“Performance-Based Approach”

Alternative Fire Protection Solutions

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Objective

To briefly discuss the needs & mechanism of utilizing the Performance-Based Approach as an alternative fire protection solution
Outline

• Introduction
• Prescriptive Codes
  ▪ Advantages and Disadvantages
• Performance-Based Approach
  ▪ Why is it needed?
  ▪ Advantages and Disadvantages
• Two Case Studies
• Conclusion & Questions
Fire Protection

- Ultimate goal of saving lives, protecting property and ensuring business continuity:

  1- Design & Engineering:
     - First line of defense
     - Codes and Regulations

  2- Administration:
     - Effective and updated procedures implemented
     - Effective and updated training conducted

  3- Loss Control:
     - Reactive mode to incidents (firefighting, rescue, hazmat, etc.)
     - Requires readiness, preparations, resources and training
Codes and Regulations

• Local & International in “Prescriptive” format
• Minimum requirements to achieve fire safety for a generic application
• Specific details — in terms of materials, time, dimensions, or specific systems
• Most of the time, a result of previous failures
Traditional Cycle of Codes Updating

Recommendations and evaluation → Prescriptive Codes → Injuries, fatalities and property → Investigation and recommendations
Prescriptive Codes Example

• NFPA 101 (Life Safety Code): Three required exits for a floor area with an occupant load greater than 500 people

• This means:
  - A floor area with an occupant load of 500 people requires only two exits
  - A floor area with an occupant load of 501 people requires three exits!

• Note that the intent or the final objective is not clear
Advantages and Disadvantages of Prescriptive Codes

**Advantages:**
- Direct with defined minimum requirements
- Easy to follow & verify
- Cover majority of occupancies

**Disadvantages:**
- Complex structure
- Intent is not defined
- Not open to innovations/alternative solutions
- Might not be cost-effective for most modern facilities
Our World Today
Our World Today
What is the Solution?

• Many developed countries have started utilizing a “Performance-Based Approach”
• Run in parallel with “Prescriptive Codes”
• To accommodate the increasing:
  ▪ Changes in modern facilities’ designs
  ▪ Knowledge & experience in fire protection
  ▪ Advancement in Fire Simulators/Modeling
  ▪ Budgetary restraints
Performance-Based Approach

• Digs into the main purposes of the prescriptive requirements to determine the intent of the code
• Meeting and fulfilling the intent is the real factor
• Then searches for different old/innovative solutions to meet/exceed these intents as needed
• These solutions must be validated before being submitted to authorities for review & approval

Note: Sometimes, the code requirements could be the best solutions; other times, they are not
Performance-Based Example

• **Prescriptive:** Three required exits for a floor area with an occupant load greater than 500 people

• **Performance-Based:** Provide a proven sufficient number of exits for each floor within the facility, to allow for safe egress to the assembly areas for ALL occupants
Performance-Based Design Process

- Establish safety goals (meeting/exceeding codes depending on the criticality of the proposed facility)
- Evaluate the condition — of the occupants, contents, process and facility equipment — with regard to safety
- Identify potential hazards and define scenarios
- Establish performance objectives (based on the Prescriptive Code intent)
- Select suitable calculation methods (e.g., computer models)
- Develop a proposed solution
- Assess the proposed solution
- Obtain approval of the proposed solution from the relevant authority
Advantages and Disadvantages of Performance-Based Approach

**Advantages:**
- Use intent instead of only minimum requirements
- Set comprehensive strategy and objectives
- Open to innovations & alternative solutions
- Enable utilization of new technologies (fire simulators/modeling)
- Enable cost effective design alternatives

**Disadvantages:**
- Difficult to define and verify (time and competency)
- Requires training for both the designing parties and the authorities for verification
- Change of occupancy or use may require revalidating the whole design
Case Study I (Evacuation)

- A major US manufacturing company decided to design fire-protection for its large building.
- One component was the safe evacuation of occupants.
- Prescriptive Codes called for automatic smoke and heat vents in the building roof & on the roof of enclosed corridors.
- As per AHJ, the intent of this code is to keep the smoke level above 7 ft for at least 15 min (max. required time for evacuation + a safety factor) to allow for safe evacuation.
- Therefore engineers wanted to know how many automatic smoke/heat vents were needed to meet the code.
Case Study 1 (Evacuation)

- They set up credible scenarios using a simulation model
- Heat release, fire growth rates, materials, and desired geometry of the building were recorded
- Using a computer-based fire model while taking worst-case scenarios with a 15% safety factor

The result: During the 15 min required for evacuation during a fire, the smoke layer would be approximately 19 ft above the floor level without any additional systems

- AHJ was satisfied and approved it without the automatic smoke & heat vents

Benefits of study: verifying that codes are being exceeded in this regard while saving money planned for construction, systems, future maintenance and testing
Case Study II (Platform Fire Protection Upgrade)

- Project’s objective is to upgrade fire protection of a critical offshore platform
- Platform consists of two levels & manned by operators
- Upgrade includes full fire protection coverage (new pumps, detectors and monitors)
- In case of fire, detectors shall detect the fire and monitors shall be automatically operated to cover all the platform with water/foam supported by the pumps
Cont’: Case Study II
(Platform Fire Protection Upgrade)

Prescriptive Code compliance & Performance-Based Approach were both done for this case:

**Prescriptive:**
- 51 IR/IR/UV Detectors
- 80 Pre-Aimed Automatic Fixed Fire Monitors
- 6,000 gpm pumping capabilities
- Additional voltage switchgears + platform extension

**Performance-Based:**
- 51 IR/IR/UV Detectors
- 48 Automatic Oscillating Fire Monitors
- 4,000 gpm pumping capabilities
- NO additional voltage switchgears nor platform extension
Case Study II Summary

Prescriptive Code:
- More monitors but less expensive type
- Coverage is less and will be affected by wind
- Manual intervention might be needed
- Larger water demand
- More cost

Performance-Based:
- Less monitors but more expensive type
- Coverage is more and minor wind effect
- No need for manual intervention
- No change in water demand
- 16% less cost

Note: Innovative/alternative solutions with Performance-Based Approach can exceed the safety level of Prescriptive Codes yet be more cost-effective.
Conclusion

• Traditional Prescriptive Codes are very useful for the majority of facilities
• The Performance-Based Approach needs to be considered in parallel with Prescriptive Codes
• The Performance-Based Approach is an important tool to address specific needs with clear safety objectives utilizing innovations and alternative solutions
• Authorities need to start preparing by:
  ▪ Developing a system/program that regulates a Performance-Based approach
  ▪ Training and certifying authorities, engineers and reviewers
Questions?
References

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• http://ssmon.chb.kth.se/vol12/3Tavares.pdf
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