

OPERA

27th April 2004

NDT: Inspection & Monitoring

Is it all it's cracked up to be?

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Testing, inspection & monitoring - all it's cracked up to be provided:

- its capability is understood**
- its purpose is understood**
- it is not expected to achieve the
impossible**

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Testing at supply/ fabrication/construction

- **establishing a procedure is appropriate**
- **establishing a component or construction accords with specification**

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Selected Sampling

Selected locations

- Components - locations related to fabrication process
- Weld procedure tests - specified locations

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Selected Sampling

Frequency of sampling

- dependent on experience of manufacturer/fabricator
- dependent on criticality in use
- determined by reference to standards and/or consideration of particular application

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Ensuring product/ construction quality

- specification establishes rejectable defects
- select test method appropriate for locating rejectable defects (if not specified)
- apply test method to an appropriate proportion of the supply (may be specified)
- reject/modify defective components

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Achieving Product Quality

- Dependent on adequacy of specification
- Benefits from knowledge encompassed in commonly recognised standards and specifications

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Inspection & Monitoring during operation

- establish condition suitable at time of inspection
- estimate or confirm rate of deterioration
- establish dates for retirement/replacement or other necessary intervention

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Establishing Requirements

- Identify likely types of deterioration
- Identify locations of likely deterioration
- Establish nature of critical defects
- Identify appropriate methods of inspection/monitoring
- Confirm assumptions
- Implement changes where necessary

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Achieving the Purpose

- Basic guidance on methods, locations and frequency in standards
- Appropriate implementation primarily reliant on knowledge of the individual asset
- Methods and frequency of inspection & monitoring only valid provided assumed operating conditions prevail

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Visual

- Success depends on what is looked for
- Valuable in opportunistic inspection
- Opportunities for opportunistic inspection limited by increased automation and limited time availability

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Cracks

Magnetic particle inspection

- surface/near surface - ferromagnetic materials
- dependent on orientation of flux

Dye penetrant testing

- surface emergent cracks
- low cost

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Ultrasonic Inspection

- **Wide range of methods, e.g.:**

- * thickness measurement
- * angle probes
- * time of flight diffraction

Differing complexities and capabilities

- **Manual or automatic**

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Ultrasonic Inspection

Dependent on location and nature of defect

- **compression probes - relatively easy to use - applicable to thickness measurement**
- **angle probes - more complex - applicable when examining features other than perpendicular to probe**
- **mats - remote**

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Other Techniques

Wide range of techniques

- e.g. radiography, thermography, long range UT, strain gauges, eddy current
- usually more complex

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Locations

- Generally representative (e.g piping circuits) - incorporating checks of validity of grouping
- Specific local sites (e.g. bends, low points, cold spots, other hot spots)
- High risk areas (probability x consequences)
- Areas of uncertainty (including where predictive models have been used)

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Monitoring

Indirect methods

- operating environment; temperature, composition, flow rate
- electrochemical probes, weight loss coupons

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Monitoring

Minimising uncertainty

- clear definition of safe operating conditions - beyond temperature & pressure where appropriate
- probes fabricated from material of same grade/condition/orientation

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Monitoring

What it can do

- indicate changes in conditions at monitoring locations
- indicate changes in rate of deterioration of assets

Interpretation necessary to determine actual effect of change

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Remote/automatic methods

- Limits delays in inspection due to restraints in access
- Can enhance understanding by identifying specific conditions leading to accelerated deterioration
- Can provide automatic alerts

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Computerised systems

Varying capability

- storage of data
- estimation/calculation of deterioration rate (from models and/or plant data)
- automatic alerts

All are tools

They do not replace discretion/decision making

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Effective Surveillance

- Is based on understanding of likely locations/types of damage
- Uses suitable inspection/monitoring methods/procedures at the appropriate intervals
- Produces and applies data suitable to ensure the integrity of the asset

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Indicators

- Decreasing anomalous results with time
- Reduced incidents/downtime
- Reduction in number of inspections outstanding

only valid provided the active types and rates of deterioration have been predicted

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Critical Factors

- Change from determination of condition on the day of inspection to assessment of likely future deterioration to:
 - * determine rate of deterioration
 - * establish date/nature of next intervention
 - * establish necessary actions

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Essential communications

- **Ensure continuing feedback -**
 - * ensure assumptions are confirmed e.g. data based on models is confirmed or replaced by plant data
 - * ensure results are interpreted and reviewed
 - * determine the reasons for deviation from the predicted
 - * apply reality checks

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Reviews

The adequacy of systems applied requires review on relevant change to:

- feedstock
- product
- equipment
- staffing
- contracting practice

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Control of the Asset

- **Depends on interpretation of the findings - current and anticipated future condition**
- **Depends on effective communications**
 - * inspection
 - * planning
 - * operations/production
 - * maintenance
 - * policy

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