metal
Alloy 2101 (UNS S32101)	ER2209
Alloy 2205 (UNS S32205)	ER2209
Alloy 2507 (UNS S32750)	ER2594

The total number of welds will be dependent on the data reviewed during Task 1. It is expected that a maximum of ten test welds will be fabricated per duplex alloy listed in Table 1 for a maximum total of 30 welds.

### **Task 2.2 – Metallographic Analysis and Ferrite Content Determination**

Thorough metallographic analysis and ferrite measurement will be conducted on each test weld. The ferrite content will be determined in ferrite number (FN) using the MagneGage in conjunction with AWS A4.2-98 and volume percent using image analysis. The weld metal hardness will be measured using both Vickers and Rockwell techniques.

### **Task 2.3 – Material Properties Determination**

This task will determine the effect of weld metal ferrite content on the mechanical properties of the weld metal for the combinations listed in Table 1. The mechanical tests will include two types of tensile tests (cross-weld and all-weld), bend tests, and Charpy V-notch (CVN) test. The cross-weld tensile test and bend tests will be in accordance with ASME Section IX. The all-weld metal tensile tests will be in accordance with AWS B4.0. The CVN samples will be notched at the weld centerline and be tested in accordance ASTM E23. A total of three CVN samples will be tested at four different test temperatures of 20°C, 0°C, and -20°C and -40°C (70°F, 32°F, -5°F, and -40°F).

In addition to the listed mechanical testing, the pitting corrosion resistance of the test welds will also be determined. The pitting corrosion will be measured in accordance with ASTM G48, Method A. This test requires 72 hour immersion in 6 percent ferric chloride at either 22°C or 50°C.

### **Task 3 – Elevated Temperature Exposure Verification**

#### **Task 3.1 – Welding**

Test welds will be deposited in the same manner as described in Task 2.1. A maximum of ten test welds will be fabricated per material listed in Table 1 for a total of 30 welds. Of the group of ten welds per material, five of the welds will be deposited following the same procedure followed in Task 1 that was shown to produce an acceptable low limit of ferrite content and five welds will be deposited following the same procedure followed in Task 1 that was shown to produce an acceptable high limit of ferrite content

#### **Task 3.2 – Elevated Temperature Exposure**

All thirty test welds will be exposed to an elevated temperature. The temperature will be based on Thermocalc® simulations which is a model that determines the minimum temperature for alpha-prime formation for each of the base and filler metals. Based on this information, samples will be exposed the minimum temperature determined by Thermocalc®, at temperatures 50°F above and below the minimum temperature predicted by Thermocalc® and at temperatures 100°F above and below the minimum temperature predicted by Thermocalc®. All the test welds will be exposed for 500 hours. It is anticipated that exposure temperatures will be in the range from 300°C to 350°C (570°F to 660°F).

#### **Task 3.3 – Metallurgical Analysis and Properties Determination**

All the exposed test welds will be analyzed and tested as described in Task 2.2 and 2.3 with the only exception being the CVN tests. The CVN tests will include three test samples at three different notch locations (weld centerline, fusion line and heat affected zone). The results of the tests of the exposed samples will be compared the non-exposed weld tested in Task 2. FN will be used determine the alpha-prime formation, since this phase is nonmagnetic and its formation reduces the FN.

#### **Task 4 – Reporting**

A comprehensive report will be provided that includes the results of weld metal characterization and mechanical testing. Recommendations on acceptable weld metal ferrite levels to achieve mechanical properties (strength and toughness) and maximum elevated temperature exposure temperatures/times to avoid Embrittlement will also be included.

### **3.2 Project Deliverables**

The independent consultant shall be responsible for and provide the following:

1. Completion of Phase 1: Task 1 – Gap Analysis
  - a. Compile and gather already published industry data that address the ferrite content and exposure limits concerns for duplex alloy welds.
  - b. Identify the gaps and propose a roadmap on how to proceed with completing the two primary objectives: Use the FY2016 BREG Agenda to further itemize the project cost estimate and a schedule description of tasks.
2. Submit a written report of findings of Phase 1 and recommendations on how to proceed with Phase 2 and 3.

The Phase 1 final report will be used to promote further sponsorship for Phases 2 and 3.

Final Deliverable: The Independent Consultant shall submit a written report that will include the results of weld metal characterization and mechanical testing, recommendations on acceptable weld metal ferrite levels to achieve mechanical properties (strength and toughness) and the maximum elevated temperature and exposed temperatures/times to avoid embrittlement.

The Report shall be provided initially as a draft and subsequently as a final that incorporates the comments of ASME ST-LLC or applicable ASME review committees, such as an ASME Peer Review Group (“PRG”). One peer review cycle is anticipated. The Independent Consultant shall then address/respond to all PRG comments and prepare the final version. ASME ST-LLC will assess that comments have been satisfactorily addressed and will work with the Independent Consultant to finalize the document. The results will be shared with all ASME construction codes that do permit the use of duplex alloys for construction. These Code sections include ASME Section VIII, ASME B31.3, ASME B31.4 and ASME B31.8. All written deliverables shall be provided as an MS Word file that is formatted in accordance with the ASME Style Guide.

### **3.3 Project Schedule**

The Independent Consultant shall complete the final deliverable within a six month period of commencing the project.

### **3.4 Project Progress Reporting**

The respondent shall provide a brief status report on a monthly basis, via email, to the ASME ST-LLC project manager identified herein. Progress reports shall be presented at ASME B31 Committee meetings, as requested by ASME ST-LLC.

## **4 Respondent Eligibility Requirements**

ASME ST-LLC is seeking proposals from all qualified organizations including, but not limited to, engineering firms, independent consultants, academic institutions, and federally funded research and development centers. In addition to relevant technical qualifications and experience, respondents must possess an understanding of relevant ASME codes and standards.

## **5 Basis for Selection and Award**

ASME ST-LLC will select the winning proposal by evaluating and comparing the merits of each respondent's complete proposal. This process reflects ASME ST-LLC's desire to select application proposal based on its potential to achieve program objectives, rather than solely on evaluated technical merit or cost. Evaluation criteria include, but are not limited to, the following:

- Respondent's technical capabilities
- Respondent's applicable experience
- Proposal price
- Project schedule
- Any exceptions to ASME ST-LLC's standard agreement

ASME ST-LLC reserves the right to award, in whole or in part, any, all, or none of the proposals/respondents answering this solicitation.

## **6 Contract Terms and Conditions**

The contract to perform the Scope of Work shall be fixed-price. A form of ASME ST-LLC's standard agreement applicable to this Scope of Work is attached as Attachment 1 to this RFP.

ASME ST-LLC will provide access to applicable codes, standards, and other technical references as needed to perform the Scope of Work.

## **7 Submission Requirements**

### **7.1 Proposal Due Date**

Proposal must be submitted by April 29, 2016. Respondents are encouraged to transmit its proposal well before this deadline. Requests for extra time must be sent by April 15, 2016 to the contact listed in Section 8 of this RFP.

ASME ST-LLC intends to select the winning proposal within three weeks of the proposal deadline.

## **7.2 Proposal Preparation Costs**

Proposal costs shall be borne by the respondent. This solicitation does not obligate ASME ST-LLC to pay any costs incurred in the preparation and submission of the proposal, in making necessary studies or designs for the preparation thereof, or to acquire, or contract for any services.

## **7.3 Proposal Clarification**

ASME ST-LLC reserves the right to request clarification of the proposal and/or supplemental information. The award may be made after few or no exchanges, discussions, or negotiations. Therefore, all respondents are advised to submit its most favorable application to ASME ST-LLC. ASME ST-LLC reserves the right, without qualification, to reject any or all proposals received in response to this solicitation and to select any proposal, in whole or in part, as a basis for negotiation and/or award. ASME ST-LLC reserves the right to modify or cancel this solicitation. All questions relating to the solicitation must be submitted to the contact listed in Section 8 herein. Any amendments to the solicitation will be posted on the ASME ST-LLC website previously referenced.

## **7.4 Treatment of Proprietary Information**

A proposal may include technical and/or other data, including trade secrets and/or privileged, confidential commercial or financial information, which the respondent does not want disclosed to the public or used by ASME ST-LLC for any purpose other than proposal evaluation. To protect such data, the respondent should specifically identify the data or information to be protected.

## **7.5 Proposal Preparation and Submittal Instructions**

ASME ST-LLC may form a committee of subject matter experts to evaluate the technical qualifications of applicants. To help facilitate this evaluation, proposals should be separated into two separate documents: (1) a Technical Proposal; and (2) a Financial Proposal.

### **7.5.1 Technical Proposal contents must include:**

- Provide organization name and contact information.
- Provide evidence of technical capabilities: credentials, qualifications, capabilities, and experience of individuals and the organization.
- Describe approach to accomplish the Scope of Work (refer to Section 3).
- Demonstrate agreement with the Scope of Work (refer to Section 3).

### **7.5.2 Financial Proposal contents must include:**

- Provide a fixed-price quotation.

- Confirm agreement with the form of agreement attached herein, or state any requested exceptions to same.

7.5.3 The respondent shall submit the Technical and Financial Proposals files via e-mail to the ASME ST-LLC contact identified in Section 8 of this RFP. Responses must be received on or before the proposal due date identified in Section 7.1 of this RFP.

## **8 ASME Standards Technology, LLC Contact Information**

All correspondence regarding this RFP is to be directed to the following person:

Mr. Luis S. Pulgarin  
Project Manager  
ASME Standards Technology, LLC  
Two Park Avenue  
New York, NY 10016  
Telephone: 212-591-8584  
E-mail: [pulgarinl@asme.org](mailto:pulgarinl@asme.org)



ATTACHMENT 1: FORM OF AGREEMENT

**ASME Standards Technology, LLC**  
**Nonexclusive Independent Consultant Agreement for**  
**Effect of Ferrite Content on Material Properties and Embrittlement of Duplex Stainless**  
**Steel Weld Metals**

This Agreement, dated as of [\_\_\_\_\_], is made between ASME Standards Technology, LLC (“ASME ST-LLC”), a New York not-for-profit corporation with its principal office at Two Park Avenue, New York, New York 10016 and [Independent Consultant TBD], (the “Independent Consultant”).

**W I T N E S S E T H:**

**WHEREAS** ASME ST-LLC desires to engage the Independent Consultant to develop a comprehensive report that will include the results of weld metal characterization and mechanical testing, recommendations on acceptable weld metal ferrite levels to achieve mechanical properties (strength and toughness) and maximum elevated temperature and exposed temperatures/times to avoid embrittlement for this project; and

**WHEREAS** the Independent Consultant agrees to accept such engagement and to perform the services hereinafter specified;

**NOW, THEREFORE**, in consideration of the foregoing and the mutual agreements of the parties contained in this Agreement, it is agreed as follows:

**1. Engagement.** ASME ST-LLC hereby engages the Independent Consultant, on an as-needed and nonexclusive basis, to perform the services defined in Annex 1 to this Agreement (the “Work”).

**2. Performance.** The Independent Consultant agrees to perform the services set forth above. The Independent Consultant agrees to perform such services professionally and to the best of its ability, to provide its services in an ethical manner, and to avoid conflicts of interest and any appearance thereof. It is understood that the Independent Consultant may obtain other consulting work and, as a result, may be unavailable, from time to time, to perform consulting services for ASME ST-LLC, but the Independent Consultant agrees to adhere to the

## ATTACHMENT 1: FORM OF AGREEMENT

ASME ST-LLC Policies on Conflicts of Interest and Ethics (<http://stllc.asme.org/Policies.cfm>). ASME ST-LLC will not set specific daily schedules. ASME ST-LLC will not provide tools, materials, supplies or equipment necessary for the Independent Consultant to perform the Work except for the necessary codes, standards, and procedures. Neither will ASME ST-LLC reimburse the Independent Consultant for the use of its tools, materials, supplies or equipment. The Independent Consultant shall not engage subcontractors to perform any portion of the Work without the written approval of ASME ST-LLC.

**3. Fees.** For all services to be rendered by the Independent Consultant to ASME ST-LLC, as required by ASME ST-LLC, the Independent Consultant will receive fees as specified in Annex 2 to this Agreement. It is understood and agreed that the Independent Consultant is performing services as an independent contractor. As a result, ASME ST-LLC will not withhold any tax, of whatever nature, from payments made by ASME ST-LLC to the Independent Consultant. The Independent Consultant is solely responsible for meeting federal, state, or local income tax liabilities. The total charges for all fees and expenses shall not exceed the contract value specified in Annex 2 to this Agreement.

**4. Expenses.** In addition to the fees provided in Section 3 of this Agreement, ASME ST-LLC shall reimburse to the Independent Consultant for reasonable expenses for the cost of travel to out-of-town Work-specific meetings, subject to the contract maximum specified in Annex 2 to this Agreement. Such reasonable expenses include food, lodging, transportation, and incidental expenses, including, but not limited to, reimbursement for automobile travel incurred with the provision of services hereunder. The Independent Consultant will receive reimbursement for reasonable expenses connected therewith on a cost basis. ASME ST-LLC will reimburse the Independent Consultant for personal automobile travel accomplished within the United States in connection with providing services to ASME ST-LLC at the Internal Revenue Service's standard mileage rate. Other expenses incurred by the Independent Consultant in connection with the Work, such as normal office charges (mail, telephone, computer, and duplication), shall be borne by the Independent Consultant as part of the total compensation for the Work.

## ATTACHMENT 1: FORM OF AGREEMENT

**5. Terms of Payment.** The Independent Consultant shall submit associated invoices and expense statements for acceptance by ASME ST-LLC prior to payment. Invoices shall be submitted monthly and shall clearly identify specific work items performed. Subject to the provisions of Sections 3 and 4 of this Agreement, ASME ST-LLC will reimburse the Independent Consultant for such expenses upon the presentation by the Independent Consultant of proper substantiation of such expenditures. Receipts are not required to be submitted with expense reports; however, receipts shall be retained by the Independent Consultant and made available for audit upon request. Payment shall be 100 percent net due 30 days after receipt of an acceptable invoice from the Independent Consultant.

**6. Benefits.** The Independent Consultant is not eligible for, and will not receive, any benefits from ASME ST-LLC based on services performed under this Agreement.

**7. Copyright and Ownership.** The Independent Consultant agrees that ASME ST-LLC specially ordered and commissioned the Work as “work made for hire” as that term is defined in the United States Copyright Act (17 U.S.C. §101), and that for purposes of the copyright laws, ASME ST-LLC shall be deemed the “author” of the Work. If it is determined that the Work is not a work made for hire under the U.S. Copyright laws, then, as of the creation of the Work, the Independent Consultant hereby assigns exclusively and irrevocably to ASME ST-LLC all worldwide, present and future right, title and interest in the Work, including the copyrights and other proprietary rights existing in the Work (including all United States and foreign copyrights, all copyrights under any treaties, conventions, proclamations, or the like, and all extensions of such copyrights; all artistic and literary property rights; all moral rights; all rights to apply for or obtain any registrations for copyright in the Independent Consultant’s name; and the right to sue and recover for any infringement of the Work). The Independent Consultant may not reproduce the Work in any form without ASME ST-LLC’s prior written permission.

**8. Indemnification and Hold Harmless.**

**a. Obligation of the Independent Consultant** – The Independent Consultant shall indemnify, defend and hold harmless ASME ST-LLC and its officers, directors, employees and agents and each of them from any and all claims, actions, causes of action, demands,

## ATTACHMENT 1: FORM OF AGREEMENT

liabilities of whatsoever kind and nature including judgments, interest, attorney's fees, and all other costs, fees, expenses and charges which ASME ST-LLC, its officers, directors, employees, agents and each of them, may incur arising out of the negligence, gross negligence or willful or wanton misconduct of the Independent Consultant, its officers, directors, employees or agents.

**b. Obligation of ASME ST-LLC** – ASME ST-LLC shall indemnify, defend and hold harmless the Independent Consultant and its officers, directors, employees and agents and each of them from any and all claims, actions, causes of action, demands, liabilities of whatsoever kind and nature including judgments, interest, attorney's fees, and all other costs, fees, expenses and charges which the Independent Consultant, its officers, directors, employees, agents and each of them, may incur arising out of the negligence, gross negligence or willful or wanton misconduct of ASME ST-LLC, its officers, directors, employees or agents.

**9. Term.** It is mutually agreed that the Independent Consultant will commence work on this project immediately upon execution of this Agreement, and continue until completion, estimated as on or about [contract end date]. This termination date may be extended by mutual agreement, which must be confirmed in writing.

**10. Termination.** ASME ST-LLC shall have the right to terminate this agreement upon 14 days' notice in writing to the Independent Consultant at any time that ASME ST-LLC shall in its judgment decide that such termination is in the best interests of ASME ST-LLC. Conversely, the Independent Consultant shall have the right to terminate this agreement upon 14 days' notice in writing to ASME ST-LLC at any time that the Independent Consultant shall in its judgment decide that such termination is in the best interests of the engineering profession. In the event of such termination, ASME ST-LLC shall pay the Independent Consultant on a pro rata basis for percent of work completed as determined by mutual agreement subject to the provisions of Sections 3 and 4 of this Agreement.

**11. Force Majeure.** The parties' performance under this contract is subject to acts of God, war, government regulation, terrorism, disaster, strikes, civil disorder, curtailment of transportation facilities, or any other emergency beyond the parties' control, making it inadvisable, illegal or which materially affects a party's ability to perform its obligations under

## ATTACHMENT 1: FORM OF AGREEMENT

this contract. Either party may terminate this contract for any one or more of such reasons upon written notice to the other party.

**12. Trademark Usage.** Independent Consultant may not use any of ASME ST-LLC's trademarks or other identifiers (including the ASME ST-LLC logo) in any manner without ASME ST-LLC's prior written approval or consent. ASME ST-LLC reserves the right to review any approved use of its trademarks and to require changes in any further use, and Independent Consultant agrees to comply with those requirements.

**13. Publicity Release and Public Affairs.** The Independent Consultant shall not make without prior review and approval of ASME ST-LLC, any publicity release of any nature of general, non-technical information in connection with this Agreement. For purposes of this Agreement, general, non-technical information means any information concerning the existence of the Agreement, the identity of the parties, and the scope and general character of the research or technical activity.

**14. Entire Agreement.** This Agreement entirely supersedes, terminates, and replaces any and all prior agreements between the parties relating to the subject matter hereof and may not be amended except by an instrument in writing signed by both parties to this Agreement.

**15. Notices.** Any notices hereunder shall be given to the parties at their respective addresses set forth above by registered mail until a new and different address shall be established for either party on the basis of notice given to the other party.

**16. Governing Law.** This Agreement shall be subject to and governed by the substantive laws of the State of New York (without regard to its conflict of laws rules).

**ATTACHMENT 1: FORM OF AGREEMENT**

**IN WITNESS WHEREOF**, ASME ST-LLC has caused this Agreement to be executed on its behalf by its officer thereunto duly authorized and the Independent Consultant has executed this Agreement as of the day and year first above written.

**ASME STANDARDS TECHNOLOGY, LLC**

By: \_\_\_\_\_  
Name: John J. Koehr  
Title: President

**INDEPENDENT CONSULTANT**

By: \_\_\_\_\_  
Name:  
Title:  
Social Security or Federal Tax ID number: \_\_\_\_\_

**ATTACHMENT 1: FORM OF AGREEMENT**

**Annex 1 – Statement of Work**

**Scope Description**

[TBD]

**ATTACHMENT 1: FORM OF AGREEMENT**

**Annex 2 – Financial Terms**

**Reporting**

**1 Fees and Expenses**

Technical services rate: [\_\_\_\_\_].

Travel rate (if applicable): [\_\_\_\_\_].

Travel expenses: [\_\_\_\_\_].

Contract Maximum: [\_\_\_\_\_].