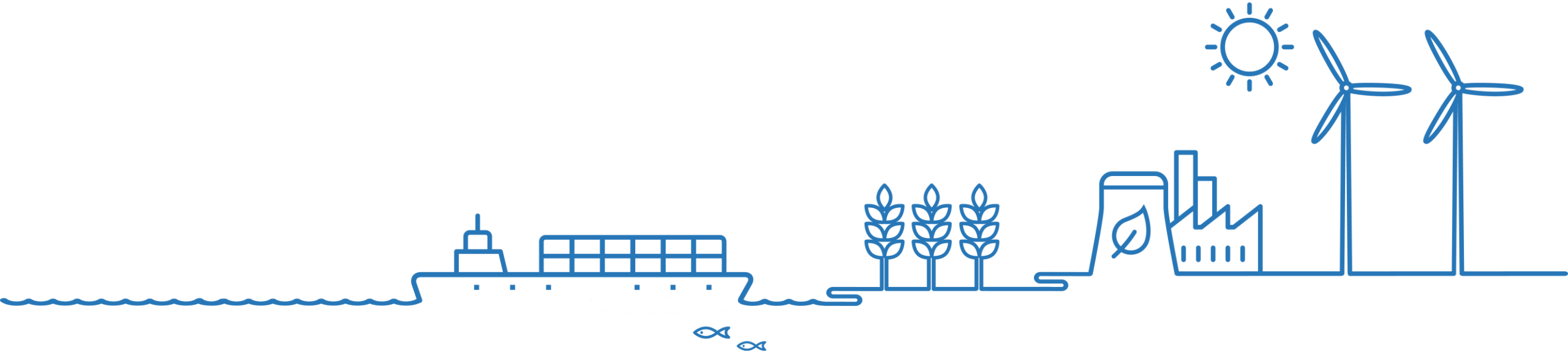
Yara Clean Ammonia

Safe Ammonia handling – Challenges & Opportunities

March 2025

Content

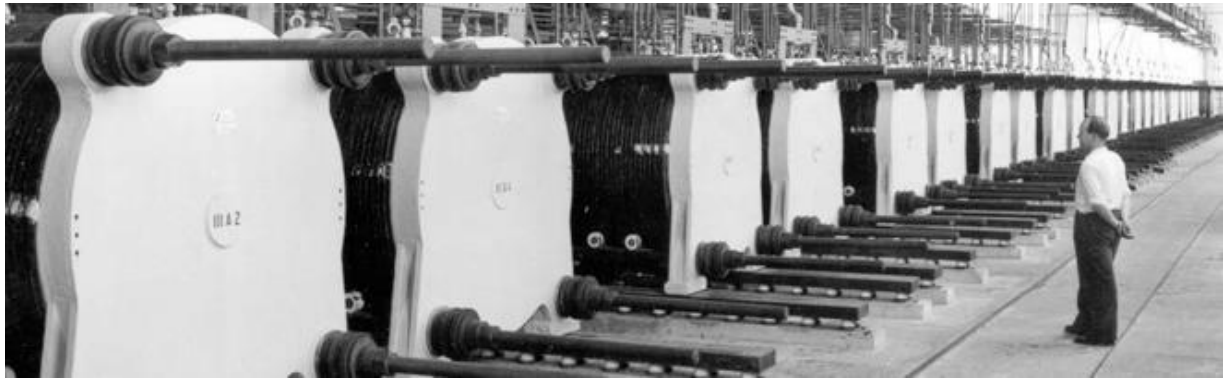
- Yara Clean Ammonia Introduction
- HESQ performance at Yara
- 40 years of learnings from OSHA
- Main challenges



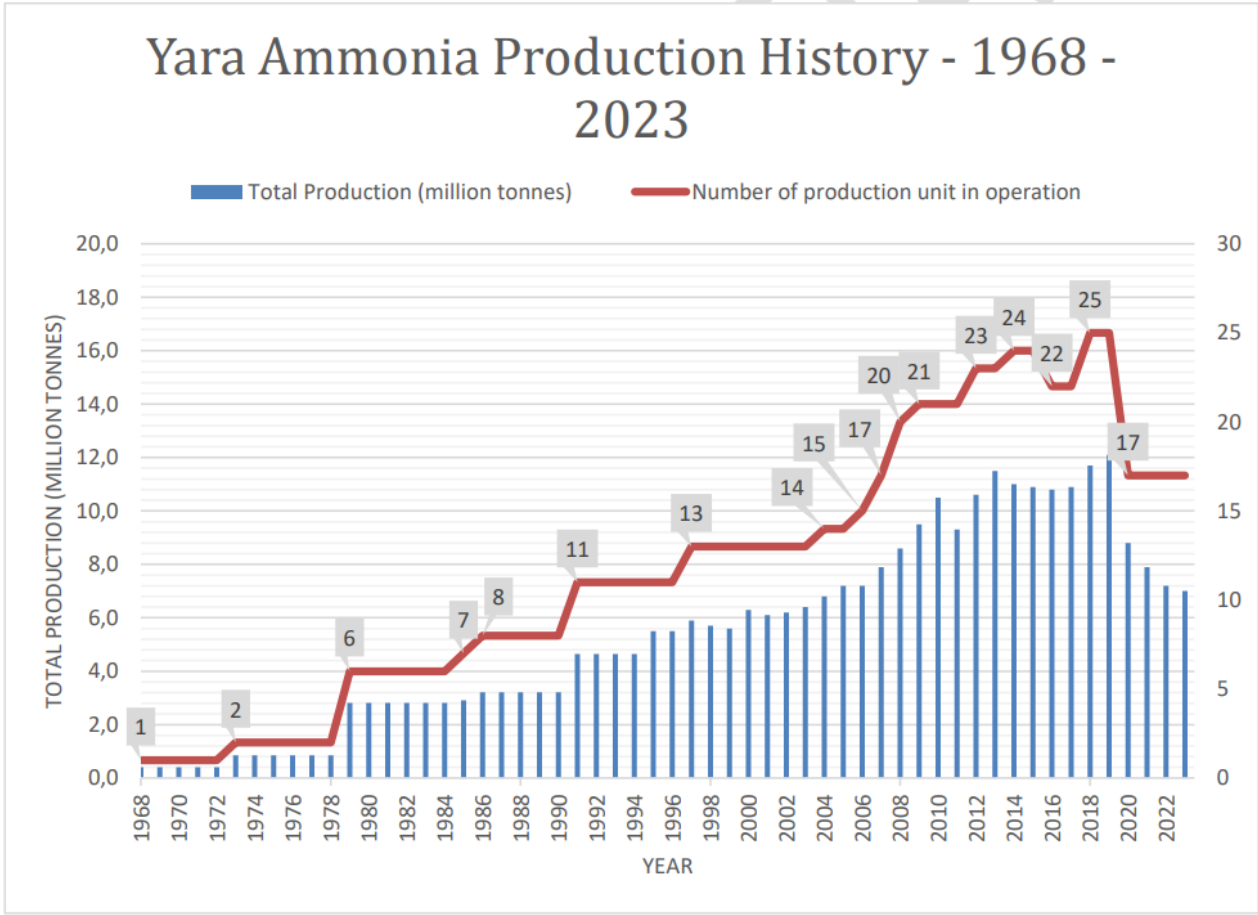
YCA Introduction

Norsk Hydro – Yara – Yara Clean Ammonia
A long history in the ammonia industry

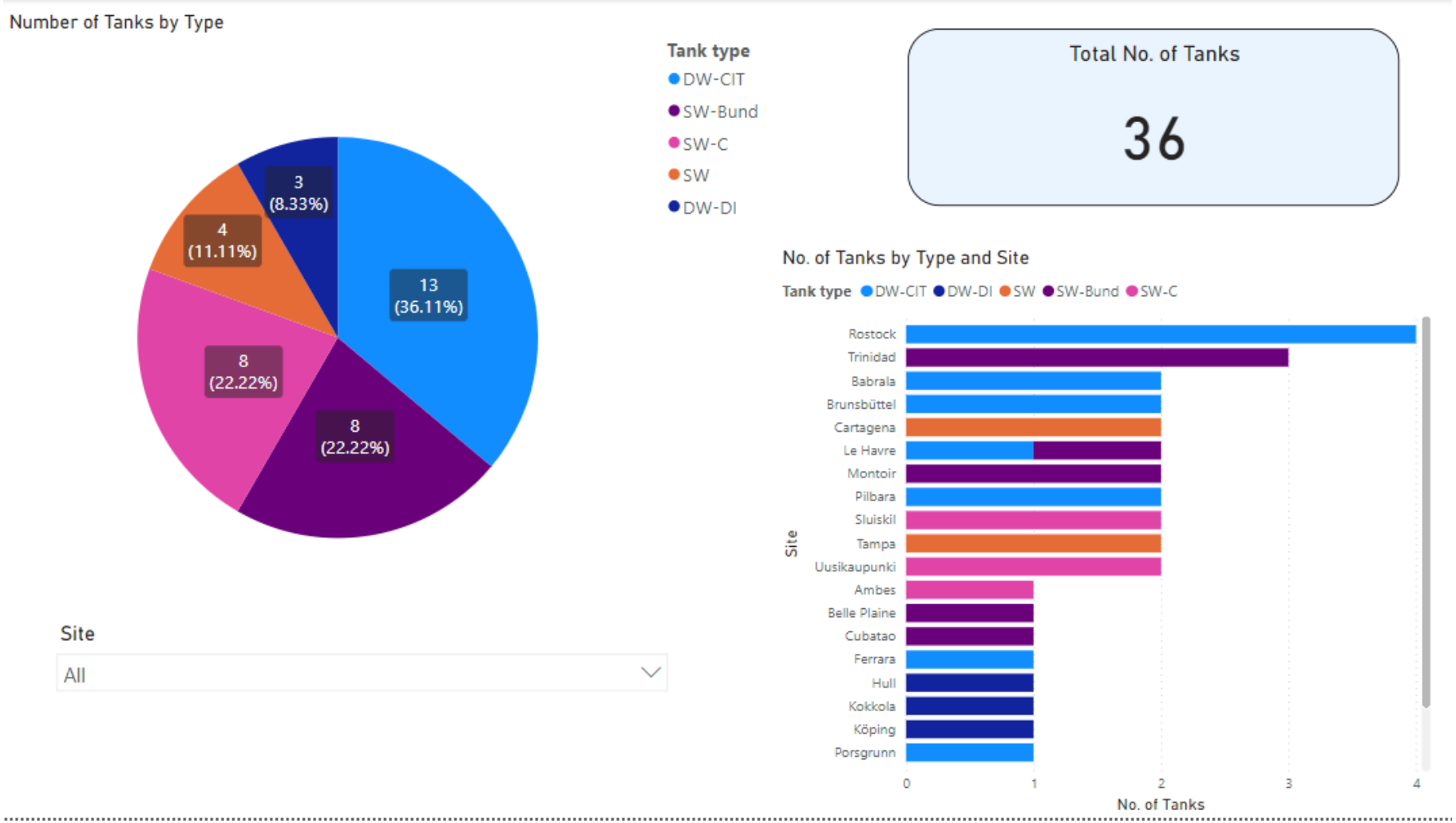
Ammonia production within Yara (Norsk Hydro) started in late 1920's using electrolysis based-ammonia synthesis process with individual ammonia unit capacity up to 295 tons/day at Rjukan, Norway. This was the maximum rated capacity of individual ammonia units until the mid-1960s when centrifugal compressors were introduced.



135 MW hydro-power electrolysis-based hydrogen production in Glomfjord, Norway 1953-1991

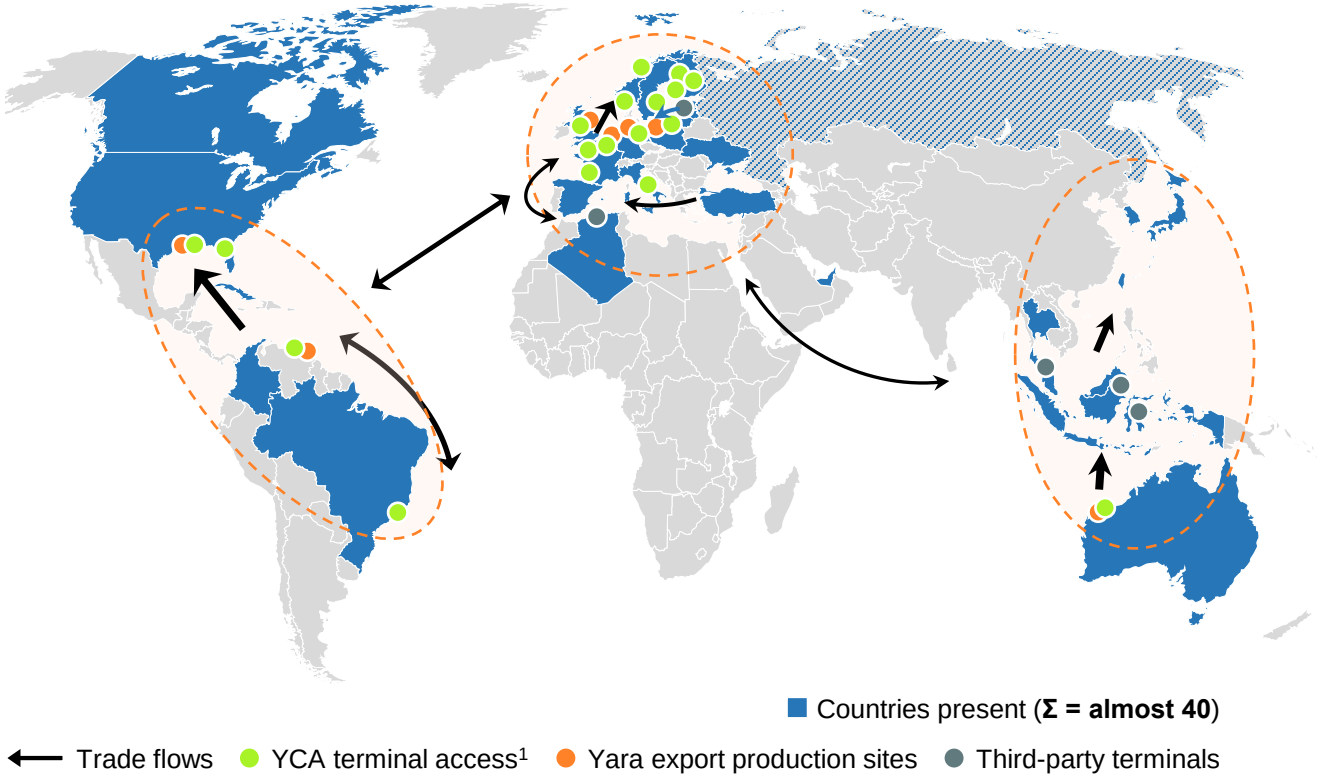


Cold ammonia storage at Yara



YCA has an established global network with access to asset-backed supply

Overview of YCA's global footprint



Overview of YCA's global footprint

- Reliable, **asset-backed supply and attractive offtaker**
- **Deep industry know-how**, market insight and track record of safe handling
- **Specialized fleet of 15 ships**
- **Global network of 18 terminals** located in key locations[1]
- **Deep-sea connection** to key bunkering hubs
- **Scalable platform** and business model

#1 global player with >20% market share[2] and leading positions in key regions

Source: Company information; Argus market study

1) YCA has exclusive access, and manages and optimizes use of Yara's ammonia tank infrastructure at terminals through sourcing and supply agreements with Yara
2) Based on volumes of traded ammonia in 2021 - Argus market study (2022)

World first ammonia tankers

Shortly after the end of WWII, Hydro decided that 3 ammonia vessels should be ordered at Marinens Hovedverft (Norwegian naval yard) in Horten.

They were constructed in co-operation with Marinens Hovedverft and Norsk Hydro's technical experts. The vessels were equipped with 27 cylindrical high-pressure tanks, which held 750 tons of ammonia. Displacement was the same as cargo vessels their size approximately 3,000 tons.

"Herøya", "Haugvik" and "Hydro" were commissioned in June 1949, December 1949 and December 1950 respectively

These vessels were unique in the world being the first specially designed ammonia tankers.

HESQ Performance

HESQ performance at Yara International
Leader in safety practices

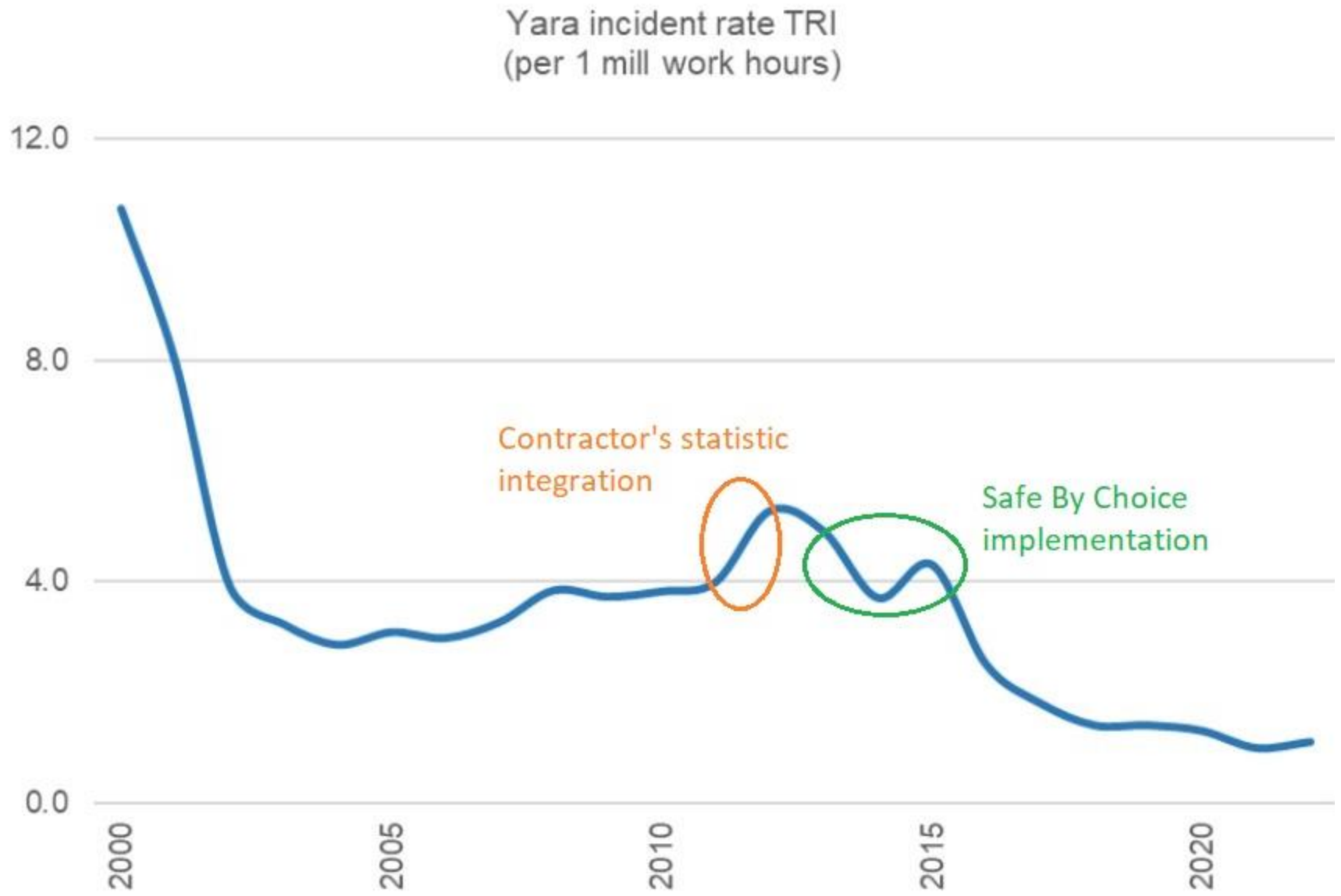
- In 2021, Yara moved from Gold to Platinum status for its sustainability performance.

Position Green

- In 2022 and 2023, Yara is one of only five companies to score a top grade of A+

- Recognizes outstanding performance in safety, health and environment (SHE) in fertilizer production

- Supported by a consistent Safe By Choice approach, Yara's leading performance in safety is demonstrated by a Total Recordable Injury rate among the lowest in the fertilizer industry.


Yara incident rate TRI
(per 1 mill work hours)
12.0
8.0
4.0
0.0
2000
2005
2010
2015
2020
Contractor's statistic integration
Safe By Choice implementation

Safe By Choice: Building Blocks

2013:
Golden Rules

2014-15:
- Systematic inspection
- HESQ Academy
- NSC Survey

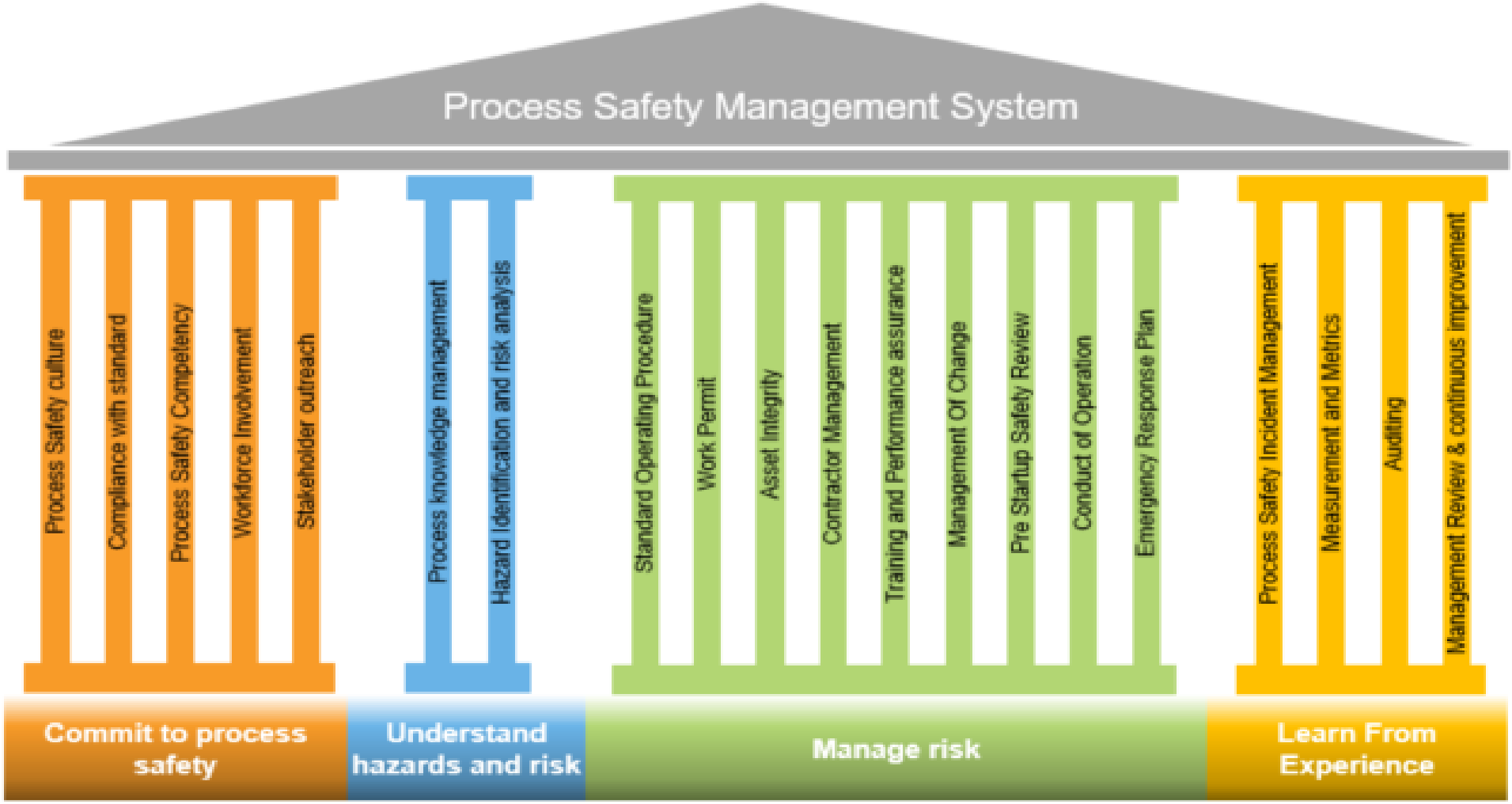
2016-17:
- Contractor safety program
- Safety Leadership
- Risk Based Process Safety

2018-20:
- Major Potential Program
- Process Safety Network & bootcamps

2020-22:
- Physical and Psychosocial Health program
- Safe by Choice addressing all HESQ areas

2023:
- Human Factor Program
- Steering system simplification

Managing Ammonia Safety – Our experience
Inherent safe design & Safety Culture

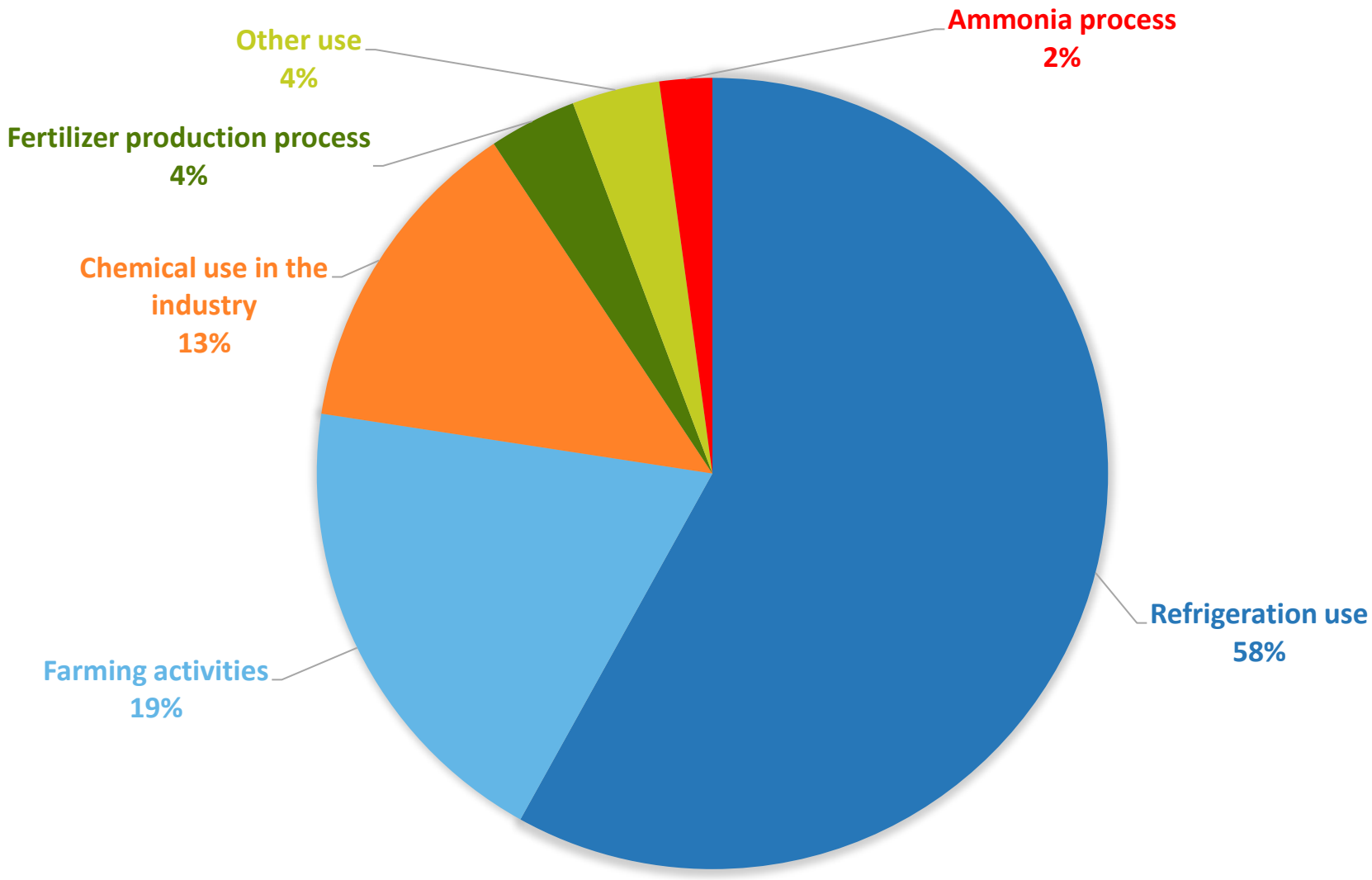


40 years of learning from OSHA

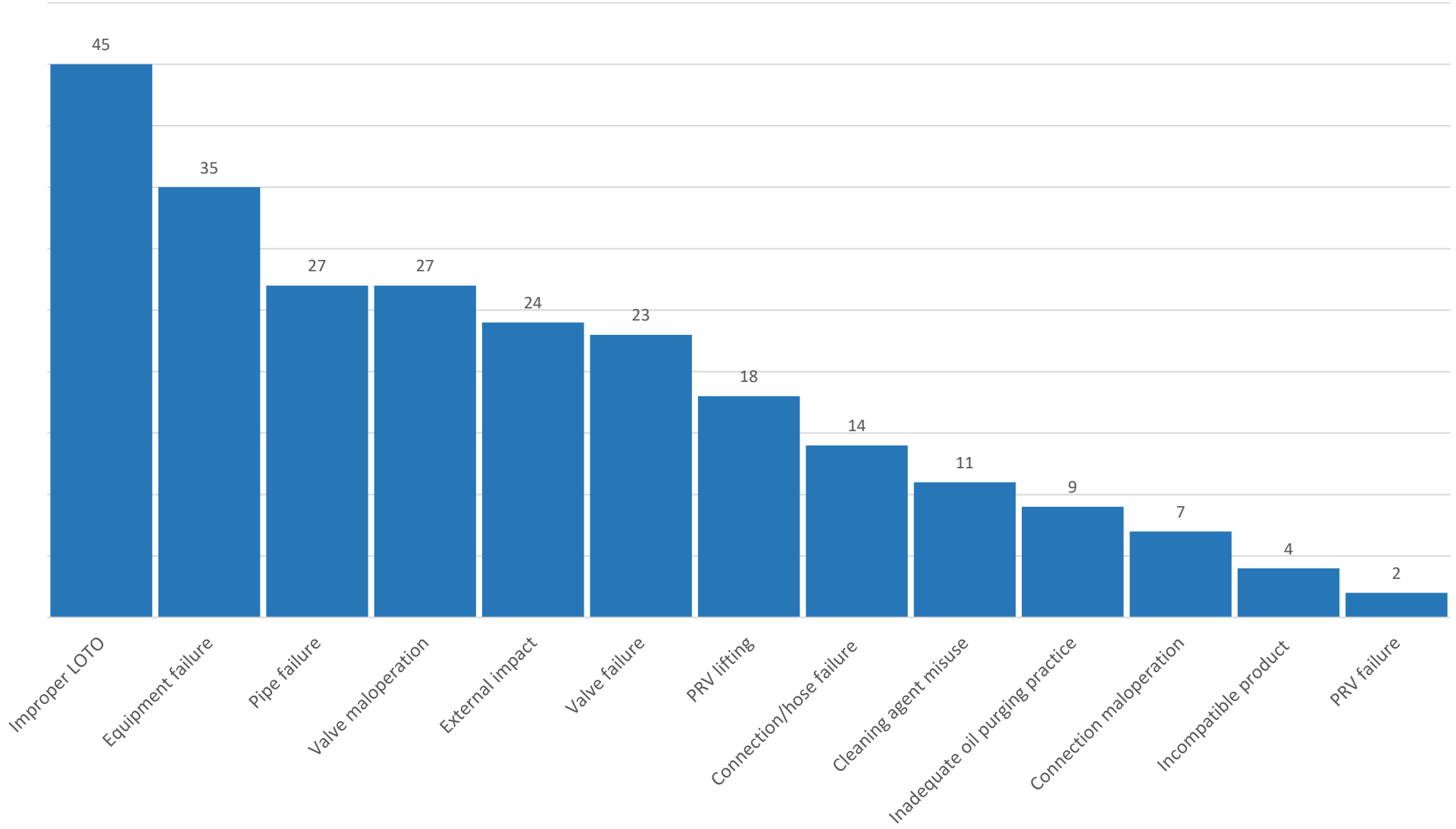
40 years of learnings from OSHA

- An extraction from the OSHA database with the key word « ammonia » revealed that 309 accidents occurred from 1984 to date.
- After a detailed review of the event description available in the database, it appears that 279 can be associated with ammonia.
- Among these 279 cases, 45 were fatal.
- Source: OSHA – Ammonia accident

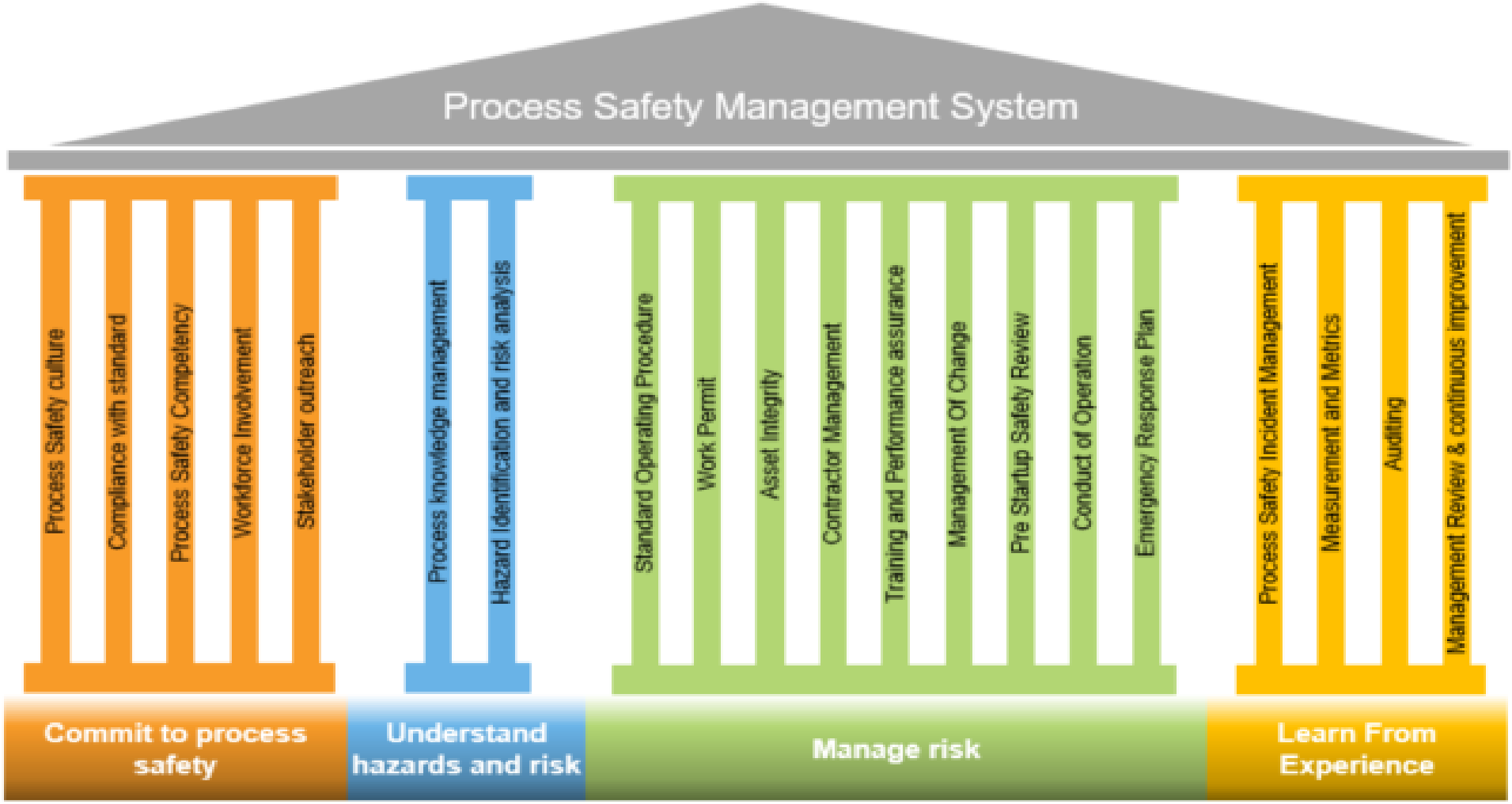
AMMONIA ACCIDENT REPARTITION PER USAGE



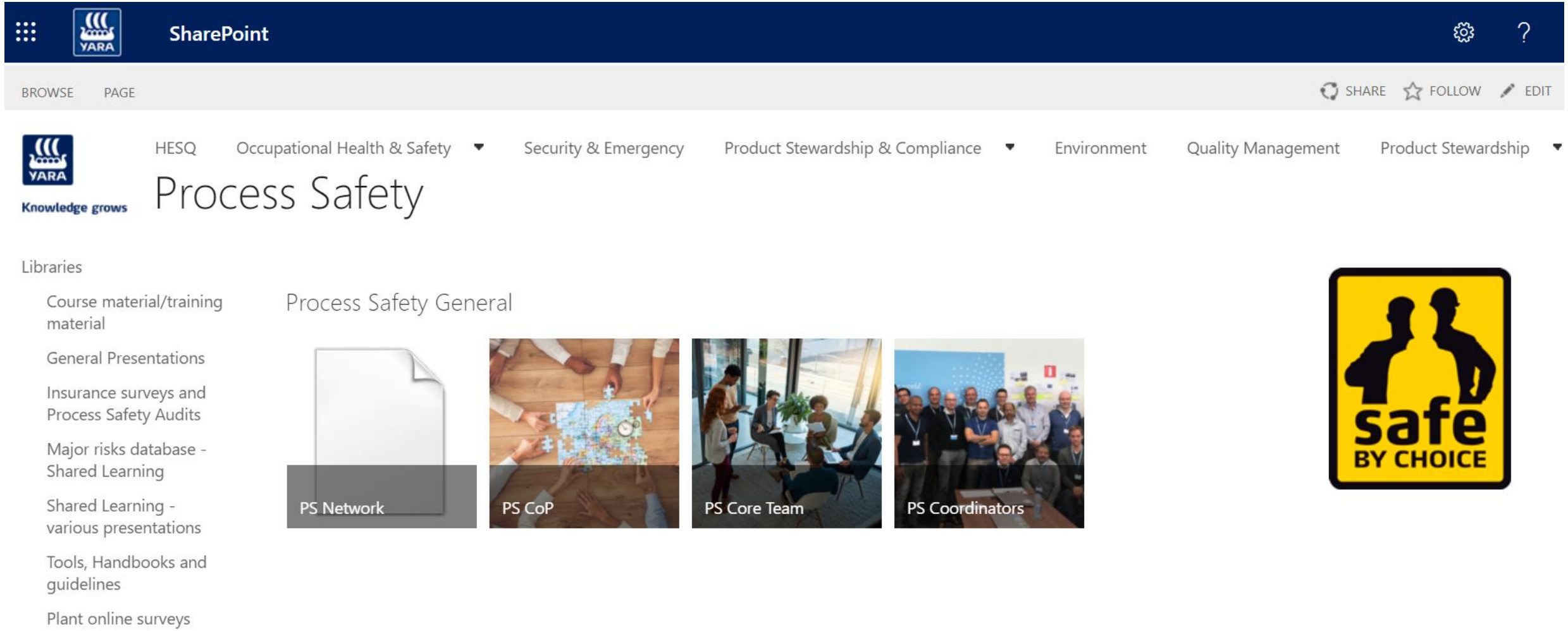
Main direct cause



Managing Ammonia Safety – Our experience
Inherent safe design & Safety Culture



Process Safety frame at Yara International



Ammonia Research & Development

SAFEN JIP

- Definition of failure modes and causes to LoC incidents
- Development of leak frequency database for hydrogen and ammonia installations
- **Human Reliability Analysis and integration of human error to the leak frequency model**
- Experimental campaign on hydrogen ignition mechanisms
- Development of ignition models for hydrogen and ammonia application
- Integration of the human error to the risk models
- Outline methodologies for risk-based decision support of the engineering process and the operation
- **Partners: DNV, GEXCON, VysusGroup, Proactima, Origin Energy, Equinor, DSB, Aker Clean H2, Var Energi**

ARISE JIP

- Experimental campaign of large ammonia spill at sea
- Collect at scale experimental data
- **Study Environmental Impact (sea water, atmosphere)**
- **Integrate learnings and adjust existing consequence modelling tools**
- Testing of various ammonia detection systems for improved monitoring, early detection and emergency response practices.
- **Partners: CEDRE, CEPPOL, INERIS, ONERA, RBINS, HSE UK**

SafeAm JIP

- Lab scale experiments of ammonia spill to water
- Development of modelling tools
- Thermophysical modelling of partition ratio and mixing effects of liquid ammonia into water
- Safety and environmental risk analysis
- Provisions of input to guidelines and procedures
- **Partners: Sintef Energy Research, University of South-Eastern Norway, Norwegian University of Science and Technology, Sintef Ocean, University of Bologna, PSA, NMA, DNV, Equinor, Total Energies, Yara CA, Wartsila**

Maritime Just Transition Task Force (by IMO, ICS, UN Global Compact, ILO, ITF)

- Define required competence and skills to handle alternative fuels
- Develop a baseline training framework for seafarers in decarbonization
- Develop pilot projects to test and advise on competence, skills, training

Ammonia is a chemical that deserves respect but should not be feared


YARA
Yara Clean Ammonia