Fire Engineering:
Meeting the Challenges of Modern Airport Terminals - A Client Perspective

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18th January 2016
Acknowledgements

- Abu Dhabi Airports’ Company Board for their support and vision.

- Abu Dhabi Civil Defense for their open and pragmatic approach in supporting the successful delivery of this iconic project which represents a significant milestone towards the 2030 Master Plan.

One team with one vision
Contents

• Challenges of Modern Terminal Design
• Approach to Fire Safety Design
• Application of Fire Engineering to solve challenges
• Define fire safety objectives and what does this mean?
• What’s different about Airports?
• Evacuation Management v Security
• Smoke Control
• Cause and Effect
• Use of Technology Smarter Airports
• On going management of “fire engineered solutions”
• The model for Success
• Conclusion
• Fly Through the New Midfield Terminal Building
Challenges of Modern Airport Terminals

The passenger expectation of large international airports has changed, expectation of service and quality has significantly increased due to the accessibility of air travel to a much wider population.

This has been partly exacerbated by increased competition between airport operators and the introduction of international standards to measure passenger satisfaction.

This is especially true for “hub operation” airports where a large proportion of passengers are transferring on to other destinations.

**Hub Operation brings a number of challenges:**

- Connectivity and transfer links;
- Time taken to complete processes;
- Need to accommodate increase in fluctuating demand;
- Increased dwell times within the airport;
- The need to provide an appropriate flexible retail experience (range of shops and facilities);
- Need to generate increased income from retail;
- Passenger “delight factor” a calming and tranquil environment providing relaxation, but still distinctive.
Modern Terminal Design

Design characteristics include:

- Large open undivided spaces (large volume);
- Diverse variance in occupancy profile;
- Layout influenced by sequence of pre-defined operational processes;
- Large fluctuation in occupancy levels;
- The need to have facilities which are flexible to accommodate changes in retail strategy and the introduction of new regulations.

Due to the general political environmental concerns regarding airport expansion, new developments have had to adopt modern methods of construction and products/systems that demonstrate compliance against stringent environmental targets.

The rise in global travel in conjunction with the ever changing face of terrorism has necessitated a more cerebral and adaptive approach to the way security is managed and operated in modern airport terminals.

Many of these characteristics provide a number of fire safety issues which need to be considered at the design stage, not only with respect to meeting code requirements but also with regard to how the building will be managed and operated.
Many of these characteristics provide a number of fire safety issues which may include:

- Extended travel distances from rule based guidance;
- Restrictive routes of travel (Security);
- The omission of sprinklers from spaces with high ceilings;
- Omission of fire detection from Concourse areas;
- Large compartment sizes;
- Difficulties for Fire Service access within and to the building;
- Fire loading in retail spaces;
- Evacuation zones not physical separated;
- Restriction on time delay, positive alarm sequence.

These aspects must be considered at the design stage, not only with respect to meeting code requirements but how these aspects will be controlled throughout the life of the building.
Modern Terminal Design

What differs between Airport Terminals and Shopping Malls?
At face value there are a lot of similarities, so what is difference?

- Occupant expectations self evacuation may be delayed;
- Controlled environment that is well managed by staff;
- Security and the need to maintain segregation;
- Defined expectation associated with operational processes and the need to complete journey;
- Associated international impact of an incident, especially relevant for hub operation (connecting flights).
Approach to Fire Safety Design

**Prescriptive:** based on applying a defined set of rules which are simple to use and understand

**Disadvantages:**
- Not flexible and in some cases impractical to apply, not one size fits all;
- Does not promote innovation in design;
- Risk is not considered as part of the design process;
- Based around life safety and does not cover other fire safety objectives;
- May have no scientific basis.

**Advantages:**
- Ease to understand and is assumed to be correct because the book “say so”;
- Likely to be approved by Regulatory Authorities without lots of questions;
- Has proven to achieve required levels of safety;
- Defendable in the event of an incident or investigation.

However:
A particular weakness in the prescriptive approach was recognized in the conclusions of the Cullen report into the Piper Alpha offshore disaster which stated that:

> Many regulations are unduly restrictive in that they are of a type that impose “solutions” rather than “objectives” and are out of date in relation to technological advances. There is a danger that compliance takes precedence over wider safety considerations

**Semi–Engineering** (BS 9999): introduces occupancy and risk profiling. Uses fire engineering principles within a framework of application without the need to perform complex calculations.
Most codes do recognise that **there** may be cases where performance based fire engineering may be appropriate.

- **Fire Engineering** (BS 7974): Application of performance based engineering to meet functional requirements and wider fire safety objectives.
- This is fundamentally different from the conventional prescriptive approach to fire safety in that it uses scientific, engineering and risk assessment principles to evaluate fire safety requirements in buildings. A fire safety engineering approach may for example look critically at how fire can start in a building, how it can spread, and the possible consequences of the fire and how these can be mitigated by different fire safety strategies.

**Advantages of FSE include:**
- Measures can be tailored to specific usage and risk.
- Encourages innovation in design without **compromising safety.**
The term QDR stands for a qualitative design review and provides a framework for developing a rationale for development of a fire safety strategy. Such an approach is necessary especially where there is a need to consider a number of strategic fire safety objectives.

It provides:

- A framework of understanding for the development of designs and establishes:
  - Balanced set of objectives
- Any quantitative or other methods of analysis with agreed input.
- Acceptance criteria
- Can be used to benchmark against design standards.
- Acceptance Criteria
- Often difficult to establish
- The term risk is often misunderstood
- Establish acceptance criteria for life safety and business continuity/operational protection and may include the following methods of analysis:
  - Probabilistic
  - Deterministic
  - Comparative
- The application of the ALARP principle may prove useful.
“To promote and sustain a proactive culture of fire safety management which forms part of our core values, embracing intelligent risk management and innovation of proven technology in reflecting how our facilities are operated and managed, contributing to the highest standards of safety and passenger experience.”

“To set the standard others aspire to follow”
Good fire safety management requires a life cycle concept which we must start to promote with senior management support and is built on three key attributes:

**Fire Prevention** – first line of defense preventing fires in the first place to a level of ALARP.

**Fire Protection** – second line of defense: systems sprinklers smoke control, fire separation etc., limiting and controlling the spread of fire, relevant to fire risks and required flexibility. These provisions should be aligned with fire safety objectives and may be higher than code requirements. These systems must be maintained correctly.

**Intervention** - last line of defense and relates to the manual action and response of emergency services.
The fire safety requirements with respect to operational protection will drive the fire strategy requirements rather than life safety.

Key issues with respect to operational protection:

- Limiting the amount and extent of smoke spread to reduce damage to the fabric of the building and operational downtime (type of smoke control) and may include reducing the possibility of smoke flow into Concourse areas and critical processing areas.

- Reduce the number of nuisance alarms and evacuations due to nuisance alarms based on the operational sensitivity of the area.

- Sprinkler protection based on existing infrastructure and the ALARP concept. (not related to life safety but to cost of operational downtime).

- Operational fire safety plan: evacuation zones related to operational zones.

- Potential for critical systems to be taken out of operation.
Evacuation Principles

PROGRESSIVE HORIZONTAL EVACUATION

Concept is to ensure the scale of the evacuation is to the nature of incident without compromising safety. Most large international airports use the concept of progressive horizontal evacuation.

The objectives met by Horizontal Evacuation are:

- Occupants should not have to leave the building except in the exceptional case of an uncontrolled fire;
- Minimize the disruption normally associated with the evacuation of a large building;
- Prevention of a mixing of landside and airside passengers;
- Prevention of a mixing of arriving and departing passengers;
- Especially suitable for special needs and persons of reduced mobility.

There could be several stages of evacuation which may include:

- Initial zone
- Adjacent zones
- Operational Zone
- Airside or landside
- Total building

The term operational zone relates to functionality of space and would include a number of evacuation zones. This type of evacuation requires management intervention and operation from a designated control room.
Evacuation Zoning
Parent/Child Relationship

Example:

Parent Zone

Child 1
Child 2
Child 1a
Child 1b
Child 2a
Evacuation Zones

OPS Zone

Airside

Landside

Total Building

Example FAS C&E Matrix – for a simple zone arrangement of a building.

- Imagine the complexity of an airport terminals C&E?
- The importance of testing this annually?
- The impact to safety and terminal operation if this is not frequently tested?
Smoke Control /Management

These systems may be used to:

- Justify extended travel distance by maintaining clear layer height;
- Reduce the sensitivity of the terminal to smoke spread especially given the open nature of modern terminals;
- Support tactical fire fighting and Fire Service intervention.

The concept of common smoke reservoirs may prove the most suitable means of meeting fire safety objectives. Advantages include:

- Limits smoke spread into open Concourse areas by containing smoke in a cabin;
- Reduces the number of fire/smoke dampers required, simplifying ongoing maintenance and testing;
- Provides flexibility to accommodate changes in retail space as the internal walls between units can be moved without any impact on the system.

However disadvantages may include:

- Limitations on retailing within the open concourse areas;
- It is possible that units within the same reservoir may become containment with smoke;
- Consideration needs to be given to unidirectional smoke flow for a fire at the end of the reservoir;
- Requirements to achieve certain shop front opening heights unless smoke curtains are provided.
Common Smoke Reservoirs
Common Smoke Reservoir

- **D** = Depth of Smoke Layer
- **Q** = Design Fire Size
- **Y** = Height of Smoke Layer (height of Shop Front)
- **Perforated Ceiling with 30% Clearance**
- **Extract**
- **Motorised Damper**

Diagram labels:
- **Smoke Layer**
- **Plume**
- **Fire**
- **Clear height**
Smarter Airports Concept

Concept - Dynamic hub that connects a multi modal transport network with people information and trade. Its serves the needs of the larger community and generates economic value for the region.

IT IS BASED AROUND 6 KEY PRINCIPLES

1) Enables growth and change: interconnected and intelligent airport integration platform that provides the flexibility to adapt to change.

2) Promotes collaboration: real time communication to all extended stakeholders and dissemination of a single source of the truth.

3) Focuses on the end to end passenger experience: emphasis on predictability of experience and seamless inter model transport.

4) Enables intelligent asset management: including maintenance and use of facilities and buildings and airport operational and IT assets.

5) Promotes a green airport: smart energy management and alignment with the ACI carbon accreditation program.

6) Increases non aviation revenue: enhancing the retail experience and employing smarter airport marketing programs.
Smarter Airports: Graphical User Interface

Innovation based on proven and tested technology

“When speed is of the essence, clarity is king”

- Present information unambiguously and consistently;
- Right information in right format at right time;
- Enable rapid operator response to events for incident management and ongoing testing and maintenance of systems;
- Remove unnecessary functions to streamline control;
- Make relevant information immediately available;
- Provide context-aware operator guidance;
- Use mobile devices for improved communications and delivery of information for field staff and Fire Service;
- Integrate PAVA, and other systems;
- Guarantee continuity in the event of hardware failure.
Graphical User Interface (GUI)

GUI aligned with Fire System interface and GIS data to provide automated information for response routes and evacuation routes to a defined assembly point area.
The fire strategy must not be seen as merely a project deliverable that is forgotten about once the building becomes operational, it remains a live document. The final fire strategy must provide a true representation of the finished product, where all changes from the original strategy are documented and approved by the Operator and Regulatory Authorities.

**Fire safety must form an integral element with respect to the ongoing management and operation of the facility by ensuring:**

- There is a suitable process in place for bringing the facilities into operation, including acceptance from the end user;
- Any changes to the building are recorded and approved against the fire strategy;
- There is a process in place which provides visibility as to the performance, testing and maintenance of all life safety systems;
- Regular desktop, modular training and live emergency exercises are conducted on a regular basis including the participation of external agencies to test and improve evacuation and emergency plans;
- Active approach to fire prevention to prevent fires, control and management of fire load and ignition sources, construction works, fire training, awareness;
- There is a suitable and sufficient governance structure within the organization including an escalation process to resolve issues where there may be no ownership, clear accountabilities;
- Data is suitably presented which is relevant to risk, focus on what is important;
- The establishment of Key Performance Indicators and performance indicators to provide true visibility of reality the data and may assist in identifying trends supporting a proactive culture of fire safety management; and
- Regular independent auditing to validate data.
Operational Fire Safety Management
Conclusion

- Whilst the application of codes are important, they may not provide all the answers.
- In order to derive a fire strategy that works in practice, the use and function of the building must be considered in conjunction with the operator.
- Operational requirements have a significant influence on the development of terminal fire strategies.
- Although “fire engineering” should be seen as useful tool in addressing design issues which are outside the boundaries of conventional guidance, it must be used with caution. The “engineered “ elements must be evaluated in context of the overall fire strategy and must be based on realistic expectations of management.
- Baseline codes for fire protection system should be established at the design stage as should the acceptance criteria used for “fire engineering design”.
- The Cause and Effect of active fire systems should be seen as an integral component of the overall fire strategy and must support operational protocols.
- In order to achieve maximum benefit fire safety, design must be delivered as part of an integrated solution which recognises other operational constraints such as security protocols.
- Intelligent engineering requires cerebral understanding of all design and operational aspirations the early involvement of the operator can only enrich the fire strategy.
• Innovation based on proven technology should be encouraged in the context of a strategic vision.

• The development of fire strategies based on fire engineering principles is the only way to meet the challenges presented by modern airport terminal design.

• An escalation process is considered to be essential in order to resolve matters at the earliest opportunity.

• Engagement with Regulatory Authorities during the design and on going development is considered essential this should extend in to the ORAT phase of the project.

• **Intelligent fire engineering will ensure best value from airport technical infrastructure investment and that the right choices are made to meet our operational aspirations**
Fire Engineering

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Thank you for listening