Integrity Management of Brownfield Projects: Challenges and Rewards

Presenters

Monzar Najami

Principal Inspection Engineer

Hooman Takhtechian

Principal Corrosion Engineer

Agenda

- **Introductions**
- **About Oceaneering**
- **Integrity Build : Definition and Objectives**
- **Brownfield RBA Overview**
- **Challenges of RBA Programmes**
- **Operational Elements and Influencing Factors**
- **Industry Best Practice - Process, Plant, People, Performance**
- **Conclusion and Discussion**

About Oceaneering

Oceaneering provides services to deep water, space, Oil & Gas, and Motion entertainment environments to execute with new, leading-edge connections to solve tomorrow's challenges, today.

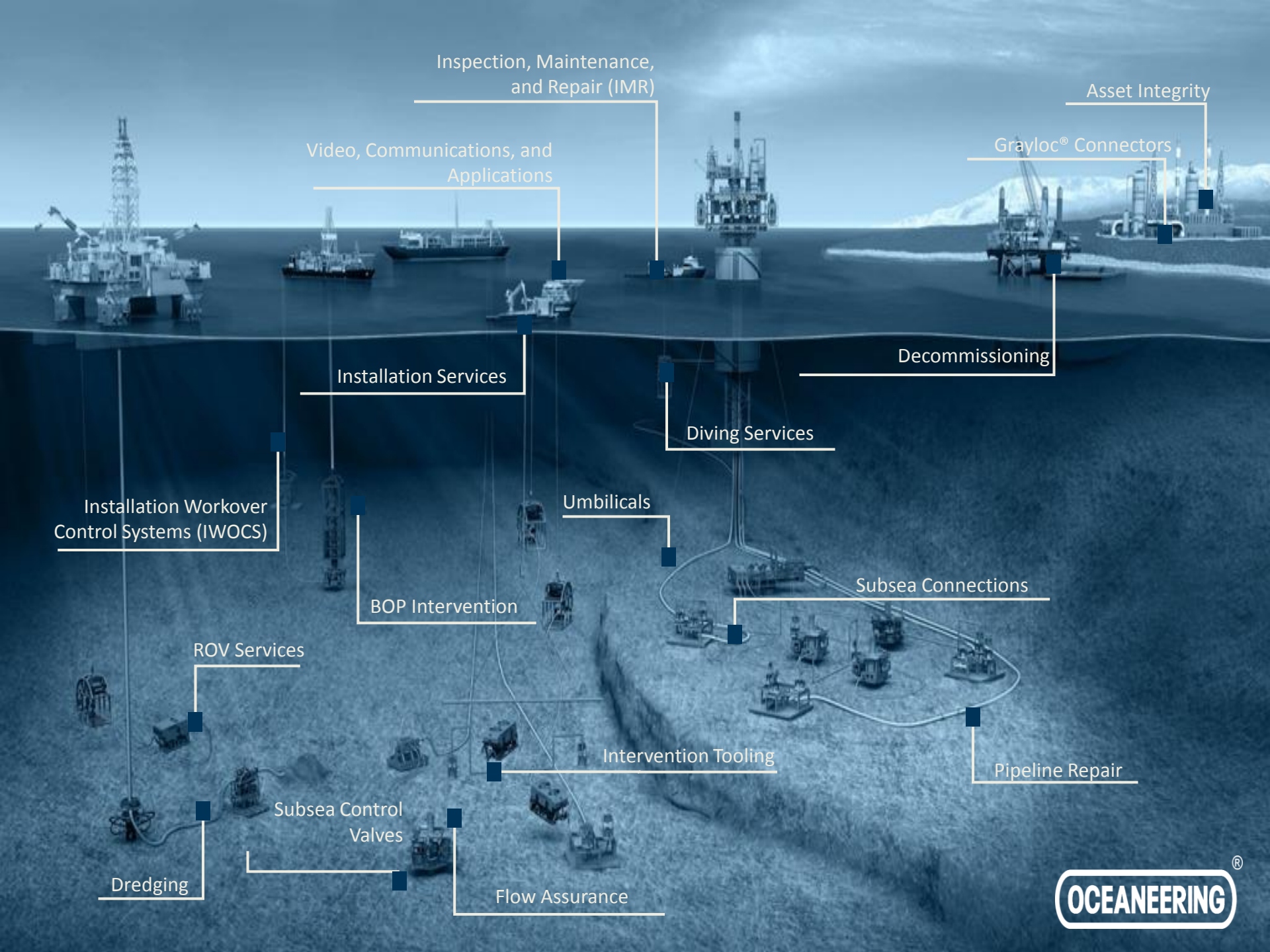
Founded in 1964 as an ROV/ Diving specialist

Oceaneering Acquisition of OIS in 2004 (Asset Integrity)

Branches in 5 continents

Has more than 8000 employees

OCEANEERING®


Inspection, Maintenance, and Repair (IMR)
Asset Integrity
Grayloc® Connectors
Video, Communications, and Applications
Decommissioning
Installation Services
Diving Services
Installation Workover Control Systems (IWOCS)
Umbilicals
Subsea Connections
BOP Intervention
ROV Services
Intervention Tooling
Pipeline Repair
Subsea Control Valves
Dredging
Flow Assurance
OCEANEERING®

Asset Integrity

Data Management

Development, management, and maintenance of customer and company software systems

Risk, Reliability, and Maintenance

Risk assessments, critical analysis reliability studies, CMMS optimization, maintenance programs, spare parts analysis

Engineering Solutions

Solutions for corrosion, structural, pipeline, and process plant requirements including asset life assessments

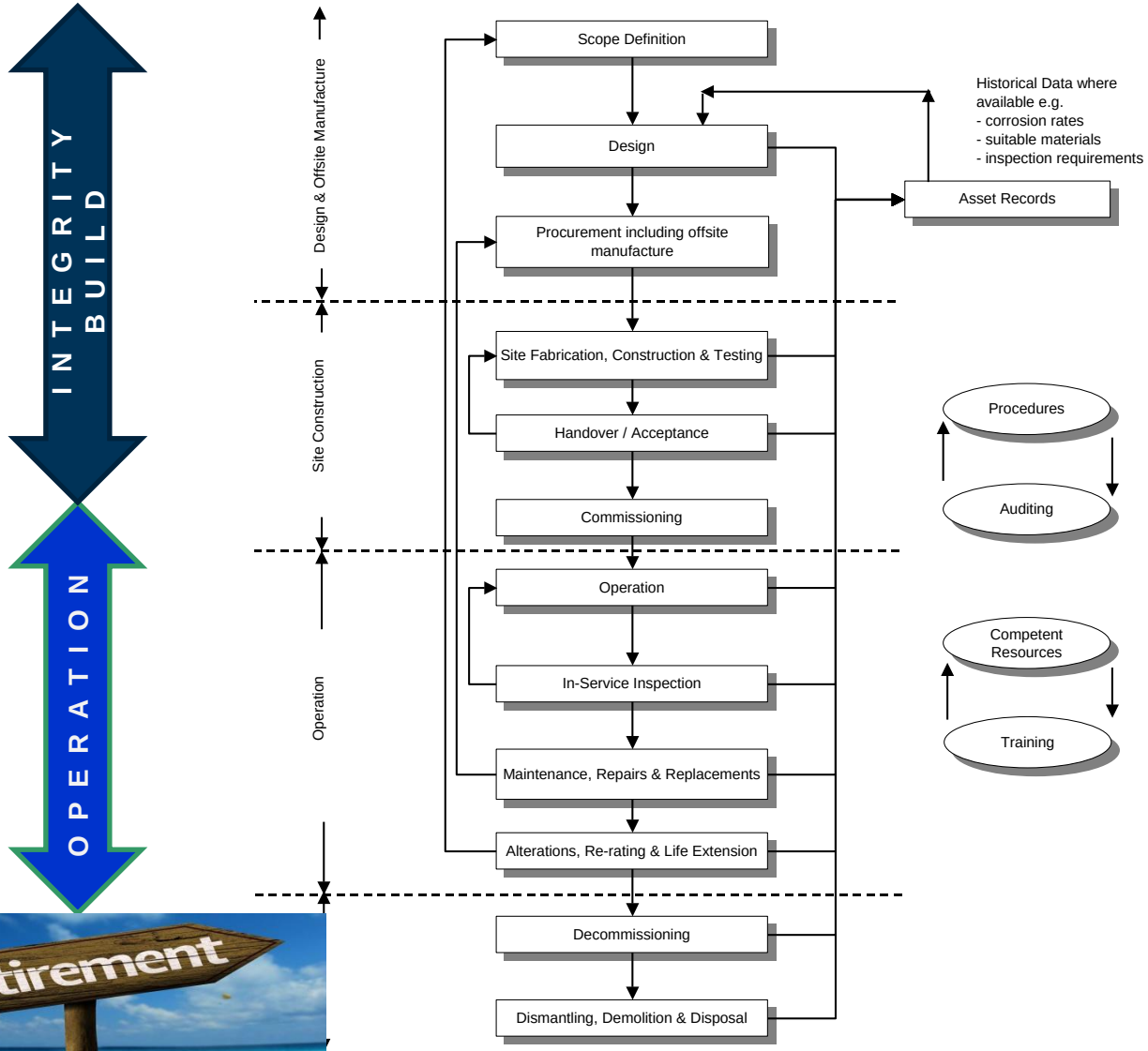
Subsea Engineering Solutions

Fitness-for-service engineering and inspection, due diligence studies, inspection campaign management, and pipeline engineering

The Aim of this Presentation is to :

- Share Best Practice for Operators/EPC/Vendors for a more efficient Integrity New Build (INB) programmes (Brownfield)
- Respond and adapt to Cost, efficiency, and Quality demands
- Lessons learnt/Best Practice in INB can benefit the existing operating facilities (e.g. Generic RBA / FM programmes)
- The Use of Technology (Recent Software RBA, CAD, IDB -Inspection Data Base) improves Governance & Standardization

Equipment Life Cycle Flowchart



Integrity Build

Integrity Build: Why is it required?

- Compliance & Standardization (Legislative Governance, such as safety Case, & Regional Requirements)
- Ensure that integrity is designed into the project.
- To ensure safe and reliable operation of the facilities, by producing Inspection and Integrity plans, uploaded into the Maintenance Management System (MMS)

Integrity Build: Deliverables?

- Front End Integrity Management Strategies include RBA, PSV, Vibration, Baseline, FHA (Flexible Hose Assembly), Inspection Dwgs, Structural, etc.
- (Desk Top related)Integrity Build RBA process, Inspection Plans, CUI register, PSV assessment etc.
- (Site related activities): Programmes Baseline Inspection, Vibration, PSV, Dead Legs, etc. implementation during the Facilities Construction stage prior to commissioning
- Operation Related Strategies: FIMS, CMS, FM Strategy

Integrity Build

Governance & Compliance

Operator/Partners/Region

Integrity Management Systems Process details

Project Deliverables

Case for Safety

IMS & Philosophy, Implementation strategy

Local Processes & Integrity Systems

Engineering Design Review & Revamp Project

Front End IMS Strategies

Use of Technology

Continuous Improvement

IMS Strategies

Risk Based Assessment

Vibration

PSV

Baseline Inspection

Fabric Maintenance

Dead Leg

Stakeholder Engagement

Life Cycle Approach

CMMS Upload

Inspection Job Plans (WSE)

Inspection Programme

Vibration Programme

PSV Testing Programme

Corrosion Management

Project Close out and Handover

Project Lessons Learnt

Commissioning

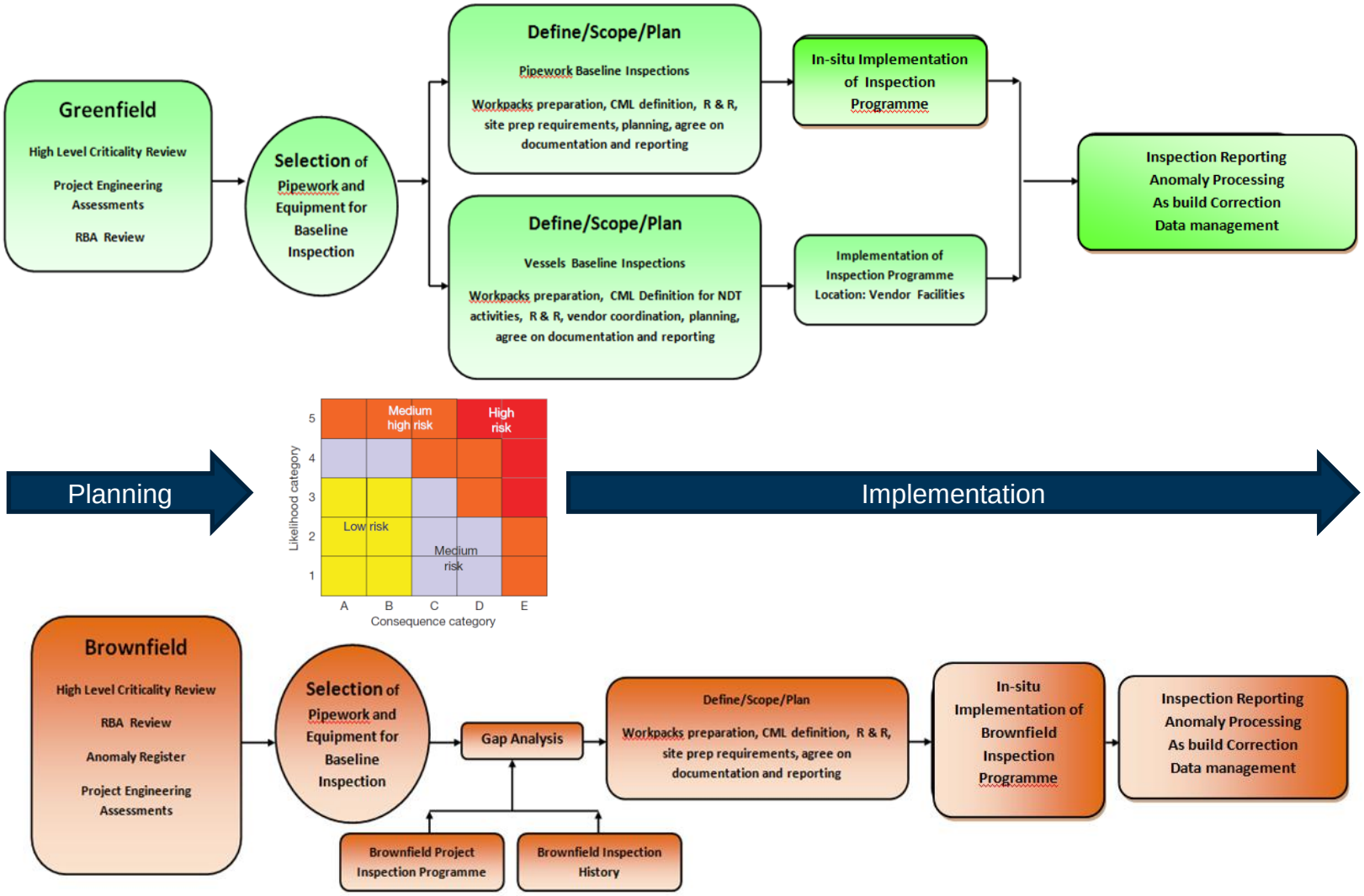
PHASE (A) PREPARE

PHASE (B) DEVELOP

PHASE (C & D) APPROVE DELIVER

OCEANEERING®

A Typical RBA process (Greenfield vs. Brownfield)

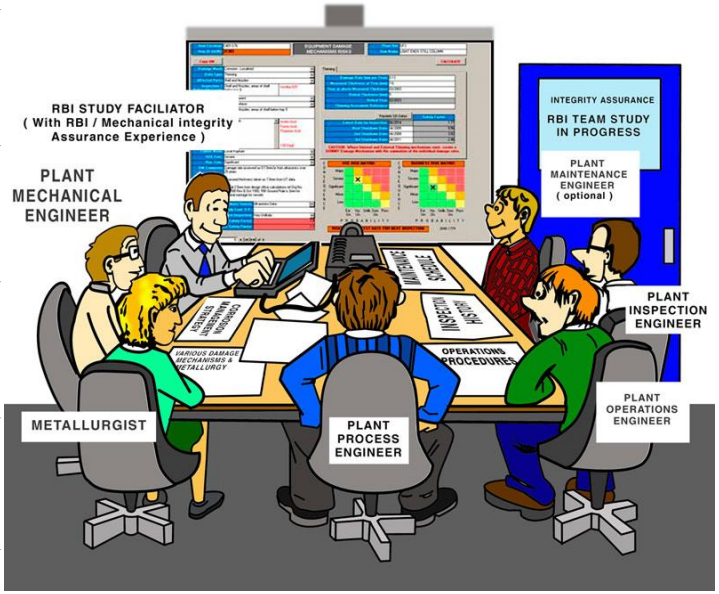


OCEANEERING®

Brownfield RBA Process Highlights

Critical path data maturity & Quality for Brownfield revamp project

- **Historical Data**
- **Revamp Project Inspection reports**
- **Existing WSE**
- **Fitness for Design Assessment:**
- **Existing MMS (SAP/Maximo etc)**



- **Format /content /availability/QA /**
- **Inspection Results interpretation/Actions**
- **Format and Contents**
- **Helpful and insightful**
- **Comprehensive /Redundant**

Brownfield data Input Crucial for PoF evaluation

Relevant Insights

RBA Process for a typical Brownfield Facility

High level Criticality review as per

-Location (Offshore/Onshore)

-Unit/System criticality (Safety, Environmental, Business)

-Process/Utility

-Fluid corrosivity (Wet, Dry, Sour, ...)

-Material Selection (CS, CRA, Clad, Non-metal, ...)

-Threat complexity and barrier effectiveness

-Inspection requirements / complexity

-History of failure / Significant anomalies in the same or similar facilities

High

- Feed gas / Unstabilized HC condensate
- Offshore unmanned platform
- Separation and Processing facilities
- Carbon steel material for wet system
- No barrier: Uncoated CRA
- Failure history in the same / similar facilities. Requirement for baseline
- Intrusive inspection / Advance NII techniques required

Medium

- Dehydrated HC, Export product
- Utility system (Boilers,
- Closed drain
- Critical vendor package
- Inland
- Barrier effectiveness to be reviewed: Storage tank CP / Chemical injection
- Failure history in the industry
- No complex NDT / Known CMLs

Low

- Low critical utility (Air, Nitrogen, lube oil, fire water ...)
- Low critical Vendor package (chemical injection, waste water treatment, ...)
- Non metals
- Passive barrier by design
- No major failure in the industry
- Only visual inspection

Challenges in conducting a Brownfield RBA

Challenges in the **consequence assessment**

-Methodology (Quantitative/Qualitative)
-Stakeholders engagement
-Different scenarios
-Various modes of failure
-Availability of backup data
-On time assessment

	Health & Safety		Environmental		Business Financial		Business Non-Financial	
	Severity	Justification	Severity	Justification	Severity	Justification	Severity	Justification
Pinhole Leak (<6mm)	6 F	leak size from the slug catcher can lead to jet fire but smaller hazard range which in ORF area is expected to be in the severity of F (One level lower than Onshore HAZOP TOR severity)	7 G	Leakage from this vessel is expected to be in the vapour phase and has no significant impact on the sensitive environment. As the environment can be restored to the equivalent capability is a short period, a CoF of G is	6 F	Since there are two parallel slug catchers in the system, and each has the full operation capacity, there wont be any business impact in case of the failure of one. CoF of F selected as more than 500K USD cost is	8 H	Since there are two parallel slug catchers in the system, and each has the full operation capacity, there wont be any business impact in case of the failure of one. CoF of H is selected
Medium	5 E	Gas release from the slug catcher can lead to jet fire which in ORF area is expected to be in the severity of E (as per Onshore HAZOP TOR severity)	7 G	Leakage from this vessel is expected to be in the vapour phase and has no significant impact on the sensitive environment. As the environment can be restored to the equivalent capability is a short period, a CoF of G is	6 F	Since there are two parallel slug catchers in the system, and each has the full operation capacity, there wont be any business impact in case of the failure of one. CoF of F selected as more than 500K USD cost is	8 H	Since there are two parallel slug catchers in the system, and each has the full operation capacity, there wont be any business impact in case of the failure of one. CoF of H is selected
Large	5 E	Gas release from the slug catcher can lead to jet fire which in ORF area is expected to be in the severity of E (as per Onshore HAZOP TOR severity)	7 G	Leakage from this vessel is expected to be in the vapour phase and has no significant impact on the sensitive environment. As the environment can be restored to the equivalent capability is a short period, a CoF of G is	6 F	Since there are two parallel slug catchers in the system, and each has the full operation capacity, there wont be any business impact in case of the failure of one. CoF of F selected as more than 500K USD cost is	8 H	Since there are two parallel slug catchers in the system, and each has the full operation capacity, there wont be any business impact in case of the failure of one. CoF of H is selected

Stakeholders

- Process safety engineer
- Environmental engineer
- Mechanical engineer
- Operation and Maintenance

Failure modes

- Pin hole leak
- Medium size
- Large size
- Full rupture

Backup data

- New / old studies
- HAZOP,
- FRA,
- ENVIID

Methodology

- Brainstorming sessions
- Software
- Manual calculation
- Use of other QRA done

Time

- Adequate time before RBA assessment

Challenges in conducting a Brownfield RBA

Challenges in the **data collection**

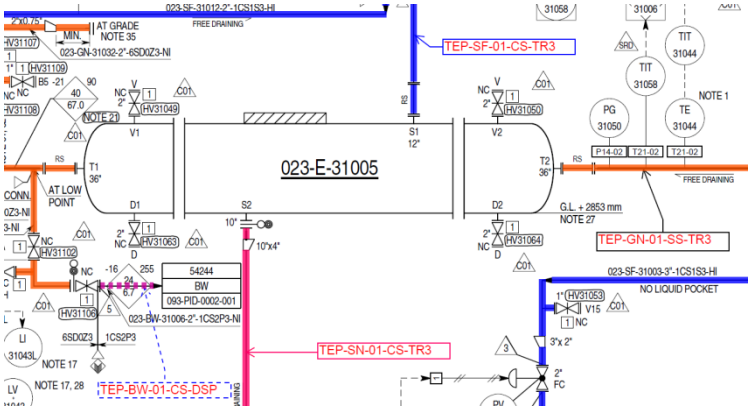
-Data availability

-Data validation

-Anomaly reports

-Tagging

-Monitoring records

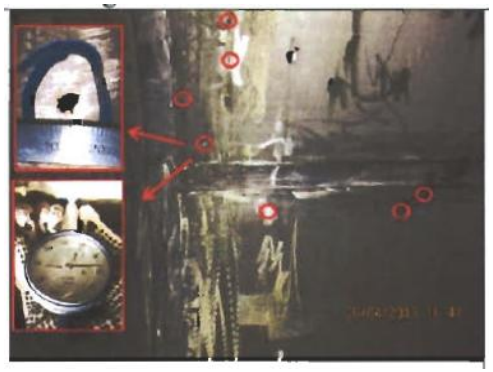


Data Availability	Data validation	Anomalies	Tagging	Monitoring
• Material certificates • Welding procedures • Equipment drawings • Datasheets • Baseline data • Inspection reports • ...	• Traceability • Gap analysis • MOC (management of change)	• List of anomalies • NCRs / TQs • Repair records • Root cause Failure Analysis • FFS (fitness for service) • ...	• Corrosion circuit mapping • Insp. Isometrics CML tagging	• Process data • Corrosion rate • Chemicals • Deposits/ Corrosion product analysis

Challenges in conducting a Brownfield RBA

Challenges in the **Threat Assessment**

How much credit can we take from the existing data?



Monitoring records	Corrosion rates from Inspection	Materials	Anomalies	Risk assessment
• Availability • Reliability • Validity due to change in the process • Sampling locations relevant? • ...	• Baseline data available? • Thickness measurement technique • Spot/Scan? • Measurement points	• Change in material spec and standard • Coating type • Manufacturing process • Cladding/ weld-overlay • ...	• Manufacturing defects • Root cause analysis available?	• Participation of operation rep. In the RBA review sessions • Late life scenarios

Solution: Hybrid corrosion rate assessment

Theoretical estimated rate vs. Calculated rate based on actual data

Challenges in conducting a Brownfield RBA

Typical list of damage mechanisms considered in the pressure system RBA

Damage Type	Internal Threats	External Threats
Wastage	Amine corrosion	Atmospheric corrosion
	Chloride pitting corrosion	Chloride pitting corrosion
	CO_2 corrosion	Corrosion under insulation / fireproofing (CUI / CUF)
	Corrosion by chemicals (including well workover fluids)	Crevice corrosion (including flange faces)
	Crevice corrosion (including flange faces)	Galvanic corrosion
	Erosion, erosion-corrosion and solids-free flow-induced damage	Marine corrosion (including external MIC and Splash Zone)
	Galvanic corrosion	Mechanical damage (abrasion, wear, galling and fretting)
	H_2S (pitting) corrosion	Soil corrosion (including external MIC)
	High temperature degradation	Stray current corrosion
	Mechanical damage (abrasion, wear, galling and fretting)	
	Microbiologically Influenced Corrosion (MIC)	
	Oxygen corrosion	
	Preferential weld corrosion (PWC)	
	Stray current corrosion	
Cracking	Amine stress corrosion cracking	Carbonate stress corrosion cracking
	Chloride stress corrosion cracking (SCC)	Chloride stress corrosion cracking (SCC)
	Fatigue (Corrosion)	Fatigue (Corrosion and Mechanical)
	Hydrogen embrittlement	Hydrogen embrittlement
	Hydrogen induced cracking (HIC) and Stress-oriented HIC (SOHIC)	
	Liquid metal embrittlement (Hg)	
	Sulphide stress cracking (SSC)	

Challenges in conducting a Brownfield RBA

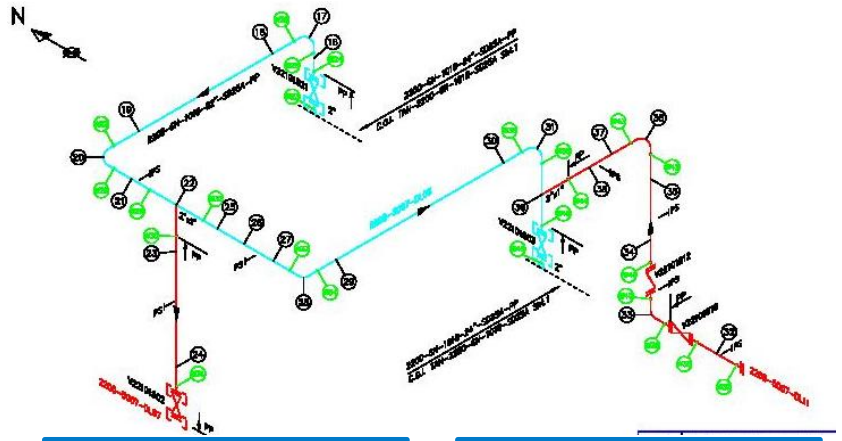
Challenges in the Brownfield **Deadleg Management**

-Deadleg identification

-Deadleg risk assessment

-Operational / Physical deadlegs

-Mitigation



Deadleg identification	Threat assessment	Operational / Physical deadlegs	Mitigation in place
• Isometrics available? • Line walk carried out? • Deadleg tagging (old and new tags) • ...	• Failure histories captured? • Sampling from deposits / stagnant fluids	• Change in the process captured? • Isolated, mothballed, decommissioned items • ...	• Draining • Flushing • Chemical treatment • Preservation philosophy

Challenges in conducting a Brownfield RBA

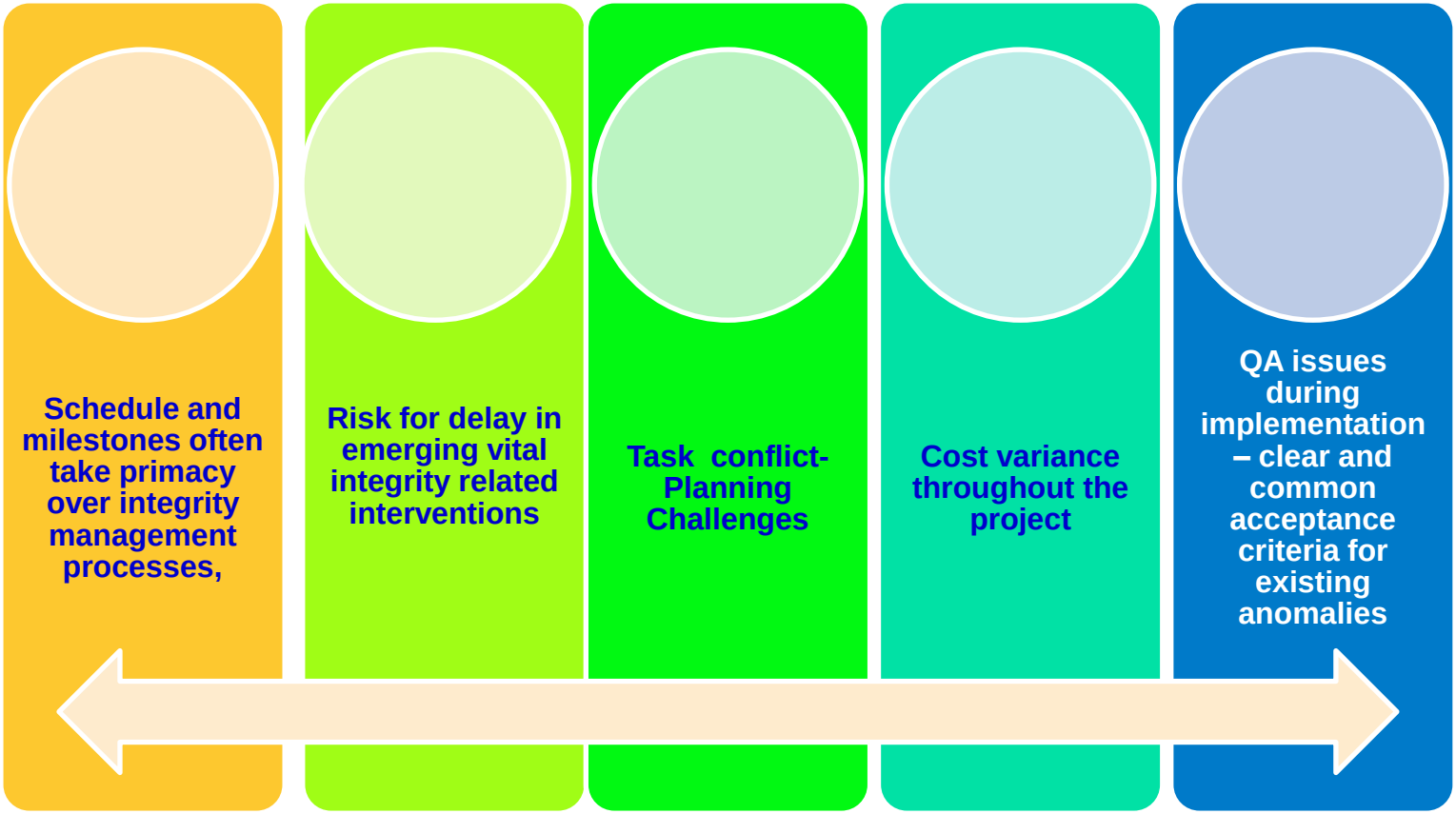
Challenges in the Brownfield CUI Management

-Coating Spec. under insulation
-Insulation type
-Removal of unnecessary insulation
-High critical location
-Failure histories

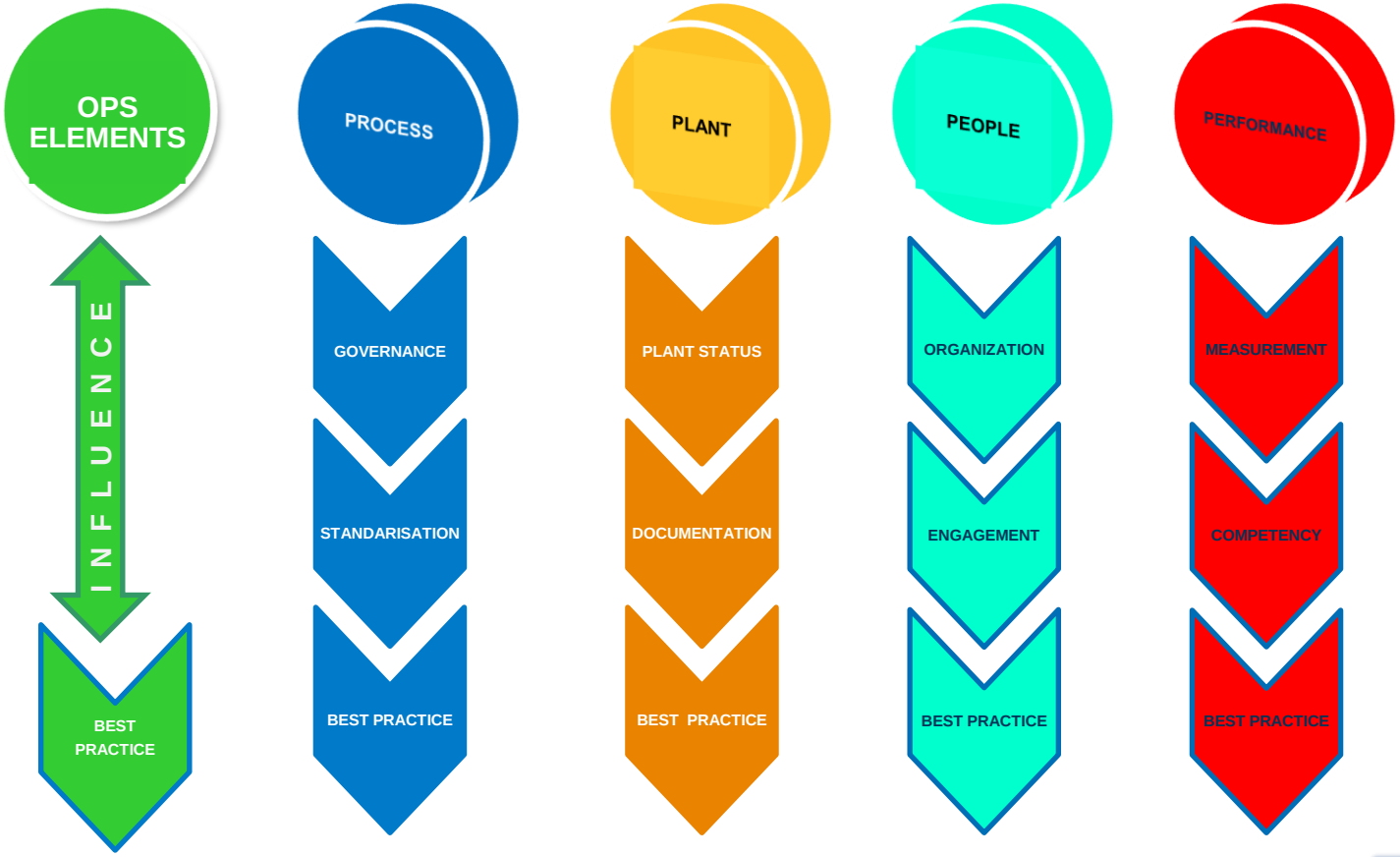


Coating	Risk assessment	High critical locations	Mitigation in place
• Coating spec for the temperature • Old/New spec. • ...	• Failure histories captured? • Insulation type • Actual operating temperature • ...	• Cyclic temperature • Branches • damaged cladding? • Line walk done? • ...	• Removal of unnecessary insulation • Available screening and NII techniques?

Challenge of developing and implementing an asset integrity program during Brownfield development projects



Operational Elements and Influencing Factors



Best Practice-Process

PROCESS

GOVERNANCE

- Clear Governance and Compliance strategies (overseas element)
- Timely Brownfield RBA scheduling :
- Post revamp project (Not too early and not too late)

STANDARISATION

- Generic Inspection Plans for Low Criticality levels
- Standard Inspection isometric – same process
- Semi quantitative RBA approach to equipment of same category

BEST PRACTICE

- Baseline Inspections: Define early & align with Project Plans
- Define and Engage with stakeholders early vendors /project etc
- More scrutiny re Revamp project documentation and decision making processes
- Ensure commensurate costing for Brownfield RBA
- FIMS & CMS Strategies to be developed and aligned with the RBA process
- Document Control : Extend the change processes outside of the organization to include Vendors (Share documents)

PLANT

PLANT STAUS

DOCUMENTATION

BEST PRACTICE

PEOPLE

ORGANIZATION

ENGAGEMENT

BEST PRACTICE

PERFORMANCE

MEASUREMENT

COMPETENCY

BEST PRACTICE

Best Practice-Plant

PROCESS

- GOVERNANCE
- STANDARISATION
- BEST PRACTICE

PLANT

PLANT STATUS

- Preservation of existing equipment
- Plant specific: U/G Piping- CP- CUI- MIC-FM
- Acceptance Criteria during revamp project and repairs
- Permanently mothballed equipment/pipework
- FM Opportunities- Blasting on Live Lines

DOCUMENTATION

- Historical data
- Punch List items – and handover process
- As build P & ID and construction drawings
- In-situ verification of existing equipment (3D laser mapping)

BEST PRACTICE

- Boundary Definition (Pipelines/ Utilities etc)
- Define process systems (what is included)
- Pressure Systems - limits (e.g. Tubing- vendor skids, auxiliaries etc)
- Interface documents -Elect/Inst/Pipeline/Vendors processes
- Vendor skids documentation and inclusion in baseline
- FM strategy applicable to Brown field

PEOPLE

- ORGANIZATION
- ENGAGEMENT
- BEST PRACTICE

PERFORMANCE

- MEASUREMENT
- COMPETENCY
- BEST PRACTICE

Best Practice-People

PROCESS

- GOVERNANCE
- STANDARISATION
- BEST PRACTICE

PLANT

- PLANT STATUS
- DOCUMENTATION
- BEST PRACTICE

PEOPLE

ORGANIZATION

- Management Structure "Organogram"
- Roles & Responsibilities
- Outline interface processes
- Project Primacy pitfalls

ENGAGEMENT

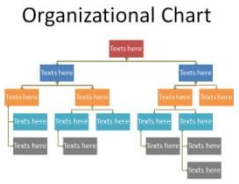
- Plant operators –Engage workforce-with local experience
- EPC/OPS/IMS/Operator – Communication protocols
- Use of Technology (Docs sharing, comms, etc)
- Understand Company Culture and Human Element
- More Engagement with RBA workshops

BEST PRACTICE

- Stakeholder identification, engagement plan
- Establish effective communication -"Integrity Sale pitch"
- Human Factors Vs Process: Ownership, Inclusion, Work load, error traps, latent conditions,
- Competency, Training and Awareness
- Safety during Brownfield Revamp- " e.g. beware of live lines"
- Integrity TA for revamp : Operation Team

PERFORMANCE

- MEASUREMENT
- COMPETENCY
- BEST PRACTICE



Best Practice-Performance

PROCESS	PLANT	PEOPLE	PERFORMANCE
GOVERNANCE	PLANT STATUSN	ORGANIZATION	MEASUREMENT
STANDARISATION	DOCUMENTATION	ENGAGEMENT	COMPETENCY
BEST PRACTICE	BEST PRACTICE	BEST PRACTICE	BEST PRACTICE

MEASUREMENT

- Project KPI and periodic monitoring
- Peer Review
- Self Verification Process
- Integrity Reviews ad as built corrections

COMPETENCY

- Competency Reviews (QA system)
- Technical Reporting Validity
- Use of technology/software / data management protocols
- Lack of experience of integrity inspection process (construction vs. Integrity)

BEST PRACTICE

- Forensic Inspections: Minimize /Manage
- Improve Inspection QA/Reporting/Recommendation (error traps)
- Identify and manage Critical Path risks at early stages of the project

Conclusion and Discussion

- RBA Brownfield Facilities; It is an Acid Test for the Facilities
- Major opportunities (FM Blasting on Live Lines/Temp Repairs/RO)
- Generic RBA's for low risk items(Cuts cost and adds value)
- Project primacy : Risk Review By Operator
- Get in early – Design phase- before manufacturing start
- Implementation Baseline inspection to be part of Engineering Projects
- Team work and local Ops experience inclusion
- The Need of a rigorous selection process for Integrity Contractor
- Revamp Project: Reporting and recommendation (QA issues)

Thank You for Your Attention!

For more information please visit:

www.oceaneering.com/asset-integrity

Or contact:

Monzar Najami (mnajami@oceaneering.com)

Hooman Takhtechian (htakhtechian@oceaneering.com)