WEDNESDAY WEBINAR

Webinar

LATE-LIFE ASSETS

- Thank you for joining. We will start momentarily.
- You can ask questions via the Q&A button in the zoom menu. During the webinar, all attendees are muted.

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STORK PROVIDES OPERATIONS & MAINTENANCE SERVICES
ACROSS MULTIPLE INDUSTRIES

SPEAKER INTRODUCTION

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Sr. Consultant-Asset Management Technology @ Stork

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Principal Integrity Consultant @ Stork

Michael Connelly

Contract Delivery Manager @ Stork

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TABLE OF CONTENT

- The challenge!
- Definition
- Strategic solutions
- Practical solutions
- Wrap-up

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THE CHALLENGE!

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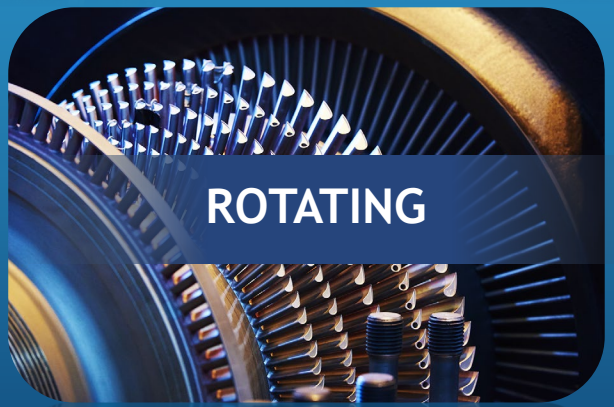
LATE-LIFE ASSETS
A HEADACHE FOR ALL DISCIPLINES



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LATE-LIFE ASSETS
OBJECT TYPES SUSCEPTIBLE TO AGING

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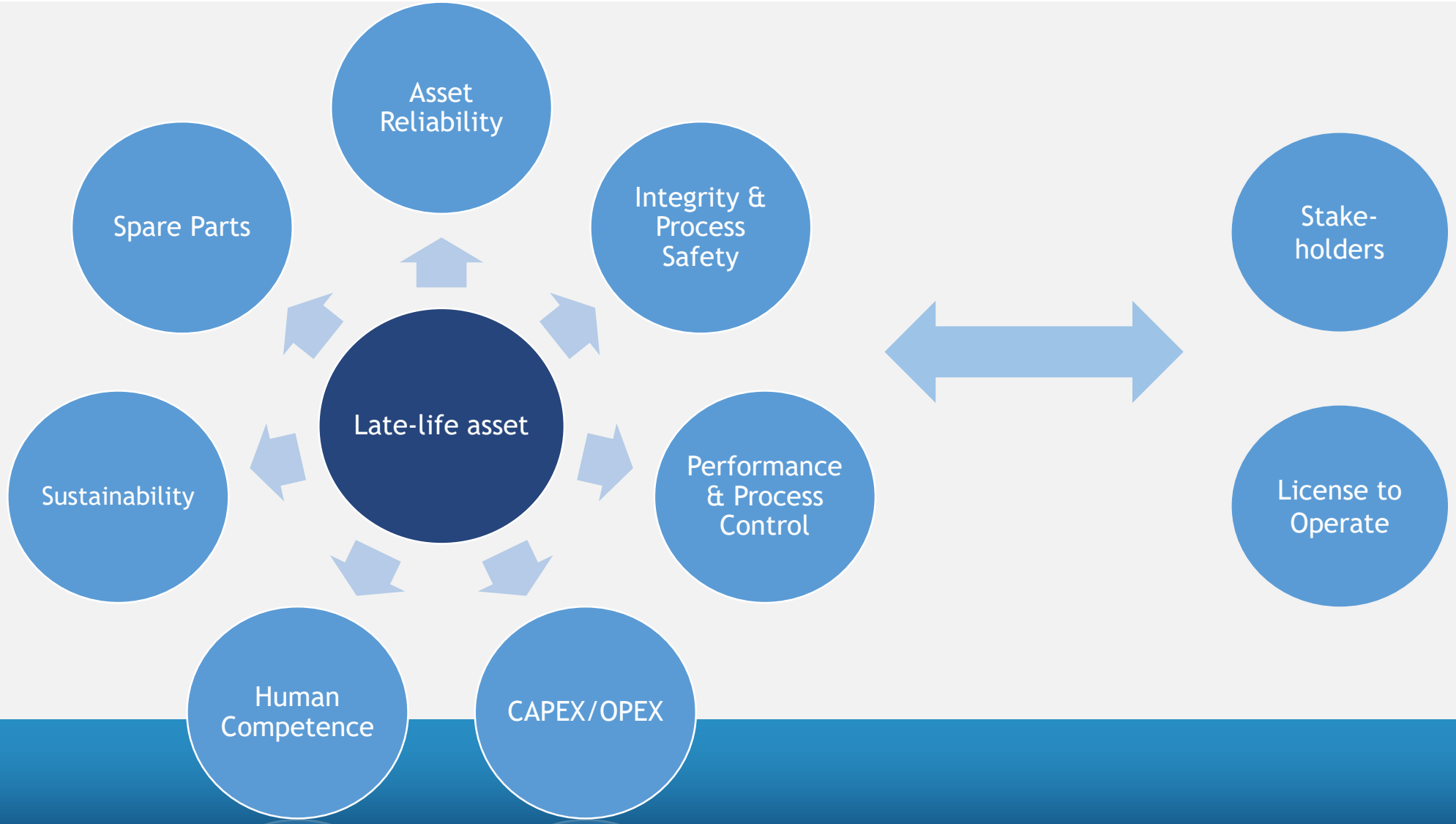
LATE-LIFE ASSETS
THE CHALLENGE



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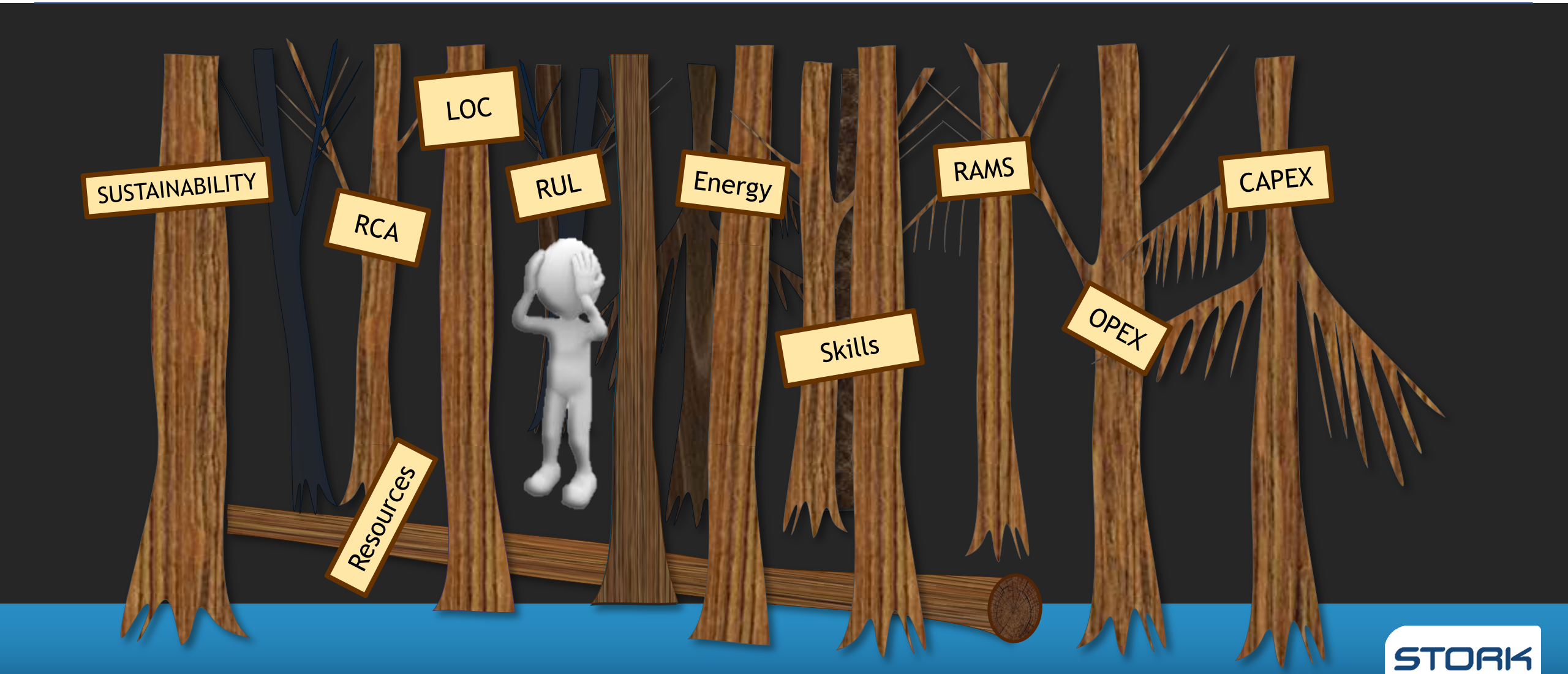
LATE-LIFE ASSETS
ARE YOU LOST IN THE FOREST?



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LATE-LIFE ASSETS
THE CHALLENGE!

- 30% of incidents have aging as a contributing factor;
- More frequent failures due to aging may impact personnel, public, environment and resources;
- Above 50% of oil platforms in the North Sea have passed their economic life;
- 1 out of 5 assets installed in the Netherlands has a remaining useful life shorter than 10 years.

Reference: [1], [2], [4]

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DEFINITION

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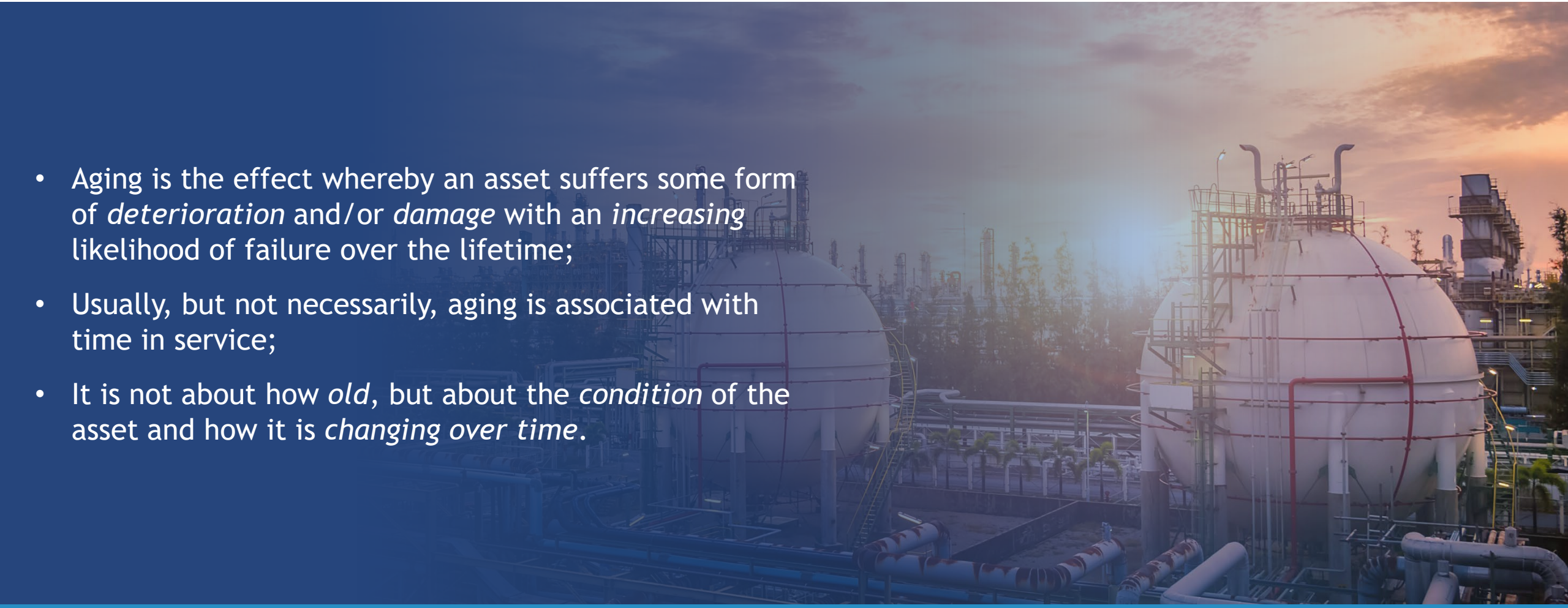
AGING ASSETS
DEFINITION



- Aging is the effect whereby an asset suffers some form of *deterioration* and/or *damage* with an *increasing* likelihood of failure over the lifetime;
- Usually, but not necessarily, aging is associated with time in service;
- It is not about how *old*, but about the *condition* of the asset and how it is *changing over time*.

Reference: [1], [5]

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LATE-LIFE ASSETS
DEFINITION

- Late-life is sometimes used for the assets which are passing last phases of their economic use, but are still profitable;
- In this case, late-life asset models should balance risk-performance-cost.

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LATE-LIFE ASSETS
FACTORS THAT REDUCE AN ASSET LIFE

- Poor design;
- Poor installation & commissioning;
- (Long-term) operating out of safe to operate limits;
- Poor maintenance;
- Poor Management Of Change;
- (Poor management of) obsolescence.

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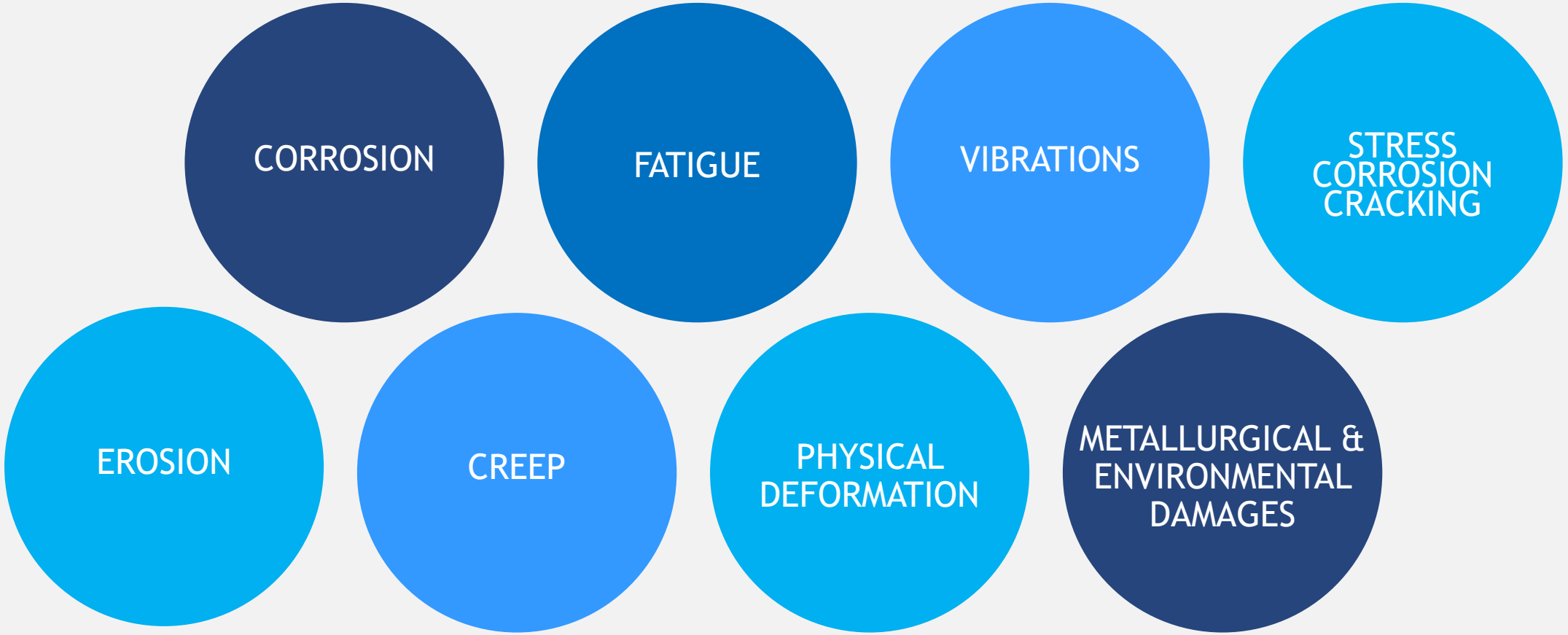
LATE-LIFE ASSETS
DOMINANT MODES OF FAILURE



Reference: [1]

LATE-LIFE ASSETS
INDICATORS OF AGING

- LEAKAGE
- DAMAGED SURFACES
- POOR EFFICIENCY
- POOR PROCESS STABILITY
- POOR PRODUCT QUALITY
- FREQUENT FAILURES
- OBSOLESCENCE

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LATE-LIFE ASSETS
A NUMBER OF APPLICABLE STANDARDS

Mechanical Integrity	• API 510: Pressure Vessel Inspection Code (In-service Inspection, Rating, Repair, and Alteration) • API 570: Piping Inspection Code (In-service Inspection, Rating, Repair, and Alteration of Piping Systems) • API 571: Damage Mechanisms Affecting Fixed Equipment in the Refining Industry • API 579-1: Fitness-For-Service • API 580 & 581: Risk-Based Inspection Methodology • API 584: IOW • API 653: Tank Inspection, Repair, Alteration, and Reconstruction
Process Safety	• IEC 61882: HAZOP studies • IEC 61508: LOPA / SIL – Hazard Identification and Risk Assessment • IEC 61511: Safety Standard for Safety Instrumented Process Systems • SEVESO III • EN 60079-10-2: Explosive atmospheres Classification of areas
Others	• ISO 15686-5: Buildings and Constructed Assets-Service life planning part 5 (life cycle costing) • NEN 2767: Condition Assessment Built Environment • IEC 62402: Obsolescence management • ISO 14224: Collection and exchange of reliability and maintenance data for equipment • IEC 60300-11: Dependability Management (RCM) • IEC 62740: RCA • Company HSE rules & regulations, MOC which become increasingly important due to dominant aging risks

STRATEGIC SOLUTIONS

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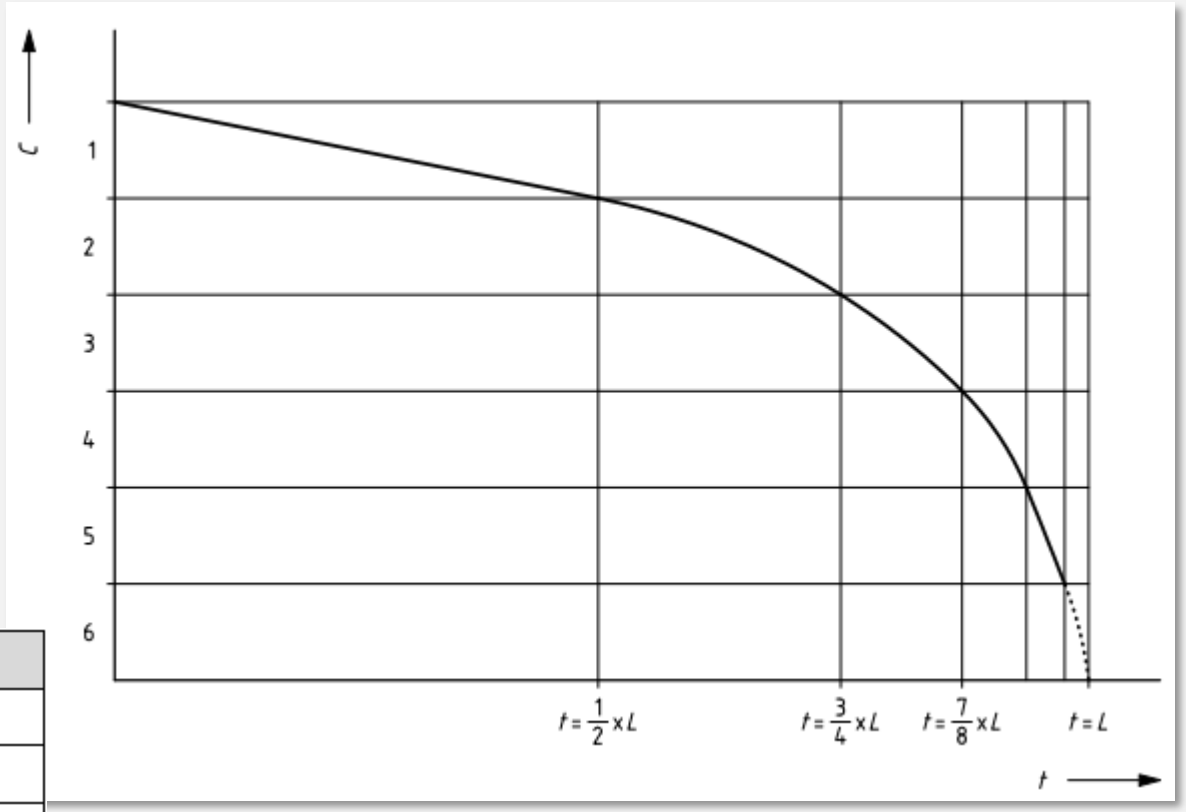
LONG TERM ASSET REPLACEMENT PLAN (LTARP)
INTRODUCTION

- LTARP provides an overview of required replacements, including non-critical assets;
- It is not directly about risk of asset failure;
- Discipline independent;
- Overall condition of assets is described in 6 levels versus remaining useful life;
- Conform Standard CEN 17385



Condition score	Description
1	Excellent condition
2	Good condition
3	Reasonable condition
4	Poor condition
5	Bad condition
6	Very bad condition

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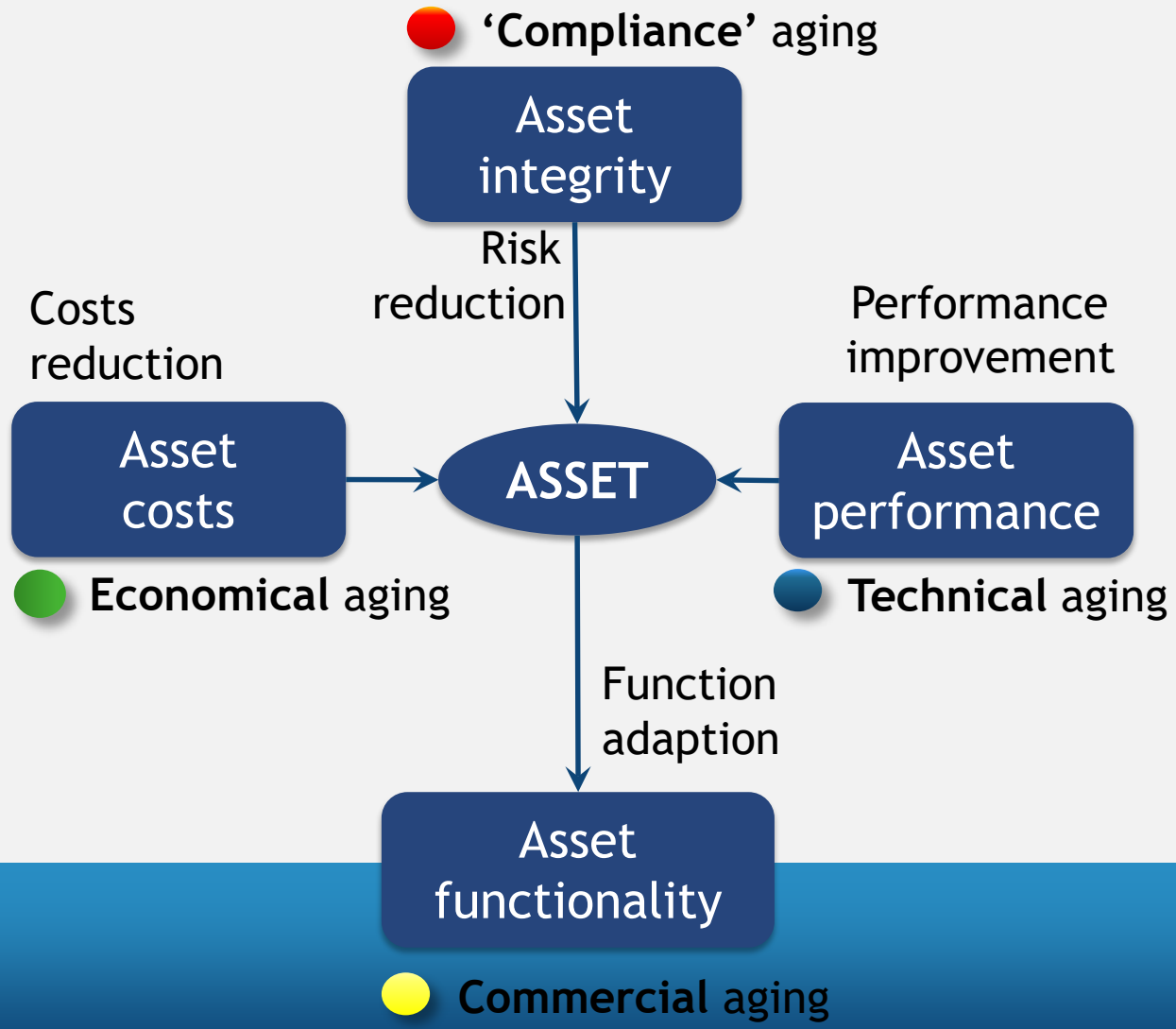
LONG TERM ASSET REPLACEMENT PLAN (LTARP)
VARIOUS END OF LIFE PREDICTIONS



VITALE
Value & Innovation Through Asset Life-time Extension

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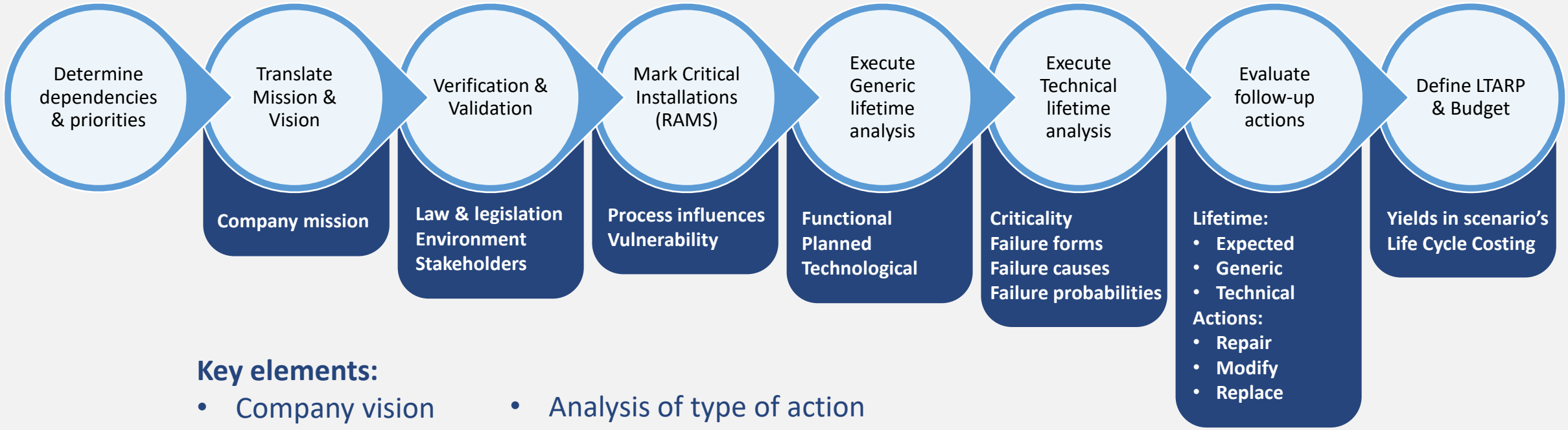
LONG TERM ASSET REPLACEMENT PLAN (LTARP)
THE PROCESS



Key elements:

- Company vision
- Legislation
- Criticality
- Functional analysis
- Analysis of type of action
- Budget planning
- Standardized approach
- Limited number of parameters

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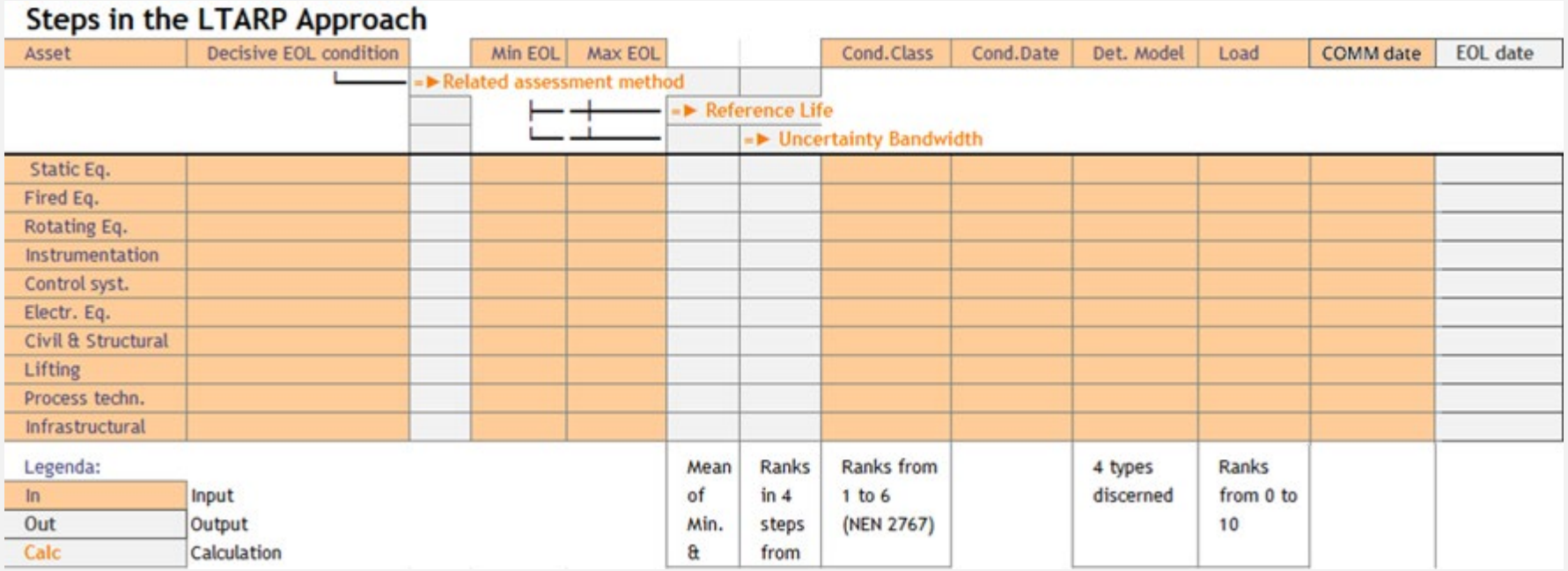
LONG TERM ASSET REPLACEMENT PLAN (LTARP)
'STATE OF THE ASSET' OVERVIEW



Steps in the LTARP Approach

Asset	Decisive EOL condition		Min EOL	Max EOL			Cond.Class	Cond.Date	Det. Model	Load	COMM date	EOL date
		=►Related assessment method										
					=► Reference Life							
						=► Uncertainty Bandwidth						
Static Eq.												
Fired Eq.												
Rotating Eq.												
Instrumentation												
Control syst.												
Electr. Eq.												
Civil & Structural												
Lifting												
Process techn.												
Infrastructural												
Legenda:					Mean of Min. &	Ranks in 4 steps from	Ranks from 1 to 6 (NEN 2767)		4 types discerned	Ranks from 0 to 10		
In	Input											
Out	Output											
Calc	Calculation											

6 [parameters]
to determine the
'reasonable worst case'
expected lifetime:

- [Lifetime model type]
- [Condition]
- [ConditionDate]
- [Load]
- [Uncertainty]
- [Date of first use]

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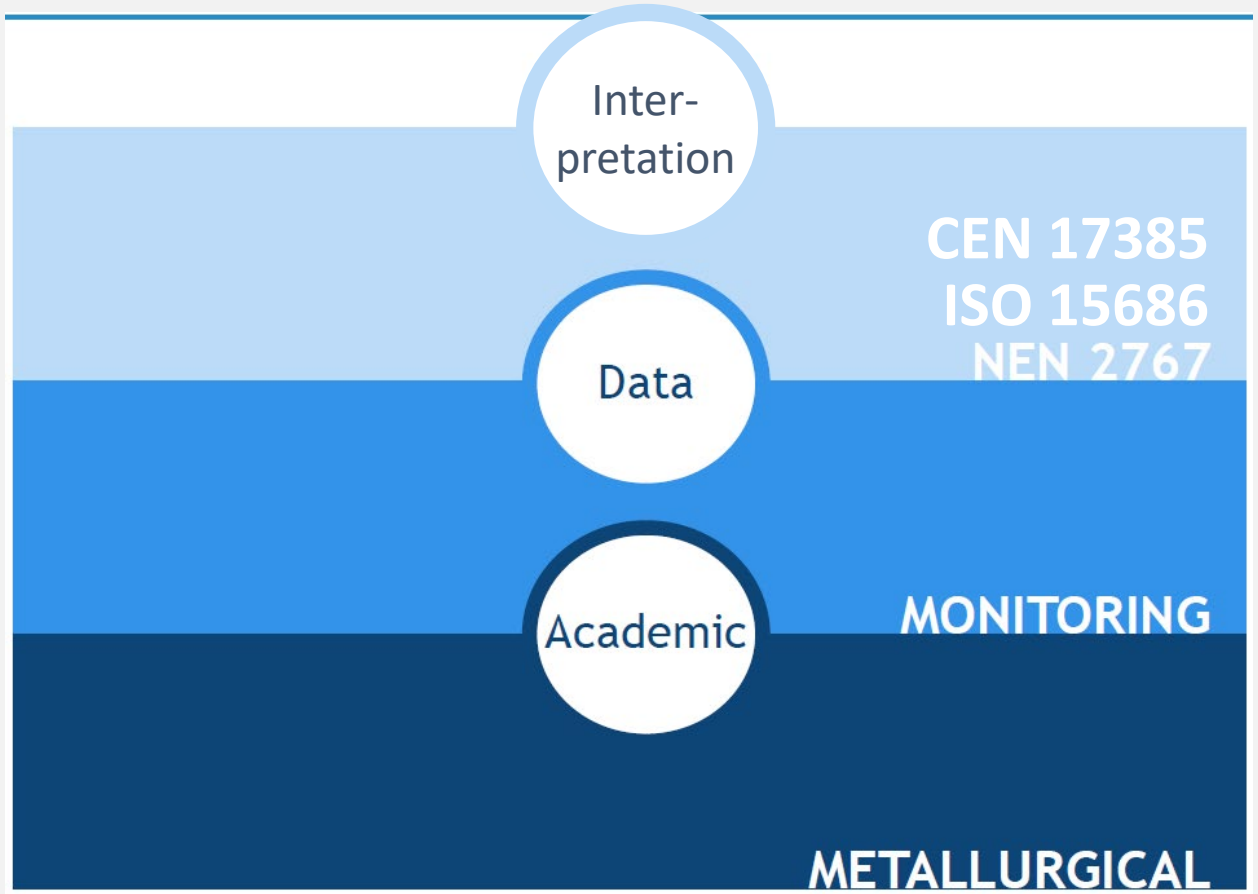
LONG TERM ASSET REPLACEMENT PLAN (LTARP)
THE PROCESS - FUNDAMENTAL APPROACH



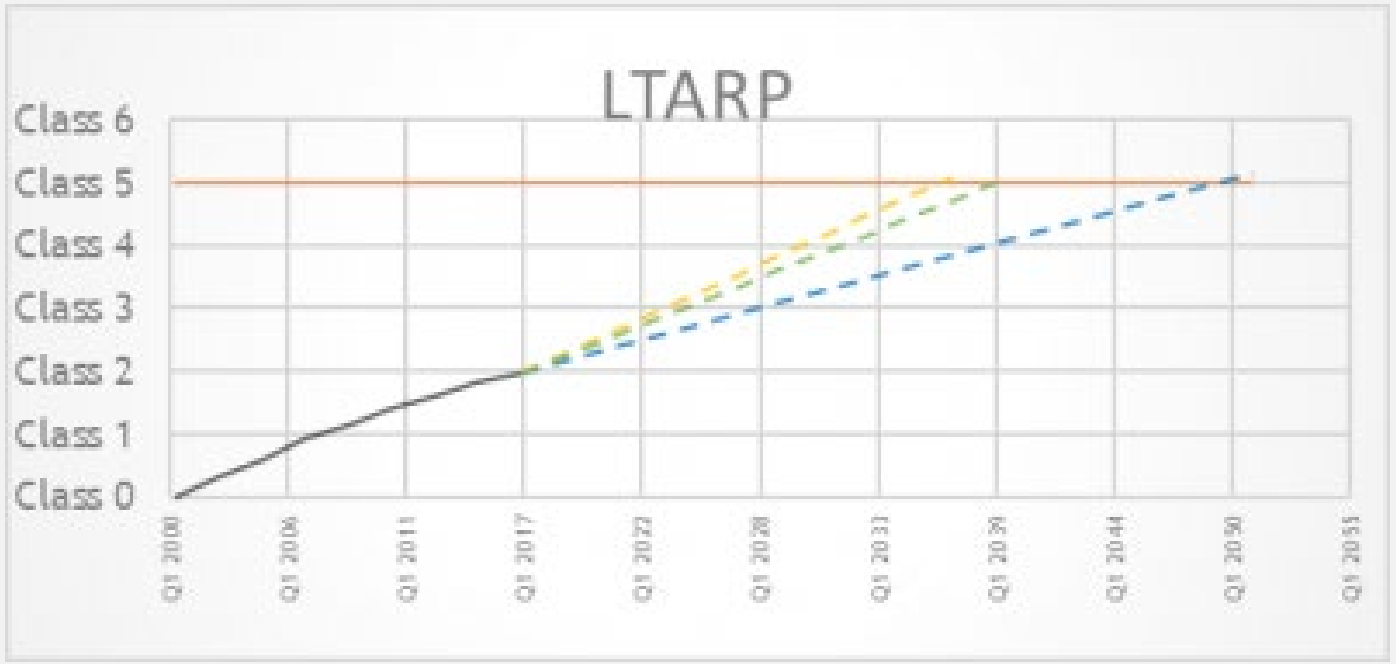
- Use of behavior on elemental level when identified by means of tangible data.
- In all cases decisions based on the accepted condition model.
- In case of lacking data on the actual condition; the observed behavior in generic practise is applied.
- Comparison with using MTTF data in an RCM study is there, now scaled up to asset level.

LONG TERM ASSET REPLACEMENT PLAN (LTARP)
THE PROCESS - THEORETICAL

Condition score	Description of condition	Explanation
1	Excellent	Incidental, minor defects
2	Good	Incidental, early-stage obsolescence
3	Reasonable	Visible obsolescence in places Function performance by construction and installation parts not jeopardized
4	Moderate	Function performance by construction and installation parts jeopardized on an incidental basis
5	Poor	Obsolescence is irreversible; the installation must be replaced
6	Very poor; unacceptable.	The installation is ready for disposal and can no longer be operated safely

- Conform CEN 17385, ISO 15686 & NEN 2767
- Condition of an installation determined based on available data & discussions with asset owner.
- Checklists containing experiential information and questions that facilitate a substantiated determination of the condition of an asset.
- Sample shows how to aggregate findings to asset level.

LONG TERM ASSET REPLACEMENT PLAN (LTARP)
THE PROCESS – ANALYTICAL APPROACH



TIME	CONDITION (MM)	CONDITION (CLASS)
Q1 2001	17,0 mm	Class 0,00
Q1 2003	16,3 mm	Class 0,32
Q1 2005	15,7 mm	Class 0,59
Q1 2007	15,0 mm	Class 0,91
Q1 2009	14,5 mm	Class 1,14

End of life value (mm)	6,0 mm
End of life condition (class)	Class 5,00
Nominal value (mm)	17,0 mm

- Data driven approach
- A traceable assessment process based on condition trend analysis.
- The complexity of data involved can vary from expertise driven, qualitative onto fully quantitative.
- A Level 2 forecast utilizes available data from the actual practise.

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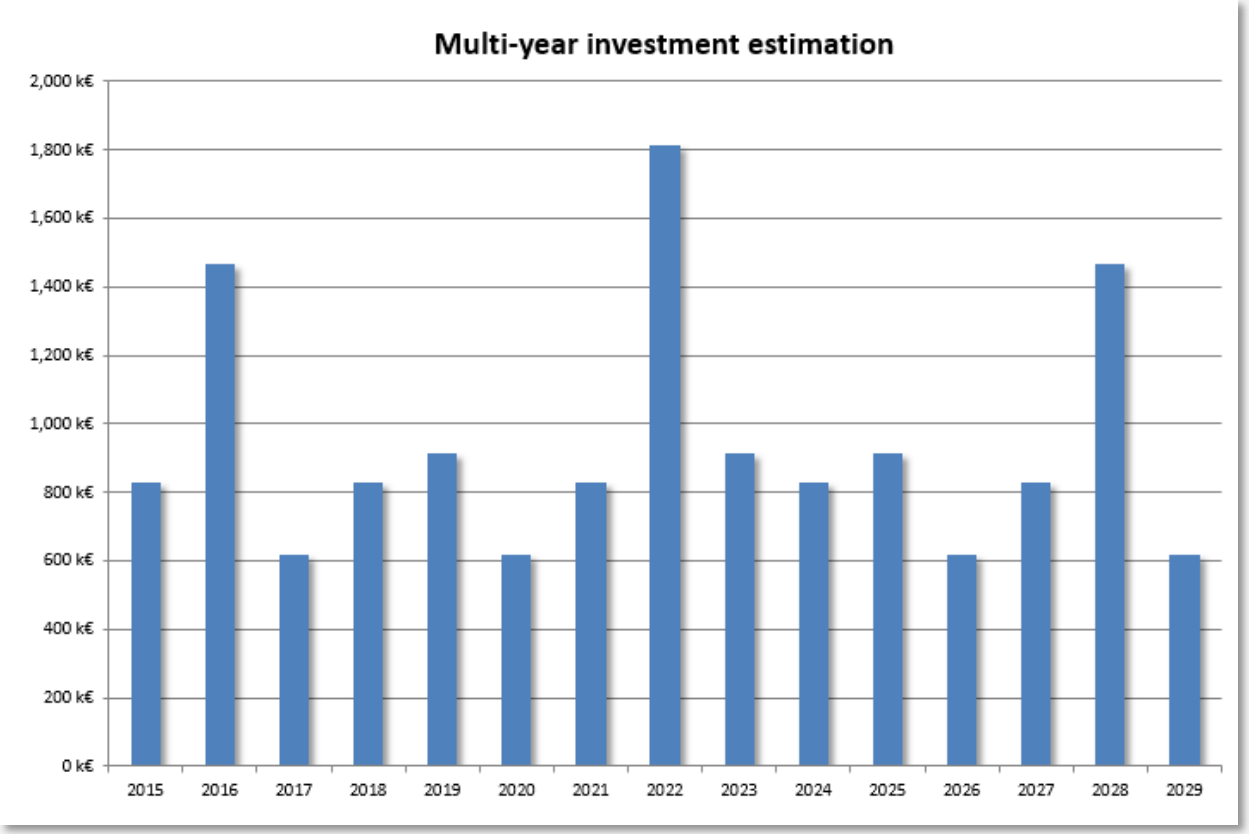
LONG TERM ASSET REPLACEMENT PLAN (LTARP)
THE PROCESS – FULLY QUANTITATIVE METHOD.



The result:

- Overview of summarized replacements / costly repairs required over time
- End of life prediction based on condition classification for the major assets as defined within the scope

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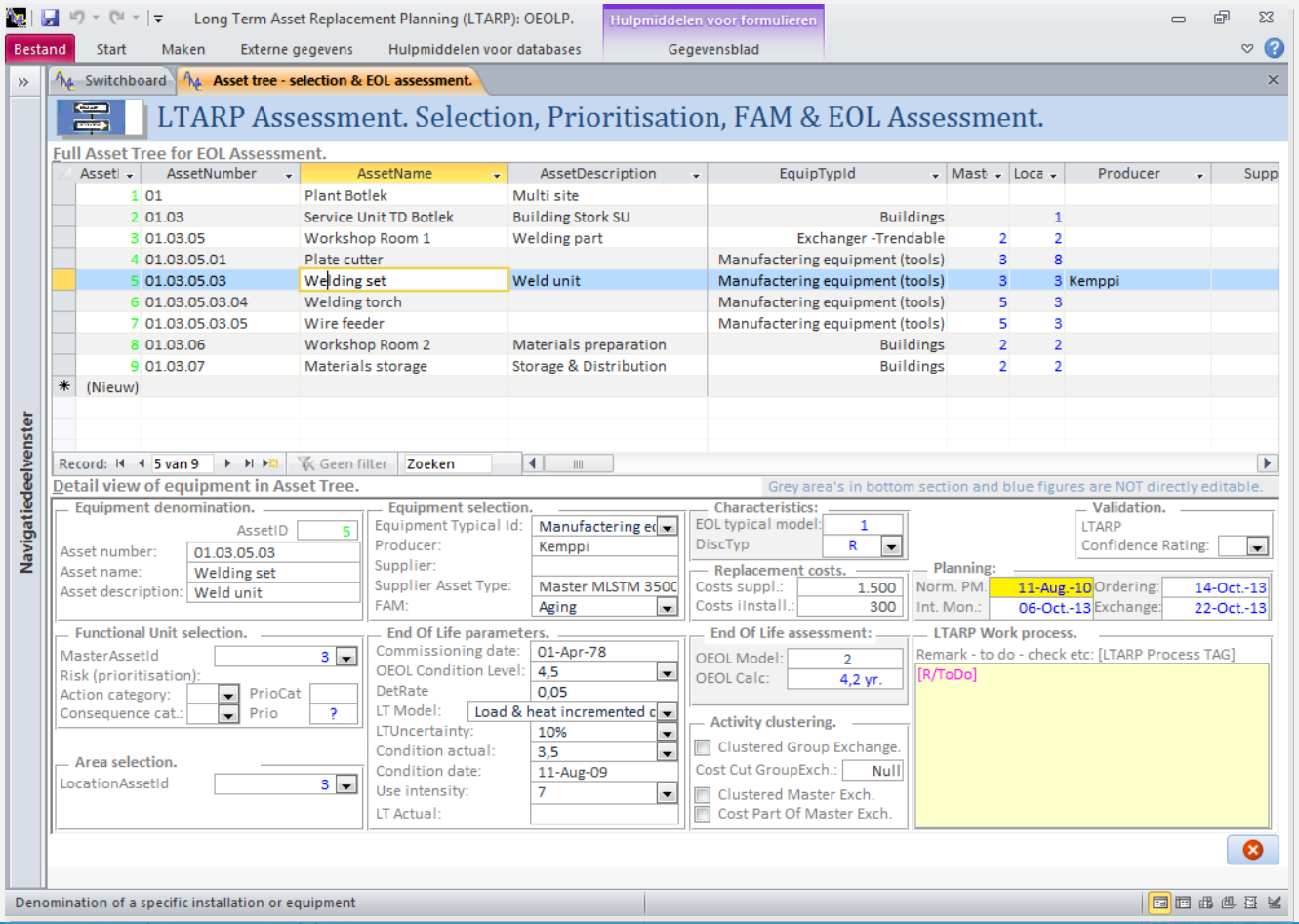
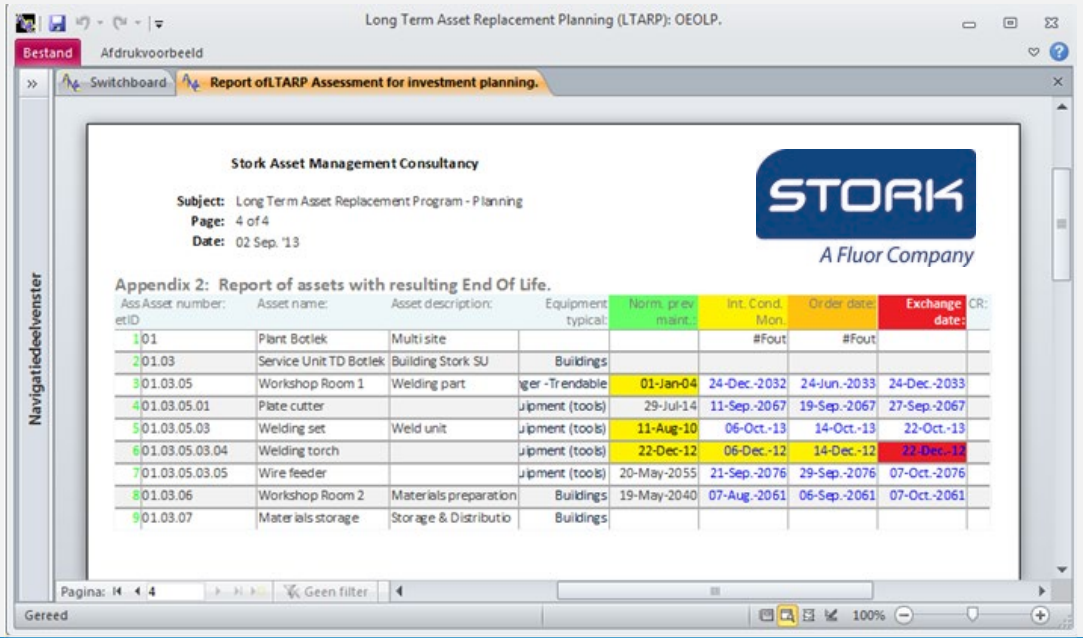
LONG TERM ASSET REPLACEMENT PLAN (LTARP)
THE OUTCOME





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LONG TERM ASSET REPLACEMENT PLAN (LTARP)
PROVEN RESULTS

CUSTOMER CASE – HEALTH CHECK - LTARP & LTMP
AZN MOERDIJK

HOW WE ADD VALUE

Challenge:
AZN Moerdijk wanted to upgrade and optimize
plans. The question was to develop a investme
improvements, modifications and asset replace
maintenance concepts were upgraded by imple
information in these concepts and maintenanc

Result:
- Higher Overall Asset Effectiveness (OAE)
- Improved maintenance concepts
- Financial clearness for the next 20 years
- Reliable investment plan

CUSTOMER CASE – INVESTMENT PLANNING - LTARP
TWENCE HENGELO

HOW WE ADD VALUE

Challenge:
TWENCE wanted to upgrade its installations
overhaul and use the opportunity to also ref
the installation. The question was to develo
the asset replacements as well as provide ar
term, defined as 10 years ahead.
As a spin-off, maintenance concepts were up
implementing the required condition classifi
information in the applied concepts and mai

Result:
- Enhanced Overall Asset Effectiveness (OA
- Improved maintenance concepts
- Financial planning for the next 10 years
- Opportunity based upgrade of the installa
- Lifetime extension of identified critical c

CUSTOMER CASE – AGING ASSETS- LTARP & LTMP
SACHEM ZALTBOMMEL

HOW WE ADD VALUE

Challenge:
Sachem Zaltbommel was in need for an adequate approach to provide validate its long term asset plans from risk perspective. The question was to develop an approach for aging assets (covering improvements, modifications and asset replacements) that complies with the requirements of the Internal Shareholders als well as external Stakeholders (being Dutch Authority in the framework of external safety). The maintenance concepts were upgraded by implementing the requirement for aging information (condition classification) in these concepts and maintenance plans.

Result:
- Transparency in long term replacement plans
- Clear prediction of the time of use of critical (glass) equipment
- Financial budget forecast for the next 12 years
- Review of level of managing of aging assets by an independent company (“four eyes principle”; “validation”).

CLIENT REFERENCE

Sachem

Asset Management – RBI, LTARP & LTMP

Investments for next 12 years

Management of aging assets

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PRACTICAL SOLUTIONS

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LATE-LIFE ASSETS
FROM AN OFFSHORE PERSPECTIVE

- Offshore oil and gas platforms are subjected to hostile, corrosive, marine environments
- They require continuous preventative maintenance to ensure prolonged and safe operation.
- Corrosion under insulation (CUI) is one of the costliest problems facing the oil and gas industry today.
- Our objective is to execute safety critical & business critical risk that remove any likelihood of a safety, environmental or production impact

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LATE-LIFE ASSETS
CONSEQUENCE OF INSUFFICIENT MAINTENANCE

Gas blast after a corroded pipe ruptured on an North sea offshore platform:

- + 2 tonnes of methane gas escaped
- Cause: Corrosion Under Insulation (CUI)
- Luckily no-one injured
- The operator was fined £1.16m.
- Reputational damage

LATE-LIFE ASSETS
CUI - REMEDIATION AND INNOVATION

Innovative Coatings

Preformed bend & Cap end

Drain Plugs

PICKING THE CORRECT COATING & INSULATION SYSTEM IS ESSENTIAL TO REDUCE FUTURE CUI ISSUES

CUI: Corrosion Under Insulation

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LATE-LIFE ASSETS
PROJECT - STRUCTURE REFURBISHMENT

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LATE-LIFE ASSETS
INSULATION REMOVED AND CORRODED AREAS REPAIRED

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LATE-LIFE ASSETS
CUI DISCOVERED – FM PREPPED AND HOLDING COAT APPLIED

LATE-LIFE ASSETS
MULTI-SKILLED TEAMS

BENEFITS OF MULTI-SKILLED TEAMS

- Reduction in ad-hoc requirements and the associated savings that brings
- Approx. 85% of the offshore FM/CUI teams are rope access qualified, thus substantially removing the need for scaffolding
- Supports personnel retention which brings the added benefit of Asset familiar personnel

LATE-LIFE ASSETS-2021 FABRIC MAINTANCE & CUI PROJECT

ROPE ACCESS SOLUTIONS-EFFICIENCY'S OVER TRADITIONAL ACCESS METHODS

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2021 FABRIC MAINTENANCE & CUI PROJECT
BENEFITS

Painting / Coating

- ✓ Reinstate (hydrocarbon containment) performance standard back to full compliance
- ✓ Ceased corrosion
- ✓ Coating life span

Passive Fire Protection

- ✓ Reinstated PS19 performance standard back to full compliance

Insulation

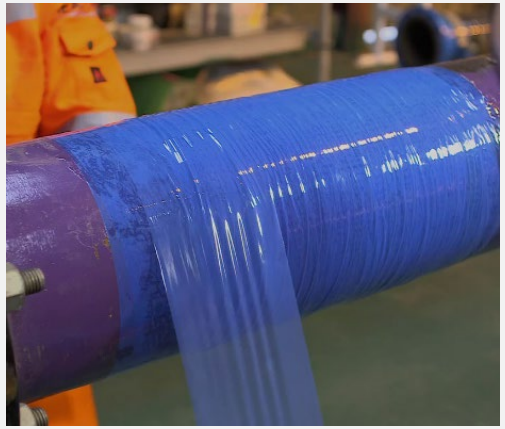
- ✓ CUI risk removed
- ✓ PPG reinstated in place of heat conversation where necessary

All

- ✓ Risk Compliance
- ✓ Reliability Assurance
- ✓ Greater process uptime
- ✓ Reducing risk of leakages / failures
- ✓ Potential Environmental impact reduced
- ✓ Protecting original material
- ✓ Cost saving v replacement

LATE-LIFE ASSETS
STRUCTURAL & PIPING REFURBISHMENT

Floors



Piping

Flanges

Bolts

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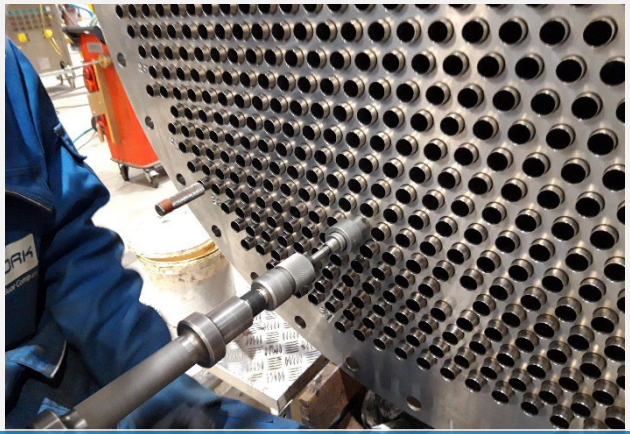
LATE-LIFE ASSETS
PROCESS EQUIPMENT REFURBISHMENT



Heat-exchangers

Condensers

Boilers

Burners

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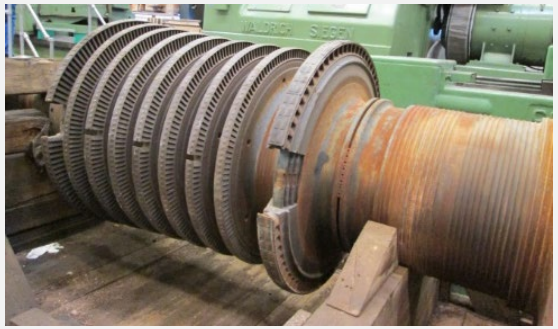
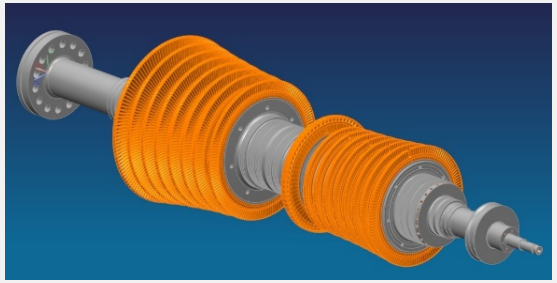
LATE-LIFE ASSETS
ROTATING EQUIPMENT REFURBISHMENT

Pumps

Compressors





Turbines

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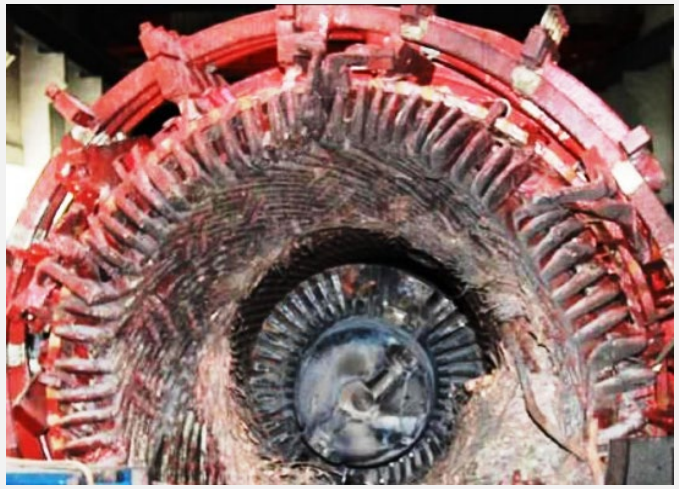
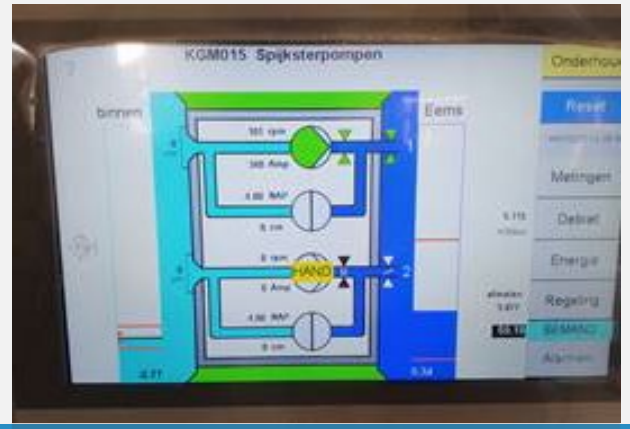
LATE-LIFE ASSETS
ELECTRICAL & INSTRUMENTATION REFURBISHMENT





Turbine controls

Pump controls

Generators

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LATE-LIFE ASSETS
WRAP-UP

Late-Life Assets is about how (far/quick) an asset deteriorates over time and what balanced solutions may be applicable

Late-Life Asset management demands a comprehensive approach

Stork applies multiple methodologies to detect, quantify and address risks & expenditures of Late-Life & Aging assets

Stork offers multiple best practices for late-life & aging Static, Rotating, Electrical, Instrumentations, and Civil assets

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LATE-LIFE ASSETS REFERENCES

- [1] Horrocks, P., et al, 2010. *Plant Ageing Study – Phase 1 Report*. Health and Safety Executive
- [2] *Major Accident Reporting System (eMARS)*, https://emars.jrc.ec.europa.eu/en/emars/content (accessed on 11.Nov.2021)
- [3] *Health and Safety Executive* [website], https://www.hse.gov.uk/offshore/statistics/index.htm (accessed on 11.Nov.2021)
- [4] Haarman, M., *Facts and figures about Asset Management in Dutch chemical industry,* APM.4 conference Antwerp, Oct.2021
- [5] Dudley, J., *Aging Assets Not a Disadvantage*, Efficient Plant [website] https://www.efficientplantmag.com/2020/05/aging-assets-not-a-disadvantage/ (accessed on 30.Nov.2021)
- Stork Knowledge Online

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> QUESTIONS?

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