

DEP SPECIFICATION

**WELDING OF METALS
(ADDITIONS TO API RP 582)**

DEP 30.10.60.18-Gen.

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ECCN EAR99

DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for welding of metals.

The scope of this DEP does not include pipelines and civil structural welding.
DEP 61.40.20.30-Gen., DEP 37.81.40.31-Gen. and DEP 30.10.60.30-Gen. cover piping and pipeline welding.

DEP 37.81.10.34-Gen. covers deepwater civil structural welding.

DEP 37.81.40.39-Gen. covers welding of subsea hardware and tie-in components.

DEP 31.38.60.10-Gen. covers hot-tapping on pipelines, piping and equipment.

This DEP is intended to be used with API RP 582:2016.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual (DEM) 1 - Application of Technical Standards.

This is a revision of the DEP of the same number dated February 2015; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor or Principal.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
Rejection	For piping: any weld that requires a repair. For equipment: any weld that requires a repair within a one-meter (3.3 ft) segment, or in a specified number of RT films.
Rejection rate	For piping: the number of repairs per number of completed welds For equipment: the number of repaired segments per total number of one-meter (3.3 ft) segments, or per a specified number of RT films
Subcontractor	Company awarded a contract by the Contractor to do part of the work awarded to the Contractor by the Principal. The work of the Subcontractor is carried out under the direction and control of the Contractor. Under its model contracts, the Principal maintains the right to review all proposed Subcontractors, and subcontracts.
Welding Technical Authority (TA)	Person identified by the Principal as the authority for welding technology. In Shell, the TA assignment will follow the structure established by the DCAF (Discipline Controls and Assurance Framework) process used in major projects. For work that is performed for small projects or maintenance activities, a welding focal point will normally be identified as the TA.

1.3.3 Abbreviations

Term	Definition
ASNT	American Society of Non-destructive Testing
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CCO	Chromium carbide overlay
CGSB	Canadian General Standards Board
CMT	Cold metal transfer
DDS	Duplex Stainless Steel
EGW	ElectroGas Welding
FCAW	Flux Core Arc Welding
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten Arc Welding

Term	Definition
HAZ	Heat Affected Zone
HTHA	High Temperature Hydrogen Attack
ITP	Inspection and Test Plan
LBW	Laser Beam Welding
LDT	Lower Design Temperature
MT	Magnetic Particle Inspection
NDE	Non-Destructive Examination
PAUT	Phased Array Ultrasonic Testing
PMI	Positive Material Identification
PREN	Pitting Resistance Equivalent Number
PT	Liquid Penetrant Examination
PWHT	Post Weld Heat Treatment
QSET	Optimal parameter setting for Short arc welding
RMD	Regulated metal deposition
RT	Radiographic Testing
SAW	Submerged Arc Welding
SMAW	Shielded Metal Arc Welding
STT	Surface tension transfer
TA	Technical Authority
TC	Thermocouple
USC	United States Customary
UT	Ultrasonic Testing
VT	Visual Testing
WPQR	Welding Procedure Qualification Record (API 582 uses "PQR" which is interchangeable with WPQR)

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (11).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2015. The following are the main, non-editorial changes.

The changes are too numerous and extensive to summarise here.

Section/Clause	Change
General	Clarification of shall/should/may per requirement statement.
General	Change from amendment/supplement style of DEP to a standalone DEP that is based on the API standard.
General	Update to base the DEP on API RP 582 Third Edition 2016.
General	Technical challenge and simplification to remove approximately 50 % of the “shall” requirements on the basis that the DEP is applied by competent Contractors who are familiar with API RP 582. Removal of informative content that should be familiar to competent Contractors.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the “Give feedback” link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select “Submit DEP Feedback”, fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

1.9 ALTERNATIVE APPROACHES

1. The Contractor may offer alternative approaches to the requirements given in this DEP.

1.10 PRECEDENCE OF DOCUMENTS

1. If documents are conflicting, the following precedence of documents shall apply:
 - a. First level - statutory laws and regulations;
 - b. Second level - this DEP;
 - c. Third level - API RP 582;
 - d. Fourth level - cross-referenced documents;
 - e. Fifth level - International codes and standards.

2. QUALITY PROGRAM

2.1 GENERAL

1. The Contractor shall operate a quality system in accordance with ISO 3834-2 and ISO 9001 or equivalent.

2.2 RECORDS

1. Post-welding documentation shall include the following:
 - a. Certificate of Compliance;
 - b. list of as build drawings with weld map;
 - c. copies of Principal approved deviations;
 - d. NDE reports;
 - e. repairs carried out;
 - f. Post Weld Heat Treatment (PWHT) records;
 - g. Any other documents as per contract requirements.
2. For high temperature alloys for steam methane and olefin furnaces, the welding specification shall include the following:
 - a. a welding map showing maximum expected temperature at each weld;
 - b. differentiation between shop and field welds.

3. GENERAL

This DEP is structured so that (Appendix C) through (Appendix J) are specific to certain materials and only apply where those materials are used.

3.1 WELDING PROCESSES

3.1.1 General

1. The use of electron beam, laser beam, and stud welding processes shall be subject to the approval of the Principal.
2. Autogenous root pass (without addition of filler metal) shall not be used.
3. For welding of small bore pipe work (DN 75 (NPS 3) and smaller), Gas tungsten arc welding (GTAW) shall be used for the root pass.
4. Vertical welding shall be vertical-up.

3.1.2 FCAW

1. Flux core arc welding (FCAW) shall not be used for the following:
 - a. welding structural items to a pressure/containment boundary;
 - b. lifting lugs or similar lifting devices;
 - c. tank floor plates.
2. Production welding using FCAW consumables shall be limited to the same Manufacturer/Supplier brand or trade name as used in the Welding Procedure Qualification Record (WPQR).

3.1.3 ElectroGas Welding (EGW)

1. All WPS for the EGW process shall be qualified with impact testing at a temperature of -18 °C (0 °F) or minimum design metal temperature (LDT), whichever is lower.

2. If multiple-pass vertical welding butt joints are made by the EGW process, the following requirements shall be applied:
 - a. Heat Affected Zone (HAZ) specimens are oriented with the base of the notch parallel to the fusion line.
 - b. If the heat input of the first pass exceeds the second pass by more than 25 %, impact specimens from both the first and final pass are taken; otherwise impact specimens from the final weld pass are taken.

3.1.4 Submerged Arc Welding (SAW)

1. Only automatic or mechanised SAW systems shall be used.
2. Run-on and run-off pads shall have the same P- number as the base material.

3.1.5 Shielded Metal Arc Welding (SMAW)

1. If iron powder rutile electrode (e.g., E7024-1) is used for tank fabrication, it shall be used for flat and horizontal fillet welds only.

3.2 MATERIALS

3.2.1 General

1. Before the start of welding, all materials, consumables and shielding gas shall adhere to the following:
 - a. Made traceable with identification to their material test certificate and in compliance with DEP 31.10.00.10-Gen. whenever applicable.
 - b. Visually inspected to confirm correctly marked and free from mechanical damage or corrosion.
2. Cast iron (gray or ductile iron) shall not be welded, unless approved by the Principal.

3.2.2 Welding consumables (filler metal and flux)

3.2.2.1 General

1. The impact test requirements of the AWS/ASME filler metal classification choice shall match or exceed the weld impact test requirements.
2. Use of synthetic consumables such as metal core wire shall be subject to review and approval by the Principal and be qualified lot-specific.
3. Welding consumables shall be supplied by a Manufacturer/Supplier accredited in accordance with ISO 9001 or an equivalent quality system approved by the Principal.
4. Filler metals proposed for use in dissimilar base metal combinations shall be agreed upon with the Principal for each specific design case if the combination is not covered in API RP 582.

3.2.2.2 Consumable certification

1. As a minimum, welding consumables shall be delivered in accordance with all of the following:
 - a. their product data sheet
 - b. certified, including chemical analysis, according to EN 10204 Type 2.2 or AWS 5.01 Sch. F;
 - c. certified, including chemical analysis, according to EN 10204, Type 3.1 or AWS 5.01 Sch. H for SAW fluxes;
2. Welds, including weld repairs, to carbon steel pressure retaining parts in environmental cracking service as defined in NACE SP0472 shall meet the welding process/consumable requirements in Table 3.1:

Table 3.1 Compositional restrictions of carbon steel filler metals for environmental cracking services

Welding Process	Filler Metal Specification	Filler Metal Classification	Compositional Restrictions
SMAW	ASME SFA-5.1 or AWS A5.1	E60XX or E70XX	As per Specification
GTAW	ASME SFA-5.18 or AWS A5.18	ER70S-6	Carbon (C) 0.10 wt.% max Manganese (Mn) 1.60 wt.% max Silicon (Si) 1.00 wt.% max
GMAW (spray, pulsed, or globular transfer modes only)	ASME SFA-5.18 or AWS A5.18	ER70S-6	Carbon (C) 0.10 wt.% max Manganese (Mn) 1.60 wt.% max Silicon (Si) 1.00 wt.% max

3.2.3 SAW

1. Flux shall only be recycled if the procedure is in compliance with the consumable Manufacturer/Supplier guidance and subject to the approval of the Principal.
2. SAW fluxes shall not be left in machine hoppers for extended periods (e.g., overnight or during non-productive shifts) when welding is not being carried out.
3. Submerged arc flux shall meet all of the following:
 - a. clearly identified in moisture-proof containers and identified in accordance with the relevant consumable standard;
 - b. stored in a dry location per the Manufacturer/Supplier instructions;
 - c. re-baked in accordance with Manufacturer/Supplier instructions before re-use.

3.3 CONSUMABLE STORAGE AND HANDLING

1. Consumables shall be stored and controlled as follows:
 - a. In accordance with the Manufacturer/Supplier's recommendations for the consumable type;
 - b. Clearly identified with brand/trade name, classification and batch number;
 - c. Electrodes and fluxes kept in moisture-resistant sealed containers;
 - d. Wire spools for automatic and semi-automatic processes stored in original packaging, preferably in cabinets;
 - e. Storage, baking, issue, and return of welding consumables controlled by procedures with documented records to ensure an auditable trail from receipt, through pre-treatment, issue, and return to store;
 - f. Discard all non-identified, damaged, wet, partially used, rusty or otherwise contaminated consumables, or wire that cannot be cleaned.
2. Consumables shall be subject to the following control from storage:
 - a. Hold fluxes in a heated silo in accordance with the Manufacturer/Supplier recommendations;
 - b. Withdraw submerged arc, gas metal arc and flux cored wire from storage only when required for immediate use;

- c. Return unused consumables to storage upon completion of the welding operation;
 - d. Discard damaged electrodes or electrodes exposed to moisture, grease or other substances or bare filler wire in coils or spools that have not been kept in sealed containers after use;
 - e. Dedicated QC procedure for consumables with AWS 5.36 hydrogen content rating of H4 or lower (better), or where vacpacs are specified, to assure and demonstrate compliance with the Manufacturer/Supplier handling requirements.
- 3. For welding of heavy wall (100 mm (4 in) and thicker) vessels, complete welding flux traceability to individual welds and their segments shall be developed and maintained.
 - 4. Bare wire for automatic or semi-automatic welding, remaining from a partly used coil or spool, may be reused as new wire if it is promptly repackaged after use in new sealed containers and stored as a new consumable.
 - 5. Consumables that cannot be identified to the satisfaction of the Contractor shall be removed from the work site and any welds that were made with such consumables cut out and re-welded.
 - 6. Low hydrogen welding consumables shall meet the following requirements:
 - a. Stored in heated storage areas under controlled temperature conditions recommended by the Manufacturer/Supplier.
 - b. Only the amount required for immediate use placed in heated quivers.
 - c. Not to be used if they have been out of the heated quiver for more than four hours;
 - d. Not stored in heated cabinets containing electrodes of other types, such as rutile or organic type electrodes.

3.4 SHIELDING AND PURGING GASES

- 1. The use of soluble dams for minimising back purge requirement during piping fabrication shall be subject to approval by the Principal.
- 2. When dams are to be used on site, the following shall be required:
 - a. Working procedures to ensure their removal after welding.
 - b. Dam application is in accordance with the Manufacturer/Supplier's recommendations.
- 3. Welds made in austenitic, nickel and copper-nickel alloys shall have back purge maintained for a minimum of both the root and second passes.
- 4. Back purging shall be demonstrated during the welding procedure qualification and production welding by means of a suitable oxygen meter.
- 5. All cylinders containing shielding gas shall be identifiable and be in a well maintained condition without signs of external corrosion or rust on the body of the cylinder.

4. WELDING PROCEDURE REQUIREMENTS

4.1 GENERAL

1. If the equipment or piping is identified as sour or wet H₂S service, refer to DEP 39.01.10.12-Gen. or DEP 30.10.02.17-Gen. as applicable.
2. All welds shall be identified on drawings using the identifier described in AWS A2.4.
3. Single pass welds shall not be used for pressure retention service.
4. Welding procedures and performance qualification by others (i.e. other than the Manufacturer/Fabricator) shall not be permitted.
5. Production welding shall not commence until approved by the Principal.

4.2 WELDING PROCEDURE SPECIFICATIONS (WPS)

4.2.1 General

1. WPS SHALL [PS] be prepared and qualified in accordance with both of the following:
 - a. ASME/BPVC Sec IX or the applicable part of ISO 15614;
 - b. the applicable construction code (e.g., ASME/BPVC Sec VIII-1 or ASME B31.3);
2. Specific service requirements (such as process conditions, environment, and equipment type) shall be addressed when preparing and qualifying the WPS.
3. WPSs previously qualified by the Contractor may be submitted for approval provided the requirements of this DEP are met.
4. Welding procedure documentation shall clearly indicate whether arc energy or heat input is being used.
5. Where existing welding documentation templates state heat input, but the values shown are actually arc energy, a note should be added to the WPS or WPQR to clarify this.
6. Laboratories designated to qualify WPSs shall have a quality system in compliance with ISO 17025 or approved by their ASME AI, or equivalent, and be subject to approval by the Principal.
7. Thin wall tubing to tubing (< 3.0 mm (1/8 in) wall) shall be welded with automatic welding equipment.
8. Two sided welds should be used unless the service is subject to stress corrosion cracking or fatigue, or if two sided welds are impractical.
9. Use of permanent backing strips or rings shall be subject to approval by the Principal.
10. Temporary backing devices (e.g., ceramics, fluxes, and copper backing strips) shall satisfy the following requirements:
 - a. the chemical composition of the weld metal is not influenced by the devices;
 - b. devices are removed without damage to the surrounding material;
 - c. after backing strip removal, the area is inspected for cracks by either liquid penetrant or magnetic particle testing;
 - d. the area is ground flush and cleaned after removal.
11. Use of temporary ceramic backing strips shall be considered an essential variable when impact testing is required.
12. Fusible inserts or removable backing devices shall be subject to approval of the Principal.

4.2.2 Mechanical requirements for FCAW

1. For FCAW welding of ferritic steels, WPQR testing shall be qualified with the following:
 - a. Impact testing of a minimum of three Charpy V-notch specimens at -18 °C (0 °F) or lower or code required temperature for testing, whichever is lower, and meet a minimum impact energy of 40 J (30 ft-lb), with no single specimen less than 27 J (20 ft-lb).
 - b. For carbon steel welds, where impact testing is exempt for the base metal, wire/electrode of type T-12 is also exempt from impact testing.

4.2.3 Hardness testing – weld procedure qualification and production testing

1. Unless the design code specifies lower values, the following hardness requirements for base material, HAZ, and weld metal shall apply for welding procedure qualification and production testing in the test laboratory:
 - a. For wet H₂S environments in oil and gas production applications, refer to DEP 39.01.10.12-Gen.
 - b. For wet H₂S environments in downstream applications, refer to DEP 30.10.02.17-Gen.
 - c. 248 HV10 maximum for ferritic metals in high-temperature (greater than 440 °C (825 °F)) service.
 - d. For 2 1/4Cr-1Mo, 2 1/4Cr-1Mo-1/4V, 3Cr-1Mo, and 3Cr-1Mo-1/4V steels for high-pressure hydrogen service, refer to API 934A.
 - e. For 1 1/4Cr-1/2Mo steel heavy wall for high-pressure hydrogen service operating at or below 440 °C (825 °F), refer to API 934C.
 - f. For 1 1/4CR-1/2Mo steel in service above 440 °C (825 °F), refer to API 934E.
 - g. When hardness testing is required by the project specification, 275 HV10 maximum for ferritic materials in non-sour process conditions.
 - h. When hardness testing is required by the project specification, 300 HV10 maximum for ferritic materials in steam, air, water, and other non-sour utility service.
 - i. 350 HV10 maximum for 9 % Ni steels in the as-welded condition.
 - j. 270 HV10 maximum for 9Cr-1Mo-V steel (P91, T91) in the PWHT condition for non-sour process service.
 - k. 290 HV10 maximum for 9Cr-1Mo-V steel (P91, T91) in the PWHT condition for steam utility service.
 - i. Hardness should be higher than the base metal.
 - l. 250 HV10 maximum for 3.5 % Ni steel ≤ 9.5 mm (3/8 in) with up to 275 HV10 in the mid-thickness and cap for joint thickness > 9.5 mm (3/8 in) when the hardness impression is located at least 8 mm (5/16 in) from the internal surface.
2. Individual HAZ hardness readings exceeding the value permitted by this DEP may be accepted if the following are met:
 - a. Average of three hardness readings taken in the equivalent HAZ profile location adjacent to the hard HAZ reading (by repolishing the existing specimen taken from that WPQT coupon or taking additional specimens from that WPQT coupon) does not exceed the values permitted.
 - b. No individual hardness reading is greater than 5 % above the specified value.

3. Unless the design code specifies lower values, the following hardness requirements for base material and weld metal shall apply for production weld testing in the field:
 - a. 300 HBW maximum for carbon and low alloy ferritic steel (up to 9Cr) in utility services.
 - b. For P91, apply API TR 938-B (275 HBW is the production weld hardness maximum for utility service).
4. The hardness measurement procedure and frequency for production welding shall refer to the applicable DEP or be subject to the approval of the Principal.

5. WELDER QUALIFICATION

5.1 GENERAL

1. All welders and welding operators shall be qualified in accordance with ASME/BPVC construction code and Sec IX.

5.2 WELDER IDENTIFICATION

1. While on site, the welders and welding operators shall be easily identifiable.
2. The Manufacturer/Supplier or Contractor shall maintain a report of welder IDs including name, photograph, and welder ID number.

6. PREHEATING AND POST WELD HEAT TREATMENT

6.1 PREHEATING AND INTERPASS TEMPERATURES

6.1.1 General

1. Unless otherwise established by procedure qualification, the maximum interpass temperature shall be 150 °C (300 °F) for 3½ % nickel steel and 175 °C (350 °F) for Alloy 400.
2. Preheat requirements should follow EN 1011-2 guidance.
3. For welding reinforced branch fittings, such as "olets", the minimum preheating temperature shall be 50 °C (90 °F) above that indicated by the applicable code.
4. The guidance of WRC-452 for pressure vessels and AWS D10.10 for piping should be followed.
5. For preheating temperatures up to 200 °C (400 °F), fuel gas/air burner systems, high-velocity gas/oil burners or infrared radiators (either locally or in a furnace), electric resistance, or induction heating may be used.
6. For preheating temperatures above 200 °C (400 °F), electric resistance, induction heating or infrared radiators should be used.
7. Welding or cutting torches shall not be used.
8. For wall thicknesses above 20 mm (3/4 in), electric resistance heating mats, induction heating or infrared radiators shall be used unless it is agreed with the Principal that access or location makes their use impractical and a log is maintained to assure that the correct preheat is achieved.
9. Handheld oxy/fuel gas burners may only be used for welds with diameter less than 150 mm (6 in) or attachment welds less than 300 mm (12 in) long.
10. Preheat temperature should not be above the lower critical transformation temperature of the base metal alloy.

6.1.2 Interruption of Welding

1. The weld should be completed before the preheating temperature is lowered.
2. Preheating shall be restored to the specified temperature before welding is recommenced.
3. Post-heating of an interrupted weld to remove hydrogen should be considered.
4. If cooling has occurred and the completed weld ligament depth is less than 25 % of the total joint thickness, then the applicable surface inspection (e.g., MT or PT) shall be performed to ensure freedom from deleterious defects.

6.2 POST WELD HEAT TREATMENT (PWHT)**6.2.1 General**

1. In addition to any code requirements, the following process conditions shall require PWHT for all carbon and low alloy steel welds of all thicknesses.
 - a. Caustic and ammonia service.
 - b. HF service.
 - c. Amine. Refer to API RP 945.
 - d. Sour service conditions if required in DEP 30.10.02.17-Gen. or DEP 39.01.10.12-Gen.
 - e. High pressure, high temperature hydrogen service as defined in API RP 941.
 - f. Alkaline sour waters containing carbonates.
 - g. HTHA services as defined in API 941.
2. For piping systems built to ASME B31.1 and B31.3 and steam generators per ASME Sec. I, exemptions such as listed in ASME B31.3 Table 331.1.3 shall not apply.
3. If PWHT is imposed because of environmental cracking concerns, combinations of longer-than-designated holding times at lower-than-designated heat treatment temperatures shall not be used.
4. For quenched/normalised and tempered steels, the PWHT temperature shall not cause an unacceptable decrease of mechanical properties of the parent material (i.e., below the level specified by the project requirements).
5. No welding or heating shall be carried out after final PWHT.
6. As a minimum, a PWHT procedure shall include the following information:
 - a. name of (sub) Contractor;
 - b. ruling specification;
 - c. material and item type;
 - d. method of heating (e.g., gas, electrical resistance, induction, furnace);
 - e. fuel gas and method of atmosphere control (if gas-fired furnace);
 - f. size and type of electrical element (if electrical resistance) and size and type of coils (if induction);
 - g. type, location and number of thermocouples;
 - h. method of thermocouple attachment and de-attachment;
 - i. details of loading and supporting arrangements to avoid distortion;
 - j. provisions to avoid flame impingement (if flame heated);
 - k. holding time and temperature;