TECHNICAL SPECIFICATION

WELDING OF PIPELINES AND RELATED FACILITIES
(AMENDMENTS/SUPPLEMENTS TO ANSI/API STD 1104)

DEP 61.40.20.30-Gen.

June 1993

DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

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NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

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PART I INTRODUCTION

1.1 SCOPE

This is a new DEP giving minimum requirements for the welding of pipelines and related facilities.

This DEP is based on ANSI/API Std 1104, seventeenth edition, September 1988, plus Errata June 1989. Part II of this DEP gives amendments and supplements to ANSI/API Std 1104 in the form of replacements or additions to specific clauses and paragraphs. Clauses and paragraphs of ANSI/API Std 1104 which are not amended by this DEP shall remain applicable as written. Tables or Figures supplementary to those of ANSI/API Std 1104, have been referred to using a capital letter, e.g. Table A, Figure B.

1.2 DISTRIBUTION, APPLICABILITY AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIPM, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group Company, and to Contractors nominated by them (i.e. the distribution code is "C", as described in DEP 00.00.05.05-Gen.).

This DEP is intended for use on pipeline projects for oil refineries, gas handling installations, chemical plants, supply/marketing installations and oil and gas production facilities.

If national and/or local regulations exist in which some of the requirements may 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 as regards safety, 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 with the objective of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which 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 which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. 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 word **should** indicates a recommendation.

1.3.2 Specific definitions

Where the term **Company** has been used throughout ANSI/API Std 1104, this shall be understood to mean the **Principal** as defined in paragraph 1.3 above.

A **Pipeline** is a system of pipes and other components used for the transportation of fluids between (but excluding) plants. A pipeline extends from pig trap to pig trap (including the pig traps), or, if no pig trap is fitted, to the first isolation valve within the plant.

1.4 ABBREVIATIONS

AWS American Welding Society

FCAW	Flux Cored Arc Welding
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten Arc Welding
HAZ	Heat Affected Zone
HV 10	Vickers Hardness (10 kg load)
IF	Incomplete Fusion
IFD	Incomplete Fusion Due to Cold Lap
IIW	International Institute of Welding
IP	Inadequate Penetration Without High-Low
IPD	Inadequate Penetration Due to High-Low
IQI	Image Quality Indicator
NDT	Non Destructive Testing
SMAW	Shielded Metal Arc Welding
WPQT	Welding Procedure Qualification Test(ing)
WPS	Welding Procedure Specification

1.5 CROSS-REFERENCES

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

1.6 UNITS

For simplicity, the common industry practice of indicating nominal pipe diameters in inches has been followed. For other dimensions, SI units have been used.

PART II AMENDMENTS/SUPPLEMENTS TO ANSI/API STD 1104

SECTION 1 GENERAL

1.1 SCOPE

Replace as follows:

This standard covers the arc welding of butt, fillet and socket welds in carbon and low alloy steel for oil, gas and utility pipelines and related facilities. The welding may be carried out by a shielded metal arc welding, submerged arc welding, gas tungsten arc welding, gas metal arc welding or flux cored arc welding process or combination of these processes using a manual, semi-automatic or automatic welding technique or combination of these techniques. The welds may be produced by position or roll welding or by a combination of position and roll welding. Roll welding is only acceptable when using a fully automatic welding process.

Oxyacetylene welding (otherwise known as gas welding) and flash butt welding processes shall not be used.

The use of gas metal arc, gas tungsten arc and flux cored arc welding (except the self-shielding type) processes shall be restricted to construction areas protected against wind and draught.

This standard also covers the acceptance standards to be applied to production welds tested to destruction or inspected by radiographic, ultrasonic or magnetic particle techniques. It includes the procedures for inspection using these techniques.

1.5.1 Pipe and fittings

Replace as follows:

This standard applies to the welding of pipe and fittings that conform to the following:

a. API Spec 5L and Shell Group line pipe specifications with a maximum Grade of X70.

b. Applicable specifications for fittings (e.g. ASTM, MSS, BS) and applicable Shell Group specifications providing amendments/supplements to these.

1.5.2 Filler metal

Replace as follows:

1.5.2.1 Filler metal and fluxes

Consumables shall conform to one of the following specifications:

- AWS A5.1
- AWS A5.5
- AWS A5.17
- AWS A5.18
- AWS A5.20
- AWS A5.28
- AWS A5.29

All welding consumables shall be selected to produce welds with yield strength exceeding that specified for the parent material. Where steels with different specified properties are joined the weld metal yield strength shall match or exceed that of the higher strength grade.

For sour service applications the deposited weld metal shall comply with the requirements of NACE MR0175.

If low-hydrogen electrodes are selected the diffusible hydrogen content shall not exceed 10 ml/100 g in the resulting deposited weld metal.

1.5.2.2 Storage and handling of filler metals and fluxes

Replace as follows:

Electrodes shall be supplied in fully sealed packages and stored in a dry storage room with a maximum relative humidity of 50 percent. All manual types of electrodes shall be properly identifiable up to the time of usage, each electrode being distinguishable by proper coding. If the coding is destroyed by baking, handling, or other causes, the electrodes shall not be used.

Low hydrogen electrodes shall not be stored in heated cabinets containing electrodes of other types, such as rutile or organic type electrodes.

Wire spools for automatic and semi-automatic processes shall be stored in cabinets with supplier wrapping not removed and remain clearly identifiable up to the time of usage. Unidentifiable wire shall not be used.

Flux shall be handled and stored in accordance with the flux manufacturer's recommendations.

Each batch of flux and wire shall be labelled with the information from the supply container.

Unidentifiable, damaged, wet, rusty or otherwise contaminated or deteriorated consumables shall not be used.

1.5.3 Shielding gases

1.5.3.1 Types

Add the following:

Unless otherwise indicated by the Principal the maximum variation of specified gas additions, e.g. 5 percent carbon dioxide, shall be ± 10 percent of the value stated. The moisture content shall correspond to a dew point not exceeding -30 °C.

1.5.3.2 Storage and handling

Add the following:

All shielding gas containers shall have clear identification labels which include the gas type.

SECTION 2 QUALIFICATION OF WELDING PROCEDURES FOR WELDS CONTAINING FILLER METAL ADDITIVES

2.1 PROCEDURE QUALIFICATION

Replace as follows:

Before production welding is started, a detailed WPS shall be prepared. Prior to carrying out qualification testing, this WPS shall be submitted to the Principal for review.

Welding procedures shall be tested to demonstrate that acceptable welds can be made by the procedure. The quality of the welds shall be determined by both non-destructive and destructive testing, as specified in (2.6). The welding procedure qualification testing (WPQT) shall be witnessed by the Principal. Only qualified and approved welding procedures shall be used for production welding.

Unless otherwise stated in the contract documents, for each contract all existing welding procedures shall be requalified by the contractor, and submitted for approval by the Principal.

Repair welding procedures shall be prepared and approved in the same manner as production welding procedures.

2.3.2.2 Pipe and fitting materials

Replace as follows:

The contract materials to which the procedure applies shall be identified on the WPS. Grouping of materials of different pipe manufacturers, supply condition, diameter, wall thickness or steel specification/grade shall not be done unless agreed by the Principal.

Where contract materials have been supplied in the same dimensions by more than one manufacturer, a qualification test may be performed using two pipes from different manufacturers. This may be used to qualify the procedure for use on the pipes from each manufacturer provided the specified range and number of tests in the heat affected zone are taken from both sides of the weld.

2.3.2.3 Diameters and wall thicknesses

Replace as follows:

Procedures shall be qualified for each combination of diameter and nominal wall thickness of contract materials.

2.3.2.4 Joint design

Add the following:

The specification shall indicate the allowable tolerances on each of the joint design details. Permanent backing bars shall not be used.

2.3.2.5 Filler metal and number of beads

Replace as follows:

Details of the filler metal sizes, classification and manufacturer/brand identity shall be given together with a sketch showing the location, minimum number, deposition sequence and characteristics (stringer or weave) of each weld bead.

2.3.2.6 Electrical characteristics

Add the following:

Additionally, the aim voltage and amperage for each bead shall be stated. The ranges of voltage and amperage shall not vary from the aim values by more than ± 10 percent.

2.3.2.10 Time between passes

Add the following:

For pipeline butt welds this time shall be 5 minutes or less.

2.3.2.12 Cleaning and/or grinding

Replace as follows:

The WPS shall state the methods to be used for inter-run cleaning, final weld surface preparation and treatment to backside of the weld, if any. The type of tools (power, manual, or both) shall be specified.

2.3.2.13 Pre- and post-heat treatment

Add the following:

Similar measures shall be taken to specify and monitor weld interpass temperatures.

2.3.2.15 Shielding flux

Replace as follows:

The type of shielding flux, the name of the flux manufacturer and the flux identity and/or brand name shall be designated.

2.3.2.16 Speed of travel

Add the following:

Alternatively, for shielded metal arc welding (SMAW) the range of electrode run-out length for each pass in each electrode size shall be clearly specified. Speed of travel or electrode run-out length shall be within a range of ± 10% of the nominal value for the specified electrode type and size as stipulated by the manufacturer.

Add the following paragraphs 2.3.2.17 to 2.3.2.20:

2.3.2.17 Heat input range

The allowable range of heat input rates to be applied by the welding processes for each weld bead shall be clearly specified. The units to be used shall be kilo joules per millimetre (kJ/mm) based on the following formula:

$$\text{Heat input (kJ/mm)} = \frac{\text{Volts} * \text{Amps}}{1000 * \text{Welding Speed (mm/sec)}}$$

2.3.2.18 Number of welders

For pipeline girth welds the WPS shall designate:

a. the number of root pass welders.

b. the number of hot pass welders.

See (4.1).

2.3.2.19 Partially complete joint

The minimum number of passes before the joint is allowed to cool to ambient temperature.

2.3.2.20 Removal of line-up clamp

The stage at which line up clamp is removed. (See 4.3).

2.4.2.2 Pipe material

Replace as follows:

For pipeline welding, a change of pipe manufacturer, manufacturing process or steel specification/grade shall constitute an essential variable, unless agreed otherwise by the Principal. In addition, requalification shall be required if the carbon content or carbon equivalent exceed the value qualified by more than 0.03.

For non-pipeline welding, a change in the pipe manufacturing process, an increase in the base material specified minimum yield stress of more than 50 N/mm^2 or an increase in the carbon content or carbon equivalent of 0.03% or greater, shall constitute an essential variable.

2.4.2.3 Joint design

Replace as follows:

A major change in joint design (for example, from V groove to U groove) or any change outside the specified joint design tolerances constitutes an essential variable. Changes within the specified tolerances of the joint design (angle of bevel, root face thickness and root gap) are not essential variables.

2.4.2.5 Wall thickness

Change title and replace as follows:

2.4.2.5 Pipe diameter and wall thickness

A change in outside diameter outside the range 0.75 D to 1.5 D and/or any change in thickness outside the range 0.75 t to 1.5 t constitute essential variables.

2.4.2.6 Filler metal

Replace as follows:

The following changes in filler metal constitute essential variables:

a. A change from one filler metal group to another (see Table 1).

b. A change from one consumable manufacturer and/or trade name, or AWS classification to another.

c. A change in the minimum specified yield strength of the filler metal.

d. A change in the diameter of electrode or filler metal.

2.4.2.9 Shielding gas and flow rate

Replace as follows:

A change from one shielding gas to another or from one mixture to another constitutes an essential variable. A flow rate of the shielding gas outside the range specified and qualified also constitutes an essential variable.

2.4.2.10 Shielding flux

Replace footnote a) of Table 1 as follows:

a. Any combination of flux and electrode in Group 4 may be used to qualify a procedure. The combination shall be identified by its complete AWS classification number, such as F71-EL12 or F62-EM12K. Any change in either wire or flux manufacturer and/or AWS classification number shall constitute an essential variable.

Add the following:

A change in the flux size grading shall also constitute an essential variable.

2.4.2.11 Speed of travel

Replace as follows:

A change in the range of speed of travel or electrode run-out length, shall constitute an essential variable.

Add the following paragraphs 2.4.2.12 to 2.4.2.18:

2.4.2.12 Electrical characteristics

A change in current type or electrode polarity (ac, dc positive, dc negative) shall constitute an essential variable.

2.4.2.13 Welding current or heat input

Any change outside the specified ranges of currents or heat inputs shall constitute an essential variable.

2.4.2.14 Wire feed speed

In semi-automatic and automatic welding processes any change of more than ± 10 percent in the wire feed speed shall constitute an essential variable.

2.4.2.15 Preheat, interpass and post-heat treatment temperature

A change in preheat, interpass or post-heat treatment temperature ranges shall constitute an essential variable.

2.4.2.16 Number and sequence of weld beads

A change in the minimum number of the weld beads deposited or the sequence of deposition shall constitute an essential variable.

2.4.2.17 Number of welders

A change in the number of root pass or hot pass welders shall constitute an essential variable.

2.4.2.18 Removal of line-up clamp

Removal of the line-up clamp at a stage earlier than the approval procedure shall constitute an essential variable.

2.5 WELDING OF TEST JOINTS - BUTT WELDS

Replace as follows:

The test weld shall be made under conditions which simulate production welding to a degree satisfactory to the Principal. For pipeline welding procedure qualification, two full pipe lengths shall be welded together using production line up and clamping equipment. A further two pipe lengths shall also be welded if necessary to obtain the required number of specimens for testing. Making the test welds shall be witnessed by the Principal.

2.6 TESTING OF WELDED JOINTS - BUTT WELDS

2.6.1 Preparation

Delete and replace by the following 2.6.1.1 and 2.6.1.2:

2.6.1.1 Non-destructive testing of test welds

On completion of welding, all procedure qualification test pieces shall be left cold for at least 48 hours and shall then be subjected to NDT in accordance with Sections 5 and 6 of this DEP. This shall be carried out prior to sectioning for mechanical testing. Post-weld heat treatment, if required, shall be performed after 48 hours has elapsed, but before NDT is performed.

The NDT shall consist of:

- Visual examination, with the aid of optical instruments where necessary, to determine the dimensions of indications (refer to (6.7)).
- Magnetic particle testing as specified in (6.4).
- Radiographic testing in accordance with (6.3), supplemented, if specified by the Principal, by ultrasonic testing in accordance with (6.6). This supplementary ultrasonic testing shall always be carried out for test welds made in whole or in part by the GMAW, GTAW or FCAW processes.

Acceptance criteria for the NDT shall be as stated in Section 6 of this DEP. If a test weld is found to be unsatisfactory following NDT it shall be rejected and not be submitted for destructive/ mechanical testing.

2.6.1.2 Destructive testing of test welds

Following satisfactory acceptance by NDT, all procedure qualification test welds shall be sectioned at the locations shown in Figure 3 and Figure A.

The minimum number of test specimens and the tests to which they shall be subjected are given in Table 2 and in (2.6.6) and (2.6.7). The specimens shall be prepared as shown in Figures 4, 5, 6 or 7. Unless specified otherwise, tests shall be performed at ambient temperature. For pipe less than or equal to 1 5/16 inches (33.4 mm) in diameter, one full-section specimen may be substituted for the four reduced-section nick-break and root-bend specimens. The full-section specimen shall be tested in accordance with (2.6.2.2) and shall meet the requirements of (2.6.2.3).

Add the following paragraphs 2.6.6 and 2.6.7.

2.6.6 Macroscopic examination and hardness tests

2.6.6.1 Preparation

Specimens shall be prepared for macroscopic examination by grinding to a 600 grit paper finish. The prepared surfaces shall be etched using a suitable etchant (e.g. 3 percent Nital or ammonium persulphate) to reveal the grain structure.

The sections of the weld taken for macroscopic examinations shall be used for hardness testing.

2.6.6.2 Method

The hardness shall be measured in accordance with ASTM E 92 using a Vickers instrument with a 10 kg maximum load. For pipe butt welds, hardness traverses shall be carried out on lines 2 mm from the inner and outer pipe surfaces on the weld cross-sections, and also a line through the mid wall if the pipe thickness is greater than 16 mm.

Lines of indentations shall give at least three values in each of the weld metal, the HAZ each side of the weld, and the base metal. One HAZ impression each side of the weld, shall be within 0.5 mm of the weld junction.

The macro-specimens shall be examined at x5 magnification.

2.6.6.3 Requirements

The macro-specimens shall not show defects exceeding the acceptance standards given in Section 6. Each specimen shall exhibit a smooth and regular profile and the reinforcement shall blend smoothly with the parent metal. Slight intermittent undercut shall be permitted provided the depth does not exceed 0.4 mm. Excess penetration shall not exceed 3 mm. Joint misalignment shall not exceed 1.6 mm.

The maximum hardness levels attained in each of the three zones, i.e. parent metal, HAZ and weld metal zone shall not exceed 325 HV 10. For welds in components or pipe designated for sour service, the hardness shall not exceed 248 HV 10.

2.6.7 Charpy V-notch impact testing

2.6.7.1 Preparation

Impact testing shall be carried out when the nominal pipe wall thickness exceeds 5 mm. Three values shall be obtained from each of the weld centre line, fusion line and the fusion line +2 mm. The specimens shall be taken from the mid-thickness with the notch in a radial orientation. When the pipe dimensions preclude the preparation of a rectangular (5 mm x 10 mm) cross-section specimen a rectangular cross-section specimen shall be prepared with the maximum feasible thickness.

In each case the impact energy shall satisfy the requirements specified for a 5 x 10 mm specimen. When the wall thickness is over 20 mm a test series at the same locations shall also be made at the root side of the weld. The positions and orientations of impact test specimens are shown in Figure B.

Testing shall be carried out at a temperature determined in accordance with Table A.

The minimum design temperature, T, shall be stated in the contract documents. If no such information is available the impact testing shall be carried out at 0 °C.

The dimensions, preparation and testing of the impact test specimens shall be in accordance with ISO 148. Subsized specimen may be used when standard specimens cannot be prepared.

Minimum required impact values are given in Table B for API Spec 5L grades of line pipe. Requirements for equivalent materials (see 5.1) shall be determined by correlating the minimum specified yield strength with Table B.

Add the following:

2.6.8 Retests

2.6.8.1 General

If the results of the WPQT are unsatisfactory due to defective preparation of the specimens or due to a local weld defect, the Principal may allow the procedure below to be followed.

2.6.8.2 Tensile test and bend test specimens

If a tensile or bend test specimen does not meet the requirements, two additional tensile tests or bend tests shall be made, both of which shall meet the prescribed requirements.

2.6.8.3 Impact test specimens

If one of the specimens gives an unsatisfactory result which is clearly caused by a local defect, a further test specimen may be taken and tested; only one such replacement shall be permitted per set of three specimens.

2.6.8.4 New procedure requirement

If the test joint fails to meet the minimum requirements a new WPS shall be established and the WPQT shall be repeated to the satisfaction of the Principal.

2.7 WELDING OF TEST JOINTS - FILLET WELDS

Add the following:

Only the vertical up direction shall be allowed for fillet welds. Fillet welds shall be made using low-hydrogen electrodes.

2.8 TESTING OF WELDED JOINTS - FILLET WELDS

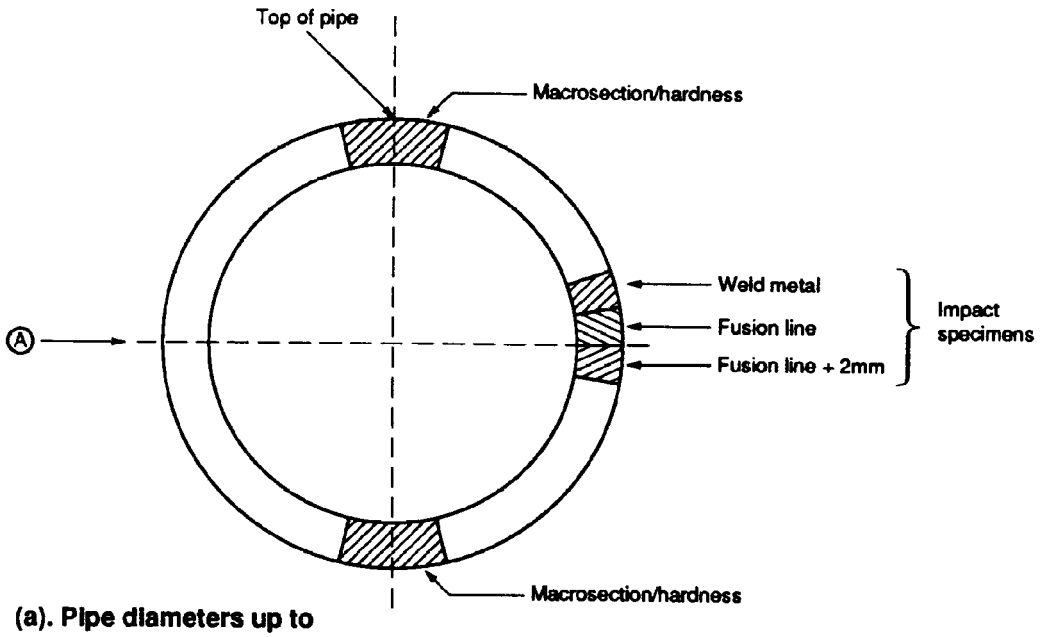
Add the following paragraph:

2.8.4 Macroscopic examination and hardness tests

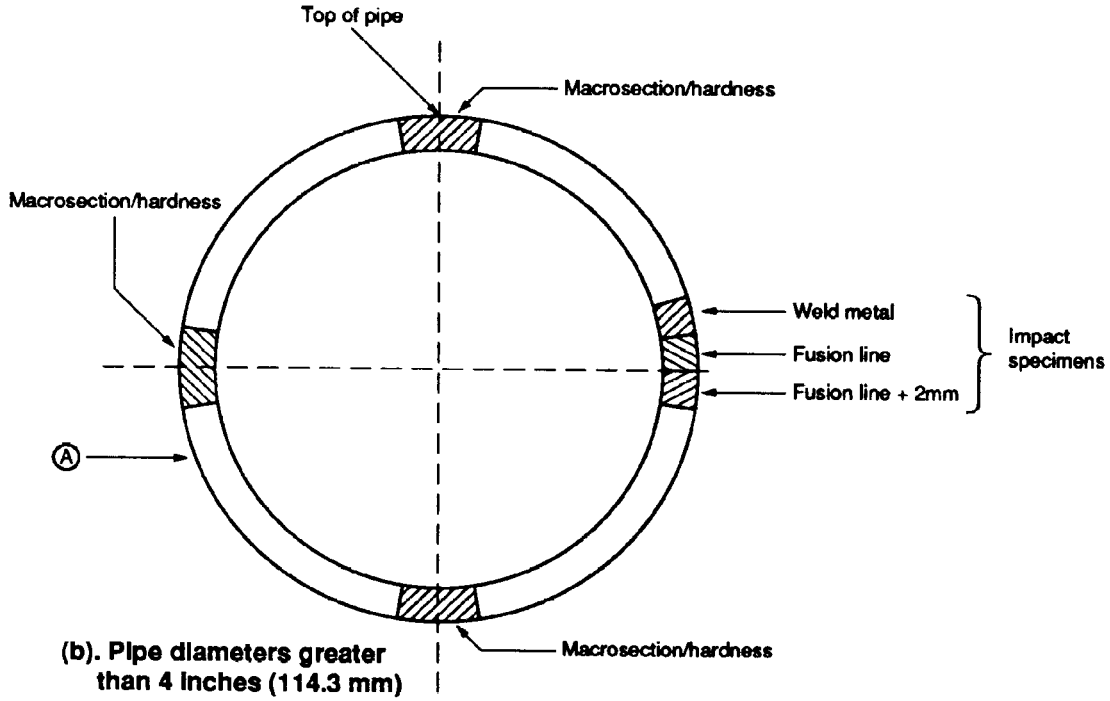
Specimens for macroscopic examination shall be extracted from fillet weld qualification welds at the same locations as shown for butt welds in Figure A.

Hardness traverses shall be carried out across the root of the fillet weld and also the cap region at a depth of 2 mm. The requirements of Section (2.6.6.3) shall also apply for fillet welds.

FIGURE A. LOCATION OF MACROSECTION AND IMPACT TEST SPECIMENS PROCEDURE QUALIFICATION OF BUTT WELDS



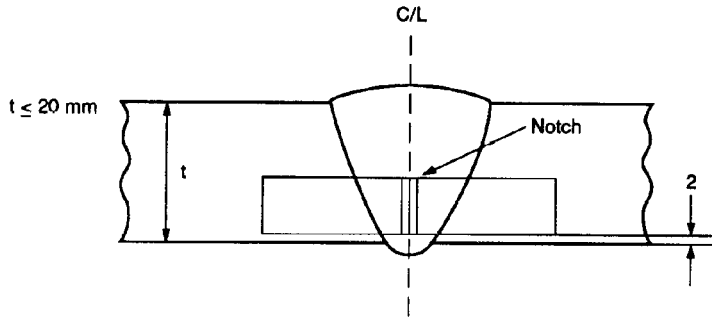
(a). Pipe diameters up to and including 4 inches (114.3 mm)



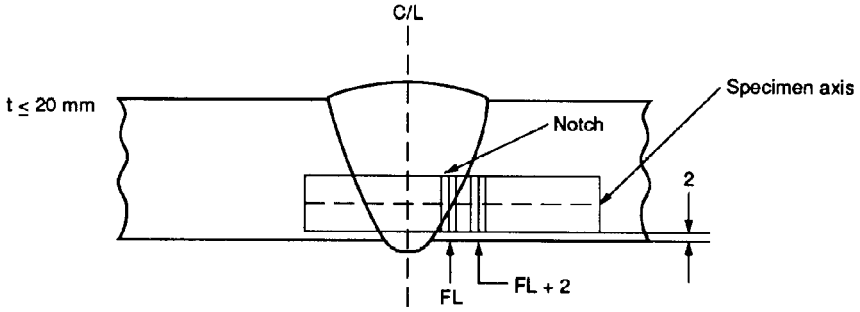
(b). Pipe diameters greater than 4 inches (114.3 mm)

Note: If additional impact specimens are required due to the wall thickness exceeding 20 mm these shall be taken from location Ⓐ

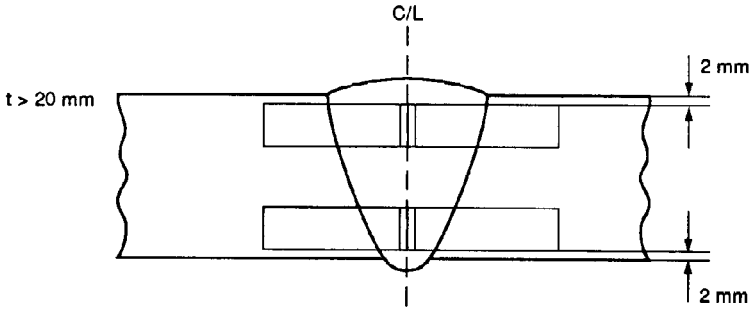
FIGURE B. ORIENTATION OF IMPACT TEST SPECIMENS FOR PROCEDURE QUALIFICATION OF BUTT WELDS



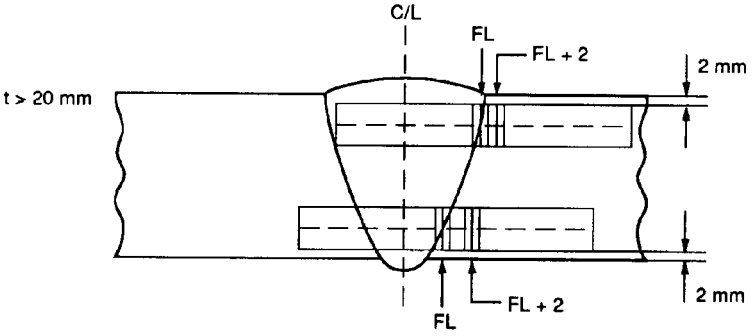
Weld metal specimen



Heat affected zone specimens



Weld metal specimens



Heat affected zone specimens

Table A - Charpy V-notch test temperature

Nominal wall thickness (t) (mm)	Test temperature (°C)
$t \leq 16$	T
$25 \geq t > 16$	T - 10
$t > 25$	T - 20

NOTE: T = minimum design temperature.

Table B - Charpy V requirements (J)

Steel grade (API Spec 5L)	Specimen size (mm)	Charpy-V requirement (Joules)	
		min. average	min. single
B	10x10 10x6.7 10 x 5	27 21 18	19 15 13
X42	10x10 10x6.7 10x5	29 23 19	22 17 15
X46	10x10 10x6.7 10x5	32 25 21	24 19 16
X52	10x10 10x6.7 10x5	36 28 24	27 21 18
X56	10x10 10x6.7 10x5	39 30 26	29 23 20
X60	10x10 10x6.7 10x5	41 32 27	31 24 21
X65	10x10 10x6.7 10x5	45 35 30	34 27 23
X70	10x10 10x6.7 10x5	48 37 32	36 28 24

SECTION 3 QUALIFICATION OF WELDERS

3.1 GENERAL

Replace as follows:

The purpose of the welder qualification test is to determine the ability of welders to make sound butt or fillet welds using previously qualified procedures. Before any production welding is performed, welders shall be qualified on contract material according to the applicable requirements of Sections 3.4 through 3.8 for each of the procedures they will be required to apply during production welding. It is the intent of this standard that a welder who satisfactorily completes the procedure qualification test is a qualified welder.

The welder shall perform the qualification test welding in accordance with the approved WPS. The qualification of welders shall be conducted in the presence of the Principal.

A welder qualification shall be valid for a period of six months. If it can be shown, by means of the results of non-destructive examination carried out in accordance with the requirements of this specification, that during this period he has successfully produced welds in accordance with the approved welding procedure, the period will be automatically extended by another six months.

3.2 SINGLE QUALIFICATION

3.2.1 General

Replace as follows:

A pipeline welder shall qualify for welding by performing a test on contract material. He will be qualified to weld only in the same position as the test weld.

For non-pipeline applications, a welder who successfully passes a butt-weld qualification test on contract material in the fixed position with the axis inclined 45 (± 10) degrees to the horizontal plane (6 G position) shall be qualified to make butt welds on contract material in all positions. This is applicable only to manual welding. Automatic or mechanical welding procedures shall be qualified in the same position as they are applied. The use of segments of pipe nipples for welder qualification shall not be permitted.

3.3 MULTIPLE QUALIFICATION

Delete.

3.7 RETESTING

Replace as follows:

If the test weld does not meet the requirements, the welder or welding operator may carry out two new test welds of the same type as the rejected one, provided the cause of failure is determined and is not attributable to inadequate training. If both these welds meet the specification requirements, the test will be considered satisfactory. If not, the test will be considered failed, and the welder will be disqualified for a period of one month.

3.8 RECORDS

Change title to:

3.8 RECORDS, AND WELDER IDENTIFICATION SYSTEM

Add the following:

A Welder's Competence Certificate, which includes references to the corresponding WPS number, the essential variables, and the test results, shall be issued for each welder or welding operator and for each test.

Whilst production welding, the welder/welding operator shall always be identifiable by a badge bearing his name, his photograph and his identification number. Welders and welding operators not wearing their badges shall be suspended from production welding. In the event that a welder ceases working on the contract his identifying mark and number shall not be assigned to another welder.

SECTION 4 DESIGN AND PREPARATION OF A JOINT FOR PRODUCTION WELDING

Change title to:

SECTION 4 PRODUCTION WELDING

4.1 GENERAL

Replace as follows:

Limitations imposed by the essential variables of the procedure qualifications shall be adhered to in production welding. No welding shall be carried out before the WPSs and WPQTs are completed, nor before the welders have been qualified, and approved by the Principal. Only qualified welders as defined in Section 3 may be employed. Preparation and welding of pipeline components shall be in accordance with the appropriate qualified WPS.

The surfaces to be welded shall be smooth, uniform and free from laminations, tears, scale, slag, grease, paint and other deleterious material that might adversely affect the welding.

If work is to be carried out in the vicinity of equipment already installed, before any welding commences adequate protection shall be provided to prevent damage from weld spatter, flame cutting droplets, etc. Care shall be taken to avoid overloading or damaging any of the pipeline components at all stages of the work.

Current return cables of welding equipment shall be connected directly to the pipe on which the welding is to be done.

If the pipe size exceeds 12 inches at least two welders shall weld simultaneously around the pipe circumference.

Arcs shall be struck only on fusion faces or on striking plates provided as an aid to arc starting. Stray arc strikes shall be removed by grinding away all material which has been affected by the arc heat. Where this results in the minimum thickness being below tolerance, the section of pipe containing the arc strike shall be removed. Weld repairs or build-up shall not be made on the base pipe.

A circular cap to prevent entry of foreign material, of a design which will not damage pipe ends, shall be used to cover the open ends of the pipe and shall be placed on the line during interruptions in the work expected to last more than two hours. Caps shall not be removed until recommencement of the work. All open ends of pipe strings shall be capped off and sealed when welding is completed.

4.2 ALIGNMENT

Replace as follows:

The pipeline components shall be firmly supported in both the vertical and horizontal plane, and no welding shall be carried out until as much of the pipeline system as will be so stiffened has been properly aligned.

Misalignment shall be reduced to a minimum by rotation of the pipes to obtain the best fit, or by other approved methods. When a pipe with one longitudinal seam is used, this seam shall be within the top 120 degrees of the circumference and the longitudinal seams of adjacent pipes shall be offset by a circumferential distance of at least half the pipe diameter.

The alignment of the abutting ends shall be set so as to minimise the offset between surfaces. If the offset exceeds 1.6 mm, provided it is caused by dimensional variations within the specified tolerances, the pipe with the smaller diameter shall be trimmed to a taper not steeper than 1 in 4.

Alignment of two pipeline components of different nominal thickness and the same outside diameter, shall be carried out by tapering the inner surface of the thicker component with a taper not steeper than 1 in 4.

Tack welds shall be avoided wherever possible. Where required, bridge tacks shall be used.

Tack welding shall be performed by qualified welders using the same qualified welding procedure as will be used for the main welds.

Hammering or otherwise plastically deforming the pipe or bevel to obtain proper alignment is not permitted.

4.3 USE OF LINE-UP CLAMP FOR BUTT WELDS

Replace as follows:

Line-up clamps, holding devices, etc. shall be used for butt welds to avoid tack welding in the groove and to optimise alignment. Internal line-up clamps of a type acceptable to the Principal shall be used for pipe sizes of 8 inches and larger. External line-up clamps may be used for pipe sizes 6 inches and smaller. For tie-in welds, external line-up clamps may be used for all pipe sizes.

Internal line-up clamps shall remain in place at least until the root pass is completed around the full circumference.

External line-up clamps shall not be removed until a minimum of 50% of the root pass, uniformly spaced around the circumference, has been completed.

Root bead segments used with external line-up clamps shall be cleaned, ground down to a feather edge at both ends and visually inspected prior to completion of the root pass. Any such segment which is not in accordance with the acceptance standards given in Section 6 shall be removed before completion of the root pass.

The pipe joint shall not be moved (or, for laybarge welding, the barge shall not be moved) until after the second weld pass (hot pass) has been made.

4.4.2 Field bevel

Replace as follows:

The equipment used for edge preparation and cleaning (e.g. cutting, grinding, gouging, brushing, etc.) shall cause no detrimental metallurgical effects to the edges to be welded.

Pipe ends shall be bevelled by machining or grinding. Preparation of weld edges by gas cutting shall, wherever practical, be done with a mechanically guided torch. Edges shall be left free of slag and the cut surface shall be ground to a smooth uniform surface by removing approximately 0.5 mm of metal.

After grinding, the bevelled edges shall be visually examined to ensure freedom from defects. Any bevelled edge that has been damaged shall be restored to within the tolerances required by the welding procedure to be applied. Restoration involving welding is not permitted. Should laminations or split ends be discovered in any pipe, the full pipe joint shall be removed and subjected to full ultrasonic examination for the presence of laminations in accordance of the linepipe purchase specification before partial reuse is considered.

4.5 WEATHER CONDITIONS

Replace as follows:

4.5 WEATHER CONDITIONS AND PROTECTION

Work shall not be performed when the weather and/or lack of sufficient protection do not permit satisfactory workmanship or inspection. Shelters shall be provided which give adequate protection to the weld area from wind, dust, rain and moisture. Surfaces to be welded shall be thoroughly dried by heating before welding. Provisions shall be made to reduce distortion which could occur due to differences in temperature between preheated and cold areas. The Principal shall decide when the weather conditions are not suitable for welding.

4.7 CLEANING BETWEEN BEADS

Add the following:

Pneumatic grinders and deslagging tools shall be designed such that the exhaust air does not impinge on a hot weld region.

4.9 ROLL WELDING

4.9.1 Alignment

Add the following:

Roll welding shall be restricted to fully automatic welding and then only when the pipe can be adequately supported on rollers with drives coupled electrically to the automatic welding machine.

4.10 IDENTIFICATION OF WELDS

Replace as follows:

Prior to starting the root pass, the welder or welding operator shall clearly mark the pipe adjacent to his weld with the identification mark assigned to him in his qualification certificate. Tack welding of components shall not be so marked.

Marking shall be done with weather-proof chalk, paint, crayon or felt pen. Die stamps shall not be used for marking the welds. The welder/operator who makes the root pass shall write his code at the top of the pipe. If, however, two welders/operators weld the root pass, each welder/operator shall mark the top of the pipe with his identification code on the side on which he has worked. Subsequent welders/operators shall write their identification codes below the first code in the sequence in which they work. The identification marks shall not be removed until after the welds have been both visually and non-destructively inspected and accepted.

4.11 PRE- AND POST-HEAT TREATMENT

Replace as follows:

4.11.1 Preheating and interpass temperature control and measurement

4.11.1.1 General

Preheating shall be carried out using either electrical resistance or induction heaters or using gas burners specifically made and shaped for this type of operation. Torches intended for flame cutting or gouging shall not be used. Induction heating coils can cause arc blow during welding, therefore power to these coils shall be off when welding is in progress.

Where induction heating is proposed for the application of either preheat or post-weld heat treatment, the equipment and the procedure to be used shall be approved by the Principal. In particular, the Contractor shall demonstrate to the satisfaction of the Principal that heating rates and required temperatures can be properly controlled and that adequate precautions have been taken against overheating.

The preheating temperature shall cover an area of at least 75 mm width on either side of the weld and shall be maintained over the full length of the weld until the weld is completed.

The weld area shall be protected from draughts, and insulation shall be provided on adjacent areas where this is necessary to maintain the required temperature of preheating during welding.

The temperature measurement for preheat and interpass temperature may be by thermocouples or thermosticks, or a combination of both. Where thermosticks are used, these shall be of the type which melt when the required temperature is reached.

4.11.1.2 Temperature requirements

The minimum preheat shall be calculated from BS 5135. The heat input value used in the calculation shall be the minimum value indicated in the procedure specification. The carbon equivalent value shall be the highest to be encountered when using the weld procedure, as determined from a survey of the relevant material certificates. Scale "A" of BS 5135 shall be used for cellulosic SMAW electrodes and Scale "C" for basic low hydrogen SMAW electrodes. The scale to be used with other processes shall be subject to the approval of the Principal. In all cases, a minimum preheat of 50 °C shall be used.

For the welding of "sweepolets" the preheat shall be 50 °C higher than that indicated by BS 5135, using the above parameters.

Preheating to a minimum temperature of 100 °C is required when the thickness of any one of the sections to be welded exceeds 32 mm.

The interpass temperature shall not be permitted to drop below the minimum preheat temperature (if required). The interpass temperature shall not be allowed to exceed 300 °C.

4.11.1.3 Tackwelding

Preheating for tack welding shall comply with the general requirements (4.11.1.1).

The material, over a zone 75 mm wide round the position of the intended bridge tack and through its full thickness, shall be heated to the required temperature. For tack welding the minimum preheating temperature shall be 50 °C above any preheat temperature specified in the WPS for production welding, with a maximum of 300 °C.

4.11.2 Post weld heat treatment (stress relieving)

The necessity for post weld heat treatment shall be determined from the applicable equipment design code or standard. In the absence of specific requirements from such codes or standards, the requirements of ANSI/ASME B31.8 para 825 shall be followed.

Stress relieving of welds in pipes of API Spec 5L Grades X60 and above, shall be carried out in the range 560 - 600 °C. Stress relieving of welds in all other grades of carbon steel shall be carried out in the range 580 - 620 °C. The holding time shall be 2.5 minutes per millimetre wall thickness, with a minimum time of one hour. The heating and cooling rate shall be a maximum of 300 °C per hour.

Pipe ends shall be covered when stress-relieving welds, to avoid draughts inside the pipe. Threads and gasket surfaces shall be protected from oxidation during heat treatment, if there is no subsequent machining operation which will remove any damage.

A sufficient number of thermocouples shall be used in order to give a reliable temperature measurement. On pipe less than 8 inches nominal diameter, one thermocouple is regarded as sufficient; those with a diameter of 8 inches to 20 inches shall have at least two at 180 degrees between each other, and pipe with a diameter of above 20 inches shall have at least three thermocouples at 120 degrees between each other. In no circumstance shall the distance between two thermocouples be greater than 800 mm, measured around the pipe circumference.

Post weld heat treatment procedures shall be submitted to the Principal for approval along with the WPS and WPQT record, prior to the commencement of work.

Add the following paragraphs 4.12 to 4.16:

4.12 SEPARATION OF GIRTH WELDS

The minimum allowable distance between girth welds shall be the external diameter of the pipe or 500 mm, whichever is the larger.

4.13 CONTROL OF WELDING CONSUMABLES DURING PRODUCTION WELDING

Ovens or storage cabinets with automatic heat controls and temperature read out

equipment shall be provided to maintain low hydrogen welding electrodes and welding flux at the required temperature.

After removal from an oven, all low-hydrogen electrodes shall be kept in a storage cabinet or quiver. No electrodes shall be left exposed to the atmosphere. Issue of low-hydrogen electrodes from the storage cabinet shall be controlled so that all electrodes are used within four hours of issue.

To maintain the low hydrogen content as specified in (1.5.2), electrodes shall be baked immediately before use at 300 °C (± 30 °C) for one hour or in accordance with Manufacturer's recommendations. This requirement may be waived when the electrodes are removed from an hermetically sealed package immediately before use. Plastic wrapped cartons are not considered to be hermetically sealed.

After drying as described above, electrodes may be transferred to an intermediate storage cabinet maintained at approximately 150 °C. Upon removal from such drying or storage the electrodes shall be transferred in small numbers to heated quivers with a minimum temperature of 70 °C and used within 4 hours.

Electrodes not used within 4 hours, or for some reason exposed to adverse atmospheric conditions, shall be baked again in accordance with the above conditions. Electrodes may be baked twice only. If these electrodes are not used within four hours after the second baking treatment, they shall be discarded.

4.14 WELD INTERRUPTION

The deposition of each weld shall generally be a continuous operation. However, in the case that onshore welding must be discontinued, this shall not take place before at least the root and hot passes are completed.

In the case that offshore welding must be discontinued, all welds at all welding stations shall be completed before the welding stations are shut down. Slow controlled cooling of the weld area shall be ensured.

Before resumption of welding, interrupted welds shall be inspected by magnetic particle examination in accordance with (8.2).

4.15 WELD FINISHING

Welds shall be left as welded and shall not be treated with a flame torch or by any mechanical means to change their appearance, other than the cleaning defined in the WPS. Welds shall not be peened.

4.16 SURFACE FINISHING

When welding is completed, all surfaces adjacent to the welds shall be cleaned to allow proper radiographic or ultrasonic inspection, and to remove all detrimental burrs and other marks. Cleaning procedures shall be indicated on the welding procedures or drawings. Any damage shall be rectified prior to NDT.

SECTION 5 INSPECTION AND TESTING OF PRODUCTION WELDS

5.2 METHODS OF INSPECTION

Change the number and heading of the existing section to:

5.2.1 General

Delete the following sentences:

The welds shall be evaluated on the basis of either Section 6 or, at the Company's option, the Appendix to this standard. In the later case more extensive inspection to determine the flaw size is required.

Replace by the following:

The welds shall be evaluated on the basis of Section 6 requirements.

Add the following:

Written NDT procedures as required in Section 8 shall be prepared and submitted to the Principal for approval. All operations shall be performed in accordance with these procedures on welds in their final condition.

Add the following paragraphs 5.2.2 to 5.2.4:

5.2.2 Radiographic examination

All radiographic examinations shall be carried out in accordance with the methods described in Section 8.

For the purposes of this DEP, radiography means the use of X-ray examination. Gamma-ray examination may be used only with the approval of the Principal. For gamma-ray examination, film type 1, as defined in (8.1.2.2), shall be used. Cobalt-60 isotopes shall not be used.

The radiographs shall be free from imperfections due to processing or other defects which could interfere with interpretation. Radiographs shall be judged in accordance with Section 6.3.

Radiography shall be supplemented by ultrasonic testing and magnetic particle testing where there is reason to suspect planar defects such as cracks or lack of fusion.

5.2.3 Ultrasonic examination

In addition to radiography, a limited ultrasonic examination shall be made in the case of the use of mechanised or semi-automatic GMAW techniques. The minimum extent of ultrasonic examination shall be 25 percent of the first 100 production welds of the same type with 5 percent of similar welds selected at random thereafter.

Ultrasonic examination may be used instead of radiographic examination if the wall thicknesses is equal to or greater than 12 mm and with the approval of the Principal. The method shall be selected such that the progress of the construction is not affected. For pipeline girth welds, only mechanised ultrasonic techniques which provide a permanent registration of the results of the examination ("hard-copy") shall be used.

All ultrasonic examinations shall be carried out in accordance with the methods described in (8.4). Acceptance criteria shall be in accordance with (6.6).

5.2.4 Sectioning of welds

The Principal shall have the right to request a test weld to be made at any stage during normal production welding to allow a metallurgical examination of the deposited weld. Similarly, when NDT cannot be carried out or gives inconclusive results, the Principal shall have the right to have a pipe section, including the weld, cut out and removed for testing. Subsequent mechanical testing shall be carried out in accordance with (2.6) or (2.8) as appropriate.

5.4 CERTIFICATION OF NON-DESTRUCTIVE TESTING PERSONNEL

5.4.1 Procedures

Replace as follows:

Non-destructive testing personnel shall be certified in accordance with ASNT Recommended Practice SNT-TC-IA for the test method used or an equivalent certification scheme approved by the Principal. Only level II or III personnel shall interpret the test results.

Add the following Section 5.5:

5.5 EXTENT OF INSPECTION AND TESTING

5.5.1 Pre-welding inspection

All materials to be welded shall be subjected to visual inspection for surface defects, laminations, etc. for compliance with the requirements in the relevant line pipe or fitting specification.

All weld preparations and repaired preparations shall be inspected visually.

Edge preparations for tie-in welds shall also receive magnetic particle examination. See (8.2) and (6.4).

5.5.2 Inspection during welding

During production welding the welding parameters shall be checked against the WPS.

5.5.3 Inspection after welding

All welds shall be visually inspected and cracks, craters, pinholes, weld spatter, residual slag or arc strikes shall not be acceptable.

All butt welds shall be fully inspected radiographically, and where appropriate inspected ultrasonically, see (5.2.3). All fillet welds shall be tested using wet magnetic particle inspection.

Where radiography is not practical or where the Principal requires a further examination of a weld to assist in the evaluation of suspected defects, ultrasonic examination and magnetic particle inspection shall be used.

SECTION 6 ACCEPTANCE STANDARDS FOR NON-DESTRUCTIVE TESTING

6.3 RADIOGRAPHIC TESTING

6.3.1 Inadequate penetration

Replace by the following:

Inadequate penetration without high-low (IP) is defined as the incomplete filling of the weld root. This condition is shown schematically in Figure 13, and is unacceptable.

6.3.2 Inadequate penetration due to high-low (IPD)

Replace by the following:

IPD is the condition that exists when one edge of the root is exposed (or unbonded) because adjacent pipe or fitting joints are misaligned. This condition is shown schematically in Figure 14, and is unacceptable.

6.3.3 Incomplete fusion (IF)

Replace by the following:

IF is a discontinuity between the weld metal and the base metal that is open to the surface. This condition is shown schematically in Figure 15, and is unacceptable.

6.3.4 Incomplete fusion due to cold lap (IFD)

Add the following:

Areas of IFD which are separated by a distance not exceeding the length of the smaller indication shall be treated as a single IFD.

For welds other than girth welds the acceptance criteria for the individual and aggregate length of defects shall be $^1/_2$ of the values indicated in a. to c. in this clause.

6.3.6 Burn through

Change title to:

6.3.6 Burn through and excessive penetration

Add the following:

6.3.6.4 Root penetration shall not exceed 3 mm.

6.3.9 Cracks

Replace by the following:

Cracks of any type are unacceptable.

6.3.11 Accumulation of discontinuities

Replace the first four lines by the following:

Any accumulation of (otherwise acceptable) discontinuities shall be unacceptable when any of the following conditions exists:

6.4 MAGNETIC PARTICLE TESTING

6.4.2 Acceptance standards

Replace by the following:

Relevant indications shall be unacceptable when any of the following conditions exist:

a. Linear indications are evaluated as cracks, including crater cracks or star cracks.

b. Linear indications are evaluated as incomplete fusion (IF).

Rounded indications shall be evaluated according to the criteria of 6.3.8.2 and 6.3.8.3 as applicable. The maximum dimension of a rounded indication shall be considered as its size for evaluation purposes.

NOTE: When doubt exists about the type of discontinuity disclosed by an indication, other non-destructive testing methods shall be used for verification.

6.5 LIQUID PENETRANT TESTING

6.5.2 Acceptance standards

Replace as indicated for 6.4.2.

6.6 ULTRASONIC TESTING

6.6.2 Linear indications

Replace by the following:

All indications that produce a response greater than 20 percent of the reference level shall be investigated to determine the location, shape, extent and type of reflectors and shall be evaluated according to the following criteria:

a. All linear indications interpreted to be cracks are unacceptable.

b. Linear indications interpreted to be open to the surface are unacceptable.

c. Linear indications (other than cracks) interpreted to be buried within the weld are unacceptable if they exceed 50 mm in length, or if they exceed 50 mm in total length in a continuous 300 mm length of weld, or if they exceed 8 percent of the weld length.

Add the following paragraphs 6.8 to 6.10:

6.8 NDT EVALUATION REPORT

An evaluation report shall be made stating the identification number of each weld inspected and the name of the welder/operator together with the description of the inspection method and, if applicable, the reason for rejection of the weld. The "I.I.W. Collection of Reference Radiographs of Welds in Steel" shall be used for identifying the defects found by radiography. For other inspection techniques a description of the defect indication shall be given.

6.9 WELDER PERFORMANCE RECORDS

The Contractor shall maintain an accurate record of the performance of each welder which shall show the repair rate. The repair rate should be expressed as a percentage of repaired welds over the total number of welds produced.

The Principal shall have the right to remove any welder from the job if his performance is considered to be of an unacceptable standard.

6.10 ASSESSMENT OF RADIOGRAPH INDICATIONS IN THE PIPE MATERIAL ADJACENT TO WELDS BEING INSPECTED

Indications that the pipe material next to the weld has been damaged in any way (e.g. arc burns, mechanical damage, weld beads, defects in the longitudinal seam of longitudinally welded pipe, etc.) shall be reason to reject the weld.

SECTION 7 REPAIR AND REMOVAL OF DEFECTS

7.1 DEFECTS OTHER THAN CRACKS

7.1.1 Authorisation for repair

Replace as follows:

Welds containing defects outside the limits given in Section 6 may be repaired only if approved by the Principal, and only one such repair may be made. A weld with unacceptable defects may be repaired once only. If the repair is then not acceptable the complete weld, including the heat affected zone, shall be removed.

All repairs shall meet the standards of acceptability given in Section 6 and shall be executed by qualified welders according to approved repair procedures (see (2.1)).

7.1.2 Removal and preparation for repair

Change title and replace as follows:

7.1.2 Removal of defects and repair

7.1.2.1 General

Before repairs are made, the defects necessitating the repair shall be entirely removed to sound metal. All slag and scale shall then also be removed.

The removal of weld metal or portions of the base metal may be done by machining, grinding, chipping, oxygen gouging or air carbon-arc gouging. When thermal gouging methods are used the appropriate pre-heating (determined from the WPS) shall be applied. Thermal gouging methods shall not be used for removal of the weld root. The unacceptable portions of the weld shall be removed without substantial removal of the base metal and in such a manner that the remaining weld metal or base metal is not nicked or undercut. Where thermal gouging is used, the edges shall be dressed to remove the hardened surface.

The repair weld grooves shall be free from scale and shall have acceptable contours. They shall be visually and magnetic particle inspected prior to rewelding to ensure the defect has been completely removed.

If planar defects in welds are to be repaired, every effort shall be made to prevent propagation of the defect during its removal. During the final stages of removal, grinding and not gouging shall be used. Magnetic particle inspection shall be carried out to check for the complete removal of the defect.

7.1.2.2 Repair procedure for sub-surface and root defects other than cracks

A repair procedure shall be formulated incorporating a prequalified repair welding procedure in accordance with Section 2 of this DEP. In addition to welding details, the repair procedure shall include:

a. Method of examination of the defect area.

b. Method of defect removal.

c. Requirements for interpass NDT, where applicable.

7.1.2.3 Weld size adjustments

For overlap or excessive convexity, excess weld metal shall be removed by grinding or machining.

Additional weld metal to compensate for any deficiency in size shall be deposited using procedures as qualified for the original weld. The surfaces shall be thoroughly cleaned before depositing the additional weld metal.

7.1.3 Testing of repairs

Replace by the following:

Repaired areas shall be re-radiographed or inspected by the same means previously used. The area of the adjacent weld, on both sides of the repair, shall also be reinspected in the same manner as the original production weld.

7.2 AUTHORISATION AND PROCEDURE FOR REPAIR OF CRACKS

Replace by the following:

A weld containing shallow crater cracks or star cracks, which are located at the stopping point of weld beads and which are the result of weld metal contraction during solidification, may be repaired provided the length of the crater cracks does not exceed 4 mm. With the exception of these shallow crater cracks, any weld containing cracks, regardless of size or location, shall be removed.

SECTION 8 PROCEDURES FOR NON-DESTRUCTIVE TESTING

8.1 RADIOGRAPHIC TEST METHODS

8.1.1 General

Delete the sentence in the third paragraph "The use of radiographic inspection and the frequency...." *and replace by the following:*

"The use of radiographic inspection and the frequency of its use shall be as stated in (5.5.3)."

Add the following:

As far as practical, internal sources (crawlers) shall be used. This is possible at least for pipelines of 8 inches diameter and larger. In cases where the sources cannot be placed inside the pipe the double-wall/single-image technique shall be applied.

8.1.2.2 Film radiography

Add the following:

i. Identification - the system(s) used to identify the weld, and the location of the radiograph in relation to the weld, shall be given in the procedure.

Radiographs shall be made using one of the film types defined below:

Table C Definition of film types

Film Type	Speed	Contrast	Grain	Examples
1	Slow	Very high	Very fine	Kodak Industrex M Kodak Industrex TMX Kodak Industrex T Agfa D2 Agfa D4 Fuji 50
2	Medium	High	Fine	Kodak Industrex AX Kodak Industrex AA Agfa D5 Agfa D7 Fuji 100

Prepacked films, e.g. roll pack, and rigid or flexible cassettes may be used.

8.1.4 Type of penetrameters

Replace by the following:

Wire type penetrameters (image quality indicators, IQIs) in accordance with BS 3971 shall be used.

8.1.5 Selection of penetrameters

Replace by the following:

8.1.5 Radiographic sensitivity

Radiographic sensitivity shall be 2 percent or better in the welded area. This shall be determined by the use of an IQI in accordance with BS 3971.

For double-wall/double-image techniques, the diameter of the wires employed shall be based on the nominal double-wall thickness of the pipe plus the measured thickness of the external weld reinforcement.

For double-wall/single-image techniques, the diameter of the wire shall be based on the nominal single-wall thickness of the pipe plus the measured thickness of the external weld reinforcement.

8.1.7 Production radiography

Replace by the following:

Only Level II or III radiographers shall interpret the radiographic images of production welds.

Radiographs shall be taken within 24 hours of weld completion. As soon as they have been taken, they shall be developed and dried and interpreted by the Contractor. Thereafter all radiographs shall be submitted to the Principal for examination and approval.

With each batch of radiographs submitted to the Principal for examination and approval, the Contractor shall give a list of the radiographs in duplicate. This list shall contain the Contractor's interpretation of each radiograph. The radiography list shall be clearly marked to show which welds are repairs or rewelds. The Principal will state on this list the acceptability, or otherwise, of the weld.

The Principal shall state whether the weld has passed, is to be repaired, is to be cut out, or requires additional NDT. The Contractor shall repair or cut out and reweld the welds, or carry out additional NDT in accordance with the statements on the list returned to him.

8.1.8 Identification of images

Replace by the following:

Images shall be clearly identified by the use of lead numbers, letters or markers so that the correct weld and any discontinuities in it can be quickly and accurately located. The following techniques shall be used for this purpose:

On pipe diameters over 3 inches, a tape measure with lead numbers every 100 mm shall be placed adjacent to the weld. The zero point shall be on the top of the pipe and the divisions shall run clockwise in ascending order, viewed in the direction of pipeline laying progress.

On diameters less than 3 inches, each shot shall be designated by a lead letter placed on the pipe, i.e. A, B, C.

Where the weld has been dressed, markers in a form to be approved by the Principal shall be placed alongside the weld, but just clear of the heat affected zone, to identify its position.

All radiographs shall be clearly identified with reference to the welds they represent. All measurements used for defect location shall be stated in metric units. If sufficient space is available, the pipeline reference weld number and section number shall be included in the radiograph identification.

Each weld shall be marked using indelible material, to provide reference points for the accurate relocation of the position of each radiograph.

8.1.10 Film density

Replace by the following:

Film shall be exposed so that the density through the weld metal is not less than 1.8 for x-rays or 2.0 for gamma rays, and should not be greater than 3.0 for single film viewing.

Radiographs with a density up to 3.5 may be acceptable if adequate viewer capacity is readily available.

Films shall not be viewed when wet.

8.1.11 Image processing

Add the following:

On-site administration, storing and recording of radiographic films prior to and after exposure shall be the Contractor's responsibility.

Conditions of storage, temperature and humidity shall comply with the recommendations of

the film manufacturer.

Before completion of the Contract, all exposed film shall be indexed, catalogued, boxed up and handed over to the Principal in accordance with the Principal's requirements.

8.1.12 Image processing area

Replace by the following:

The image processing room and all accessories therein shall be equipped to handle the processing of all radiographs taken and shall be kept clean and dust free at all times.

Viewing illuminators shall be used which will produce sufficient light intensity so that all portions of the radiograph of the weld and base metal will transmit sufficient light to reveal the pertinent details of the radiograph. The light intensity shall be compatible with the density of the radiograph specified herein.

8.1.13 Radiation protection

Replace by the following:

The Contractor shall be responsible for the protection of all persons in the vicinity of the radiographic equipment. The Contractor shall familiarise himself with the safety requirements as set out in Shell publication "Protection against ionising radiation hazards" which contains recommendations for protection against hazards from sealed sources and equipment producing ionising radiation. A copy of this publication shall be made available to the Contractor by the Principal. This document shall form the basis of safety precautions to be applied in conjunction with any local statutory regulations or other legislation which may exist. The Contractor shall satisfy the Principal that all aspects of relevant safety procedures are adequately covered and have been implemented.

The Contractor shall identify the areas where radiography is being performed by means of signs, symbols, etc. and shall be responsible for the policing of such areas.

The Contractor shall be responsible for effectively coordinating the radiographic functions so as to minimise interference with other primary activities.

8.2 MAGNETIC PARTICLE TEST METHOD

Add to this paragraph the following:

If approved by the Principal, liquid penetrant testing in accordance with 8.3 may be substituted for magnetic particle testing.

8.4 ULTRASONIC TEST METHOD

After the first sentence, add the following:

Calibration for surface breaking and near surface defects shall be carried out in accordance with API Spec 5L, using an N10 reference notch.

SECTION 9 AUTOMATIC WELDING

9.1 ACCEPTABLE PROCESSES

Change title and replace as follows:

9.1 GENERAL

The requirements of the preceding sections shall also be applicable to automatic welding except where specifically amended in this Section 9.

Automatic welding shall be carried out using one or more of the following processes:

a. Submerged arc welding.

b. Gas metal arc welding.

c. Gas tungsten arc welding.

d. Flux cored arc welding with external shielding.

9.2 PROCEDURE QUALIFICATION

Replace the 2nd sentence as follows:

Three consecutive complete test welds shall be made between either complete pipe joint lengths or nipples, following all the details of the WPS under conditions which simulate those of the site production location.

9.4.2.2 Pipe and fitting materials

Replace as follows:

The contract materials to which the procedure applies shall be identified. Grouping of materials of different pipe manufacturers, supply condition, diameter, wall thickness or steel specification/grade is not allowed unless specifically agreed by the Principal.

9.4.2.3 Diameters

Replace as follows:

9.4.2.3 Diameters, wall-thickness group and number and sequence of beads

Procedures shall be qualified for each combination of diameter and nominal wall thickness of contract materials.

The range of numbers of beads required for each contract pipe thickness and the machine used for each bead, shall be clearly identified.

Delete:

9.4.2.4 Wall-thickness group and number and sequence of beads

9.4.2.5 Joint design

Add the following:

Permanent backing bars shall not be used.

9.4.2.6 Filler metal

Replace as follows:

Details of the filler metal(s) sizes, AWS classification and manufacturer/ brand identity shall be given together with a sketch showing the location, number and deposition sequence of each weld bead.

9.4.2.7 Electrical characteristics

Add the following:

The aiming voltage, amperage and travel speed for each bead shall be specified.

For pulsed arc welding the pulsing characteristics, including the frequency, amplitude, shape, base level, delay and crater fill, shall be specified.

9.4.2.8 Position

Add the following:

For roll welding by the submerged arc or flux cored arc processes, the position of the electrode in relation to the top centre (external welding) or bottom centre (internal welding) shall be stated and indicated by a sketch.

9.4.2.10 Time between passes

Add the following:

This time shall not exceed 5 minutes.

9.4.2.11 Type of line up clamp

Replace as follows:

The WPS shall state which type of line-up clamp, internal or external, is to be used. It shall also state at which stage during welding of the joint the line-up clamp shall be removed. In the case of internally clamped joints this shall not be before the complete root bead has been deposited. For welds made using external clamps a minimum weld deposit of 50 percent of the root pass shall be deposited before clamp removal. (See (4.3))

9.4.2.12 Cleaning

Replace as follows:

The specification shall describe the joint end cleaning required.

The specification shall state the methods to be used for inter-run cleaning, final weld surface preparation and treatment, if any, to the backside of the weld. The type of tools, power or manual or both, shall be specified.

9.4.2.13 Preheat treatment

Add the following:

Similar measures shall be taken to specify and monitor weld interpass temperatures.

9.4.2.16 Shielding flux

Replace as follows:

The type of shielding flux, the name of the manufacturer and the flux identity and/or brand name shall be designated.

9.4.2.18 Other factors

Add the following as first paragraph:

The range of allowable heat input rates to be applied by the welding process(es) for each weld bead shall be clearly specified. The units to be used shall be kilo joules per millimetre (kJ/mm) based on the following formula:

$$\text{Heat input (kJ/mm)} = \frac{\text{Volts} * \text{Amps}}{1000 * \text{Welding Speed (mm/sec)}}$$

9.5.2.2 Pipe material

Replace as follows:

A change of pipe manufacturer or manufacturing process for the same pipe diameter, nominal wall thickness and steel specification/grade shall constitute an essential variable.

9.5.2.6 Filler metal

Replace as follows:

The following changes in filler metal constitute essential variables:

a. A change from one filler metal group to another (see Table 1).

b. A change from one consumable manufacturer and/or trade name, or AWS classification to another.

c. A change in the minimum specified yield strength of the filler metal.

d. A change in the diameter of electrode or filler metal.

Add the following:

9.5.2.11 Shielding flux

Replace footnote a) as follows:

a. Any combination of flux and electrode in Group 4 may be used to qualify a procedure.

The combination shall be identified by its complete AWS classification number, such as F71-EL12 or F62-EM12K. Any change in either wire or flux manufacturer and/or AWS classification number shall constitute an essential variable.

Add the following:

A change in the size grading shall also constitute an essential variable.

9.5.2.13 Pre and post-heat treatment requirements

Replace as follows:

A change in preheat, interpass or postheat treatment temperature ranges shall constitute an essential variable.

Add the following:

9.5.2.15 Number and sequence of weld beads

A change in the minimum number of the weld beads deposited or the sequence of deposition shall constitute an essential variable.

9.9 ACCEPTANCE STANDARDS FOR NON-DESTRUCTIVE TESTING

Delete the following:

.... or, at the Company's option, the Appendix.

Add the following:

9.12 ULTRASONIC TESTING

Ultrasonic testing shall be in accordance with (8.4).

Additionally, ultrasonic testing as required by (5.2.3) shall be carried out.

SECTION 10 AUTOMATIC WELDING WITHOUT FILLER METAL ADDITIONS

10.1 ACCEPTABLE PROCESSES

Replace as follows:

Automatic welding without the addition of filler metal shall not be used.

Delete paragraphs 10.2 to 10.11.

APPENDIX ALTERNATIVE ACCEPTANCE STANDARDS FOR GIRTH WELDS

This Appendix shall not be applied.

PART III REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Line pipe for use in oil and gas operations under non-sour conditions (Amendments/Supplements to API Spec 5L)	L-2-2/3
Line pipe for use in oil and gas operations under sour conditions (Amendments/Supplements to API Spec 5L)	L-3-2/3
Protection against ionising radiation hazards	Shell Group Industrial Safety Committee

AMERICAN STANDARDS

Welding of pipelines and related facilities September 1988, plus Errata June 1989	ANSI/API Std 1104
Specification for line pipe	API Spec 5L

Issued by:
American Petroleum Institute
1220 L Street Northwest
Washington, DC 20005
USA.

Gas transmission and distribution piping systems 1989 Edition; Addenda B31.8A-1990, Addenda B31.8B-1990, Addenda B31.8C-1992	ANSI/ASME B31.8

Issued by:
American Society of Mechanical Engineers
345 East 47th Street
New York, NY 10017
USA.

Specification for carbon steel electrodes for shielded metal arc welding	ANSI/AWS A5.1
Specification for low alloy steel covered arc welding electrodes	ANSI/AWS A.5.5
Specification for carbon steel electrodes and fluxes for submerged arc welding	ANSI/AWS A.5.17
Specification for carbon steel filler metals for gas shielded arc welding	ANSI/AWS A5.18
Specification for carbon steel electrodes for flux cored arc welding	ANSI/AWS A5.20
Specification for low alloy steel filler metals for gas shielded arc welding	ANSI/AWS A5.28

Specification for low alloy steel electrodes for flux cored arc welding	ANSI/AWS A5.29

Issued by:
American Welding Society
550 NW Le Jeune Road
P.O. Box 351040
Miami, Florida 33135
USA.

Standard test method for Vickers hardness of metallic materials	ASTM E 92

Issued by:
American Society for Testing and Materials
1916 Race Street
Philadelphia 19103
USA

Standard material requirements - Sulfide stress cracking resistant-metallic materials for oilfield equipment	NACE MR0175

Issued by:
National Association of Corrosion Engineers
1440 South Creek Drive
P.O. Box 218340
Houston, Texas 77218-8340
USA.

BRITISH STANDARDS

Methods for radiographic examination of fusion-welded circumferential butt joints in steel pipes	BS 2910
Specification for image quality indicators for industrial radiography (including guidance on their use)	BS 3971
Specification for arc welding of carbon and carbon manganese steels	BS 5135

Issued by:
British Standards Institution
2 Park Street
London W1A 2BS
United Kingdom.

INTERNATIONAL STANDARDS

Steel; Charpy impact test (V-notch)	ISO 148
Collection of reference radiographs of welds in steel	International Institute of Welding

Issued by:
International Organization for Standardization
1 Rue de Varembé
CH-1211 Geneva 20
Switzerland.