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Automated Ultrasonic Testing of Pipeline Girth Welds

Group Instruction for Supply

**BP GROUP
ENGINEERING TECHNICAL PRACTICES**

Foreword

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Introduction

This document provides guidance on the issues to be addressed when automated ultrasonic testing is being considered for inspecting the girth welds of new pipelines in construction. The inspection is intended to show that the welds meet the design acceptance criteria in all respects before the pipeline is put into service.

The technical integrity of all aspects of design, construction, and operation of pipelines is of the highest importance to BP and compliance with BP HSE policy is paramount. BP's philosophy regarding the construction of pipelines for the transmission and distribution of hydrocarbon, chemical, or other flammable fluids is that such pipelines should be welded, whenever possible, by mechanised or automatic welding methods, using welding procedures and materials that have been rigorously qualified by test to produce welds that are fully capable of meeting all aspects of the design premise of the pipeline. In association with this it is recognised that automated ultrasonic testing offers the potential for a significant reduction in the exposure of personnel to ionising radiation, as well as a reduction in the use of the chemicals associated with the processing of radiographic films. These HSE aspects must be carefully considered when deciding what non-destructive testing regime is to be used when planning new pipeline construction projects.

Construction and testing shall be carried out by competent contractors using a well trained, qualified, and experienced workforce, using reliable, modern, and well maintained technology and the work must comply with safe and environmentally sound working practices at all times. In particular non-destructive testing and inspection personnel shall be properly trained and qualified to recognised industry standards by examination and/or by individual test and be widely experienced in operations with the equipment.

Automated ultrasonic testing is a relatively new technology. However, the content of this document shall not be construed to limit improvements where new equipment, methods, or knowledge allows such improvements. Nevertheless, the following shall be considered as the minimum requirement and shall be used as the bench mark against which any new developments must be judged.



1. Scope

This GIS refers to the use of Automated Ultrasonic Testing (AUT) applied to the inspection of the girth welds of new onshore and offshore BP pipelines during their construction.

Depending on the design and construction code of practice BP pipelines are welded in accordance with one of the following: GIS 43-331, GIS 43-332, or GIS 43-333. Corrosion resistant alloy or internally clad pipelines are welded in accordance with GIS 43-334. General guidance on the welding of pipelines is provided by GP 43-33.

AUT has been used widely for projects involving seam welded pipes which are made with close wall thickness tolerances. The use of seamless pipes is somewhat more complicated due to the wider tolerance on wall thickness generally applicable to that product. Some attention to these complications is warranted by the AUT contractor in defining their application of the technology in such a case. Similarly, any concessions on pipe supply to the normally defined standards must be declared to the AUT contractor since these may have implications for the testing.

This scope is specific to pipelines and should not be applied to other components such as steel catenary risers, where additional requirements may apply and a specific procedure with extensions to the requirements defined here may be necessary.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical practice are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

American Petroleum Industry (API)

API Std 1104 Welding of Pipelines and Related Facilities.

American Society for Testing and Materials (ASTM)

ASTM E1961 Standard Practice for Mechanised Ultrasonic Examination of Girth welds Using Zonal Discrimination with Focussed Search Units.

BP

GIS 43-331 Pipeline Welding (API 1104).

British Standards Institute (BSI)

BS EN 1330 Non-destructive testing – Terminology –
Part 1- List of general terms.
Part 2- Common Terms for NDT methods.

BS EN 12668 Characterization and verification of ultrasonic equipment
Part 1: Instruments.
Part 2: Probes.
Part 3: Combined Equipment.

BS 7706 Guide to calibration and setting-up of the ultrasonic time of flight diffraction (TOFD) technique for the detection, location and sizing of flaws.



BS 7910 Guide to methods for assessing the acceptability of flaws in metallic structures.

Det Norsk Veritas (DNV)

DNV OS-F 101 Offshore Standard, 'Submarine Pipeline Systems', Appendix E (AUT), with amendments and corrections as at Jan 2003.

International Standards Organization (ISO)

ISO/DIS 6520-1 (also BS EN 26520) Welding and allied processes - Classification of geometric imperfections in metallic materials - Part 1: Fusion welding.
 ISO/TS 18173 Non-destructive testing - General terms and definitions.
 ISO 12710 Non-destructive testing - Ultrasonic inspection - Evaluating electronic characteristics of ultrasonic test instruments.
 ISO 17637 Non-destructive testing of welds – Visual testing of fusion-welded joints.

3. Terms and definitions

For the purposes of this GIS, the following terms and definitions apply:

Non-Destructive Testing (NDT) terminology will generally be as defined in BS EN 1330, ISO/TS 18173 or API 1104.

4. Symbols and abbreviations

For the purpose of this GIS, the following symbols and abbreviations apply:

NDT Non Destructive Testing - similarly called nondestructive evaluation or inspection.
 AUT Automated Ultrasonic Testing
 ECA Engineering Critical Assessment
 PoD Probability of Detection – the statistical probability of detecting a defined size of flaw by the NDT system. The reliability of achieving this probability can additionally be defined.
 QA/QC Quality Assurance and Quality Control
 ToFD Time of Flight Diffraction.
 EDM Electro Discharge Machining
 FSH Full Screen Height – signal level on the ultrasonic display.

5. System requirements

5.1. General

- a. The AUT system shall detect all flaws in the pipeline girth welds which might compromise its structural strength and its physical integrity as a chemical barrier.



- b. The system should be accepted by qualification to a rigorous specification (clause 8.1) or alternatively by a verification procedure, during which a previous qualification is verified as being applicable for a new application, (clause 8.2).

'Verification' is not the 'validation' cited in other documents, but an option intended to allow the maximum use of pre-existing knowledge to shorten project timescales and preparation costs.

- c. If the AUT system is to be used for inspecting repaired sections of weld, this shall be demonstrated to be effective as part of either the qualification and/or the verification process.

5.2. Agreed items

Any AUT system and examination procedure proposed for use shall be approved by BP before any production weld examination is carried out. A range of items shall be agreed with BP. These shall include:

1. Any relaxation to the requirement to detect flaws that are oriented transverse to the direction of the weld.
2. The system performance requirement, ECA based or otherwise; the types and minimum sizes of flaws that are required to be detected shall be defined.
3. The need for a full qualification or the acceptance of verification.
4. The requirements of either qualification or verification. This includes the associated probability of detection of the minimum sized flaws, with a defined target for the reliability (e.g. DNV OS-F 101 defines 90% and 95 % respectively).
Guidance on these levels is given in clause 8.1.b through k). It is important to be realistic about the need for large numbers of tests, as the costs are high, in terms of both time and money, to prepare the flaws and to analyse them. Moreover the activity often occurs just before the production starts and so is likely to be a critical path activity with the associated pressure on time that this often involves.
5. The design of the calibration block(s) shall be approved by BP before manufacture.
6. The frequency of calibration scans, following the first 20 welds.
7. The maximum loss of signal (its diminution and extent along the weld) due to reduced coupling, which can be tolerated. It is recommended that this does not exceed 6 dB.
8. Details of the means of sectioning the qualification flaws to define the actual dimensions of the flaws.
9. The parameters of the AUT system used for its qualification and the qualification programme. These shall be agreed as valid and appropriate for the production and qualification weld testing, as defined in clause 6, and shall additionally include:
 - a) The method used to determine the height of flaws, with sufficient detail to allow BP inspectors to replicate any assessment.
 - b) Details of the method used to determine the length of flaws, including the treatment of 'intermittent' flaws.
 - c) The treatment of flaws near the intersection of the seam and girth welds.
 - d) Flaw interaction rules, e.g. those in API 1104 or BS 7910, or project-specific rules.
 - e) The number of qualification test repeats over the same test welds with the system and guide band removed and replaced between scans.

