7º Congreso Internacional de Ingeniería de Seguridad contra Incendios
7th International Congress on Fire Safety Engineering

Guidelines in Nordic Countries

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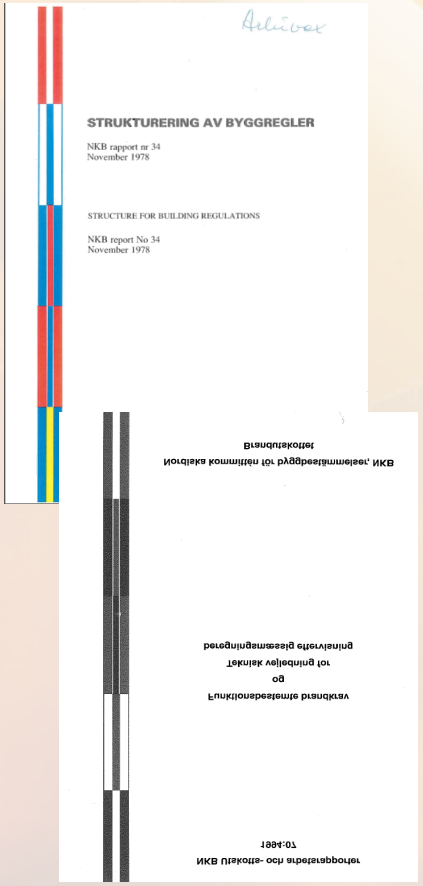
Madrid, 20 – 22 de Febrero de 2013
Centro de Convenciones Mapfre

The Nordic Committee on Building Regulations – NKB 1994:07
A preliminary guideline



Deterministic analyses

- Some simple calculation methods and acceptance criteria

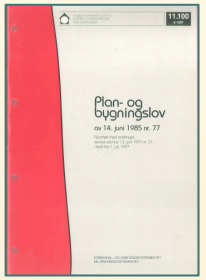
Probabilistic analyses

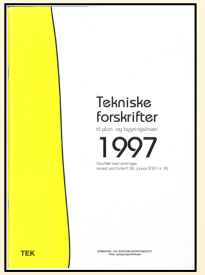
- ”Referring to the literature”

NKB 1994 committee:

- *“International standardization has not yet come so far that it provides the tools necessary for design and control in order to be able to verify that the performance based requirements are met”*

NKB Hierarchy





Goals

Functional requirements

Operative requirements

??

OR

Verification

Approved Document

Performance-based design

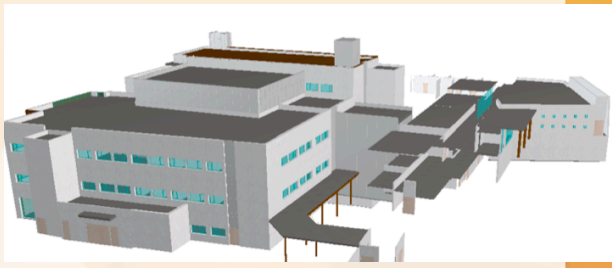
Goals (law)

Functional requirements (Building Regulations)

Performance-based building design (verification)

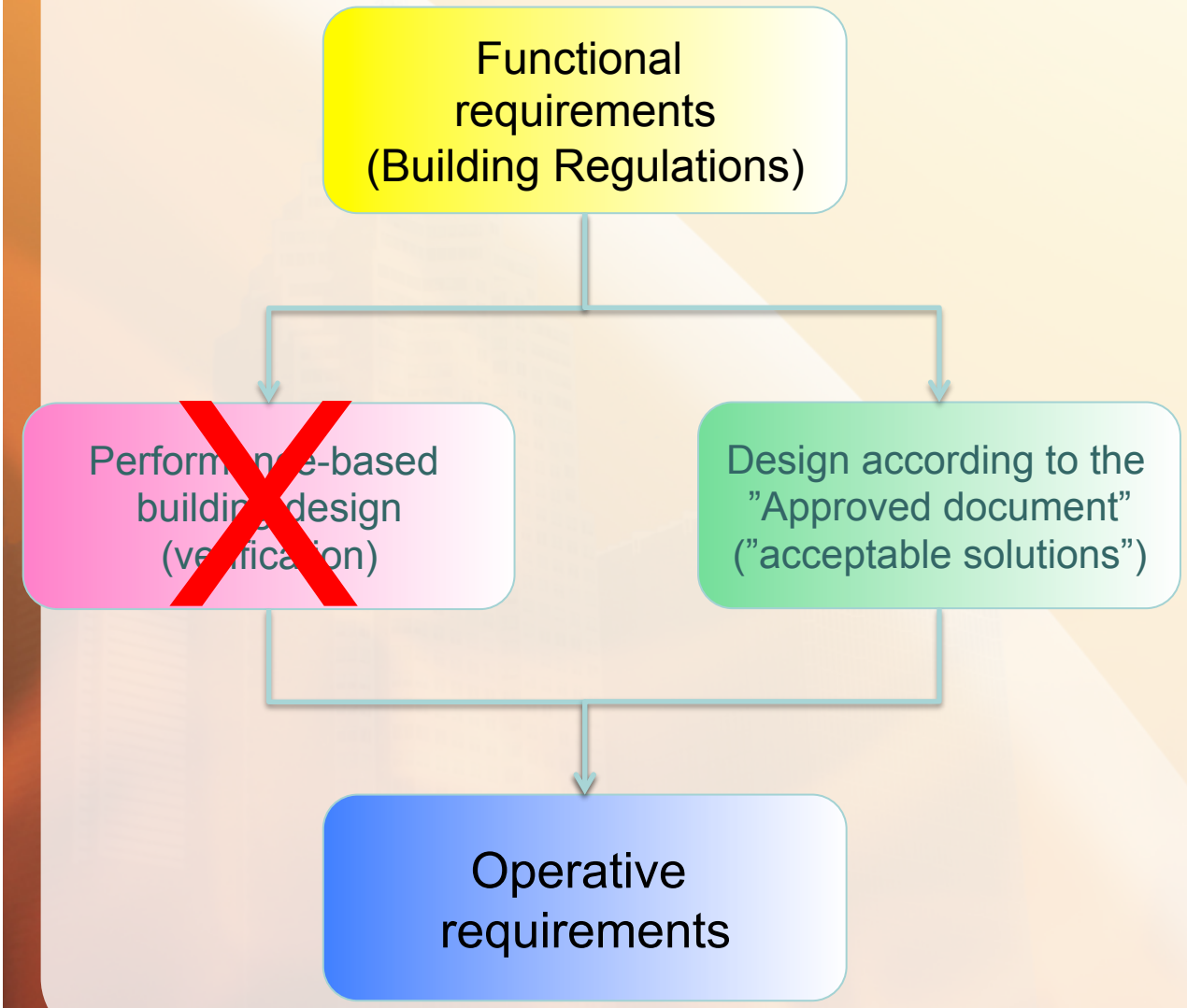
Design according to the ”Approved document” (”acceptable solutions”)

Operative requirements



Performance-based design

Example



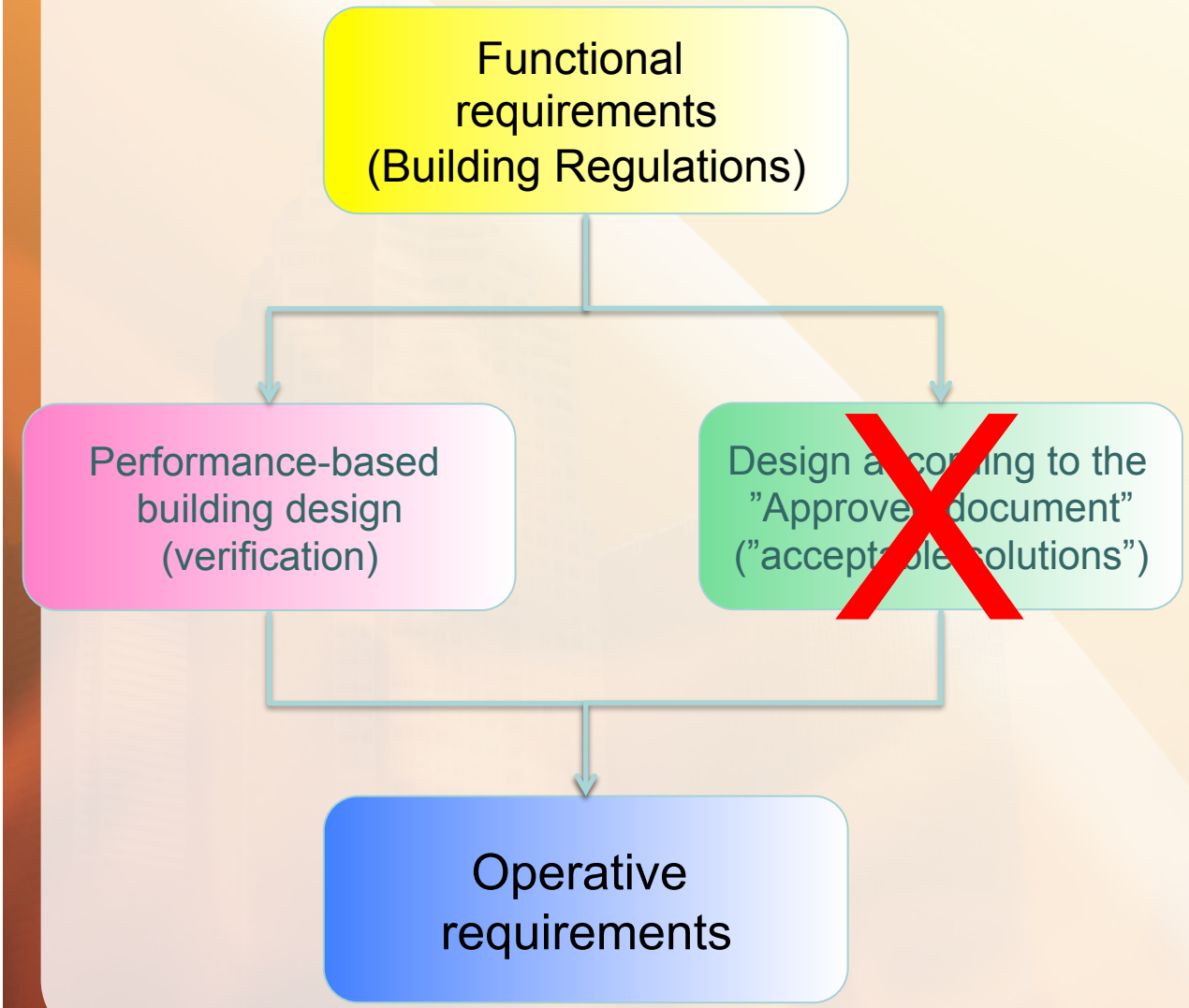
"..stability and load-bearing capacity for at least the time required to escape and rescue persons being in and on the construction works."

REI 60

"Acceptable solution" in a four-storey residential building

Performance-based design

Example



"..stability and load-bearing capacity for at least the time required to escape and rescue persons being in and on the construction works."

REI 30 + sprinkler

Alternative, designed solution

Performance-based design

Goals (law)

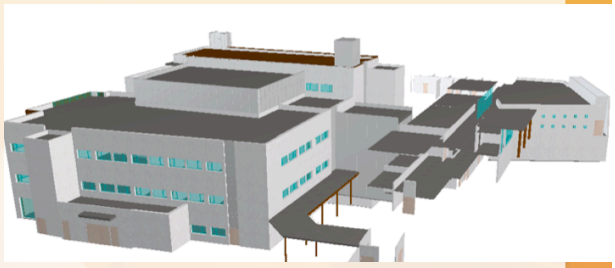
Functional requirements (Building Regulations)

Performance-based building design (verification)

Design according to the "Approved document" ("acceptable solutions")

Verfication methods

Operative requirements



Performance-based design

Verification methods (1)

- How to verify the fire safety design as a whole?
- Risk analyses

< 5 %

Verification methods (2)

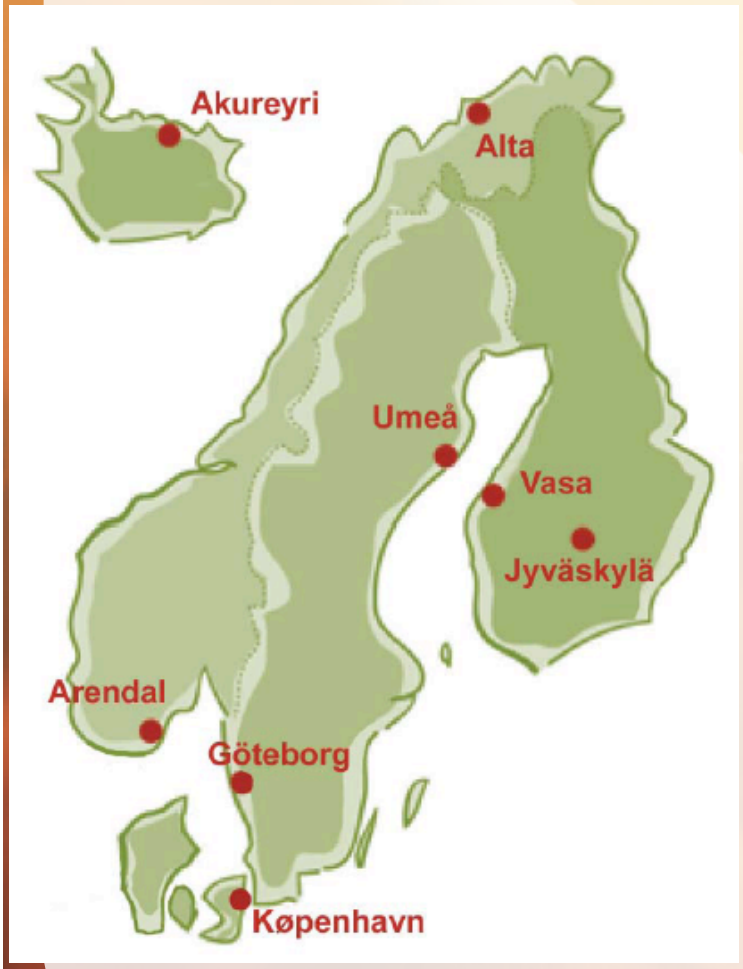
- How to verify deviations from Approved Document?
- Comparative analyses

> 95 %

The performance of Fire Safety Engineering

We have to get the engineers on the same track!

Fire safety engineering – Nordic standardization activities



Nordic Standardization (INSTA)

- Verification of fire safety in buildings
  - Design fire scenarios and design fires
  - Acceptance criteria
    - Tenability limits etc.

Standards Norway (NS)

- Revised standard on requirements to risk assessment for fire in construction works (NS 3901:2012)
  - Including comparative analyses

Fire safety engineering – Nordic standardization activities

Scenario-based comparative analyses

- Task: Compare an alternativ design solution to pre-accepted/acceptable/deemed-to-satisfy solutions

- Deterministic analyses
  - Mandatory design fire scenarios (NS and INSTA)
  - Design fires (INSTA)
  - Tenability limits etc. (INSTA)

- INSTA-TS based on
  - F. Nystedt: Verifying Fire Safety Design in Sprinklered Buildings, Report 3150, Dept. of Fire safety Engineering, Lund University, 2011
  - Previous Nordic work (NKB)
  - ISO, SFPE etc.

- Basis for deterministic analyses of fire safety design alternatives
- Aims
  - More consistent and uniform performance-based design process
  - Support and guidance for a simplified, standardized fire safety engineering approach
  - Guidance on performance/acceptance criteria
- Special focus on the use of sprinkler systems

Contents

- General procedure
- Fire scenarios and design fires
- Escape of persons
- Structural fire safety and spread of fire
- Services and safety for rescue operations
- Identification of affected fire safety objectives
- Uncertainty management
- Documentation
- Annex A (Informative) Guidance on verifying design alternatives
- Annex B (Informative) Further guidance on design fires
- Annex C (Informative) Human tenability limits
- Annex D (Informative) Further guidance on required safe egress time (RSET)

General procedure

1. Identification of deviations and affected fire safety objectives
2. Verification of fire safety objectives and performance criteria
3. Uncertainty management
4. Documentation

prINSTA TS 950

Fire Safety Engineering — Verification of fire safety design in buildings

Fire safety objective (note that the table below may have to be divided into additional sub-objectives).	Deviations from pre-accepted solutions							
	Added measure				Removed measure			
	A1	A2	A3	A4	R1	R2	R3	R4
Escape of persons								
Stability and load-bearing capacity in case of fire								
Protection against the occurrence of fire								
Protection against fire and smoke spread within the building								
Protection against fire spread between buildings								
Services and safety for rescue operations								

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Fire Safety Engineering — Verification of fire safety design in buildings

Check against → / Deviation from	Stability and load-bearing structures	Fire spread between buildings	Fire compartments (cells)	Fire compartments (sections)	Linings/ finishes	Technical installations	Means of egress	Facilitating fire service operations	Comments
Stability and load-bearing structures									
Fire spread between buildings									
Fire compartments (cells)									
Fire compartments (sections)									Societal risks
Linings/ finishes									
Technical installations									
Means of egress									
Facilitating fire service operations									

Mandatory design fire scenarios:

- Worst credible case scenario
- Robustness scenario(s)

Photo: Ole Raymond Lehne

Performance criteria – deterministic or probabilistic

- Relative/comparative
  - Compare to pre-accepted/acceptable/deemed-to-satisfy solutions
- Absolute
  - Example - deterministic: Smoke layer min. 3,0 m above the floor
  - Example - probabilistic: Probability of an event less than 1×10^{-7}
- National building authorities must specify the safety level
  - Acceptable solutions (Approved Document)
  - Absolute performance criteria

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Fire Safety Engineering — Verification of fire safety design in buildings

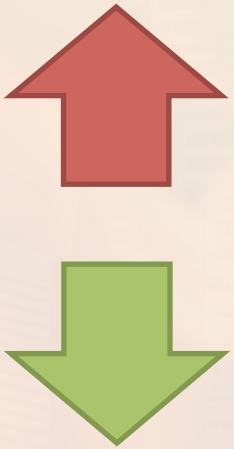
Table 2 Untenable conditions when evaluating the safety of persons (NKB, 1994 and adaptation by INSTA).

Parameter	Criteria	
Visibility	Visibility no less than 3 m in the primary fire compartment at area of ≤ 100 m^2). Visibility no less than 10 m at height of 2 m in escape routes and compartments of areas > 100 m^2. As an alternative to determine visibility, a smoke free height of 1,6 m + 0,1 x H	
Thermal*	Continuous radiation intensity of maximum 2.5 kW/m^2 and, a short-term radiation intensity of maximum 10 kW/m^2 if the maximum radiant dose is less than 60 kJ/ m^2.	
Temperature	Gas temperature not higher than 80 °C.	
Toxicity#	CO CO_2 O_2	< 2 000 ppm < 5 % > 15 %
NOTE The recommendations in Table 2 may be subject to national regulations.		
* In addition to the energy from background radiation. # Toxicity does not need to be calculated when the visibility is more than 5 m.		

Uncertainty management strategy

(1) Reducing the uncertainty by using better data and/ or more thorough analysis, or

(2) Using safety factors to account for the uncertainties.



Increased need for safety factor

- High sensitivity, low robustness
- Input based on assumptions or without sufficient scientific support (high uncertainty)
- Conclusions alter due to minor input variations
- The conclusions rely on few fire safety measures or measures with low or unknown reliability

Reduced need for safety factor

- Low sensitivity/uncertainty, high robustness
- Reliable, conservative data (low uncertainty)
- Well verified tools used for calculations
- Several redundant fire safety measures, or high reliability
- Statistical data, experiments or other studies supports the conducted assessment

Gracias por su atención
Thanks for your attention

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