Human Factors guidance to improve reliability of non-Destructive testing in the Offshore Oil and Gas Industry

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Abstract

It is well established from cross-industry trials and experience that the reliability of NDT inspection can be significantly affected by human performance issues. Examples of major trials where human factors on inspection have been assessed include the HSE PANI Project, PISC III in the Nuclear industry, the US Ageing Aircraft Programme and the NIL POD trials.

A common misconception is that the source of poor reliability is the inspector; this neglects the many other factors such as environment, organisation, team and procedure that impact on reliability.

This paper outlines results from a new project on human factors in offshore inspection started in 2016 within the HOIS offshore inspection JIP (www.hois.co.uk) to raise awareness of the influence of human factors on the effectiveness and reliability of inspections in the offshore and onshore oil & gas industries.

Phase 1 of the work examined general issues, lessons learnt from past trials, offshore experience, and the human factors relevant to the individual stages of an offshore inspection work scope. Key factors identified were the competency of operator and inspector staff, good communication between operator and the inspection teams, knowledge of the local areas being inspected and damage history, the importance of a well-qualified offshore inspection engineer (OIE) offshore, good access and scaffolding, real or perceived time pressure, and experience of inspectors in field inspections.

The current phase is developing specific human factors guidance for NDT in the Oil & Gas sector including general guidance, reporting protocol for internal visual inspection (IVI), external visual inspection for corrosion and manual ultrasonics. To facilitate uptake by the industry, a simple step-by-step graphical approach is being developed for the guidance using ‘Bow-tie’ plots to show the key human factors effects and mitigation possible at each stage in an offshore inspection workscope.

HOIS
Advancing NDT in oil & gas

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Engineering, Safety & Risk

HUMAN FACTORS GUIDANCE TO IMPROVE RELIABILITY OF NON-DESTRUCTIVE TESTING IN THE OFFSHORE OIL AND GAS INDUSTRY

Dr Martin Wall, ESR Technology Ltd. United Kingdom,

7th European-American Workshop on Reliability of NDE
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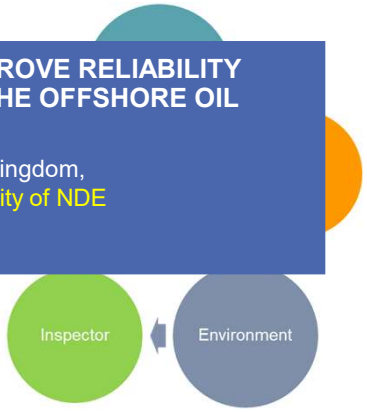

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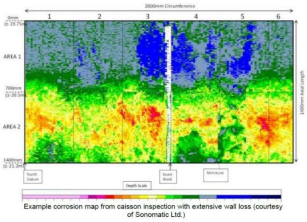
Outline of talk

1. Introduction
2. Human factors v human error
3. HOIS human factors projects Phase 1 and 2
4. Human factors for Oil & Gas inspections
5. Example - Visual inspection (CVI) for corrosion
6. New graphical approach
7. How do you implement improvements?

Introduction



Example corrosion map from caisson inspection with extensive wall loss (courtesy of Sonomatic Ltd.)

The reliability of NDT inspection can be significantly affected by human performance issues.

Major trials on human factors on inspection include the HSE PANI Project, PISC III in the Nuclear industry, the US Ageing Aircraft Programme and the NIL POD trials.

Common misconception[1] is that the source of poor reliability is the inspector; this neglects the many other factors such as environment, organisation, team and procedure that impact on reliability.

This paper introduces a new project on human factors in offshore inspection started in 2015 within the HOIS offshore inspection JIP (www.hois.co.uk)

Raise awareness of the influence of human factors on the effectiveness and reliability of inspections in the offshore and onshore oil & gas industries.

1. M Bertovic; Thesis on Human Factors in Non-Destructive Testing (NDT): Risks and Challenges of Mechanised NDT, 2015 & 6th EAW paper 2015

HOIS Joint Industry Project (JIP)

HOIS is a major well established JIP. The 41 members comprise oil & gas operators, the HSE, NDT service companies and equipment vendors and the Oil and Gas Technology Centre.

HOIS improves effectiveness of in-service inspection for the oil & gas industry and promotes good practice by:

- Developing **good practice documents** for specific inspection applications
- Assessment of the performance of current and developing inspection techniques by means of rigorously controlled **blind trials**
- **Industry forum** for latest developments – what's new and what works

What is a human factor?

Human factors refer to the factors that affect the people when dealing with a technical system: individual; group, technology, organization; environment. As a result, the reliability and performance of the system is degraded compared to the expected capability. *In an NDT context defects may be missed or poorly characterised and the inspections undertaken less effective.*

The following definition is used regarding inspection which is an adaptation of one used in the HSE guidance in relation to health and safety and definitions used in the European-American reliability workshops[2].

"Human factors in NDT refers to environmental, organizational and job factors, and human and individual characteristics, which influence the effectiveness, performance and reliability achieved in NDT inspections."

Human error?

A human factor is different to a human error, which is an action which failed to achieve its intended outcome for human reasons. Reason[11] gives the following definition of human error:

"All those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcome, and when these failures cannot be attributed to the intervention of some chance agency"

An error can only be described as such in retrospect.

Categories of human factor

Overall

NDE experts, Human Factors (HFs) experts and phycologists involved.

ESR and Lloyds Register suggestion,

Human limitations and ergonomics

- Routine task Probability of human error 1 in 10
- Task involving thinking Probability of human error 1 in 5
- Task involving thinking under stress Probability of human error 1 in 2

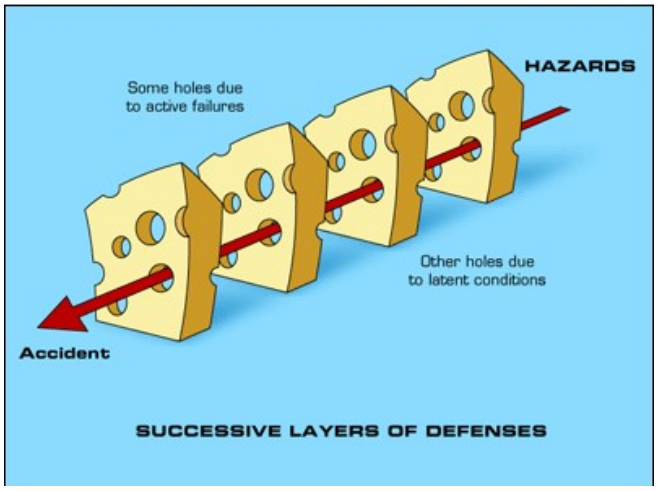
Have to look at ways to mitigate.

Equipment improvements, ergonomics.

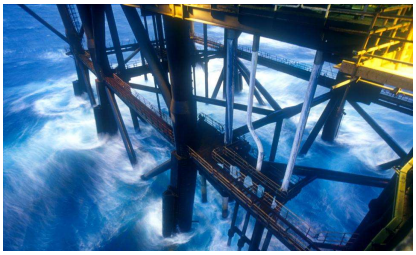
No more than 3-4 changes to get commitment. Step by step.

Achieve an objective NOT stop all human errors (non reliant brittle system → new human errors)

Swiss cheese model (JT Reason 1990)



What is different offshore?



Challenging environment

Gaining suitable access

Limitation of persons on board (PoB)

Distractions

Long shifts

Repetitive work

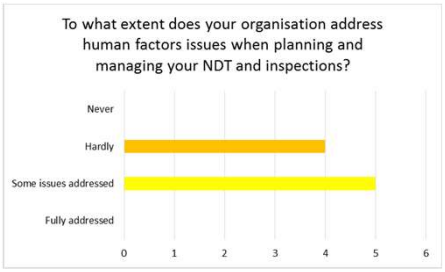
Tight schedules

Neighbouring activities

Safety considerations (no hot-work etc.)

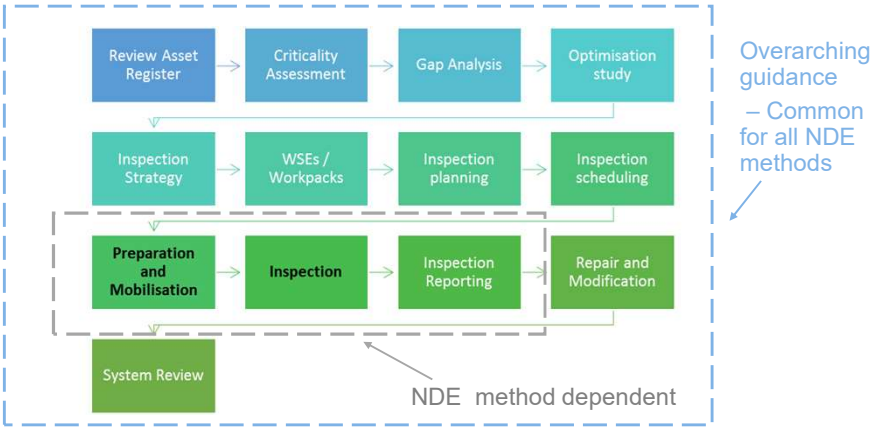
Platform specific safety – issuing work permits, briefings, unknown condition of plant and equipment, etc.

Industry survey (example)

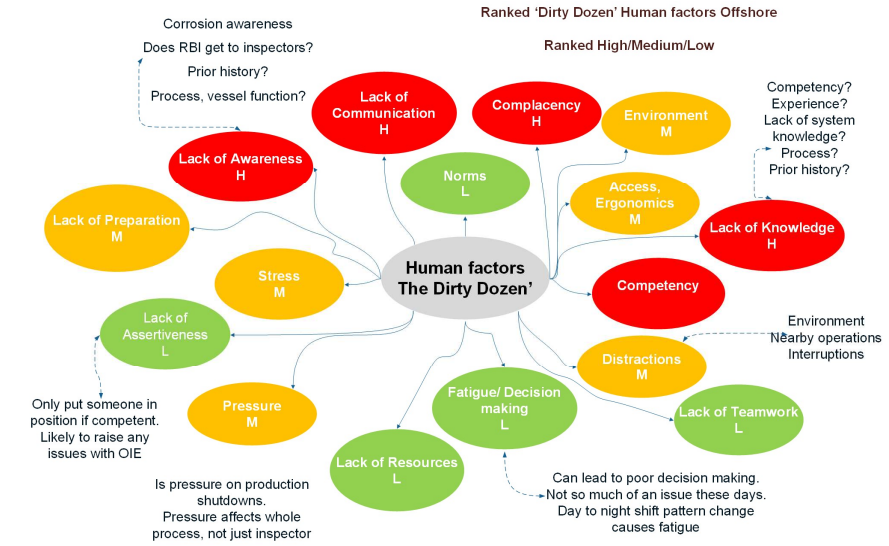


Stages in an offshore (and onshore) inspection workscopes?

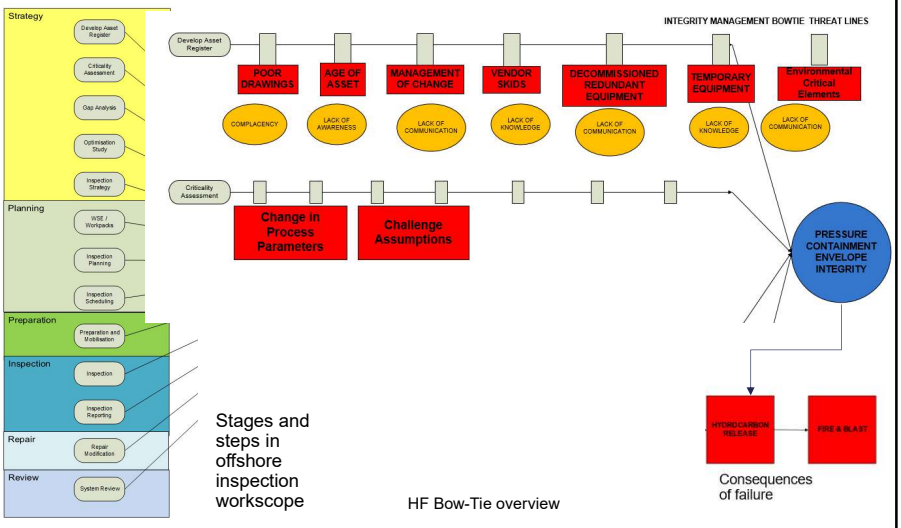
Human errors can affect any stage in the offshore and onshore inspection workscope



‘The dirty dozen’ Key human factors offshore



Graphical approach – Bow-Tie diagrams



Stages and steps in offshore inspection workscope

HF Bow-Tie overview

Consequences of failure

Example IVI Reporting Protocol and proforma

Reporting protocol and proforma shown in HOIS trials to have impact on the reliability (POD) achieved in internal visual inspections (IVI) of pressure vessels

HF guidance

- 'Workpack' specific to vessel being inspected
- Prescriptive fields where information is required (e.g. location, thickness WT measurements)
- Free text fields for inclusion of comments, observations, photographs (and video)
- Accurate definition and recording of datums, areas of vessel and where measurements are required
- Space to comment on nearby plant areas
- Good communication with operator and platform staff (ATEX mobile phones and smart technology increasingly used offshore).

Example – General guidance

Competence. Inspectors have technical expertise and experience offshore. Familiarity with the offshore environment; Knowledge of systems and platform. Review NDT techniques and inspector competences. Qualification of inspectors for complex or critical inspections. Assist in developing competence by job and operator specific training. Improve self-awareness;

Communication. Good communication between the OIE or supervising operations staff and inspection teams. Use teams with experience of the particular installation. Continuity of inspectors;

Ergonomics. Provide suitable scaffolding and access;

Fatigue. Help to avoid fatigue. Frequent breaks and avoid long shift-times if possible. Consider and monitor inspector well-being;

Distraction. Ensure no areas are omitted in the inspection, particularly after breaks or distractions. Mitigate environmental factors, noise and distractions.

Procedure. Optimise the inspection procedure. Adopt better planning. Prior history of inspections available to inspectors;

Awareness. Clear working instructions, reporting protocol and proforma. Awareness of neighbouring activities from 'toolbox talks' and platform briefings;

Equipment, Ergonomics. Replace human input (e.g. mechanised UT, scanning aids, drones). Use of permanently installed sensors (PIMS). Use of Smart technology (ATEX mobile, GoPro type cameras) to improve interactions of operator staff with OIE and inspectors and recording of damage locations.

Example - Visual inspection (external corrosion & IVI)

Major in-service issue in the oil & gas and other industries, especially on ageing assets

Corrosion follows break-down of coating system. As the corrosion progresses, corrosion product or scale builds up

Removal of corrosion product for fabric maintenance purposes on **live process pipework** can have significant risks

Consideration of Human Factors important to ensure areas of concern are identified on external or internal (IVI) visual inspection.

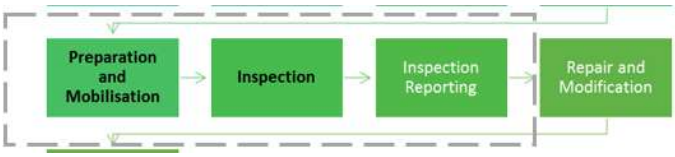
Data sources and case studies- Visual inspection for corrosion

Specific guidance relevant to visual inspection includes:

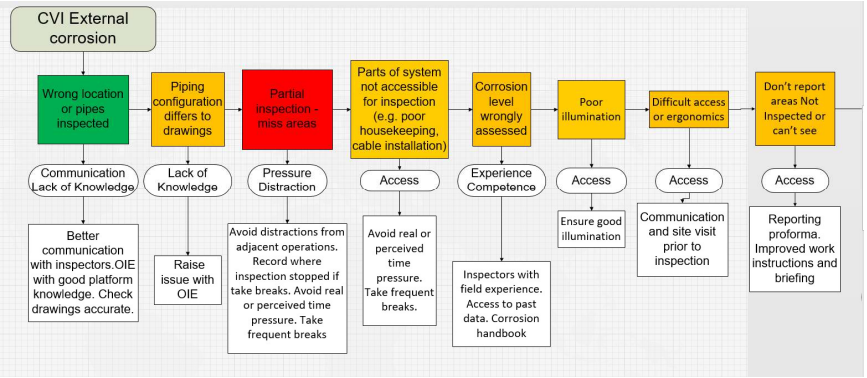
- HOIS member experience
- EPRI guidance on visual inspection
- Sandia study on visual inspection
- BS EN standards
- PANI III general code of conduct
- HOIS(17)R2 IVI guidance
- Conoco Phillips – Surface preparation handbook
- Other operator handbooks

HF approach - Visual inspection for corrosion – Issues, human factors, mitigation?

- Steps in inspection?
- Potential issues or human errors (‘threats’)?
- Relevant human factors?
- Ranking H/M/L?
- Mitigations to prevent (or remedies)?
- Case study examples? Other information.



Example – Bow-tie plot – Visual inspection (CVI) for corrosion



Making improvements

- Raise awareness
- Specific guidance documents
- Graphical approach ‘Bow-Tie’
- HF Campaign – No more than 3-4 factors. ‘3 better than 4’
- Training course

Human factors in POD modelling

POD models do not normally take account of human factors.

It is not currently considered possible to physically model human factor (HF) effects on NDE.

At the 7th EAW the approach was suggested (Bertovic) that the model-derived POD curves are presented as :”this is what you could in principle expect for POD, provided you take steps to reduce any impact of human factors. This is a good solution that encourages users to think of human factors.

- There have been many studies of human factors (PISC III, PANI etc.) that provide a basis for empirical (transfer-function) corrections for human factors to POD or distributions that can be input into POD models.
- Experimental trials may implicitly include some human factors and provide a basis by comparison for tuning model POD values for HFs
- There is merit in this approach, that has been deployed by Wall (5th EAW) and Lilley (ECNDT)

The author’s view is that such HF corrections will be more precise if applied to the model inputs, rather than the outputs like POD curves

Conclusions

1. Human factors on offshore inspections is being investigated for the first time within the HOIS JIP developing general and specific guidance
2. The project has raised awareness of the issue and produced substantive information and guidance documents.
3. How to make improvements in human factors on NDE is a key driver. An innovative graphical approach has been developed.
4. NDE methods considered include *visual inspection for external corrosion, IVI reporting protocol, and manual UT for corrosion*
5. Human factors is a large area. In each case the work seeks to focus on the 3 or 4 issues considered to have the most impact on offshore inspections and where guidance can have an influence.
6. The findings are relevant to both offshore and onshore oil and gas inspections.

Acknowledgements

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