NDE 4.0 for In-Service Inspection, Monitoring and Integrity Management in the Energy Sector (including HOIS Initiatives)

Martin WALL

1 ESR Technology Limited/HOIS, 22 East Central
127 Olympic Avenue, Milton Park Oxfordshire OX14 4SA UK

Contact e-mail: martin.wall@esrtechnology.com

Abstract

Digital transformation is all around us and forms an increasing part of our daily lives. For inspection and monitoring, the emerging technologies behind this revolution in automation and use of data (including AI/machine learning, digital twins, cyber-physical systems (CPS), autonomy, cloud computing, information flow and transparency, big data processes, the internet of things (IoT)) and augmented reality) are collectively referred to as NDE 4.0. Inspection and monitoring data are increasingly acquired using robotic or automated systems and sensor networks that gather large amounts of data in a digital framework. This is true of advanced NDE methods used in aerospace or more routine automated inspections like MFL floor scanning of oil storage tanks. Data acquired in this way is amenable to NDE 4.0 solutions and display in digital twins.

The paper will give an overview of the use of NDE 4.0 technologies in the energy sector for in-service inspection, monitoring and integrity management including initiatives within the HOIS JIP and forum (www.hois.co.uk) including a core digitalisation and NDE 4.0 Agenda’. Examples include guidance on data information flow; cloud data storage for acquisition, storage, processing, and reporting of NDE inspections; use of photogrammetry and optical methods and bespoke software to build plant level digital twins (DTs) offshore and subsea; mini-DTs for storage tanks and process vessels; guidance for use of drones and AUVs for remote visual inspection (RVI, CVI), and robot crawlers for remote internal inspection (RII) of pressure vessels.

Early uptake is most likely for new NDE technologies with large NDE data requirements (robotics, phased arrays); for improved visibility and integrity analysis of data via mini-DTs; or for time consuming NDE activities such as analysis of more complex NDE data sets. FMC, PAUT, TOFD).
NDE 4.0 for in-service inspection, monitoring and integrity management in the energy sector (including HOIS initiatives)

1st International NDE 4.0 Conference
14/15 & 20/21 April 2021
https://2021.nde40.com/

Applications 3 session
Dr Martin Wall

Introduction

1. Digitalisation and NDE 4.0.
2. The ‘NDE value chain’
3. Types of innovation with NDE 4.0
4. Key technologies: digital twins (DTs), mini-DTs, interfaces, data processes and analytics, LIDAR scanning, AI/ML, data lake
5. HOIS JIP and the HOIS Digitalisation Forum (HDF)
6. NDE 4.0 examples in ISI and integrity management
Digitalisation is everywhere...and an integral part of Industry 4.0

Digitalisation and NDE 4.0 Interactions

Evolutionary stages of NDE 4.0

Key to Industry 4.0 and NDE 4.0 is the data...
Digital transformation in the Oil and Gas and Energy sectors is underway…

Exploration
Design
Build and installation
Process
Monitoring and control
Operations
Inspection and maintenance
Data analytics and modelling
Supply chain

Industry 4.0 and NDE 4.0 are important parts of this data revolution.

OGTC Digital Transformation Roadmap summarises opportunities

The NDE 4.0 (and digitalisation) value chain

Roles/Characteristics:

- Product support
- Efficient NDE services
- Support inspection planning
- Many others …

- Integrated w. multiple tools
- Ease of operation
- Efficient execution
- Many others …

- Data processing
- Store Data
- Analyse/Condense raw data
- Many others …

- Data management
- Integrate with own and client IT environment
- Maintain access to raw data
- Many others …

End-to-End information flow
Types of Innovation with NDE 4.0

**Process efficiency improvement**

*Do the same thing but typically one or all of:*  
• Faster  
• Better  
• Cheaper

Benefit comes from making the process more efficient.

Example:  
• Integration of inspection system outputs with integrity database

**Process transformation**

*Technology and innovation provide the opportunity to do something completely different.*  

Transformative benefits, often much larger than just making the process itself more efficient.

Examples:  
• Drone inspection replacing need for people on flare stacks, in tank inspections, and working at height  
• Photogrammetry or optical scanning methods with AI/ML replacing visual inspection (95% of in-service inspections are visual)  
• Non-intrusive inspection (NII) replacing internal visual inspection (IVI)  
• Statistical analysis of sampling inspections

Transformation in Inspection and Integrity with NDE 4.0 and digitalisation

<table>
<thead>
<tr>
<th>Assessment and Planning</th>
<th>Data collection</th>
<th>Data analysis</th>
<th>Update and Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Modelling</td>
<td>• Inspection data acquisition systems</td>
<td>• Advanced digital signal processing (large volume)</td>
<td>• Data and insight driven decision making processes</td>
</tr>
<tr>
<td>• Simulation</td>
<td>• Transducers</td>
<td>• Machine learning</td>
<td>• Ready access to info via AI driven databases</td>
</tr>
<tr>
<td>• Statistical analysis</td>
<td>• Techniques</td>
<td>• Statistical analysis</td>
<td>• Statistical “what if” scenario assessment</td>
</tr>
<tr>
<td>• Visualisation</td>
<td>• Volume of quantified data</td>
<td>• Inspection data QA</td>
<td>• Cost-benefit analysis</td>
</tr>
<tr>
<td>• Quantified inspection performance</td>
<td>• Deployment (Robotics)</td>
<td>• Quantified risk</td>
<td></td>
</tr>
<tr>
<td>• Data mining</td>
<td>• Automation &amp; remote control</td>
<td>• Automation</td>
<td></td>
</tr>
<tr>
<td>• Machine learning</td>
<td></td>
<td>• Delivering insights</td>
<td></td>
</tr>
</tbody>
</table>

Software driven integrated workflow processes  
Using data to support decisions....
NDE 4.0 data interfaces, data flow, format and ownership

- Decision on action
- Choice of action
- Contextualise inspection data
- Generate & interpret inspection data
- Provide tools to generate data

NDE deployment (Crawler, robotics, drone)

End-to-End information flow

NDE 4.0 Example: GE Inspection Robotics (GEIR) BIKE Robot

A digital replica of a physical asset data connects both worlds.
Key NDE 4.0 technology Drone inspection (LIDAR, with AI/ML)

Optical or photogrammetry scanning using drone to replace visual survey. Example FPSO tank inspection (LIDAR, with AI/ML)

HOIS – Who are we?

A JIP on good practice for NDT/NDE in the energy industry managed by ESR Technology. HOIS develops detailed and authoritative guidance for NDT and integrity management good practice. Annual budget ~£800k

<table>
<thead>
<tr>
<th>Operators</th>
<th>Inspection service, equipment vendors and notified appointed bodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chrysaor</td>
<td>Aker Solutions HSE</td>
</tr>
<tr>
<td>CNODC</td>
<td>Applis RTD Inspectahire</td>
</tr>
<tr>
<td>Dow</td>
<td>Baugh &amp; Weedon Lloyd's Register</td>
</tr>
<tr>
<td>Equinor</td>
<td>Bltnger Mistras Group</td>
</tr>
<tr>
<td>Sasco</td>
<td>Bureau Veritas Oceanenergy International</td>
</tr>
<tr>
<td>Petronius</td>
<td>CAN Olympus NDT</td>
</tr>
<tr>
<td>Repsol Boreas</td>
<td>Cybernax Rosen Swiss AG</td>
</tr>
<tr>
<td>RockRose (Chair)</td>
<td>DNV SGS</td>
</tr>
<tr>
<td>Saudi Aramco</td>
<td>Doosan Babcock Sonomatic</td>
</tr>
<tr>
<td>Shell</td>
<td>Eddyfi Stork Technical Services</td>
</tr>
<tr>
<td>Spirit Energy</td>
<td>FujiFilm TRAC Oil and Gas</td>
</tr>
<tr>
<td>Total (Deputy Chair)</td>
<td>QE Inspection Technologies The OGTc</td>
</tr>
<tr>
<td>Woodside Energy</td>
<td>GUL</td>
</tr>
</tbody>
</table>

HOIS digitalisation and NDE 4.0 focus

Digitalisation and NDE 4.0 are large areas and require a focus. The HOIS focus on digitalisation and NDE 4.0 developed from discussions with HOIS members and digitalisation stakeholders is:

‘Digitalisation for inspection, NDE, monitoring and integrity management in the energy sector’

with particular emphasis on

| Digital twins | Data processes | Data quality | Inspection and monitoring technology |

HOIS Digital and NDE 4.0 Agenda

Digitalisation is a broad field – need for focus

This is defined by the HOIS Digitalisation Agenda

- Discussion
  - Information exchange
  - Digitalisation Forum
  - Digitalisation working groups
  - Highlight key projects
  - Networking
  - Updates

- Technical focus
  - NDE 4.0
  - Digital twins
  - Data processes
  - Data quality
  - Inspection and monitoring technology

- Applications
  - Inspection requirements
  - Utilisation of inspection techniques
  - Inspection anomaly optimisation
  - Evaluation of results

- Validation
  - Inspection technology
  - Analysis methods
  - Machine learning
  - Predictive models

- Guidance
  - Recommended practices
  - Guidance notes

Validation Flow Diagram
NDE 4.0 and digitalisation: HOIS relevant projects

Core Project on digitalisation of NDE (including NDE 4.0) and asset integrity in the Energy Sector. (Started 2019)
- Landscaping Study. HOIS role, focus and agenda.
- HOIS Digitalisation Forums (HDF1-7)
- Working Group Meetings (HDWG)
- Networking: Operators, service and technology providers, R&D organisations
- Development of best practice guidelines: Often the precursor to large scale introduction of change that brings benefits
- Guidance on mini-Digital Twins, Inspection Data Processes

New HOIS Digitalisation 2 (including NDE 4.0) project approved March 2021
- Core, HDF forum, technical projects DP3-DP5 End-End information flow. AI/ML or ultrasonic data (with University of Bristol)

Current and historical HOIS projects with an NDE 4.0 and digitalisation theme:
- Guidance on use of AUVs and drones, NII guidance HOIS-RP-103, statistical analysis of inspection data, remote internal inspection (RII), effective pipework inspection driven by data analytics.

HOIS members recognise the importance of digitalisation (including NDE 4.0) and how it can bring transformative benefits

Digitalisation themes

- Asset integrity management (AIM).
- NDE and inspection.
- Plant monitoring.
- Digital twin (or virtual plant model).
- NDE sensors for remote deployment
- Artificial Intelligence (AI) and robotics
- Imaging tools
- Automated analysis of NDE data
- Geo-tagging and adding NDE data
- Trending of (raw) NDE data
- Performance of Structural Health Monitoring
- Data processes (data streaming, storage, coordinate systems, formats, large NDE data sets etc.)
HOIS Digitalisation Forum HDF (including NDE 4.0)

HOIS Digitalisation Forum HDF launched in May 2020
Visual remote seminars (on Teams) with recording.
‘To promote engagement with NDE 4.0 and digitalisation stakeholders worldwide and across industry sectors: end-users, NDE solution providers, technology providers, academia. NDE 4.0 solution providers often very different to traditional NDE providers in the Energy sector
Becoming one of the most influential forums Digitalisation of in-service inspection and related integrity activity.

Opened after HDF2 to non-HOIS members
Seven HDF virtual seminars held HDF1-7 (Bi-monthly) held.
Audience up to 100+

- Wide range of digitalisation topics
- Talks from end-users and supply chain
- Well attended internationally. Has enhanced awareness of HOIS
- Shows technical solutions that are ‘out there’
- Presentations and recordings available for download
- Introductory presentations by Sieger Terpstra (Shell Global Solutions) Project Champion)

Digitalisation of inspection, NDE and integrity management in the Energy Industry
Digital twins, NDE data processes, NDE 4.0, integrity management and cloud solutions

https://eu.workplace.datto.com/filelink/689f6-649e94a-
651144e-6d341a5f85-2
https://eu.workplace.datto.com/filelink/689f6-65114e-
6d341a5f85-2

Digitalisation of inspection, NDE and integrity management in the Energy Industry
Digital twins, NDE data processes, NDE 4.0, integrity management and cloud solutions

HOIS Digitalisation Forum (HDF) virtual seminars – technology examples

GE Inspection Robotics (GEIR)
BIKE robot

Mistras Vessel mini-DT
3D model

CAN, Akselos, OGTC Mini-DT
HDF NDE 4.0 Example: CUI monitoring (Corrosion RADAR)

HDF NDE 4.0 Example: Storage tank inspection (Eddyfi Silverwing)

FROM DATA COLLECTION TO REPORT

Tank
- Inspection pre-requisites
- Data collection and signal processing (Floormap)

Remote location
- ‘SIMS’ creating the surrogate digital twin
  - Provides tools to:
    - Automate plate stitching,
    - Trend analysis,
    - Making repair plans.

Client
- Tank condition report
- Data files

- Large area tank floor data recording and mapping
- 36 channels total
**HOIS-R-042 mini digital twins (mini-DTs) Guidance**

- Addresses the need for guidance on mini-DTs
- Examples of real-life applications to be included in the appendices.
- Seeking examples from members.
- Seeking feedback on draft document.
- [susan.osbeck@esrtechnology.com](mailto:susan.osbeck@esrtechnology.com)

---

**NDE 4.0 and digitalisation current projects: Guidance document for mini-Digital Twins**

**Guidance document for mini-Digital Twins**

Benefits of the guidance

- Increased uptake of DT applications (benefits to operators and service companies)
- Industry specification of minimum standards
- Consistency of application
- Simplification of inspection data gathering and reporting – improved efficiency
- Straightforward and robust inspection QA and conformance assessment
- Transferability of results (open format for model and data)
- Ease of integration with other applications, e.g. advanced data analysis and evaluation, Risk Based Inspection systems, Reporting databases
Multiple interfaces where data and information is transferred

With amount of data available from inspection increasing, exponentially in some cases, what to keep and how to access it is increasingly important

Consideration of what information flows in both directions will enable improved, faster utilisation of the information gathered during inspection

This is an essential foundation to maximising the benefit of NDE 4.0 and Digitalisation processes

Guidance for Inspection Information Flow in Integrity Management

Benefits of the guidance

- Highlights the role of different participants in the inspection value chain
- Identifies changes in information requirements evolving from incremental digitalisation through to transformative digitalisation
- Demonstrates the requirement of pull through from end-users
- Implications of comparing different types of inspection results
- Identification of inspection analytics requirements
- Cost-benefit analysis of different inspections
- Discusses the stages and interconnections that inspection data passes through from generation to end-user
- Recommends embedding expert knowledge of inspection at the reporting stage to allow robust inspection analytics
- Identifies the key data parameters which need to be consistent throughout
  - Basis for future standardisation
HOIS NDE 4.0 example: Recommended practice for NII of pressure vessels: HOIS RP 103

Assessment
• Review process, history, and risks.
• Determine suitability, strategy, coverage, techniques, and locations.

Work Scope
• Provide inspection instructions, locations, reporting requirements etc.

Inspection
• Inspect to work scope and additional if required.
• Report results showing locations and coverage achieved, anomalies found, minimums etc.

Evaluation
• Review conformance to work scope.
• Analyse results, trend data, and calculate corrosion rates (if required).
• Confirm/update RBI and recommend actions.

Latest version, fully updated and revised, launched February 2020
Download from www.hoispublications.com

NII – NDE 4.0 and Digitalisation – Sampling Inspection

Sampling Inspection is an important element of Type A and B strategies for NII in accordance with the HOIS Guidance.

Type B strategies (the majority of applications) permit a partial coverage and are explicitly reliant on statistical analysis to make estimates for the area not inspected.

Assessment and planning
Assess applicability of NII
Determine strategy
Define performance requirements
Define techniques
Define coverage
Define locations

Inspection
Carry out and report results

Evaluation
Conformance
Statistical analysis
NDE 4.0 data analytics: Statistical Analysis of Inspection Data HOIS(12)R8

- Statistical analysis is playing a growing role in inspection and integrity, particularly as availability of data is increasing and methods evolve.
- HOIS has carried out work on statistical analysis over a long period.
- Initially to support NII and then to include wider applications.
- Project focused on developing a Recommended Practice for Statistical Analysis of Inspection Data started in 2011.
  - RP issued in 2013, ref HOIS(12) R8.
  - Training notes issued in 2014.

The focus of the RP is on sampling inspections.
- Framework for applications
- Planning for sampling inspections
  - Degradation scenarios (depth, density, homogeneity)
  - Impact of inspection performance (POD and accuracy)
  - Coverage and distribution of coverage
- Analysis of sampling inspections
  - Extreme value analysis
  - Use of underlying distributions from high density data
  - Making estimates for uninspected area
  - Reliability of estimates and factors affecting reliability
- Tiered analysis methodology (Level 1 - Level 3)

Data from the areas inspected is used to infer the condition in the area not inspected.
NDE 4.0 and digitalisation current projects:
Remote Internal Inspection (RII)

- Over the past decade there have been major advances in:
  - Remote Digital Visual Inspection (RDVI)
  - Light based techniques such as laser
  - Robotic deployment capabilities
  - Deployability of techniques
  - Reporting and visualisation of results

for remote internal inspection (RII) of pressure equipment.

- RII can play a major role in effective minimum intervention strategies, as a supplement or sometimes alternative to NII.

- There are as yet no formalised guidelines covering planning, implementation and evaluation of RII for pressure systems.

- HOIS members voted in March 2020 to approve a project to develop a Recommended Practice for RII of pressure vessels.

- The first stage of the project was to gauge interest and establish current practices and capabilities through a survey and individual engagement. Thanks to all participants!

Conclusions

- NDE 4.0 and digitalisation provides the opportunity for realisation of significant benefits for in-service inspection (ISI) in the Energy and other sectors, including a move to condition-based integrity management.

- NDE 4.0 technology solutions and methods are increasingly available, and already transforming the way asset integrity is managed including inspection performance and reliability (POD).

- Key technologies include robotics, digital twins, large data and phased array scanning methods, AI/ML and automated defect recognition (ADR), mini-DTs, and data analytics and compilation.

- Processes for implementation end-to-end are key to realising the benefits. Take up of NDE 4.0 is most likely where there is significant cost benefit or it transforms the inspection and integrity management process. Offers a route to ‘condition based’ integrity management.

- HOIS is active in developing industry best practice in use of NDE 4.0 technologies to assist in implementation and management of change

- There is substantial and ongoing HOIS activity on NDE 4.0 and digitalisation related topics including the influential HOIS Digitalisation Forum (HDF).
Acknowledgements

Thanks to all HOIS members who have contributed to Digitalisation and NDE 4.0 related initiatives

Thanks to you all for your time!

Additional slides not presented
NDE 4.0 and digitalisation current projects: Inspection information flow

Guidance for Inspection Information Flow in Integrity Management

Benefits of the guidance

• Highlights the role of different participants in the inspection value chain
• Identifies changes in information requirements evolving from incremental digitalisation through to transformative digitalisation
• Demonstrates the requirement of pull through from end-users
  • Implications of comparing different types of inspection results
  • Identification of inspection analytics requirements
  • Cost-benefit analysis of different inspections
• Discusses the stages and interconnections that inspection data passes through from generation to end-user
• Recommends embedding expert knowledge of inspection at the reporting stage to allow robust inspection analytics
• Identifies the key data parameters which need to be consistent throughout
  • Basis for future standardisation

NDE 4.0 Non-intrusive inspection (NII) – HOIS-RP-103

Ongoing HOIS activity on NII dating back to 2000. Most NDE 4.0 technologies for ISI are non intrusive Focus is on development of best practice guidance for the industry.

Widespread application of the HOIS NII RP (now published as HOIS-RP-103).
NII – NDE 4.0 and Digitalisation - Inspection

The inspection will typically rely on advanced techniques that collect and store large amounts of digital data which acts as a record of the inspection achieved and the findings (HOIS-G-103)

Techniques for NII
- Multiphysics numerical simulation to develop and optimise technique performance
- Advanced multi-element transducers
- High throughput Analog to Digital systems
- High volume digital storage
- Advanced algorithms for automated data analysis
- Software for visualisation of results
- Quantified performance (POD, accuracy)

Deployment methods
- Support for digital record of coverage (encoded)
- High speed scanning
- Magnetic crawlers
- Robotic tools
- Autonomous operation (advanced navigation and localisation)

NDE 4.0 data analytics: Statistical Analysis of Inspection Data

Approach in the Stats RP recognises and facilitates advances afforded by other aspects of Digitalisation.

- Analysis methods
  - Making the most of large volume, high density datasets increasingly available from corrosion mapping systems
  - Use of full wall thickness distributions (computationally feasible to deal with datasets with tens or hundreds of millions of readings)
  - Importance of spatial distributions and subsampling (accurate spatial data increasingly available from inspection and reporting systems)
- Simplified processes that can be adopted in practice
- Providing a basis for expanding expertise – recognising the need for integrity teams to include Statistical/Data Science capabilities
Statistical Analysis of Inspection Data

Applications
- Restricted access inspection
- Pressure vessel NII
- Pipework inspection optimisation
- Storage tank wall and floor inspection
- Heat Exchanger tube inspection
- Unpiggable pipelines
- Accurate corrosion growth rates
- Inspection QA

Benefits
- Cost effective inspection
- Improved understanding of the condition of assets
- Improved understanding of uncertainty in knowledge of the condition of assets
- Increased opportunities for use of NII in place of IVI
- Reduced shut down time
- Improved control of inspection service provider delivery

Statistical analysis at the core of growing interest in methods to maximise the role of data in integrity processes: Data mining, data science, predictive analytics, digital twins, machine learning, artificial intelligence

Effective Pipework Inspection

HOIS Guidance document (HOIS-G-010) issued in 2018
Defines a data driven process linking:
- Corrosion behaviour
- Inspection
- Integrity
- Analysis

Methodology in HOIS-G-010 provides a driver for integration of digitalisation throughout the integrity cycle.
Effective Pipework Inspection

Pipework integrity is challenging. HOIS members raised concerns:
• Considerable investment is made in pipework inspection for internal degradation (a major part of typical budgets)
• Effectiveness is not quantified
• Is inspection data being fully utilised?
• Improvements possible!

HOIS project initiated in 2015 to develop Guidance for Effective pipework inspection
• Provide a framework for setting up and managing inspection programmes that deliver effective assurance of pipework integrity in an efficient manner
• Scope of the RP to include both integrity and inspection aspects
• Provide practical guidance on how to implement and manage improvements to current practice

NDE 4.0 data analytics: Effective Pipework Inspection

The HOIS Pipework Guidance outlines a range of statistical concepts and methods of visualisation particularly useful for pipework analytics and applicable to NDE 4.0 application.

Strong data analytics and visualisation provide the basis for actionable insights
Effective Pipework Inspection

A key feature of the HOIS Pipework Guidance is recognition of importance of spatial distribution of degradation.

*Inspection requirements are very different for cases where degradation is more general vs cases where degradation is very isolated*

This is often under-appreciated in CML optimisation approaches.

The Guidance provides a practical framework for defining appropriate requirements according to degradation characteristics and lifecycle stage.

---

Quantifying NDE 4.0 inspection performance

- Substantial value in understanding actual performance, e.g. POD or accuracy, of techniques used.
  - Improved risk management
  - Planning for more efficient inspection
- Assessing technique performance through controlled trials has been a major HOIS activity over many years. HOIS manages a test facility for this specific purpose and has a wide range of samples.
- NDE 4.0 and digitalisation, including for e.g. digital data outputs from techniques, statistical simulation and data analytics, provides a basis for *leapfrog improvements in planning for efficient and effective inspection* using quantified performance models as a basis.
- The need for, and value of, quantifying technique performance and assessing performance as achieved is growing rapidly.
Current NDE 4.0 related projects: Remote Internal Inspection (RII)

- Technical/practical include:
  - Access issues
  - ATEX/IECEx requirements
  - Cleaning
  - Inspection times too long

- Confidence includes:
  - Insufficient understanding of available technologies and capabilities.
  - Variability of experience, [lack of] standards and training
  - Lack of framework

- Financial includes:
  - Total cost of inspection
  - Comparative cost of inspection

HOIS RP for RII aims to address this:

- Create a framework to support a consistent approach to assessment, planning and evaluation of RII (similar to HOIS-RP-103)
- Build confidence in inspection methods (clarifying requirements and quantifying capabilities)

Current Projects: Remote Internal Inspection (RII)

Extensive work across developers and JIP’s on relevant aspects of technology, processes and standards/guidance

- SPRINT Robotics active in developing guidance on deployment aspects primarily
- UK HSE Industry funded project on Remote Visual Inspection
- HOIS-SPRINT-HSE are collaborating to ensure there is no duplication of effort, outputs are complementary and aligned
- HOIS is seeking active participation and input from industry stakeholders (not restricted to HOIS members) to ensure guidelines reflect best practice
- This will be addressed in future forums.
Current projects: NDE 4.0 and digitalisation

Guidance document for mini-Digital Twins (Mini-DTs)

- Focus on mini-DTs aimed at inspection and related integrity applications, addressing basic requirements for the following aspects:
  - Inspection planning
  - Workscopes
  - Inspection enactment
  - Data collection
  - Inspection results presentation and reporting (visualisation)
  - Facilitation of inspection data analysis and evaluation
  - Feedback to integrity management systems
- Aim is to drive wider availability to operators and more straightforward application
  - Identifying and clarifying roles of the DT
  - Standardisation around minimum requirements for model to be written to a common open format
  - Consistent inspection data collection and processing for integration with DTs
  - Standardised open format for processed data
- Scope restricted to mini-DTs for internal corrosion of vessels and pipework initially

Guidance for NDE 4.0 and digitalisation Inspection Data Processes

- Consider the NDE information generated at each stage in the process
- How information can flow and be utilised through the process to enable digital transformation
  - Which to pass on, which to retain and which to feedback
  - How the workflow can be transformed not just made more efficient
- Based on understanding of NDE and will build in findings from existing HOIS guidance and RPs