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EFFECTIVE INSPECTION SKILLS FOR INFRASTRUCTURAL DEVELOPMENT

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ABSTRACT

Inspection is a quality control method that involves Destructive (DT) and Non-destructive testing (NDT). It is an engineering discipline which has become enormously important during the last five decades due to the need to impart quality and as such materials, parts, components and structures need to be tested during all stages of manufacture. While the destructive methods are use to characterize materials, the Non-destructive methods are used to ensure that the fabrication process does not violate their integrity or functionality. A wide spectrum of industries and the academia need to embrace particularly the non destructive method of testing in ensuring quality and for diagnoses in ensuring effective maintenance practice if catastrophic failures are to be avoided. Failure of engineering infrastructure and concomitant effects are direct prices that our dear nation pays as a result of lack of sufficient inspection skills, non functional NDT policy and infrastructure. With the Nigerian Content Development programme, there is now some awareness in this area but the skill 'building capacity' posture is still very much inadequate for a developing nation like Nigeria. The NDT methods are numerous and skills development in them will enhance the much needed technological development in all facets of the infrastructural development needs of the Nation, This is an area that will create employment and empowerment for the teaming unemployed youth if given the much needed attention.

INTRODUCTION

Non destructive testing (NDT) is the use of physical methods which will test materials, components and assemblies for flaws in their structure without damaging their future usefulness. It is concerned with revealing flaws in the structure of a product. It, however, cannot predict where flaws will develop due to the design.

All NDT methods have the following common characteristic:

i. The application of a testing medium on the product to be tested.
ii. The changes in the testing medium to the defects in the structure of the product.
iii. A means by which it detect these changes.
iv. Interpretation of these changes to obtain information about the flaws in the structure of the product.

IMPORTANCE OF NDT

NDT plays an important role in the quality control of a product. Desired quality can only be imparted through effective monitoring of all production variables. It is used during all stages of manufacturing of the product. It is used to monitor the quality of the:

i. Raw materials which are used in the fabrication of the product.
ii. Fabrication processes which are used to manufacture the product.
iii. Finished product before it is put into service.

Use of NDT during all stages of manufacture results in the following benefits:

i. It increases the safety and reliability of the product during operation.
ii. It decreases the cost of the product by reducing scrap and conserving materials, labour and energy.
iii. It enhances the reputation of the manufacturer as producer of quality goods

All of the above factors boost the sales of the product which brings more economical benefits to the manufacturer.

NDT is also used widely for routine or periodic determination of quality of plants and structures during service. This not only increases the safety of operation but also eliminates any forced shut down of the plant.

Most structures have one form of welding defects or another and Welded structures are subjected to more types of tests than any other metal produced although they can be tested in the same manner as any other form of metal. It is important to know that a weld will meet the requirements of the company and /or codes or standards only if the integrity is ensured. To ensure the quality, reliability, and strength of a weldment demands, an active inspection program. The extent to which a welder and the welded product are subject to testing and inspection depends upon the intended service of the product.

Items that are to be used in light routine-type service such as ornamental iron, fence posts, gates, and so forth are not inspected as critically as products in critical use such as nuclear reactor container vessel, oil refinery, high-pressure vessels, aircraft frames, bridges and so on. The type of inspection required is then very much dependent on the type of service the welded part will be subjected to.

TYPES OF NDT METHODS

The methods of NDT range from the simple to the complicated. Visual inspection is the simplest of all. Surface imperfections invisible to the eye may be revealed by penetrant or magnetic methods. If really serious surface defects are found, there is often no need to proceed to more complicated examinations of the interior by ultrasonic or radiography. NDT methods

may be divided into groups for the purpose of this presentation; conventional and non-conventional.

The first group may belong to the methods which are commonly used and include Visual or Optical inspection, Dye Penetrant Testing, Magnetic Particle Testing, Eddy Current Testing, Radiographic Testing and Ultrasonic Testing. The second groups of NDT methods are those used only for specialized applications and consequently are limited in use. Some of these methods include Neutron Radiography, Acoustic Emission, Thermal and Infrared Testing, Straining Sensing, Microwave Techniques, Leak Testing, Holography e.t.c. It must also be remembered that no one of these methods can give us solutions to all the possible problems, i.e. they are not optional alternatives but rather complementary to each other.

COMPARISON OF DIFFERENT NDT METHODS

Frequently it may be necessary to use one method of NDT to confirm the findings of another. Therefore, various methods must be considered complementary and not competitive or as optional alternatives. Each method has its particular merits and limitations and these must be taken into consideration when any testing program is planned. Table 1 gives a summary of the most frequently used NDT methods.

NDT METHOD SUMMARY

No single NDT method will work for all flaw detection or measurement applications. Each of the methods has advantages and disadvantages when compared to other methods. The table below summarizes the scientific principles; common uses and the advantages and disadvantages for some of the most often used NDT methods (www.ndt.ed.org)

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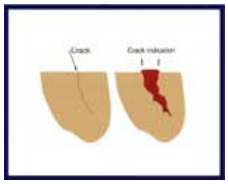
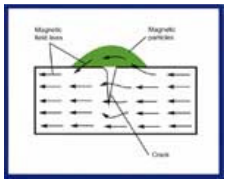
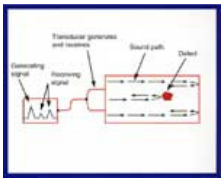
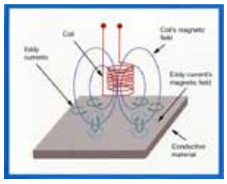
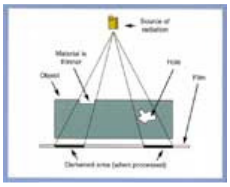
Penetrant Testing	Magnetic Particle Testing	Ultrasonic Testing	Eddy Current Testing	Radiographic Testing
				
Scientific Principles				
Penetrant solution is applied to the surface of a pre-cleaned component. The liquid is pulled into surface-breaking defects by capillary action. Excess penetrant material is carefully cleaned from the surface. A developer is applied to pull the trapped penetrant back to the surface where it is spread out and forms an indication. The indication is much easier to see than the actual defect.	A magnetic field is established in a component made from ferromagnetic material. The magnetic lines of force travel through the material and exit and reenter the material at the poles. Defects such as crack or voids cannot support as much flux, and force some of the flux outside of the part. Magnetic particles distributed over the component will be attracted to areas of flux leakage and produce a visible indication.	High frequency sound waves are sent into a material by use of a transducer. The sound waves travel through the material and are received by the same transducer or a second transducer. The amount of energy transmitted or received and the time the energy is received are analyzed to determine the presence of flaws. Changes in material thickness and changes in material properties can also be measured.	Alternating electrical current is passed through a coil producing a magnetic field. When the coil is placed near a conductive material, the changing magnetic field induces current flow in the material. These currents travel in closed loops and are called eddy currents. Eddy currents produce their own magnetic field that can be measured and used to find flaws and characterize conductivity, permeability, and dimensional features.	X-rays are used to produce images of objects using film or other detector that is sensitive to radiation. The test object is placed between the radiation source and detector. The thickness and the density of the material that X-rays must penetrate affect the amount of radiation reaching the detector. This variation in radiation produces an image on the detector that often shows internal features of the test object.
Main Uses				
Used to locate cracks, porosity, and other defects that break the surface of a material and have enough volume to trap and hold the penetrant material. Liquid penetrant testing is used to inspect large areas very efficiently and will work on most nonporous materials.	Used to inspect ferromagnetic materials (those that can be magnetized) for defects that result in a transition in the magnetic permeability of a material. Magnetic particle inspection can detect surface and near surface defects.	Used to locate surface and subsurface defects in many materials including metals, plastics, and wood. Ultrasonic inspection is also used to measure the thickness of materials and otherwise characterize properties of material based on sound velocity and attenuation measurements.	Used to detect surface and near-surface flaws in conductive materials, such as the metals. Eddy current inspection is also used to sort materials based on electrical conductivity and magnetic permeability, and measures the thickness of thin sheets of metal and nonconductive coatings such as paint.	Used to inspect almost any material for surface and subsurface defects. X-rays can also be used to locates and measures internal features, confirm the location of hidden parts in an assembly, and to measure thickness of materials.

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Main Advantages

Large surface areas or large volumes of parts/materials can be inspected rapidly and at low cost. Parts with complex geometry are routinely inspected. Indications are produced directly on surface of the part providing a visual image of the discontinuity. Equipment investment is minimal.	Large surface areas of complex parts can be inspected rapidly. Can detect surface and subsurface flaws. Surface preparation is less critical than it is in penetrant inspection. Magnetic particle indications are produced directly on the surface of the part and form an image of the discontinuity. Equipment costs are relatively low.	Depth of penetration for flaw detection or measurement is superior to other methods. Only single sided access is required. Provides distance information. Minimum part preparation is required. Method can be used for much more than just flaw detection.	Detects surface and near surface defects. Test probe does not need to contact the part. Method can be used for more than flaw detection. Minimum part preparation is required.	Can be used to inspect virtually all materials. Detects surface and subsurface defects. Ability to inspect complex shapes and multi-layered structures without disassembly. Minimum part preparation is required.

Disadvantages

Detects only surface breaking defects. Surface preparation is critical as contaminants can mask defects. Requires a relatively smooth and nonporous surface. Post cleaning is necessary to remove chemicals. Requires multiple operations under controlled conditions. Chemical handling precautions are necessary (toxicity, fire, waste).	Only ferromagnetic materials can be inspected. Proper alignment of magnetic field and defect is critical. Large currents are needed for very large parts. Requires relatively smooth surface. Paint or other nonmagnetic coverings adversely affect sensitivity. Demagnetization and post cleaning is usually necessary.	Surface must be accessible to probe and couplant. Skill and training required is more extensive than other technique. Surface finish and roughness can interfere with inspection. Thin parts may be difficult to inspect. Linear defects oriented parallel to the sound beam can go undetected. Reference standards are often needed.	Only conductive materials can be inspected. Ferromagnetic materials require special treatment to address magnetic permeability. Depth of penetration is limited. Flaws that lie parallel to the inspection probe coil winding direction can go undetected. Skill and training required is more extensive than other techniques. Surface finish and roughness may interfere. Reference standards are needed for setup.	Extensive operator training and skill required. Access to both sides of the structure is usually required. Orientation of the radiation beam to non-volumetric defects is critical. Field inspection of thick section can be time consuming. Relatively expensive equipment investment is required. Possible radiation hazard for personnel.

THE NIGERIAN LOCAL CONTENT DEVELOPMENT

A lot of focus and obviously a lot of effort are currently geared towards getting Nigerians to be involved in the oil and gas activities with the Nigerian local content drive and to optimize its impact on the general economy of the nation in the face of inefficiency in our local skills.

Nigerian content is defined by the Nigerian Content Development Act (2010) as “the quantum of composite value added or created in the Nigerian economy by a systematic development of capacity and capabilities through deliberate utilization of Nigerian human, material resources and services in the oil and gas industry”. The “Nigerian Content” vision is to transform the oil

and gas industry into the economic engine for job creation and growth. Such goods and services must be within acceptable quality, health, safety and environmental standards in order to stimulate the development of indigenous capabilities. This measure is aimed to:

• Develop in-country capacity and indigenous capabilities.
• Ensure greater proportion of the work is done in Nigeria with active participation of all sectors
• Position Nigeria as hub for service delivery within the West African sub region and beyond
• Take Nigeria on path to industrialization – producer Nation

This paper therefore seeks to address the issue of competency in technogical skills in general but with particular interest in the welding inspection skills given the current mandate on local participation especially the recent increase in local oil and gas industry activities in the country.

THE WELDING INSPECTOR

A welding inspector is a technical expert who examines welded metal components in buildings, infrastructures, and manufactured goods to ensure the components are securely bonded. Inspector's duties include the inspection of welds on structures and goods both finished and in process, welds produced by machines and humans and welds made at construction sites and in machine shops. These duties can only be done effectively by a certified welding inspector. Certified welding inspectors ensure that welders adhere to the strict guidelines and safety rules that keep both the welder and the end user/product safe. Welding Inspectors are therefore employed to assist with the quality control (QC) activities that are necessary to ensure that welded items will meet specified requirements and be fit for their application.

Education Requirements

For employers to have confidence in welding Inspectors work, they need to have the ability to understand/ interpret the various Quality Control Procedures and have sound knowledge of welding technology. Welding Inspector training and education is like any other technological training. Educational pathways for certified welding inspectors include high school welding classes and certificate programs at vocational schools, trade schools, technical schools or community colleges.

Candidates can even earn associates or bachelor's degrees in welding technology before becoming inspectors. Common course topics include introductory welding, gas welding, pipe welding, arc welding, blueprint reading, mechanical drawing, physics and mathematics.

Theoretical Course Content will include

- Welding processes and consumables
- Welding defects

- Materials technology
- Visual inspection
- Distortion and control of dimensions
- Welder qualification
- Inspection and quality assurance of welded fabrications
- Health and safety

PRACTICAL CONTENT Include:

- To Perform visual inspections on welded samples and complete inspection reports
- Accept or reject welds to a construction code or specification
- Qualify procedures and welder performance to a construction code

Certification can also be done in level:

Level Inspector

Level I Inspector is an individual that is trained in a specific NDT method, has the skills and knowledge to perform specific tests, specific calibrations and, with prior written approval of the appropriate Level III inspector, specific interpretations and evaluations for acceptance or rejection, as well as document the results in accordance with specific procedures. The individual shall be knowledgeable in any necessary preparation of parts before or after inspection. The individual shall be able to follow procedures in the techniques for which he is certified.

Level II Inspector

Level II Inspector shall have the skills and knowledge to set up and calibrate equipment, conduct tests, and to interpret, evaluate and document results in accordance with procedures approved by the appropriate Level III inspector. The individual shall be thoroughly familiar with the scope and limitations of the method in which he is certified and capable of directing the work of trainees and Level I personnel. The individual will be able to organize and document NDI or NDT results. The individual shall be able to follow procedures in the techniques for which certified and shall receive the necessary guidance or supervision from a Level III inspector. The individual shall be familiar with the codes, standards, and other contractual documents that control the method as utilized by the employer.

Level III Inspector

Level III Inspector will have the skills and knowledge to interpret codes, standards, and other contractual documents that control the method as utilized by the employer; select the method and technique for a specific inspection; and prepare and verify the adequacy of procedures.

Only individuals certified to Level III shall have the authority to approve procedures for technical adequacy in the method to which they are certified. The individual shall also have general knowledge of all other NDI or NDT methods utilized by the employer. The individual shall be capable of conducting or directing the training and examination of personnel in the method certified. The individual shall not conduct NDI or NDT for the acceptance of parts unless the demonstration of proficiency in this capability was included in the practical examination upon which, in part, the certification is based.

SKILLED WELDING INSPECTORS AND CERTIFICATION IN NIGERIA

Personnel Certified as welding inspector in Nigeria are still very few to be able to key into the local content policy fully. Level III inspectors are rear to come by and any one with this level of certification will not look for employment but will decide what jobs he wants to perform.

Some of the NDT methods require very handy equipment that can be carried to site jobs by the user to perform jobs and taken back home. They are also affordable and can be owned by single individuals for private practice

To meet the goal of the Nigerian content development, more skill development is required in this all important area.

Some companies have collaborations with foreign bodies such as the American welding Society- AWS America, The Welding institute-TWI, UK to train and certify Welding Inspectors

The Petroleum Training Institute, Effurun also host a National NDT centre and can carry out training in the common methods up to level III.

CONCLUSION

Nigeria, at present, needs a vibrant oil and gas industry that will be anchored on sound, home-grown, human and technological initiatives, which can spur the revitalization of the oil and gas industry in particular and the fabrication industry in general. The Nation's infrastructural need is still a high riser and also is the skill development needs. A lot of jobs can be created in the

Testing and Inspection area and at the same time ensuring that the fabrication industry can produce structures that will be highly reliable.

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