BELIMO®

Durability of Thermal Energy Meters

Philip Holoch

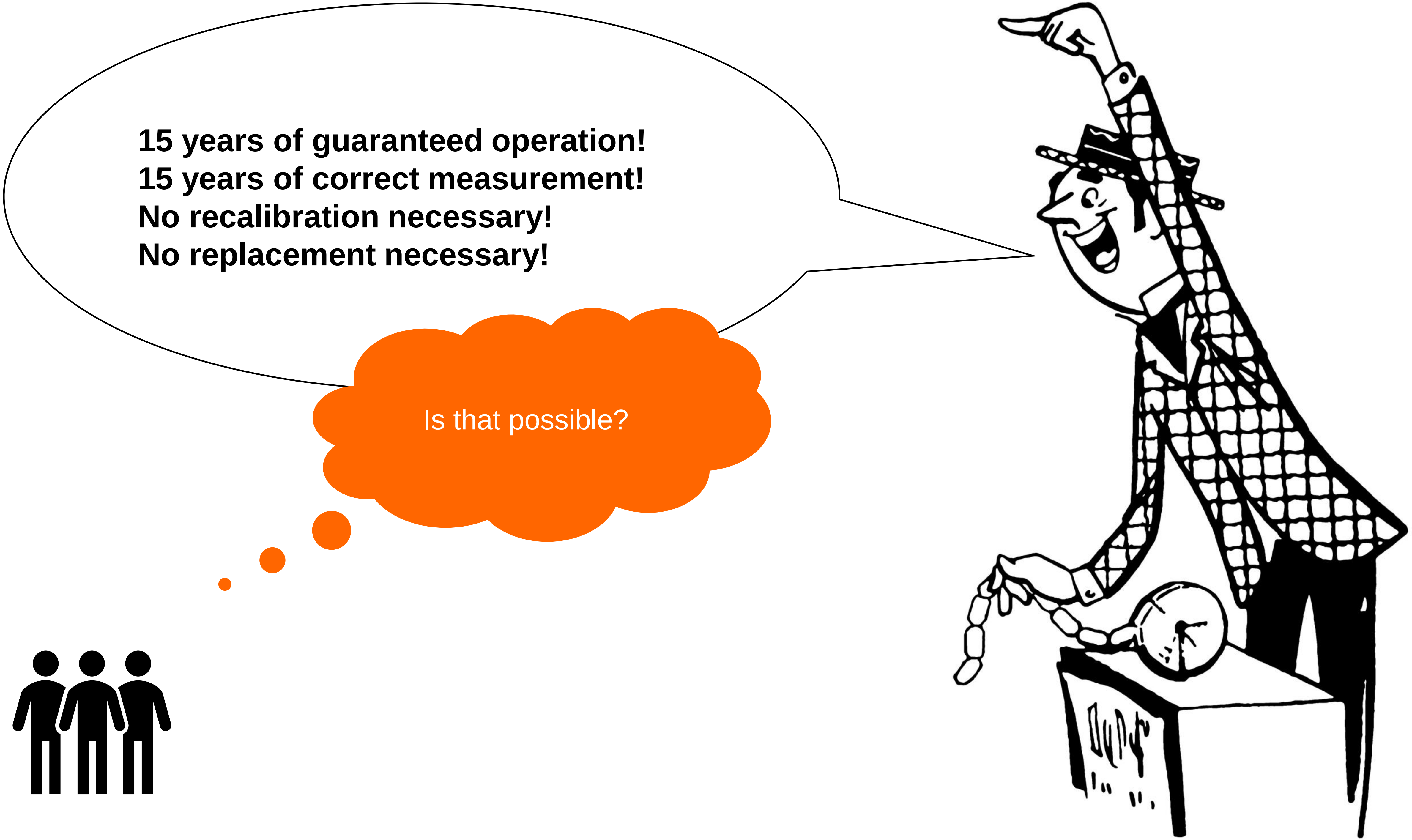
EN 1434-1:2022

3.24
durability
characteristic of a measuring instrument to keep the metrological characteristics over time (e.g. to fulfil the double of MPE), provided that it is properly installed, maintained and used within the permissible environmental conditions

Waste of Ressources
Waste of Labour
Waste of Money

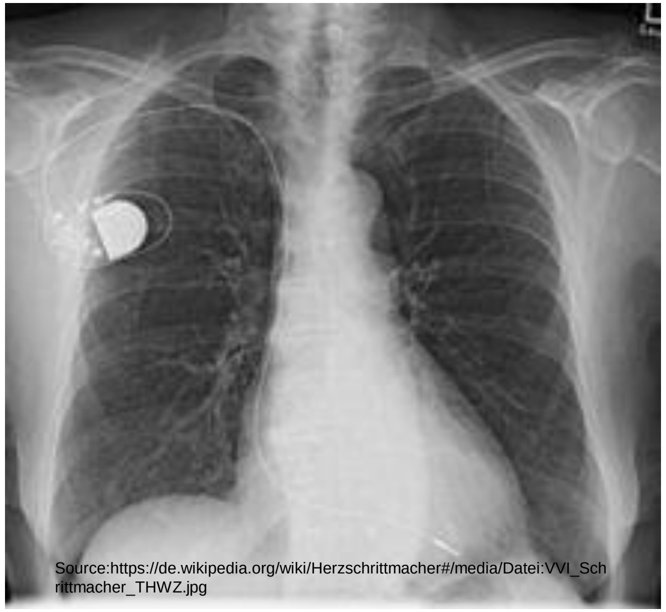
Every year more th... ...gy
meters are being rep... ...y in Ge... ...ny

Ca. 90% are being disposed


15 years of guaranteed operation!
15 years of correct measurement!
No recalibration necessary!
No replacement necessary!
Is that possible?

Long Durability is Possible

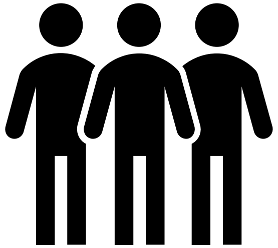
Source:https://de.wikipedia.org/wiki/Wetterfunkdienst_%C3%BCber_Satelliten#/media/Datei:NOAA-M.jpg



Source:https://de.wikipedia.org/wiki/Herzschrittmacher#/media/Datei:VVI_Schrittmacher_THWZ.jpg

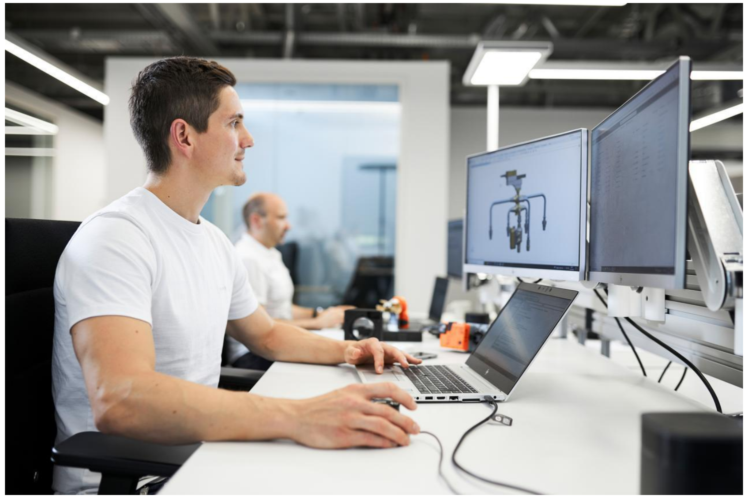
Source:Kabelleger / David Gubler (http://www.bahnbilder.ch) - Eigenes Werk: http://www.bahnbilder.ch/picture/7318, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=12687028

Of course!

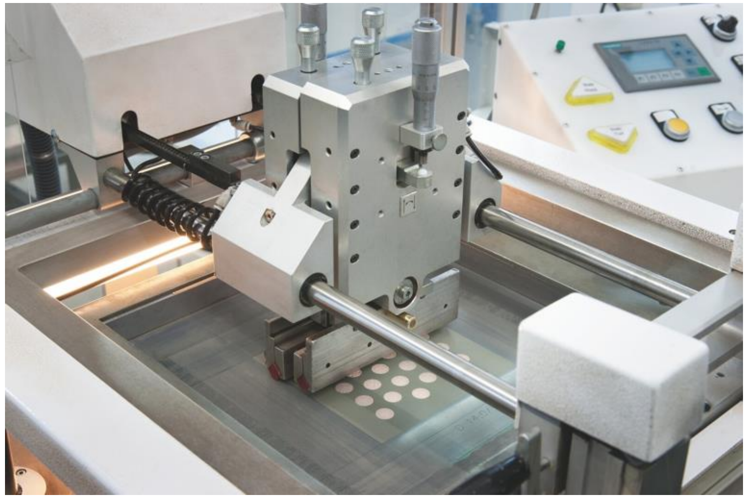


Influencing Factors on the Durability of a Meter

Design



Production



Operation

Today's Method

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Design

Module B

Production

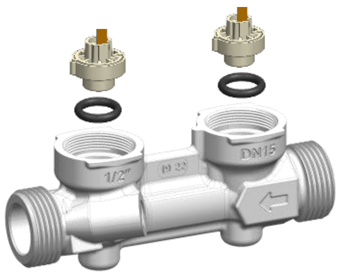
Module D

Operation

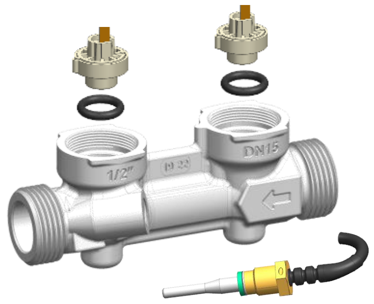
Recalibration periods

Today’s Type Approval Durability Test (EN1434-4)

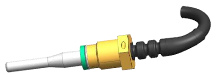
- Basic test
  - 100 days
  - Varying flows
  - At maximum specified temperature (e.g. 120°C)



- Accelerated test
  - 4000 temperature cycles = 5 years
  - 8000 temperature cycles = 10 years
  - 15…20°C / 80…85°C



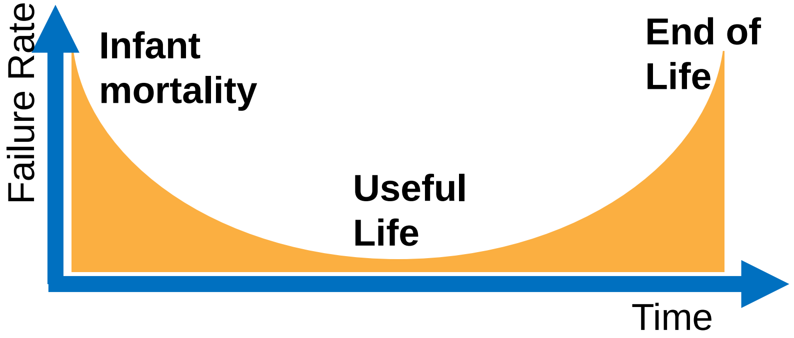
- High temperature test
  - 10 cycles à 24h
  - 22h at max. temperature (e.g. 120°C) / 2h at ambient temperature



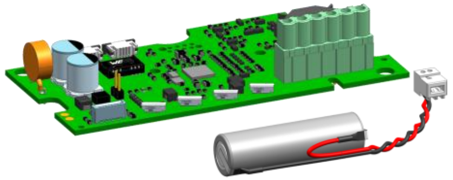
Drawbacks in Today's Approvals


Source: ecohausshop.ch

- Application requirements are not reflected

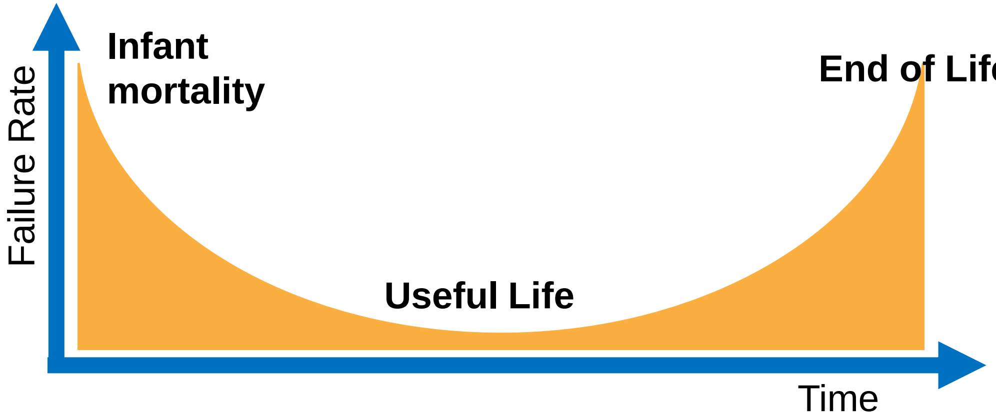


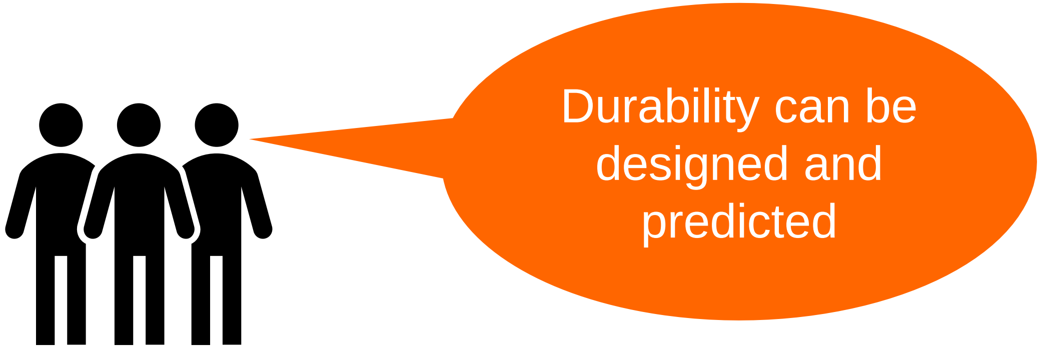
- Approval tests with only 5 samples
  - No statistical data to predict durability



- Just increasing the number of cycles or samples is not enough
  - Only parts in contact with the liquid are tested on durability
  - Other failures could occur, if the weak components are improved
    → e.g. electronics and battery are not covered in durability tests

Legal Recalibration Periods without Foundation





Country	Recalibration period heat meters	Recalibration period district heat meters
Austria	-	5 years
Belgium	8 years	-
Bulgaria	2/5 years	2 years
Croatia	-	3 years
Czech Republic	-	4 years
Denmark	-	6 years
Estonia	-	2 years
Germany	8 years	6 years
Hungary	-	6 years
Poland	5/10 years	4 years
Romania	4 years	4 years
Sweden	-	5/10 years
France, BH, Cyprus, Greece, Ireland, Italy, Malta, Montenegro, Portugal, Spain, Turkey, UK	-	-

Source: heat meter accuracy testing, David Butler/Alan Abela, Chris Martin, UK Department for Business, Energy & Industrial Strategy, November 2016, “Heat_Meter_Accuracy_Testing_Final_Report_16_Jun_incAnxG_for_publication.pdf”

Where do we need to improve? → Analysis and Prediction

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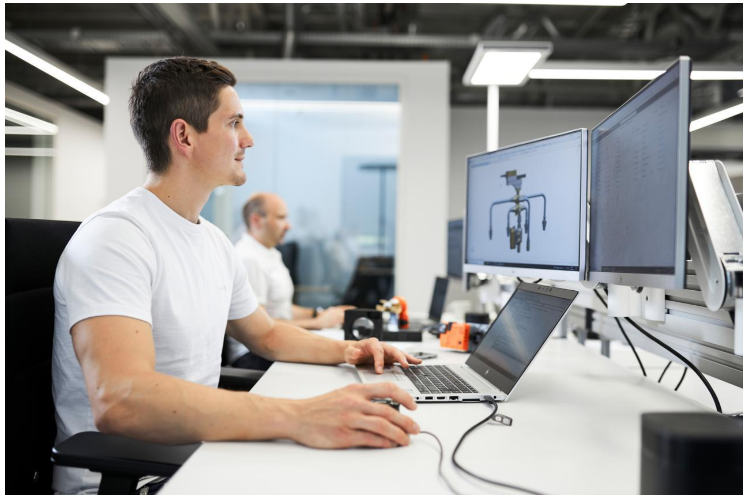
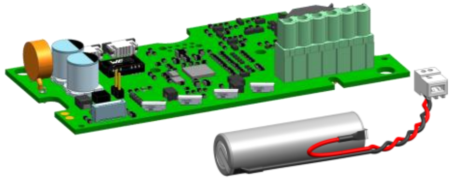
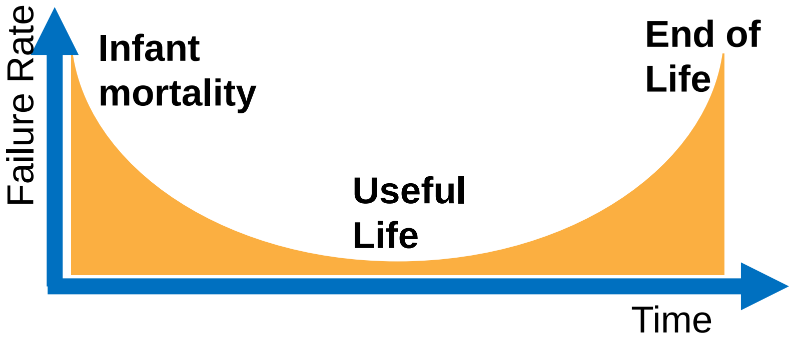
Design



- Take a look at all components
- Risk based approach to improve quality and durability on component level
- Create statistical data to predict durability





Where do we need to improve? → Recalibration Periods

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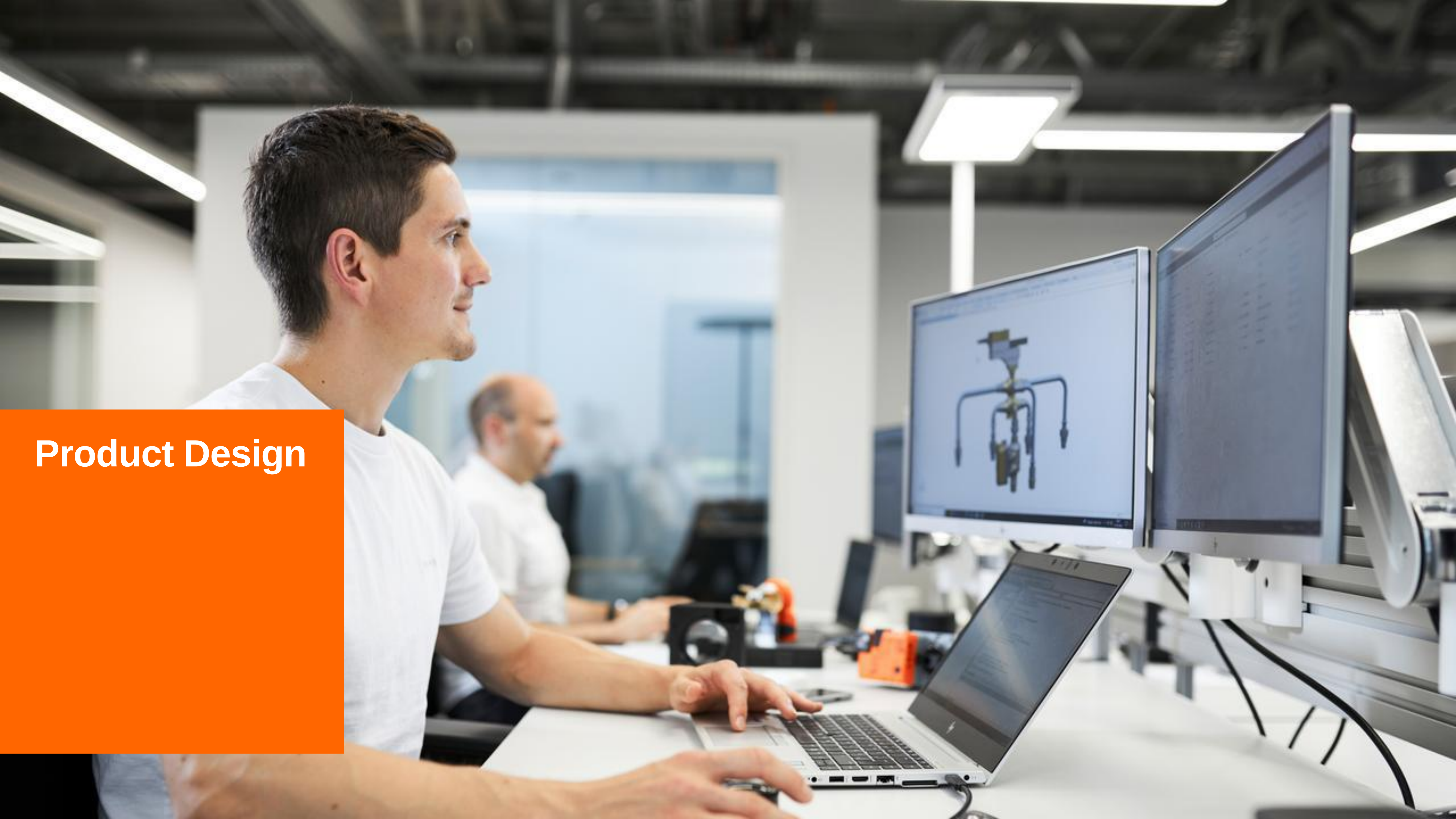
Recalibration periods should be founded on

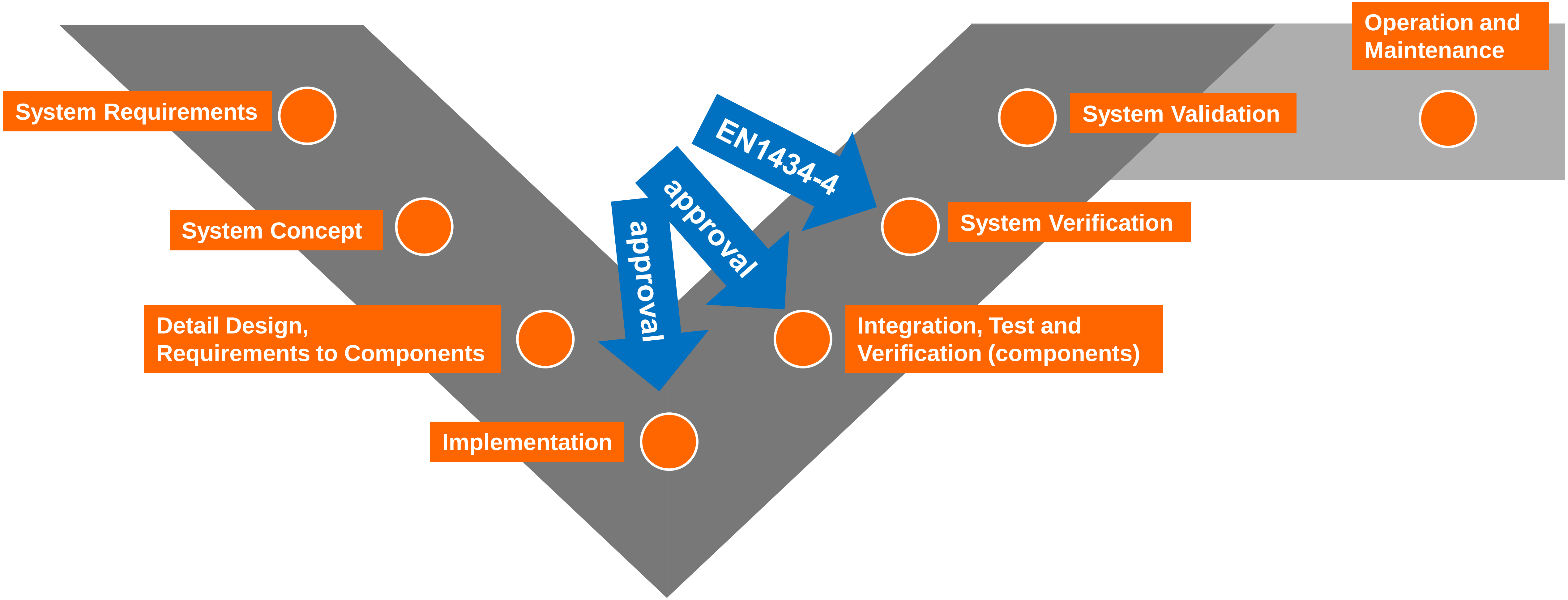
- **designed and statistically proven durability**
- **health state of the meter**
- **stress level of the meter**

Operation

Product Design



Product Design



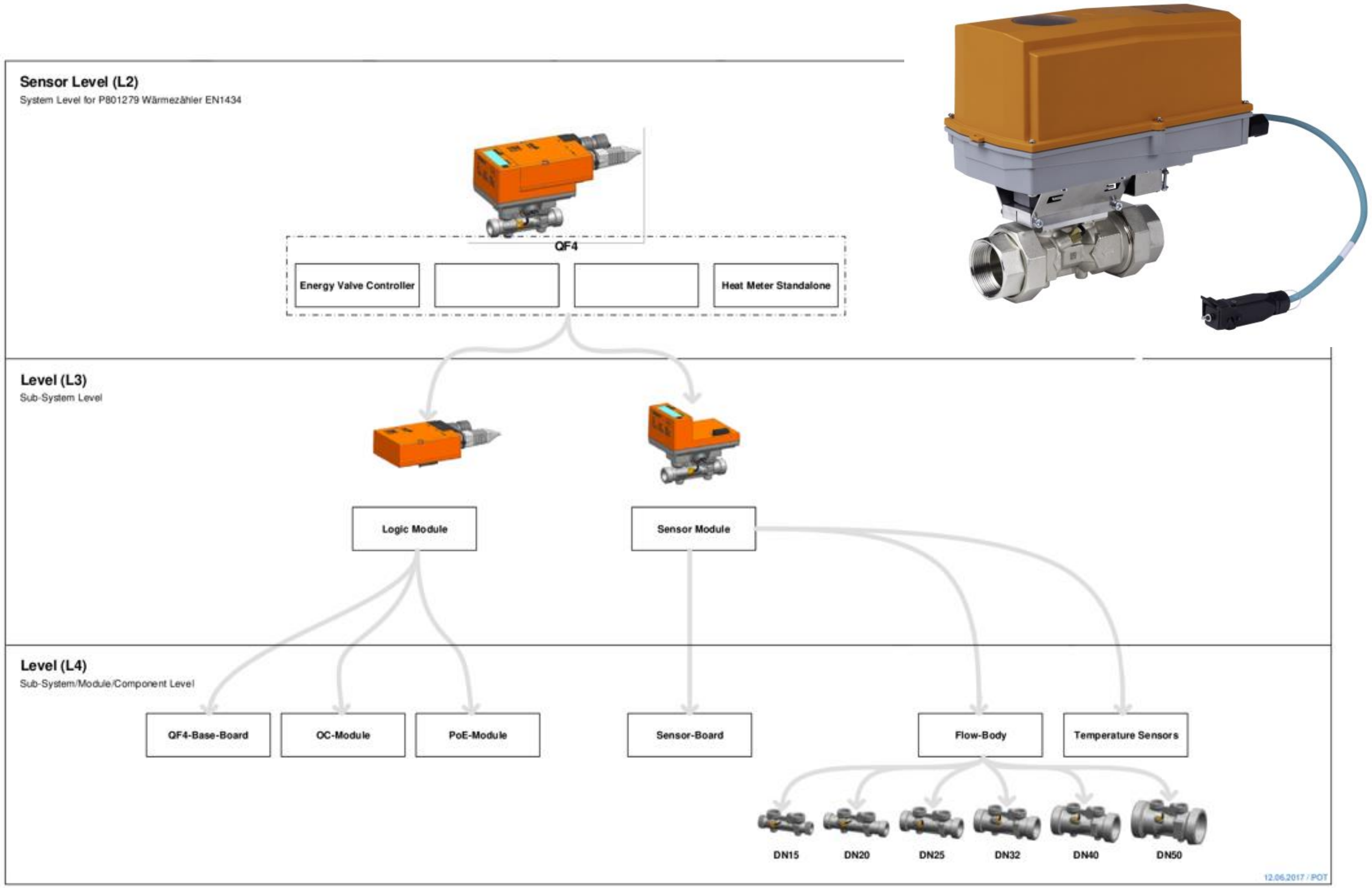
Requirements

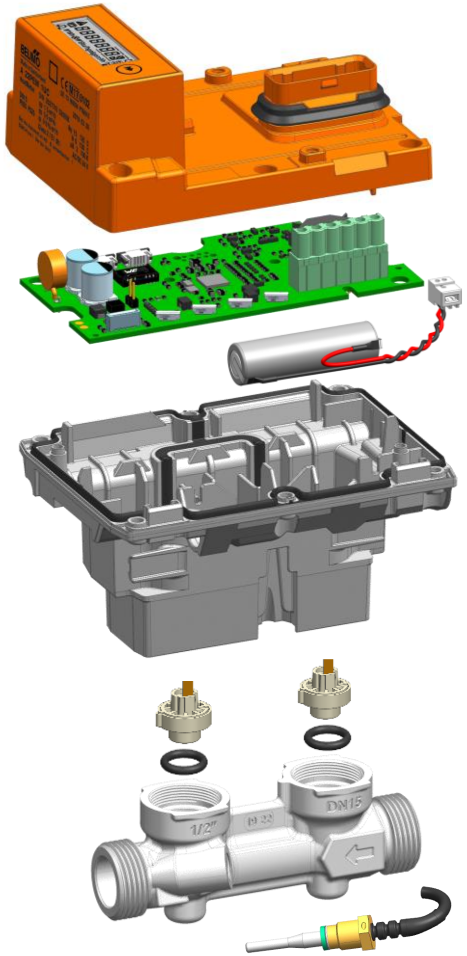
Source: www.imegcorp.com,

Source: ecohausshop.ch

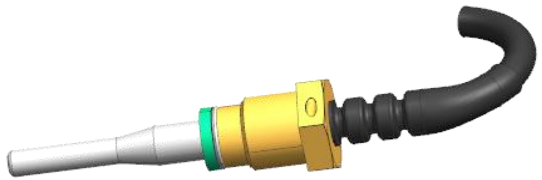
Source: www.hornbach.ch

System Concept → Split into Components

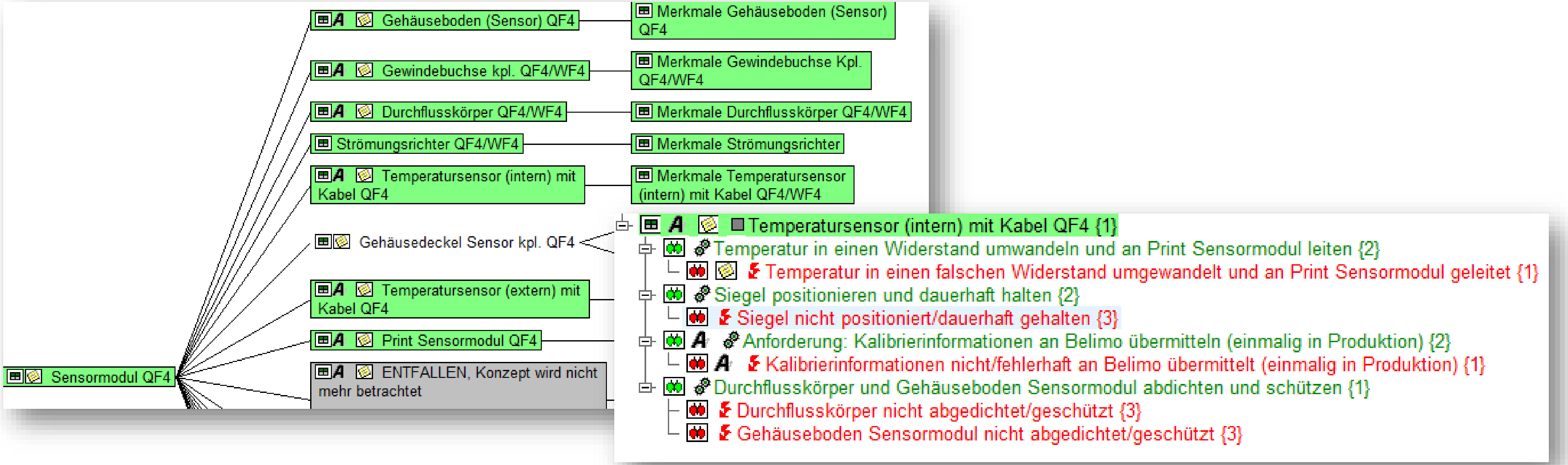




Requirements to components

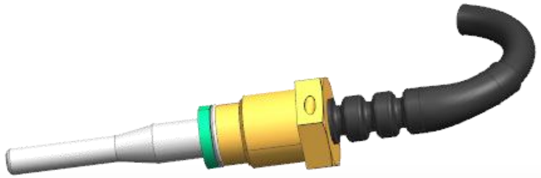


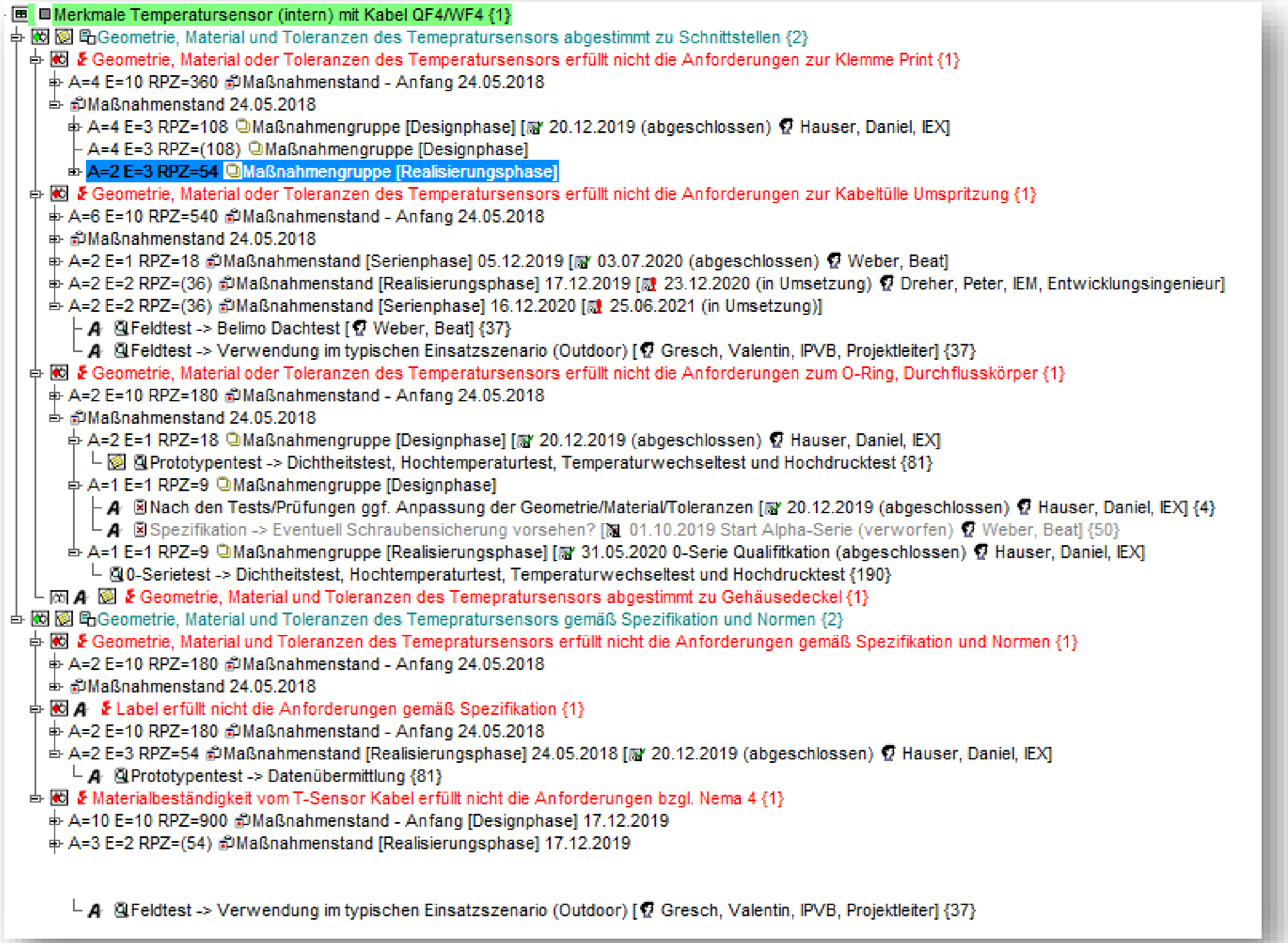
- Define functionalities of components
- Do a risk assesment (e.g. FMEA = Failure Mode and Effects Analysis)
  - Identify failure modes



Detail design Implementation

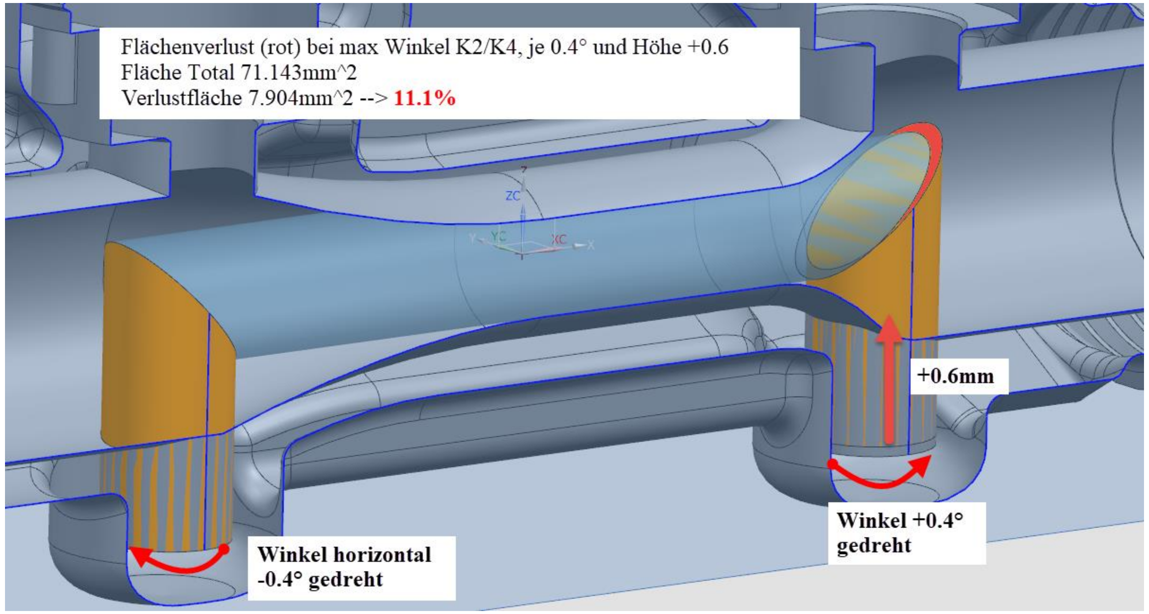
- Implement measures against risks
  → Detect weak spots
  → Avoid failures

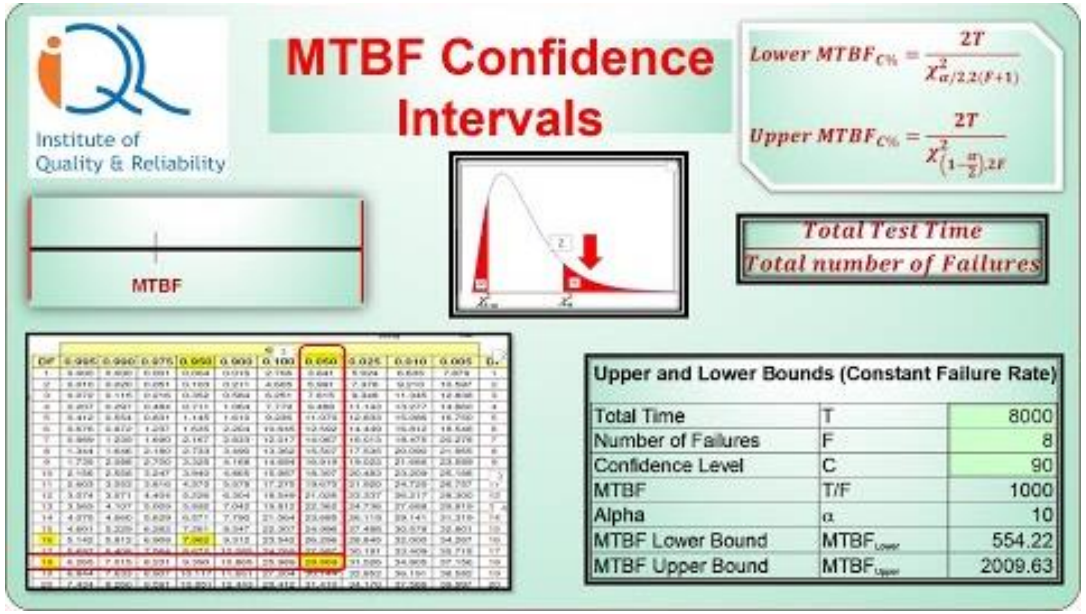




Integration, Test and Verification (Component Level)

- Calculations (e.g. tolerances)
- Simulations
- MTTF investigations





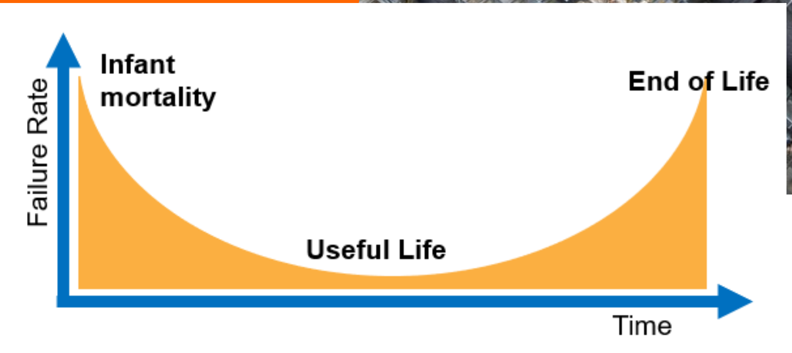
Source: Institute of Quality and Reliability

Integration, Test and Verification (Component Level)

- Tests
  - Sealing tests
  - Environmental tests (climat… …)
  - Aging tests
  - Contamination tests
  - EMC tests
  - …

verify on component level !

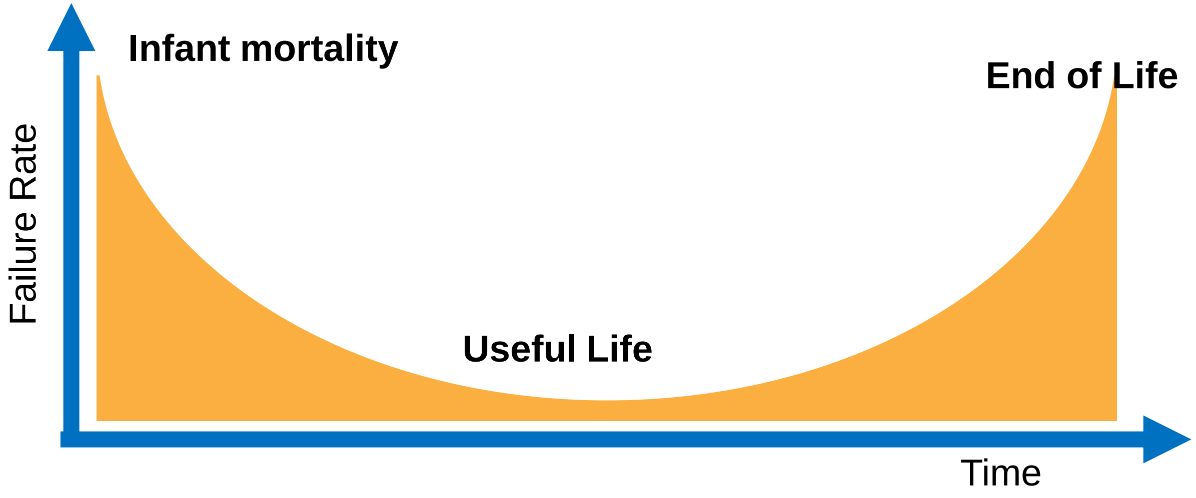
- Tests are easier and faster
- Tests are more focused to the failure mode
- Tests can be done in higher numbers to gain statistical information



System verification → Tests on System Level

Operation & Recalibration

Recalibration period based on predicted durability

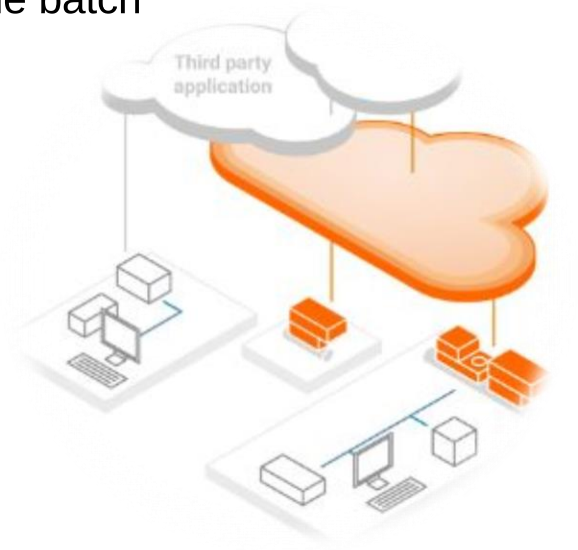


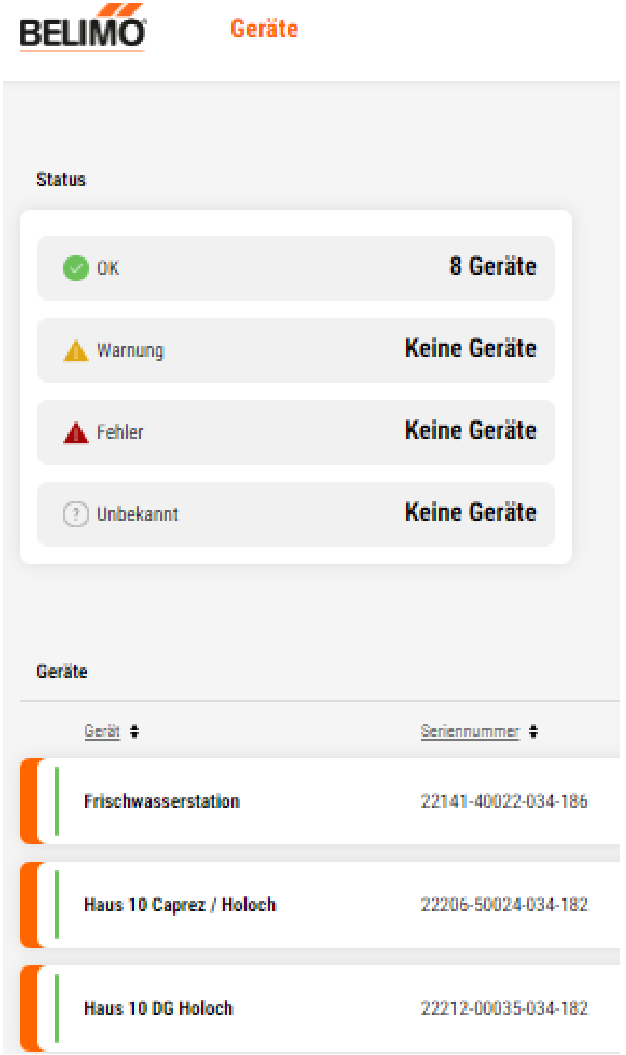
Statistically proven during approval process

Recalibration period depending on health state

- Supervision of the installed meters
  -

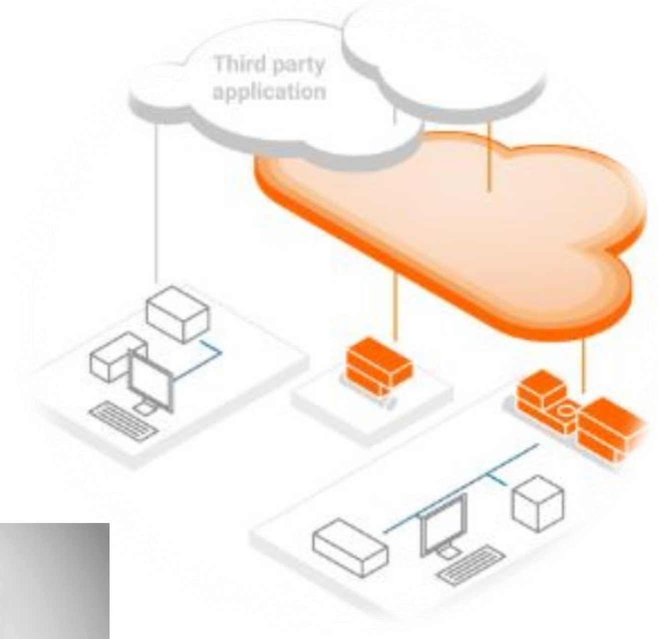
    Within the meter itself
    - zero flow at known operating points
    - amplitude of ultrasonic signal
    - …
  - Remote through available communication technologies
    - comparison of operating points over time
    - comparison with meters in same system
    - comparison with meters from same batch
    - …





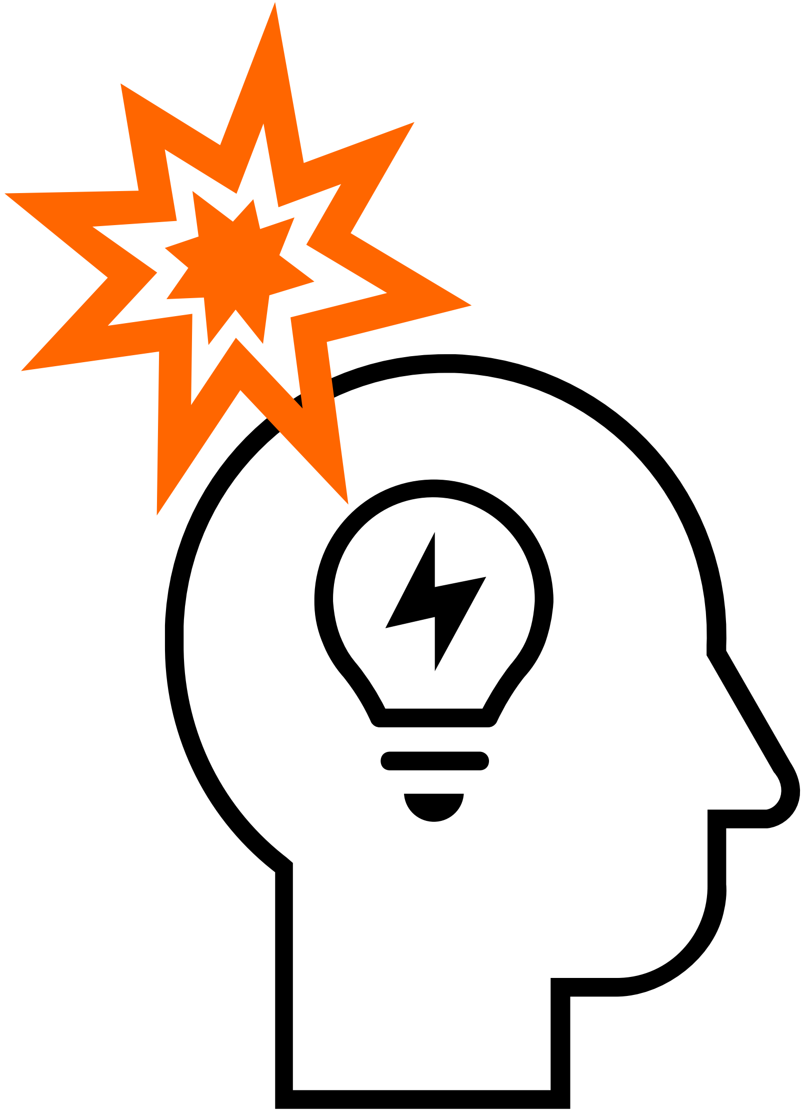
Recalibration period depending on stress level

- Compare operational data with meter specification to judge stress level



Safety data	Protection class IEC/EN	III, Protective Extra-Low Voltage (PELV)
	Degree of protection IEC/EN	IP54 Logic module: IP54 (with grommet A-22PEM-A04) Sensor module: IP65
	Pressure equipment directive	CE according to 2014/68/EU
	EMC	CE according to 2014/30/EU
	Certification IEC/EN	IEC/EN 60730-1:11 and IEC/EN 60730-2-15:10
	Quality Standard	ISO 9001
	Type of action	Type 1
	Rated impulse voltage supply	0.8 kV
	Pollution degree	3
	Ambient humidity	Max. 95% RH, non-condensing
	Ambient temperature	-30...55°C [-22...130°F]
	Fluid temperature	-20...120°C [-5...250°F] At a fluid temperature of < 2°C [< 36°F], frost protection must be guaranteed
	Storage temperature	-40...80°C [-40...176°F]

Conclusion



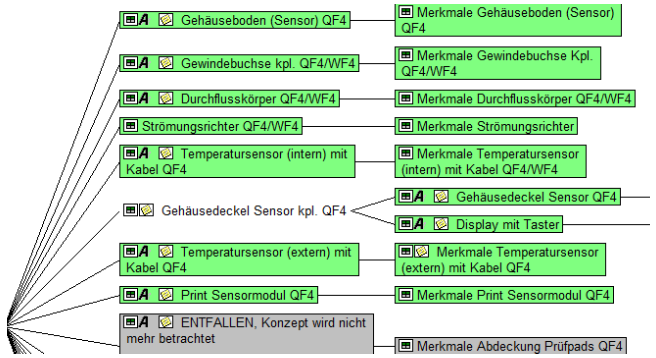
Why do we strive for longer durability?

- Long durability of thermal energy meters is a demand
  - For the customer
  - For the environment

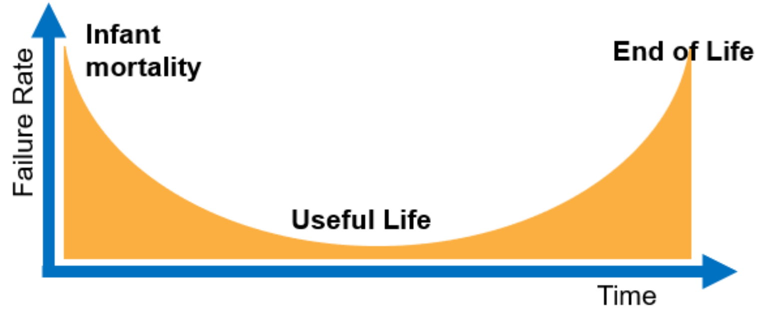
Waste of Ressources
Waste of Labour
Waste of Money

What do we have to change in the approval process to get a predicted durability?

- Do a risk assessment to focus on weaknesses
  → D-FMEA needs to become part of the approval
  → Measures from risk analysis need to become part of the approval



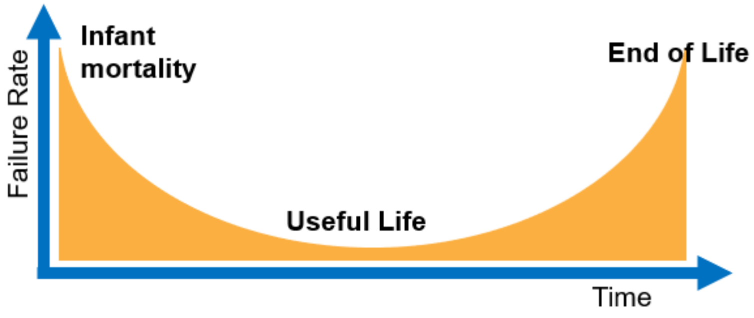
- Tests on component level generate statistical data to predict durability

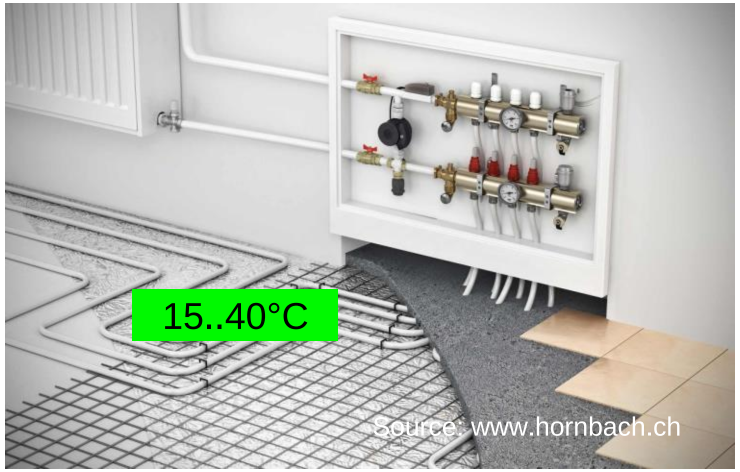


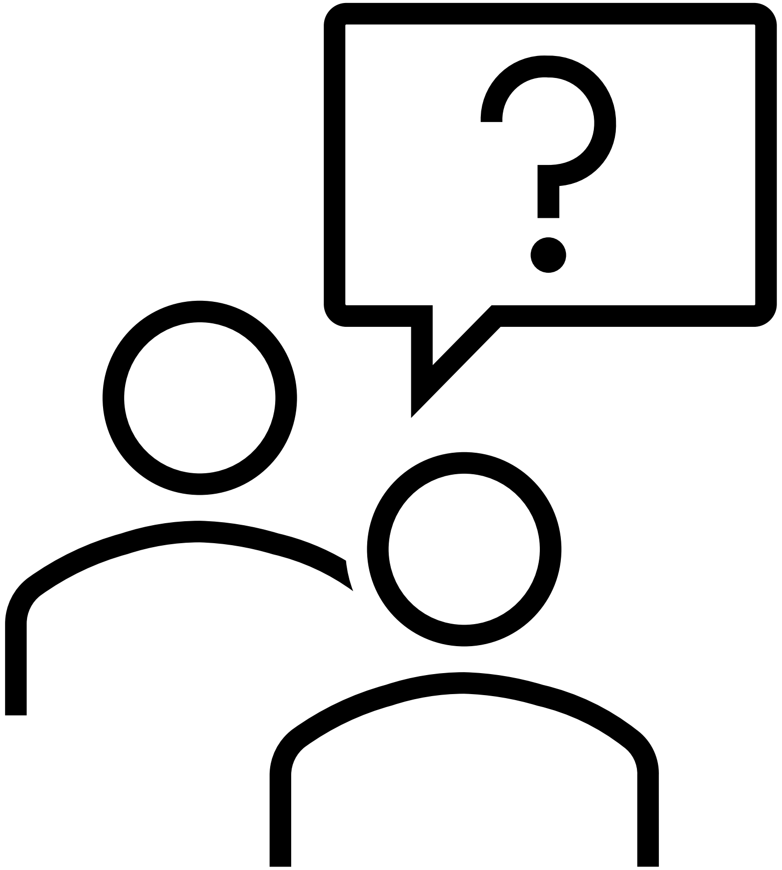
→ The approval is less standardized but more focused on the design of the specific product

How can we extend recalibration periods to reduce waste?

- Consider the designed and statistically proven durability
- Extend recalibration periods through supervision of the devices
  - Considering the health state of the meter
  - Considering the stress level of the meter







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