HQ AFCESA FIRE PROTECTION

STRUCTURAL RESPONSE GUIDANCE

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INTRODUCTION

PURPOSE

The purpose of this guide is to clarify the Air Force (AF) implementation of Department of Defense Instruction (DoDI) 6055.6, *Department of Defense Fire and Emergency Services Program* (10 October 2000). This guide provides a template for Major Air Commands (MAJCOMs) and base level senior fire officials to utilize during assessments and to communicate fire protection capabilities to MAJCOM Civil Engineers (CE) and wing leadership. Furthermore, it consolidates existing AF criteria pertaining to structural response criteria, staffing and vehicle requirements, and outlines the use of a risk assessment process. This guide also includes sample fire protection risk management assessment models. It does not address the technical aspects of operational risk management, that are covered in AFI 90-902, *Operational Risk Management (ORM) Guidelines and Tools*.

BACKGROUND

The Office of the Under Secretary of Defense for Environmental Security (Force Protection), OUSD/ES(FP), revised DoDI 6055.6 to align DoDI 6055.6 response guidelines with current industry standards, e.g. National Fire Protection Association (NFPA), International City Management Association (ICMA), Occupational Safety and Health Administration (OSHA). This revision resulted in changes to structural response criteria, vehicle and staffing requirements, and the use of a risk assessment process. DoDI 6055.6 provides service components the authority to identify service specific capabilities to support their fire protection mission. The Air Force uses Air Force Instruction (AFI) 32-2001, *The Fire Protection Operations and Fire Prevention Program*, Allowance Standard (AS) 019, *Vehicle Fleet (Registered) All MAJCOM Common*, and Air Force Manpower Standard (AFMS) 44EF, *Fire Protection Flight*, as the means to identify service specific requirements to implement DoDI 6055.6.

DISCUSSION

A proactive management and performance-based approach by senior fire officials (SFOs) is key to an effective fire protection program. A thorough understanding of structural response criteria, vehicle and staffing requirements, and the use of risk assessment procedures will enable SFOs to effectively execute DoD and Air Force implementation instructions. The fire protection flight has an inherent responsibility to conduct comprehensive fire risk assessments. SFOs are responsible for utilizing available resources to the fullest extent possible and must notify senior leadership when fire protection capabilities fall below mission requirements. A comprehensive fire risk management plan, supported by documented ORM assessments, provides information for both the MAJCOM CE and wing leadership to make key risk-acceptance decisions.

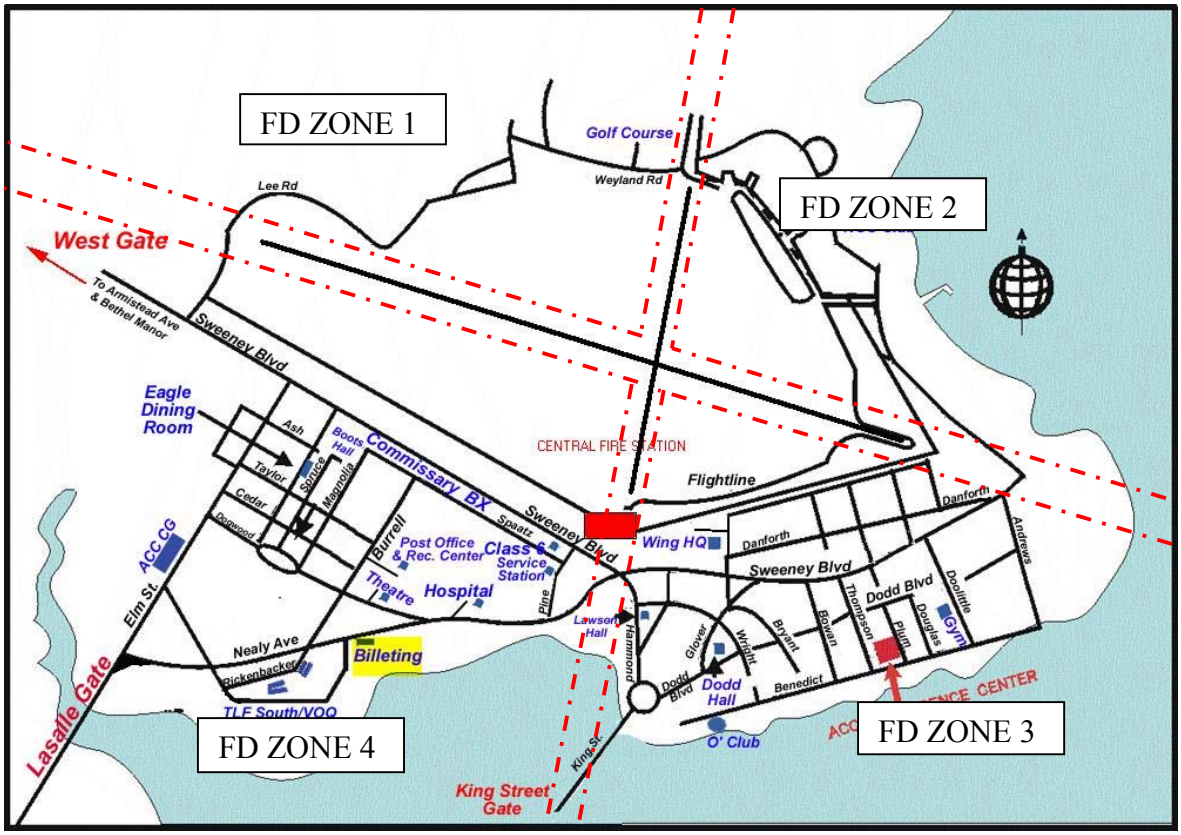
STUCTURAL RESPONSE GUIDANCE

Several factors are considered when determining structural response criteria: fire demand zones (FDZs), travel time, staffing and vehicle requirements, and the use of a risk assessment process.

SECTION 1 – FIRE DEMAND ZONES

DoDI 6055.6 defines FDZs as *small areas that represent a single demand for fire service.* Typically, an Air Force installation can be divided into FDZs using the airfield as the center point. FDZs are usually established by geographical boundaries, quantifiable risks, and travel time. There are several factors to consider when establishing FDZs. These include, but are not limited to: travel time, occupancy classification, type of construction, installed fire protection systems, nature of contents, value at risk, mission criticality, water supplies, mutual aid, and other relevant factors.

The diagram below is an example of how an Air Force installation can be divided into FDZs.



SECTION 2 – TRAVEL TIME

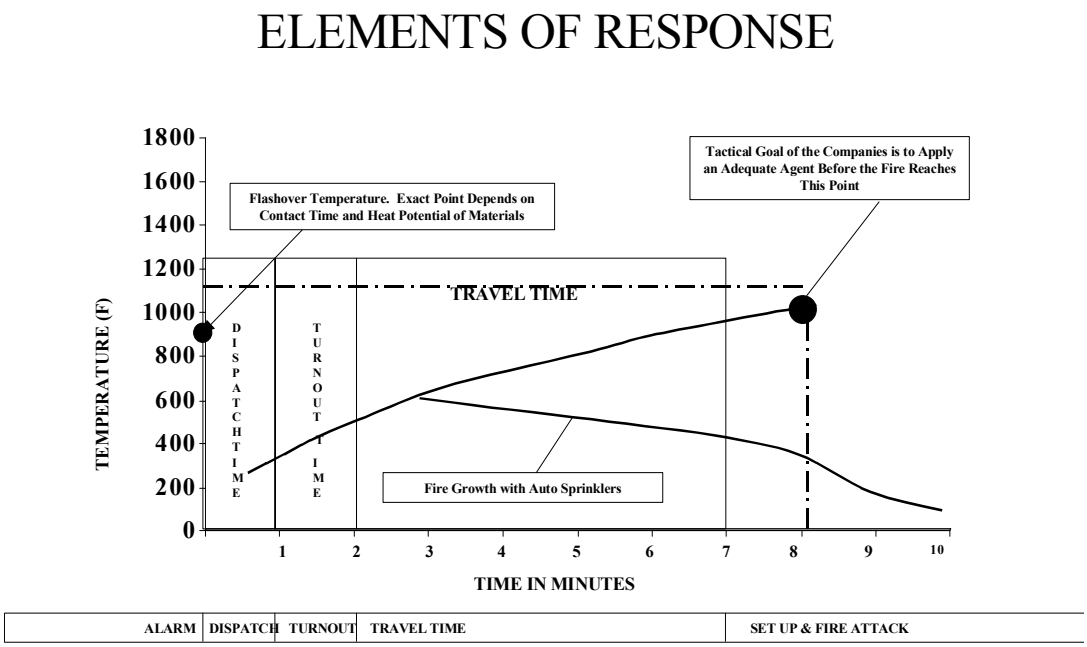
A. DODI 6055.6 – STRUCTURAL TRAVEL TIME REQUIREMENTS

Travel time criteria for AF installations is contained in DoDI 6055.6. Travel time is based upon the amount of time it takes for a piece of structural fire fighting apparatus to travel from the fire station to a facility-related fire incident. The first structural fire fighting vehicle (pumper) must arrive within 5-minutes to 90% of all structural alarms, and remaining structural unit(s) must arrive within 10-minutes to 90% of all alarms.

B. CONCEPT OF TRAVEL TIME

Total response time is made up of three components: alarm processing (or dispatch) time, turnout time, and travel time. With the October 2000 revision of DoDI 6055.6, the basis of structural emergency fire response changed from total response time to simply ***travel time***. This decision to use travel time was based upon the directive for government agencies to use industry standards whenever appropriate.

The chart below shows the relationship between response time and the fire growth in a residential occupancy (a severe fire growth characteristic). This chart indicates alarm processing and turnout times on average are approximately one minute each. These 1-minute processing and turnout times are goals. However, AF experience indicates that these times may vary up to a total of 3-minutes depending upon the complexity of the notification and time of day for the response.

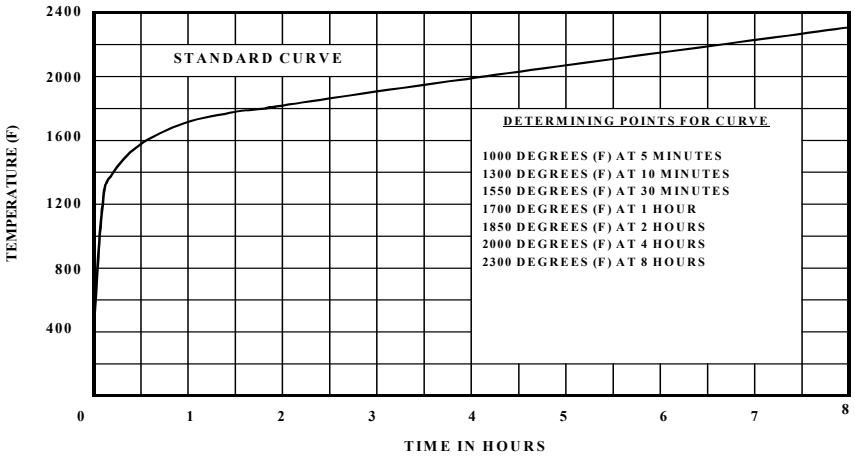


The International City Manager's Association (ICMA) is an industry group comprised of city managers and other senior management from cities across the US and worldwide. Among other activities, the ICMA develops publications and standards relevant to municipal services. The ICMA endorses the concept that in cities, fire stations should be sited to enable the first-arriving pumper to reach a facility fire in time to apply water on that fire before flashover. Flashover is typically considered to occur when the room temperature reaches 1100 °F. It is considered relevant because that is the point at which an unprotected person in that room would not be expected to survive.

The ICMA uses the fire growth characteristics of a residential fire. It is recognized that the physical conditions in a residential occupancy (low ceiling heights, relatively small compartments, extensive combustible fuel loadings, etc.) all contribute to an extremely fast-developing fire with a rapid flashover condition. The ICMA's recommended travel time is derived from the time-to-flashover being approximately 8-10 minutes for residential occupancies. (Note: Recent data indicates that flashover in residential occupancies may even be quicker due to peoples' tendency to incorporate more and more highly combustible materials into their homes.) For cities, this is a logical decision because residential occupancies (homes, hotels, motels, hospitals, etc.) are typically distributed throughout all cities. Additionally, in cities where the fire department is solely responsible for providing Emergency Medical Services (EMS), even shorter travel times of 4-minutes may be required based on American Heart Association (AHA) guidelines.

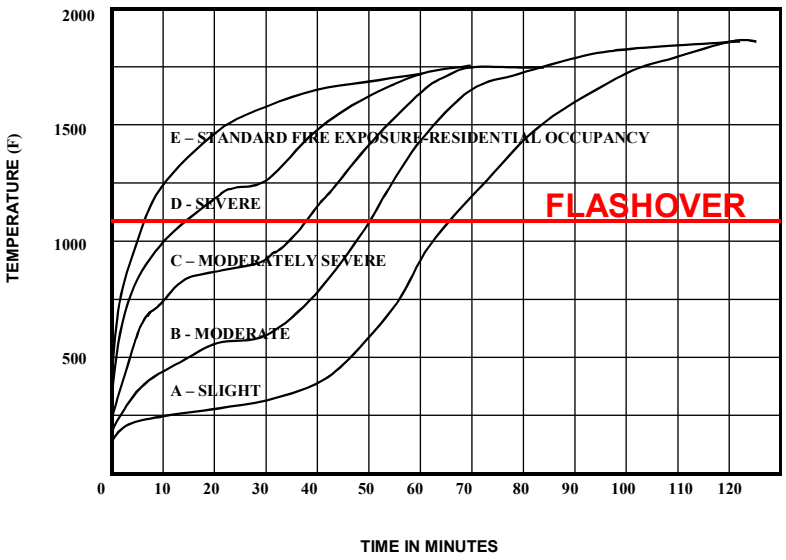
This time-to-flashover for residential occupancies can be associated with the following American Society of Testing and Materials (ASTM) Standard Time-Temperature Curve:

STANDARD TIME-TEMPERATURE CURVE



As discussed before, time-to-flashover in other occupancies is dependent upon ceiling heights, combustible fuel loading, degree of compartmentation, and other factors. The chart below, extracted from the NFPA Fire Protection Handbook, 18th Edition, compares fire growth curves and time-to-flashover for various occupancies.

TIME-TO-FLASHOVER IN VARIOUS OCCUPANCIES



Consistent with the National Technology Transfer Act of 1995 (Public Law 104-113), to use industry standards whenever appropriate, DoDI 6055.6 adopted the ICMA's recommended 5-minute travel time as the baseline for DoD's structural fire response goals. Based on an Air Force request, the DoDI also authorizes Service Components to accept increased travel times for remote or outlying facilities when such increased travel times are supported by a risk assessment process.

The AF implements the DoDI criteria in the documents referenced in the background section of this document. However, the AF also recognizes that an Air Force base (AFB) is substantially different than a city in a few significant ways:

(1) Substantially more facilities on an AFB, compared to a typical city, are sprinklered. The probability of flashover is extremely low in facilities with standard sprinkler protection. For at least the last twenty years, DoD and AF standards have required sprinkler protection in essentially all complex and high value structures.

(2) In non-residential facilities, occupancy processes and hazards are rigorously self-controlled by regulations and instructions. Additionally, the AF has strong oversight mechanisms including fire prevention, safety, and IG inspections that reinforce the strict application of those regulations and instructions.

(3) While unsprinklered residential occupancies on AFBs still require very short response times, these types of occupancies are usually not dispersed throughout the installation. Residential occupancies on AFBs are generally limited to military family housing, temporary lodging facilities, visiting officer/airmen quarters, dormitories, medical treatment facilities, and possibly mobile home parks. Typically, these risks are in concentrated areas, rather than being dispersed across the entire base.

Air Force fire stations should be sited to support the DoDI criteria for all major accumulations of buildings, including the main cantonment area and MFH areas. However, the AF recognizes that the 5-minute travel time requirement, that is based upon the very rapid flashover in residential occupancies, is not appropriate for other classes of occupancies and types of construction for which slower fire growth is expected.

Consequently, the AF has adopted the following guideline:

> **Remote or Outlying Areas**: For the purpose of fire department structural responses, facilities that are beyond the 5-minute emergency response travel time are classified as ***remote* or *outlying facilities***.

This definition enables an AF installation to apply an intelligent, performance-based assessment of risks, costs, and benefits as opposed to a prescriptive travel time that may not be relevant to the facility in question.

Likewise, the AF standard recognizes that some facilities may be sited remotely for safety or geographical reasons. Additionally, some facilities have security requirements that are specifically intended to restrict vehicle access.

C. MEASUREMENT OF TRAVEL TIME

Travel time can be measured by one of three methods.

(1) **Historical Travel Time Data**: Historical fire department logs provide the best indication of real travel times. A review of fire department logs for at least the past **24 months** should determine actual travel times to specific facilities or areas within a FDZ. If historical records reflect ***total response time***, ***travel time*** should be calculated by subtracting 3-minutes for alarm processing and turnout time.

(2) **Plotting using Grid Map**: When historical records are not available, plotting response patterns on a scaled base grid map may be used.

a. In built-up areas of the base, use 35 mph as an average response speed; this average speed is supported by national statistics for cities. When using a scaled grid map, 35 mph is equivalent to 3,186 feet/minute or 53.1 feet/second.

b. In less-developed areas, where the concentration of facilities is low and higher speeds are completely safe, greater emergency response speeds should be possible while

being reasonable and proper with due regard for actual and potential hazards. These speeds can be converted into feet/minute or feet/second and plotted on a grid map.

(3) **Computer Model**: The ideal tool for estimating emergency response travel times, assuming historical records are not available, is a computer model that accounts for roadway configurations, intersection controls, applicable emergency response speed limits, and traffic patterns.

NOTE – Time Trails: Conducting a vehicle time trial of travel time is the least desirable method of validation. It should only be used when historical records, plotting, or computer modeling are not available. Should structural time trials be conducted, fire chiefs should utilize installation directives and local and state laws to determine the prudent response speed limits. These time trials should be conducted as close as possible to actual emergency responses. IAW Air Force Joint Manual (AFJMAN) 24-306, *Manual for Wheeled Vehicle Driver*, the speed of emergency vehicles should be reasonable and proper with due regard for actual and potential hazards. When responding to an incident, emergency vehicles should follow the guidelines contained in NFPA 1500, *Fire Department Occupational Safety and Health Program*. It should be noted that many states and municipalities recognize "posted plus 10 mph" to be an appropriate general guideline for emergency responses (lights and siren), especially outside of principal business districts.

D. REMOTE AND OUTLYING FACILITIES TRAVEL TIME

For the purpose of fire department structural responses, facilities that are beyond the 5-minute emergency response travel time are classified as ***remote* or *outlying facilities***. DoDI 6055.6 permits the Service Component to increase travel times for these situations using a risk assessment process. This allows the Service Components to make performance-based decisions, as opposed to using prescriptive standards, when facilities or complexes are beyond the 5-minute travel time. For remote or outlying facilities outside the established travel times, a risk assessment must be accomplished to identify the potential impact of a delayed arrival. Such risk assessments must consider, as a minimum, occupancy classification, type of construction, installed fire protection systems, nature of contents, value at risk, mission criticality, water supplies, mutual aid, and other relevant factors.

For example: Just because facilities or complexes have travel times in excess of 5-minutes for the first arriving engine company does not necessarily mandate additional resources (vehicles, staffing, and stations). A fact-based risk assessment must be conducted to determine the ***probability and consequence*** of a fire incident and what ***alternative measures*** can be implemented to reduce the risk. These risk reducing or controlling measures can include a number of ***process changes*** that effect an incident's outcome, i.e., fire suppression and detection systems, improved facility fire prevention practices, increased facility fire prevention risk management surveys, facility fire protection engineering enhancements, changing fire department strategies to increase

initial response force tactics (people, equipment or/and water), use of new technologies to improve an incident's outcome, etc.

SECTION 3 – STAFFING AND VEHICLE REQUIREMENTS

The foundation for Air Force peacetime fire protection staffing and standards of emergency response coverage requirements are based upon DoDI 6055.6. Air Force fire protection staffing requirements are established in AFMS 44EF. In addition, the Air Force has established variances, that take into consideration unique mission requirements and base configurations. The AFMS 44EF application is accomplished by the local Manpower and Organization Office and validated by the MAJCOM Fire Protection Office (FPO). That data should be reviewed annually for currency by the Fire Chief and MAJCOM FPOs. Application of the AFMS should be maintained as an official record on file at both the fire department and MAJCOM FPOs.

AS 019 provides an authorization for a core vehicle set that includes two structural fire fighting vehicles for an installation. These structural fire fighting vehicles can be any combinations of P-22 and P-24 structural pumpers, or P-21 aerial platform vehicle. Historically a P-21 is provided in place of a structural pumper when an aerial platform capability is required. AS 019 has been changed to recognize a quint/aerial ladder truck as a suitable substitute when replacing a P-22 or P-24 structural pumper. Replacement of P-22/P-24 pumpers will be accomplished via attrition. MAJCOM FPOs have identified and prioritized initial quint/aerial ladder truck requirements for FY 02-07.

A. EXAMPLE OF CORE VEHICLE SET 3

The following is an example extracted from AFMS 44EF that illustrates a typical AFB staffing requirement for a Core Vehicle Set 3. Authorized staffing is provided for only one of the two authorized structural pumpers. The second pumper would be cross-manned with ARFF vehicle personnel.

FIRE DEPARTMENT FLYING INSTALLATION FOR B-1, B-52, C-17, A/C-130, C-141, KC-135, L-1011, MD-90, 727, and 767 AIRCRAFT (Aircraft with an overall length of 150 feet, up to but not including 200 feet)			
Core Vehicle Set	**Manpower**	**Management**	**Manpower**
P-22 – Pumper	**4**	Fire Chief	1
P-24 – Pumper	**0**	Assistant Chief Operations and Readiness (Deputy)	1
P-23 - ARFF	3	Assistant Chief Operations	2
P-23 - ARFF	3	Assistant Chief Training	1
P-19 - ARFF	3	Assistant Chief Fire Prevention	1
P-18/P-26 Tanker	1	Fire Prevention Inspector/Educator	1
P-10/P-28 Rescue	3	Communications	5
HazMat	0	Administration	1
Total Shift Firefighters	**17**	**Total Management**	**13**
17 X PMF 2.581 = **43.877**	**44**	**Management + Operations**	**13** **44**
		Total Manpower for the Fire Department	**57**

B. RELATIONSHIP OF STAFFING AND VEHICLES TO STANDARDS OF RESPONSE COVERAGE (SORC)

SORC define a predetermined fire fighting capability predicated upon a specific level of fire department resources (staffing, vehicles, equipment, and fire station locations). If any one of these critical resources are not available, mission objectives cannot be accomplished. It is important to understand that a fully staffed structural vehicle ***can accomplish*** initial offensive fire ground operations when arriving prior to flashover. Conversely, inadequately staffed structural vehicles ***cannot accomplish*** initial offensive fire ground operations. Fire Chiefs need to articulate SORC shortfalls to Wing leadership and how such shortfalls impact mission support capabilities. The results of these shortfalls include:

(1) Execution of offensive vs. defensive fire ground operations
(2) Implementation of OSHA 2 In/2 Out policy (29CFR1910.134)
(3) Increase severity of loss
(4) Inability to conduct interior search and rescue/ Rapid Intervention Team (RIT)
(5) Compromises the safety of firefighters on the fire ground
(6) Degrades Incident Command (IC) structure

These impacts can result in loss of life, or property, reduce operational processes and/or mission continuity, or environment damage.

SECTION 4 – RISK ASSESSMENT PROCESS

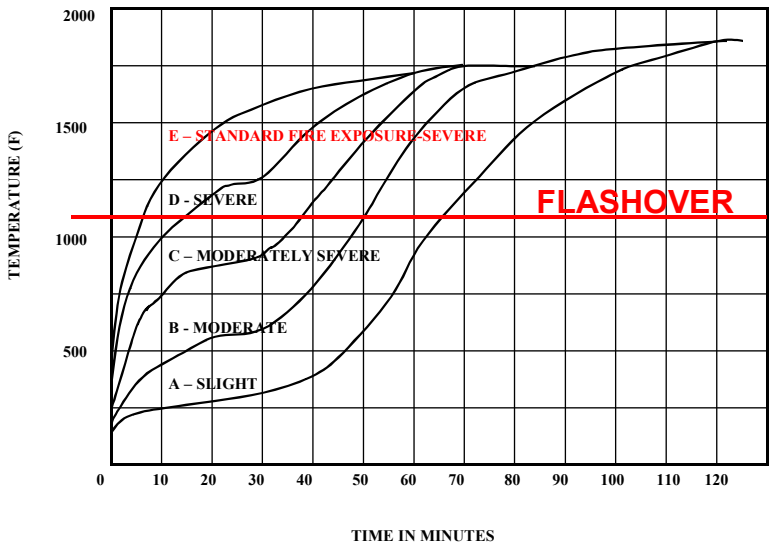
For remote or outlying facilities, outside the established travel times, a risk assessment must be accomplished to identify (1) whether an increased travel time fails to meet the performance goal (agent application before flashover), and (2) when additional features/controls will be required within the facility to offset the impact of a delayed arrival. Such risk assessments must consider, as a minimum, occupancy classification, type of construction, installed fire protection systems, value at risk, mission criticality, and life safety.

For cases in which the decision involves investments of >$1M or recurring annual costs >$100K, the informal risk assessment process described below must be replaced with a strategic ORM assessment and qualitative engineering analyses.

A. OCCUPANCY CLASSIFICATION AND TYPE OF CONSTRUCTION

The risk assessment process should begin with a determination of expected fire growth in the facility being considered. While there are computer fire models that can accurately predict temperature growth curves for specific fuel packages, the use of data from the NFPA is sufficient for this risk assessment. The following chart from NFPA Fire Protection Handbook, 18th Edition, should be used to estimate the total response time available before flashover would be expected.

TIME-TO-FLASHOVER



Occupancy Classification Definitions:

(1) Temperature Curve A (Slight)

NFPA Fire Protection Handbook	Air Force Example
Well-arranged office, metal furniture, noncombustible building	
Welding areas containing slight combustibles	CE Shops
Noncombustible powerhouse	
Noncombustible buildings, slight amount of combustible occupancy	Labs and most R&D operations AF depot a/c maintenance & overhaul

(2) Temperature Curve B (Moderate)

NFPA Fire Protection Handbook	Air Force Example
Cotton and waste paper storage (baled) and well-arranged, noncombustible building	
Paper making processes, noncombustible building	
Noncombustible institutional buildings with combustible occupancy	Admin/Offices: Labs and R&D ops with >50 gals of flammable liquids outside of storage cabinets/rooms

(3) Temperature Curve C (Moderately Severe)

NFPA Fire Protection Handbook	Air Force Example
Well arranged combustible storage, e.g. wooden patterns, noncombustible buildings	
Machine shop having noncombustible floors	

(4) Temperature Curve D (Severe)

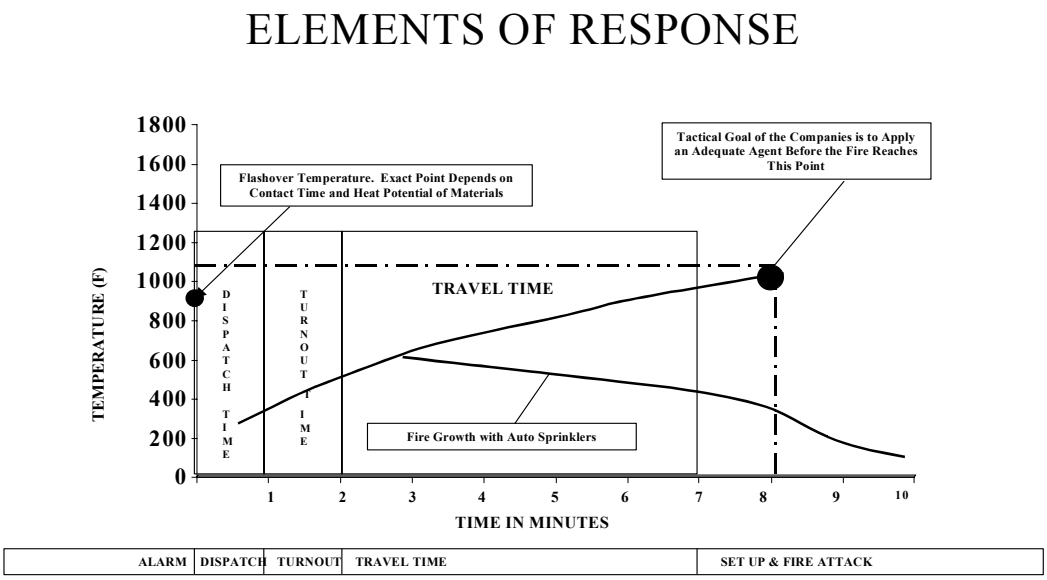
NFPA Fire Protection Handbook	Air Force Example
Manufacturing areas, combustible products, noncombustible buildings	
Congested combustible storage areas, noncombustible building	

(5) Temperature Curve E (Standard Fire Exposure-Severe)

NFPA Fire Protection Handbook	Air Force Example
Flammable liquids	
Woodworking areas	
Office, combustible furniture and buildings	
Paper working, printing, etc.	
Furniture manufacturing and finishing	
Machine shop having combustible floors	
Residential occupancies (inserted by USAF)	MFH, VOQ/VAQ, TLF, Dorms, Hospitals

B. INSTALLED FIRE PROTECTION SYSTEMS

The probability of flashover is extremely low in facilities with standard sprinkler protection. The graph below depicts generic fire growth. Where sprinkler protection is present, there is a significant reduction in fire growth, fire intensity, and room temperatures. As a result, the criticality of ***rapid*** fire department intervention is substantially reduced. Sprinkler protection also provides a safer environment for an interior offensive attack.



For remote or outlying facilities with properly installed sprinkler systems, travel time for the first arriving structural fire fighting vehicle is increased to 10 minutes. However, it must be recognized that even in sprinklered facilities (where fire development is negated and flashover is not expected), the extent of the fire loss *may* continue to grow in direct proportion to the a delay in fire department response.

Successful sprinkler performance is predicated on proper design for the occupancy, standard installation, and continual life-cycle testing and maintenance. Of particular importance in remote and outlaying facilities, it is essential that sprinkler protection be reliable. The result of a risk assessment may indicate that increased frequency of life-cycle testing and maintenance of fire protection systems may be warranted. Note: The cost of additional maintenance is insignificant when compared to the cost of additional fire protection resources (staffing, vehicles, and/or facilities).

When sprinkler protection does not meet NFPA design or installation criteria, a strategic ORM assessment must be completed to ensure that the facility fire protection system will provide enough protection to justify an increased travel time.

C. VALUE AT RISK AND MISSION CRITICALITY

A strategic ORM assessment must be accomplished to justify increased travel times under the following conditions: (1) mission priority assets are at risk, (2) facility or content values exceed $20M (replacement cost), or (3) facility operations are directly critical to combat mission support.

D. LIFE SAFETY

In any facility where people are routinely present, consideration must be given to their ability to safely egress during an emergency. In remote or outlying facilities any failures to comply with the NFPA Life Safety Code (LSC) and any special Air Force requirements must be corrected as high priority projects. Conversely, when a facility complies with the LSC, and any special AF requirements, facility occupant safety during a fire is rarely a legitimate cause for special consideration except in limited situations (e.g., children or disabled adults are present, people are physically restrained, etc.).

E. INTEGRATION OF RISK ASSESSMENT AND THE ORM PROCESS

The Air Force uses the Operational Risk Management (ORM) process to perform formal risk assessments. The process is contained in AFI 90-902, *Operational Risk Management Guidelines and Tools*. The results of a basic fire risk assessment may justify the development of a formal ORM assessment. Some installations may experience deficiencies in establishing SORC. These deficiencies could include staffing shortages, reduced vehicle capability, and response to remote or outlying facilities. These deficiencies may result in the necessity to perform a fire risk assessment using the ORM process.

A separate fire risk assessment may not be necessary for every facility outside the 5-minute travel time. There may be circumstances where a single fire risk assessment is sufficient for low or medium hazard occupancies in a small cluster of facilities within a single fire demand zone.

If a fire risk assessment determines that additional fire department resources, staffing, or vehicles are required to meet the 5-minute travel time for facilities, complexes, or fire demand zones, then a strategic ORM plan must be prepared and coordinated with the affected organization and the installation safety office. The coordinated ORM plan must be submitted to the Installation Commander and the MAJCOM CE for approval.

F. SAMPLE FIRE PROTECTION RISK MANAGEMENT ASSESSMENT EXHIBIT

A comprehensive fire risk assessment will result in factual data that should be presented to senior wing leadership. The matrix below is an example of how the results of a risk assessment can be visually presented to demonstrate fire protection capability when responding two structural fire fighting vehicles and a rescue crew. The matrix presents a direct correlation between staffing levels, response vehicles, and travel time to FDZs with corresponding color-coded levels of capability. See the notes section for details. This information will enable wing leadership to better understand departmental capabilities so that key risk-acceptance decisions can be made.

INITIAL STRUCTURAL FIRE RESPONSE									
RISK ASSESSMENT CATEGORIES	**1ST Engine Company**			**2nd Engine Company**			**Rescue Company**		
Crew Size	**Initial Interior Attack**	**Rescue Only**	**2 In 2 Out**	**RIT**	**Ventilation**	**Exterior Operations**	**Search & Rescue**	**2 In 2 Out**	**Ventilation**
5	G	G	G	G	G	G	N/A	N/A	N/A
4	G	G	G	G	G	G	N/A	N/A	N/A
3	R	R	R	G	Y	Y	G	G	G
2	R	R	R	Y	R	R	Y	Y	Y
FDZ - Travel Times									
FDZ: 90%-100%	G	G	G	G	G	G	G	G	G
FDZ: 75%-89%	Y	Y	G	G	Y	G	Y	G	Y
FDZ: 74%-Below	R	R	G	G	R	G	R	G	R
Fire Flow GPM Requirements									
Meets	G	G	N/A	G	G	G	N/A	N/A	N/A
Does Not Meet	R	R	N/A	R	Y	R	N/A	N/A	N/A

NOTES

1. R (RED): **Structural firefighting actions cannot be expected to be successful.** Firefighting forces can perform only limited defensive operations until recall of off-duty firefighters and mutual aid support can arrive. Personnel must exit under their own power; rescue of trapped personnel should not be expected.

2. Y (YELLOW): **Structural firefighting actions will be severely limited.** SFO will make decision of offensive or defensive actions based on initial size up. Personnel must exit under their own power; rescue of trapped personnel determined by fire ground conditions. Recall of off-duty firefighters and mutual aid support will be required.

3. G (GREEN): **Reasonable expectation firefighting forces will be successful** at structural firefighting actions for offensive or defensive. SFO will make decision of offensive or defensive actions based on initial size up.

4. Manpower requirements for a typical moderate-fire risk structural fire are 13 firefighters on the fire ground. (1-IC, 1-Safety Officer, 4-1st Engine Company, 3-Rescue Company, and 4-2nd Engine Company.