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To Study Non-Destructive Testing

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Abstract: The International Atomic Energy Agency (IAEA) is promoting the industrial applications of radiation technology, which include non-destructive testing (NDT) under its various programmes such as individual country technical co-operation (TC) projects, regional projects and co-ordinated research projects (CRPs). The NDT technology is essentially needed for the improvement of the quality of industrial products, equipment and plants all over the world, especially in the developing Member States. An important feature of the NDT programme, notably in the East Asia and Pacific (RCA) region, has been the establishment in each of the Member States of a system for training and certification of NDT personnel based on the International Organization for Standardization standard ISO/FDIS 9712-1999, "Non- destructive Testing: Qualification and Certification of Personnel". The main focus is the creation of a core group of personnel who are trained and qualified to establish the training and certification process in their respective countries. An important requirement for such a process is to have appropriate training materials that include, among others, NDT test specimens having standard known dimensions and in-laid artificial defects simulating the real defects that can or may occur in industrial components

I. INTRODUCTION

NDT test specimens constitute a very important part of training and certification of NDT personnel and are important for carrying out actual inspection and testing, and for achieving international harmonization of NDT practices. Naturally, therefore, there is a need to pay greater attention to this subject. A number of seminars and workshops on NDT test specimens have been organized for this purpose during the past years under various RCA regional projects while a number of additional activities, such as regional training courses and seminars, are planned for the future. It has always been felt that there is a strong need to have a proper guidebook addressing various issues and problems related to the fabrication of NDT test specimens. Such a book would be useful for conducting training courses on this theme in the future, thereby spreading the know-how for the fabrication of NDT test specimens and establishing and strengthening education, training and certification process in many Member States on a sustainable basis.

II. LITERATURE REVIEW

IAEA organized an advisory group of experts to develop a Guidebook for the Fabrication of NDT Test Specimens. The experts consulted the ISO/FDIS 9712-1999 requirements for training and certification of personnel and the suitability of various types of NDT test specimens that are needed to meet such requirements. A set of appropriate NDT test specimens, as well as the methodology and procedures for their fabrication, were established. These are presented in this guidebook. The experts recommended that these procedures be taken only as a guide, and can be expanded and perfected by the national certifying bodies of the Member States. It was felt that there is the need to compile similar procedures for the remaining types of test specimens but this could not be addressed due to limited time. The IAEA wishes to express its appreciation to the governments and organizations who provided financial, technical and administrative support, and to the experts who contributed to the production of this Guidebook. The IAEA officer responsible for this publication was A.A. Khan of the Division of Physical and Chemical Science.

EDITORIAL NOTE

In preparing this publication for press, staff of the IAEA made up the pages from the original manuscript(s). The views expressed do not necessarily reflect those of the IAEA, the governments of the nominating Member States or the nominating organizations. Throughout the text names of Member States are retained, as they were when the text was compiled. The use of particular designations of countries or territories does not imply any judgement by the publisher, the IAEA, as to the legal status of such countries or territories, of their authorities and institutions or of the delimitation of their boundaries. The mention of names of specific companies or products (whether or not indicated as registered) does not imply any intention to infringe proprietary rights, nor should it be construed as an endorsement or recommendation on the part of the IAEA.

TABLE II. FLUX CLASSIFICATION OF AWS ELECTRODES FOR SUBMERGED ARC WELDING AWS flux classification Tensile strength ksi MPa Yield strength ksi MPa Elongation in 5 mm % F6X-EXXX 62 to 80 430-

550 50 345 22 F7X-EXXX 70 to 95 485 60 415 22 F8X-EXX-X 80 to 1000 550-690 68 470 20 F9X-EXXX-X 90 to 110 620-760 78 540 17 F10X-EXXX-X 100-120 690-825 88 605 16 F11X-EXXX-X 110 to 130 760-895 98 675 15 F12X-EXXX-X 120 to 140 825-965 108 755 14   2.3.4.5.

Disadvantages (a) Limited welding positions (flat and horizontal) (b) Weld puddle not visible (c) Portability restricted.

2.3.5. Gas tungsten arc welding GTAW is an arc welding process that fuses together the parts to be welded by heating them with an arc between a non-consumable tungsten electrode and the work. Filler metal may or may not be used with the process. Shielding is obtained from an inert gas or inert gas mixture. Slang names for the process are TIG welding, Argon-arc welding and Tungsten arc welding. The GTAW process can be used to weld commercial metals, including steel, stainless steel, aluminium, magnesium, copper, nickel, titanium, and others. The process can be used on a wide range of metal thicknesses. However, due to the relatively low deposition rates associated with the process, thinner materials are most often welded. It is also popular for depositing the root and hot passes on pipe and tubing. This process can be used in all welding positions to produce quality welds on almost all metals used in industry. Since the shielding gas is used, the weld is clearly visible to the welder, no spatter is produced, post weld cleaning is reduced, and slag is not trapped in the weld. The GTAW process is normally applied using the manual method. The welder controls the torch with one hand and feeds the filler metal with the other. The semi-automatic method is also sometimes used in some applications. The filler metal is fed into the weld puddle by a wire feeder similar to that used in GMAW. The machine and automatic methods are sometimes used in New Zealand. With these systems, the welding operator monitors the welding operation and little welding skill is required. In the manual method, a high degree of welding skill is required.

2.3.5.1. Equipment The major components required for gas tungsten welding are:

welding machine or power source GTAW torch, including the tungsten electrode shielding gas and controls filler rod, when required.   2.3.5.2. Shielding gas A shielding gas prevents the weld puddle and tungsten electrode to oxidize during welding. The two most commonly used shielding gases with the GTAW process are argon and helium. The most common shielding gas is argon since it is less expensive. Argon produces a lower arc voltage than helium. This makes it especially useful for thin gauge materials where lower arc heat is necessary to prevent excessive penetration. Helium may be used on heavy welds where high heat input is required to produce deeper penetration. Argon is heavier than air, causing it to remain in the arc area longer when the puddle is located below the gas nozzle. 2.3.5.3. Tungsten electrodes.

The electrodes used with the GTAW process are made of tungsten alloys (Table III). Tungsten has the highest melting point of any metal, which is around 3400oC and is considered non-consumable. When properly used, the electrode does not touch the molten weld puddle. If the tungsten electrode accidentally touches the weld puddle it becomes contaminated and must be cleaned immediately. If it is not cleaned, an erratic arc will result. The filler metal for GTAW is a solid wire. The filler metal size is determined by the diameter. Filler metals are available in a wide range of sizes in an approximate range from 1.6, 2.4, 3.2 mm. Filler metals are manufactured in straight cut lengths for manual welding and continuous spools for semi-automatic and automatic welding. Filler metals for GTAW are classified using the same system for GMAW electrodes, such as ER70S-6. The only difference is that gas metal arc wires carry electric current and are considered electrodes (E), while gas tungsten welding wires normally do not carry current and are considered filler rods (R).

TABLE III. CLASSIFICATION OF AWS ELECTRODES FOR TUNGSTEN ARC WELDING AWS classification Tungsten % (min.) (by difference) Thoria % Zirconia % Total of other elements (max.) % Colour code EWP 99.5 - - 0.5 Green EWTh-1 98.5 0.8-1.2 - 0.5 Yellow EWTh-2 97.5 1.7-2.2 - 0.5 Red EWTh-3 98.95 0.35-0.55 - 0.5 Blue EWZr 99.2 - 0.15-0.40 0.5 Brown 0.05.

The purpose of ANOVA is to investigate which welding process parameters significantly affect the quality characteristics. This is accomplished by separating the total variability of the S/N Ratios, which is measured by the sum of squared deviations from the total mean of the S/N ratio, into contributions by each welding process parameter and the error. The percentage contribution by each of the welding process parameters in the total sum of the squared deviations can be used to evaluate the importance of the process parameter change on the quality characteristic.

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