A Summary of How Proposed Firefighting Standards Would Impact Airports

DETAILS

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Research Results Digest 7

A SUMMARY OF HOW PROPOSED FIREFIGHTING STANDARDS WOULD IMPACT AIRPORTS

This digest presents the results of ACRP Project 11-02, Task 11, "How Proposed Firefighting Standards Would Impact Airports." The research was conducted by Richard Golaszewski and Gregson Helledy of GRA Incorporated, in association with Benedict D. Castellano and Robert E. David. The contractor's final report is available as *ACRP Web-Only Document 7* on the TRB website (www.trb.org) by searching for "ACRP Web-Only Document 7."

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BACKGROUND

Section 311 of H.R. 915 EH, *FAA Reauthorization Act of 2009* calls for more closely aligning airport rescue and fire fighting (ARFF) regulations under Title 14 Code of Federal Regulations (CFR) Part 139, Certification of Airports, with voluntary consensus standards. The airport community has noted that these requirements could impact airport costs and air service levels at airports, necessitating research on these issues. Thus, the Airport Cooperative Research Program (ACRP) commissioned this study of the potential impacts on airports from adopting new ARFF standards. This report provides technical information and analyses that can be used by others, in conjunction with information from other sources, in formulating policies, regulations, and procedures related to this issue.

The analyses in this report compare existing ARFF standards with those of two organizations that also promulgate ARFF standards: the International Civil Aviation Organization (ICAO) and the National Fire Protection Association (NFPA). These standards would have to be incorporated into revised ARFF regulations, which would likely take place under the notice and comment provisions that apply to agency rulemaking. This report provides information that can be used to assess the potential impacts on airports from aligning FAA regulations with these standards. The research does not examine impacts of extending ARFF regulations to airports that are not currently required to hold Part 139 certificates.

The analyses include a review of 11 years of aircraft accident data covering the types of operations governed by Part 139. This research examined whether revised ARFF standards would have made a difference in the number of fatalities in these accidents. In addition, a number of Part 139 airports were interviewed to assess the impacts of revised ARFF standards on airport costs.

There are 562 airports certified under Part 139 in the United States (as of February 9, 2009). Figure 1 shows the classes FAA uses to define airports based on the seating capacity and nature of service. This study reports on the incremental costs of adopting ICAO and/or NFPA standards over the current levels of ARFF provided at the 476 airports certified Class I, II and III Part 139 airports. Class IV airports were excluded because they only have occasional

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Airport Class	Scheduled Passenger Operations	Non-Scheduled Passenger Operations	Numbers of Airports
I	10 or more	31 or more	377
II	10 or more but less than 31	31 or more	57
III	10 or more but less than 31	Less than 30	42
IV	N/A	31 or more	86

Figure 1 Numbers of airports by class.

operations by unscheduled air carriers using aircraft with 31 or more passenger seats.

COMPARISON OF PART 139 WITH ICAO AND NFPA STANDARDS

Under the statutory provisions of Title 49, United States Code 44706, the FAA is authorized to certificate airports receiving scheduled air carrier service with aircraft having more than 9 passenger seats and unscheduled air carrier service with aircraft having more than 30 passenger seats. 14 CFR Part 139 is the regulation that sets forth the requirements for airport certification. It is not applicable to heliports or to airports that (1) are served by large all-cargo aircraft only, (2) are in Alaska and are served by air carrier aircraft with less than 31 passenger seats, or (3) do not have air carrier service that uses aircraft with more than 9 passenger seats.

ICAO Annex 14, paragraph 1.2.2 states: "The specifications, unless otherwise indicated in a particular context, shall apply to all aerodromes open to public use in accordance with the requirements of Article 15 of the (Chicago) Convention." However, Annex 14 standards apply to countries and are only applicable to airport operators if their country adopts the Annex 14 standard. In addition to standards, ICAO also provides recommendations. Countries may adopt or not adopt ICAO standards and recommendations.

NFPA standards are written for airports of all sizes that have all-cargo and general aviation operations, as well as air carrier passenger operations. NFPA standards apply to airport operators if the state where the airport is located or the airport operator has adopted those standards. NFPA 403, Standard for Aircraft Rescue and Fire-Fighting Services at Airports (2009 Edition), is the principal standard governing ARFF, although there are a number of other NFPA standards that affect airports and airport operations.

The FAA and the NFPA have worked together to adopt common standards whenever possible; however, there are areas where the FAA and NFPA differ significantly. One example is the requirement in Part 139, which deals with aircraft rescue and firefighting, and NFPA 403. Section 139.319 (h) requires an airport operator to show that its aircraft rescue and fire fighting vehicles can respond to the midpoint of the farthest air carrier runway in 3 min for the first vehicle and 4 min for all other required vehicles. NFPA requires the first vehicle to reach any point on the operational runway in 2 min or less (NFPA 403, paragraph 9.1.3 [2009 Edition]).

ICAO also has a response time standard, which requires airports to demonstrate that the first ARFF vehicle can reach anywhere on the runway within 3 min.

Response time limits are very important in determining the numbers and locations of fire stations required at an airport and therefore the required numbers of ARFF vehicles and staffing.

In addition to ARFF response times and locations from which these apply, FAA, ICAO, and NFPA also have standards for the minimum numbers of ARFF vehicles and rules for determining the required numbers of staff. As shown in Figure 2, these are affected by the sizes of aircraft typically serving the airport, and each entity has a classification system for the levels of ARFF required. (While FAA uses classes to define the types of aircraft in terms of seating capacity and type of service, it uses an "index" to further subdivide the ARFF categories, based on the physical dimensions of the aircraft.)

Figure 3 shows the minimum numbers of ARFF vehicles required under FAA Part 139, ICAO, and NFPA standards. As can be seen, these are broadly comparable, but response time standards generally require that an airport certified under Part 139 will have to add vehicles and fire stations to meet NFPA and ICAO standards.

FAA Airport Index	Aircraft Length	ICAO Airport Category	Aircraft Length Up To But Not Including	Width Up To But Not Including	NFPA Airport Category	Aircraft Length Up To But Not Including	Width Up To But Not Including	Sample Aircraft
A	<90’	4	78’ 24m	13.1’ 4m	4	78’	13.0’	EMB120
A	<90’	5	91’ 28m	13.1’ 4m	5	90’	13.0’	CRJ-200, Saab 340
B	90’ <126’	6	127’ 39m	16.4’ 5m	6	126’	16.4’	DC-9, A320
C	126’ <159’	7	160’ 49m	16.4’ 5m	7	160’	16.4’	B-757-200, B-767-200ER
D	159’ <200’	8	200’ 61m	22.9’ 7m	8	200’	23.0’	A300, B-757-300
E	>200’	9	249’ 76m	22.9’ 7m	9	250’	23.0’	A340-600, B-777
E	>200’	10	295’ 90m	26.2’ 8m	10	295’	25.0’	AN-225, A380

Figure 2 FAA ARFF Index comparison to ICAO and NFPA.

NFPA also has minimum staffing requirements based on the class of airport. FAA and ICAO do not use a minimum number of firefighters but require that a “sufficient number” of trained personnel be present, which in turn is determined by the number of fire stations and vehicles required to meet response time standards. Figure 4 shows an alignment of the FAA, ICAO, and NFPA airport categories along with the staffing required by NFPA.

SAFETY ANALYSIS

Fatal air carrier accidents over an 11-year period (from January 1, 1997, to December 31, 2007) were reviewed to determine if revised ARFF standards would have made a difference in the number of fatalities. The review included all fatal accidents in the United States for Part 121 scheduled or non-scheduled operations and Part 135 scheduled air taxi or commuter operations. There were 23 Part 121 accidents and 13 scheduled Part 135 accidents that occurred during the review period. The most recent reviewed accident occurred on July 10, 2007.

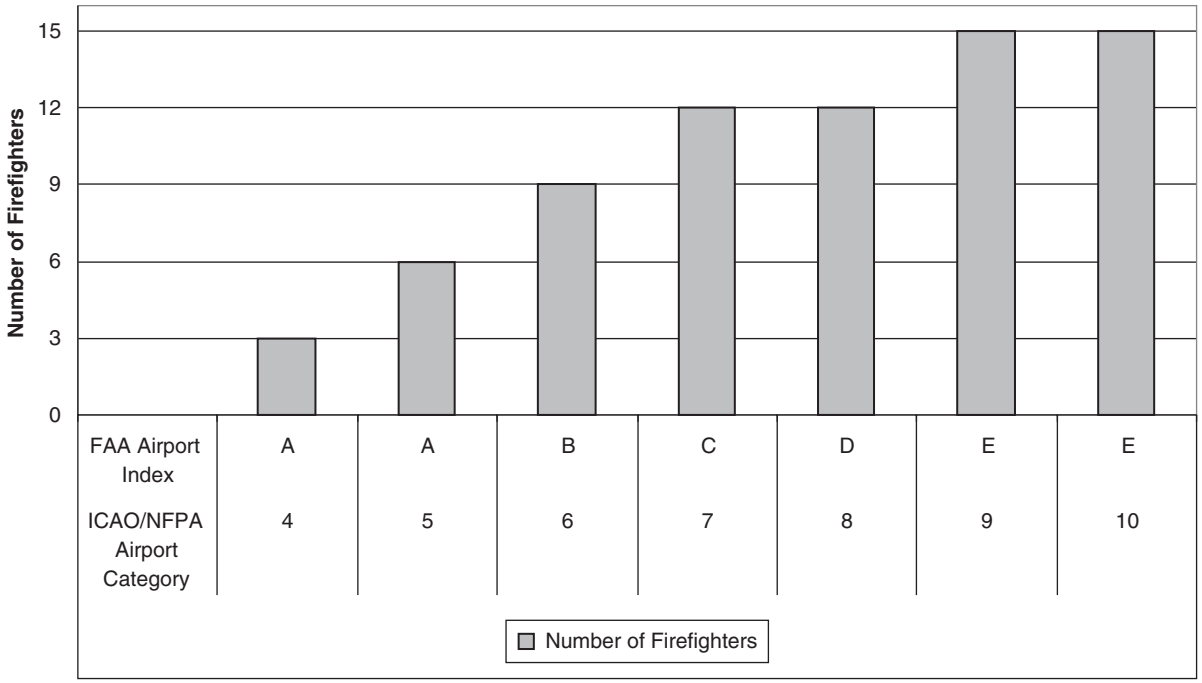
Part 121 Accidents

Of the 23 Part 121 aircraft accidents, 11 occurred far from airport property, according to the National Transportation Safety Board (NTSB) reports. As such, these accidents were not considered to be relevant from an ARFF perspective. Of the remaining 12 Part 121 aircraft accidents, 9 were not considered to be relevant to an ARFF response even though they occurred on airport property. These included seven accidents involving fatalities to ground personnel, such as someone walking into a propeller, someone getting sucked into a jet engine, or a collision between ground equipment and parked aircraft.

The three remaining Part 121 accidents required a review of pertinent sections of the full NTSB report

ICAO/NFPA Airport Category	FAA Airport Index	Vehicles			Example Aircraft
		ICAO	FAA	NFPA	
4	A	1	1	1	DHC-8-100
5	A	1	1	2	ATR-72
6	B	2	1–2	2	B-737-300, Emb-145
7	C	2	2–3	3	B-757
8	D	3	3	3	A300, B-767-300
9	E	3	3	4	B-747-200, A340-400
10	E	3		4	AN-225, A380

Figure 3 Minimum number of ARFF vehicles required.



Note: FAA and ICAO do not have an explicit minimum staffing requirement.

Figure 4 NFPA 403 minimum number of firefighters per shift.

to determine if different ARFF standards might have had any impact on the outcome in terms of reducing the severity of injuries or in preventing deaths:

- **Little Rock, Arkansas, June 1, 1999**—An MD-80 aircraft carrying 139 passengers and a crew of six overran Runway 4R while landing during a rainstorm. In its analysis, the NTSB determined that the accident was potentially survivable for two of the passengers that died; but that, even with a shorter ARFF response time, the lives of these two passengers would not have been saved if emergency responders had arrived on the scene earlier. In one case, the passenger would have had to evacuate the aircraft immediately and, in the second case, the ARFF response team would have had to enter the aircraft instead of first suppressing the fire.
- **Charlotte, North Carolina, January 8, 2003**—A Beech 1900 crashed into a maintenance hangar shortly after takeoff from Runway 18R at Charlotte-Douglas International Airport. The aircraft was destroyed by impact and post-crash fire. It was determined that all 21 people on board the aircraft died from "multiple blunt injuries due to an airplane crash."
- **Lexington, Kentucky, August 27, 2006**—A CRJ-100 took off on the wrong runway, ran off the end of the runway and impacted the perimeter fence, trees and terrain. The accident site was located off airport property approximately 1,800 ft from the departure end of the runway. Of the 50 people on board, only the first officer survived. There were several passengers who survived the crash but died due to smoke inhalation or thermal injuries. The NTSB found it was not possible to determine how long these passengers survived, but noted that all of the passengers were found close to their seats.

Scheduled Part 135 Accidents

In 2004, Part 139 was amended to require airports with scheduled operations by aircraft having more than nine passenger seats to be certificated. This change did not apply to airports located in the state of Alaska. Of the 13 accidents involving scheduled Part 135 operations, 10 occurred in Alaska. The site of these accidents varied from 300 yards from the airport to 49 miles from the airport.

Of the three accidents that occurred in the "lower 48," only two occurred on the airport and neither one of these airports was required to be certificated under Part 139. The autopsies from one of these two accidents (which occurred in 2000) revealed that four of the fatalities resulted from asphyxia from smoke

inhalation and/or thermal injuries. However, even with the change to Part 139 in 2004, this operation would not have been affected since the aircraft had only nine passenger seats and, therefore, the aircraft was not required to operate only at certificated airports.

Summary of Safety Analysis

In the Lexington, Kentucky, accident, the NTSB indicated that some people on board died from thermal injuries and/or smoke inhalation. However, it is not clear that the adoption of NFPA 403 standards or ICAO Annex 14 standards would have resulted in their survival. The accident site was located off airport property and outside NFPA's prescribed Rapid Response Area (RRA). Even if the NFPA standards were in effect, the survivability of this accident would not have changed because there still would have been a substantial period of time before ARFF could have reached the aircraft. In its analysis of the Little Rock accident, the NTSB found that the accident was survivable for two of the passengers; however, it also determined that an improved ARFF response time would not have resulted in these two lives being saved.

It is difficult to suggest what might happen in terms of future accidents. With the very small number of accidents in passenger air carrier operations and the multiplicity of causes and outcomes, it is not possible to reach a conclusion from past accidents about how improved ARFF response times and capabilities would reduce accident mortality. However, the review of accidents described above suggests that enhanced ARFF standards may have made a difference in the outcome for at most one individual.

COST ANALYSIS APPROACH

The potential costs of adopting ICAO or NFPA ARFF standards were assessed using an interview program with a representative group of Part 139 Class I, II, and III airports. These were selected to provide a geographic as well as a size distribution of airports. A total of 53 interviews were completed at the airports shown in Figure 5. The interviews were conducted with airport managers and/or their designees, which included staff from operations, fire chiefs, and other knowledgeable individuals.

The analysis focused on the key costs of moving to the ICAO and NFPA standards. These costs included the additional staffing, firehouses, ARFF vehicles, and other equipment needed to meet the ICAO and NFPA response time standards. The analysis also considered the minimum staffing requirements of NFPA, and the training and other costs that result from increased staffing. It also identified those costs that could not be quantified. Figure 6 shows the number of airports interviewed in each Part 139 Class/Index group. As can be seen, about 11 percent of the 476 airports were interviewed. Class IIA and IIIA airports are put into one group in the cost analysis below, which summarizes these cost impacts and expands them to the 476 Part 139 airports.

Figure 7 shows the number of firefighters and ARFF vehicles for each airport group as reported in the interviews, and provides an indication of the scale of ARFF operations at the different airport classes. In addition, the figure also shows the average number of firefighters for airports within each group. As expected, the larger airports have the largest numbers of firefighters and ARFF vehicles. These data are expanded to cover the 476 Class I, II, and III Part 139 airports. While the average airport has 26 firefighters and three vehicles, Class IA airports have 10 firefighters and two vehicles, and Class IE airports have 115 firefighters and seven vehicles.

ESTIMATED COST IMPACTS

The estimated cost impacts on airports from adoption of ICAO and/or NFPA standards were developed using information gathered during the airport interviews. While information on the full range of potential costs was gathered, the results presented below focus on the major cost categories, including the construction of new ARFF stations, the acquisition of new ARFF vehicles, and the additional firefighters that would be needed to (a) meet minimum personnel requirements and to (b) staff the additional fire stations and ARFF vehicles required to comply with response time standards. The baseline against which costs are measured is the current ARFF capability at the airport, which may exceed the minimum level required by Part 139. Figure 8 shows the changes in numbers of firefighters and ARFF vehicles under the ICAO and NFPA standards. The estimates for the runway response time requirements also include the staffing and vehicles added to meet minimum ICAO and NFPA requirements. The NFPA 2-min runway response requirement would double the number of firefighters and vehicles of the 476 airports.

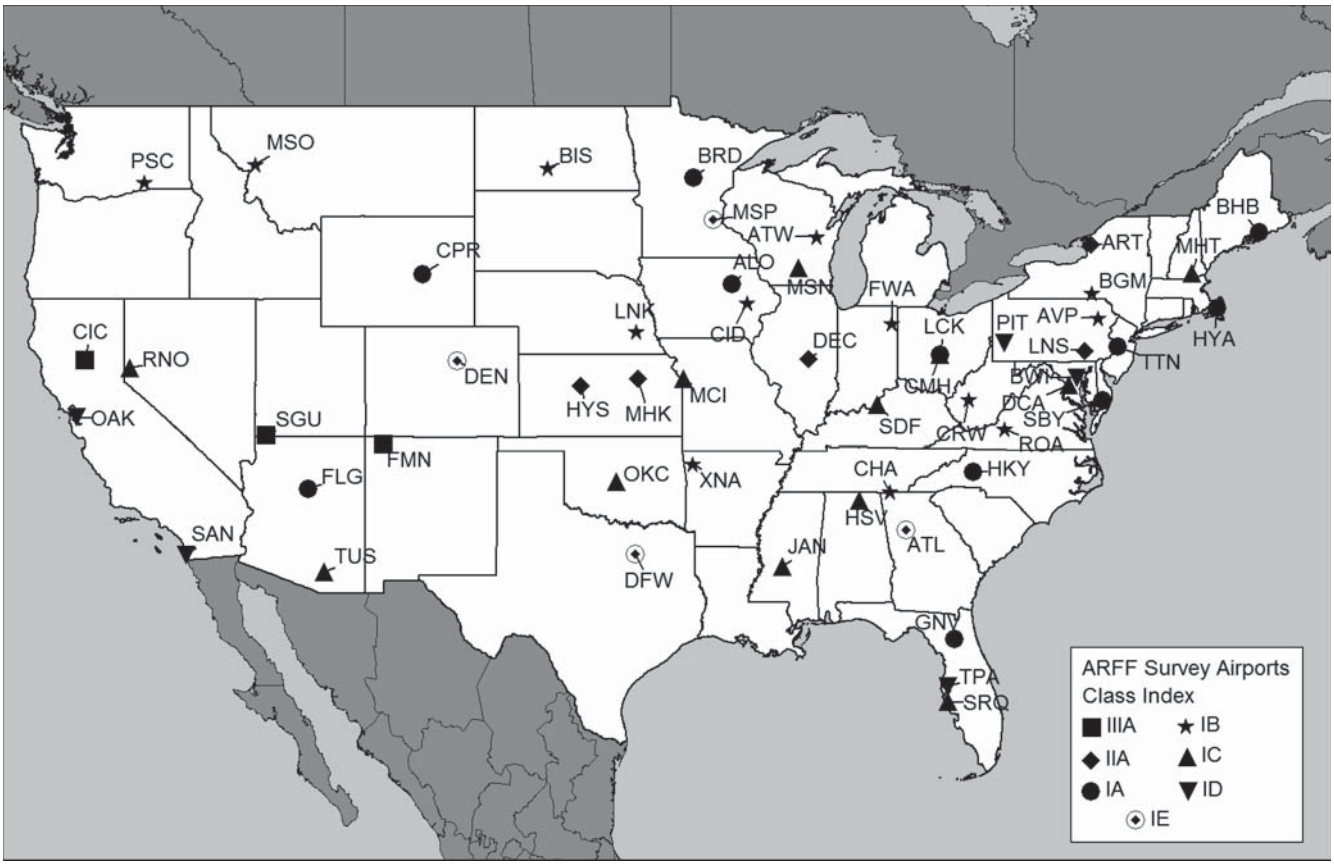


Figure 5 Airports interviewed.

Airport Class	ARFF Index	Number of Airports	Percent of Airports	Airport Interviews Completed	Percent Interviews Completed
Total		**476**	**100.0%**	**53**	**11.1%**
Class III	A	42	8.8%	3	7.1%
Class II	A	57	12.0%	5	8.8%
Class I	A	131	27.5%	11	8.4%
Class I	B	111	23.3%	13	11.7%
Class I	C	78	16.4%	12	15.4%
Class I	D	33	6.9%	5	15.2%
Class I	E	24	5.0%	4	16.7%

Figure 6 Number and percentage of airports and interviews.

Reported Firefighters and ARFF Vehicles and Estimated Total for Part 139 Airports							
Airport Class	**IIIA/IIA**	**IA**	**IB**	**IC**	**ID**	**IE**	**Total**
Number of Firefighters from Interviews	60	103	193	256	215	460	1,287
Number of Airports Responding	8	10	13	9	5	4	49
Average Number of Firefighters	8	10	15	28	43	115	26
Estimated Firefighters for 476 Airports	**743**	**1,349**	**1,648**	**2,219**	**1,419**	**2,760**	**10,137**
Number of ARFF Vehicles from Interviews	10	17	22	38	22	29	138
Number of Airports Responding	8	11	13	12	5	4	53
Average Number of ARFF Vehicles	1	2	2	3	4	7	3
Estimated ARFF Vehicles for 476 Airports	**124**	**202**	**188**	**247**	**145**	**174**	**1,080**

Figure 7 Average and total firefighters and vehicles.

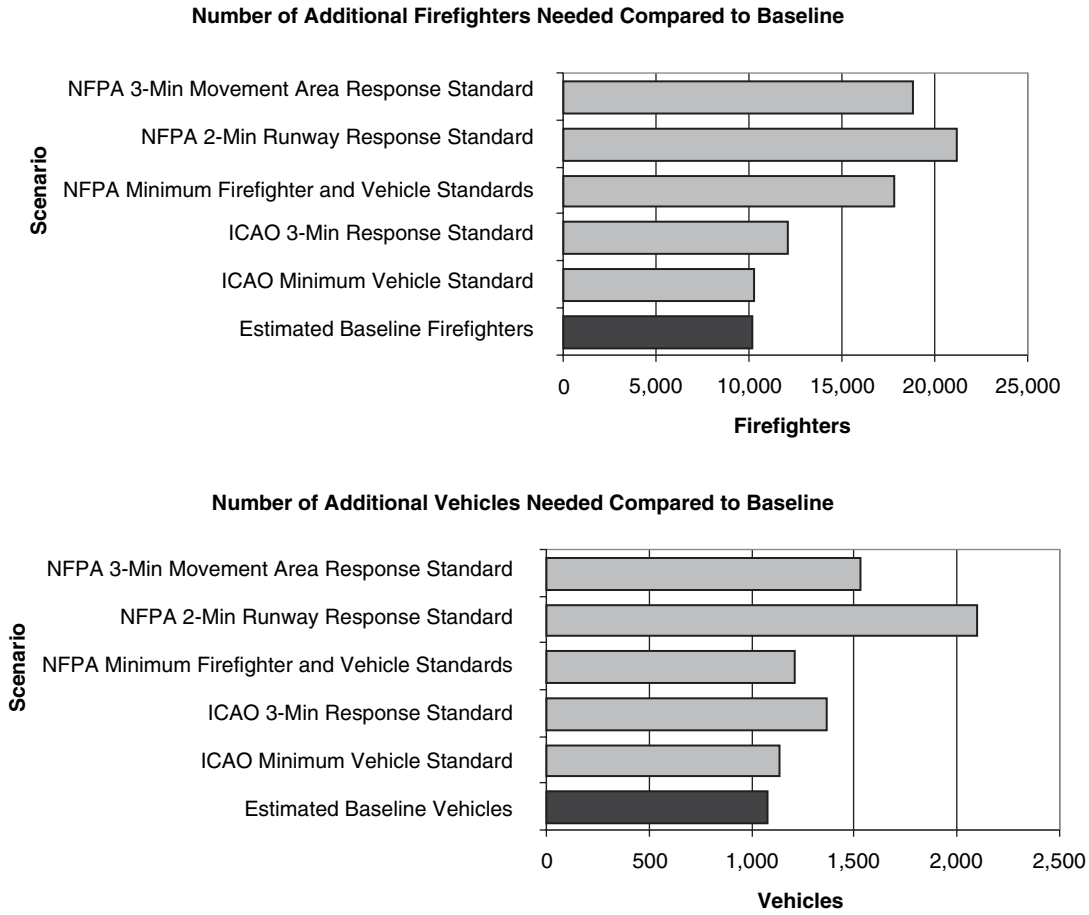


Figure 8 Summary of baseline firefighters and vehicles required to meet ICAO and NFPA standards at 476 airports.

The NFPA 2-min runway response requirement could more than double the number of firefighters and ARFF vehicles at the 476 Part 139 airports considered in this study.

Figure 9 summarizes the cost impacts of the ICAO and NFPA standards, reporting the increase in total and average costs per airport for each class. As can be seen, NFPA standards have a higher total cost and average cost per airport than ICAO standards. The 2-min demonstrated response time to the runway end has the higher costs of the two NFPA response standards, with an annualized cost of approximately $1.03 billion. The ICAO minimum vehicle requirements have a relatively small impact and affect only Class IB airports, while the estimated costs of the NFPA minimum vehicle and staffing requirements are much larger and affect all airport groups. In general, the average cost per airport is higher for those groups with a larger baseline ARFF presence. Firefighter salaries represent the largest annual cost impact.

The annual recurring costs of the NFPA 2-min response standard are estimated to total $1.0 billion, the majority of which is the salaries for additional firefighters. This includes meeting the NFPA minimum vehicle and firefighter requirements.

Data on operating and annualized investment costs were developed for each airport using financial data reported by airports to FAA. This was used to calculate the cost per enplaned passenger for each airport group. Figure 10 shows the current cost per enplaned passenger for each airport group and the increase in costs in both absolute and percentage terms for both the minimum vehicles requirement and the 3-min runway response standard. As noted

Summary of Annual Cost Impacts of ICAO and NFPA Standards ($ millions)					
Total Annual Operating and Depreciation Costs					
Airport Class	**ICAO**		**NFPA**		
	Vehicle Minimum	3-Min	Staff/Vehicle Minimum	2-Min	3-Min
IIIA/IIA	$0.0	$14.0	$21.6	$40.8	$15.7
IA	$0.0	$9.4	$116.4	$148.9	$132.9
IB	$16.5	$57.8	$216.0	$260.8	$232.2
IC	$0.0	$69.3	$150.2	$296.3	$198.6
ID	$0.0	$25.6	$46.5	$95.5	$49.2
IE	$0.0	$56.7	$17.6	$191.6	$119.3
All	**$16.5**	**$232.8**	**$568.3**	**$1,033.9**	**$747.8**
Average Annual Operating and Depreciation Costs					
Airport Class	**ICAO**		**NFPA**		
	Vehicle Minimum	3-Min	Staff/Vehicle Minimum	2-Min	3-Min
IIIA/IIA	$0.0	$0.1	$0.2	$0.4	$0.2
IA	$0.0	$0.1	$0.9	$1.1	$1.0
IB	$0.1	$0.5	$1.9	$2.3	$2.1
IC	$0.0	$0.9	$1.9	$3.8	$2.5
ID	$0.0	$0.8	$1.4	$2.9	$1.5
IE	$0.0	$2.4	$0.7	$8.0	$5.0
All	**$0.0**	**$0.5**	**$1.2**	**$2.2**	**$1.6**

Note: The costs of minimum vehicle and staff requirements are included in the response time estimates.

Figure 9 Summary cost impacts.

above, the ICAO minimum vehicles requirement only affects Class IB airports, which would face a 1.5 percent increase in costs per enplaned passenger. The requirement to demonstrate a 3-min response to the farthest runway end would increase the cost per enplaned passenger for all airport groups. The amount of the increase ($8.83) and the percentage increase (13 percent) is largest at Class IIA and IIIA airports.

Figure 11 shows the change in costs per enplaned passenger from the NFPA standards. The NFPA minimum staffing and vehicle requirements would result in an increase in costs per enplaned passenger of approximately 20 percent at Class IA, IB, IIA, and IIIA airports. The airport is required to demonstrate that the first vehicle can reach the farthest runway end within 2 min during good visibility and surface conditions. The impacts of this 2-min response time combined with the minimum staffing and vehicles requirements would result in a 40 percent cost increase at Class IIA and IIIA airports, and an increase of over 20 percent at Class IA and IB airports. The estimated cost differences per enplaned passenger for the NFPA 3-min response time standards for the taxiways, ramp and apron are lower than for the 2-min standard at Class ID and IE airports. The percentage changes for the 3-min standard are approximately the same as for the 2-min standard at Class IA, IB, and IC airports. However, the cost differences at Class IIA and IIIA

Annual Cost per Enplaned Passenger						
Class/Index	**ICAO Vehicle Minimum**			**ICAO 3-Min**		
	Current	**Increase**	**Percent Increase**	**Current**	**Increase**	**Percent Increase**
IIIA/IIA	$68.24	$0.00	0.0%	$69.74	$8.87	13.0%
IA	$88.73	$0.00	0.0%	$88.73	$1.66	1.9%
IB	$35.55	$0.52	1.5%	$34.48	$1.81	5.1%
IC	$26.38	$0.00	0.0%	$26.38	$0.34	1.3%
ID	$24.07	$0.00	0.0%	$25.99	$0.10	0.4%
IE	$19.15	$0.00	0.0%	$19.15	$0.08	0.4%

Note: The current cost by group can differ based on the number of airports responding.

Figure 10 Cost per enplaned passenger under ICAO standards.

Annual Cost per Enplaned Passenger									
Class/Index	NFPA Staff/Vehicle Minimum			NFPA 2-Min			NFPA 3-Min		
	Current	Increase	Percent Increase	Current	Increase	Percent Increase	Current	Increase	Percent Increase
IIIA/IIA	$68.24	$13.67	20.0%	$69.74	$27.72	39.7%	$69.74	$10.64	15.2%
IA	$88.73	$20.58	23.2%	$88.73	$26.33	29.7%	$88.73	$23.49	26.5%
IB	$35.55	$6.77	19.1%	$34.48	$7.89	22.9%	$35.55	$7.28	20.5%
IC	$26.38	$0.73	2.8%	$26.38	$1.44	5.4%	$26.38	$0.96	3.6%
ID	$24.07	$0.17	0.7%	$25.99	$0.37	1.4%	$25.99	$0.19	0.7%
IE	$19.15	$0.03	0.1%	$19.15	$0.28	1.5%	$19.15	$0.18	0.9%

Note: The current cost by group can differ based on the number of airports responding.

Figure 11 Cost per enplaned passenger under NFPA standards.

airports, where the costs of the 3-min standard are less than the costs for the minimum staffing and vehicles, are due to a change in the number of airports responding.

> The cost increases for smaller airports can be significant. As an example, the minimum ARFF vehicle and firefighter requirements are estimated to raise the cost per enplaned passenger by over $10.00 at Class I, II, and III A airports.

It was not possible to estimate all costs; the most significant of these is the requirement to make the entire RRA accessible to ARFF vehicles within 2 and ½ min. Although the airport may own the land beyond the FAA-required runway safety area (RSA), it is often a major undertaking to make this area accessible to ARFF vehicles. This could entail the construction of access roads, moving fences, major earth moving and fill, and other improvements. In addition, even after these areas were made accessible, the airport still may have to relocate existing ARFF stations or build new ones to meet the 2 and ½-min response times in the RRA recommended by NFPA.

SUMMARY

Figure 12 summarizes the estimated investment cost impacts for additional fire stations and vehicles, and the annual operating and depreciation cost impacts of the ICAO and NFPA standards for the 476 Class I, II, and III airports. While the minimum vehicle (ICAO and NFPA) and firefighter standards would have relatively low initial costs, the annual operating and depreciation costs of the NFPA minimum vehicle and firefighter standard are $568.3 million. The ICAO 3-min runway response has initial costs of $884.5 million and recurring costs (primarily for additional firefighters) of $232.8 million (including the annualized initial costs). The NFPA 2-min runway response standard has the highest costs, with initial costs of $2.9 billion and annual operating and depreciation costs of $1.0 billion. The NFPA 3-min response to taxiways, ramps and aprons (maneuvering area) has initial costs of $1.2 billion and annual operating and maintenance costs of $747.8 million.

Standard	Total Initial Costs	Annual Operating and Depreciation Costs
ICAO Minimum Vehicles	$36.3	$16.5
ICAO 3-Min Runway Response	$884.5	$232.8
NFPA Minimum Firefighters and Vehicles	$143.5	$568.3
NFPA 2-Min Runway Response	$2,858.1	$1,033.9
NFPA 3-Min Maneuvering Area Response	$1,220.2	$747.8

Note: Response standard estimates include meeting minimum standards for vehicles and firefighters, as appropriate.

Figure 12 Summary cost impacts of ICAO and NFPA standards at 476 airports ($ millions).

- The NFPA 2-min runway response requirement is estimated to increase airport investment costs for constructing and equipping fire stations and acquiring ARFF vehicles by $2.9 billion.
- The NFPA 3-min response to anywhere on the airport maneuvering area has estimated investment costs of $1.2 billion and annual recurring costs of $747.8 million.
- The ICAO 3-min response standard has estimated investment costs of $884.5 million and annual recurring costs of $232.8 million.

In summary, it must be noted that the cost estimates contained in the report are based on the stated differences in the FAA, ICAO, and NFPA standards. The actual increase in ARFF costs experienced by any airport would be based on the specific changes to Part 139, because FAA has the latitude to adopt all, some, or none of the other industry standards. In addition, these changes would be subject to the normal requirements of agency rule making.

ATTACHMENT

Appendix D: Cost Factors

This attachment is Appendix D of the contractor's final report.

Firefighter salaries are an ongoing cost of increasing ARFF standards, and represent the largest type of cost in the scenarios examined. Costs are based on salary and benefit figures provided by the interviewed airports. Figure D-1 shows that the NFPA 2-min scenario has the highest salary costs, followed by the NFPA 3-min scenario.

Employee turnover costs represent the initial training and equipment expense for new firefighters, to replace those who leave. Firefighters brought on to meet ICAO/NFPA requirements are assumed to be replaced at 20 percent per year. This

Firefighter Salaries								
$ Millions	Type of Station	IIIA/IIA	IA	IB	IC	ID	IE	Total
ICAO 3-Min Runway Response Time Demonstration	Full*	$7.2	$6.1	$41.2	$44.4	$47.7	$111.6	$258.2
	Sat†	$7.2	$6.1	$41.2	$44.4	$19.1	$44.7	$162.6
ICAO Minimum Staff/Vehicles Requirement‡		$0.0	$0.0	$12.4	$0.0	$0.0	$0.0	$12.4

Firefighter Salaries								
$ Millions	Type of Station	IIIA/IIA	IA	IB	IC	ID	IE	Total
NFPA 2-Min Runway Response Time Demonstration	Full	$28.6	$126.0	$207.6	$201.3	$166.6	$365.4	$1,095.5
	Sat	$28.6	$126.0	$207.6	$201.3	$66.6	$146.2	$776.3
NFPA 3-Min Movement Area Demonstration	Full	$13.2	$123.0	$207.4	$162.6	$86.4	$223.4	$816.0
	Sat	$13.2	$123.0	$207.4	$162.6	$39.8	$89.3	$635.4
NFPA Minimum Staff/Vehicles Requirement		$20.9	$111.3	$205.5	$145.1	$45.7	$17.2	$545.7

*Full assumes that additional stations are "full," standalone stations.

†Sat assumes that additional stations at Index D and Index E airports are smaller "satellite" stations.

‡ICAO does not have a minimum staffing requirement, but additional vehicles require additional staff at some airports.

Figure D-1 Annual firefighter salary costs.

means that annual turnover costs are one-fifth of initial training and equipment costs. Figure D-2 shows that these costs are highest at Index E and Index B airports, and are highest for the NFPA 2-min scenario.

Firefighting vehicles added to meet ICAO/NFPA requirements are depreciated over a period of 15 years, with a 10 percent residual value. This means that the annualized investment cost is 6 percent of the initial vehicle cost. Figure D-3 shows that depreciation is largest at Index E and Index C airports, and is larger for the NFPA 2-min scenario than for the other scenarios.

Fuel and maintenance costs represent the operating costs of firefighting vehicles added to meet ICAO/NFPA requirements. These costs are assumed to equal 5 percent of the initial cost of the vehicle. Figure D-4 shows that these costs are highest at Index E and Index C airports, and are higher for the NFPA 2-min scenario than for the other scenarios.

Fire stations added to meet ICAO/NFPA requirements are depreciated over a period of 30 years. Annualized investment costs are therefore 1/30, or 3.33%, of the initial construction cost. Figure D-5 shows that depreciation is largest at Index E and Index C airports, and is larger for the NFPA 2-min scenario than for the other scenarios.

Additional fire stations incur costs for utilities and maintenance. These are assumed to equal 5 percent of the initial construction costs each year. *Additional* fire stations, those which represent an increase in the number of fire stations on the airport, produce increased utility and maintenance costs. *Relocated* fire stations, which are newly built replacements of previous fire stations to improve response times, do not produce increased utility and maintenance costs. Therefore, the costs shown in Figure D-6 do not correlate directly with station construction costs shown in the body of the report. Utility and maintenance costs are highest for Index E and Index C airports, and for the NFPA 2-min scenario.

Annual operating and investment cost represents the total annualized cost of the scenarios examined and is shown in Figure D-7. As such, it is the sum of costs in Figures D-1 through D-6. Index B, Index C, and Index E airports have the highest total cost levels,

Annual Employee Turnover Costs								
$ Millions	Type of Station	IIIA/IIA	IA	IB	IC	ID	IE	Total
ICAO 3-Min Runway Response Time Demonstration	Full*	$0.2	$0.2	$1.2	$1.1	$1.0	$2.1	$5.8
	Sat†	$0.2	$0.2	$1.2	$1.1	$0.4	$0.8	$3.9
ICAO Minimum Staff/Vehicles Requirement‡		$0.0	$0.0	$0.3	$0.0	$0.0	$0.0	$0.3

Annual Employee Turnover Costs								
$ Millions	Type of Station	IIIA/IIA	IA	IB	IC	ID	IE	Total
NFPA 2-Min Runway Response Time Demonstration	Full	$1.0	$3.8	$6.5	$5.6	$4.5	$8.4	$29.9
	Sat	$1.0	$3.8	$6.5	$5.6	$1.8	$3.4	$22.1
NFPA 3-Min Movement Area Demonstration	Full	$0.6	$3.7	$6.2	$4.3	$1.4	$4.8	$21.0
	Sat	$0.6	$3.7	$6.2	$4.3	$0.7	$1.9	$17.4
NFPA Minimum Staff/Vehicles Requirement		$0.7	$3.4	$6.1	$3.9	$0.7	$0.4	$15.3

*Full assumes that additional stations are "full," standalone stations.

†Sat assumes that additional stations at Index D and Index E airports are smaller "satellite" stations.

‡ICAO does not have a minimum staffing requirement, but additional vehicles require additional staff at some airports.

Figure D-2 Annual employee turnover costs.

depending on the scenario. The NFPA 2-min scenario has the highest level of cost overall.

UNPUBLISHED MATERIAL

Appendixes A, B, C, and E

Appendixes A, B, C, and E as submitted by the contractor are not published herein. These appendixes can be found on the TRB website along with the online version of the contractor's report (published as *ACRP Web-Only Document 7*). Their titles are as follows:

Appendix A: Part 139 Certification Status Table
Appendix B: Aircraft Length and Width
Appendix C: Interview Guide Response Form
Appendix E: Analytic Methodology

Annual Investment Cost for Additional Vehicles								
$ Millions	**Type of Station**	**IIIA/IIA**	**IA**	**IB**	**IC**	**ID**	**IE**	**Total**
ICAO 3-Min Runway Response Time Demonstration	Full*	$0.4	$0.2	$3.8	$3.7	$3.2	$5.8	$17.1
	Sat†	$0.4	$0.2	$3.8	$3.7	$1.3	$2.3	$11.7
ICAO Minimum Staff/Vehicles Requirement‡		$0.0	$0.0	$2.1	$0.0	$0.0	$0.0	$2.1

Annual Investment Cost for Additional Vehicles								
$ Millions	**Type of Station**	**IIIA/IIA**	**IA**	**IB**	**IC**	**ID**	**IE**	**Total**
NFPA 2-Min Runway Response Time Demonstration	Full	$0.7	$1.8	$9.0	$16.8	$13.9	$21.6	$63.8
	Sat	$0.7	$1.8	$9.0	$16.8	$5.5	$8.6	$42.5
NFPA 3-Min Movement Area Demonstration	Full	$0.0	$1.2	$4.1	$5.9	$4.0	$14.4	$29.6
	Sat	$0.0	$1.2	$4.1	$5.9	$1.6	$5.8	$18.6
NFPA Minimum Staff/Vehicles Requirement		$0.0	$1.0	$2.4	$0.6	$0.0	$0.0	$4.0

*Full assumes that additional stations are "full," standalone stations.

†Sat assumes that additional stations at Index D and Index E airports are smaller "satellite" stations.

‡ICAO does not have a minimum staffing requirement, but additional vehicles require additional staff at some airports.

Figure D-3 Annual investment cost for additional vehicles ($ millions).

Annual Fuel and Maintenance Costs for Additional Vehicles								
$ Millions	**Type of Station**	**IIIA/IIA**	**IA**	**IB**	**IC**	**ID**	**IE**	**Total**
ICAO 3-Min Runway Response Time Demonstration	Full*	$0.3	$0.2	$3.2	$3.1	$2.6	$4.8	$14.2
	Sat†	$0.3	$0.2	$3.2	$3.1	$1.1	$1.9	$9.8
ICAO Minimum Staff/Vehicles Requirement‡		$0.0	$0.0	$1.7	$0.0	$0.0	$0.0	$1.7

Annual Fuel and Maintenance Costs for Additional Vehicles								
$ Millions	**Type of Station**	**IIIA/IIA**	**IA**	**IB**	**IC**	**ID**	**IE**	**Total**
NFPA 2-Min Runway Response Time Demonstration	Full	$0.6	$1.5	$7.5	$14.0	$11.6	$18.0	$53.1
	Sat	$0.6	$1.5	$7.5	$14.0	$4.6	$7.2	$35.4
NFPA 3-Min Movement Area Demonstration	Full	$0.0	$1.0	$3.5	$4.9	$3.3	$12.0	$24.7
	Sat	$0.0	$1.0	$3.5	$4.9	$1.3	$4.8	$15.5
NFPA Minimum Staff/Vehicles Requirement		$0.0	$0.8	$2.0	$0.5	$0.0	$0.0	$3.4

*Full assumes that additional stations are “full,” standalone stations.

†Sat assumes that additional stations at Index D and Index E airports are smaller “satellite” stations.

‡ICAO does not have a minimum staffing requirement, but additional vehicles require additional staff at some airports.

Figure D-4 Annual fuel and maintenance costs for additional vehicles ($ millions).

Annual Investment Cost for Additional Fire Stations								
$ Millions	**Type of Station**	**IIIA/IIA**	**IA**	**IB**	**IC**	**ID**	**IE**	**Total**
ICAO 3-Min Runway Response Time Demonstration	Full*	$3.3	$1.6	$4.0	$9.1	$4.0	$9.6	$31.5
	Sat†	$3.3	$1.6	$4.0	$9.1	$1.5	$2.8	$22.3
ICAO Minimum Staff/Vehicles Requirement‡		$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Annual Investment Cost for Additional Fire Stations								
$ Millions	**Type of Station**	**IIIA/IIA**	**IA**	**IB**	**IC**	**ID**	**IE**	**Total**
NFPA 2-Min Runway Response Time Demonstration	Full	$5.7	$8.7	$12.9	$23.4	$17.3	$36.0	$104.1
	Sat	$5.7	$8.7	$12.9	$23.4	$6.7	$10.5	$68.0
NFPA 3-Min Movement Area Demonstration	Full	$1.9	$1.6	$5.0	$9.1	$7.4	$24.0	$49.0
	Sat	$1.9	$1.6	$5.0	$9.1	$2.9	$7.0	$27.4
NFPA Minimum Staff/Vehicles Requirement		$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

*Full assumes that additional stations are “full,” standalone stations.

†Sat assumes that additional stations at Index D and Index E airports are smaller “satellite” stations.

‡ICAO does not have a minimum staffing requirement, but additional vehicles require additional staff at some airports.

Figure D-5 Annual investment cost for additional fire stations ($ millions).

Annual Utility and Maintenance Costs for Additional Fire Stations								
$ Millions	**Type of Station**	**IIIA/IIA**	**IA**	**IB**	**IC**	**ID**	**IE**	**Total**
ICAO 3-Min Runway Response Time Demonstration	Full*	$2.5	$1.2	$4.5	$7.8	$5.9	$14.4	$36.3
	Sat†	$2.5	$1.2	$4.5	$7.8	$2.3	$4.2	$22.5
ICAO Minimum Staff/Vehicles Requirement‡		$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Annual Utility and Maintenance Costs for Additional Fire Stations								
$ Millions	**Type of Station**	**IIIA/IIA**	**IA**	**IB**	**IC**	**ID**	**IE**	**Total**
NFPA 2-Min Runway Response Time Demonstration	Full	$4.2	$7.1	$17.3	$35.1	$26.0	$54.0	$143.7
	Sat	$4.2	$7.1	$17.3	$35.1	$10.1	$15.8	$89.6
NFPA 3-Min Movement Area Demonstration	Full	$0.0	$2.4	$6.0	$11.7	$7.4	$36.0	$63.5
	Sat	$0.0	$2.4	$6.0	$11.7	$2.9	$10.5	$33.4
NFPA Minimum Staff/Vehicles Requirement		$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

*Full assumes that additional stations are “full,” standalone stations.

†Sat assumes that additional stations at Index D and Index E airports are smaller “satellite” stations.

‡ICAO does not have a minimum staffing requirement, but additional vehicles require additional staff at some airports.

Figure D-6 Annual utility and maintenance costs for additional fire stations ($ millions).

Annual Operating and Investment Cost								
$ Millions	**Type of Station**	**IIIA/IIA**	**IA**	**IB**	**IC**	**ID**	**IE**	**Total**
ICAO 3-Min Runway Response Time Demonstration	Full*	$14.0	$9.4	$57.8	$69.3	$64.4	$148.3	$363.1
	Sat†	$14.0	$9.4	$57.8	$69.3	$25.6	$56.7	$232.8
ICAO Minimum Staff/Vehicles Requirement‡		$0.0	$0.0	$16.5	$0.0	$0.0	$0.0	$16.5

Annual Operating and Investment Cost								
$ Millions	**Type of Station**	**IIIA/IIA**	**IA**	**IB**	**IC**	**ID**	**IE**	**Total**
NFPA 2-Min Runway Response Time Demonstration	Full	$40.8	$148.9	$260.8	$296.3	$239.8	$503.4	$1,490.1
	Sat	$40.8	$148.9	$260.8	$296.3	$95.5	$191.6	$1,033.9
NFPA 3-Min Movement Area Demonstration	Full	$15.7	$132.9	$232.2	$198.6	$109.9	$314.6	$1,003.7
	Sat	$15.7	$132.9	$232.2	$198.6	$49.2	$119.3	$747.8
NFPA Minimum Staff/Vehicles Requirement		$21.6	$116.4	$216.0	$150.2	$46.5	$17.6	$568.3

*Full assumes that additional stations are "full," standalone stations.

†Sat assumes that additional stations at Index D and Index E airports are smaller "satellite" stations.

‡ICAO does not have a minimum staffing requirement, but additional vehicles require additional staff at some airports.

Figure D-7 Annual operating and investment cost ($ millions).

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