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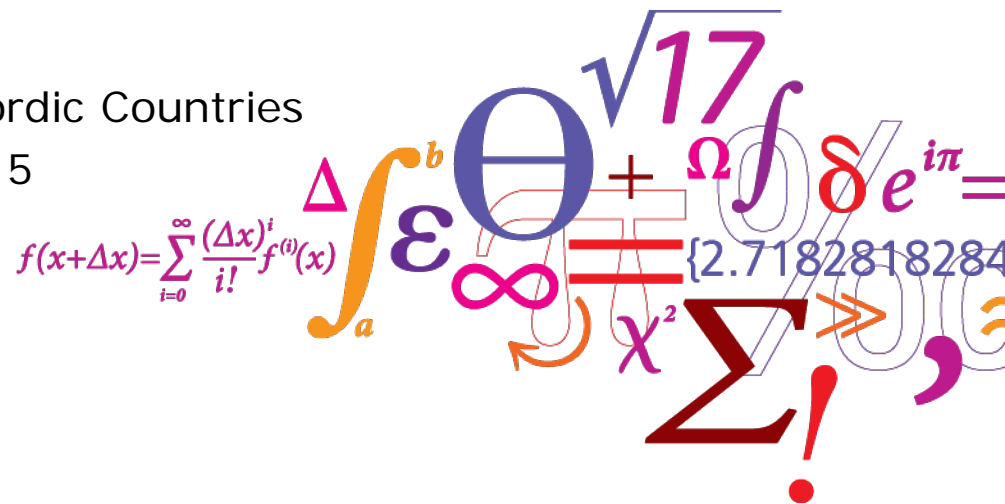
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Can prescriptive and performance-based risk management co-exist?

Nijs Jan Duijm

The Future of Risk Analysis in the Nordic Countries
Lund, Sweden, 16-17 November 2015



Problem statement

- Prescriptive standards and regulations are used to control risk. The principle of these standards is:
 - IF standard is adhered to THEN Risk is controlled to an acceptable level
- Performance (or risk based) standards and regulations require a risk assessment, and the result should be compared with an explicit criterion for acceptable risk, using some parameterization of “risk” (e.g. Potential Loss of Life)
- The two methods differ fundamentally, but in some cases, both methods are applied and may lead to conflicting conclusions.

Prescriptive standards

- Advantages
 - Relatively easy to apply (prescriptions)
 - Practicable solutions
 - No need to dwell on the interpretation of risk (risk is not considered explicitly)
 - Easy to verify compliance (objective evidence)
 - No uncertainty (compliance or non-compliance)
- Disadvantages
 - Rigid
 - Does not allow (or slowly) for innovation
 - No knowledge of real risk level, so no possibility to optimize resources, cannot be compared with other sources or risk

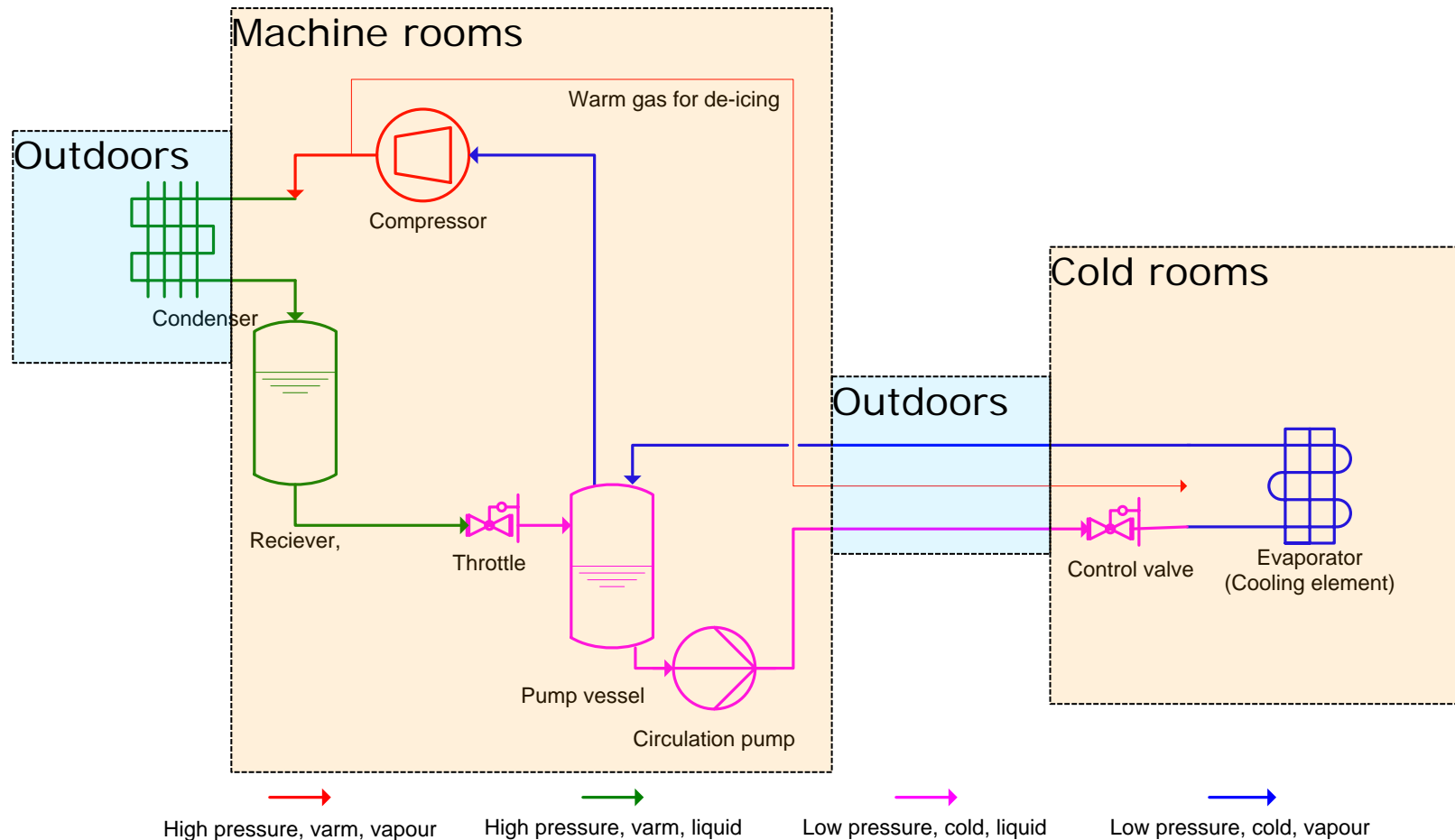
Risk-based regulations

- Advantages
 - Flexible, allow for innovative solutions
 - Explicit definition of acceptable risk level
 - Allow comparison or “risk” across alternative solutions as well as across domains
 - Allow allocation of risk contribution to subsystems
 - Allow optimization of resources to fulfil criteria at system level
 - Safety-critical issues are explicitly addressed
- Disadvantages
 - Risk assessments are relatively difficult to perform and document
 - Risk may be uncertain or impossible to quantify
 - Variability in risk assessment may lead to different conclusions
 - Verification of risk assessment is questionable
 - Risk parameterisation may not be adequate and risk is due to subjective perceptions

Simultaneous use of both principles

- No problem if:
 - It can be, or has been, proven that the prescriptive standards fulfil (at least) the risk-based criteria within the same area
 - Can be applied if the set of prescriptive standards is limited
 - E.g. fire safety standards: prescriptive for domestic housing, risk-based for large buildings, warehouses, etc.
- Problematic if:
 - There is no demonstration of the risk level that is linked to the application of the prescriptive standard
 - The addressed hazards are different (e.g. occupational safety vs. environmental damage)

Ammonia (R717) cooling installation (slaughter houses, dairies)



EN 378: Refrigeration systems and heat pumps/safety and environmental requirements

- Technical prescriptions, only local performance requirements
 - *"Piping joints shall be designed so that they will not be damaged due to the freezing of water on the outside. They shall be suitable for the pipe, the piping material and the pressure, temperature and fluid."*
 - *"Refrigerating systems shall be provided with sufficient isolating valves so as to minimize danger and loss of refrigerant particularly during repair and/or maintenance."*
- Focus on occupational safety
- Special requirements for Ammonia (R717), charge over 3000 kg:
 - Emergency stop
 - Remote controlled shut-off valves in the liquid line (connected to emergency stop)
 - Remote controlled shut-off valves on suction side of pumps

Note there is no limitation on isolated volumes or requirements for automatic detection

External safety



External safety

- Authority requirement for risk acceptance: location-based individual fatality risk $< 10^{-6}$ per year for population outside the establishment.
- EN-378 does not provide information on this
- Quantitative risk assessment necessary, using recognized method for process industry
 - Based on "best practice" failure data on process equipment (DNV GL failure frequency guidance) and assessment of technical and organizational barriers (as required by EN-378)
 - Recognized consequence and risk models (DNV GL PHAST/SAFETI)

Conclusion: risk criterion is exceeded in residential areas close to large establishments

- Additional requirements necessary on top of EN-378 to ensure compliance with external risk criteria

European railway safety – CSM-RA



- European Commission, Regulation on Common Safety Methods for Risk Assessment (CSM-RA, 402/2013)
- The regulation allows 3 different risk acceptance principles:
 1. The application of codes of practice
 2. A comparison with a similar system (reference system)
 3. Explicit risk estimation and evaluation

CSM-RA: Application of codes of practice

- Corresponds largely to using prescriptive standards.
- Codes of practice shall be:
 - Widely recognised
 - Control the hazard in question
 - Available for assessment
- Implicit risk acceptance: If built/constructed/operated according to recognised codes of practice, the risk is acceptable (it is safe)

CSM-RA: Explicit risk estimation and evaluation

- The acceptability of the estimated risks shall be evaluated using risk acceptance criteria (...)
- Explicit risk acceptance criteria have been formulated for specific type of equipment (E/E/PE systems): failures that can lead to “catastrophic accidents” shall be highly improbable, i.e. less than 10^{-9} per hour.
 - No explicit risk criteria required for other areas; member states may use national criteria, or criteria have to be defined case-by-case

CSM-RA: Dilemma

- *If the risk for a particular hazard cannot be made acceptable by the application of codes of practice, additional safety measures shall be identified by applying one of the two other risk acceptance principles.*
- Example: A material is used that does not (fully) comply with the technical standard. One expects to be able to maintain the safety level by more frequent inspection – What is the maximum inspection interval?
- This requires and explicit risk estimation, both for the alternative material *but also for the prescribed material in order to obtain a reference: the risk acceptance implicit in the technical standard needs to be made explicit*
 - Only this way one can conclude whether sufficient safety is maintained.

(CSM-RA: The explicit risk estimate example)

- The risk estimate in this example should include:
- An identification of the hazards that are associated with another material under the given operating and environmental conditions, such as: higher corrosion rate, cathodic corrosion, wear, ...;
- An assessment of how fast corrosion, wear, ..., e.g. would lead to loss of material, both for the material that meets the technical standard, as well as for the alternative material;
- What critical limits can be put up for loss of material, and what level should be monitored by inspection to ensure that safety is maintained .

Conclusions

- Compliance with prescriptive standards does not guarantee compliance with explicit risk criteria
- If prescriptive and risk-based standards and regulations are to be used side by side, the risk performance of the prescriptive standard needs to be known (the implicit risk acceptance needs to be made explicit)

Thank you for your attention