Comparison of Non-Destructive and Destructive Examinations in Today´s Inspection Practices

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Abstract

This paper attempts to highlight the problems being experienced when carrying out inspection either with the DE/DT/DI OR NDE/NDT/NDI as the case may be. The issue of inspection is a very serious matter in the engineering profession and it cuts across all facets of the production stages. The main objective of carrying out inspection is the need for quality and weld quality as an important part of the overall quality effort. Several factors come into play when product quality is of concern, such factors as economics, safety, government regulations and global competition, the use of less constructive designs and more. The paper compared the two and concluded that the two methods ought to be complimentary rather than being competitive.

1. Introduction

The issue of inspection is a very serious matter in the engineering profession and it cuts across all facets of the production stages. The main objective of carrying out inspection is the need for quality, and weld quality is an important part of the overall quality effort. Several factors come into play when global competition, the use of less constructive designs etc.

The welding inspector is one of the front line persons who must check to see if all of the required manufacturing steps have been completed properly.

2. Who is a Welding Inspector?

The responsible person involved in the determination of weld quality according to applicable codes and /or specifications is known as the welding inspector.

The welding inspector must possess what is referred to as KASH and be a communicator Knowledge, Attitude, Skill & Habit(See the illustration Page 5)

3. Types of Welding Methods

There are numerous types of welding methods in use today in the industry, while many more are still being developed. Development in welding technology is largely dictated by the rapid development in materials science as well as environmental conditions such as underwater and deep sea locations\(^1\)
The are following:

### 3.1.1 Oxy-acetylene Welding
Most popular for local welders as it is used for the most popular construction material/steel
- Oxygen is usually supplied from steel cylinders at pressures up to 200 bar at 15% and acetylene at low pressures up to 0-6 bars.
- Capable of welding, braze-welding and brazing a wide variety of materials.

### 3.1.2 Electric arc welding
- An electric arc is formed when an electric current passes between two electrodes separated by a short distance.
- In arc welding, the welding rod is one electrode while the other is the metal to be welded.
- Also a very popular method for local welders Can be used for a wide variety of metals.
- Particularly popular for welding of pipes.

### 3.1.3 Gas Shielded metal arc welding
- The Metal Inert Gas (MIG) and the Active Gas (MAG) methods are growing in popularity, displacing the traditional oxy-acetylene and arc methods.
- In these methods, the arc is shielded with either argon, helium, carbon dioxide or various mixtures of them, generally requires reduced heat and better weld quality.
- Popular for thin sheets such as in the automobile industry
- Susceptible to automation.

### 3.1.4 Tungsten Inert Gas Welding (TIG)
This method was developed for the welding of aluminium and magnesium alloys to avoid the use of corrosive flux.
- Also used for a number of ferrous alloys.
- Susceptible to automation.

### 3.1.5 Plasma-arc welding
- Plasma is the gas region in which there is practically no resultant change, making the region an electrical conductor.
- Plasma welding is a method, which compliments and can substitute the TIG method.
- Achieves greater welding speed, better quality weld and less sensitive to process variations.

### 3.1.6 Resistance Welding
- In this method of welding, use is made of the heating effect which occurs when a current flows through a resistance.
- Mostly used for spot welding and seam welding.

### 3.1.7 Submerged Arc Welding (SAW)
- This is basically an electric arc welding process, but fully automated.
– The bare or flux cored wire and the parent plate, the arc, electrode and molten pool are all submerged in a fused powder which turns into a slag, to protect the weld.
– The wire electrode and the flux are fed automatically at controlled speeds and quantity to completely submerge the arc without spatter.
– Used mainly in industrial mass production of parts and components.

3.1.8 Underwater Welding

– The welding of underwater structure can be carried out in one of 3 main methods-wet welding, localized dry chamber and dry habitat methods (2).
– Wet welding method uses the normal MMA process with specially treated electrodes to keep them dry; carried out by a diver-welder, and using special underwater equipment.
– Used only for emergency and non-critical welds.
– Localised dry chambers and dry habitats are pressurized chambers built around the location to allow a diver-welder work with all safety facilities.

4. Inspection and Testing of Welds

Inspection and Testing of welds, is a very important aspect of welding technology and its contribution to industrial productivity. Many countries have gone great lengths to ensure that the efficacy and reliability of the welding processes are high enough to ensure industrial productivity and safety (2).
During the process of welding, faults of various types may creep in and these must be eliminated or detected before the welded item is passed for use.
Available methods of testing welds can be classified into 2:
• Non-destructive testing
• Destructive Testing

4.1.1 Non-Destructive Testing (NDT)
commonly applied are:
• Visual Inspection, dye penetrant fluid.
• Radiography: X-ray and Gamma-ray
• Ultrasonics
• Application & load.
• Each of these tests are subject to standard methods of approach which must be adhered to.

4.1.2 Destructive Testing (DT)
Destructive tests are usually carried out either on test specimens made for that purpose or may be made on one specimen taken as representative of several similar items.
They are done in laboratories, workshops or training centers and can be chemical or mechanical in nature (2).
Please see tables 1 & 2 Pages 4-5 for the comparison that exist in the available methods of testing
5. Conclusion
The use of DE or NDE have been in place over the years. It should be the privileg of the welding inspector to utilize the visual inspection (VI) and call for any of the NDI techniques to compliment if there is reason to be suspicious of a specific joint.

REFERENCES
1. Modern welding technology, by Howard B. Cary
2. Welding inspection technology, by AWS

DESTRUCTIVE AND NON-DESTRUCTIVE TESTING
The corresponding advantages and disadvantages of Destructive and Non-destructive tests are compared in the below tables 1 & 2.

Comparison of Destructive and Non-Destructive Test

<table>
<thead>
<tr>
<th>Destructive Test</th>
<th>Non-Destructive Test</th>
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<tbody>
<tr>
<td>Advantages</td>
<td>Limitations</td>
</tr>
<tr>
<td>1. Tests usually simulate one of more service conditions. Consequently, they tend to measure serviceability directly and reliably.</td>
<td>1. Tests usually involve indirect measurements of properties of no direct significance in service. The correlation between these measurements and serviceability must be proved by other means.</td>
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<tr>
<td>2. Tests are usually quantitative measurements of load for failure, significant distortion or damage, or life to failure under given loading and environmental conditions. Consequently, they may yield numerical data useful for design purposes or four establishing standards or specifications.</td>
<td>2. Tests are usually quantitative and rarely quantitative. They do not usually measure load for failure or life to failure even indirectly. They may, however, reveal damage of expose the mechanisms of failure.</td>
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<td>3. The correlation between most destructive test measurements and the material properties being measured (particularly under simulated service loading) in most observers may agree upon the results of the test and their significance with respect to the serviceability of the material or part.</td>
<td>3. Skilled judgement and test or service experience are usually required to interpret test indications. Where the essential correlation has not been proven, or where experience is limited, observers may disagree in evaluating the significance of test indications.</td>
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<td>4. Destructive tests are not usually convenient to apply to parts in service. Generally, service must be interrupted and the part permanently removed from service.</td>
<td>4. Non-destructive tests may often be applied to parts in service assemblies without interruption or service beyond normal maintenance or idle periods. They involve no loss of serviceable parts.</td>
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<td>5. Cumulative change over a period of time cannot readily be measured on a single unit. If several units from the same lot or service are tested in succession over a period of time, it must be proven that the units were initially similar. If the units are used in service and removed after various periods of time, it must be proven that each was subject to similar conditions of service, before valid data can be obtained.</td>
<td>5. Non-destructive tests permit repeated checks of a given unit over a period of time. In this way, the rate of service damage, if detectable, and its correlation with service failure may be established clearly.</td>
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<td><strong>6.</strong></td>
<td>With parts of very high material or fabrication cost, the cost or replacing the parts destroyed may be prohibitive. It may not be feasible to make an adequate number and variety of destructive tests.</td>
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<tr>
<td><strong>6.</strong></td>
<td>Acceptable parts of very high material or fabrication costs are not lost in non-destructive testing. Repeated testing during production or service is feasible when economically and practically justified.</td>
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<td><strong>7.</strong></td>
<td>Tests are not made on the objects actually used in service. Consequently, the correlation or similarity between the objects tested and those used in service must be proven by other means.</td>
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<tr>
<td><strong>7.</strong></td>
<td>Tests are made directly upon the objects to be used in service. Consequently, there is no doubt that the tests were made on representative test objects.</td>
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<td><strong>8.</strong></td>
<td>Tests can be made on only a fraction of the production lot to be used in service. They may have little value when the properties vary unpredictably from unit to unit.</td>
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<tr>
<td><strong>8.</strong></td>
<td>Tests can be made on every unit to be used in service if economically justified. Consequently, they may be used even when great differences from unit to unit occur in production lots.</td>
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<tr>
<td><strong>9.</strong></td>
<td>Tests often cannot be made on complete production parts. The tests are often limited to test bars or from production parts or from special material specimens processed to stimulate the properties of the parts to be used in service.</td>
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<tr>
<td><strong>9.</strong></td>
<td>Test may be made on the entire production part or in all critical regions of it. Consequently, the evaluation applies to the part as a whole. Many critical sections of the part may be examined simultaneously or sequentially as convenient and expedient.</td>
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<td><strong>10.</strong></td>
<td>A single destructive test may measure only one or a few of the properties that may be critical under service conditions.</td>
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<tr>
<td><strong>10.</strong></td>
<td>Many non-destructive tests, each sensitive to different properties or regions of the material or part, may be applied simultaneously or in sequence. In this way, it is feasible to measure as many different properties correlated with service performance as desired.</td>
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**KNOWLEDGE, ATTITUDE, SKILL AND HABIT (KASH)**

**A WELDING INSPECTOR BRINGS CERTAIN AMOUNTS OF KASH TO THE JOB**

- Knowledge of drawings and specifications
- Knowledge of welding terms
- Knowledge of welding processes
- Knowledge of testing methods
- Professional attitude
- Training in engineering and metallurgy
- Inspection experience
- Welding experience
- Safe practices
- Ability to maintain records
- Good physical condition
- Good vision

*Figure 1.2—The Inspector Possesses a Great Amount of Knowledge, Attitudes, Skills and Habits (KASH)*