

## APPENDIX D—FEDERAL AVIATION ADMINISTRATION WILLIAM J. HUGHES TECHNICAL CENTER FIRE TESTS

### D.1 AVTURF BURN TEST BACKGROUND.

Live fire demonstrations were conducted on the artificial turf AvTurf. AvTurf is a polypropylene artificial turf product being marketed for runway safety areas on airports. There were several safety concerns with using this artificial turf on an airfield that had to be addressed by the Federal Aviation Administration (FAA). One of the prime concerns is fire safety. The FAA had no data regarding what could happen in the event of a postcrash fire involving a fuel spill on this material.

### D.2 OBJECTIVES.

- Determine how easy the artificial turf ignites.
- Determine how rapid the fire spreads.
- Evaluate the condition of burnt material.
- Determine the intensity and temperature of the fire.
- Determine the degree of difficulty to extinguish.
- Evaluate the condition of burnt material when mixed with aqueous film forming foam (AFFF).

### D.3 TEST METHOD.

The demonstrations were conducted at the FAA William J. Hughes Technical Center Airport Rescue and Firefighting (ARFF) Research Program's Fire Test Facility. All demonstrations were conducted using one of the two, two-dimensional (2D) fire test pans shown in figure D-1. The smaller pan measured 4 by 8 ft, while the larger pan dimensions were 7 ft 4 in. by 8 ft.



FIGURE D-1. LARGE AND SMALL TEST PANS

To maintain installation consistency, for each demonstration, the artificial turf was installed by the manufacturer, per their specification. Materials for the base and ballast were selected by the manufacturer.

In each of the demonstrations, JP-8 fuel was used. Application amounts varied with each of the four demonstrations.

Fire tests were conducted using 10 and 20 gallons of JP-8 on a pool of water only to baseline fire temperatures. Additional baseline tests were conducted using 10 and 20 gallons of JP-8 on sod test beds. These were conducted to baseline the fire propagation and AFFF interaction.

#### D.3.1 DEMONSTRATION 1.

For the first demonstration, the smaller 2D pan was used. The product was installed by the manufacturer, per their specification. There was no fuel used in this demonstration. The objective was to record the degree of difficulty in igniting the artificial turf itself. Using a propane torch, the demonstration coordinator attempted to ignite the artificial turf. The degree of difficulty in igniting the material was recorded.

#### D.3.2 DEMONSTRATION 2.

This demonstration used the same installation in the smaller pan. For this demonstration, 3 gallons of fuel was poured into the upwind corner of the pan. The fuel-soaked area was measured and recorded.

Using a propane torch, the demonstration coordinator ignited the fuel. The main objective of this demonstration was the fire spread; therefore, the following data were recorded:

- The time it took for fire to propagate across the pan.
- The infrared pyrometer temperature of the fire.
- The amount of fire propagation (burnt area).
- The temperature of the artificial turf after the fire extinguished, as taken with an infrared pyrometer and a thermocouple probe.
- The condition of the burnt artificial turf.

#### D.3.3 DEMONSTRATION 3.

The third demonstration used an installed sample in the smaller pan as well. Ten gallons of fuel was evenly poured onto the entire sample. The fuel was then ignited using the propane torch. For this evaluation, the fire was allowed to self-extinguish.

The primary objective of this demonstration was to determine the condition of the burnt material. This was investigated because of concerns for the passengers that may be able to self-evacuate an

aircraft involved in a postcrash fire. A primary concern was to ensure that by installing the material on an airport, no additional hazards are introduced.

The following data were recorded during the demonstration:

- The infrared pyrometer temperature of the fire.
- The temperature of the artificial turf after the fire extinguished, as taken with an infrared pyrometer and a thermocouple probe.
- The condition of the burnt artificial turf.

#### D.3.4 DEMONSTRATION 4.

The final demonstration was conducted in the larger pan, as shown in figure D-2. The demonstration was conducted to determine if there is any change in the condition of the burnt material when AFFF is applied to the burning material. Twenty gallons of fuel was evenly poured onto the entire sample. The fuel was then ignited using the propane torch. For this evaluation, the fire was allowed to fully involve the pan before using AFFF to extinguish the fire.



FIGURE D-2. LARGE 2D PAN SAMPLE

For this evaluation the following data were recorded:

- Extinguishment time.
- Gallons of AFFF used.

- The temperature of the artificial turf after the fire extinguished, as taken with an infrared pyrometer and a thermocouple probe.
- The condition of the burnt artificial turf.

#### D.4 RESULTS.

##### D.4.1 DEMONSTRATION 1.

The objective of this demonstration was to record the degree of difficulty in igniting the artificial turf itself. Several attempts were made to ignite the artificial turf using a propane torch. When the torch flame came in contact with the artificial turf, it would melt away under the torch. The material would not support combustion on its own, as shown in figure D-3. The air temperature for the day was 48°F with 11-mph winds. Immediately after the torch was removed from the surface of the material the temperature was recorded at 300°F and dropped to 58°F within 3 minutes.



FIGURE D-3. BURNT AREA (OUTLINED IN YELLOW) FROM PROPANE TORCH

##### D.4.2 DEMONSTRATION 2.

For this demonstration, 3 gallons of fuel was poured into the pan. The fuel-soaked area measured 46 by 210 inches. The fuel was then ignited. The fire did not spread throughout the entire fuel-soaked area. The area burnt was 35 by 17 inches. Both an infrared pyrometer and a thermocouple probe were used to record the temperature of the fire area. Both units recorded a temperature of 330°F with a rapid decline. In the areas where the material was able to completely burn and self-extinguish, the remaining material was a powdery dust, as shown in figure D-4.



FIGURE D-4. FUEL-SOAKED (OUTLINED IN RED) AND BURNT AREAS (OUTLINED IN YELLOW)

#### D.4.3 DEMONSTRATION 3.

The third demonstration again used an installation in the smaller pan. Ten gallons of fuel was evenly poured onto the entire sample. The fuel was then ignited using the propane torch. For this evaluation, the fire was allowed to self-extinguish. The fire burned for 12 minutes and 30 seconds before the demonstration coordinator determined that the fire had subsided enough to call the end of the test. Figure D-5 shows the small pan fully involved in fire.



FIGURE D-5. SMALL PAN FIRE—10 GALLONS OF JP-8

In comparison, when 10 gallons of JP-8 was allowed to burn freely on a bed of water, it took 5 minutes to completely burn off the fuel. This increase in time to burn off the fuel in the artificial turf test bed was determined to be caused by the slower vaporization of the fuel from within the fuel-soaked ballast material. When 10 gallons of fuel was applied to natural grass test beds, as shown in figure D-6, the fire had little intensity and remained low to the ground. The natural grass burned for 10 minutes before the test was called. Within 5 minutes of each natural grass test, the fire was only visible at the seams of the sod used to create the test bed, as shown in figure D-7. Figures D-8 and D-9 show the temperature traces and peak temperatures of the sod and AvTurf demonstrations.



FIGURE D-6. NATURAL GRASS FIRE—10 GALLONS OF JP-8



FIGURE D-7. NATURAL GRASS FIRE—ONLY SEAMS INVOLVED

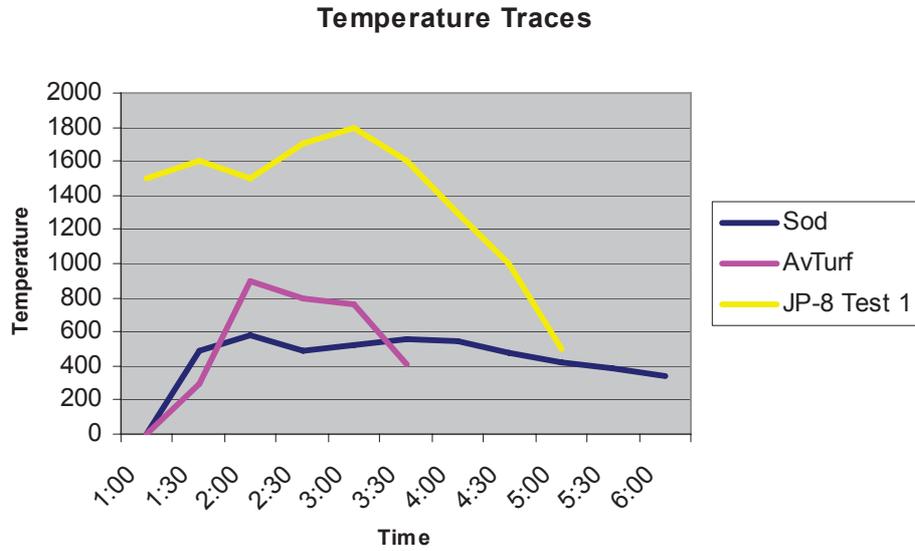


FIGURE D-8. SOD AND AVTURF TEMPERATURE TRACES

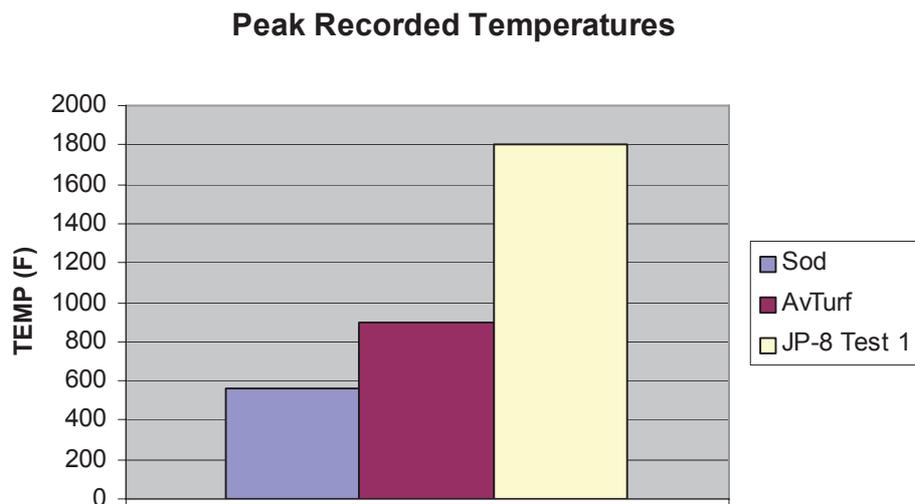


FIGURE D-9. PEAK RECORDED TEMPERATURES

The primary objective of this demonstration was to determine if the condition of the burnt material would hinder the evacuation of passengers across an area with artificial turf installed in a postcrash fire event. The infrared pyrometer recorded temperatures of up to 1000°F during the demonstration. As in the earlier demonstration, in the areas where the material was able to completely burn and self-extinguish, the remaining material was a powdery dust. This is evident in figure D-10 of the postfire inspection. With the exception of where the edges of the material came into contact with the stainless steel pan, the backing material stayed intact with no damage. In most areas, there was still a small amount of artificial turf fiber that was buried in the ballast material that remained intact. The exposed portion of the fiber was melted away but the buried material remained.



FIGURE D-10. POSTFIRE INSPECTION

Also of interest in this demonstration was the lack of fuels that permeated through the artificial turf and its backing material onto the base material. As shown in figure D-11, the artificial turf backing material had a grid of perforation holes in it for drainage. The dots on the base material are the areas where fuel seeped through the backing material. These wet spots were only on the surface of the base material and did not saturate the area.



FIGURE D-11. POSTFIRE INSPECTION OF TURF AND BASE MATERIAL

#### D.4.4 DEMONSTRATION 4.

The final demonstration was conducted to determine if there is any change in the condition of the burnt material when AFFF is applied. For this demonstration, 20 gallons of fuel was evenly poured onto the entire sample installed in the large pan. The fuel was then ignited using a propane torch. For this evaluation, the fire was allowed to become fully involved in the pan before using AFFF to extinguish the fire, as shown in figure D-12.

The fire was extinguished very rapidly by the AFFF agent with only a small amount of agent discharged. The peak temperature recorded with the infrared pyrometer during the burn was 1000°F and rapidly dropped to 130°F upon agent application.



FIGURE D-12. APPLYING AFFF

The condition of the burnt artificial turf was similar to the previous burns with the burnt artificial turf turning to a powdery substance. There were some portions of the material that did burn enough to damage the backing material of the artificial turf, as shown in figure D-13. A firefighter in protective gear walked across the test bed to determine what it would be like to evacuate across the burnt material. Even in the areas where the backing material was damaged, the traction was good. When the integrity of the artificial turf and backing material was compromised, the base material was exposed and gave a solid surface for evacuation.



FIGURE D-13. DAMAGED BACKING MATERIAL

#### D.5 CONCLUSIONS.

- The artificial turf demonstrated could not be ignited using a propane torch. The artificial turf would melt under the flame of the torch but would not continue to burn. The artificial turf was unable to support combustion on its own.
- The fire did not spread across the test beds. The only signs of fire spread were with gusts of wind, which then subsided as the wind gust diminished.
- The condition of the burnt artificial turf was the same in all demonstrations. The burnt artificial turf turned to a powdery substance. There were some portions of the material that did burn enough to damage the backing material of the artificial turf.
- Some of the initial fire, immediately after ignition, was more intense with the artificial turf beds than the natural grass. However, in most cases, that fire quickly died down to a low-level burn closer to the ground. Temperatures of the artificial turf burns were consistent with those using JP-8 alone.
- The fires involving the artificial turf were very easy to extinguish and required minimal agent application.
- There was no noticeable adverse reaction of the aqueous film forming foam solution mixing with the burnt artificial turf.

## D.6 AIR FIELDTURF BURN TEST.

A series of nine live fire demonstrations were conducted on the artificial turf Air FieldTurf. Air FieldTurf is a polyethylene artificial turf being marketed for runway safety areas on airports. There were several safety concerns with using this artificial turf on an airfield that had to be addressed by the FAA. One of the prime concerns is fire safety. The FAA had no data regarding what could happen in the event of a postcrash fire involving a fuel spill on this material.

## D.7 OBJECTIVES.

The objectives of the burn tests were to

- determine how easy the artificial turf ignites.
- determine how rapid the fire spreads.
- evaluate the condition of the burnt material.
- determine the intensity and temperature of the fire.
- determine the degree of difficulty to extinguish the fire.
- evaluate the condition of the burnt material when mixed with AFFF.

## D.8 TEST METHOD.

The demonstrations were conducted at the FAA William J. Hughes Technical Center ARFF Research Program Fire Test Facility. All demonstrations were conducted using one of the two 2D fire test pans. The smaller pan measured 4 by 8 ft, while the larger pan measured 7 ft 4 in. by 8 ft.

To maintain installation consistency, for each demonstration, the artificial turf was installed by the manufacturer, per their specification. Materials for the base and ballast were selected by the manufacturer. In each of the demonstrations, the fuel used was JP-8.

Demonstrations 1 through 5 used a 2-inch fiber material with 1 inch of sand infill. The variation between samples in the first five demonstrations was in the backing material. The demonstrations used either a permeable or nonpermeable backing material. Demonstrations 6 through 9 also used a 2-inch fiber; however, the infill materials varied. These demonstrations were conducted to compare combinations of sand versus pebble infill with permeable- and non-permeable-backed material. All samples were applied over a base material of crushed stone.

Fire tests were conducted using 10 gallons of JP-8 on a pool of water in the smaller pan to baseline fire temperatures. Additional baseline tests were conducted in the smaller pan using 10 gallons of JP-8 on sod test beds. These were conducted to baseline the fire propagation and AFFF interaction.

### D.8.1 DEMONSTRATION 1.

For the first demonstration, the smaller 2D pan was used. The product was a 2-inch-tall fiber with 1-inch infill and a permeable backing. The manufacturer, per their specification, installed the artificial turf. There was no fuel used in this demonstration. The objective was to record the

degree of difficulty in igniting the artificial turf itself. Using a propane torch, the demonstration coordinator attempted to ignite the artificial turf. The degree of difficulty in igniting the artificial turf was recorded.

#### D.8.2 DEMONSTRATION 2.

This demonstration used the same installation in the smaller pan. For this demonstration 3 gallons of fuel was poured into the pan. The fuel-soaked area was measured and recorded.

Using a propane torch, the demonstration coordinator ignited the fuel. The fire spread was the main objective of this demonstration; therefore, the following data were recorded:

- The infrared pyrometer temperature of the fire.
- The amount of fire propagation (burnt area).
- The temperature of the artificial turf after the fire extinguished, as taken with an infrared pyrometer and a thermocouple probe.
- The condition of the burnt artificial turf.

#### D.8.3 DEMONSTRATION 3.

The third demonstration was a non-permeable-backed sample installed in the large pan, as shown in figure D-14. Twenty gallons of fuel was evenly poured onto the entire sample, then ignited using a propane torch. For this evaluation, the fire was allowed to free-burn for a period of time before AFFF was applied.

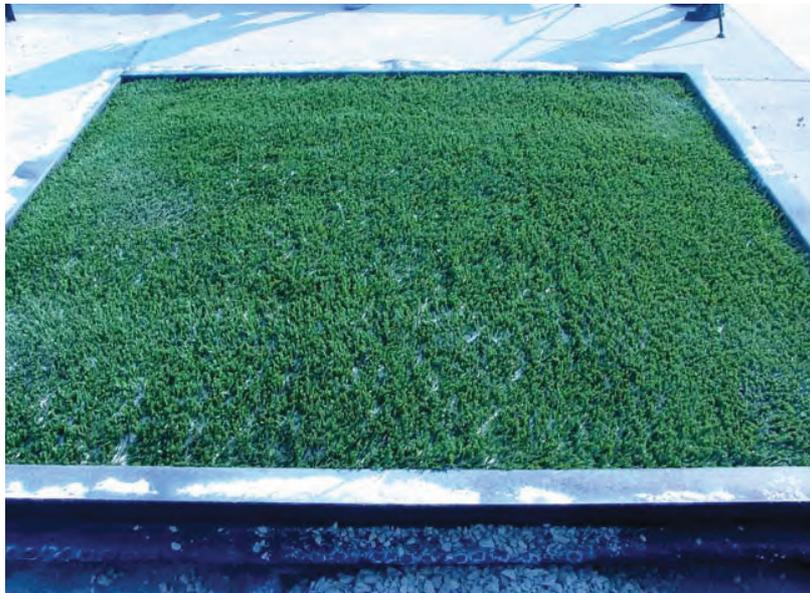


FIGURE D-14. LARGE 2D PAN SAMPLE

The primary objectives of this demonstration were to determine the difficulty in extinguishment, and the condition of the burnt material. This was investigated because of concerns for the passengers that may be able to self-evacuate an aircraft involved in a post-crash fire. A primary concern is to ensure that by installing this material on an airport, no additional hazards are introduced.

The following data were recorded during the demonstration:

- The infrared pyrometer temperature of the fire.
- The temperature of the artificial turf after the fire extinguished, as taken with an infrared pyrometer and a thermocouple probe.
- The condition of the burnt artificial turf.
- The degree of difficulty to extinguish the fire.

#### D.8.4 DEMONSTRATIONS 4 AND 5.

Demonstrations 4 and 5 were conducted in the smaller pan to evaluate the effects of the permeable and non-permeable backing of the samples. Demonstration 4 used a permeable-backed material, and demonstration 5 used a non-permeable-backed material. Ten gallons of fuel was evenly poured onto the entire sample, then ignited using a propane torch.

#### D.8.5 DEMONSTRATIONS 6 THROUGH 9.

Demonstrations 6 through 9 were conducted to compare combinations of sand versus pebble infill with permeable- and non-permeable-backed material. These demonstrations were also conducted in the smaller pan using 10 gallons of JP-8 fuel. Table D-1 shows the matrix of infill used and backing material for each sample.

TABLE D-1. INFILL MATRIX

Demonstration No.	Infill	Backing Material
6	Sand	Nonpermeable
7	Pebble	Nonpermeable
8	Pebble	Permeable
9	Sand	Permeable

### D.9 RESULTS.

#### D.9.1 DEMONSTRATION 1.

The objective was to record the degree of difficulty in igniting the artificial turf itself. Several attempts were made to ignite the artificial turf using a propane torch. The air temperature for the day was 69°F with 11-mph winds. When the torch flame came in contact with the artificial turf, it melted away under the torch. The artificial turf did not support combustion on its own, as

shown in figure D-15. Immediately after the torch was removed from the surface of the artificial turf the temperature was recorded at 200°F and dropped to 115°F 30 seconds later.



FIGURE D-15. BURNT AREA (OUTLINED IN YELLOW) FROM PROPANE TORCH

#### D.9.2 DEMONSTRATION 2.

For this demonstration, 3 gallons of fuel was poured into the pan, then ignited. The fire did not spread throughout the entire fuel-soaked area. An infrared pyrometer was used to record the temperature of the fire area, with the initial temperature being 625°F, then peaking at 768°F, and a final recorded temperature of 525°F 8 minutes into the demonstration. There was more fire spread with this demonstration than in a similar demonstration run with a different artificial turf. This was attributed to the more permeable backing material and the looser crushed stone base material, which allowed for more propagation of the fuel and increased vaporization. Figure D-16 shows the fire in the initial fuel-soaked area. Figure D-17 shows the spread of the fuel once the artificial turf was removed from the base of crushed stone. In the areas where the artificial turf was able to completely burn and self-extinguish, only a powdery dust remained, as shown in figure D-18.



FIGURE D-16. INITIAL FIRE ON FUEL-SOAKED AREA



FIGURE D-17. FUEL-SOAKED AREA (OUTLINED IN YELLOW) ON BASE MATERIAL

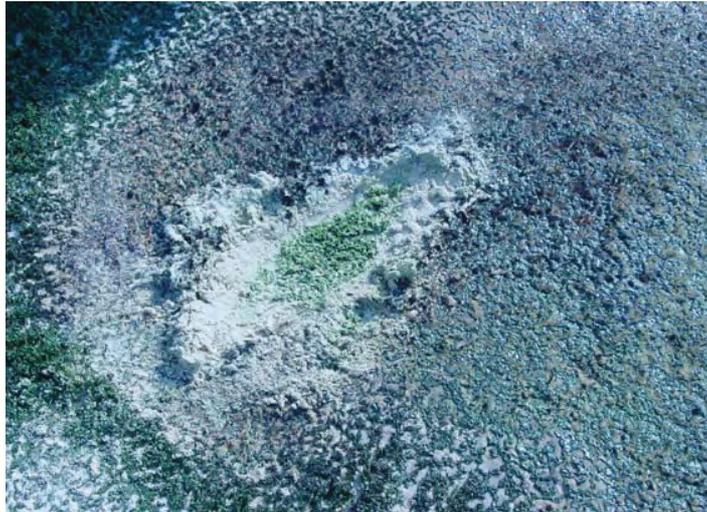


FIGURE D-18. BURNT MATERIAL

### D.9.3 DEMONSTRATION 3.

Demonstration 3 used an installation in the larger, 8- by 8-ft pan to determine if there was any change in the condition of the burnt material when AFFF was applied. For this demonstration, 20 gallons of fuel was evenly poured onto the entire sample installed in the large pan and ignited with a propane torch. For this demonstration, the fire was allowed to free-burn for approximately 4 minutes to fully involve the sample, as shown in figure D-19. At that point, AFFF was applied to extinguish the fire and evaluate the residual material. The fire was extinguished very rapidly by the AFFF agent with only a small amount of agent discharged. The peak temperature recorded with the infrared pyrometer during the burn was 1350°F, which rapidly dropped to 200°F upon agent application.



FIGURE D-19. LARGE PAN FIRE—20 GALLONS OF JP-8

Figure D-20 shows the condition of the material after extinguishment. The base material shown in figure D-21 had no fuel contamination due to this sample having a nonpermeable backing.



FIGURE D-20. CONDITION AFTER FIRE IS EXTINGUISHED



FIGURE D-21. BASE MATERIAL WITH NO FUEL CONTAMINATION

#### D.9.4 DEMONSTRATIONS 4 AND 5.

Demonstrations 4 and 5 were conducted in the smaller pan to evaluate the effects of the permeable and nonpermeable backing of the samples. Demonstration 4 used a permeable-backed material, and demonstration 5 used a non-permeable-backed material. Ten gallons of fuel was evenly poured onto the entire sample, and then ignited with a propane torch. In demonstration 4, the fire was more intense initially with a long lasting low-level, sustained fire as the fuels burned off, as shown in figures D-22 and D-23.



FIGURE D-22. INITIAL PHASE OF FIRE



FIGURE D-23. LOW-LEVEL, SUSTAINED FIRE

The low-level, sustained fire of demonstration 4 began at the 10-minute mark of the demonstration and continued until the test was called at 45 minutes. For demonstration 5, the test was called at the 9-minute mark when the fire reached the same low-level intensity as in demonstration 4 with limited fire area involved. This was a subjective decision made by the demonstration coordinator. The recorded peak temperature for demonstration 4 was 1220°F, while demonstration 5 achieved a peak temperature of 1050°F. While these peak temperatures were very close, the fire in demonstration 5 died down to the low-level, sustained fire much quicker than in demonstration 4. This can be seen in the data traces shown in figure D-24.

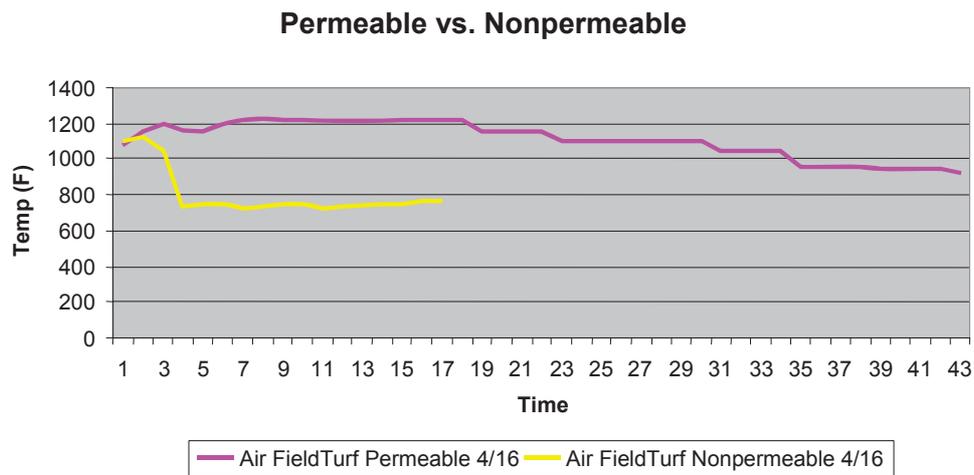


FIGURE D-24. DATA TRACES OF PERMEABLE- AND NON-PERMEABLE-BACKED SAMPLES

A key objective of this demonstration was to determine if the condition of the burnt material would hinder the evacuation of passengers across an area with artificial turf installed during a postcrash fire event. The infrared pyrometer recorded temperatures in excess of 1000°F during the demonstrations. As in demonstration 4, in the areas where the material was able to completely burn and self-extinguish, the remaining material was a powdery dust. With the exception of where the edges of the material came into contact with the stainless steel pan, the backing material stayed intact with no damage. In most areas, there was still a small amount of artificial turf fiber that was buried in the ballast material that remained intact, whereas exposed portion of the fiber was melted away.

#### D.9.5 DEMONSTRATIONS 6 THROUGH 9.

Demonstrations 6 through 9 were conducted to compare combinations of sand versus pebble infill with permeable- and non-permeable-backed material. These demonstrations were also conducted in the smaller pan using 10 gallons of JP-8 fuel. In demonstrations 6, 8, and 9, the duration of the demonstration lasted 28 minutes at which time the evaluation was called by the demonstration coordinator. These three burns had very similar characteristics. The peak recorded temperatures for these burns were between 1000° and 1100°F as shown in chart in figure D-25.

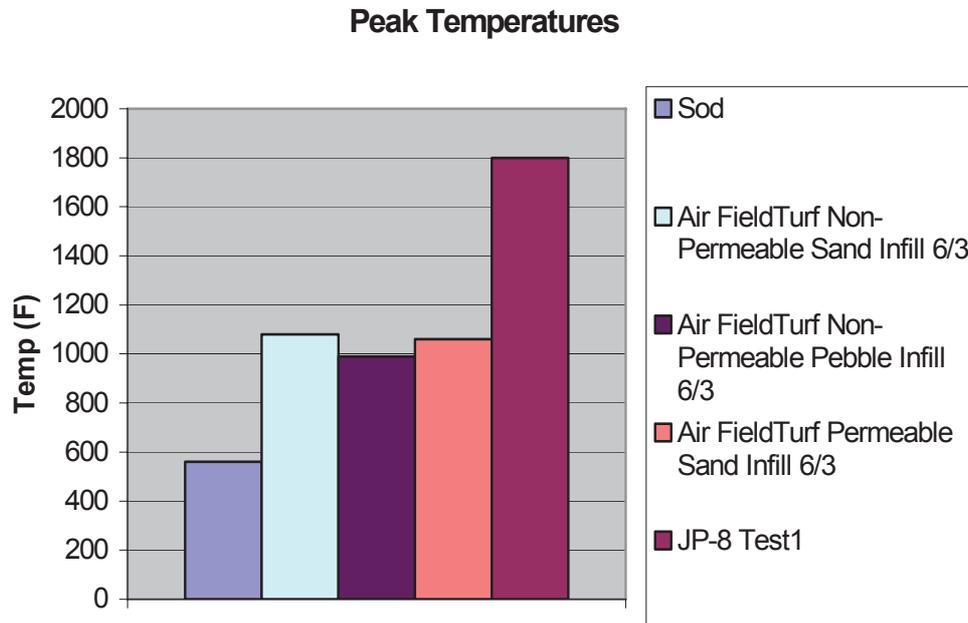


FIGURE D-25. PEAK RECORDED TEMPERATURES

Demonstration 7 appeared to be the best combination of infill and permeability. In this demonstration, the fire self-extinguished in 1 minute and 30 seconds. As could be expected, there was also much less damage to the material than in the other three in this group. Figures D-26 and D-27 show the extent of the damage to the material between the burn that lasted 1 minute and 30 seconds and the ones that were called at 28 minutes.



FIGURE D-26. DAMAGE TO MATERIAL AFTER A SHORT BURN (1:30)



FIGURE D-27. DAMAGE TO MATERIAL AFTER A LONG BURN (28:00)

For comparative purposes, 10 gallons of fuel was applied to natural grass test beds, as shown in figure D-28. The fire had little intensity and remained low to the ground. The natural grass burned for 10 minutes before the demonstration was called. Within 5 minutes of each natural grass demonstration, the fire was only visible at the seams of the sod used to create the test bed, as shown in figure D-29. To baseline temperatures and burn durations, 10 gallons of JP-8 was allowed to burn freely on a bed of water, it took 5 minutes and 20 seconds to completely burn off the fuel. The fire reached a maximum recorded temperature of 1800°F. The increase in time to burn off the fuel in the artificial turf test bed was determined to be caused by the slower vaporization of the fuel from within the fuel-soaked ballast material.



FIGURE D-28. NATURAL GRASS FIRE—10 GALLONS OF JP-8



FIGURE D-29. NATURAL GRASS FIRE—ONLY SEAMS INVOLVED

Figure D-30 shows the temperature traces over the duration of demonstrations 6 through 9 and the sod baseline. Due to the rapid self-extinguishment of demonstration 7, there was insufficient data to create a trace of that burn.

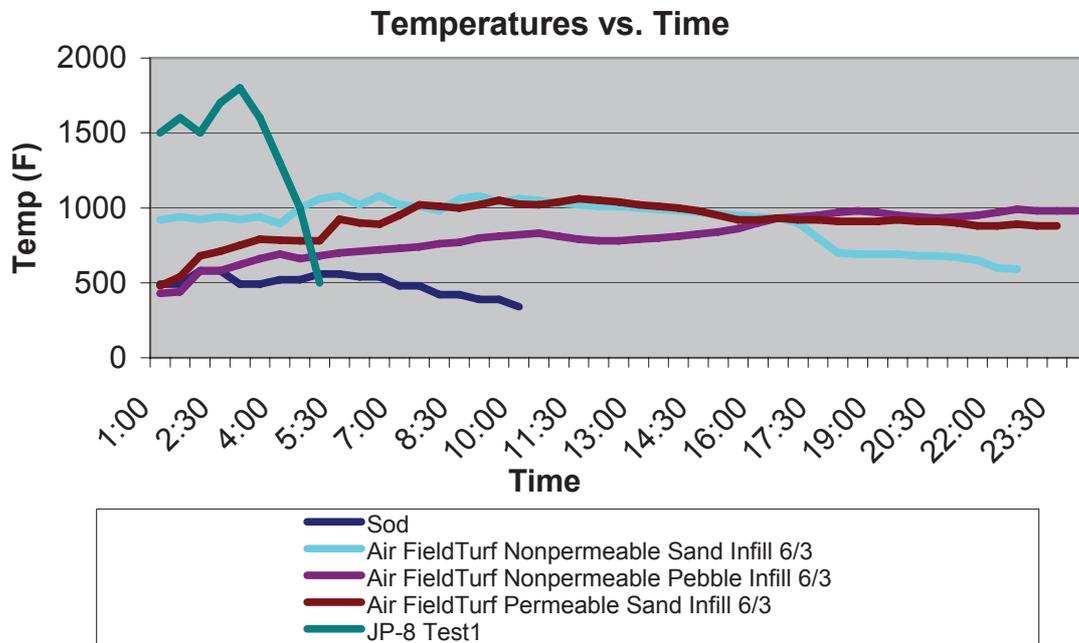


FIGURE D-30. TEMPERATURE TRACES

## D.10 CONCLUSIONS.

- The artificial turf demonstrated could not be ignited using a propane torch. The artificial turf would melt under the flame of the torch but would not continue to burn and was unable to support combustion on its own.
- The fire could spread across the test beds. This appeared to be as a result of the free flow of the fuel through the permeable backing material and the loose stone base material. In comparison to the artificial turf previously tested, this artificial turf allowed for more fuel spread and further contamination of the soil around the spill.
- The burnt artificial turf turned to a powdery substance. There were some portions of the material that did burn enough to damage the backing material of the artificial turf.
- Some of the initial fire, immediately after ignition, was more intense with the artificial turf beds than the natural grass beds. However, in most cases, that fire quickly died down to a low-level burn closer to the ground. Temperatures of the artificial turf burns did not peak as high as those as the baseline test using JP-8 only, but remained at a reasonable high temperature for a longer length of time.
- The fires involving the artificial turf were very easy to extinguish and required minimal agent application.
- There was no noticeable adverse reaction of the AFFF solution mixing with the burnt artificial turf material.

## D.11 AIR FIELDTURF GLUE APPLICATION BURN TEST BACKGROUND.

A series of live fire demonstrations were conducted on the Air FieldTurf artificial turf glued to concrete. The artificial turf developed a secondary use as a surface contrasting material for vast concrete apron areas. Airports with large continuous concrete apron areas would traditionally delineate taxiways and other vehicle movement areas by painting green island areas to appear as grass. As a follow-up to previous live fire demonstrations, the FAA needed to determine if the proposed adhesive materials used in attaching the turf to the concrete would pose any additional fire hazard.

### D.11.1 OBJECTIVES.

- Determine if the adhesive material adds to the intensity or spread of the fire.
- Determine how the use of an infill affects the fire on a solid surface.

### D.11.2 TEST METHOD.

Seven 4- by 8-ft concrete pads were constructed in metal frames. The pads were constructed to simulate the concrete surfaces the artificial turf would be installed on at an airport. For purposes

of containing the fuel applied to the artificial turf, the edges were flared approximately 4 inches, as shown in figure D-31.

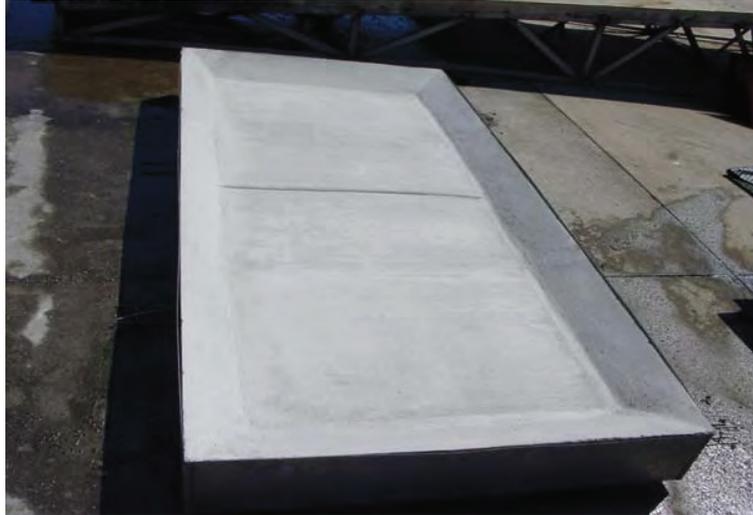


FIGURE D-31. CONCRETE TEST PAD

Test samples were installed by the manufacturer on the concrete pads. The samples consisted of variations of artificial turf installations both attached and unattached as well as with and without sand infill. All tests had an initial JP-8 fuel application of 3 gallons. The samples with sand infill had an additional 2 gallons applied in one specific area to compensate for fuel absorption into the sand as well as providing an area of pooled fuel to allow for more rapid fire development. Figure D-32 shows the fire intensity with sand infill, while figure D-33 shows the fire intensity without the sand infill.



FIGURE D-32. DEMONSTRATION WITH 1-INCH SAND INFILL



FIGURE D-33. DEMONSTRATION WITHOUT SAND INFILL

Two baseline tests were conducted. Approximately 1 inch of water was poured into a test pad. In the first baseline, 3 gallons of JP-8 fuel was applied to the surface of the water and ignited. Data were recorded for temperature and duration of the burn. The same baseline was then repeated using 5 gallons of fuel to compare to the sand infill demonstrations.

#### D.12 RESULTS.

The key objective of this round of demonstrations was to determine if either selected adhesive materials (rubberized or hot-melt glue) contributed to the fire intensity. Figures D-34 and D-35 show the peak temperatures of the samples without and with sand infill, respectively. As can be seen from these figures, the addition of the adhesive materials did not add to the fire intensity.

Figures D-36 and D-37 show the relationship of temperature and time during the demonstrations for samples without and with sand infill, respectively. It is apparent in these figures that adding the sand infill variable greatly affects the ability to have consistent and repeatable demonstrations. One key factor that was drawn from this data was that the fire burned longer due to the slower release of fuel vapors from the sand infill. The demonstrations with sand infill had a tendency to have initial peak intensity, fully involving the 4- by 8-ft sample, then declined into a fire that only involved portions of the sample. This added some subjectivity to the selection of areas to record the data. While the recorded temperatures for these demonstrations remained high well past the 20-minute mark, the overall intensity of the fire was lower, as shown in figure D-38.

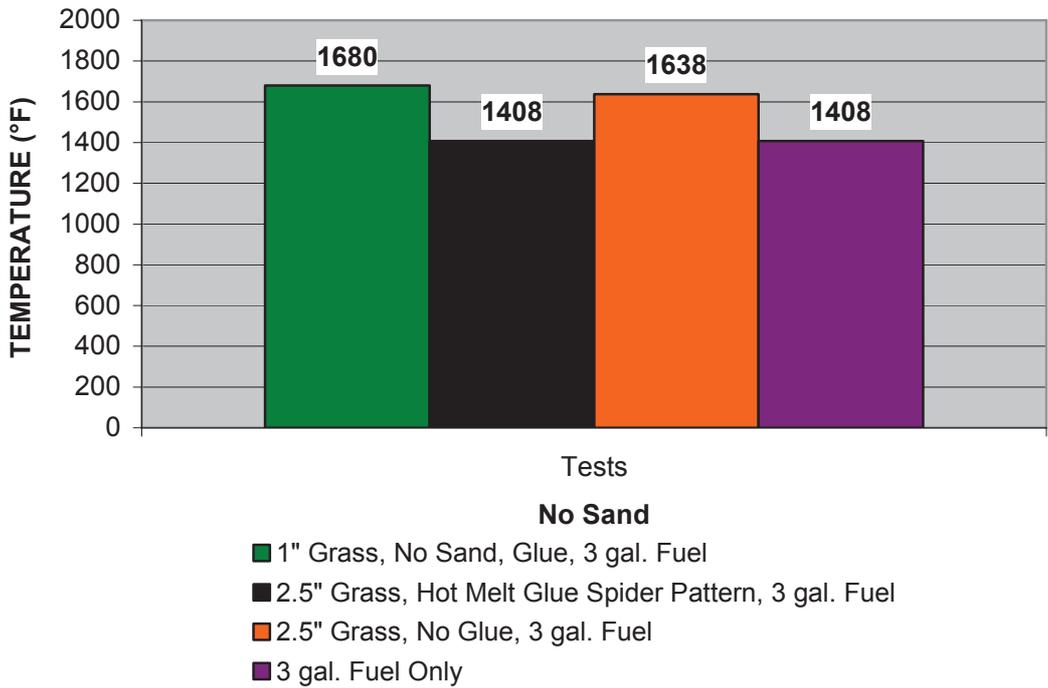


FIGURE D-34. PEAK TEMPERATURES (NO SAND INFILL)

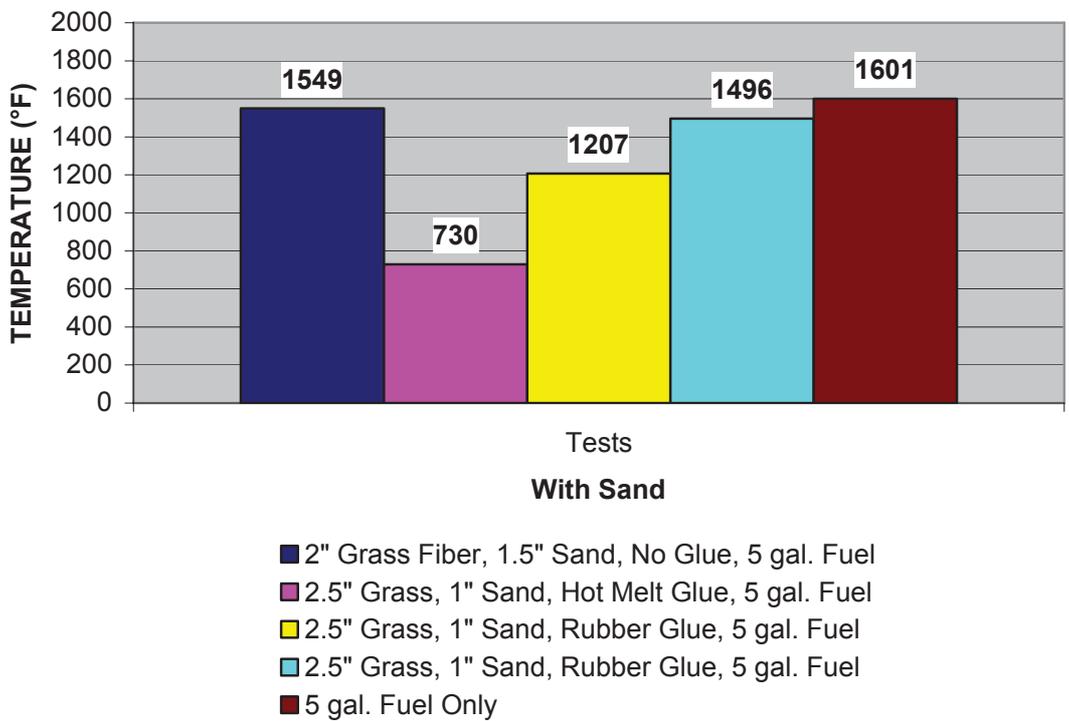


FIGURE D-35. PEAK TEMPERATURES (SAND INFILL)

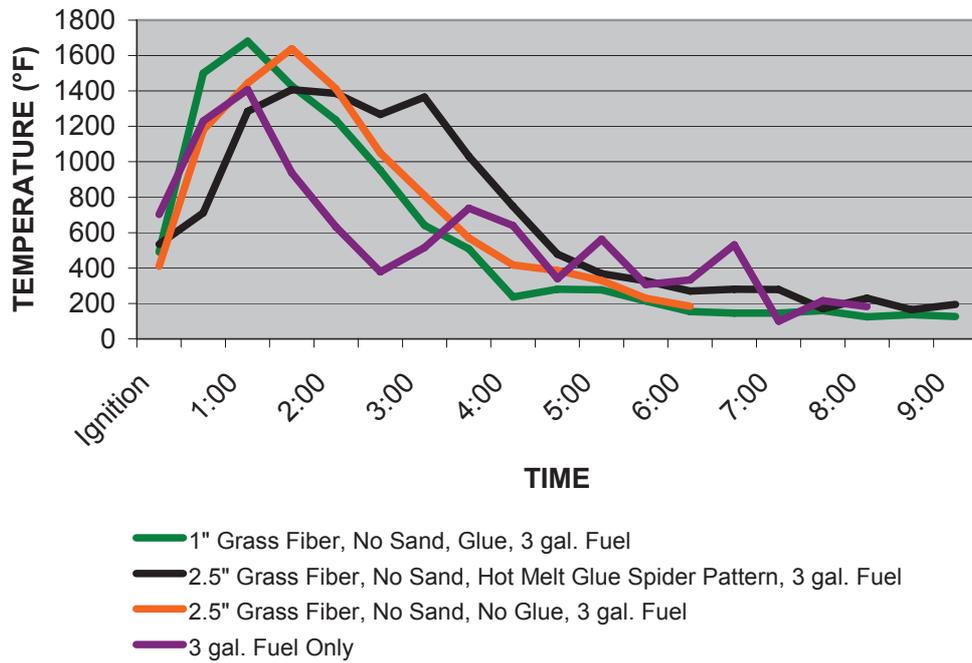


FIGURE D-36. TEMPERATURE VS TIME (NO SAND INFILL)

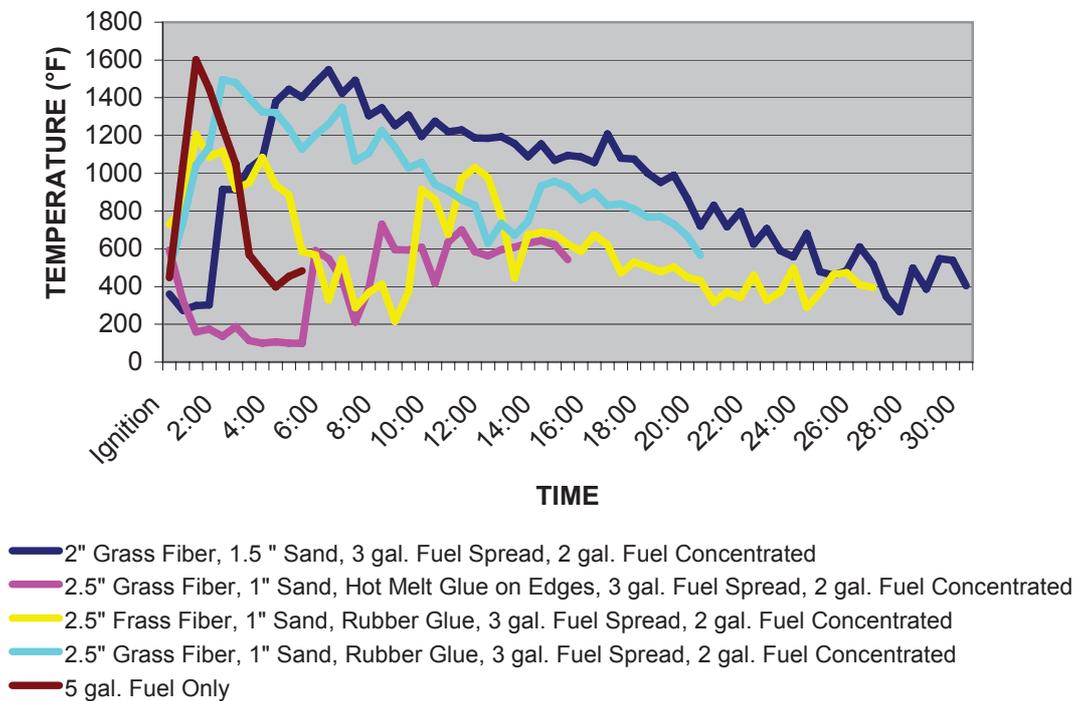


FIGURE D-37. TEMPERATURE VS TIME (SAND INFILL)



FIGURE D-38. PARTIAL INVOLVEMENT OF SAMPLE AREA

#### D.13 CONCLUSION.

It was determined through this demonstration that neither adhesive material significantly contributed to the intensity of the fire or fire propagation. However, of particular importance, none of the products of combustion from the smoke plume were collected and analyzed during this demonstration. Data should be collected to determine whether the adhesive materials significantly add to the toxicity levels of the smoke plume.