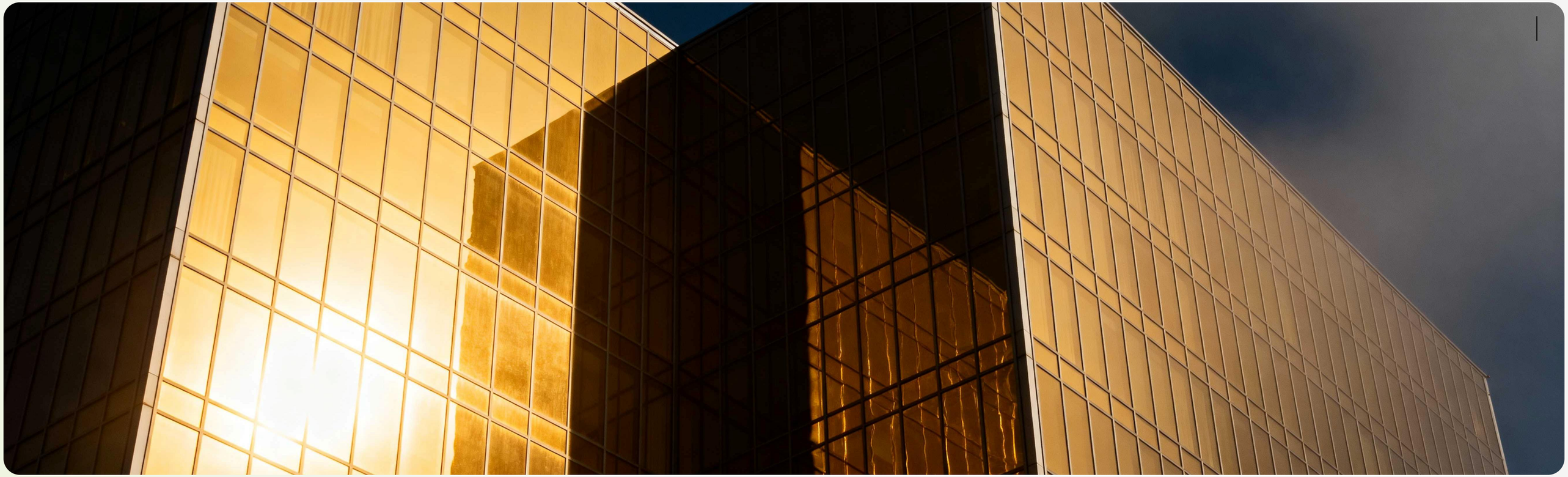


Performance-Based Fire Engineering for Sustainable and Resilient Hospital Infrastructure

Survival, continuity, and controlled movement in hospitals.

The Fire Engineer

Karel Roodt

Fire Engineer

Agenda Overview

This session outlines the critical fire safety standards, comparing SANS 10400-T, HTM, and NFPA protocols, while highlighting the unique fire engineering challenges specific to hospital environments and performance-based safety requirements.

1. Opening & Context 01
2. SANS 10400-T Scope 02
3. Hospital Specifics 03
4. Code Comparison 04
5. SANS 10400-T Limits 05
6. Fire Engineering 06
7. Insights & Closing 07

Is Hospital Infrastructure Truly Fire Safe?

While hospital designs often meet basic compliance standards, they frequently fail to account for real-world failure conditions, aging infrastructure, resource scarcity, and rising operational complexity.

Aging Infrastructure

Legacy building components and outdated electrical systems degrade over time, making hospitals significantly less resilient against modern fire hazards and emergency scenarios.

Water Scarcity

Insufficient water pressure or limited supply reserves directly threaten the efficacy of automatic sprinkler systems and firefighting capabilities during sustained emergency events.

Power Instability

Frequent grid fluctuations or unreliable backup power generation prevent critical safety systems, like alarms and automated doors, from functioning during a crisis.

Operational Complexity

Hospitals now house denser equipment and higher occupancy levels, complicating evacuation routes and the effectiveness of traditional, static fire suppression strategies.

Understanding SANS 10400-T:2024 (Edition 5.01)

Deemed-to-satisfy NBR

- Establishes minimum compliance
- Part of NBR Part T regulation

Specific fire safety areas

- Escape routes and fire resistance
- Compartmentation and detection

SANS baseline logic

- SANS compliance meets NBR rules
- Does not guarantee optimal safety

Understanding SANS 10400-T : Scope

Analysis of the regulatory boundaries for SANS 10400-T. Clarifying what the scope explicitly implies, what it excludes regarding healthcare facilities, and how it enables flexible performance-based design solutions.

Broad Application

The current scope applies broadly to various types of buildings, ensuring a standard baseline.

01

Not Healthcare-Specific

It does not target specific healthcare facility needs, focusing only on general safety standards.

02

Rational Design Allowed

The standard allows for rational design and performance-based solutions rather than rigid rules.

03

Compliance with SANS 10400-T = Safety

Why this myth persists

- Regulatory misunderstanding
- Reliance on outdated standards
- Overestimation of baseline rules

Hospitals require advanced risk mitigation

Mandatory safety layers

- Expert fire engineering judgment
- Advanced building fire modelling
- Detailed patient scenario analysis

Why hospitals differ

Complex

- Non-ambulant
- Sedated
- ICU-dependent

Critical

- Medical gas lines
- Life support systems
- Critical power grid

Operational flow

- 24/7 occupancy
- Staff-led evacuation
- Assisted horizontal movement

HTM 05-01 Framework for Fire Safety Management

The HTM 05-01 standard establishes critical management guidelines, focusing on essential safety protocols, staff training, and the integration of operational and engineering solutions.

Patient Safety

Prioritizing the physical well-being of patients during fire emergencies remains the primary objective of the management framework, ensuring minimal risk throughout the clinical environment.

Staff Response

Empowering healthcare teams through standardized training and rapid reaction drills ensures efficient evacuations and effective containment strategies during urgent fire scenarios.

Fire Protocols

Strict adherence to documented fire protocols provides a clear roadmap for hazard prevention, emergency communication, and site-wide safety coordination during incidents.

Integrated Safety

The standard recognizes that robust fire protection requires balancing operational management strategies with precise engineering solutions to maintain a secure healthcare facility.

HTM 05-02 Design

Healthcare-specific fire safety protocols for hospitals that differ significantly from standard SANS building regulations.

- Progressive **horizontal evacuation** enables safer movement.
- Enhanced **sub-compartmentation** slows fire spread.
- Defend-in-place **containment strategy** prioritizes patients.
- Optimized **hospital streets** improve transit access.
- Designated **refuge zones** for safe holding areas.

HTM 05-03 Part J: Fire Engineering Framework in Healthcare

Building Complexity

Used when the building layout involves high complexity, requiring advanced fire safety modeling beyond standard prescriptive codes.

Prescriptive Limits

Applied when prescriptive design methods are impractical or prevent necessary architectural modifications for patient care.

Existing Structure

Necessary when working with existing healthcare structures where traditional compliance upgrades are structurally impossible.

Operational Needs

Critical when ensuring operational continuity during fire events is the primary goal, supporting high-level performance-based design.

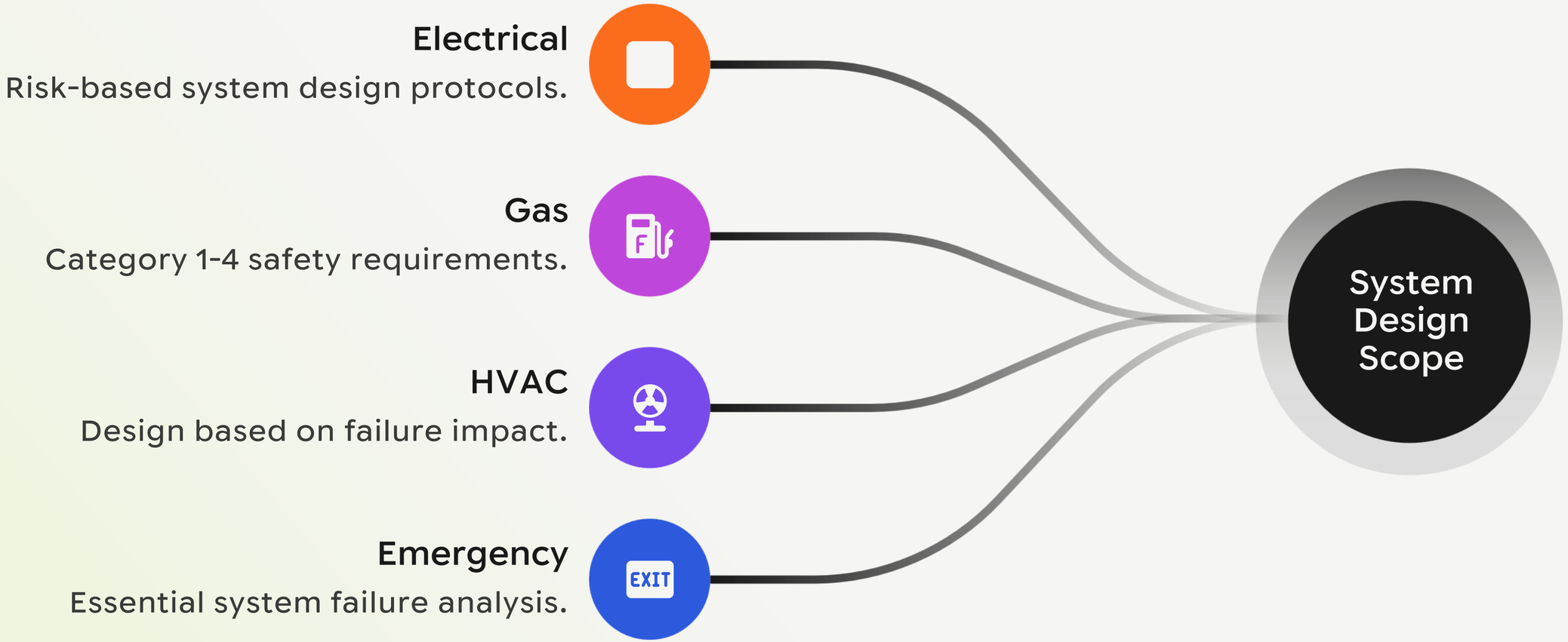
NFPA 99: Shifting to a Risk-Based Healthcare Code

Electrical
Risk-based system design protocols.

Gas
Category 1-4 safety requirements.

HVAC
Design based on failure impact.

Emergency
Essential system failure analysis.



Code Comparison

A comparative analysis of safety standards: SANS 10400-T, HTM, and NFPA 99 focusing on evacuation, systems, and engineering.

Aspect	SANS	HTM	NFPA
Approach	Prescriptive	Healthcare-specific	Risk-based
Evacuation	Exit-based	Horizontal/phased	Assisted
Systems	Limited	Integrated	Critical focus
Fire Eng.	Implied	Explicit	Embedded
Hospitals	Generic	Core focus	Core focus

Identified Critical Gaps in SANS Standards

SANS standards lack coverage for key hospital fire safety factors. Addressing these gaps is vital to ensure patient safety and maintain operational continuity.

Patient dependency

Current standards fail to account for the specific needs of immobile or high-dependency patients during emergency evacuation procedures.

Phased evacuation

Procedures lack structured, step-by-step guidance for moving large populations within high-risk hospital environments during fire events.

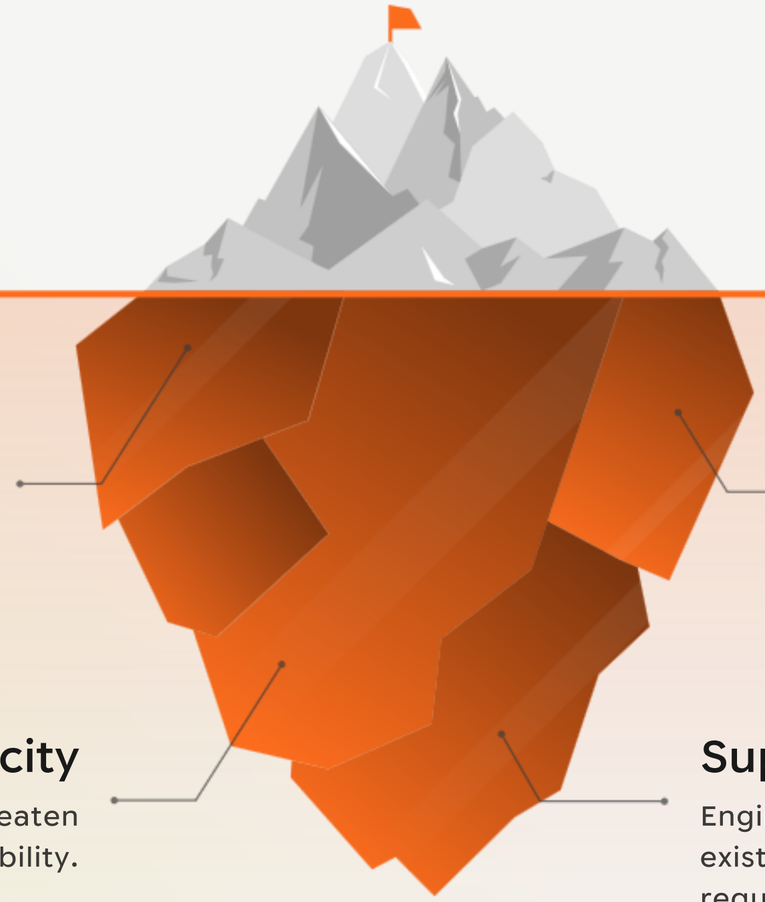
Smoke tenability

There is insufficient data regarding smoke control levels required to maintain safe conditions for patients and staff in hospital facilities.

Medical gas hazards

Current guidelines do not adequately address the unique risks posed by medical gas systems during fire-related structural hospital emergencies.

Navigating Water Constraints in South African Projects



Municipal reliance

Projects depend heavily on municipal infrastructure availability to meet site

100mm requirement

Specific connection standards dictate physical pipe size and flow capacity mandates.

Water scarcity

Regional water shortages directly threaten continuous site operations and feasibility.

Supply validation

Engineering teams cannot assume supply exists; independent verification is required.

Smoke: The Real Killer—Risk and Mitigation Strategies

SANS Standards

Limited smoke strategy

Hospital Priority

Smoke is the primary threat

HTM Approach

- Smoke containment
- Zoned control
- Tenability design (CFD)

Evacuate the building

The standard assumption

- Complete building clearance required
- Immediate total evacuation

Strategy based on RSET vs ASET

Verified safety protocols

- Defend-in-place approach
- Horizontal movement methods
- Staff-controlled evacuation
- Time-critical decision making

Performance-Based Fire Engineering: A Strategic Design Approach

CFD Modelling

Utilizing advanced Computational Fluid Dynamics to simulate smoke flow and temperature.

Egress Modelling

Analyzing occupant movement and exit patterns to ensure safe evacuation during events.

Scenario-Based Design

Testing building safety against specific, realistic fire incident scenarios and impacts.

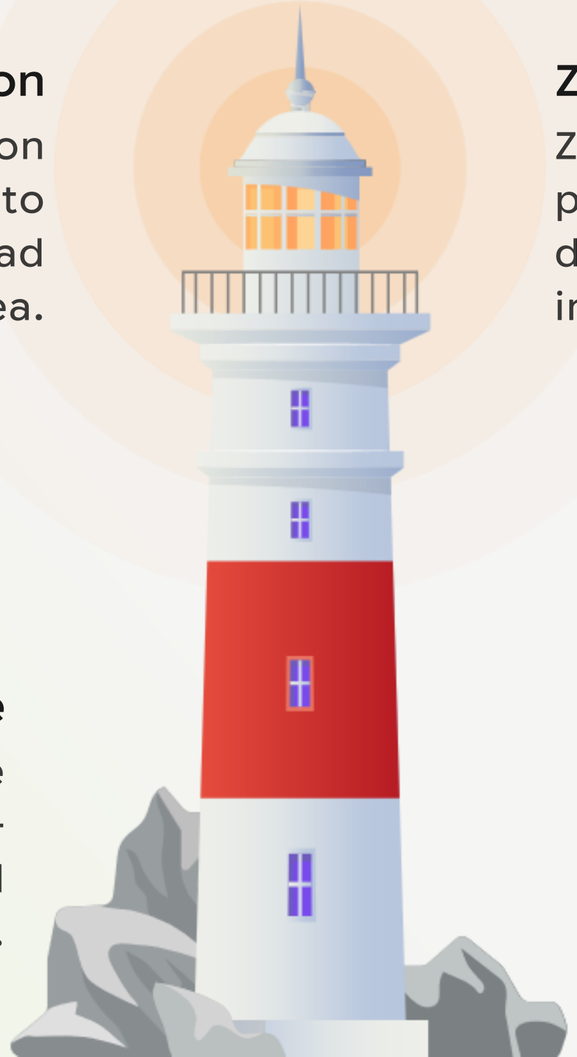
System Failure Analysis

Evaluating resilience by assessing how systems behave when active fire controls fail.

Risk Quantification

Applying data-driven metrics to validate safety performance beyond simple compliance.

What Good Looks Like



Compartmentation

Utilizing compartmentation and sub-compartments to isolate fires and limit spread area.

Zoned Detection

Zoned detection systems providing precise location data for rapid, targeted intervention.

Smoke Management

Active management of smoke pathways to keep patient escape routes clear and breathable.

Staff Response

Defined staff response protocols ensuring coordinated, safe, and efficient evacuations.

Water Resilience

Ensuring fire water resilience through reliable, high-capacity, and protected supply.

Redundant Systems

Implementing redundant safety systems to guarantee function during primary system failure.

Case insights from SA hospitals: Lessons on regulatory compliance and gaps in facility safety protocols

Non-compliant fire doors

Fire doors failed to meet mandatory safety standards, compromising containment capabilities.

Missing or incorrect dampers

HVAC dampers were either absent or improperly installed, risking smoke spread during fires.

Inadequate zoning systems

Fire detection zones were poorly configured, causing delayed alarms and localized response.

Unreliable water systems

Suppression water supply systems lacked the necessary reliability for emergency activation.

Lack of evacuation plans

Facilities lacked structured evacuation strategies, putting patients and staff at severe risk.

Core Philosophy

The Initial Mindset

- Code compliance
- Prescriptive thinking

Target Outcomes

The New Engineering Approach

- Performance verification
- Engineering thinking
- Design for failure

Conclusion: Minimum Standards

SANS 10400-T is a minimum standard; sustainable hospitals require rigorous engineering validation and operational continuity to ensure patient safety and life support where they are located.