BELÜGYMINISZTÉRIUM
ORSZÁGOS KATASZTRÓFAVÉDELMI FŐIGAZGATÓSÁG
„Magyarország szolgálatában a biztonságért!”

Hungarian approach for assessing the multi-aspect ageing phenomena

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Department for Hazardous Establishments

TWG2 EU Webinar on Ageing and Maintenance, 8 Feb 2022

Driving force

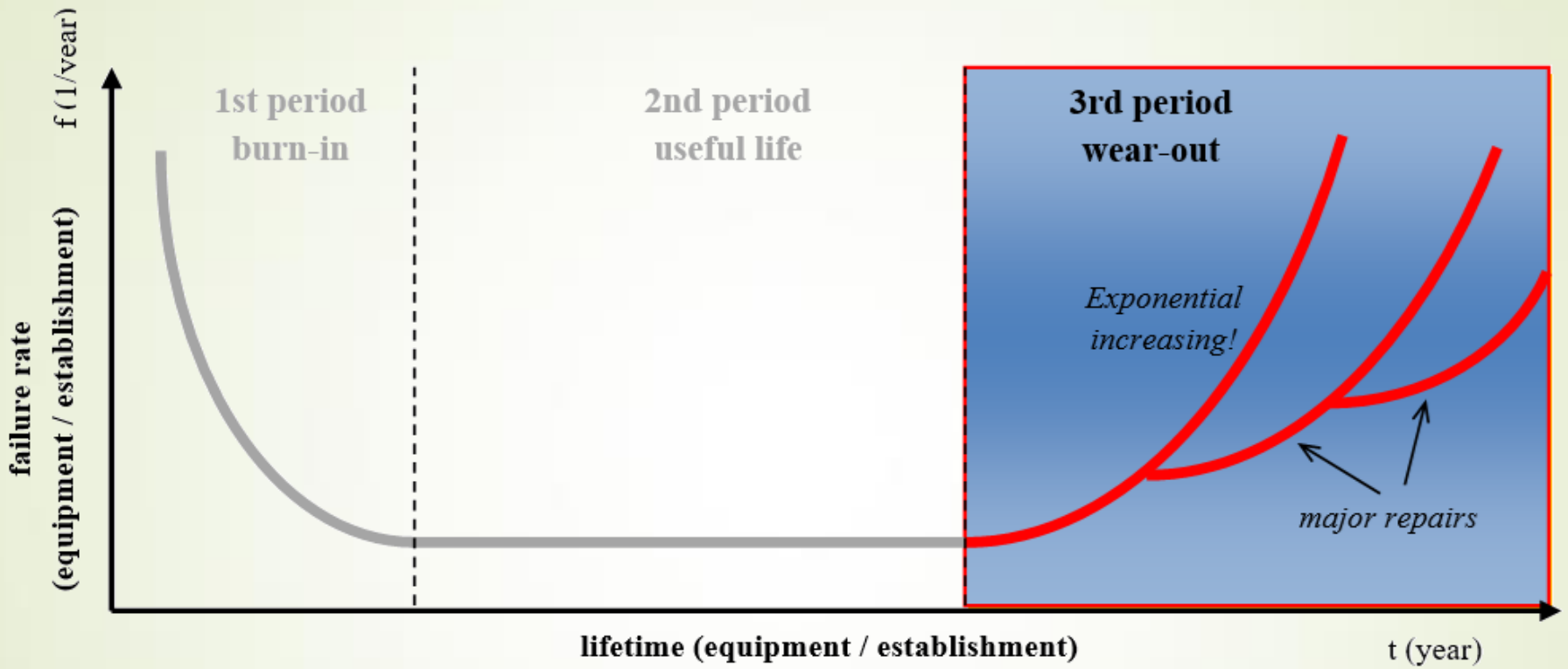
- MJV 2019. Malta → **Good practice report** - EU JRC MAHB [1] → Guidance for ageing assessment (HUN)

- Recent accidents

November 2019.
CNG explosion
64 bar DN800
1,7 million m^3 methane

October 2021.
Digester explosion
Biogas plant
3 victims (subcontractors)

Physical degradation



- Ageing: **not a constant** source of danger
- Running time reduces the reliability of the equipment
- Dangerous establishment = a set of devices and equipment that failure rates are increasing near to the end of their life cycle (3rd period)

Multi-aspect phenomena

- complex establishment = hundreds of equipment (tanks, pipelines), and thousands of devices (physically)

- These are, however, only a part of an **even more complex system**.

- Aging is a multi-aspect phenomenon that includes the obsolescence of all of the following:

1. Physical integrity
   - Hazardous installations
   - Process facilities and infrastructure
   - Electrical devices, systems

2. Procedures
   - Operating procedures
   - Documents
   - Drawings, P&IDs
   - Digitalization

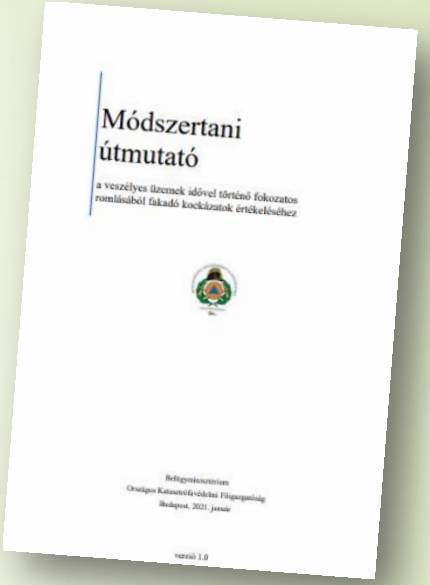
3. People
   - Retirement, reorganization
   - Loss of knowledge
   - Fluctuation
   - Age of physical workers

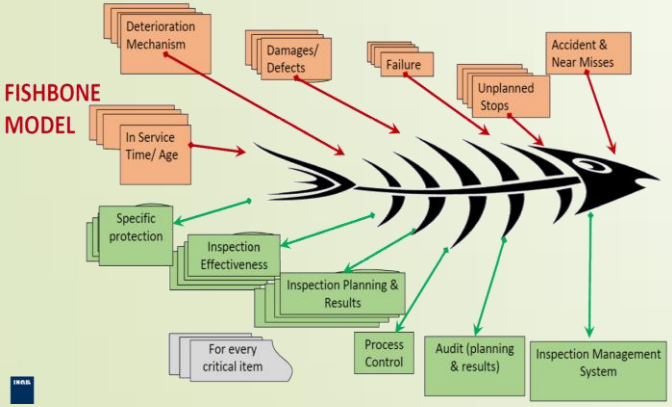
- The assessment model should identify all of these aspects/factors.

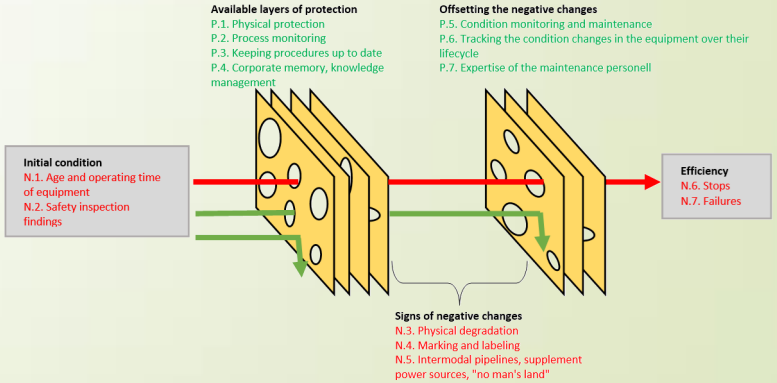
Adaptation of existing methodologies

In Italy, the evaluation methodology has been developed as a result of extensive collaboration and scientific work. During its adaptation, it was modified according to the following principles:

- the **domestic conditions**, and the **available resources;**
- **all the three aspects** of aging (physical, documentary, human);
- **diversity**: developing a method that can be used for both huge complexity upper-tier establishments and small, low-volume sites;
- **a simple, rapid survey** that could follow with limited expertise;
- keep the **verifiability**, **reproducibility,** and **transparency**;





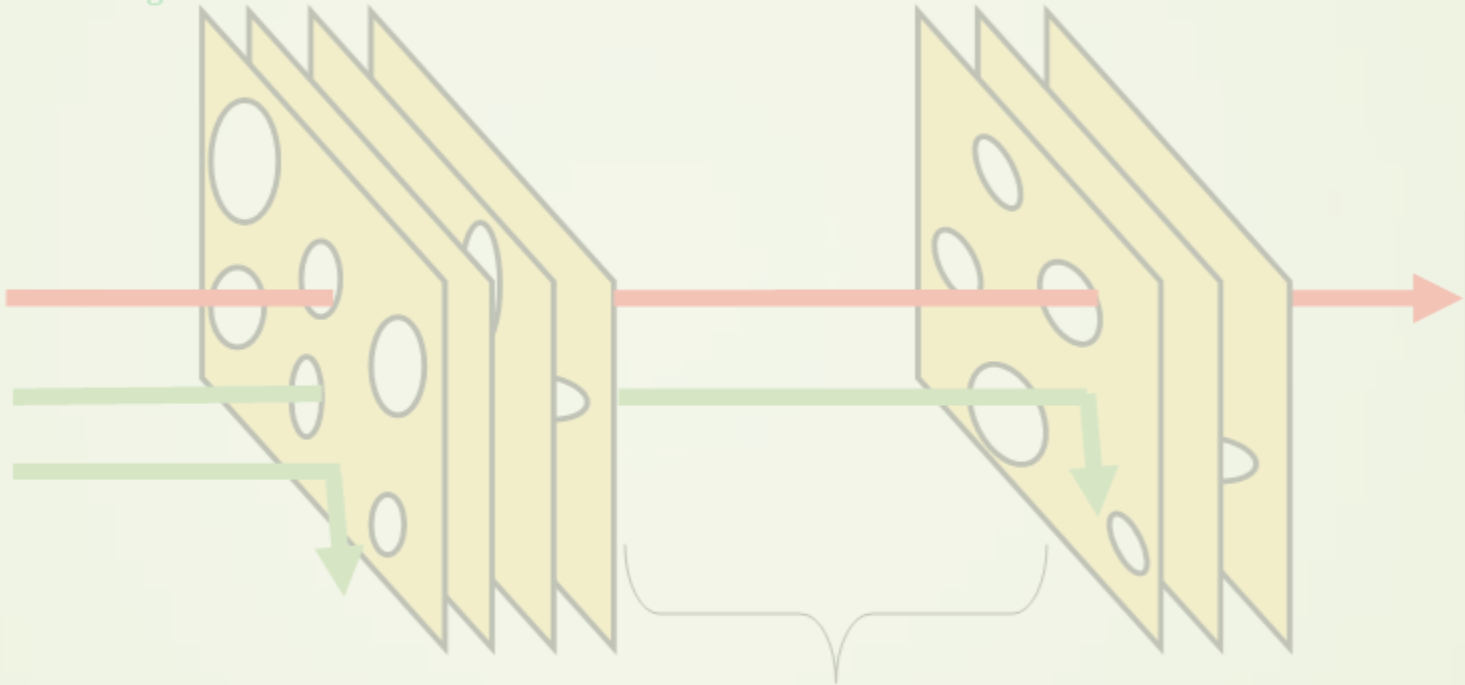


Logical structure

Available layers of protection
P.1. Physical protection
P.2. Process monitoring
P.3. Keeping procedures up to date
P.4. Corporate memory, knowledge management

Offsetting the negative changes
P.5. Condition monitoring and maintenance
P.6. Tracking the condition changes in the equipment over their lifecycle
P.7. Expertise of the maintenance personell

Initial condition
N.1. Age and operating time of equipment
N.2. Safety inspection findings



Efficiency
N.6. Stops
N.7. Failures

Signs of negative changes
N.3. Physical degradation
N.4. Marking and labeling
N.5. Intermodal pipelines, supplement power sources, "no man's land"

N.1. Age and operating time of equipment

CRITICAL EQUIPMENTS

- atmospheric containment
- pressure vessel
- pipeline section
- isolation device
- safety valve
- pump,compr motor
- reactor, tech. vessel
- crit. instrument

x3

$$f_{n1} = \frac{\text{actual age, operating time}}{\text{designed lifetime}}$$

remaining service life

$$t = t_0 + R_L$$
$$t_0 = T_{RL} - T_0$$

t: age / operating time of equipment [year]
t_0: actual age [year]
R_L: remaining service life based on meassurements [year]
T_{RL}: examination date [year]
T_0: installation date [year]

f_{n1} - aspect classification: *Severity*

Category	Criteria
1	$f_{n1} < 0,5$
2	$0,5 \le f_{n1} < 0,75$
3	$0,75 \le f_{n1} < 1$
4	$1 \le f_{n1}$, and if any of the data is missing

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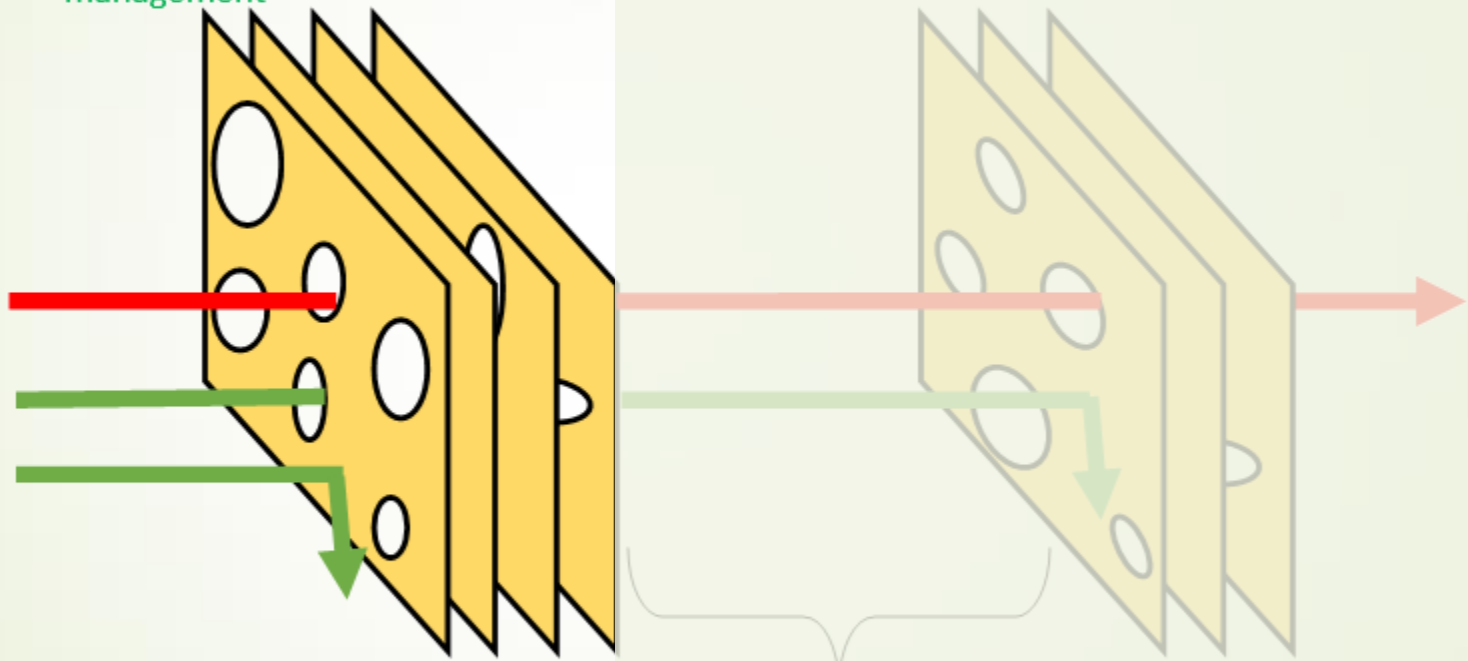

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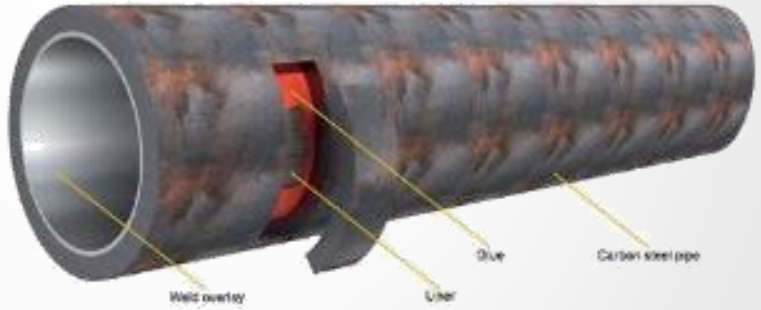
P.1. Physical protection

Solutions (hierarchy!):

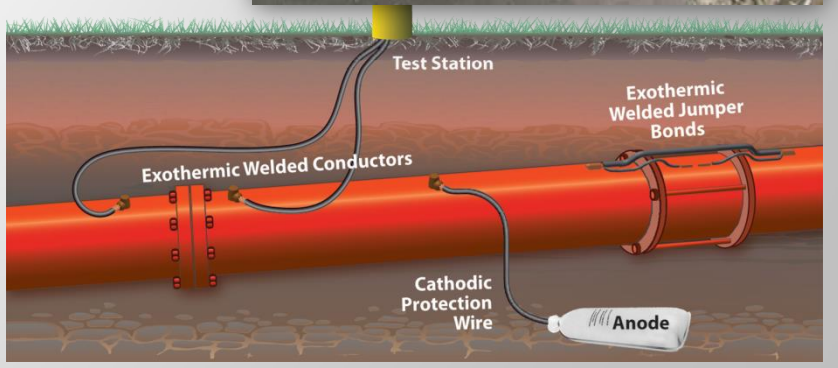
- use of chemically stable materials as structural materials (eg stainless steel, fiberglass)
- hot dip galvanizing;
- anodizing;
- cladding (inner metal alloy coating);
- lining (inner fiberglass coating);
- fireproof coating;
- cathodic protection;
- exterior coating (painting).



fp_1 - aspect classification: *Protection ability*

Category	Criteria
a	excellent (perfect) condition
b	good condition
c	average condition, protection to be taken into account
d	there is no physical protection, or the condition is not suitable for protection

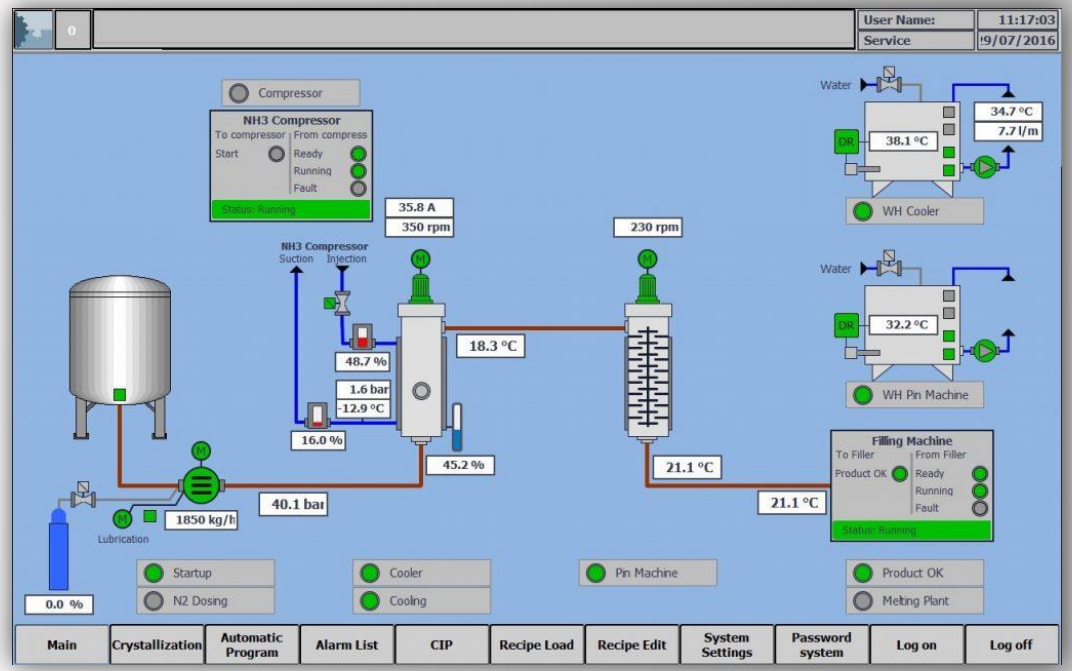
Date of the last inspection/renovation!



P.2. Process monitoring

Checklist:

- ✓ Instrumentation and process control system?
- ✓ Data archiving of the process control system?
- ✓ Alarm by the process control system?
- ✓ Manual emergency stop option through the process control system?
- ✓ Remoted and automated emergency shutdown by the process control system?



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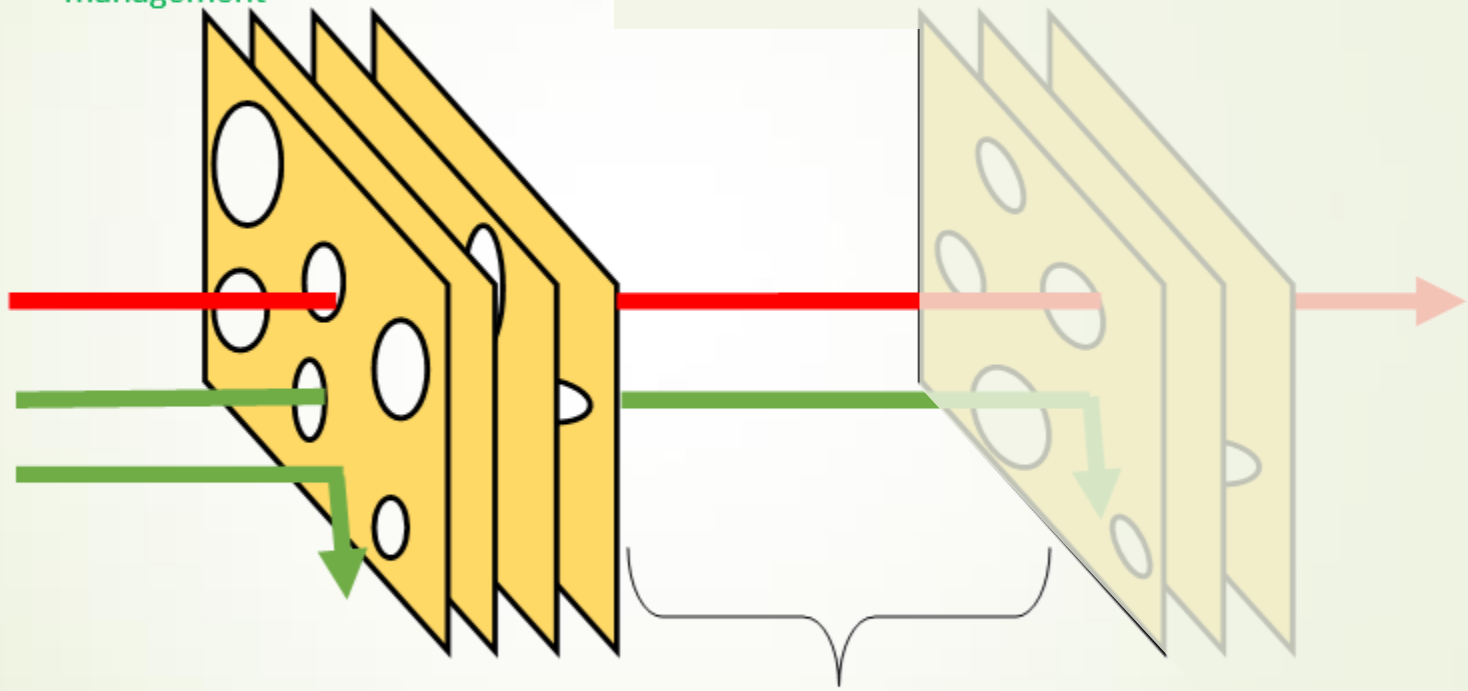

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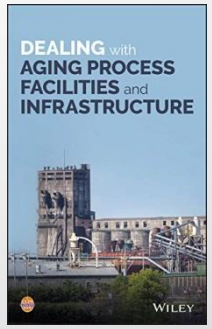
N.3. Physical degradation

N.3.a Visual signs of degradation

Group of equipment	Severe deterioration	General deterioration	Good condition	Perfect, new condition
Atmospheric containment				
Pressure vessel				
Pipeline section				
Isolation device				

N.3.b Critical infrastucture's aging

N.3.c Electrical network's condition



Checklists:

- ✓ Structural Assets
- ✓ Fire Water, Cooling Water and Sewers
- ✓ Electrical Distribution System

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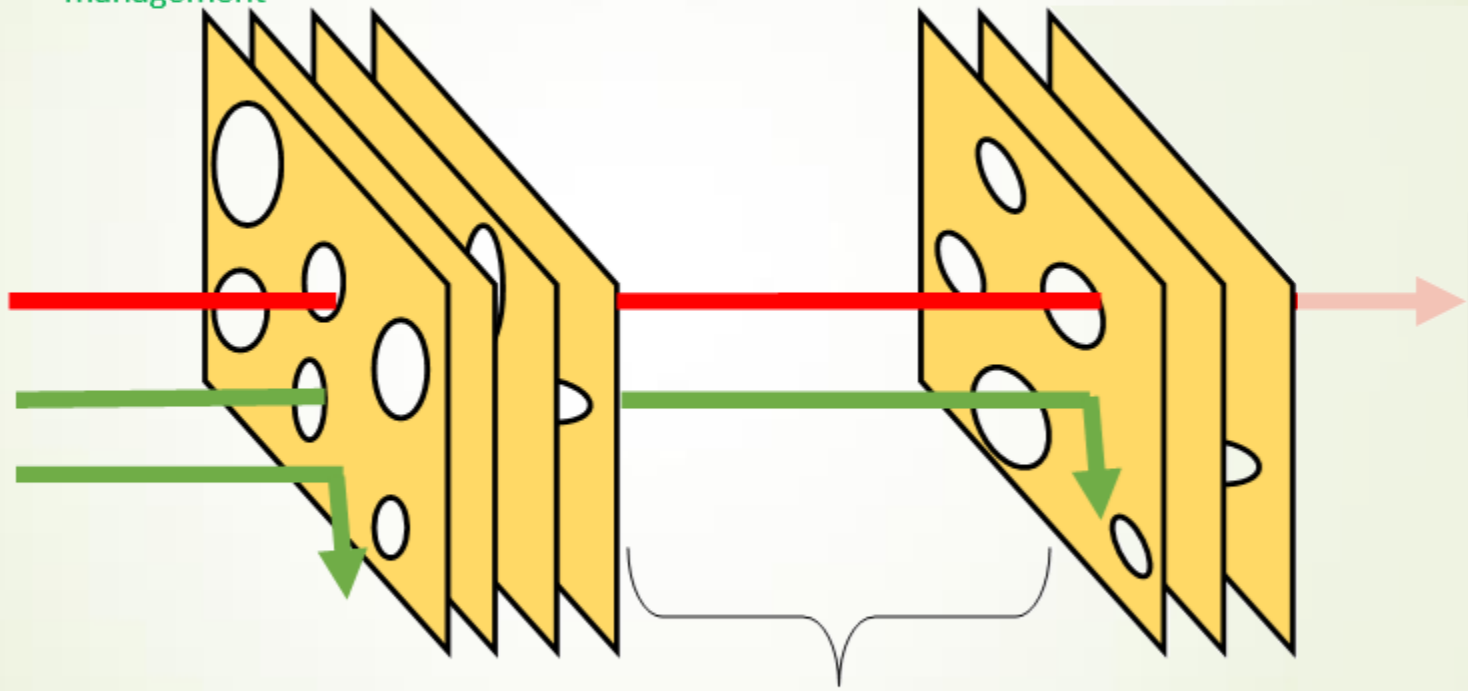

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P.4. Corporate memory, knowledge management

P.4.a Knowladge abut the condition changes in the equipment over their lifecycle

Is the following information available about the designing conditions?

- For what type of substance the equipment was planned?
- For what temperature range the equipment was planned?
- For what pressure range the equipment was planned?

} Any change of these conditions during the lifetime?

P.4.b Compliance with current standards

RAGAGEP (= recognized and generally accepted good engineering practices)

P.5. Condition monitoring and maintenance

P.5.a The system of condition monitoring

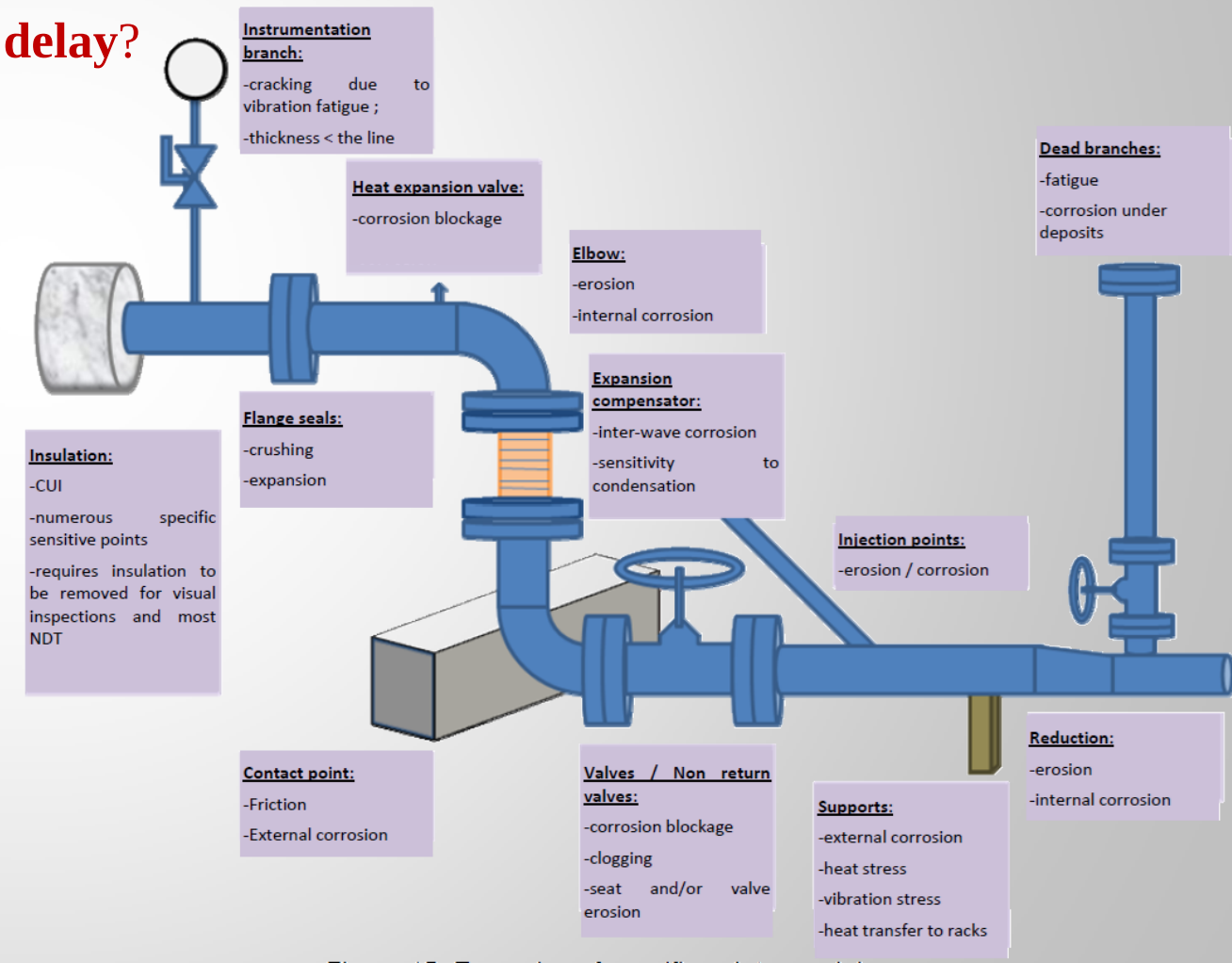
P.5.b Condition monitoring's efficiency

→ Checklist: **18** questions

P.5.c Accomplishment of the maintenance plans → Any **delay**?

Main topics:

- critical equipment's list
- monitoring frequency (Hazard Study?)
- Risk-Based Inspection
- thickness measurement locations
- weakest point analyzes
- equipment located in hard-to-reach places
- trend analyzes



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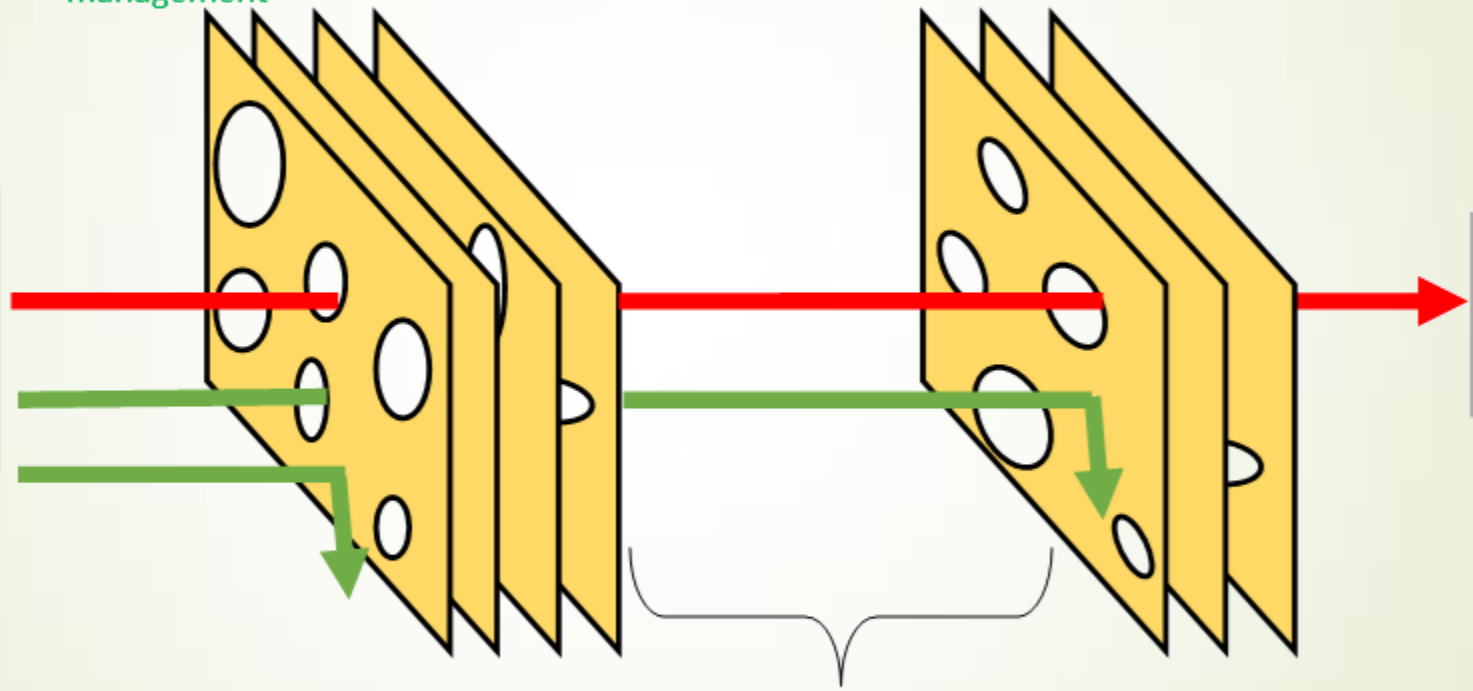

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N.6. Stops

unexpected / uncontrolled **STOPS** → **sudden drops/increase** of pressure & temperature → **damaging the material properties** (mechanical, structural) of the equipment → **shorten** the life of the equipment

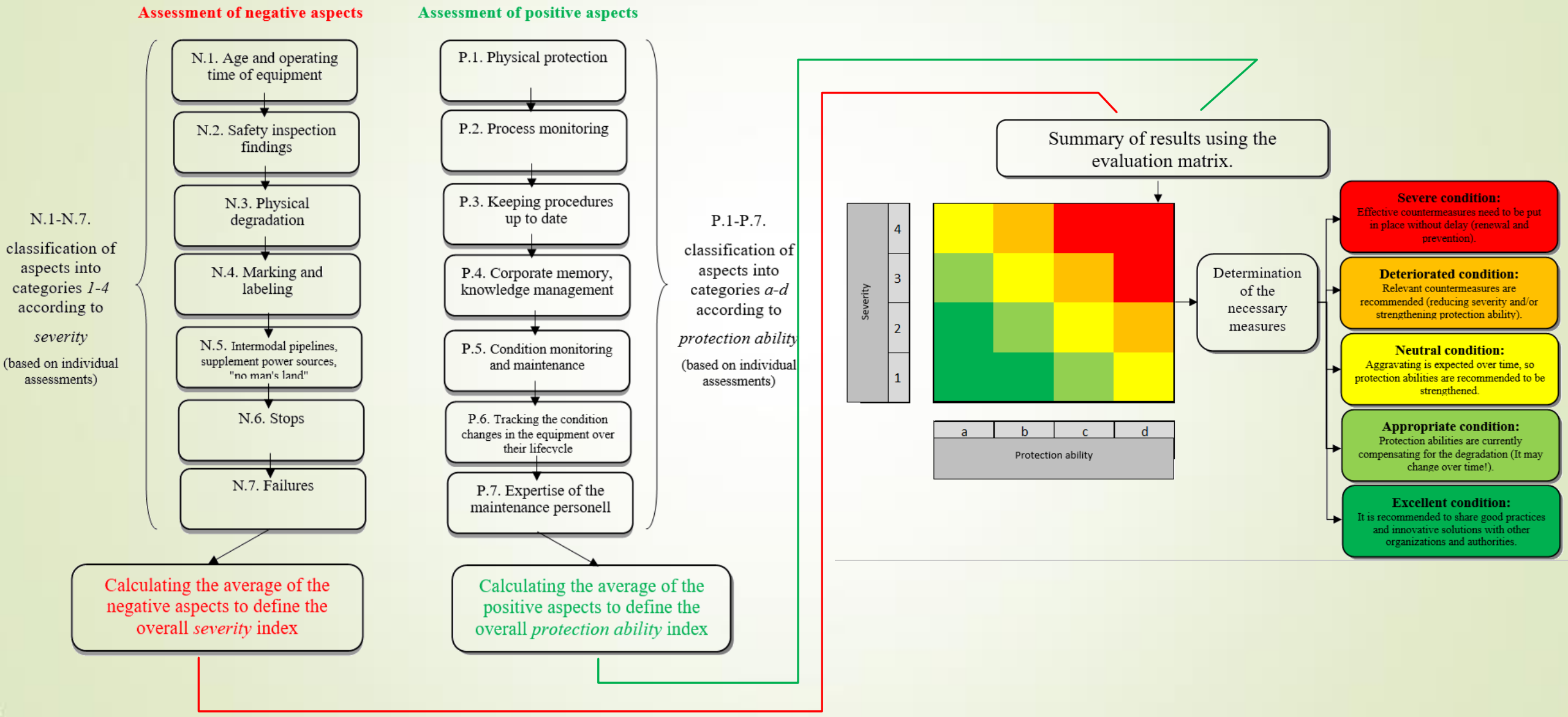
+ The increase in the frequency of outages due to unexpected failures may call attention to the growing aging trend, as frequent unexpected outages are also signs of general deterioration.

$$f_{n6} = \frac{\text{unexpected stops (during the last 3 years)}}{\text{planned stops (during the last 3 years)}}$$

f_{n6} - aspect classification: *Severity*

Category	Criteria
1	$f_{n6} < 0,1$
2	$0,1 \leq f_{n6} < 0,25$
3	$0,25 \leq f_{n6} < 0,6$
4	$0,6 \leq f_{n6}$

Flowchart


Assessment of negative aspects
Assessment of positive aspects
N.1. Age and operating time of equipment
N.2. Safety inspection findings
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N.1-N.7.
classification of aspects into categories 1-4 according to
severity
(based on individual assessments)
P.1-P.7.
classification of aspects into categories a-d according to
protection ability
(based on individual assessments)
Calculating the average of the negative aspects to define the overall severity index
Calculating the average of the positive aspects to define the overall protection ability index
Summary of results using the evaluation matrix.
Severity
4
3
2
1
a
b
c
d
Protection ability
Determination of the necessary measures
Severe condition:
Effective countermeasures need to be put in place without delay (renewal and prevention).
Deteriorated condition:
Relevant countermeasures are recommended (reducing severity and/or strengthening protection ability).
Neutral condition:
Aggravating is expected over time, so protection abilities are recommended to be strengthened.
Appropriate condition:
Protection abilities are currently compensating for the degradation (It may change over time!).
Excellent condition:
It is recommended to share good practices and innovative solutions with other organizations and authorities.

Literatures

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Available here: https://www.katasztrofavedelem.hu/application/uploads/documents/2021-02/73544.pdf

Thank you for your attention!