Knowledge grows

How Yara is dealing with aging plants

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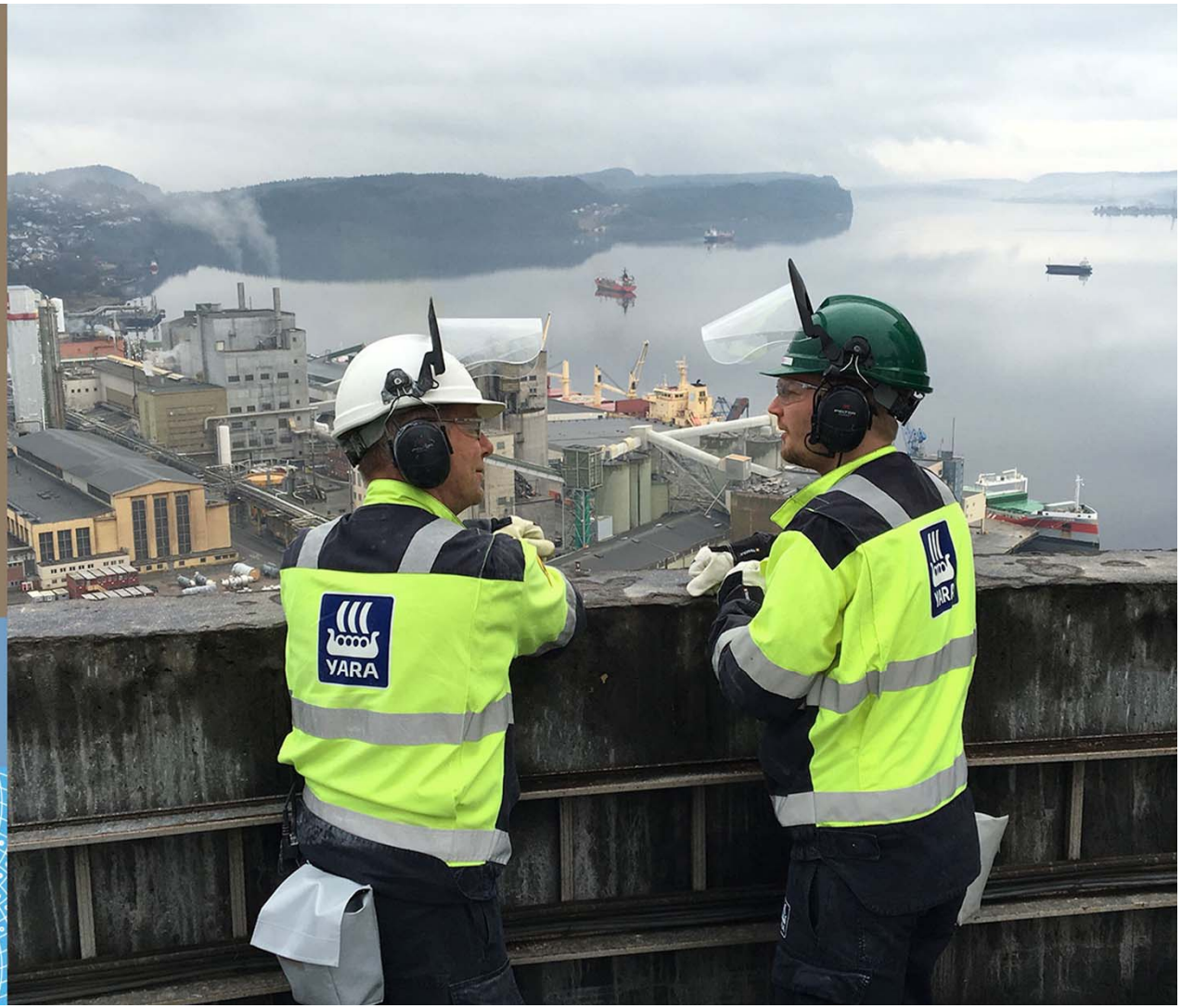


Yara is one of the biggest fertilizer producers in the world
Our global presence is growing

+17000
The number of people we employ

+160
The number of countries we sell to

+60
The number of countries we operate in

300 million
people our products help to feed

9000
Retail outlets

800
Agronomists on the ground

20 million
The number of farmers we work with

In numbers

More than

17,000

employees

Sales to about

160

countries

Revenue

NOK 93.8 Billion

(USD 11.4 Billion)

In 2017

Our Mission

Responsibly feed the world and protect the planet

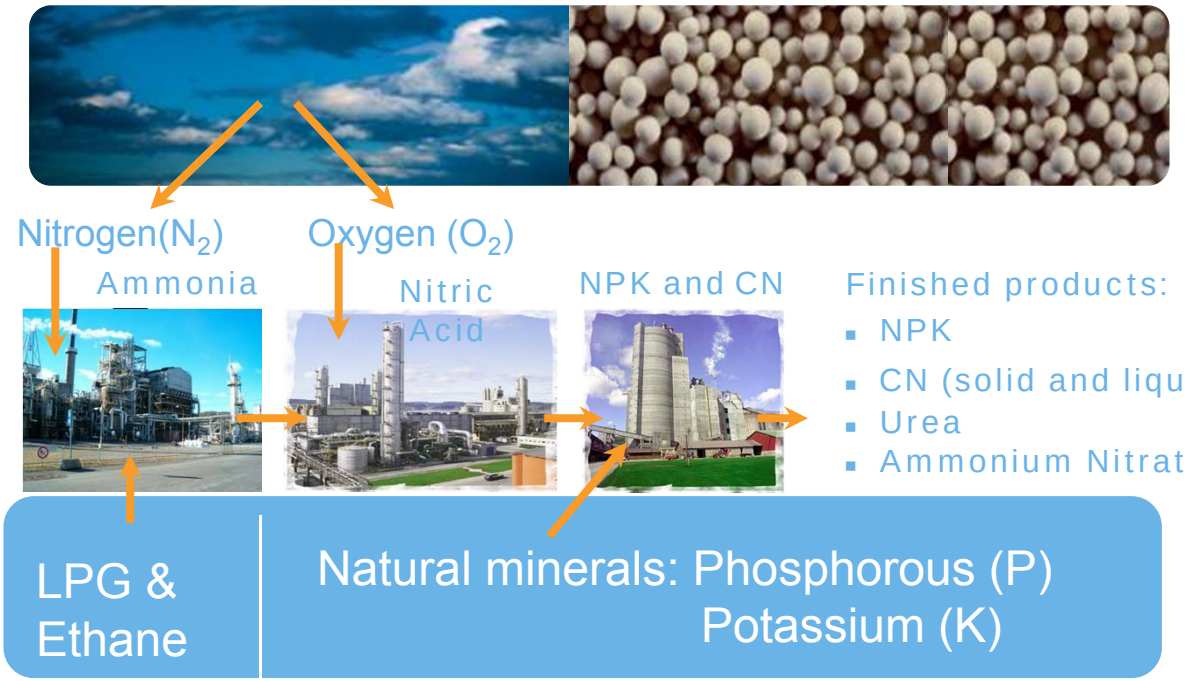
Our Vision

A collaborative society; a world without hunger; a planet respected

Aging plants

- Yara has more than 25 chemical plant locations around the world
- Many of the plants are aging including the best performers.
- Several of the units in Porsgunn facility are aging and among the largest in its product group

Set up of Yara production



Herøya 1927 and today - the location of Yara Porsgrunn

Key criteria in successful operation of aging plants

They must

- be reliable and safe
- satisfy authorities and legal requirements (emissions, technical standards etc).
- be economical

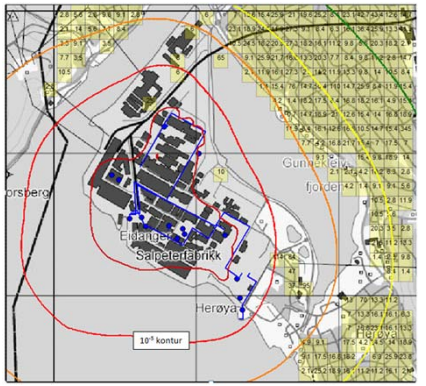
Management will include aging and obsolescence.

Operating and managing of aging plants is a continuous improvement process that includes the above criteria.

Aging plants
How Yara is handling the safety requirements

- Risk assessments (QRA, HAZOP, LOPA, SIL)
- Integrity of process equipment
- Integrity Operating Window (IOW)
- Process safety and control systems. Functional Safety.
- Management of change
- Working with people

Aging plants
Risk assessments



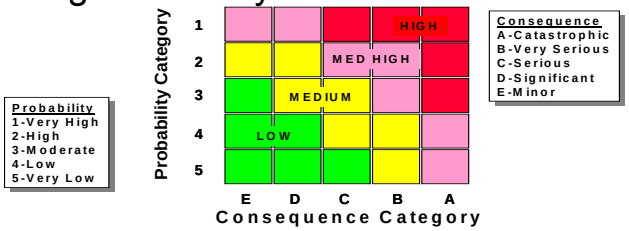
- **QRA – Quantitative Risk Assessment**
  - Normally used for calculating individual risk contours
- **HAZOP – qualitative hazard identification**
  - Include auxiliary systems
  - Updated every 10 years
- **LOPA – assessment of risk barriers**
  - Used to determine the required reliability of the Safety Instrumented Functions (SIF)
  - Likelihood of failure of protection layer
- **SIL – safety integrity level**
  - Safety Instrumented Function (SIF)
  - Assessment of risk reduction required from SIF to give a sufficiently low level of risk in relation to a hazardous event.

- By applying modern methods for risk ranking on old plants and system designs, Yara believes risk can be better controlled

Integrity of process equipment.
Risk Based Inspection

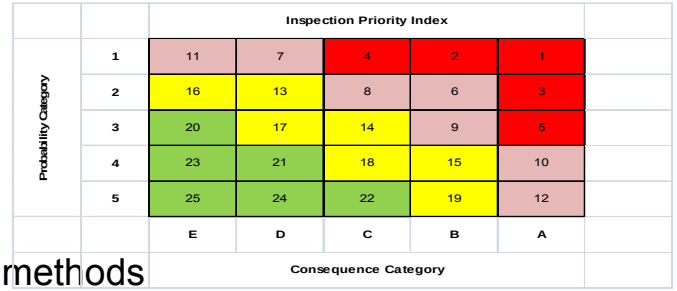
The primary purpose of an RBMI assessment is to manage risk on an asset level based on expected degradation mechanisms.

- 10 years ago, Yara introduced RBI. RBMI Capstone software package from Lloyds was selected
- The system was introduced to already aging plants



Input

- Corrosion loops
- Process parameters
- Materials and dimensions. Construction code
- Susceptible to CUI?
- Risk ranking
- User experience (other degradation mechanisms)



Output

- Inspection plan including damage mechanisms and inspection methods
- Inspection Priority Index

Integrity of process equipment.
Risk Based Inspection

Benefits

- An improved understanding of current risk allows to focus resources on the high risk items
- Development of inspection plans that address ways to manage risks at the equipment level taking into account not only what happened in the past but also what could happen;
- A tool for continuous improvement: ever greening the RBI process gives a continuous risk reduction;
- Increased reliability and higher safety standard.
- Well documented process and inspection program.

Equipment not included in RBI program

- Equipment not containing dangerous media
- Inspection program based on criticality, competence and experience
- Inspection program assessed after each inspection

Aging plants
Integrity of process equipment

In case issues are found/things go wrong

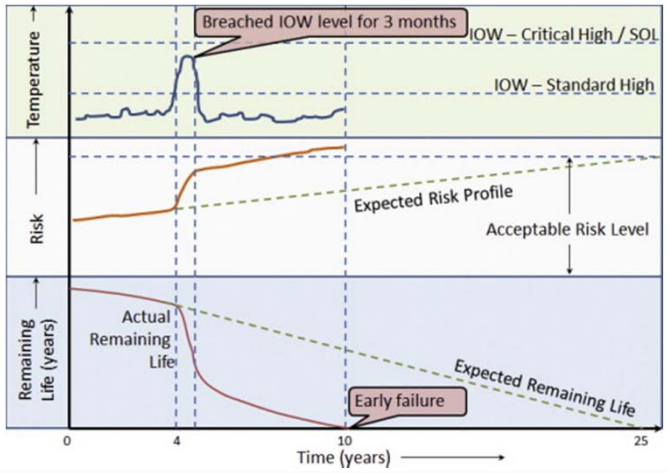
- Fitness For Service (FFS)
- Repair
- Replacement/modifications. Management of Change (MOC)
- Root Cause Analyzes. Share!

Replacement of equipment

- When equipment need to be replaced, the replacement are designed and constructed according to today's rules.
- Improvements -> MOC

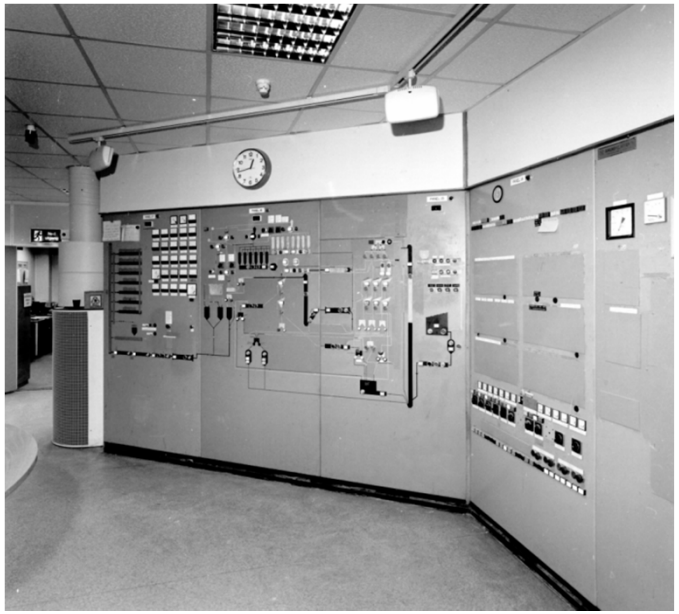
Integrity of Process Equipment
Integrity Operating Window (IOW)

- **Integrity Operating Windows** (IOWs) are sets of limits used to determine the different variables that could affect the **integrity** and reliability of a process equipment or unit.
- It is important to develop limits for each damage mechanism.
- When operating an equipment inside the limits, it is normally considered safe.
- Alarms when process parameters are outside limits -> involvement of inspection department and assessment of possible damage/actions.



Electronic control and safety systems.

Aging plants, however following development within control and safety systems.
Illustration of control room decades ago and today

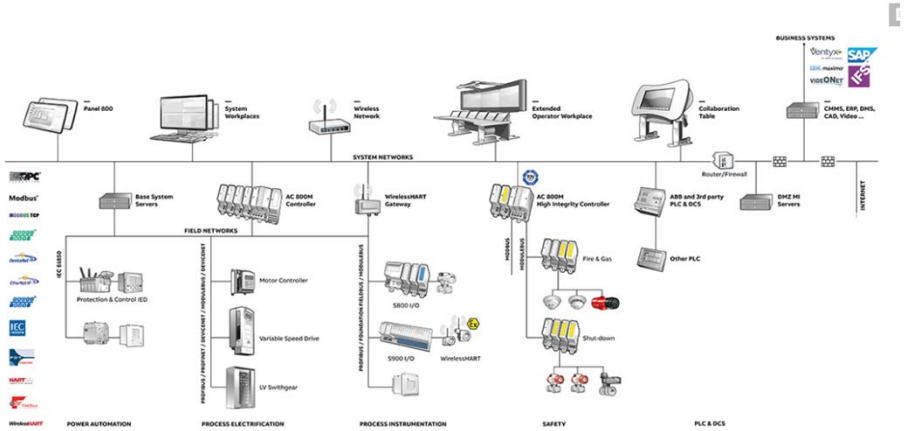


Aging plants
Electronic control systems and safety systems

- Functional safety, electronic safety systems and control systems have developed rapidly during the last 30 years and Yara is following this development closely and aiming for improvements .
- Today's digital technology focuses on good and intuitive user interfaces. The threshold to use the system is low.
- The technology behind can be more challenging

How to stay updated?

- Maintain a culture for gaining and sharing competence
- Close cooperation with suppliers – "us"
- Standardize on equipment
- Try new solutions and dare to think new.
- Participate in projects
- Networking and training



Concern

- New updates of DCS systems might lead to overflows of alarms. Alarm management.

Aging Plants
Management of change

- Management of change is about maintaining integrity by controlling the many changes that occur during the lifetime of a site operating process plant.
- 4 types of changes to be assessed:
  - Plant: Adding, changing or removing plant hardware
    - P&ID, piping, materials, change of relief valves etc
  - Process: changing the plant control
    - Logic, alarm and trip setting, process control chemicals, feedstock etc
  - People: changes to the organization supporting the plant
  - Procedures: changes to operating procedures

Aging plants
Emissions

- Allowable limits for emissions and noise from process plants becomes lower and lower.
- Yara Porsgrunn is certified according to ISO 14001 Environmental management systems.
  - Identify issues, interested parties and expectations, defining processes. Identify risks and opportunities.
  - Plan and work in a systematic way to reach goals
  - Evaluate performance
- Dust removal.
- Reduction of emissions to air and water.
- Noise reduction

Aging plants
Working with people

Key success factors:

- Competent people through the whole organization
  - correct attitude
  - ownership to equipment and processes
  - systematic training and refresher training (more important than ever due to higher rotation of people)
- An open 2 way communication
- A systematic way of working
  - A good system for asset integrity management and following up. Feedback to the organization.
  - Continuous focus on derogations and dangerous conditions.
  - Plant tours to improve equipment and the way of working, effectiveness and safety.