1.0 Purpose

The purpose of the specification is to establish the minimum requirements for structural steel welding.

2.0 Scope

2.1 This specification shall apply to all Contractors performing shop fabrication and/or structural steel installation at NRG facilities in accordance with ANSI/AWS D1.1.

2.2 The specification addresses welding requirements applicable to welded structures and structural components. It is to be used in conjunction with a project specification that contains the material, quantity, bid, contract, schedule, transportation, delivery, and other job, plant and site-specific requirements.

3.0 Definitions

3.1 ASME - American Society of Mechanical Engineers

3.2 ANSI – American National Standards Institute

3.3 ASNT – American Society for Nondestructive Testing

3.4 AWS – American Welding Society

3.5 Contractor – The responsible fabricator or installer.

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

3.7 NRG QA - The NRG individual responsible for the welding and quality aspects of the project

3.8 Witness Point – Points identified within the Contractor's Work Process Documentation that require the Contractor to notify NRG prior to proceeding. NRG may elect to perform inspections at that time or waive the right to inspect.

3.9 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 witness 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/AWS D1.1,"Structural Welding Code –Steel"

4.2 ANST TC-1A, "Personnel Qualification and Certification in Nondestructive Testing"

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

4.4 AWS B2.1, "Welding Procedure and Performance Qualification"

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 Contractor 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 all required welding, inspection, test, and quality control documentation. 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 submit Weld Process Documentation for NRG review and approval prior to the start of work.

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 shall provide the Contractor with the dimensions, thickness, and material specification and grade of the component being welded.

5.5 NRG shall provide the Contractor with drawings that specify the location, type, size, and extent, and surface finish of all welds and the corresponding weld joint design. Shop and field welds shall be clearly distinguished as well as weld joints for which sequencing is important to control shrinkage and distortion.

5.6 NRG may issue a NRG Quality Assurance Plan that details site-specific requirements.

6.0 Welding Procedure Specifications

6.1 The Contractor shall have weld procedure specifications (WPS) and supporting procedure qualification records (PQR) which conform to the rules ANSI/AWS D1.1.

6.2 WPS's qualified under the ASME B&PV Code, Section IX are acceptable.

6.3 Contractor's PQR's and WPS's shall be submitted to NRG QA for review and approval at least two weeks prior to the start of work at a NRG facility. For shop fabrication, PQR's and WPS's shall be made available to NRG QA for review.

6.4 The gas metal arc welding process (GMAW) shall not be used in the short circuiting arc transfer mode.

7.0 Welder Performance Qualification

7.1 Contractor's welders shall be qualified in accordance with their Quality System and ANSI/AWS D1.1.

7.2 The Contractor shall submit copies of the welder performance qualifications and proof of continuity to NRG QA for review and approval prior to the start of work at a NRG facility. For shop fabrication, this information shall be made available to NRG for review

7.3 Welders that were previously qualified under the ASME B&PV Code, Section IX are not required to requalify under ANSI/AWS D1.1. However, the welder's qualification shall be limited by the essential variables of ANSI/AWS D1.1.

7.4 Welders qualified through "AWS Certified Welder Program" may be accepted by NRG QA on a case by case basis. If accepted by NRG QA, contractor shall submit welder qualification record and proof of continuity as maintained by AWS Certified Welder Program procedures.

7.5 NRG reserves the right to retest any welder performing work at a NRG facility.

7.6 Welders without current qualifications must qualify on-site. On-site qualification testing shall comply with Paragraph 7.1 and the following:

7.6.1 The Contractor shall notify NRG QA before any on-site testing.

7.6.2 NRG QA reserves the right to witness or inspect any phase of the welder qualification test.

7.6.3 Upon completion, NRG QA and the Contractor's QC Inspector shall perform a visual inspection of the weld coupon. The test coupon shall be free of:

7.6.3.1 Cracks
7.6.3.2 Lack of penetration
7.6.3.3 Incomplete fusion
7.6.3.4 Surface undercutting exceeding 1/32"
7.6.3.5 Weld reinforcement exceeding 1/8"
7.6.3.6 Root surface concavity exceeding 1/16"
7.6.3.7 Burn through exceeding 1/8"
7.6.3.8 Burn through of the backing ring or plate (when used)

7.6.3.9 Abrupt valleys between passes. Craters shall be filled to the full cross-section of the weld and the face of the weld shall be flush with the surface of the base metal.

Failure to meet the above criteria shall result in rejection of the test coupon.

7.6.4 After visual acceptance, radiographic examination or bend testing shall be performed by the Contactor with acceptance criteria per ANSI/AWS D1.1 for welder coupons.

7.6.5 A welder whose test coupon fails to meet the acceptance criteria is permitted to take a multi-coupon retest. A welder who fails the retest is not permitted to take any further tests for those processes for the duration of the contract.

8.0 Material Control

8.1 The Contractor shall furnish Certified Material Test Reports or Certificates of Compliance for any material which shall become an intricate part of the final weld. A Certificate of compliance is acceptable for A36 structural steel. NRG shall provide Certified Material Test Reports or Certificates of Compliance for material supplied to the Contractor by NRG.

8.2 The base metals to be welded under this specification are carbon and alloy steels commonly used in the fabrication of steel structures and are listed in ANSI/AWS D1.1. Steels other than those listed may be used if special qualification requirements are met as described in ANSI/AWS D1.1. Materials used for welding other than those listed as prequalified shall be subject to approval by NRG.

8.3 Welding filler metals shall be as shown in ANSI/AWS D1.1, except non-low hydrogen electrodes are prohibited for shop fabrication and new construction.

8.4 Permanent backing materials, when utilized, shall be compatible with the base material being welded.

8.5 The minimum filler metal control requirements are as follows:

8.5.1 Portable rod ovens, in working condition, shall be utilized at each work area.

8.5.2 The following storage requirements apply to electrodes once removed from the hermitically sealed containers:

8.5.2.1 Non-low hydrogen (e.g., E-6010, E-7010-A1) and inconel (e.g., ENiCrFe-2, ENiCrFe-3) electrodes shall be maintained at room temperature in a secure, clean, and dry environment.

8.5.2.2 Low-hydrogen (e.g., E-7018, E-801X-BX, E-9018-B3) and austenitic stainless steel (e.g., E-3XX-15/16) electrodes shall be stored at 250° F to 300° F in rod ovens with temperature indication.

8.5.3 Carbon steel and low alloy electrodes shall not be used after a period of four hours for E70XX Type, two hours for E80XX Type, and one hour for E90XX Type from the time they were issued from holding ovens or a portable rod warmer. Coated electrodes shall be scrapped or redried per the manufacturer's recommendations if exposure is longer than specified above. Coated electrodes that have been wet shall be discarded. Low-hydrogen electrodes shall not be rebaked more than once.

8.5.4 Filler metal utilized for GTAW welding shall be identified on both ends of the wire indicating wire classification.

8.5.5 Straight lengths or spooled electrodes and filler metal shall be suitably protected from being contaminated at the work site.

8.6 Gas shielding shall be welding grade.

9.0 <u>Welding</u>

9.1 Weld end preparations shall be in accordance with the Work Process Documentation and ANSI/AWS D1.1.

9.2 Prior to welding, the base metal surface shall be cleaned at least ½" from the end preparation.

9.3 Welding shall be done only on clean metal, free of cracks, scale, rust, oil, grease, paint, water, or any foreign matter which would adversely affect the quality of the weld.

9.4 Vertical welding shall be performed uphill except that the root pass for double welded joints may be welded downhill provided the root

is back-gouged and visually inspected prior to welding the opposite side.

9.5 Each weld shall be uniform in width and size throughout its full length. Each layer of weld passes shall be smooth, free of slag, and shall be completely fused to the adjacent weld bead and/or to the base metal. The cover pass(es) shall be free of coarse ripples, irregular surfaces, high crowns, crevices, or high ridges, and suitable for interpretation of any subsequent non-destructive examination required.

9.6 Each weld layer shall be cleaned by suitable means, such as brushing, filing, grinding or chipping, prior to depositing additional weld passes and after the final weld layer. Slag shall be removed entirely.

9.7 Welding shall not be permitted on base metals with a temperature lower than 32° F (0° C) unless the requirements of the notes to Table 4.2 of ANSI/AWS D1.1 are met. Welding shall not be performed on surfaces which are wet and the weld area shall be protected from inclement weather.

9.8 Any grinding or chipping of welds shall be done so as not to gouge, groove or reduce the base metal thickness.

9.9 Peening or quenching of welds is not permitted.

9.10 Oxygen gouging shall not be used on quenched and tempered steel.

9.11 Parts to be joined by fillet welding shall be brought into contact as close as practical. Gaps shall not exceed 3/16" for tee, corner and skewed connections. The separation between faying surfaces of lap joints and of butt joints landing on a backing shall not exceed 1/16". Wide welds made to overcome poor fit-up are prohibited. Poor fit-up shall be remedied by suitable means such as base metal weld build-up and approved by NRG in writing prior to performing the work.

9.12 Permanent tack welds shall be made by a qualified welder. Tack welds are subject to the same quality requirements as the final welds except as noted in ANSI/AWS D1.1.

9.13 All temporary welds shall be removed and base metal visually examined. Removal requires grinding to contour of base metal, unless approved by NRG QA.

9.14 Defective/ rejected welds shall be repaired using the same process used to perform the original weld or with a qualified repair procedure.

9.15 No defective weld area shall be repaired by welding more than twice without written approval from NRG. All repairs shall be made by the method permitted in ANSI/AWS D1.1.

9.16 The method for identifying and documenting each welder's work shall be established between the Contractor and NRG prior to the start of work.

10.0 Preheat and Post Weld Heat Treatment

10.1 The minimum preheat temperatures shall be per the Work Process Documentation.

10.2 Preheating may be accomplished by utilizing either electric resistance heating pads, induction heating or oxy-fuel torches.

10.3 Either temperature indicating crayons or contact pyrometers (thermocouples) shall be used for monitoring minimum preheat and maximum interpass temperature.

10.4 Post weld heat treatment, if required, will be as indicated in the NRG technical specification, drawings, or design documents.

10.5 Post weld heat treatment shall be performed in accordance with QAS 4.05.

10.6 Welds requiring post weld heat treatment shall be preheated utilizing the same methods (i.e., electric resistance, induction heating) unless otherwise approved by NRG QA.

11.0 Work Process Documentation

11.1 The Contractor shall develop Removal and Replacement Procedures, Weld Data Sheets, Repair Plans, or Contractor-equivalent forms (hereafter referred to as Work Process Documentation) for each type of job.

11.2 Work Process Documentation shall document the weld procedure specification being used, the essential details of the welding process (e.g., base metal, filler metal, preheat, etc.), special procedures/techniques (e.g., heat treatment), material verification

and control, witness points, and design control calculations for alterations (see Attachment 8.1 as an example).

11.3 For work at a NRG facility, Work Process Documentation shall be submitted to NRG QA for review and signature approval prior to the start of work. For shop fabrication, Work Process Documentation shall be made available to NRG for review.

11.4 Work Process Documentation shall be posted at the work location for reference by the welder, contractor QC and NRG QA.

12.0 Inspection and Testing

12.1 The Contractor's Quality System shall include a formalized Inspection program that includes, as a minimum, the verification of the following attributes:

12.1 Joint preparation
12.2 Joint fit-up
12.3 Welding filler metals
12.4 Weld preheat
12.5 Root inspection
12.6 Final weld inspection
12.7 NDE
12.8 Post weld heat treatment

12.2 The Contractor shall establish a formalized program using weld maps, tables, or drawings to perform and document their inspections of in-process and completed work.

12.3 Each crew's in-process work shall be inspected and documented.

12.4 Inspection frequency shall be uniform throughout the job and increased when nonconforming work is identified.

12.5 100% of all finished welds shall be visually inspected and the inspection results documented.

12.6 Visual inspection shall be conducted prior to any NDE that may be performed.

12.7 Visual inspections shall be conducted prior to any painting, coating or insulation.

12.8 Finished welds shall be visually inspected in accordance with ANSI/AWS D1.1. Acceptance criteria shall be per ANSI/AWS D1.1.

12.9 Non-Destructive Examination shall be performed in accordance with ANSI/AWS D1.1.

12.10 NDE personnel shall have current Level II or III qualifications and certification in accordance with the requirements of ASNT-TC-1A. NDE may be performed by non-certified personnel if it is for information purposes only.

12.11 The Contractor shall make available NDE procedures, personnel qualifications and certification to NRG QA for review and approval.

12.12 NRG QA reserves the right to perform non-destructive examinations at its own discretion. If NDE examinations results are not acceptable to applicable codes and standards, the Contractor shall be responsible for the cost of labor and materials for repair.

12.13 When spot nondestructive examination is specified, the sample size shall be 10% of each weld.

12.14 Welds to be examined 100% by MT, PT, RT or UT shall be as indicated on the drawings or specifications.

12.15 Liquid penetrant or magnetic particle examination shall be in accordance with ASTM E-165 and ASTM E-709, respectively.

12.16 If an unacceptable weld is found in a test group, an additional 10% of that type weld or group of welds shall be inspected as described above. Inspection shall be continued until no unacceptable defects are found in a test group.

12.17 Repair welds shall be re-examined by the same method that revealed the original defect.

13.0 Quality Control

13.1 The Contractor shall implement their Quality System for all structural steel shop fabrication and field installation.

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

13.2.1 Material control
13.2.2 Welding control
13.2.3 Inspection program
13.2.4 Control of nonconformances

13.2.5 Control of nondestructive examination
13.2.6 Control of heat treatment
13.2.7 Document control

13.3 The Contractor shall have available their latest Quality System Manual, Quality System Procedures and other Quality System documents at the job location during execution of the contract for NRG QA review and audit.

13.4 The Contractor shall provide a full time qualified Quality Control (QC) representative for all shifts during fabrication and installation.

13.5 The QC representative shall administer the Contractor's Quality System and assure conformance to the program requirements.

13.6 The QC representative shall not be a craft supervisor unless approved by NRG prior to the award of the contract.

13.7 The Contractor's QC personnel performing visual inspection shall be an AWS Certified Welding Inspector, a CAWI working under the direct supervision of a CWI, or a competent engineer or technician with experience in metals fabrication, inspection and testing.

13.8 The Contractor shall make available a copy of QC personnel certifications to NRG QA for review.

13.9 The Contractor's QC representative shall be on site prior to the start of work to become familiar with the project and prepare the required Work Process Documentation.

13.10 Nonconforming work shall be documented in accordance on the Contractor's Nonconformance Report (NCR) or equivalent.

13.11 A copy of all NCRs issued by the Contractor's QC representative shall be submitted to NRG QA within 24 hours. The Contractor shall provide a recommended disposition for NCRs for NRG review and approval.

13.12 The Contractor shall resolve all nonconformance reports in a timely and judicious manner to the complete satisfaction of NRG, including those issued to the Contractor by NRG.

13.13 Contractors performing shop fabrication of structural steel shall submit a Quality Plan or Schedule for assignment of witness points by NRG.

14.0 Documentation

At the conclusion of the project, the Contractor shall submit to NRG QA a complete documentation package consisting of:

14.1 Material certifications (when applicable)
14.2 Work Process Documentation
14.3 Welder qualification records
14.4 QC and NDE personnel certifications
14.5 Inspection checklists
14.6 NDE reports (when applicable)
14.7 Heat treatment charts (when applicable)
14.8 Nonconformance reports

Documentation to be in a format agreed to by NRG and the Contractor at the start of work.

15.0 Attachments

15.1 Work Process Documentation (example)

Attachment: 15.1
QAS No.: 4.03

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