Integrated approach to safety and asset performance in cold climates

Winterwind 2016

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Lloyd's Register Consulting

Working together for a safer world

Dedicated to safety and asset optimization

We apply our expert knowledge and independence to help clients and regulators design, construct and operate their capital intensive assets and businesses to their highest levels of safety and performance.

Photo: E.Leonhardsen

Our history

Old days

1971-2013

SCANDPOWER Risk Management

ØDS Human Engineering

Today

Lloyd's Register Consulting

Who am I

- Aeronautical engineer
- Royal Norwegian Airforce, technical officer
- Scandinavian Airlines System, SAS, engineering manager
- Joined Scandpower, now LR Consulting, in1997, Senior Principal Consultant

Adding risk to operations

Snow and icy conditions represent the possibility of ice-throw from turbines, slippery conditions during maintenance work and production downtime due to asset failure.

Photo: A.Sandve

Reliability promote safety

Asset managers are expected to optimise the performance of assets to meet business requirements.

Reliability is fundamentally a question of good design.

Optimizing performance is a question of operational strategy and planning.

Photo: Kjeller Vindteknikk

Risk communication as part of operating strategy

Asset: Stamåsen operated by Statkraft

Project partner: Kjeller Vindteknikk

- Safe operations and asset performance influenced by cold climate conditions.
- Risk related to ice-throw part of risk assessment processes.
- The monitoring of ice-build up a significant challenge to reliability.
- 3rd party risk communication is recognized to be key element in creating safe environment.

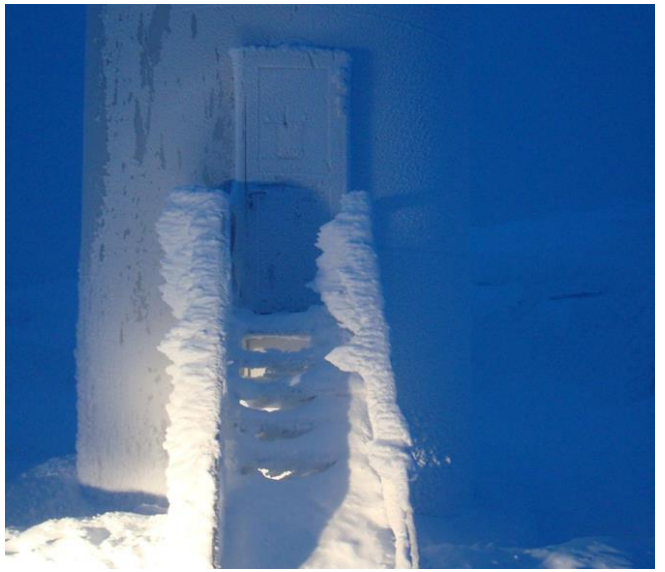


Photo: Statkraft

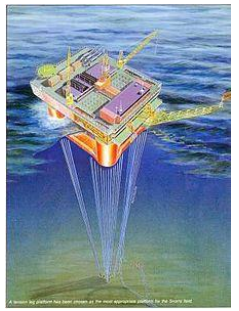
Asset risk -Reliability centered maintenance (RCM) and asset management; Experience

Railway

Flytoget, Type 71

Aviation/defence

?



Offshore/ onshore industry

What is RCM in the perspective of asset management

- RCM is a systematic method or approach to evaluate critical physical assets by how their functions can fail and the effect of failures.
- RCM decide effective maintenance task strategies based on failure causes and knowledge of components failure characteristics and behavior
- RCM improves the basis of physical asset management

RCM has a wide range of contributions to effective asset management, in the following presentation we will dive into RCM and control of external influences on technical systems.

Improves;

Safety

Environment

Operational availability

Maintainability

Reduces;

Cost values

Maintenance burden (personnel)

Impacts of production interruptions

RCM and the «system engineering approach»

- The concept of operations defines the system functional requirements, as the maintenance concept defines the Maintenance Requirements.
- The maintenance requirements enables requirements for input into the system design for improved maintainability in the operational phase.
- The systems engineering approach was originally developed in the aerospace industry in the 1960's and 1970's to combat an alarming failure rate for large aircrafts. The systems engineering process does not guarantee success, but it has certainly improved the chances of getting there.

Operational concept;

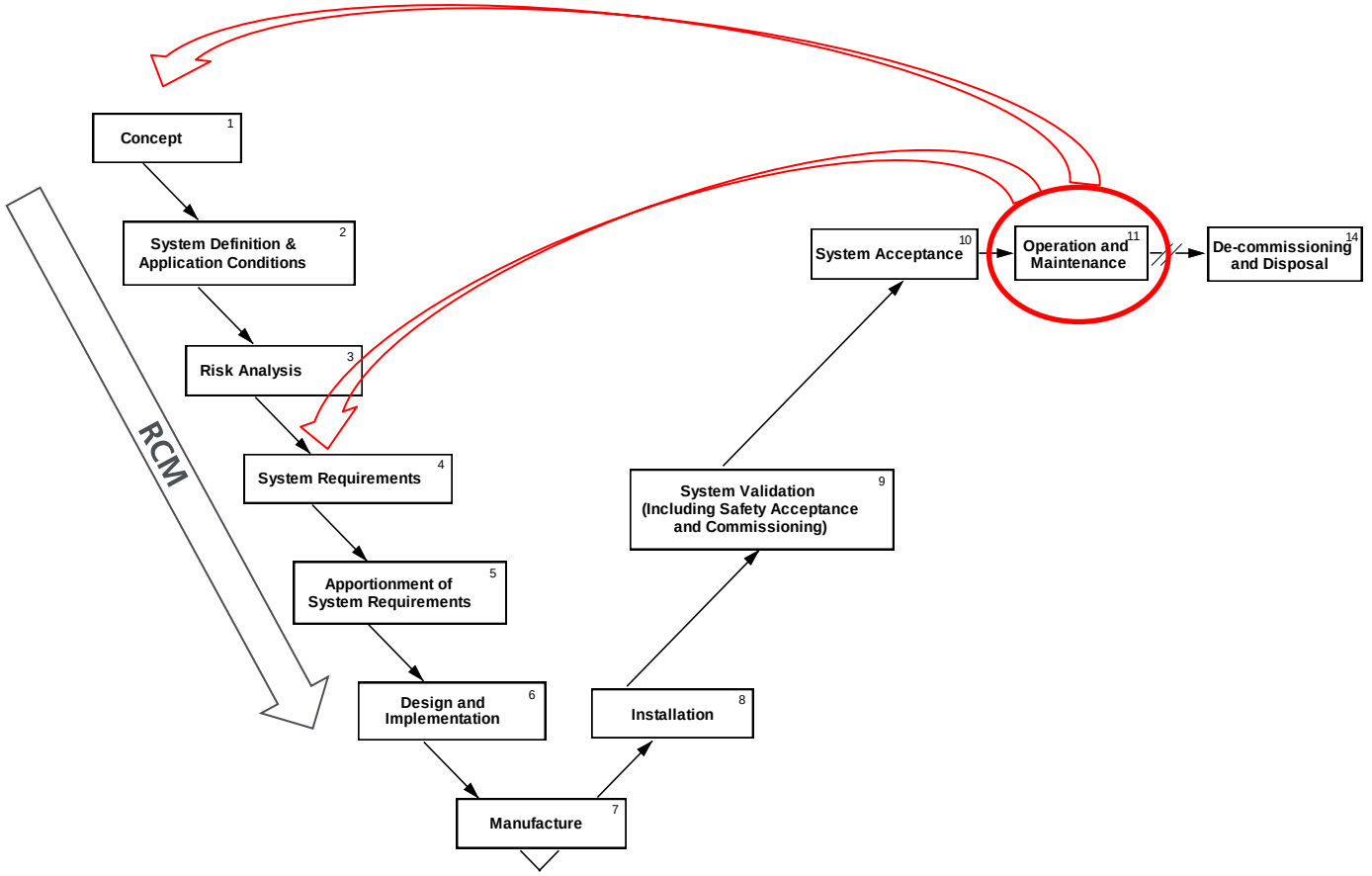
- Planned uptime
- Unmanned facility
- Remotely controlled
- Etc.

Maintenance concept;

- Defined lowest interval of planned visits
- Responsive maintenance
- Spare parts logistics/availability
- Environmental conditions
- Etc.

Life cycle V-model

The maintenance concept and RCM approach are designed to complement the systems engineering process and support the operational concept



Challenges in maintenance and operation
External influences

External influences are more likely to cause a component failure but may be observed and reported as an inherent failure.

External influences may not necessary lead to a direct failure but reduce the components remaining life significantly.

External influences

- Climate conditions
- Impacts, foreign objects
- Human factors
- Pressure
- Pollution
- Etc.

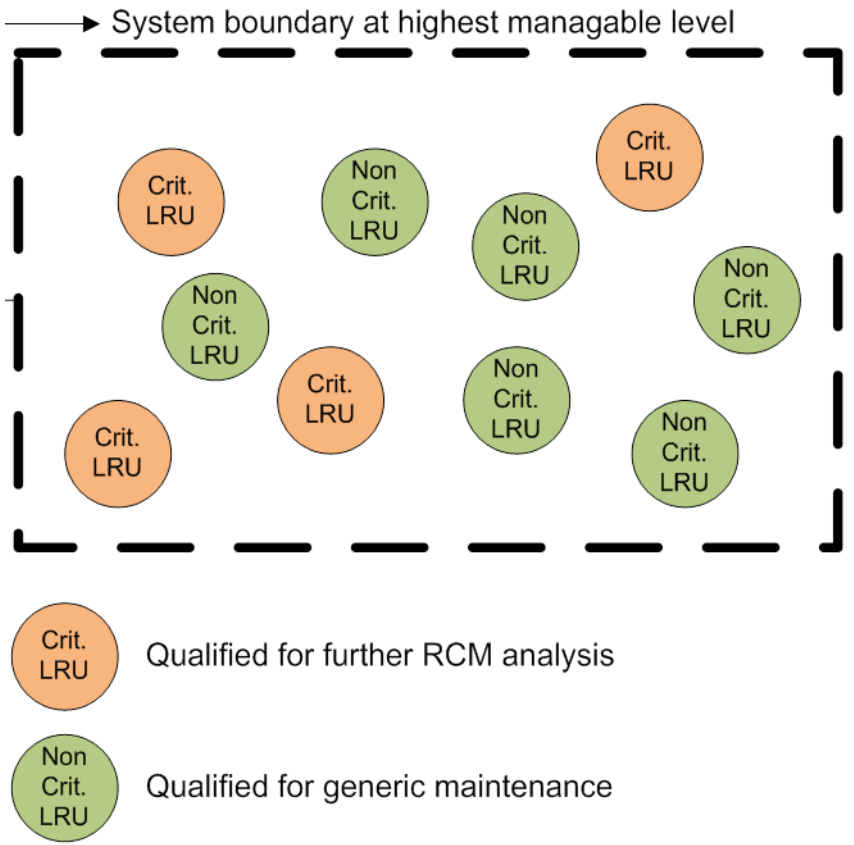
External influences
Cold climate

Rail tracks are welded over long distances and are exposed to extreme tensile stress in cold conditions. Crack initiations are critical and need timely detection

Undetected clear ice build up on wing surface may cause foreign object damage to engines and empennage.

Ice build-up in bogies reduces the spring and damper effect and may change the running behavior and overload other structural elements and reduce remaining life

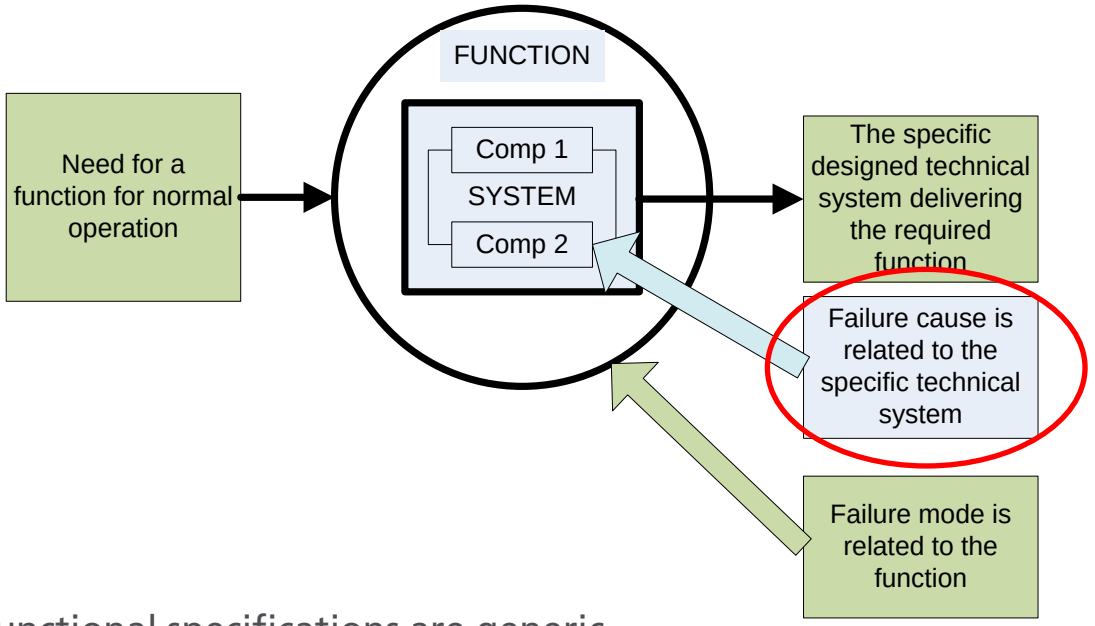
Critical functions and mapping maintenance critical components (LRU – Line replaceable units)



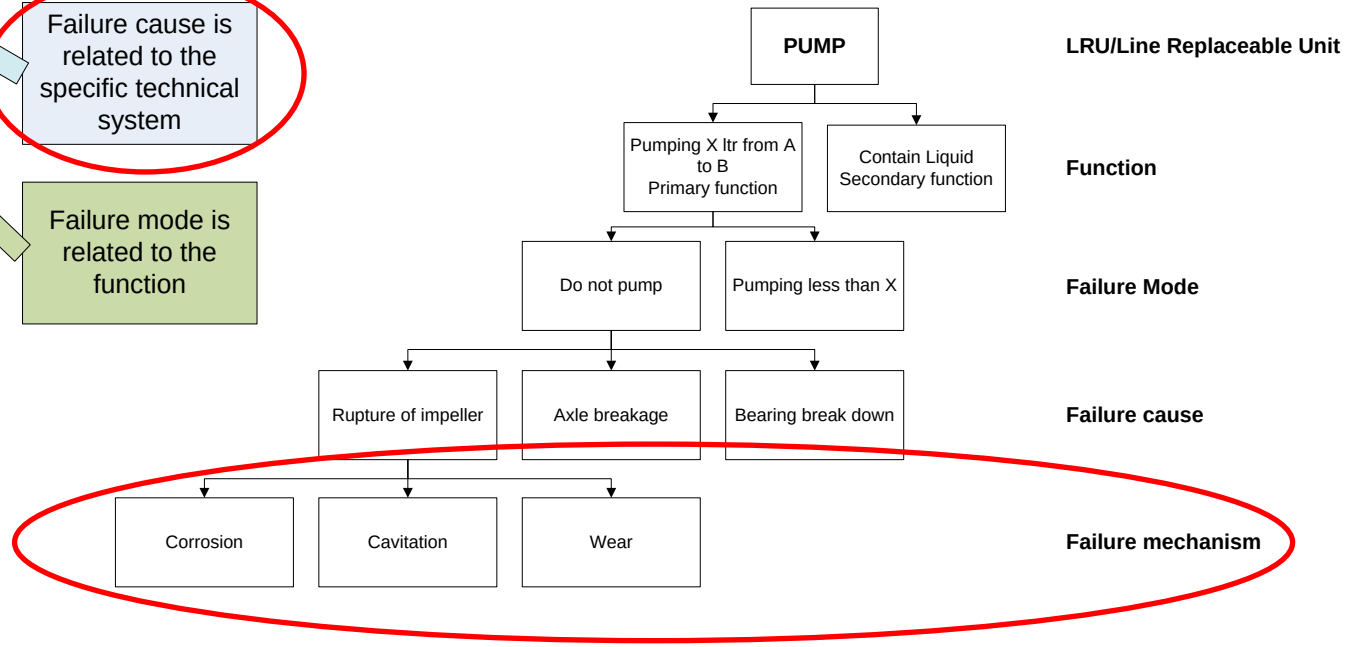
Value to the client;

Eliminating unnecessary analysis work

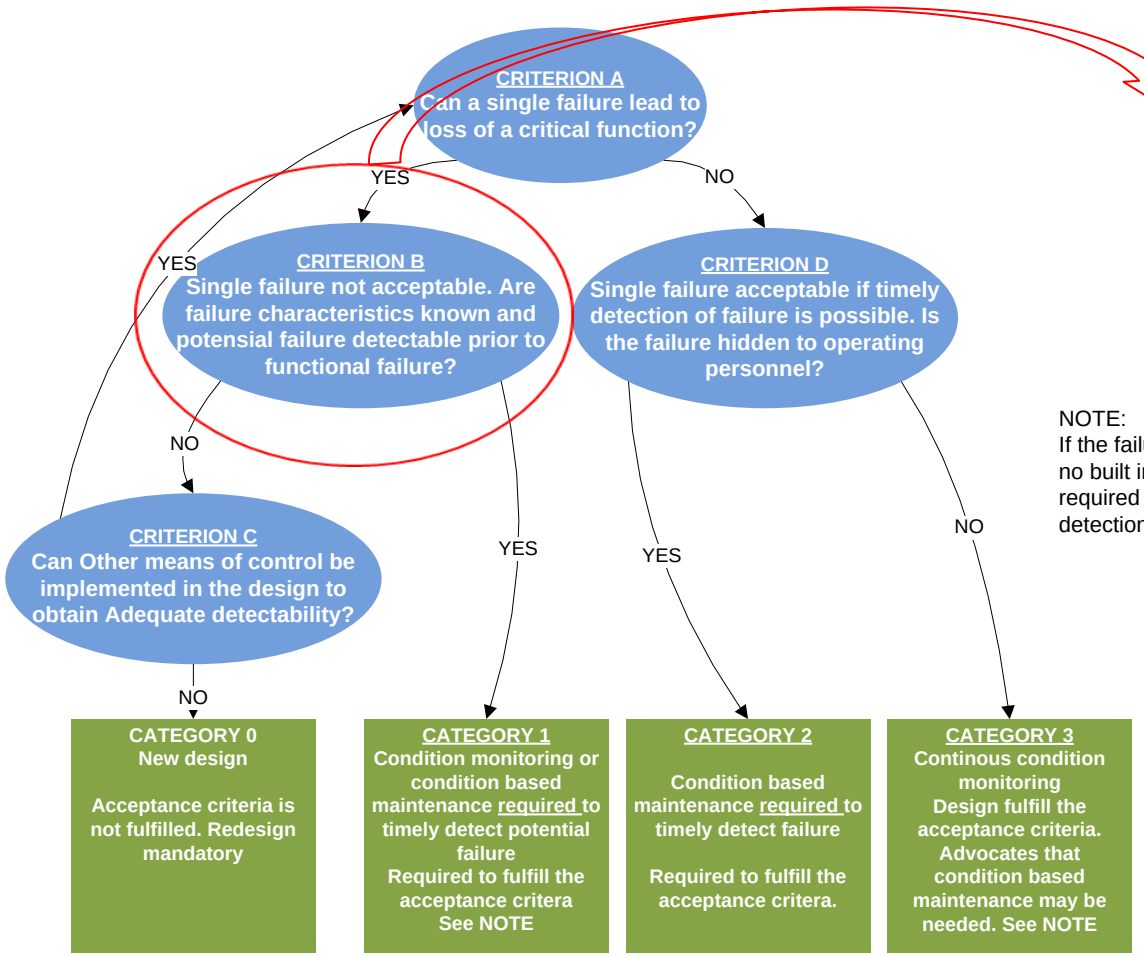
Understanding functions and the nature of technical systems

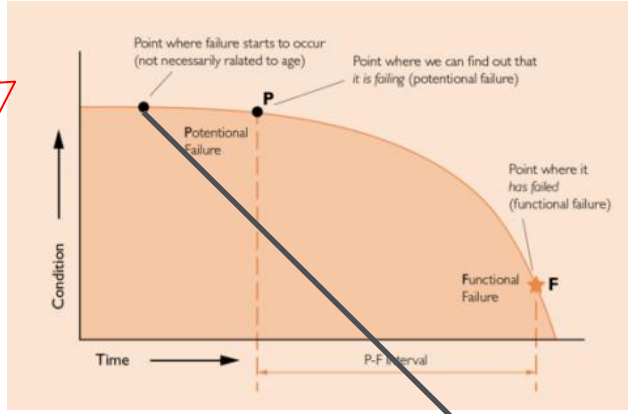


Functional specifications are generic. Technical system design may be different depending on suppliers, environmental conditions, etc.

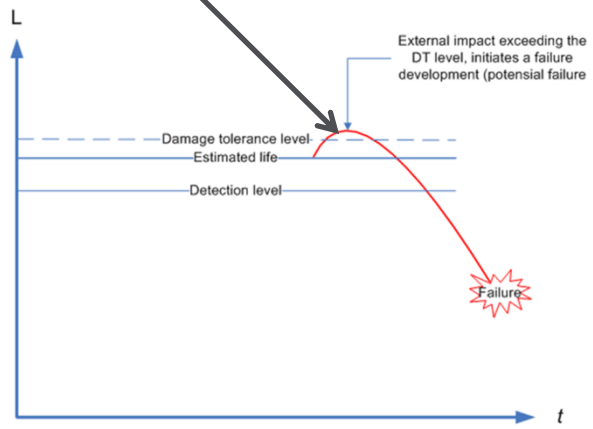


Decision logic - Asset risk assessment with focus on CBM

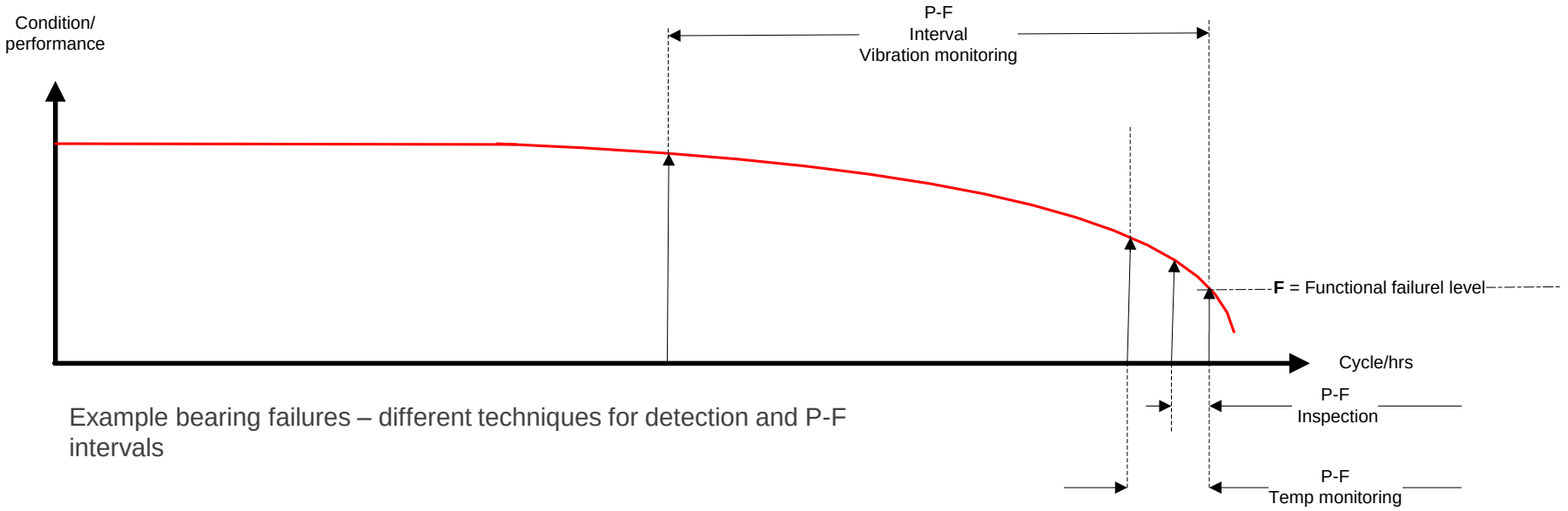




NOTE:
If the failure indication system has no built in test (BiT), FUC may be required to ensure sufficient detection probability..



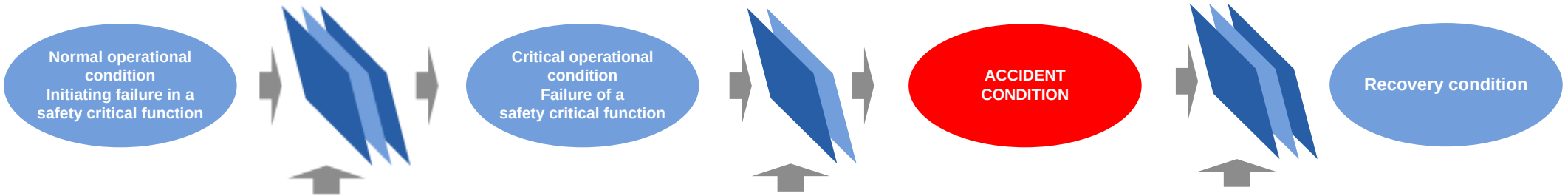
Asset management
Understanding failure predictions and intervals



Example bearing failures – different techniques for detection and P-F intervals

MTBF and failure rate cannot be used to define a P – F interval. A P – F interval is dependent of the components material behavior and may not always be known. Knowledge and experience is essential in the evaluation and defining a P – F interval.

Asset management
Critical functions and maintenance, generic barrier concept

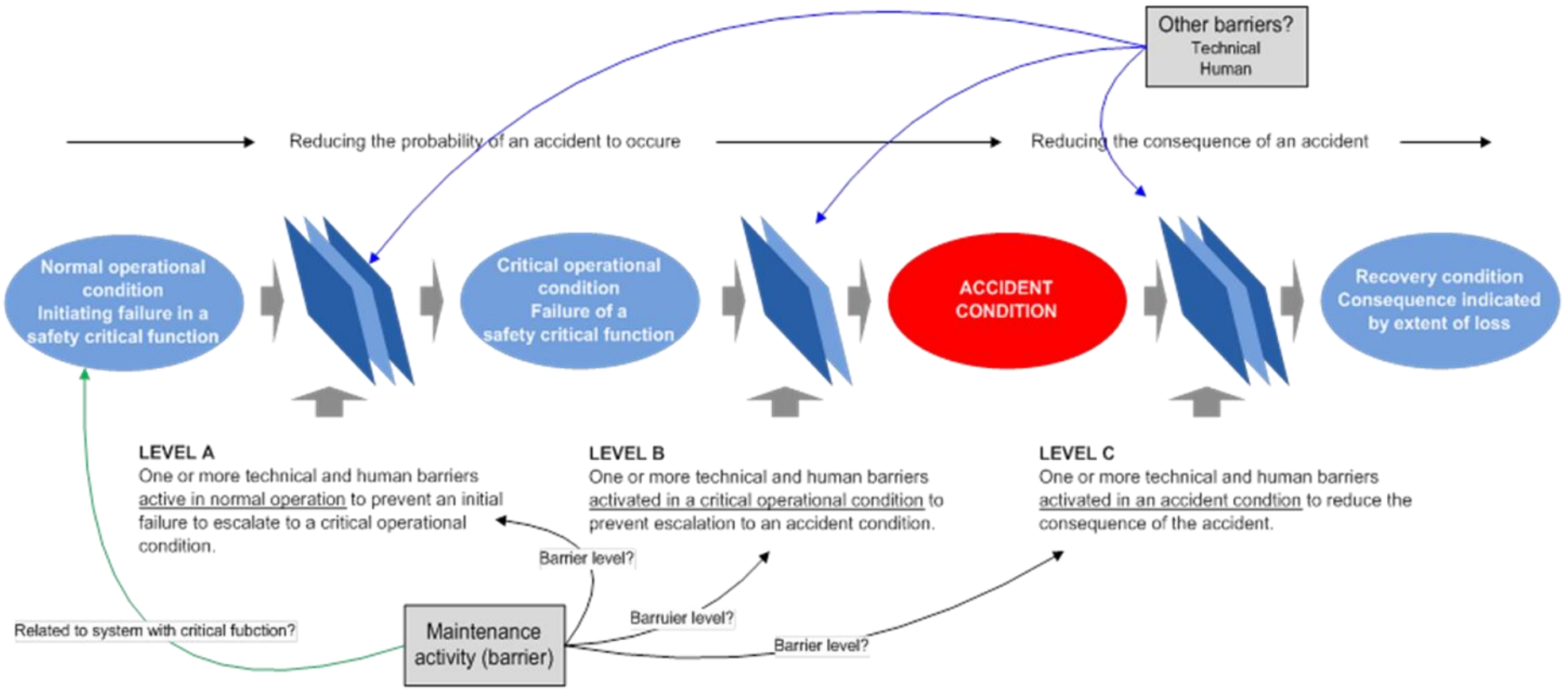


One or more technical and human barriers <u>active in normal operation</u> to prevent an initial failure to escalate to a critical operational condition.

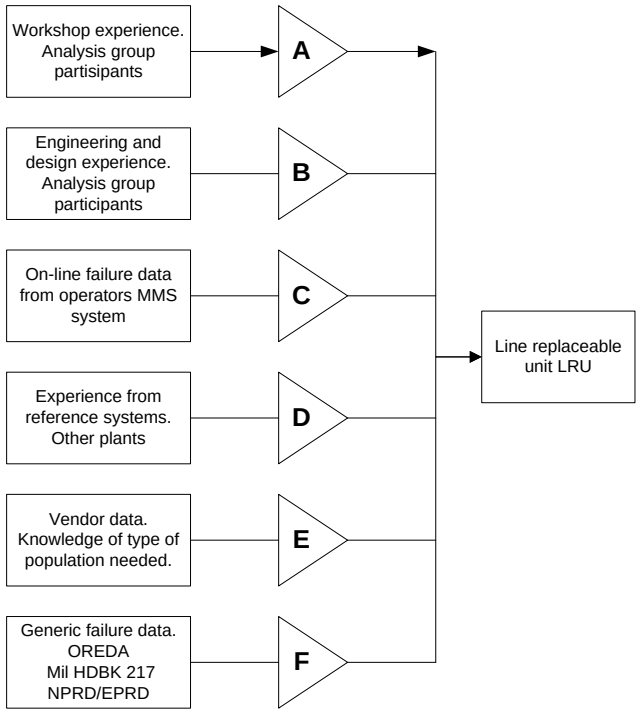
One or more technical and human barriers <u>activated in a critical operational condition</u> to prevent escalation to an accident condition.

One or more technical and human barriers <u>activated in an accident condtion</u> to reduce the consequence of the accident.

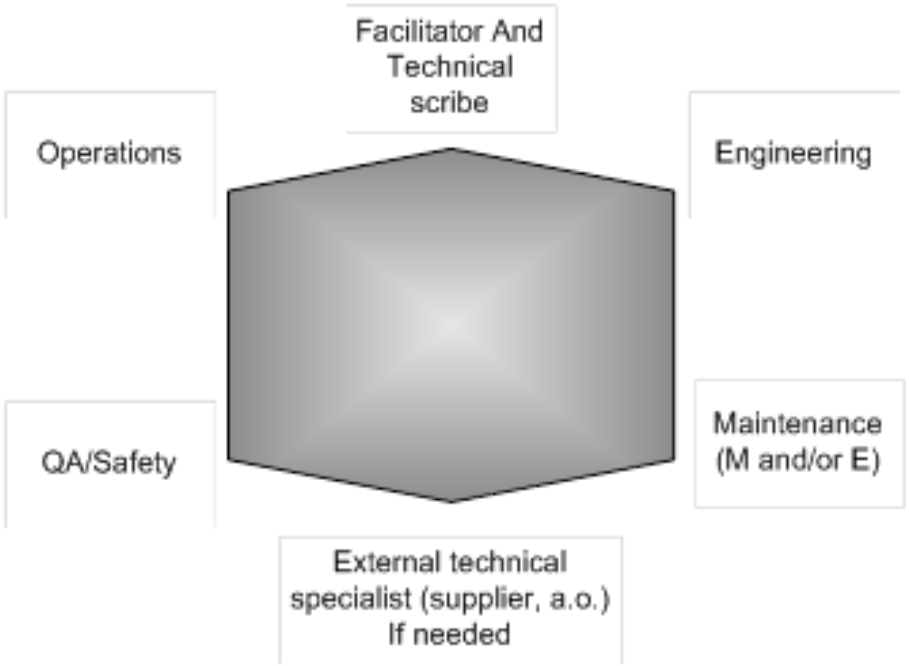
Asset management
Barrier concept and approach for optimization



Data sources to determine P-F intervals



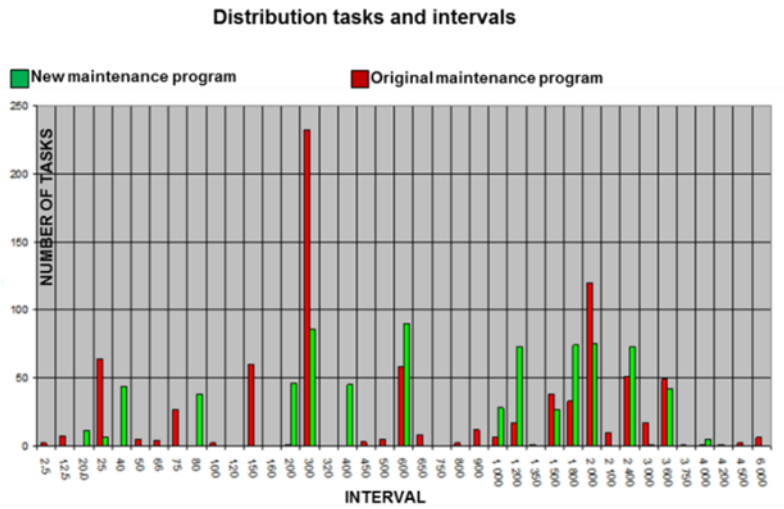
Putting together a RCM analysis team and competence



- Knowledge and experience with the RCM analysis method and process (Analysis leader team);
- detailed knowledge of the item and appropriate design features;
- knowledge of the item's operating context;
- knowledge of the condition of the item (when analysing existing equipment);
- understanding of failure modes and effects;
- specialist knowledge of constraints, such as safety and environmental legislation, etc.;
- knowledge of the maintenance techniques and tools;
- knowledge of maintenance cost;
- experience with logistics and spares;
- Experience with maintenance planning

Lessons learned from other industries

- Cost reductions
- Reduced down time
- Improved design for maintainability
- Reduced time based maintenance
- Improved maintenance management
- Reduced external influences



Øresund train/OTU;

Reduced maintenance burden 31%

Increased availability 10

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