



Document No.	GIS 43-332
Applicability	Group
Date	31 July 2006

Guidance on Industry Standard for ISO 13847 Pipeline Welding

GIS 43-332

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GIS 43-332. This Guidance on Industry Standard (GIS) is newly created and not directly based on heritage documents from the merged BP companies though it does use concepts from other BP pipeline welding documents.

Uncontrolled Copy



Table of Contents

	Page
Foreword	2
Introduction	3
1 Scope	3
1.1 HSE for pipeline welding operations	3
1.2 General duties of contractor	3
1.3 Pre-production consultation	3
1.4 Quality management	3
1.5 Contractor's personnel	3
2 Normative references	3
3 Terms and definitions	3
3.6 Company	3
3.7 Contractor	3
3.20 BP	3
3.21 Quality plan	3
3.22 Welding consumable	3
3.23 Lot	3
4 Symbols and abbreviations	3
5 Welding procedure specification testing and approval	3
5.1 General	3
5.2 Welding procedure specification	3
5.3 Welding of test piece	3
5.4 Inspection and testing of test pieces	3
5.5 Re-testing	3
5.6 Essential variables and range of approval	3
5.7 Welding procedure specification for repair welding	3
5.8 Period of validity	3
6 Approval and testing of welders and welding operators	3
6.4 Test welding	3
6.5 Inspection and testing of test welds	3
6.7 Range of approval	3
7 Production welding	3
7.1 General	3
7.2 Equipment	3
7.3 Working clearance	3
7.4 Weather conditions	3
7.5 Pipe end preparation	3
7.6 Support	3
7.7 Line-up	3



7.8	Tack welding	3
7.10	Electrodes and filler materials	3
7.11	Shielding gases	3
7.12	Preheating	3
7.13	Stray arcs	3
7.16	Weld metal deposition.....	3
7.17	Weld cleaning and peening.....	3
7.18	Partially completed welds.....	3
7.19	Post-weld heat treatment	3
8	Non-destructive examination.....	3
8.1	General.....	3
8.2	Qualification of NDE personnel	3
8.3	NDE procedure qualification	3
8.4	Visual examination.....	3
8.5	Radiographic examination.....	3
8.6	Ultrasonic examination.....	3
8.7	Magnetic particle examination.....	3
9	Acceptance criteria for non-destructive examination	3
9.1	General.....	3
9.3	Visual examination.....	3
9.4	Radiographic examination.....	3
9.8	Acceptance criteria – ECA	3
10	Repair and removal of defects	3
10.1	General.....	3
10.2	Authorization for repair.....	3
10.3	Multiple repairs	3
10.4	Defect removal and preparation for repair.....	3
10.5	Repair records	3
11	Documentation.....	3
Annex A (Informative)	Hyperbaric welding	3
A.1	General.....	3
Annex B (Normative)	Special requirements for welding of CRA-clad and CRA pipelines	3
Annex C (Informative)	Recommendations for brazing and aluminothermic welding of anode leads	3
C.2	Specification and approval of procedure	3
Annex E (Normative)	Additional requirements for pipelines subject to high strain levels	3
E.1	Introduction	3
E.2	General.....	3
E.3	Weld procedure qualification testing.....	3
E.4	Production welding.....	3
Bibliography		3



List of Tables

Table A - Minimum preheat levels for cellulosic welds	3
Table 1 - Inspection and testing of the test pieces for girth welding.....	3
Table 1A - Inspection and testing of the test pieces for fillet welding ^a	3
Table B - Minimum delay time before NDE for WPQT welds.....	3
Table C - Charpy V impact test requirements.....	3
Table 2 - Maximum permissible weld and HAZ hardness values (HV10)	3
Table 3 - Diameter and test pipe thickness range of approval for WPQT	3
Table D - Type and number of test specimens for repair weld procedure qualification test	3
Table E - Grade and thickness limits for cellulosic electrodes	3
Table 6 - Penetrameter sensitivity levels.....	3

List of Figures

Figure 1 - Location of test specimens for a fixed-position girth weld in pipe for upwards welding	3
Figure 2 - Location of test specimens for a fixed-position girth weld in pipe for downwards welding	3
Figure A - Girth weld hardness indent locations	3
Figure B - Fillet weld hardness indent locations	3



Introduction

- a. Guidance for pipeline welding is based on ISO 13847.
- b. Guidance statements of this GIS are modifications to ISO 13847, Petroleum and natural gas industries - Pipeline transportation systems - Welding of pipelines, First Edition 2000-09-15 including 2001-12-15 Technical Corrigendum 1.
- c. Modifications to ISO 13847 are identified as Add, Modify to Read, or Delete.
- d. Paragraph numbers in this specification correspond to ISO 13847.
- e. Paragraphs of ISO 13847 that are not revised remain applicable.
- f. If any statement is contradictory to ISO 13847, the requirements of this GIS shall take precedence.



1 Scope

Modify First Sentence of Second Clause to Read

Application is restricted to pipes with a diameter of 20 mm and wall thickness of 3 mm or more, and a specified minimum yield strength not exceeding 827 MPa (equivalent to X120 grade).

Add

The following items are outside the scope of this GIS:

- Corrosion resistant alloy (CRA) clad linepipe.
- Solid CRA linepipe.
- The welding of process piping in terminals, pump or compressor stations, or in refineries.
- Hyperbaric welding.
- Wet welding.
- Overlay welding.
- Steel catenary risers.

Additional requirements for high strain pipelines are given in Annex E.

Add

1.1 HSE for pipeline welding operations

Welding, cutting, NDE, and associated operations shall be undertaken in a safe manner and with due regard to individual health and safety and the minimisation of environmental impact. Welding, cutting, NDE activities, and associated operations shall feature in operational safety planning and in the safety audit schedule.

During welding operations, adequate ventilation shall be provided and the quality of breathing air shall be controlled.

Further information may be provided by government bodies such as the Occupational Safety and Health Administration (OSHA) in the USA and the Health and Safety Executive (HSE) in the UK. Detail of good practice related to safety during welding, cutting, and associated operations can be found in AWS Z49.1.

Radiography operations shall conform to local regulations regarding the dangers of ionizing radiation, e.g. in the UK radiography should be undertaken in accordance with the [Ionising Radiation Regulations 1999 \(SI 1999 No. 3232\)](#) and the Approved Code of Practice and Guidance – Working with Ionising Radiation: Ionising Regulations 1999.

Environmental guidance shall be taken from EN 14717 when undertaking welding and its associated processes.

1.2 General duties of contractor

Be responsible for quality management.

Be responsible for the compliance of sub-contractors with this GIS.

Unless advised otherwise by BP, supply necessary welding and associated equipment including, but not limited to: heating equipment, fluxes, gases, filler metals, mechanical handling, and inspection and testing equipment.

If NDE is conducted by the contractor, appropriate NDE equipment, including consumables and handling equipment, shall be provided.



If NDE services and equipment are provided by sub-contractors, ensure that the equipment provided is suitable, well maintained, and, if necessary, calibrated.

1.3 Pre-production consultation

Pre-production meetings shall be held with BP and any third-party inspection personnel in order to ensure that all parties fully understand the specified requirements. These meetings shall be held before welding procedure qualification testing and before commencement of fabrication.

The BP Welding Engineer shall, as a minimum, be consulted at the following stages:

- a. During bid evaluation to review the basic welding and NDE methods proposed and to advise on acceptability
- b. Before weld procedure qualification for approval of the proposed welding procedures
- c. Before production welding for final WPS approval

1.4 Quality management

The quality management system shall comply with either ISO TS 29001 (API Q1) or ISO 9001.

A Quality Plan for the systematic control of construction, inspection, and testing shall be prepared and implemented. The Quality Plan shall define inspections and tests, the sequence in which they are to be performed during fabrication, and the level of involvement for the contractor's quality control/inspection personnel, third-party inspection personnel, and BP.

The Quality Plan shall be submitted to BP and approval shall be obtained before commencement of fabrication.

1.5 Contractor's personnel

1.5.1 Welding engineer

A competent and suitably qualified Welding Engineer shall be employed. The Welding Engineer shall be responsible for the technical aspects of welding operations including the following:

- a. Selection of welding processes, equipment, and consumables;
- b. Preparation and qualification of welding procedures;
- c. Qualification of welders;
- d. Providing technical oversight of the production welding;
- e. Liaison with BP and the NDE sub-contractors.

The minimum experience and qualification level for the Welding Engineer should be:

- In Europe/Rest of the World: Chartered Engineer (C Eng/ Dipl Ing) holding, as a minimum, a degree in engineering, metallurgy, or materials science and having specialised training in welding technology. The requirements of 5.2.2 of EN 719 should be met as demonstrated by the European Welding Engineer (EWE) or International Welding Engineer (IWE) qualification. Professional Membership of The Welding Institute (UK) is desirable and a minimum of 5 years relevant experience in the pipeline welding or fabrication industry is required.
- In USA: Professional Engineer (PE) holding, as a minimum, a degree in engineering, metallurgy, or materials science and having specialised training in welding technology. Membership of American Welding Society (AWS) is desirable and a minimum of 5 years relevant experience in the pipeline welding or fabrication industry is required.



1.5.2 Welding inspectors

Competent and certificated welding inspection personnel shall be employed in sufficient numbers to ensure that welding related activities are adequately inspected.

Welding Inspectors shall have a sound knowledge of welding processes and their application to pipeline welding, and possess the knowledge and skills to carry out the tasks given in the approved Quality Plan, including those necessary for the following:

- Conduct of routine inspections and checks on site or at suppliers in a systematic manner;
- Production of accurate records and reports.

Welding Inspectors shall, as a minimum, hold current certification to any of the following standards:

- CSWIP (TWI, UK) – Welding Inspector;
- BGAS-CSWIP (TWI, UK) – Welding Inspector;
- PCN (BINDT, UK) – Weld Inspection Level 2;
- AWS QC1 (1996 or later edition) – Certified Welding Inspector (CWI).

Alternative Welding Inspector certification is unacceptable unless approved by BP.

A Senior Welding Inspector shall be employed to coordinate and supervise the work of the welding inspectors. The role of Senior Welding Inspector requires at least 10 years relevant experience and sound knowledge of welding processes and their application. Formal engineering training through apprenticeship and technical college education are required.

Senior Welding Inspectors shall, as a minimum, hold current certification to any of the following standards:

- CSWIP (TWI, UK) – Senior Welding Inspector;
- BGAS-CSWIP (TWI, UK) – Senior Welding Inspector (SWI) or Senior Pipeline Inspector (SPI);
- PCN (BINDT, UK) – Weld Inspection Level 3;
- AWS QC1 (1996 or later edition) – Senior Certified Welding Inspector (SCWI).

2 Normative references

Add

ISO 2504	Radiography of Welds and Viewing Conditions for Films - Utilization of Recommended Patterns of Image Quality Indicators (I.Q.I.).
ISO 3183	Petroleum and Natural Gas Industries – Steel Pipe for Pipeline Transportation Systems.
ISO 3690	Welding and Allied Processes - Determination of Hydrogen Content in Ferritic Steel Arc Weld Metal.
ISO 3834	Quality Requirements for Welding - Fusion Welding of Metallic Materials.
ISO 5580	Non-Destructive Testing - Industrial Radiographic Illuminators - Minimum Requirements.
ISO 9001	Quality Management Systems – Requirements.
ISO 10005	Quality Management – Guidelines for Quality Plans.
ISO 11699-1	Non-Destructive Testing - Industrial Radiographic Films – Part 1: Classification of Film Systems for Industrial Radiography.



ISO 17636	Non-Destructive Testing of Welds – Radiographic Testing of Fusion-Welded Joints.
ISO 17638	Non-Destructive Testing of Welds – Magnetic Particle Testing.
ISO 17640	Non Destructive Testing of Welds – Ultrasonic Testing of Welded Joints.
ISO TS 29001	Petroleum, Petrochemical and Natural Gas Industries Sector-Specific Quality Management Systems Requirements for Product and Service Supply Organizations.
AWS D1.1/D1.1M	Structural Welding Code - Steel.
AWS A4.3	Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding.
AWS A5.32/A5.32M	Specification for Welding Shielding Gases.

Add**American Petroleum Institute (API)**

API Std 1104	Welding of Pipelines and Related Facilities.
API Spec Q1	Specification for Quality Programs for the Petroleum, Petrochemical and Natural Gas Industry.

BP

GIS 43-311	Guidance on Industry Standard for Manufacture of Longitudinal or Helical Seam Submerged Arc Welded Linepipe in Grades up to X80.
GIS 43-312	Guidance on Industry Standard for Manufacture of High Frequency Induction (HFI) or Electric Resistance Welded (ERW) Linepipe in Grades up to X70.
GIS 43-313	Guidance on Industry Standard for Manufacture of Seamless Linepipe in Grades up to X80.
GIS 43-334	Guidance on Industry Standard for Welding of CRA, Internally Clad or Mechanically Lined Pipelines.
GP 18-02	Guidance on Practice for the Storage and Control of Welding Consumables.
GP 43-34	Guidance on Practice for Automatic Ultrasonic Testing of Pipeline Girth Welds.

British Standards Institute (BSI)

BS 4515-1	Specification for Welding of Steel Pipelines on Land and Offshore – Part 1: Carbon and Carbon Manganese Steel Pipelines.
BS 7448-1	Fracture mechanics toughness tests – Part 1: Method for determination of K_{Ic} , critical CTOD and critical J values of metallic materials. Part 2: Method for determination of K_{Ic} , critical CTOD and critical J values of welds in metallic materials.
BS 7910	Guide on methods for assessing the acceptability of flaws in metallic structures.

Canadian Standards Association (CSA)

CSA Z662	Oil and Gas Pipeline Systems.
----------	-------------------------------



European Standards (EN)

EN 439	Welding Consumables – Shielding Gases for Arc Welding and Cutting.
EN 719	Welding Coordination – Tasks and Responsibilities.
EN 1011-2	Welding Recommendations for Welding of Metallic Materials - Part 2: Arc Welding of Ferritic Steels.
EN 10204	Metallic Products - Types of Inspection Documents.
EN 10208-1	Steel Pipes for Pipelines for Combustible Fluids. Technical delivery Conditions. Pipes of Requirement Class A.
EN 10208-2	Steel pipes for Pipelines for Combustible Fluids. Technical Delivery Conditions. Pipes of Requirement Class B.
EN 14717	Welding and Allied Processes – Environmental Check List.

UK regulations

SI 1999 No. 3232	Ionising Radiation Regulations 1999 Statutory Instrument 1999 No. 3232
	Work with ionising radiation - Ionising Radiations Regulations 1999 Approved code of practice and guidance (UK HSE)

3 Terms and definitions**3.6 Company**Modify to Read

BP or its authorised representative

3.7 ContractorModify to Read

A contractor responsible to BP for construction (including welding) of the pipeline

Add**3.20 BP**

BP plc, an associate or subsidiary of BP, or other organisation as defined in the Conditions of Contract on a project.

3.21 Quality plan

Document specifying which procedures and associated resources shall be applied by whom and when to a specific project, product, process or contract.

Note: Guidance for the production of Quality Plans is given in ISO 10005.

3.22 Welding consumable

Wire, electrode, or flux

3.23 Lot

A single heat of filler wire, a single blend of flux, or for covered electrodes or cored wire, the combination of a single heat of cored wire with a single dry blend of flux cover or core



4 Symbols and abbreviations

Add

ACCP	ASNT Central Certification Program
ASNT	American Society for Non-Destructive Testing
AUE	Automatic Ultrasonic Examination
BAM	Federal Institute for Materials Research and Testing (Germany)
BGAS-CSWIP	British Gas Approval Scheme – Certification Scheme for Welding and Inspection Personnel
BINDE	British Institute of Non-Destructive Testing
CEIIW	Carbon Equivalent (IIW formula)
CEng	Chartered Engineer (UK)
CSWIP	Certification Scheme For Welding And Inspection Personnel
Dipl Ing	Diploma Ingenieur (Europe)
DWE	Double Wall Exposure
ID	Internal diameter
IIW	International Institute of Welding
MDT	Minimum Design Temperature
MUE	Manual Ultrasonic Examination
NIST	National Institute of Standards and Technology (USA)
PCN	Personnel Certification in Non-Destructive Testing
PGMAW	Pulsed Gas Metal Arc Welding
PQR	Procedure Qualification Record
pWPS	preliminary Welding Procedure Specification
RMS	Root Mean Squared
RE	Radiographic examination
SWE	Single Wall Exposure
SWV	Single Wall Viewing
TWI	The Welding Institute (UK)
WPQT	Welding Procedure Qualification Test

5 Welding procedure specification testing and approval

5.1 General

Add

Mechanised and automatic welding processes are preferred and should be used whenever possible for pipeline girth welding. Main line welding should be by mechanised or automatic gas metal arc welding (GMAW) which may include single, multi-torch, or tandem-arc variants of the process and the use of cored wires. If the use of mechanised or automated GMAW processes is impracticable, alternative processes may be used. In such instances, welding may be performed by shielded metal arc welding (SMAW), manual or automated gas tungsten arc



welding (GTAW), semi-automatic GMAW processes using solid or cored wires, or a combination of these processes.

For double or multiple jointing, girth welds should be made using submerged arc welding (SAW) if possible. If SAW cannot be used then the alternative mainline processes listed above may be utilised either alone or in combination with SAW.

The welding of pipelines by the oxy-acetylene process or by any other process not covered by ISO 13847 is not permitted.

BP will not supply approved WPSs to the Contractor for new construction.

It shall be anticipated that weld procedure qualification is required for each new Project.

During weld procedure qualification, relevant procedure data, irrespective of whether the item is a listed essential variable, shall be captured and recorded. Sufficient information shall be recorded to allow full replication of the procedure qualification welds. A record of the data shall be kept for the purpose of aiding production and to assist with the diagnosis of problems, but need not be formally entered onto the PQR, e.g. GMAW machine 'slope-in' settings.

The methods of measuring the welding parameters and the records to be kept shall be agreed with the BP Welding Engineer.

Following qualification, the pWPS shall be revised to reflect the parameters recorded during qualification. The revised WPS values for current, voltage, and travel speed for each pass shall be either:

- (i) Within the range recorded during WPQT. Transient or anomalous values shall not be used to establish the range, or
- (ii) The mean value $\pm 10\%$

The arc energy shall be calculated using the recorded values of current, voltage, and travel speed without the addition of a percentage.

The final WPS shall state parameters for each pass. However, if fill passes (i.e. passes other than root, hot pass, and cap) have similar values, the parameters may be combined on the WPS.

If a welding consumable or group of consumables is qualified to weld several different components or pipe sizes, every effort should be made to ensure that the parameters specified on the individual WPSs are common across the group of WPSs.

A WPS written with more than one supporting Procedure Qualification Record (PQR) shall not permit optional processes, but shall specify the process for each pass.

Welding procedures, including repair procedures, shall be qualified by visual examination, NDE, and mechanical testing as specified herein.

The witnessing of mechanical tests shall include the positioning of the notches for Charpy and CTOD tests.

The final WPS shall be approved by BP before being used for production welding.

Modify Fifth Clause to Read

Test pieces shall be welded using project-specific materials.

5.2 Welding procedure specification

Modify First Sentence to Read

The WPS shall incorporate the technical contents specified in ISO 15609-1, clause 5.6 and the following:

Add to List in First Clause

- Material manufacturer;



- A sketch of the joint design/configuration and dimensions;
- Weld run sequence;
- Voltage range;
- Travel speed range;
- Arc energy.

For processes using wire feeding:

- Wire feed speed (and pulse rate for pulsed wire procedures);
- Contact tip to work distance;
- Torch angle (for mechanized processes);
- Power supply manufacturer, type and model number;
- Software version (if applicable);
- Hot wire diameter, feed speed, current, and voltage (if applicable).

For multi-wire processes the following parameters shall also be specified on the WPS when applicable:

- Number and size of wires;
- Electrode spacing;
- Individual wire angles relative to pipe surface;
- Head spacing for multi-head welding;
- Offset from top dead centre for 1G rotated welding;
- Direction of rotation for 1G rotated welding;
- Shroud diameter for tandem GMAW;

For welding processes involving multiple heads, the BP Welding Engineer may require further parameters to be shown on the WPS.

Modify Fifth Clause to Read

Previously approved weld procedures will not be accepted by BP for new pipeline construction Projects (see clause 5.8).

Add

The relevant BP approved WPSs shall be displayed at each work location and shall be readily available to each welder.

For applications involving significant plastic strain refer to Annex E.

Add

5.2.1 Joint design

The use of permanent or consumable backing rings is not permitted. An exception is the outer pipe welds in a pipe-in-pipe system. Non-consumable temporary backing as an integral permanent feature on an internal clamp will be permitted subject to satisfactory demonstration of the process.

5.2.2 Preheat temperature

As a minimum, the preheat temperature shall be selected to ensure that:

- the pipe is dry before welding;

