1.0 Purpose

The purpose of this specification is to establish the minimum quality assurance requirements for field-applied corrosion-resistant weld overlay of boiler tubing at NRG owned or operated facilities.

2.0 Scope

2.1 This specification applies to boiler tubes that have experienced external wall loss due to wastage, erosion, corrosion or external cracking, but have not failed, leaked, or sustained a through-wall defect.

2.2 Boiler tubing that is weld overlayed must meet the “calculated” minimum wall requirements of the ASME Boiler & Pressure Vessel Code, Section I.

3.0 Definitions

3.1 ASME – American Society of Mechanical Engineers

3.2 ASNT – American Society for Nondestructive Testing

3.3 Contractor - The responsible repair organization

3.4 NRG - The NRG individual responsible for overall management of the project cost and schedule

3.5 NRG QA – The NRG individual responsible for quality and welding aspects of the project

3.6 NBI – National Board of Boiler and Pressure Vessel Inspectors

3.7 SSPC – The Society for Protective Coatings

3.8 QAS – NRG Quality Assurance Specification

3.9 QC - Quality Control refers to the Contractor's quality activities

3.10 Weld Overlay – The deposition of a corrosion-resistant weld metal using an automatic or semi-automatic pulsed gas tungsten arc or pulsed gas metal arc welding process

3.11 Work Process Documentation (WPD) – A tracking form that documents the weld procedure specification being used, the essential details of the welding process (e.g., base metal, filler metal, preheat, etc.), and any special procedures/techniques, materials and hold points. Work process documentation may be a Removal and Replacement Procedure, Weld Data Sheet, Repair Plan, or Contractor-equivalent form.

4.0 References

4.1 ANSI/NB-23, "National Board Inspection Code"

4.2 ASME Boiler & Pressure Vessel Code, Section I, "Rules for Construction of Power Boilers"

4.3 ASME Boiler & Pressure Vessel Code, Section II, Parts A and B "Ferrous and Non Ferrous Material Specifications"

4.4 ASME Boiler & Pressure Vessel Code, Section II, Part C, "Specifications for Welding Rods, Electrodes, and Filler Metals"

4.5 ASME Boiler & Pressure Vessel Code, Section V, "Nondestructive Examination"

4.6 ASME Boiler & Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators"

4.7 SNT-TC-1A, "Personnel Qualification and Certification in Nondestructive Testing"

4.8 NRG QAS 4.08, "Boiler Tube Base Material Build Up"

4.9 SPPC SP-10 (NACE 2), “Near-White Blast Cleaning”

The latest edition of the above codes, standards, and specifications shall apply. In the event of conflicts between this specification and the references cited above, the Vendor shall notify NRG, who will make the final judgment and interpretation.

5.0 Responsibility

5.1 The contractor shall be responsible for fulfilling the requirements as set forth in this specification including the submission of all welding, welder qualification, and quality control documents. Exceptions to and deviations from this specification shall be clearly delineated in the Contractor’s bid for disposition by NRG.

5.2 The Contractor shall hold a valid “R” Stamp issued by the NBIC.

5.3 The Contractor shall identify clearly in their proposal any and all subcontractors intended to be used. All subcontractors must be approved by NRG prior to the issuance of a purchase order.

5.4 NRG is responsible for providing the contractor with the design information necessary to perform the weld overlay. This information will be transmitted using the Weld Overlay Data sheet provided in Attachment 1 or equivalent form.

5.5 NRG is responsible for ensuring the tubes to be overlayed have adequate wall thickness in accordance with Paragraph 2.2. If required, a base-material build up will be performed in accordance with NRG Specification QAS 4.08 prior to the weld overlay.

5.6 NRG is responsible for the surface preparation of the waterwall tubes to be overlaid. This will consist of sandblasting to SSPC SP-10 with a low carbon, low dusting abrasive, which does not embed itself in the substrate followed by the application of a deoxyaluminate coating, one to two mils dry thickness.

5.7 NRG is responsible for conducting a hydrostatic test of the boiler after the completion of all welding.

6.0 Weld Procedures

6.1 The Contractor shall submit a weld procedure specification (WPS) and supporting procedure qualification record (PQR) to NRG QA for

review and approval. The WPS and PQR shall conform to the rules of the ASME Boiler & Pressure Vessel Code, Section IX.

6.2 The PQR and welding operator's qualification shall be qualified using a base material with a wall thickness no greater than the minimum wall thickness for welding shown in Attachment 1 or equivalent form.

6.3 Prior to installing the corrosion-resistant weld overlay, NRG *may* request the Contractor to perform a base material buildup using a weld filler material that matches the composition of the waterwall tubes. The Contractor shall have the required weld procedures in place should this situation occur. Base material build up shall be in accordance with NRG Specification QAS 4.08.

6.4 The Contractor shall submit a bead sequence sketch detailing the instructions and operating technique for applying the weld overlay.

7.0 Welder Qualification

7.1 Welders shall be qualified in accordance with the Contractor's Quality System and the ASME Boiler & Pressure Vessel Code, Section IX, and specifically the requirements of Paragraph QW-214 for Corrosion Resistant Weld Metal.

7.2 As a minimum, all welders performing weld overlay shall be qualified in the 3-G (vertical) position. Weld progression shall be downhill. Additional qualifications may be required depending on the field application.

7.3 The Contractor shall submit copies of the welder performance qualification record and proof of continuity to NRG QA for review and approval prior to the start of welding.

7.4 Contractor welders assigned to weld overlay who do not have current qualifications must qualify on-site.

7.4.1 The Contractor's QC Inspector shall administer the on-site welder qualification test. NRG QA reserves the right to witness or inspect any phase of the testing.

7.4.2 The coupon shall be tacked into the designated position at the welding station. Once tacked into position it shall not be removed until the completion of the test.

7.4.3 All grinding, filing, or brushing shall be performed in the designated test position and is considered part of the test.

7.4.4 Upon completion, NRG QA and the Contractor's QC Inspector shall perform a visual inspection of the test coupon prior to bend testing. The test coupon shall be free of:

7.4.4.1 Surface Porosity
7.4.4.2 Cracks
7.4.4.3 Burn Through
7.4.4.4 Lack of Fusion between Passes
7.4.4.5 Undercutting Exceeding 1/32"
7.4.4.6 Excessive Weld Spatter

7.4.5 After visual acceptance, two test specimens shall be cut from the test coupon and bent by the Contractor. Acceptance shall be in accordance with the ASME Boiler & Pressure Vessel Code, Section IX.

8.0 Welding Requirements

8.1 After the surface preparation is completed, the Contractor and NRG QA shall inspect the waterwall tubes to determine the acceptability for overlay. This inspection shall take place before the deoxyaluminate coating is applied.

8.2 Prior to welding, the Contractor and NRG QA shall inspect the tubes to be overlaid for signs of pitting and external corrosion. These areas will be considered for base material buildup as specified in Paragraph 6.3 or tube replacement.

8.3 The following welding processes are permitted:

8.3.1 Pulsed Gas Metal Arc (GMAW), manual or automatic and semiautomatic with 0.035" maximum diameter electrodes. Larger diameters require workmanship samples to be submitted to NRG for approval.

8.3.2 Other welding processes will be considered if the Contractor can demonstrate the ability to use the process to the satisfaction of NRG. The Contractor shall submit to NRG the complete details of the filler material, surface preparation, welding equipment, welding techniques, welding procedures,

and procedure qualification tests for each of the proposed processes.

8.4 For overlay of P1 and P3 materials, the tubes shall be filled with water prior to welding, unless directed otherwise, in writing, by NRG. A minimum preheat temperature shall be maintained in accordance with the Contractor's approved welding procedure.

8.5 For overlay of P4 and P5A materials, the minimum preheat temperature requirements shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section I, Table PW-39.

8.6 For membrane tube construction, the weld overlay shall extend to the membrane welds on either side of the tube (i.e., 180° coverage), plus the area of the membrane.

8.7 For tangent tube construction, the weld overlay shall extend from tube tangent to tube tangent for approximately 150° of the tube surface to cover the maximum possible area without welding the tubes together.

8.8 The weld overlay shall be smooth and continuous, with no gaps, burn through, or exposed tube area between passes, and consistent in thickness. All stops and starts and tie-ins shall be blended/ground to a smooth transition.

8.9 The overlay thickness shall not be less than the minimum overlay thickness or greater than the maximum overlay thickness indicated in Attachment 1, except for local areas such as stops, starts and overlaps, which may exceed the thickness range.

8.10 The minimum overlap between weld passes shall be 10%.

8.11 The Contractor shall perform local surface preparation, such as flush grinding of existing butt weld reinforcements, if required. This shall include the complete removal of any toe cracks at existing butt welds.

8.12 In areas where the boiler waterwalls have been previously overlaid, the new overlay shall be tied into the existing weld overlay. There shall be complete fusion with the existing weld without voids.

8.13 Track attachments shall be welded to the membrane and not the waterwall tubes. On tangent tube boilers, attachments shall be welded to the tubes using a vertical down progression with the

minimal weld size and length necessary to ensure adequate track support.

8.14 NRG will advise the Contractor of any required repairs or replacements based on the severity of the as-found conditions. NRG will be responsible for tube replacements necessitated by as-found conditions.

8.15 All welders will have torches and the appropriate temp sticks to verify preheat and interpass temperature.

8.16 Any surface damage caused by the Contractor, including grinding nicks, shall be repaired by the Contractor using methods approved by NRG and at no cost to NRG.

8.17 Any burn through or other problems should be immediately reported to the Contractor QC Representative and NRG QA. Weld repair of such tubes will not be permitted unless otherwise directed by NRG.

9.0 Inspection and Testing

9.1 The Contractor and NRG QA shall perform 100% final visual inspection of the weld overlay after power brushing has been completed for conformance with Paragraphs 9.6 through 9.10 and Attachment 1. Any areas that do not meet the minimum or exceed the maximum weld overlay thickness specified in Attachment 1 shall be reported as a nonconformance.

9.2 The Contractor shall perform a 100% liquid penetrant examination of the weld overlay area using a water washable method.

9.3 The Contractor and NRG QA will inspect the weld overlay area during the hydrostatic test. Any tubes that leak as a result of the Contractor's work, whether within the overlay area, or immediately adjacent to the overlay area, shall be identified for replacement.

9.4 Tubes within the weld overlay area that are damaged by the weld overlay (i.e., burned through) or found to be leaking during the hydrostatic test shall be replaced at the expense of the Contractor.

10.0 Quality Control Requirements

10.1 The Contractor shall implement their Quality System for all work. The Contractor shall have available their latest Quality System

Manual, Quality System Procedures and other Quality System documents at the job location. All Quality System documents shall be available to NRG for review and audit.

10.2 The Contractor's Quality System shall, as a minimum, include the following:

10.2.1 On-site testing of welders with completed QW 484's and administrative paperwork submitted to NRG QA for approval
10.2.2 Submission of any and all welder continuity updates to NRG QA for approval
10.2.3 Receipt inspection of incoming wire for compliance with the requirements of the ASME Boiler & Pressure Vessel Code, Section II, Part C and to verify the proper wire was received
10.2.4 Visual in-progress inspection of at least 20% of the work for each welder performing weld overlay
10.2.5 Coordination with the Contractor's Authorized Inspector as required
10.2.6 Material analysis with an alloy analyzer if requested by station personnel

10.3 The Contractor shall submit their Work Process Documentation to NRG QA for review and approval prior to the start of work (see Attachment 2 for example). The Work Process Documentation shall include detailed instructions for applying the weld overlay, including a bead sequence sketch, and the welding machine setup or program of the critical parameters, including voltage, amperage, travel speed and wire feed speed. The Work Process Documentation shall be posted at each workstation.

10.4 The Contractor shall have a full-time qualified QC Representative on site for all shifts during the overlay work. The QC Representative shall have the following credentials:

10.4.1 American Welding Society Certified Weld Inspector or an individual certified in accordance with the company's Visual Weld Inspection Program

10.4.2 At least two years QC experience with field-applied waterwall tube weld overlay

10.5 Resumes of prospective candidates for the QC Representative function shall be submitted to the NRG Project Manager at least two weeks prior to mobilization.

11.0 Documentation

The Contractor's final documentation package shall, as a minimum, include the following:

11.1 R-stamp certificate
11.2 Completed and signed R-1 form
11.3 Weld procedure specifications and procedure qualification records
11.4 Welder qualifications
11.5 Certified material test reports for the filler metal (submitted prior to welding)
11.6 Work Process Documentation
11.7 QC representative's resume with CWI certification document
11.8 Marked-up as-built drawings of the completed work indicating where the weld overlay was applied and where any repairs or special procedures were used

12.0 Attachments

1. Weld Overlay Data Sheet
2. Work Process Documentation (example)

Attachment: 1
QAS No.: 4.04

DATA SHEET # _____ NRG Energy INC Page __ of __

DATE _____ **WELD OVERLAY DATA SHEET**

STATION _____ UNIT _____

PANEL LOCATION DATA

FURNACE N S E W

WALL F R C R L

EL. FROM		EL. FROM	
EL. TO		EL. TO	
TUBE # FROM		TUBE # FROM	
TUBE # TO		TUBE # TO	
ACTUAL AREA	SQ. FT.	ACTUAL AREA	SQ. FT.
PROJECTED AREA	SQ. FT.	PROJECTED AREA	SQ. FT.

TUBE MATERIAL DATA

TUBE MATERIAL SA- _____ _____

DIAMETER X MWT _____ " x _____ "

MWT FOR WELDING _____ " _____ "

MEMBRANE W x _____ THICK

MATERIAL CS CM

AVG. TUBE WALL THICKNESS _____ INCHES

THINNEST TUBE MEASURED _____ INCHES

BOILER WATERWALL INSPECTION REPORT NO. _____

REPORT DATE _____

WELD METAL OVERLAY DATA

WELD MATERIAL TYPE _____ MIN. OVERLAY THICKNESS _____ " MAX. OVERLAY THICKNESS _____ "

WELD PROCEDURE P NO. _____ TO P NO. _____ COMPLETED MIN. WALL THICKNESS _____ COMPLETED MAXIMUM WALL THICKNESS _____

SKETCH PANEL AREA/LOCATION

Use additional sheets as required for each area

SKETCH TUBE MEMBRANE CONFIGURATION

Use additional sheets as required

SPECIAL CONDITIONS (DESCRIBE): Pad Welds, Metal Spray, Studs, Previous Overlay Tie-In, Old/New Tubes, High/Low Wastage Tubes

Prepared By: _____ Date: _____

Approved By: _____ Date: _____

QA Specification No.	4.01
R&R Number	

Station _____ Unit _____ Work Order Number _____

National Board No. _____ Serial No. _____ Year Built _____

Job Description _____

Applicable Code(s) _____

Pipe Line Spec No. _____ Design Pressure _____ psig Design Temp _____ °F

Removal Procedure & Replacement Material

Removal Method [ ] Arc [ ] Flame [ ] Saw [ ] Grinding Wheel [ ] Machine

Rep.Material _____ SA-_____ Gr_____ P-No. _____ _____"OD _____" Thk. / Press. Class

_____ SA-_____ Gr_____ P-No. _____ _____"OD _____" Thk. / Press. Class

_____ SA-_____ Gr_____ P-No. _____ _____"OD _____" Thk. / Press. Class

_____ SA-_____ Gr_____ P-No. _____ _____"OD _____" Thk. / Press. Class

Replacement Procedure

Weld Procedure Specification: _____ Rev. ____

Type of Weld Joint: ____[ ] Fillet ____[ ]* Socket [ ] **Butt _____[ ]Build up ____/____[ ] Overlay____

***All welds** shall have at least two layers of filler metal. **Max. thickness of butt weld reinforcement _____

Material P-No. ____ To ____ GTAW _____ SMAW _____ FCAW/GMAW _____

Weld Preparation: Root Gap _____ Bevel _____ Land _____

Root Design: [ ] GTAW [ ] Open [ ] Backing [ ] ID Argon Purge Required

Preheat Temperature: _____ °F Interpass Temperature: _____ °F

Prep NDE:	[ ] Visual	[ ] PT	[ ] MT	[ ] RT	[ ] UT
Root NDE:	[ ] Visual	[ ] PT	[ ] MT	[ ] RT	[ ] UT
Final NDE:	[ ] Visual	[ ] PT	[ ] MT	[ ] RT	[ ] UT

Comments:

Post Weld Heat Treatment

Required ? [ ] Yes [ ] No Procedure No. _____

Temperature _____ °F Soak Time _____

Heat Rate _____ °F/hr (above 600 °F) Cooling Rate _____ °F/hr (above 600 °F)

Hydrostatic Test

Required ? [ ] Yes [ ] No Pressure _____ PSI Hold Time _____ Minutes

Hold Points – The following HOLD POINTS must be signed off by the AI and/or NRG QA Rep. Initial/Date

A: _____ _____

B: _____ _____

C: _____ _____

D: _____ _____

Approvals - The following approvals must be obtained prior to start of work:

	Signatures	Date
Authorized Inspector	_____	_____
Contractor QC Rep.	_____	_____
NRG QA Rep	_____	_____

(Document Repairs on Weld Repair Record)

Date: 12/13/11 Rev. 2