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Life Safety Plan Review at the Miami International Airport

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Abstract
This paper presents the different approaches to the life safety at the Miami International Airport, Miami Dade County, Florida, USA. The main codes used to enforce the above are the South Florida Building Code and the South Florida Fire Prevention Code. A subset of the above requirements created by the owner is the life safety master plan and the guidelines for the designers. The South Florida Building Code and the South Florida Fire Prevention Code is used as the base of the life safety. (Code NFPA 101, NFPA= National Fire Protection Association). The main elements of life are fire rated exits, stairs, corridors, exit lights, emergency lights, for a prompt evacuation from the buildings. For fire suppression, the use of fire sprinklers, deluge, foam, clean agents (FM-200) are in accordance with the codes NFPA 13, 14, 231, 11, 12, 17, 2001. For fire detection, the installation of smoke detectors, beam detectors in accordance with NFPA 72 are utilized. Audiovisual devices are installed in accordance with ANSI A-117.1, ADA requirements, NFPA 70, NFPA 72.

Keywords
Life safety, Fire Sprinklers, Fire Alarm, Smoke Control, Performance-Based Design.

1. Introduction

Smoke control systems are installed in accordance with NFPA 92A, 92 B, ASHRAE, 5 & South Florida Building Code. Speakers for the voice communication are used in accordance with NFPA 72; the speakers have to be UL listed for the fire use. A hybrid fire alarm (paging system) is used. Diesel emergency generators are installed as per NFPA 70, 110, 37 and South Florida Building Code.

Fire pumps are installed in accordance with NFDA 20. Fire hydrants, water mains, fire lanes, follows the Miami Dade County Ordinances. Water mains are installed in accordance with NFDA 24. The insurance company and third parties are also involved in the plan review processor.

The MIA has 4 million square feet and the current expansion will increase the area to 8 million square feet. The cost of expansion is about 5 billion dollars. The flow of passengers is about 40,000 people per day. Today, the airport has eight concourses. It will be increased to have the

north terminal which is one mile long with five floors and the train on the roof. The airport is located in Miami, Florida, USA in the tropical setting, on the edge of the Atlantic Ocean; serving the USA, South America, Central America, The Caribbean, Europe and Asia. The airport is owned by the Miami Dade County Department. The airport has fire sprinklers, fire alarm, smoke control and fire hydrants as the main elements to comply with the county codes, state codes and federal codes.

In 1998, in order to improve the life safety features at the airport, the life safety master plan was implemented. Also, the airport has guidelines of decision. Both documents try to address the documentaries of the airport and harmonize the different codes.
The plan review is performed by several engineers and fire inspectors, from the fire Department in coordination with the plan reviewers of the Building Department, Department of Environment Resources and Zoning Department.

2. Stages of the Plan Review

2.1 Book Design
The book design indicates the need of the particular product; construction schedule; the need of a Value Engineering study; infrastructure. At this point the fire safety plan reviewers indicate the need of fire lanes, fire hydrants, fire sprinklers, fire alarms, smoke controls, exits, stairs, doors, emergency exits, exit lights, emergency generators, and fuel tanks. Plans are sent back to Architect/ Engineers.

2.2 Preliminary Sketches
The life safety plan reviewers check if the life safety issues indicated in the design book were addressed. If not, the preliminary sketches are sent back to the Architect/Engineers.
In revising the sketches, if new information is added or new life safety features are needed, the plans are marked with notes and stamps.

2.3 Schematic
The life safety plan reviewers check if the previous comments have been addressed. Since more details of the building are coming out to light, they are checked against the Florida Building Code, the Florida Fire Prevention Code, The Life Safety Code NFPA 101, The Fire Alarm Code NFPA 72 and the Fire Sprinkler Standard NFPA 13. If specific issues arrive, the pertinent codes are addressed. For example, if gas lines are part of the project, then plans are reviewed in accordance with the Gas Code (NFPA 54). The schematic plans are sent back.

2.4 30% Plans and Specifications
At this point, all the parties know how the building looks like. Here the life safety plan reviewers check for fire walls, elevators, enclosed stairs, exit doors, smoke detectors, speakers, phone jacks, roof manifolds, standpipes, sprinklers, fire hydrants, atriums, vertical openings, elevators, emergency lights and exit lights.
It should be noted that in all these stages of the process, numerous meetings are being held with the different parties, such as the Architects, Engineers of the airport, the maintenance department, different agencies, the Architect/Engineers of the product, etc.

2.5 50% Plans and Specifications
In this step all the previous comments are reviewed if they have been incorporated in the plans. Since, most of the devices are shown; battery calculations and voyage drop calculations are

requested in the fire alarm plan. In the fire sprinkler alarms, the hydraulic calculations and the flow tests are requested. Fire exposures to other building are examined. Potential ever spill points are checked.

2.6 65% Plans and Specifications

Here the missing links are connected. The fire sprinklers piping are connected to real existing water mains. The fire alarm panels are connected to the main control panel and the fire alarm provider knows that new devices are going to be connected to his system. Emergency generators and fuel tanks UL-2085 are in place. Smoke exhaust fans are in the plans. All the fire sprinklers, smoke detectors, speakers for voice communication, all the fuel station and fire extinguisher are indicated in the plans.

2.7 75% Plans and Specifications

Value Engineering is performed at this point to see, if by which different materials or different approaches without affecting life safety, or the intent of the owner, cost can be reduced. Life safety plans and the life safety calculations are presented here.

1. Complete Fire Alarm plans are presented with calculations.
2. Complete Fire sprinklers plans are presented with calculations.
3. Complete Fire hydrants plans are presented with calculations.

2.8 90% Plans and Specifications

Previous comments not addressed before are integrated at this point. Life safety plans are reviewed. Occupancy load calculations are reviewed. If computing modeling for performance base decision are checked. Smoke generators calculations and plans for the smoke control system are reviewed. Flammable liquids if any are addressed. Fire wall, fire stopping details, guardrail details, handrail details, finishes of the room is checked.

2.9 100% Plans and Specifications

Anything missing in the previous submittals is found here. Cut sheets of sprinklers, strobe lights, wall fire hydrants, speakers are reviewed. The quantity of people against the number of exit doors is checked. The travel distance, the common path of travels and dead ends are examined.

2.10 ubmittal of the Plans to the Building Department and Fire Department.

Officially the Architect/Engineer presents to the Government the finished plans and specifications to obtain a permit to build the structure. The plans are reviewed by the Building Department which includes the plan reviewers are:

1. The Building Department.
2. The Accessibility (Handicap) Department.
3. The Mechanical Department.
4. The Plumbing Department.
5. The Electrical Department.
6. The Structural Department.
7. The Energy Department.
8. The Shop-drawing Department
9. The Department of Environmental resources, plan reviewers which include:
    - I. The Air section plan reviewer.
    - II. The Water section plan reviewer.
    - III. The Airport section plan reviewer.
    - IV. The Zoning plan reviewer.
    - V. The Planning plan reviewer.
    - VI. The Water and Sewer plan reviewer.

VII. The Public Works plan reviewer.
VIII. The Public Works Traffic plan reviewer.
IX. The Trees plan reviewer.
X. The Health and Rehabilitation Services plan reviewer.
XI. The Fire Flow plan reviewer.
XII. The Fire Department plan reviewer.

2.11 Review of plans by all the reviewers

In accordance with the type of building seventeen or more plan reviewers check the plans. One way to save the time is to send one complete set of plans to each reviewer so that all the plans are being checked at the same time. Each reviewer has 10-15 days to return the plans. This is okay with small buildings, let us say 100-200, but when the plans are 2,000-3,000 sheets, then you hire more plan reviewers or a good plan review is not made. Other way is the permit by affidavit which means that the Architect/Engineer is responsible for any failure and he/she can avoid the building department plan review, but not Fire or Zoning Department of the Environment and Health Department.

2.12 Plans sent back to Architect/Engineer with comments

Sometimes plans are turned back because of the missing information or conflicts between codes. The codes have deficiencies and loopholes. When conflicts arise, the Architect/Engineers can go to the Building Board and appeal their case there. Many Architect/Engineer do not prefer the affidavit systems because their insurance increases.

2.13 Resubmittal of Plans

The plans are reviewed again and if they meet Code, are approved. Many meetings are held with the different agencies to solve the problems. Performance based design is accepted subject to presentation of computer modeling. New materials must be approved by a recognized national laboratory. The airport uses the factory mutual insurance company.

2.14 Approval of the Plans for Construction

Once all the reviewers have signed all the plans, the permit is given to the Architect/Engineer to build the structure.

3. Fire Sprinkler Plans

The code used is the installation of the sprinkler system, NFPA 13 from the National Fire Protection Association. The airport is considered an assembly occupancy minimum and is ordinary hazard –Group 2 with 0.1816 gallons per minute per square feet. The coverage for each sprinkler is maximum 100 square feet. The sprinklers are quick response sprinklers. No concealed sprinklers are installed. The hose stream demand is 500 GPM as per NFPA 415 & 416.

The roof manifold at top must have 100 pounds per square inch. The piping is Blake steel pipe schedule 40, ASTME A 53 painted red as per ANSI A 13. All areas must have sprinklers. If not, then use NFPA 2001 clean agent systems (FM 200, Inergen, etc.). All soffits have sprinklers. All concavities, pockets in the ceiling should have sprinklers. If glass is needed to be protected, WS sprinklers (cooled head) from the central corporation are installed. Deluge systems are used too. The fire sprinkler zones are 40,000 square feet vested with the smoke control zones, fire alarm zones, speaker zones, with sprinklers below and above the conveyors. Vertical openings are

protected with sprinklers at six feet on center. The specs of plans are presented for review with calculations by the certified Fire Sprinkler Contractor for his permit.

4. Fire Alarm Plans

The code applied is NFPA 72, National Fire Alarm Code, by the National Fire Protection Association. All areas of the airport must have smoke detectors as an early warning system. The fire alarm is intelligent and addressable, style 'A'. The alarm is transmitted to the Maintenance Department and the Fire Department. The smoke control system is connected to the fire alarm. The speakers are connected to the fire alarm as well. The tamper switches and flow switches of the sprinklers, the audio visual (strobe tights, horn and speaker), as per ANSI A.117.1 are connected to the fire alarm. Fire alarm is however fixed on Excel. The new fire alarm panels are going to stand alone and can communicate with each other. Lon work technology may be in the future, to integrate all the functions of the airport. An open architecture is desired. At this moment, all systems, devices must be compatible with the existing system. Fire alarm zones are 20,000 square feet nested with fire sprinkler zones, smoke control zones, speaker zones.

5. Speakers

The voice communication is as per NFPA 72 (Fire Alarm) and NFPA 101 (Fire Safety Code). The system at the airport is hybrid. The speakers to comply with fire requirements to be underwriter's laboratories listed for fire conditions. The speakers can be used for all call for normal operation at the airport. If the Architect/Engineer needs to install in addition, other speakers to increase the intelligibility, he can do so. But he has to connect those speakers to the fire speakers.

6. Smoke Control Plans

The smoke control plans are reviewed in accordance with NFPA 92A, 92B, ASHRAE-5, South Florida Building Code and the South Florida Fire Prevention Code. The South Florida Building Code prescribes 9 air changes per hour of exhaust and 6 air changes per hour supply air. In case of atria, the air change may be reduced if it is proved with computer modeling and the following of the "Standard for performance based submissions." The zones of smoke control are maximum 40,000 square feet nested with the fire alarm zones, fire sprinkler zones.

7. Fire Hydrant Plans

The fire hydrants are located at 300 feet maximum. The fire water flow is minimum 3000 gallons per minute at 20 points per square inch pressure. The fire hydrants can be post type, flush mounted on the wall, or flush mounted on the floor. For a few feet of length of 6 inch water pipe connect to the fire hydrants, after that usually is 8 inches water pipes for about 50 feet length. The 8 inch pipe is connected to 12 inch for about 100 feet length. The 12 inch is connected to the 16 inch water main.

8. Standard for Performance-Based Submissions

The Miami-Dade County Fire Rescue Department is receptive to new and innovative technologies and approaches that provide an equal or greater degree of life safety and property protection than the prescriptive codes. We also recognize that acceptable departures from the provisions of the adopted, perspective codes can contribute to esthetic and economic advantages. However, the burden of proof of the validity, reliability, and benefit of any "performance-based" proposal is incumbent upon the applicant.

The guideline establishes the minimum standards and reporting criteria necessary for the Miami-Dade County Fire Rescue Department to accept for consideration and review proposals that substitute "performance-based" alternative designs for prescriptive code standards. The minimum standards identified in this guideline shall apply to all drawings submitted and formal presentations made for the fire department review that incorporate any deviation from the prescriptive codes, regardless to how minimally those changes might deviate from them.

All "performance-based" design submissions shall provide realistic documentation supporting the selected model's validation, verification and evaluation for the specific use intend, as identified in the "American Society for Testing Materials" (ASTM) Standard Guide for "Evaluating the Predictive Capacity for Deterministic Fire Model" (E1355-97). All extrapolations of information from proven benchmark models or previously published test data shall also be predicated upon the selection of models proven to be appropriate for the specific use intend.

The validity of any "alternative design" or "models" appropriateness, it's underlying assumptions, limitations, and estimates of the accuracy of the resulting predictions shall be rigorously documented including a side by side comparison of the existing prescriptive code provisions being addressed and the assumptions and conclusions arrived at through the application of the alternative design analysis. Since uncertainty is inherent in any prediction, based in part upon the assumptions of the "designs" parameters, the model's limitations and the nature of the input data, a safety factor of a minimum of two shall be required to account for the unanticipated and unknown variables.

Some design proposals may be based on assumptions that limit the "robustness/enforcement" of the building by offering flexibility, which would not limit the potential for future changes in occupancy use or their enforcement over the life of the building. Such proposals have assumptions that create problems due to the difficulty of their enforcement over the life of the building will not be accepted. The Miami-Dade County Fire Rescue Department is not responsible for proving the inadequacies of proposals that have been submitted, reviewed and rejected for cause.

The algorithm utilized for the respective models shall provide a robust and conservative resolution to the issue of equivalency and not simply serve as an alternative to the code requirements. The methodologies for establishing and evaluating the predictive capabilities of a fire model for specified use can be found in the ASTM guide, E1335-97, and the documents referenced within this publication. The format presented in these ASTM guidelines shall be utilized in preparing proposals for fire department review.

Performance based proposals that require a higher level of confidence than inspired by the conclusion offered by the analysis for projects of significant size, complexity or other relevant factors shall require a "peer review" or third party certification of the analysis. The peer reviewer

shall be the chosen from among the available options at the time by the AHJ with the consent of MDAD. Those costs associated with the review will be the responsibility of the submitter.

Submissions addressing equivalency of performance-based proposals with the adopted prescriptive code provisions, performance-based alternatives, shall at the time of submission include the complete documentation for any and all references utilized within the proposals. Selective excerpts from any standard, study, model, reference, or publication will not be accepted out of context. The complete document shall be submitted for review.

The unique nature of individual "alternative design" proposal requires a more time consuming review process than the standard plans processing review. Applicants can anticipate a time frame for plan or proposal review commensurate with the size and complexity of their respective projects.

Checklist

i. **Evaluation, Validation, & Verification of the Model -** Documentation shall be provided to demonstrate the model's sustainability for it's application in justifying a performance-based design as follows:

   a. If the model has been certified in accordance with ASTM E1335-97, "Standard Guide for Evaluating the Predictive Capability of Deterministic Fire Models", documentation substantiating that the certification covers the specific intend application shall be provided, or

   b. If the model has not been certified in accordance with ASTM E1335-97, documentation shall be provided demonstrating that the model is appropriate for its intended use and application. Suitable documentation is outlined in ASTM E1335-97.

A sensitivity analysis, which determines the effect of change in individual input parameters on the results of a given model, shall be made to determine its sustainability for use in specific application. This analysis may involve holding constant all factors, except one input variable, and systematically studying the effects of changes in that one variable on the predicted result. To assess a model's ability to accurately predict outcomes, a comparison may be made with standard tests, large scale compartment fire tests, or published data on full-scale tests where the specific input/output parameters being evaluated have been measured.

All limitations on the use of the model as outlines in the applications manual or the supporting technical literature shall be submitted. After consultation with the AHJ, this requirement may be waived for models and methodologies accepted by nationally recognized authoritative organizations such as NFPA (e.g. NFPA 92B, 72, 204, 555) and SFPE (e.g. EVACNET+, EXODUS, SEM/SEC (Spreadsheet Evacuation Model/Schirmer Engineering Corporation), ASET, RSET, CFAST, FASTlite, FPETool, BR12, HAZARD I , DETACT).

ii. **Scenarios Being Modeled-** All scenarios that are modeled shall state their assumptions and limitations**.** Only the most applicable and conservative assumptions will be approved by AHJ.

iii. **Input and Output data-** All input data used by the model to predict the outcome of a specific fire scenario shall be supplied. Input data may include but is not limited to, the heat release rate of the burning material, compartment boundaries, size and location of vents, physical and heat transfer characteristics of wall ceiling materials, heating, ventilating and air-conditioning information, and furnishings or contents. The output for each run of the model shall be presented in table and/or graphical format.

iv. **Comparison of Prescriptive and Performance Designs-** A side-by-side comparison shall be provided of applicable prescriptive code provisions and the alternative performance-based options being proposed.

v. **Assumptions and Safety factors-** all assumptions shall be documented to demonstrate their sustainability for the application. Since uncertainty is inherent in any prediction, an appropriate safety factor shall be chosen based on the complexity of the problem and the confidence in the validity of the inputs. For calculations relating hazard development time and required egress time the safety factor shall not be less than two.

vi. **Robustness/Enforcement Issues-** All assumptions that limit the flexibility of the future use of the building shall be documented.

vii. **Referenced Materials-** At the time of the submission, complete documentation for all references utilized within the proposal shall be included. Selective excerpts from any standards, study, model, reference, or publication will not be accepted out of context. At the end of the review process, all textbooks will be returned to the submitter if copies are not provided.

9. Conclusions

Life safety plan review is a long process and it includes many disciplines. The life safety plan reviewer must check all the plans from the architectural drawings to zoning drawings, passing their structural, mechanical, electrical, plumbing, and many other plans. The key point is protecting the public's welfare and safety through enforcement of the South Florida Building Code, the South Florida Fire Prevention Code, and other applicable construction regulations.

10. References

Florida fire Prevention Code 2001 Edition based on- NFPA1, Fire Prevention Code, 2001 Edition, NFPA 101, Life Safety Code, 2000 Edition.
Florida Building Code 2001- Mechanical, Building, Fuel Gas, Plumbing.
Florida Accessibility Code for Building Construction- Chapter 11, October 1997 Edition.
NFPA 72, National Fire Alarm Code, 1999 Edition
NFPA 13, Standards for the Installation of Sprinkler Systems, 1999 Edition