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Results of Intermediate-Scale Flammability Tests Performed on Hypalon™ RB71 Aircraft Duct Insulation

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16. Abstract

Intermediate-scale flammability testing of Hypalon™ RB71, a thermal acoustical insulation primarily used to insulate ducts, was conducted in a section of a wide-body aircraft. The aircraft section was configured to represent the attic area of a transport category aircraft. Baseline tests were also conducted using metallized Tedlar™ film cover over fiberglass to wrap the ducts. Temperature versus time and the relative energy release rate versus time were evaluated and are presented in this report.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

PURPOSE.

This report presents data collected from intermediate-scale flammability tests performed on aircraft thermal acoustic insulation.

BACKGROUND.

Thermal acoustic insulation is used in numerous locations throughout an aircraft. One particular insulation, Hypalon™ RB71 film laminated to polyimide foam, is used extensively to insulate ducts. Hypalon is a trademark of DuPont de Nemours. It is a chloro-sulfonated polyethylene elastomer and is bonded to the polyimide foam with adhesive. This particular Hypalon RB71 assembly has been used in transport category aircraft for a number of years.

In November 2005, intermediate-scale flammability tests were run by the Fire Safety Branch, Airport and Aircraft Safety R&D Division at the Federal Aviation Administration William J. Hughes Technical Center. This testing evaluated the Hypalon RB71 assembly under a realistic fire scenario. Baseline tests were also conducted with metallized Tedlar™ film cover/fiberglass blankets encapsulating the ducts.

The variation of temperature versus time and relative energy release rate versus time were evaluated during these tests.

TEST SETUP, MATERIALS, AND RESULTS

The fuselage section with three, 12-inch-diameter, 10-foot-long ducts (stove pipe ducts) used for this testing is shown in figure 1. Thermocouples were placed in various locations in the test article to monitor temperatures during testing and are shown in figure 2. A polyurethane foam block measuring 4 by 4 by 9 inches with 10 cubic centimeters of Heptane served as the ignition source.

FIGURE 1. FUSELAGE SECTION WITH DUCTS INSTALLED

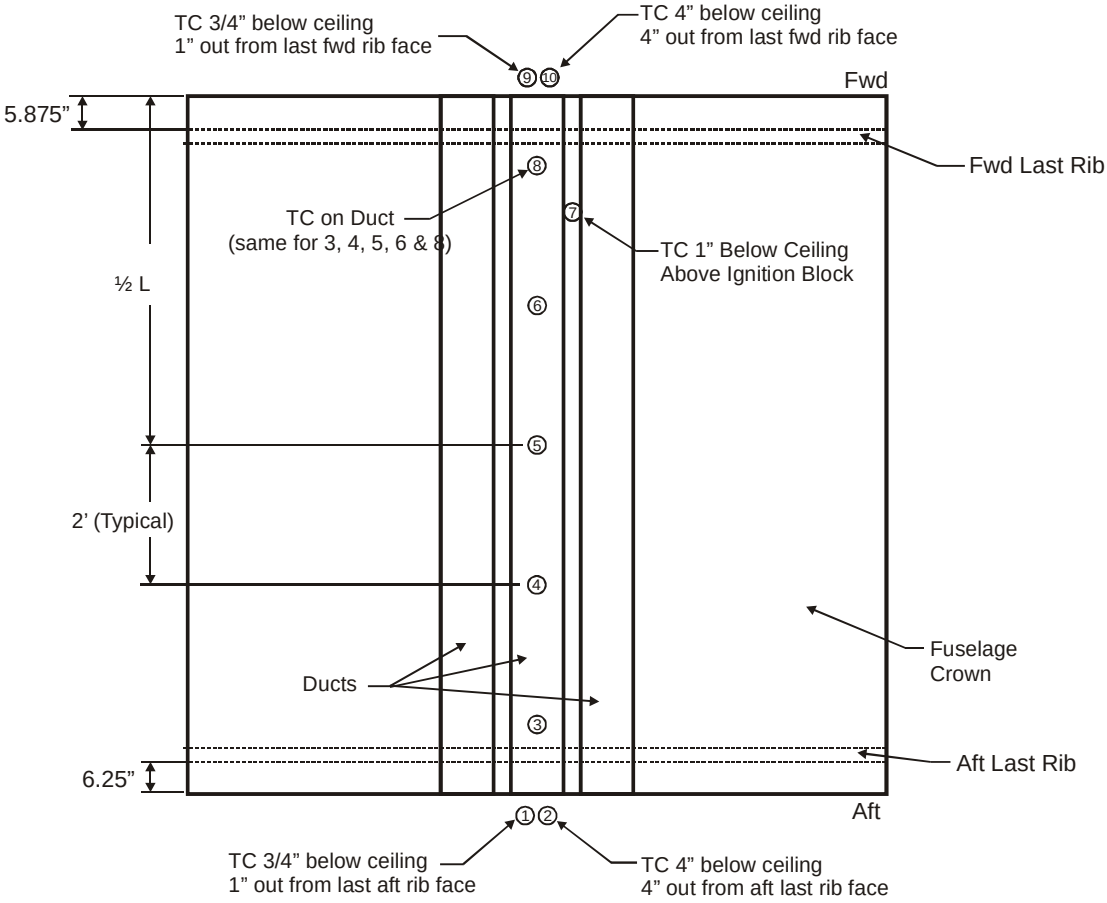

FIGURE 2. THERMOCOUPLE LOCATIONS

BASELINE TESTS.

Two baseline tests were conducted. In each test, the fuselage section and ducts were insulated as described below. Six bay blankets were installed in the test article, with cap strips covering the fuselage formers. The bay blankets were fabricated with three layers of 0.42 pound per cubic foot (pcf) density fiberglass and covered with metallized Tedlar film, which weighed 1 ounce per square yard (oz/yd^2). The cap strips were fabricated with one layer of 0.42 pcf-density fiberglass and covered with the same metallized film as the bay blankets. The three ducts were wrapped with three layers of 0.42-pcf-density fiberglass and covered with metallized Tedlar film weighing 1 oz/yd^2. The duct cover assembly was held together with 4-inch-wide metallized Tedlar tape on the top of each duct. Eight-inch concrete block spacers were used to increase the volume of test area in the first test. They were placed at the corners of the fuselage section. The concrete block spacers can be seen in the rear of figure 1.

The first test (test 1), with the foam block almost fully consumed, is shown in figure 3. The temperature versus time graph is shown in figure 4, and the relative energy release rate versus time is shown in figure 5. In the second baseline test (test 2), the spacers were removed, as shown in figure 6. The foam block was placed at the opposite end of the test article. The test in progress is shown in figure 7. The temperature versus time graph is shown in figure 8, and the relative energy release rate versus time is shown in figure 9. The distance from the top of the insulated ducts to the aluminum surface of the test article for tests 1 and 2 is given in table 1.

FIGURE 3. TEST 1

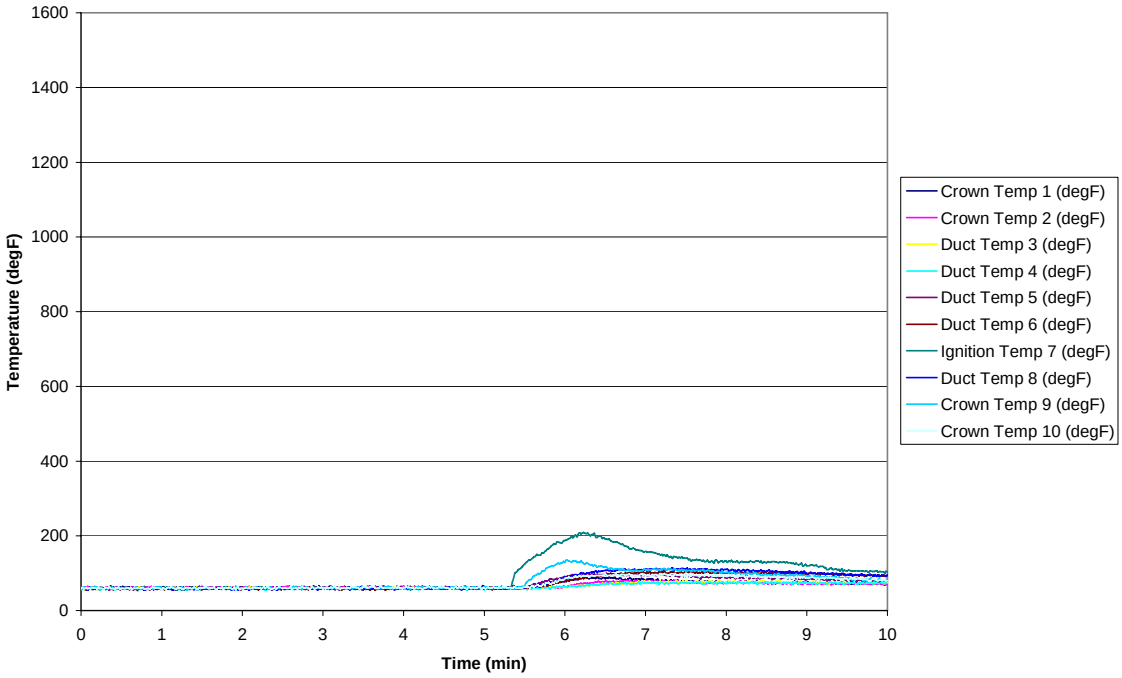

FIGURE 4. TEST 1—TEMPERATURE VS TIME
(The individual curves are close together and somewhat difficult to differentiate; however, it shows that all the temperatures are close together.)

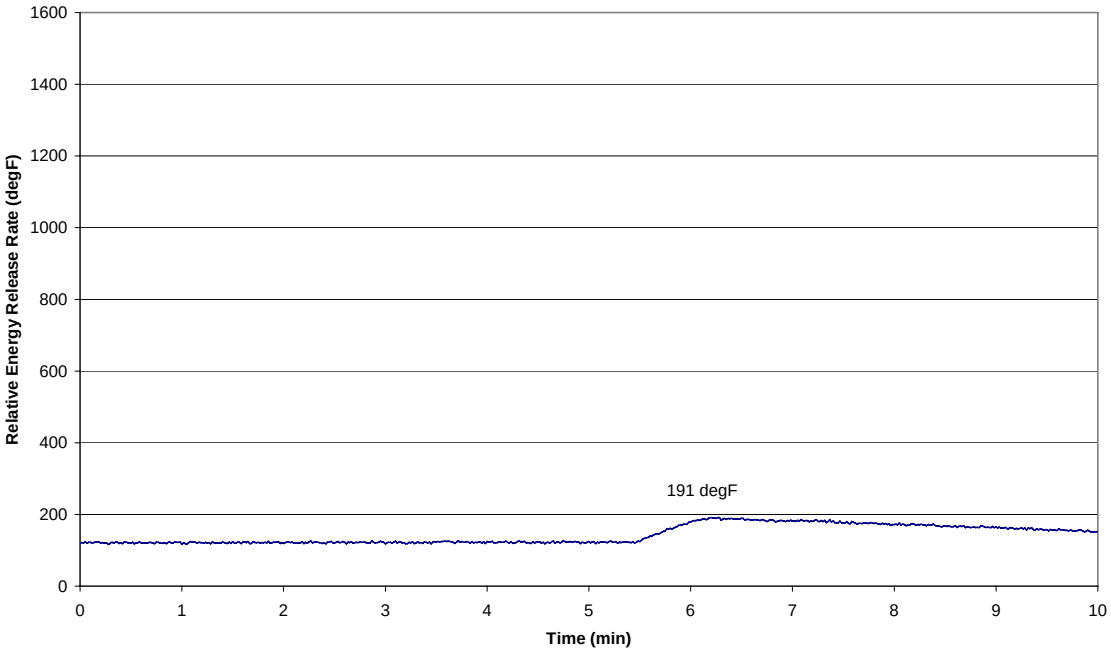

FIGURE 5. TEST 1—RELATIVE ENERGY RELEASE RATE VS TIME

FIGURE 6. TEST 2

FIGURE 7. TEST 2 IN PROGRESS

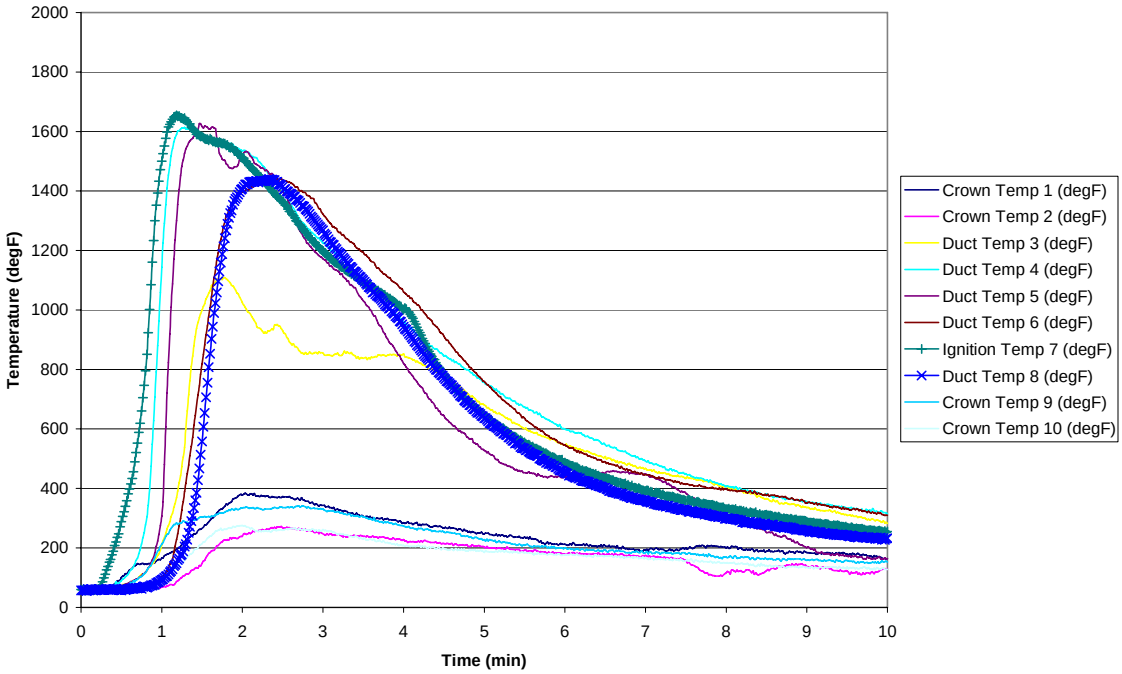

FIGURE 8. TEST 2—TEMPERATURE VS TIME

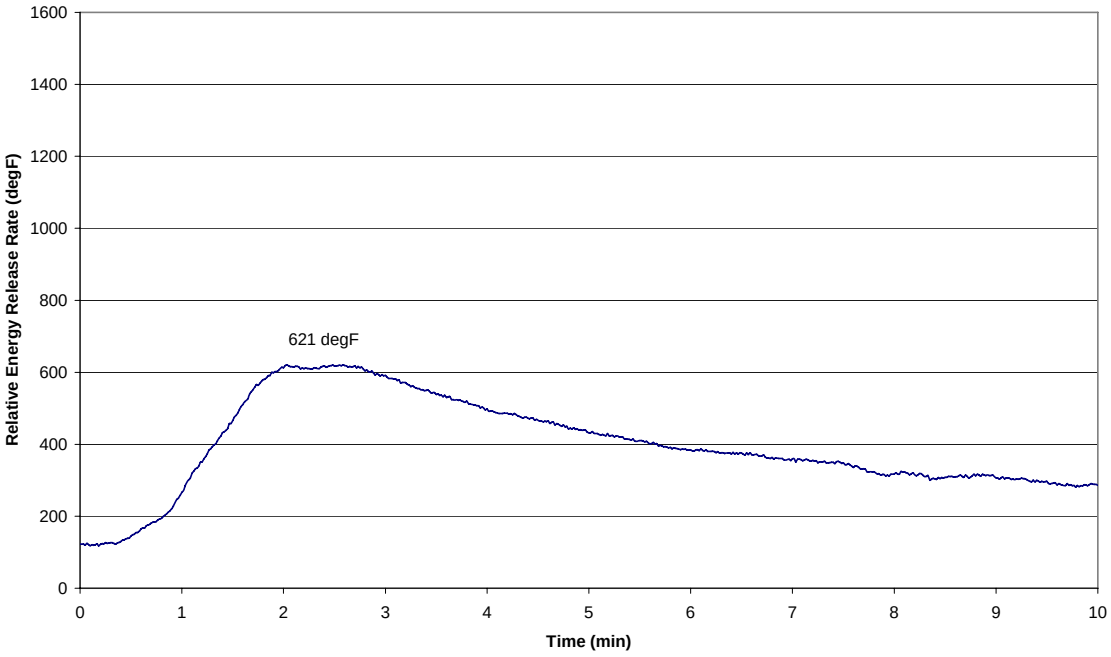

FIGURE 9. TEST 2—RELATIVE ENERGY RELEASE RATE VS TIME

HYPALON RB71 TESTS.

Two Hypalon RB71 assemblies were evaluated. One assembly was 1.5 inches thick and the other was 3/8 inches thick. The bay blankets and cap strips were fabricated with the same materials used in the baseline tests. In these tests, the ducts were wrapped with the Hypalon RB71 assembly and taped together at the bottom of the ducts with 6-inch-wide metallized Tedlar tape, as shown in figure 10. In the first test (test 3), with the 1.5-inch-thick Hypalon RB71 assembly, 4-inch spacers were used as opposed to the 8-inch spacers used in the first baseline test. This decreased the volume of test area. The test in progress is shown in figure 11. The temperature versus time graph is shown in figure 12, and the relative energy release rate versus time is shown in figure 13. A posttest photograph of the ducts is shown in figure 14.

Two tests were conducted with the 3/8-inch-thick Hypalon RB71 assembly. In the first test (test 4), 8-inch spacers were used. Figure 15 depicts the test near completion. The temperature versus time graph is shown in figure 16, and the relative energy release rate versus time is shown in figure 17. A posttest view of the ducts is shown in figure 18. In the second test (test 5), 4-inch spacers were used. A pretest view of the ducts with the foam ignition block is shown in figure 19. The temperature versus time graph is shown in figure 20, and the relative energy release rate is shown in figure 21. A posttest photograph of the ducts is shown in figure 22. The distance from the top of the insulated ducts to the aluminum surface of the test article for tests 3, 4, and 5 is given in table 1.

FIGURE 10. TEST 3

FIGURE 11. TEST 3 IN PROGRESS

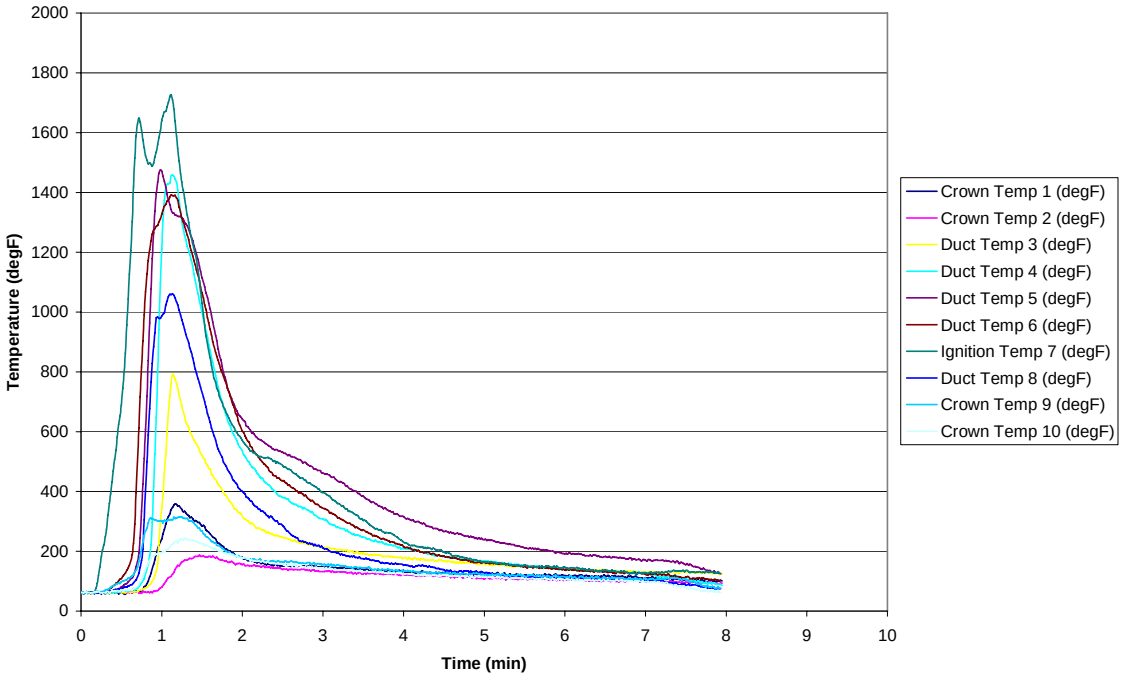

FIGURE 12. TEST 3—TEMPERATURE VS TIME

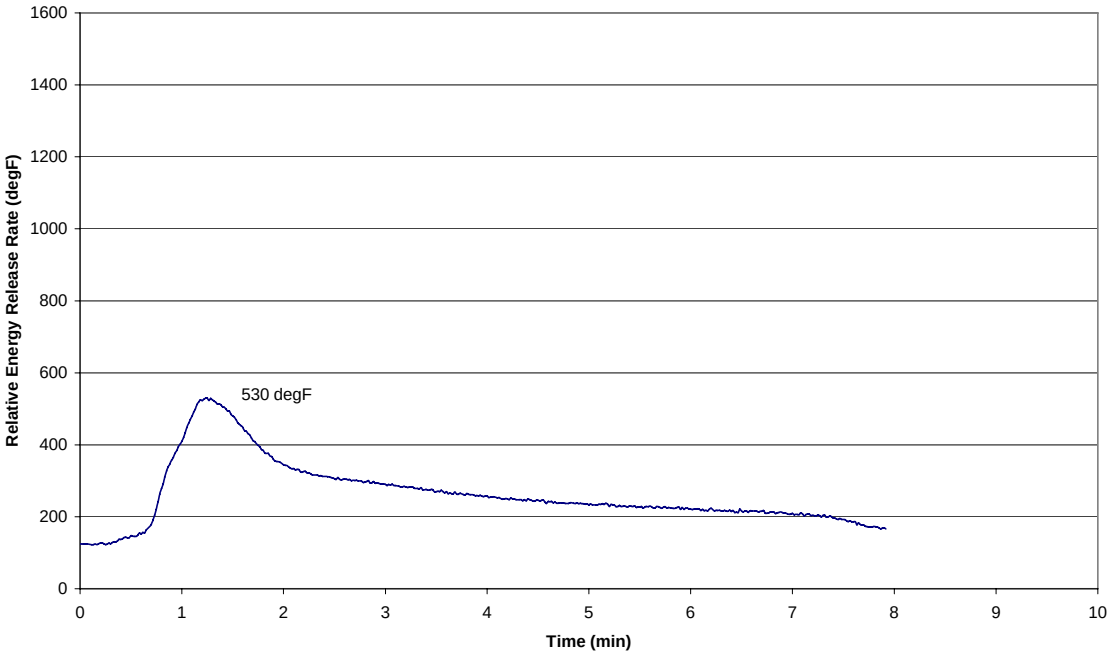

FIGURE 13. TEST 3—RELATIVE ENERGY RELEASE RATE VS TIME

FIGURE 14. TEST 3—POSTTEST PHOTOGRAPH OF DUCTS

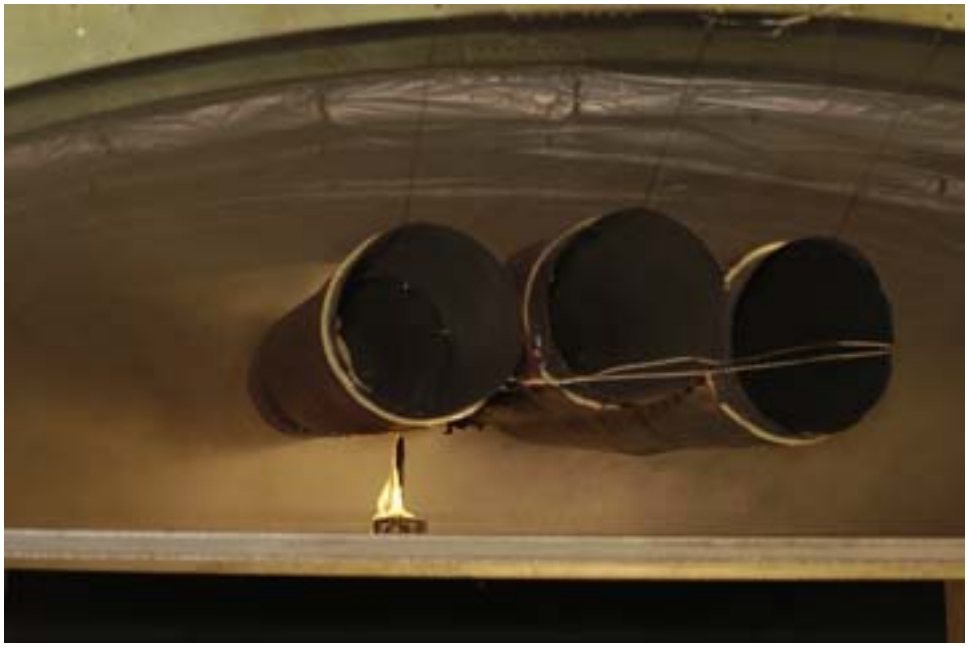

FIGURE 15. TEST 4—NEAR COMPLETION

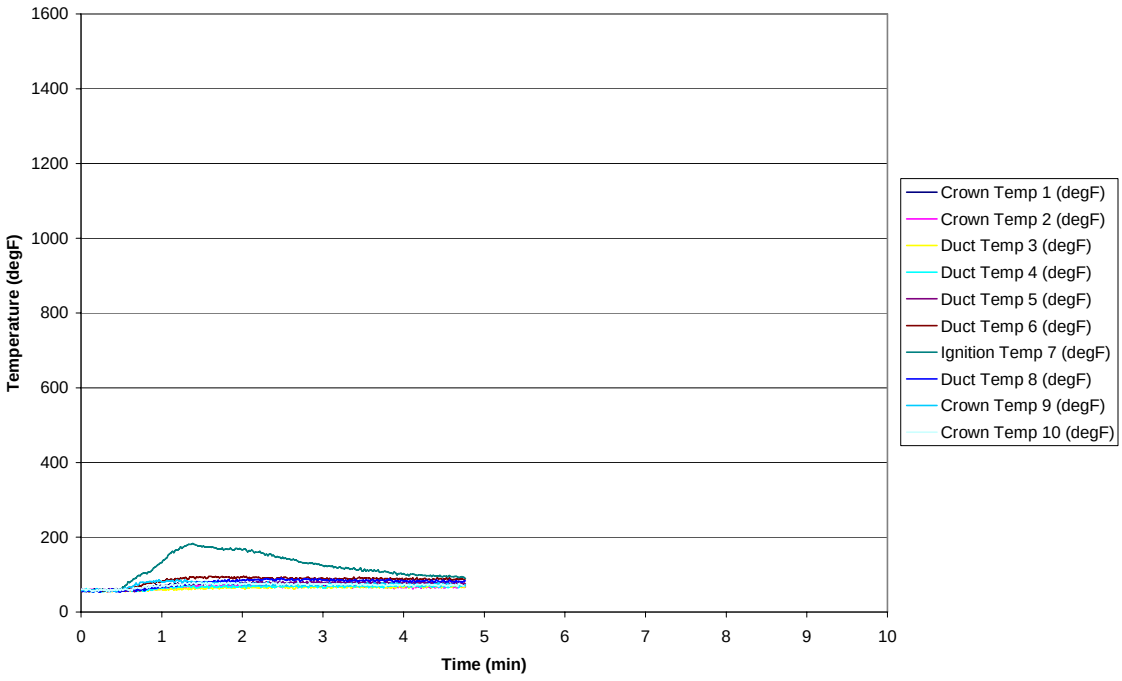

FIGURE 16. TEST 4—TEMPERATURE VS TIME
(The individual curves are close together and somewhat difficult to differentiate; however, it shows that all the temperatures are close together.)

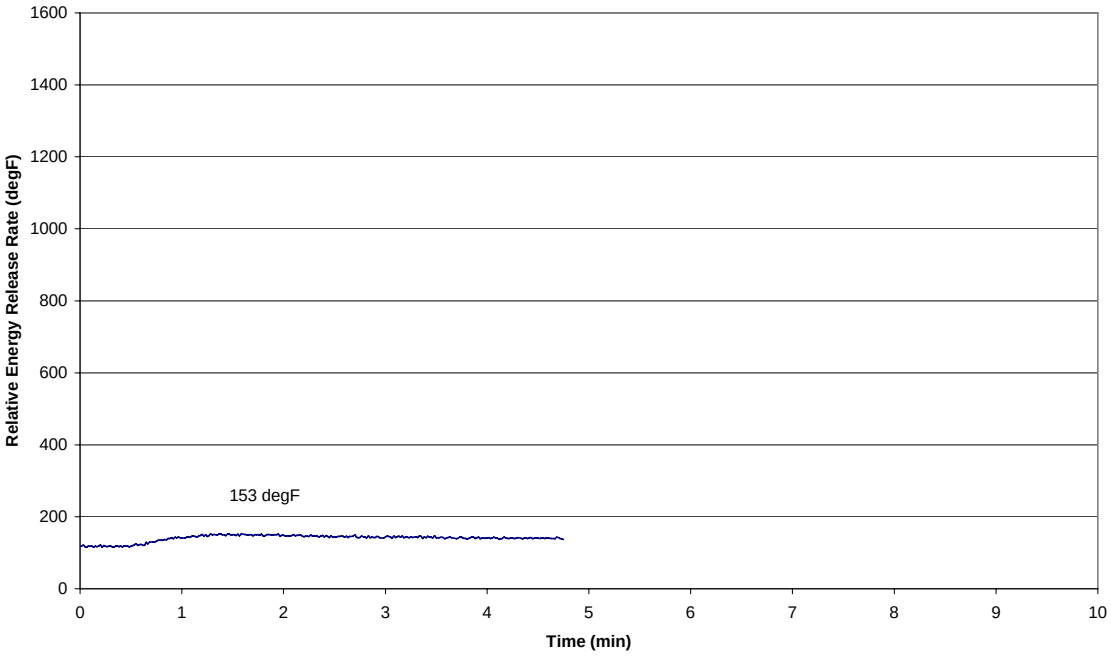

FIGURE 17. TEST 4—RELATIVE ENERGY RELEASE RATE VS TIME

FIGURE 18. TEST 4—POSTTEST PHOTOGRAPH OF DUCTS

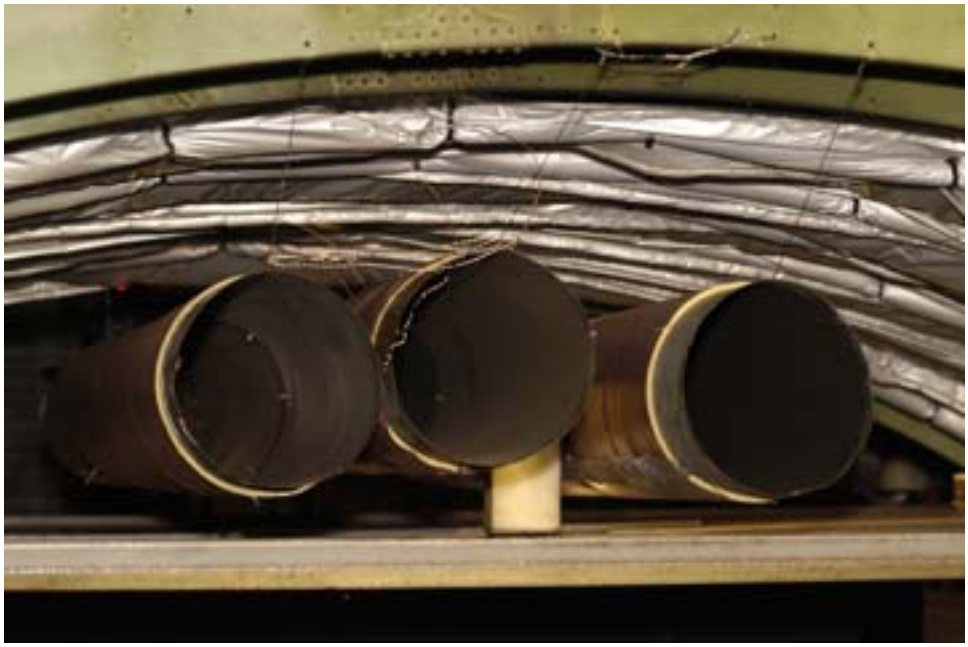

FIGURE 19. TEST 5

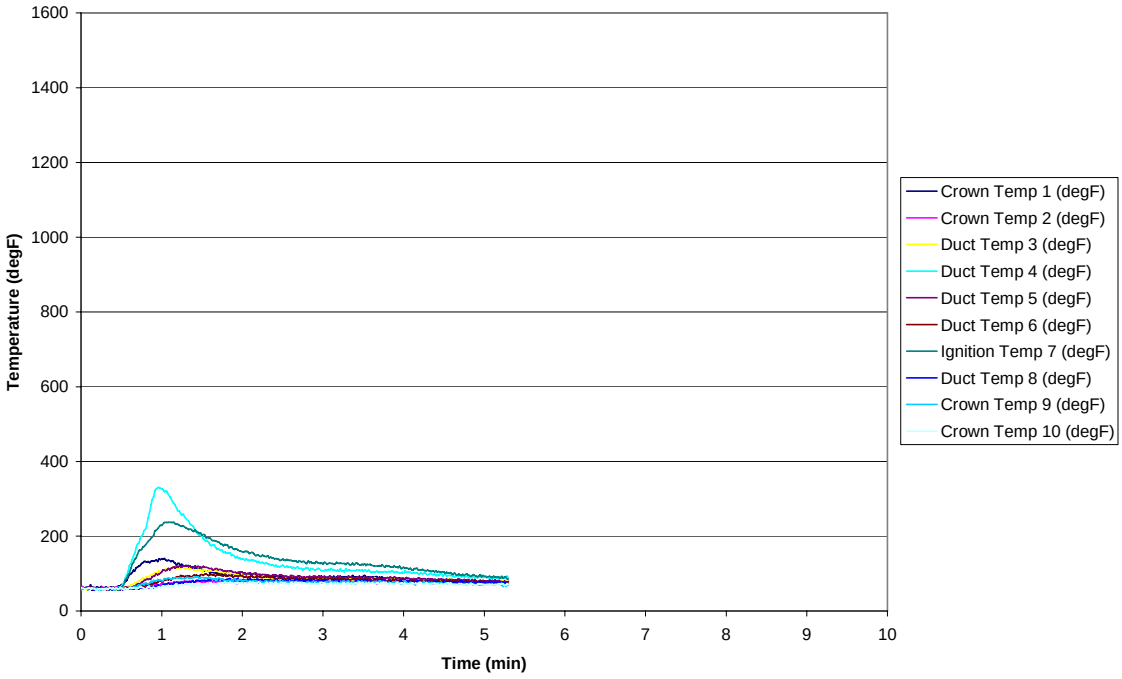

FIGURE 20. TEST 5—TEMPERATURE VS TIME
(The individual curves are close together and somewhat difficult to differentiate; however, it shows that all the temperatures are close together.)

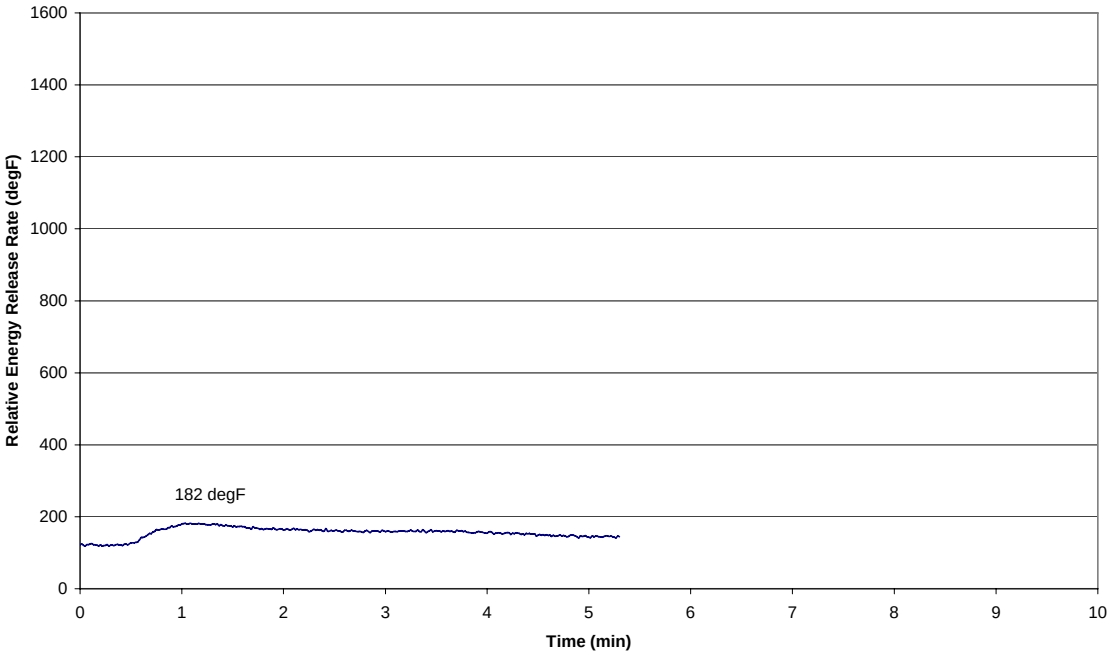

FIGURE 21. TEST 5—RELATIVE ENERGY RELEASE RATE VS TIME

FIGURE 22. TEST 5—POSTTEST PHOTOGRAPH OF DUCTS

TABLE 1. DISTANCE FROM TOP OF INSULATED DUCTS TO ALUMINUM SURFACE OF TEST ARTICLE

Test	Distance (inches)
1	10.75
2	10.5
3	11.25
4	11.75
5	12
6	12
7	10
8	12

ADDITIONAL BASELINE TESTS OF METALLIZED TEDLAR FOR CONFIGURATION CONSISTENCY.

Three additional baseline tests were performed to configure the ducts with the tape on the bottom and the 4-inch spacers installed, as was done in two of the three Hypalon RB71 tests. The film cover material weight and the amount and density of fiberglass used in the first two tests differed from those used in the first set of baseline and Hypalon RB71 tests. In these first two tests, the bay blankets, cap strips, and ducts were fabricated with two layers of 0.34-pcf-density fiberglass and covered with metallized Tedlar film, weighing 1.25 oz/yd^2. The material covering the ducts, however, was taped at the bottom with 6-inch-wide metallized Tedlar tape, as opposed to the first baseline tests where they were taped on top with 4-inch-wide tape. A pretest picture of the first test (test 6) is shown in figure 23. The temperature versus time graph is shown in figure 24, and the relative energy release rate versus time is shown in figure 25. A posttest picture of the ducts is shown in figure 26.

In the second test (test 7), the ducts were positioned 2 inches closer to the ceiling of the test article. A pretest photograph is shown in figure 27. The temperature versus time graph is shown in figure 28, and the relative energy release rate versus time graph is shown in figure 29.

In the third test (test 8), the bay blankets and cap strips were fabricated with the same materials used in the first baseline test and all of the Hypalon RB71 tests. The ducts were also wrapped with the same material used in the first baseline tests, but were taped together at the bottom with 6-inch-wide metallized Tedlar tape. The test in progress is shown in figure 30. The temperature versus time graph is shown in figure 31, and the relative energy release rate versus time graph is shown in figure 32. A posttest photograph of the ducts is shown in figure 33. The distance from the top of the insulated ducts to the aluminum surface of the test article for tests 6, 7, and 8 is given in table 1.

FIGURE 23. TEST 6

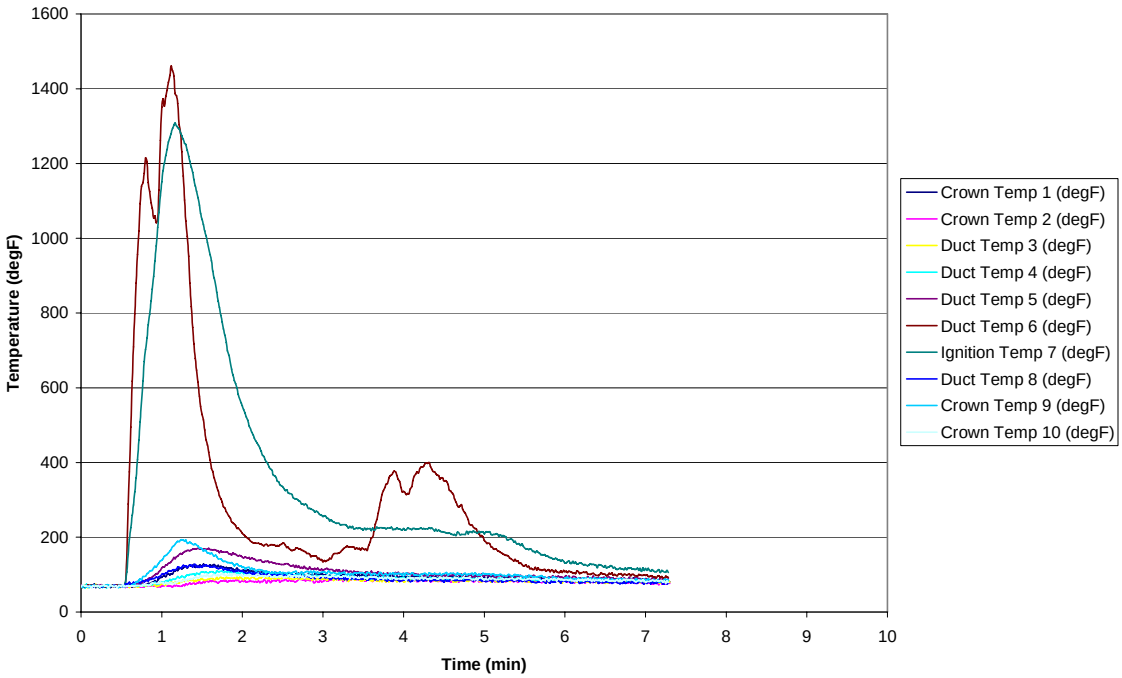

FIGURE 24. TEST 6—TEMPERATURE VS TIME

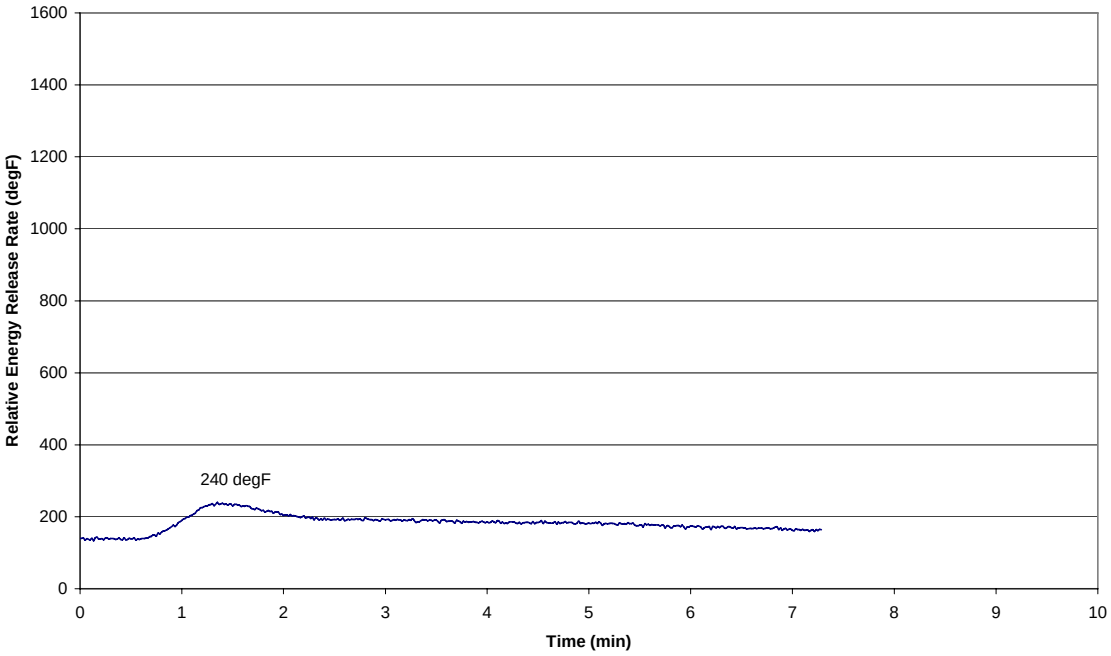

FIGURE 25. TEST 6—RELATIVE ENERGY RELEASE RATE VS TIME

FIGURE 26. MPV TEST 6—POSTTEST PHOTOGRAPH OF DUCTS

FIGURE 27. TEST 7

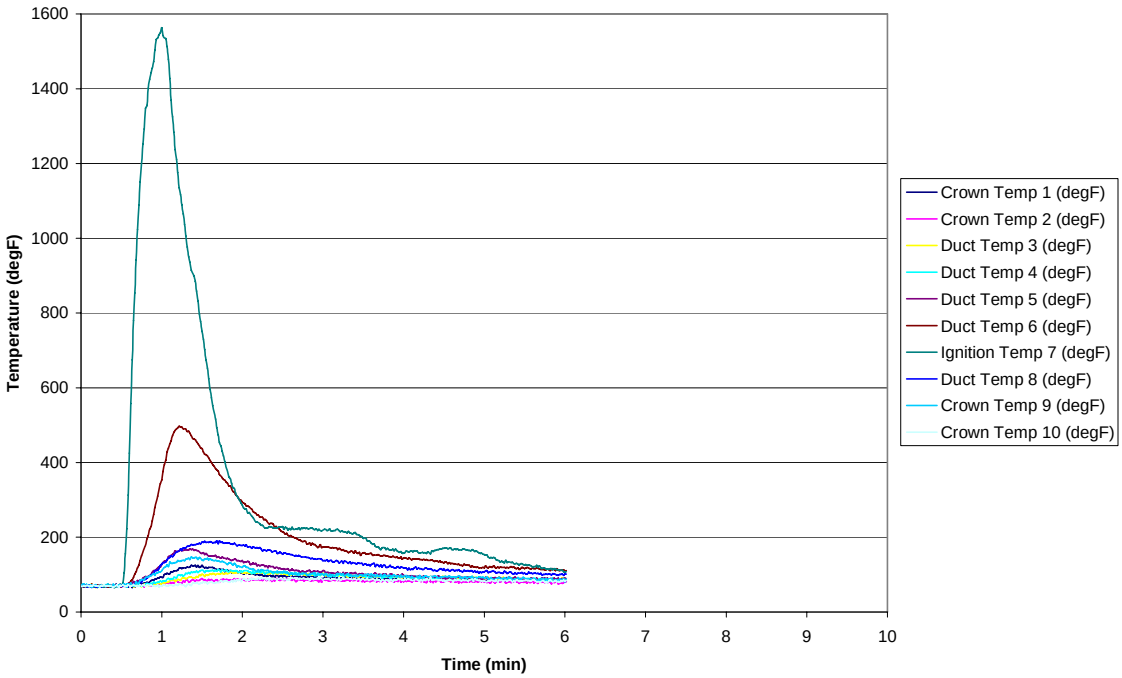

FIGURE 28. TEST 7—TEMPERATURE VS TIME

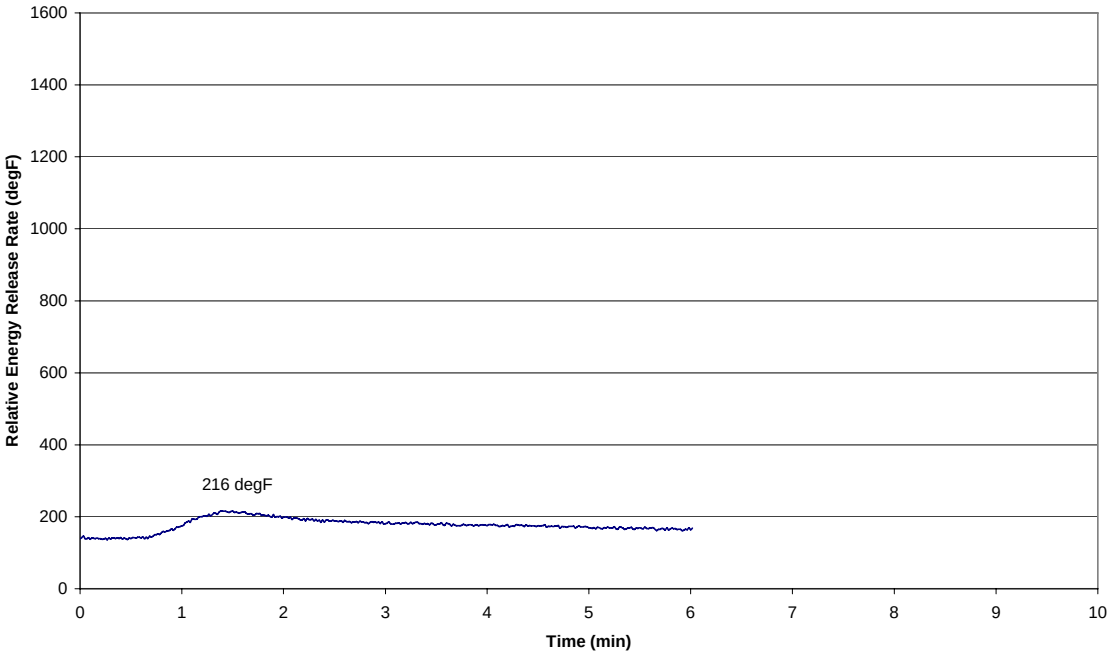

FIGURE 29. TEST 7—RELATIVE ENERGY RELEASE RATE VS TIME

FIGURE 30. TEST 8—IN PROGRESS

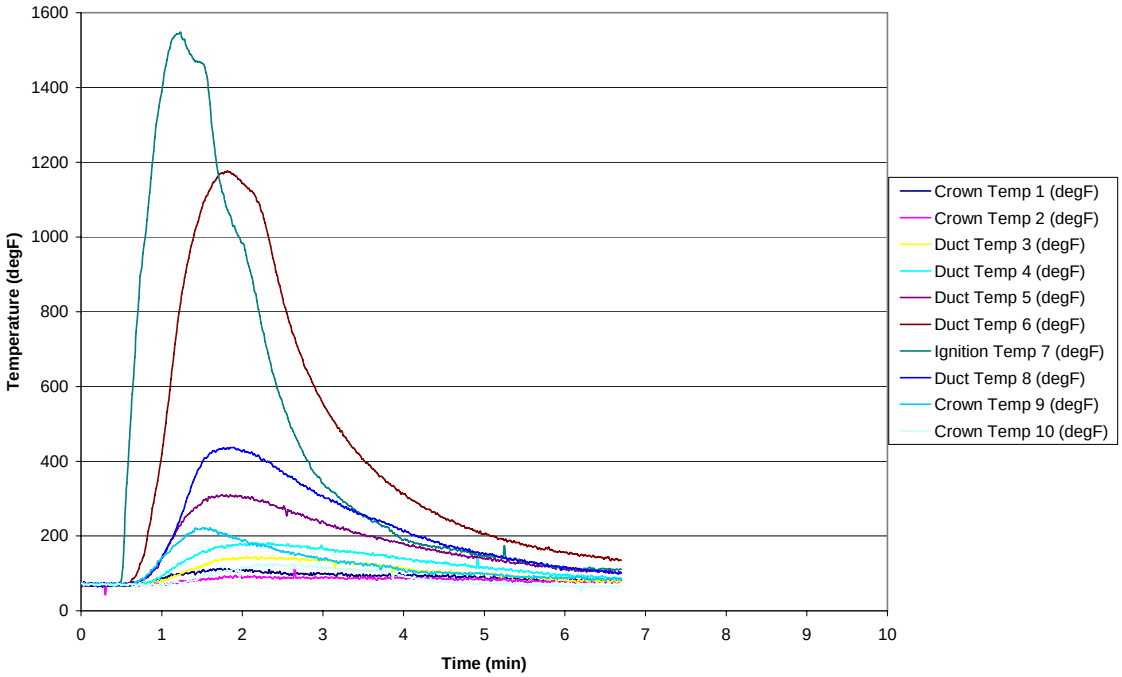

FIGURE 31. TEST 8—TEMPERATURE VS TIME

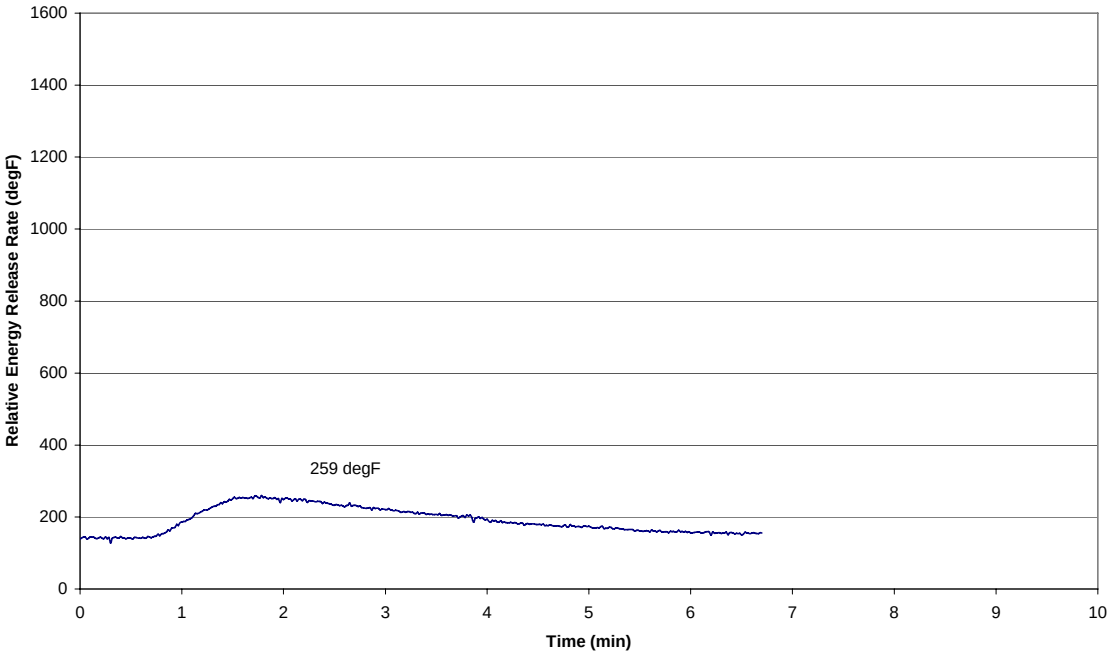

FIGURE 32. TEST 8—RELATIVE ENERGY RELEASE RATE VS TIME

FIGURE 33. TEST 8—POSTTEST PHOTOGRAPH OF DUCTS