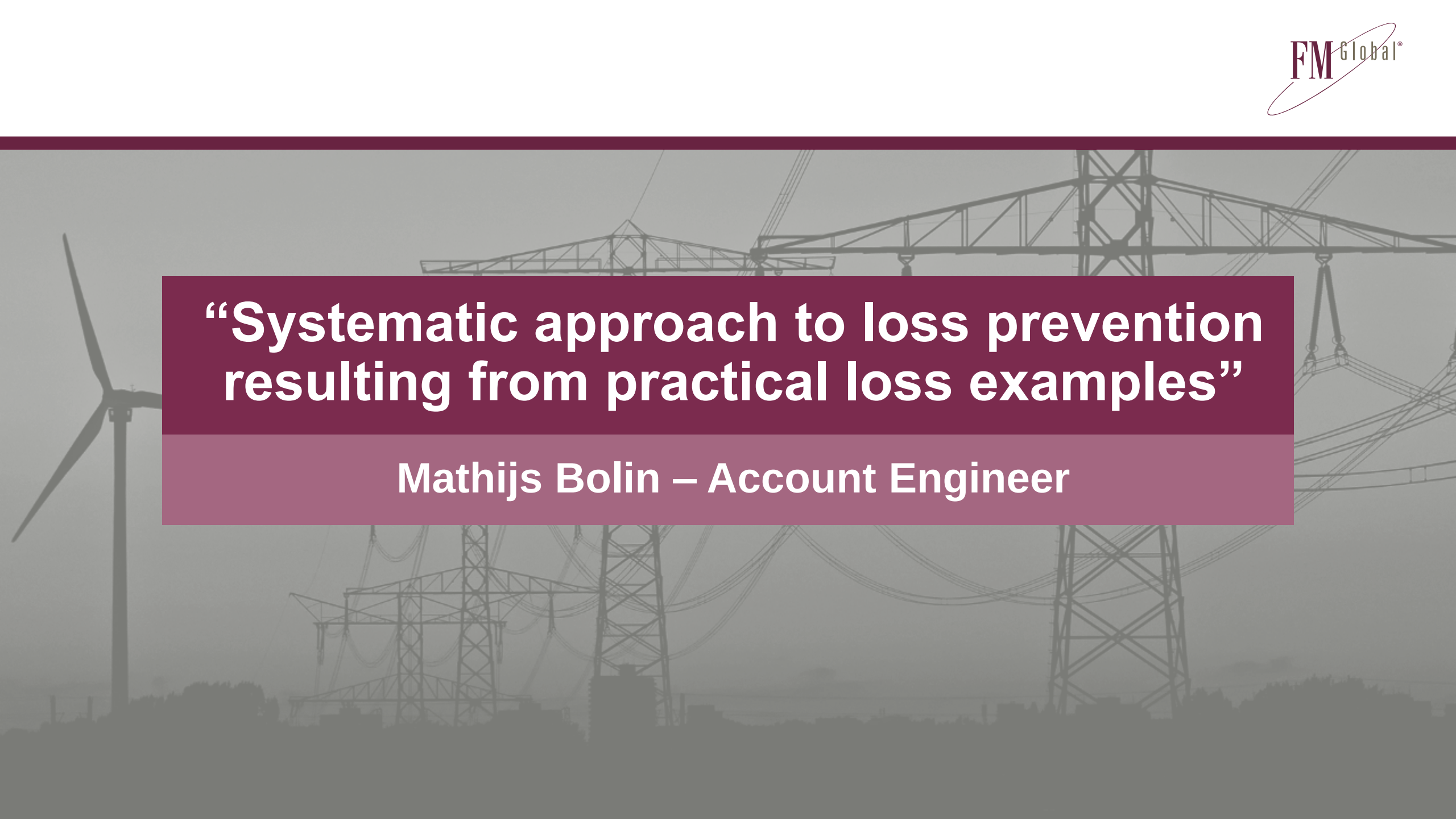
VoK Skadegruppens temadag 2019

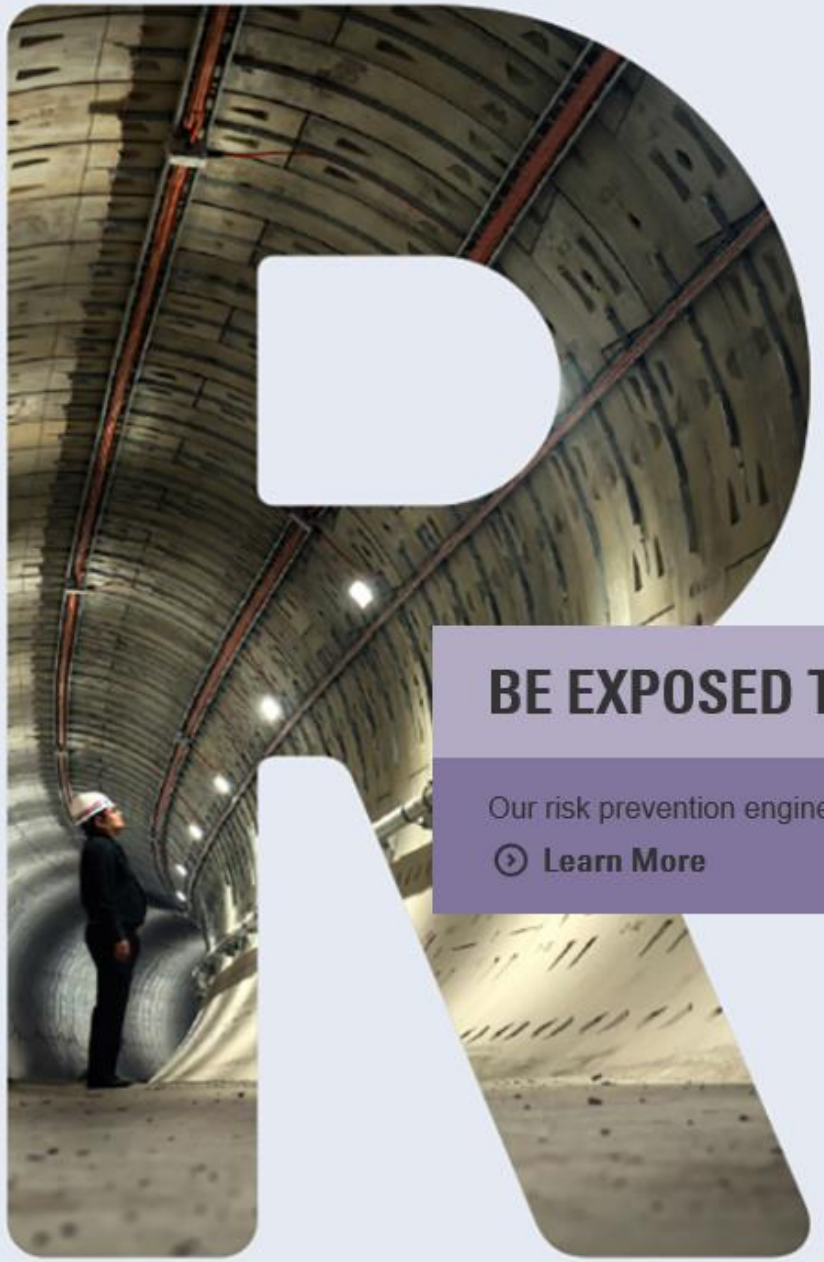
Stockholm, Sweden, November 13 2019



“Systematic approach to loss prevention resulting from practical loss examples”

Mathijs Bolin – Account Engineer

FM Global – A unique company

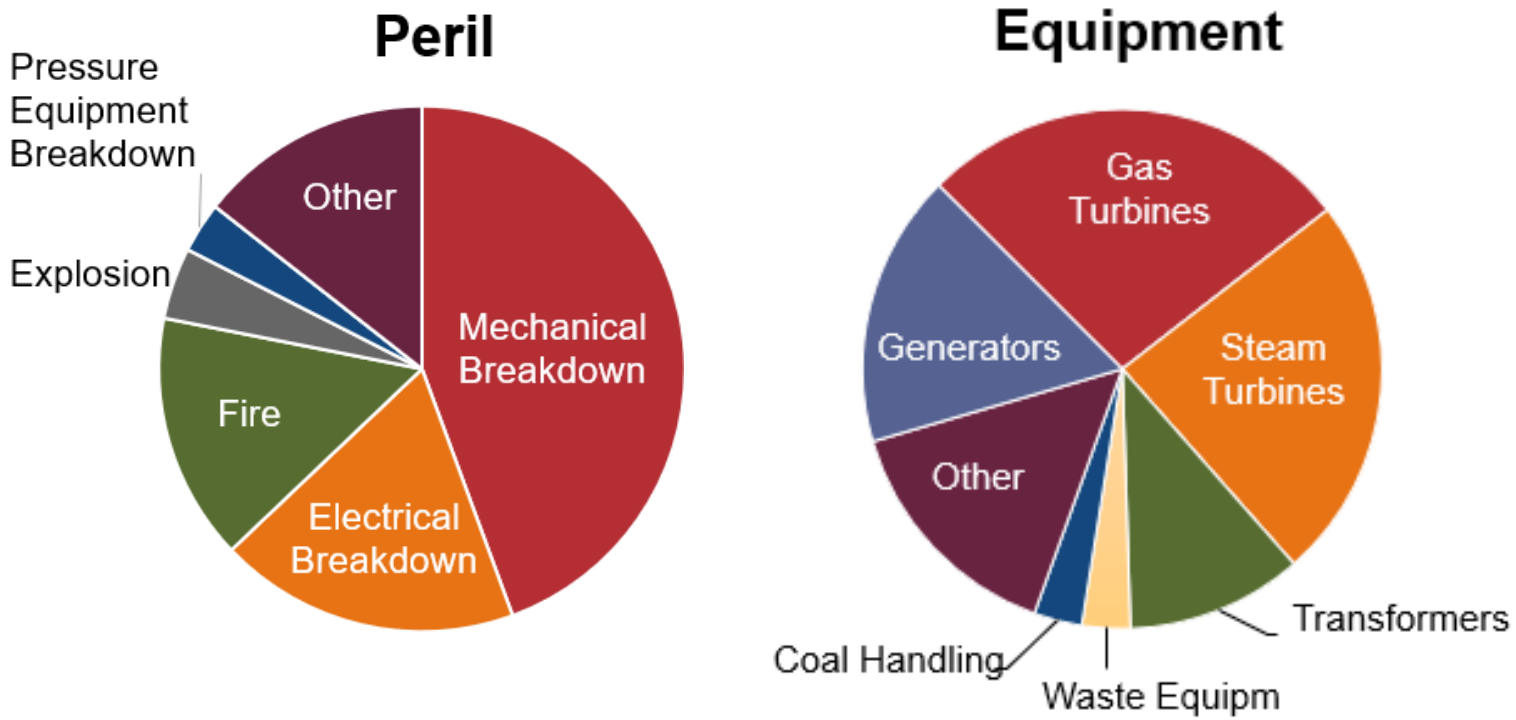


BE EXPOSED TO RISK OR ENGINEER IT OUT?

Our risk prevention engineers help prepare your facilities for potential disaster.

Learn More

Power Generation Losses (incl. paper industry)



Turbine Losses - Some Statistics

16 losses/year

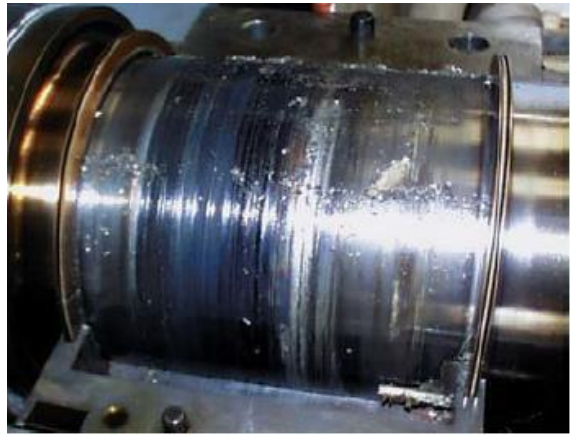
Component failure: 7/year

Overspeed: 1/year

Contributing factor:

Safety device failure: 8/year

Lube oil fire: 1/year



Lube oil starvation: 3/year

Turbine loss scenario #1: Flow path components

Flow path component failure is highly related to:

steam purity (solid, liquid or vaporous contamination) & quality (moisture).

It is essential that critical equipment be properly protected during periods of extended outages. This turbine rotor was severely corroded because the casing was not completely drained of condensate and measures were not taken to dehumidify the environment.

This double-flow, low-pressure steam turbine rotor displays severe precipitate of chlorides and sodium. It is clear that the precipitate is pressure/temperature-dependent because it did not continue through downstream stages. The corrosion products had carried over from the boiler and were detected during a forced outage caused by an electrical fault that resulted in a major pressure parts system upset. The boiler and the turbine (rotating and stationary parts) required significant mechanical and chemical cleaning to eliminate the corrosion products.

Turbine loss scenario #1: Flow path components

FM Global
Property Loss Prevention Data Sheets **10-8**

April 2016
Interim Revision January 2019
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OPERATORS

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Turbine loss scenario #1: Flow path components

FELAKTIGA PROVTAGNINGSSYSTEM

Matarvattensektionen Medlemsblad Nr 1, 2014
Mats Hellman, Hellman Vatten AB

På senare tid har det visat sig att ansvarig pannleverantör har installerat provtagningssystem med stora brister vid nybyggda pannor.

Matarvattenkonferensen 2014-11-12

HELLMAN VATTEN

Vanliga fel

- Felaktig dimension på provtagningsledningar
- Felaktig placering av provuttag
- Provuttag på ånga utan sond

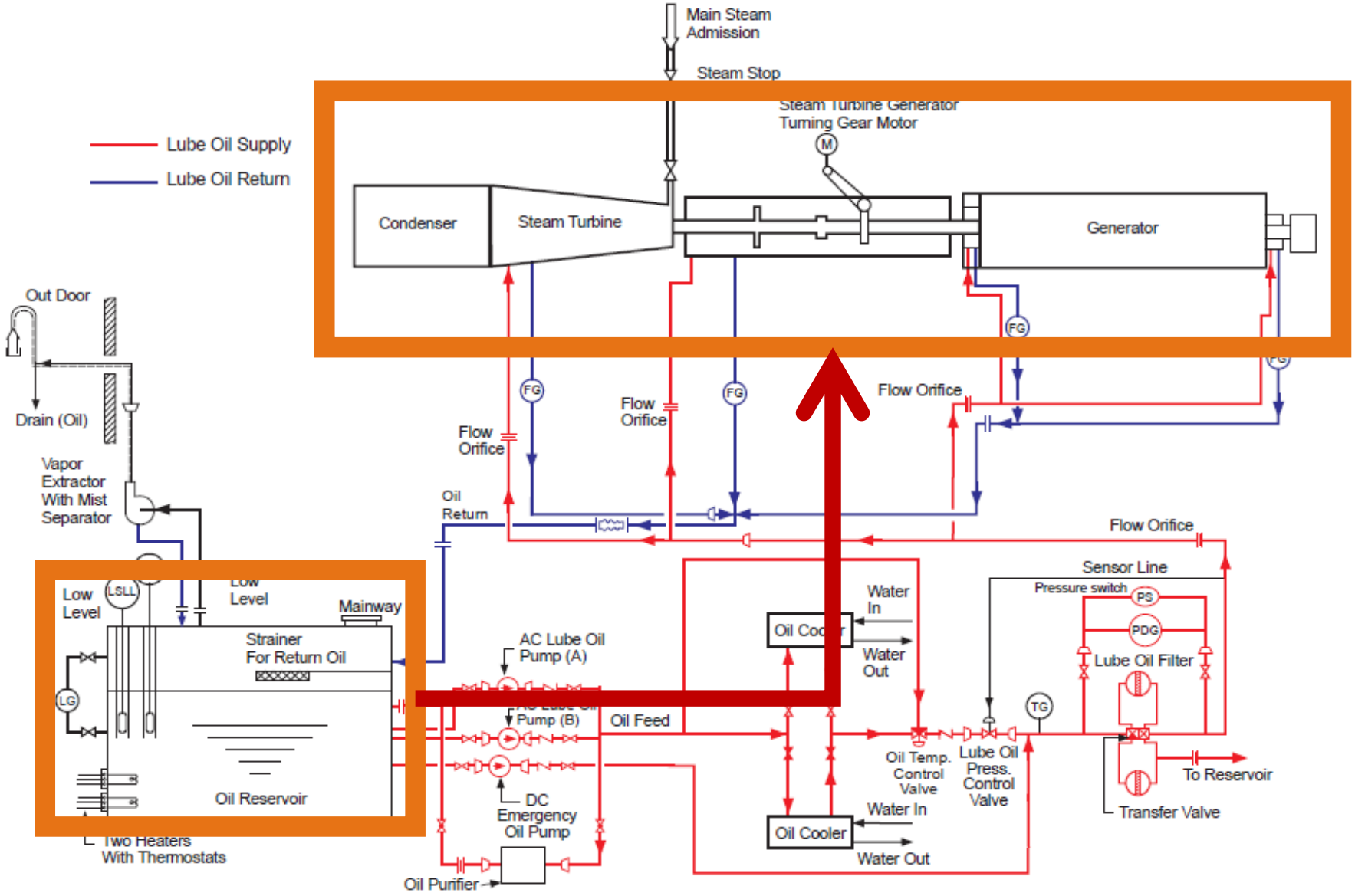
Turbine loss scenario #1: Flow path components

Practical loss prevention references

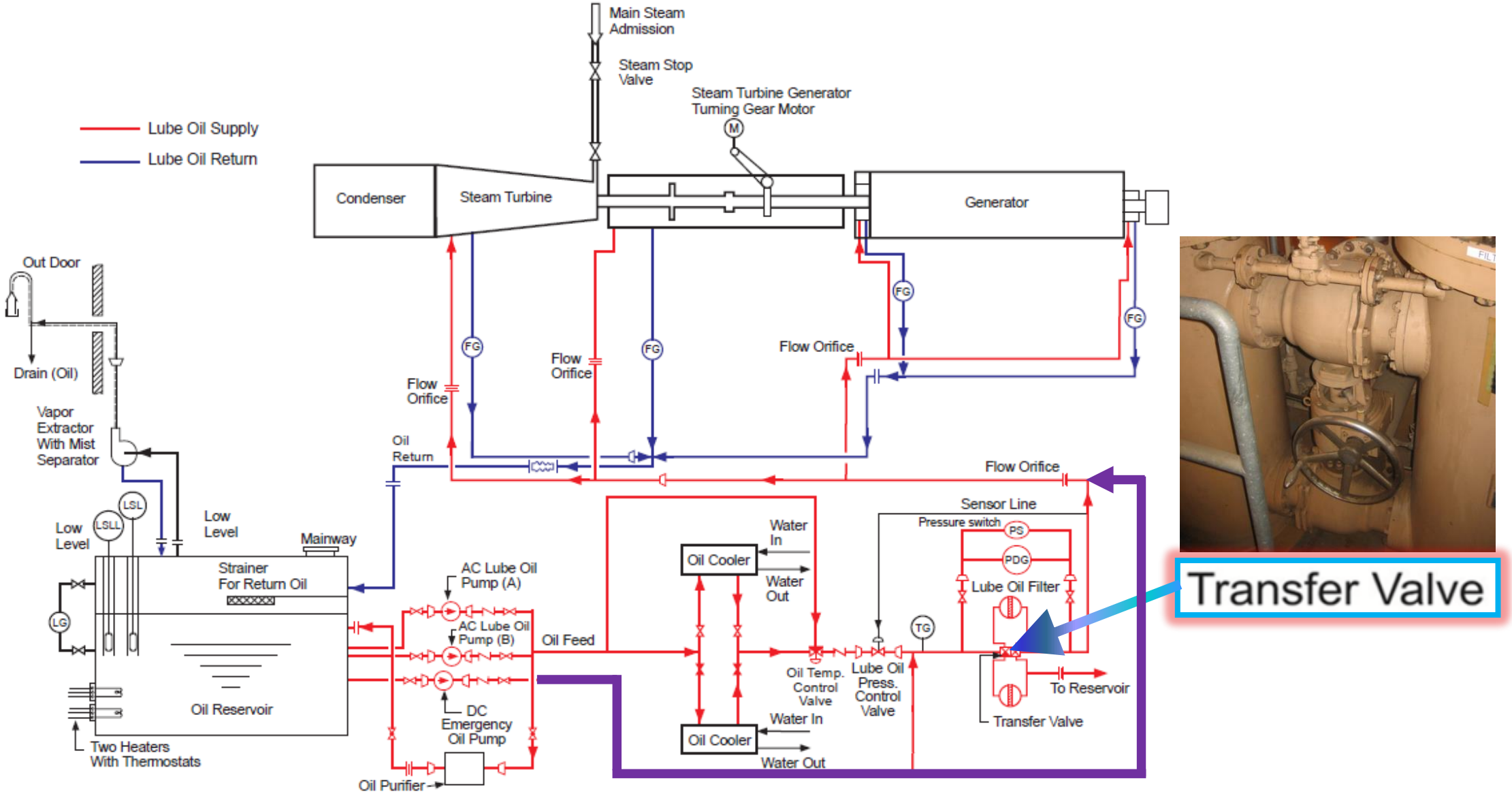
- Operate within design operating parameters (load, temperature, etc.).
  - Standard Operating Procedures and Operator Training are critical.

- Control the steam purity/quality.
  - Understand the sampling system installation (placement, probes, etc.).
  - Conduct regular online/offline analysis. Ensure regular equipment servicing and calibration.
  - Review analysis results against set limits, correct deviations and review trends.

Turbine loss scenario #2: Loss of lube oil

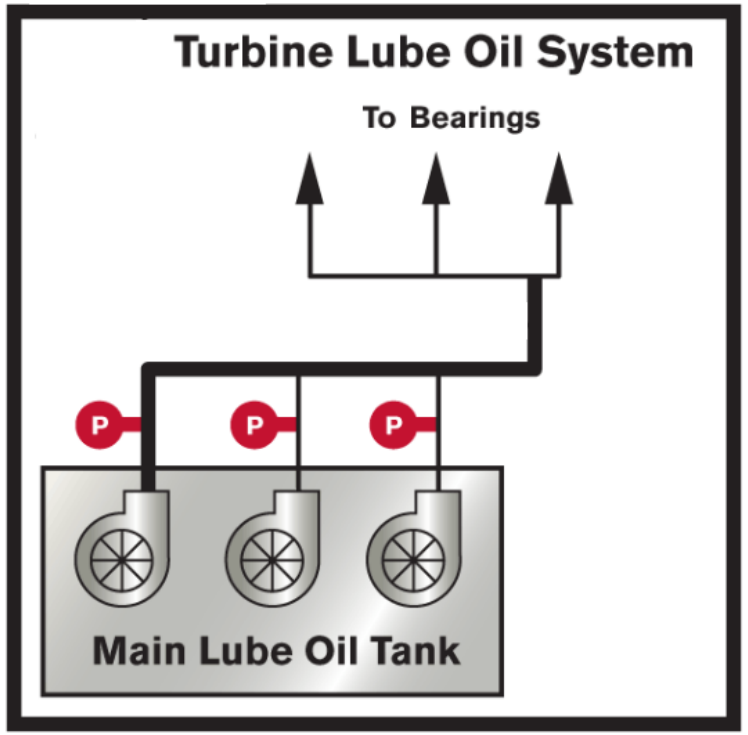


Turbine loss scenario #2: Loss of lube oil

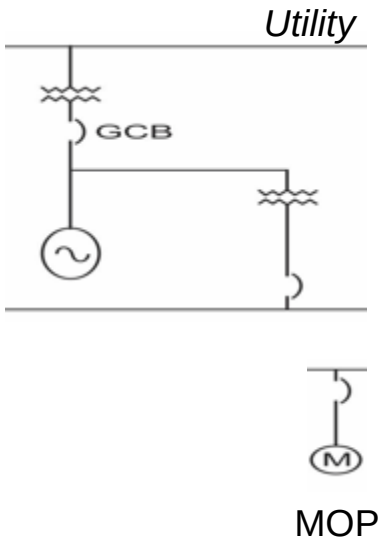


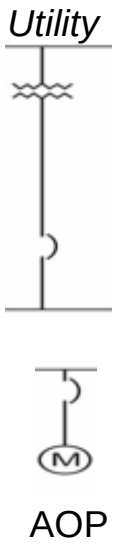
Transfer Valve

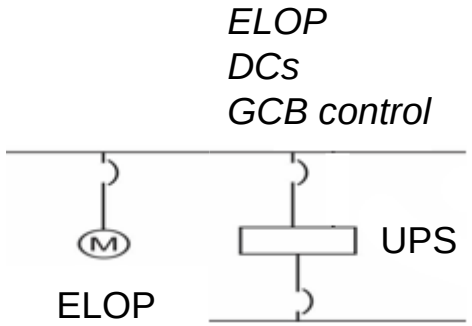
Turbine loss scenario #2: Loss of lube oil



Main lube oil pump (MOP)
Auxiliary lube oil pump (AOP)
Emergency DC oil pump (ELOP)





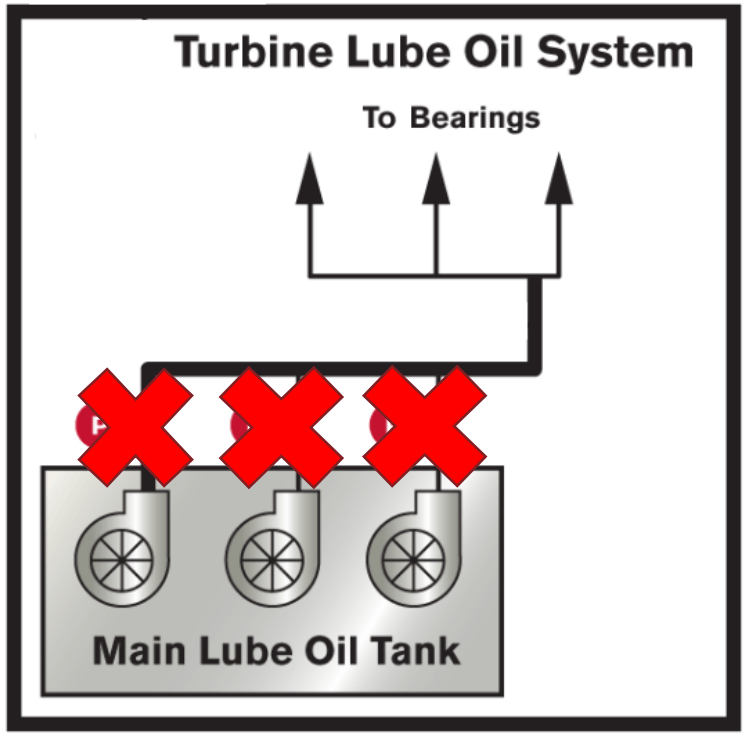


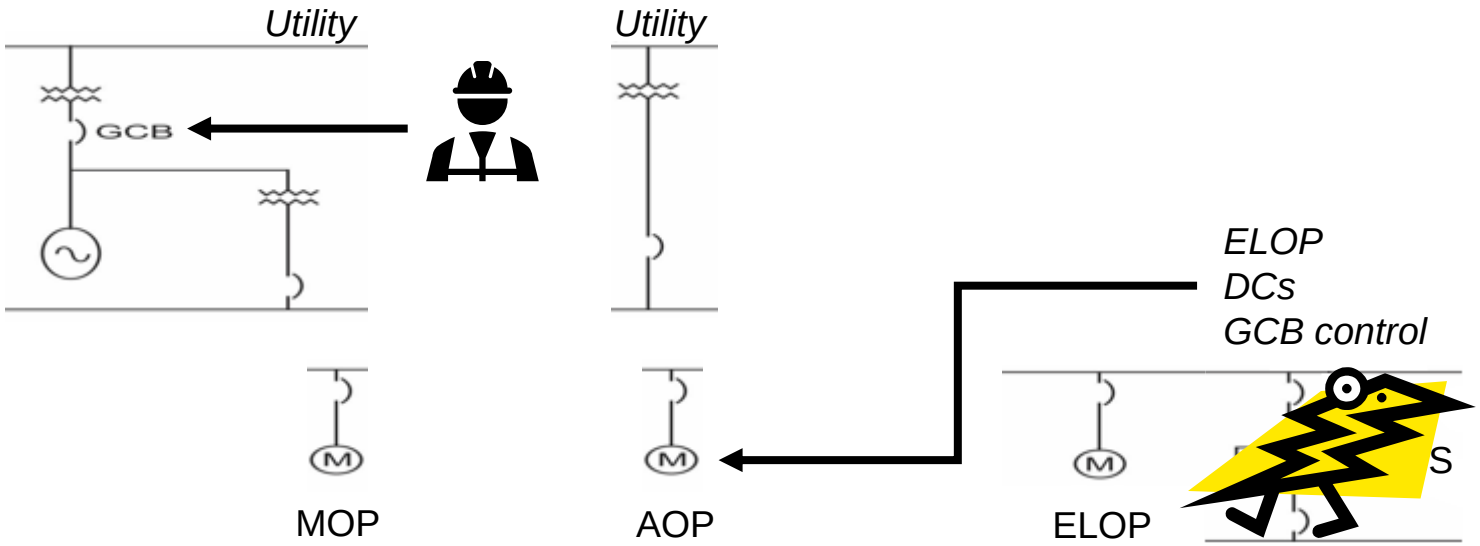
Turbine loss scenario #2: Loss of lube oil

INCIDENCE BRIEF DESCRIPTION

- ONE OF REDUNDANT DIRECT CURRENT (DC) POWER SOURCES WAS ISOLATED FOR ONE BANK OF BATTERIES REPLACEMENT.
- OPERATION ENGINEER ASSIGNED WITH THE TASK OF NORMALIZING THE POWER SUPPLY BY CONNECTING BACK THE ISOLATED POWER SOURCE.
- INSTEAD OF CONNECTING BACK THE POWER SOURCE NOT IN SERVICE, HE DISCONNECTED THE ONLY OTHER SOURCE FEEDING THE VITAL AREAS.

Turbine loss scenario #2: Loss of lube oil





Main lube oil pump (MOP)
Auxiliary lube oil pump (AOP)
Emergency DC oil pump (ELOP)

Turbine loss scenario #2: Loss of lube oil

Practical loss prevention references

- Ensure free flow of oil supply from DC pump to bearings:
  - Prevent isolation of (emergency) oil supply by valves, coolers, filters, etc.

- Arrange for adequate DC pump start:
  - Prevent isolation valves in pressure sensing lines.
  - Allow DC pump start upon loss of signal.
  - Test pump start regularly – in a safe manner (SOP)!

- Create an adequate AC/DC power supply:
  - Prevent manual isolation of both battery banks.
  - Avoid (if possible) overcurrent or overtemperature interlocks to protect the DC motor.
  - Consider a common DC buss bar as a potential single point of failure.

Turbine loss scenario #3: Overspeed

This overall view of a generator shows the damage done to the inboard end during a steam turbine overspeed event. Notice the absence of coupling and turning gear that were ejected.

Key Safety Devices

Overspeed Protection:
- Electronic
- Mechanical

Main Steam – Emergency Stop Valve

Extract Steam – Non-Return Valves

FM Global's view on key loss prevention areas

Key loss prevention focus areas

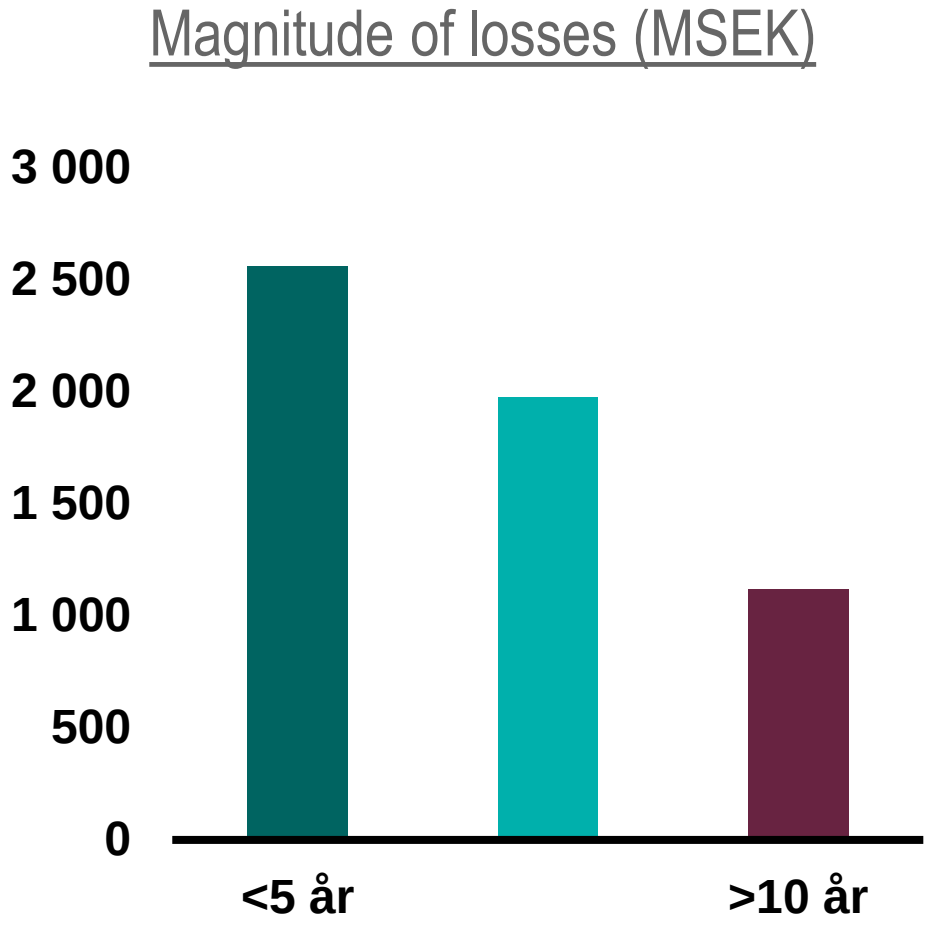
A systematic approach to understand the functioning of safety devices and to inspect, test and maintain these devices is critical.

A systematic approach is needed to develop Standard and Emergency Operating Procedures and to train Operators to follow the procedures.

A systematic asset integrity program should focus on Maintenance Strategy and Planning, followed by Execution, Reporting and Analysis.

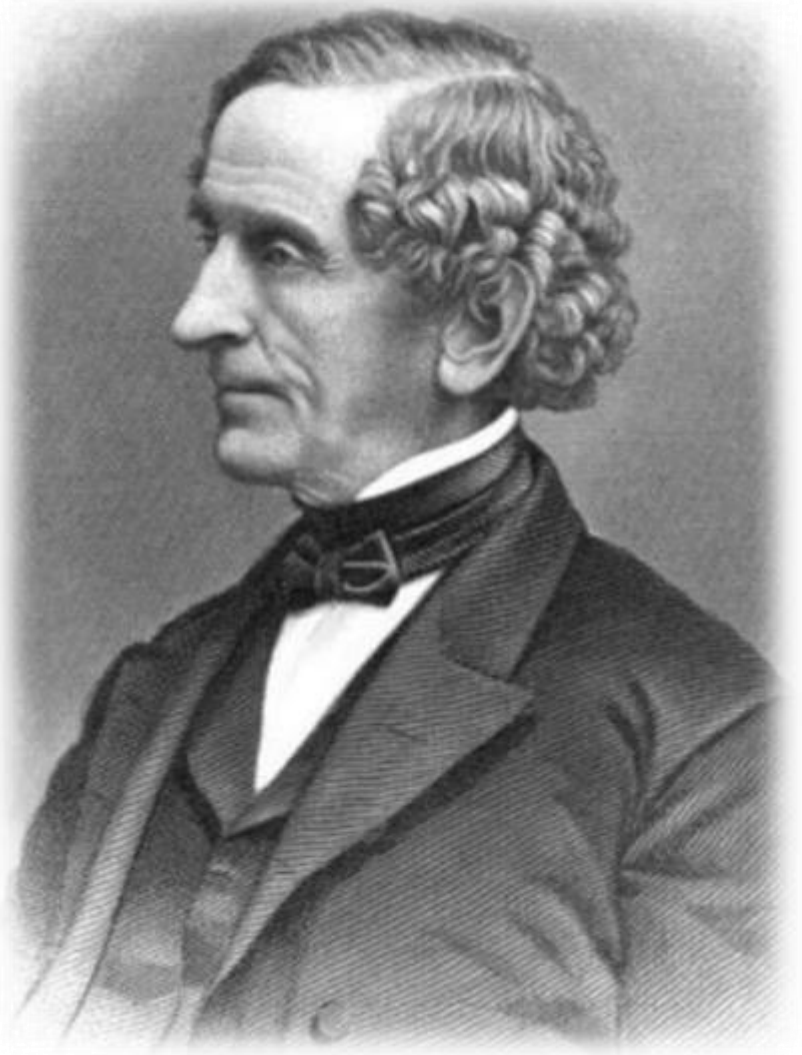
Evaluation


Number of losses
100
80
60
40
20
0
<5 år
>10 år


Magnitude of losses (MSEK)
3 000
2 500
2 000
1 500
1 000
500
0
<5 år
>10 år

Evaluation

The majority of all loss is preventable!



Zachariah Allen – Founder of FM Global in 1835

Thank you! Questions?

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