TEMPERATURE PROFILE BEHIND TEST PANEL OPENING USING THE STANDARD BURNER AND PAN FIRE

Paul N. Boris
John J. Collins

Purpose

The purpose of the tests described herein was to determine the temperature profile behind a hole through a flame barrier when subjected to the flame of the standard 2-gallon per hour (GPH) burner, and a pan fire. The effect of hole diameter on temperature profile was investigated. These tests were intended to simulate an aircraft fire impinging upon a cargo liner with an as-designed opening.

Background

FAR 25.857 states in part that "each specimen tested must simulate the cargo compartment sidewall or ceiling liner panel, including design features, such as joints, lamp assemblies, ..." A nebulous aspect in this regard includes recesses or duct openings as design features, such as a recessed light fixture or vent. Such design features would be more remote from the flame impingement area during testing of a proposed design configuration and interpretation of results may be open to question. These tests are intended to provide some additional information as to whether current test methods are adequate or whether some test modifications may be required to accommodate recessed or other anomalous design features. Further, these tests were also intended to provide some insight into possible design guidelines from a fire-hardening standpoint.

DISCUSSION

Test Apparatus

The test apparatus for the first series of tests was the standard burner as described in CFR Part 25. For the second series of tests, the flame environment was provided by a 12m x 12m pan fire. The fuel for the aforementioned tests was JP-4.

The test specimens were three pieces of 1/2-inch thick Kaowool through which were cut a 2-, 4- and 6-inch diameter hole, respectively, at its geometric center. During testing, the test specimen was mounted in a holding fixture which supported it above the standard burner (or pan fire). A thermocouple was placed at the edge of the hole immediately adjacent to the rear face of the specimen and one each, an inch apart, so that they were aligned vertically above the test specimen. The same arrangement of thermocouples was positioned above the geometric center of the hole. This test setup was used for both the standard burner and pan fire. See figure 1 for a typical test setup and thermocouple location.

Test Procedure

The tests conducted were those shown in table 1. The standard burner was calibrated to the specifications stated in CFR Part 25, Appendix F. When conducting these tests using the standard burner, the procedure followed was that the burner was turned on and allowed to operate until temperatures stabilized. Temperature data was then taken for a period of one minute. For those tests in which the heat source was the pan fire, the fuel tray was filled with one inch of JP-4 fuel, allowed to burn until temperatures stabilized and subsequently data taken for a period of one minute. For the pan fire, the distance, H, as shown in figure 1, was measured from the top of the JP-4 fuel puddle before the test began, noting of course, that this distance, H, would increase slightly as the test progressed. Temperatures were scanned at a rate of one cycle per second.

The standard distance between the test panel and the standard burner as specified in CFR Part 25 is 8 inches. This distance was bracketed, i.e., tests were conducted at 4, 6, 8 and 10 inches for both the standard burner and pan fire.

Discussion of Data

All tabulated data is contained in the Appendix along with the arithmetic average temperature as sensed by each thermocouple over the one minute test duration.

The time/temperature data can be presented in several ways. For the purpose of these tests it is probably most meaningful to compare tests with like diameters. Therefore, figures 2 through 13 contain the averaged temperature versus distance above the back face of the panel for like diameters; comparing the results using the standard burner and pan fire. The data shown in these figures is for the center row of thermocouples only.

Although the pan fire is intended to represent a free burning diffusion flame as one might expect from a burning fuel puddle, it does not compare in intensity with the flame of the standard burner. In every instance, the standard burner provided the more severe environment than did the pan fire. This is considering every test, at all distances (H) from the heat source, all test panel diameter openings and temperatures measured within the six inches on the rear face of the test panel. Figure 11, which contains the data from tests 21 and 22 shows the closest agreement between the pan fire and the standard burner. The 10-inch diameter, however, exceeds the 8-inch standard distance as specified in CFR Part 25. Also note that this was for the 2-inch diameter only. For all other tests, there is a pronounced

the burner extension horn. The largest diameter opening in these tests was 6 inches. This is exactly equal to the smallest dimension of the standard burner extension horn. Perhaps a test panel opening of 4 inches in diameter of less would be a product limitation under the current test procedures.

Considering the 4-inch diameter opening only, figure 9 indicates that the temperature 6 inches away from the rear piece of the panel was about 1500 °F. If the duct is constructed of the same material as the panel, and the panel survives the standard test, it can be assumed that the duct passes also. However, an additional aspect that must be considered is the duct panel interface and this also must endure without failure.

If the panel to undergo testing contains a recessed light fixture, it must survive the standard test. This includes, if necessary, the light itself. The testing of such a design should include not only the light itself, but criteria for passing the standard test should be that the light should still be functioning upon termination of the tests, i.e., it must be on during the test, continue operating throughout the duration of the test, and must still be functioning upon burner shutdown.

Other testing may be conducted to supplement the data in this report. One series of tests that could be considered is to modify the test panel to include a duct on its back face, the same diameter as the opening through the panel. A temperature decay along the interior of the duct could serve as an aid in determining a selection of materials for the duct. Somewhere along the duct, the temperature would decrease enough to permit the use of alternate materials. Another series of tests could include a similar arrangement with the exception being that the duct of the test panel would be dead-ended, the variable being the length of the dead-ended duct. Limitations to such tests would be the use of the standard burner only and a maximum diameter in the test panel of 4 inches.

Table 1

TEST IDENTIFICATION

BURNER			PAN FIRE		
Test No.	H (in.)	D (in.)	Test No.	H (in.)	D (in.)
1	8	2	10	8	2
2	8	4	11	8	4
3	8	6	12	8	6
4	6	2	13	6	2
5	6	4	14	6	4
6	6	6	15	6	6
7	4	2	16	4	2
8	4	4	17	4	4
9	4	6	18	4	6
			19	10	6
22	10	2	20	10	4
23	10	4	21	10	2
24	10	6			

APPENDIX I

FIGURES

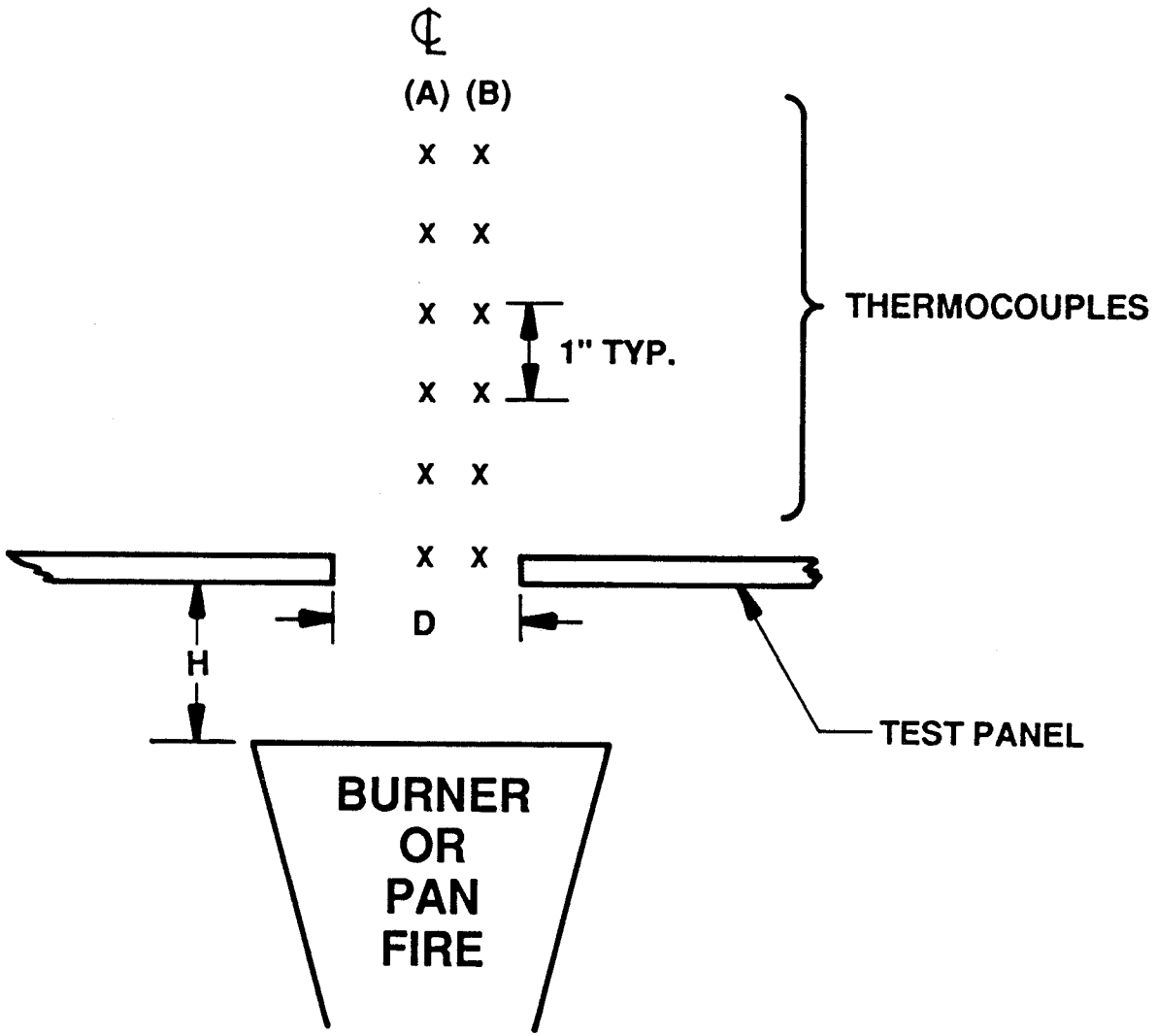

FIGURE 1 - Typical Test Set-up for Standard Burner and Pan Fire Tests

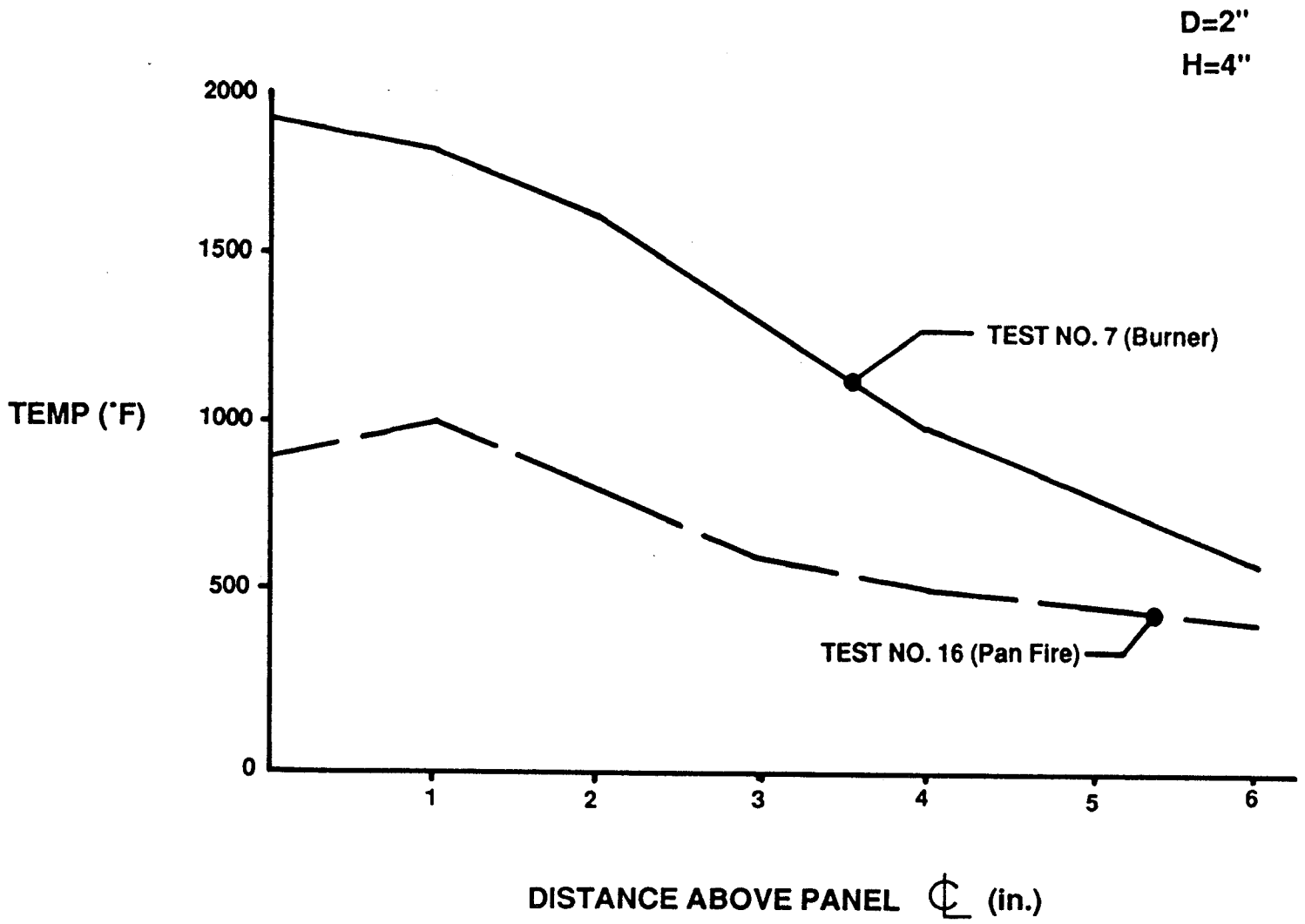

FIGURE 2-Temperature Profile for Test Nos. 7 and 16

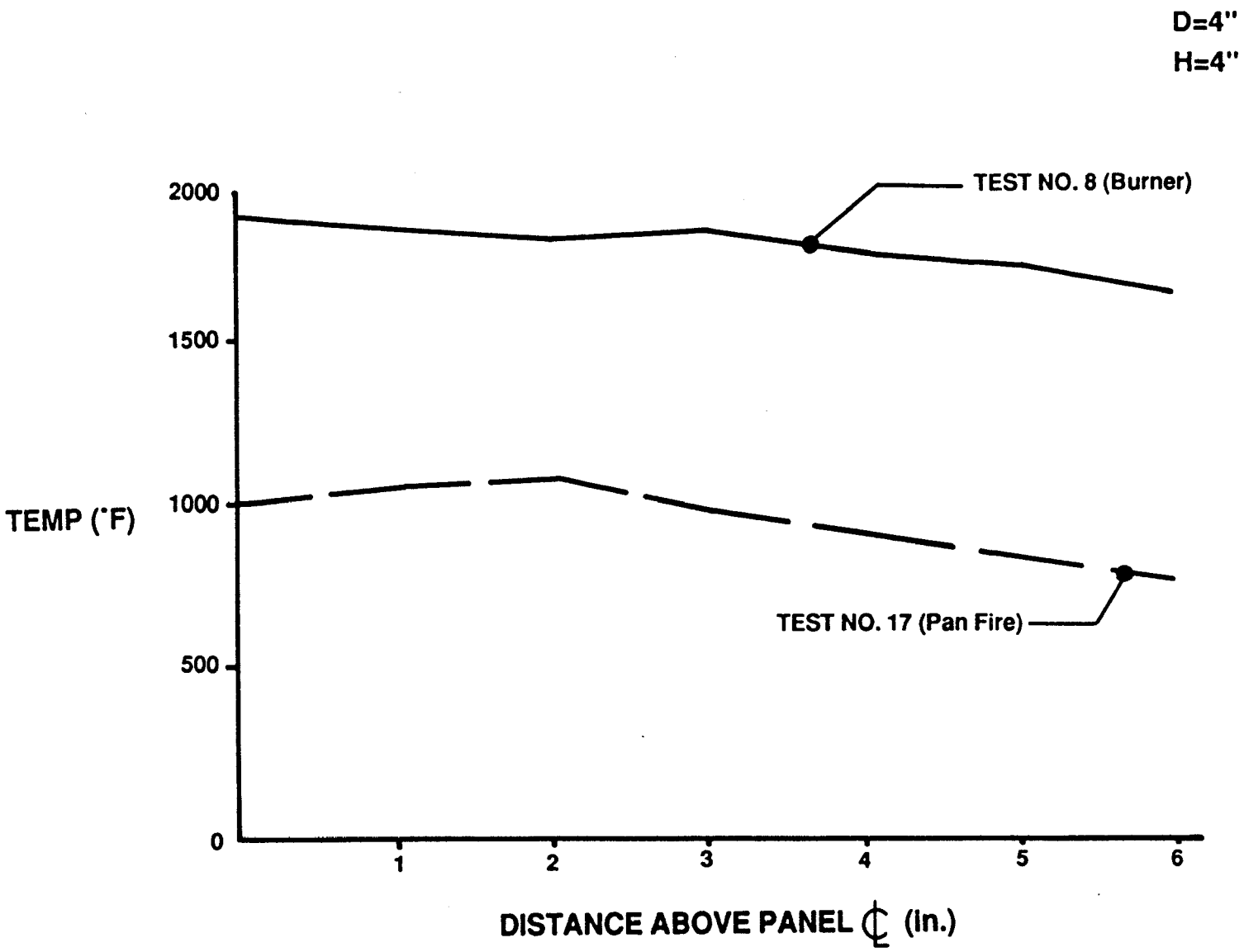

FIGURE 3-Temperature Profile for Test Nos. 8 and 17

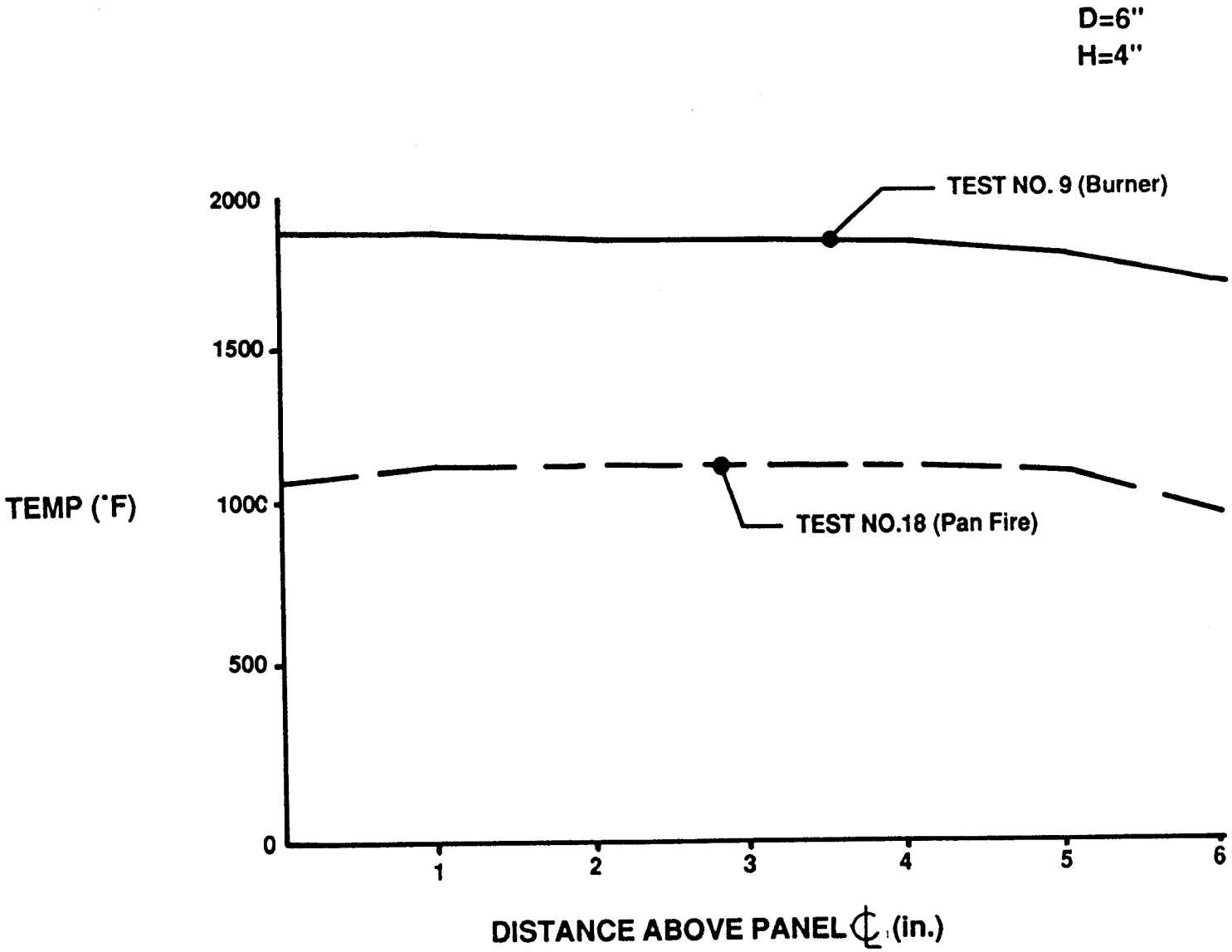

FIGURE 4-Temperature Profile for Test Nos. 9 and 18

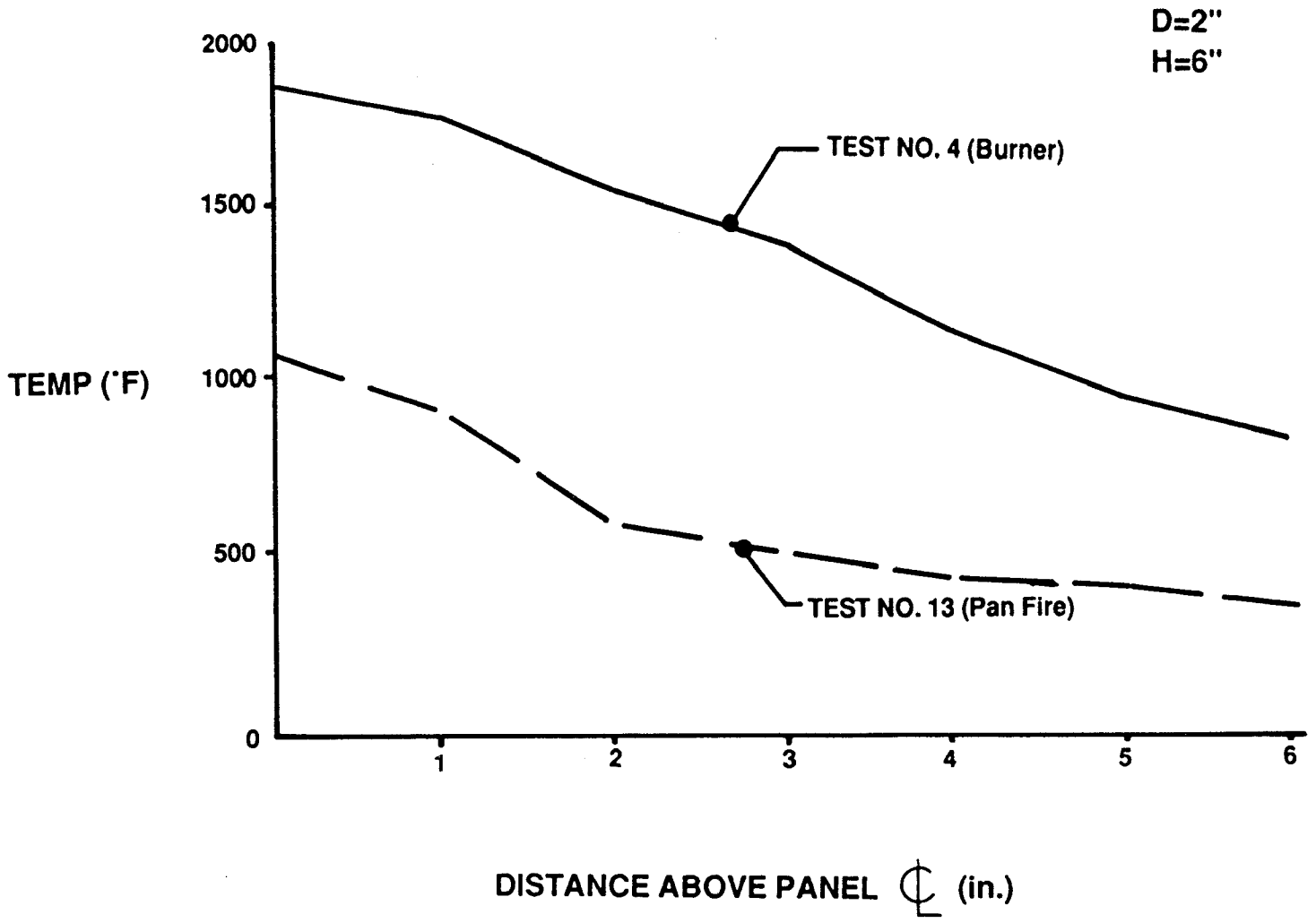

FIGURE 5-Temperature Profile for Test Nos. 4 and 13

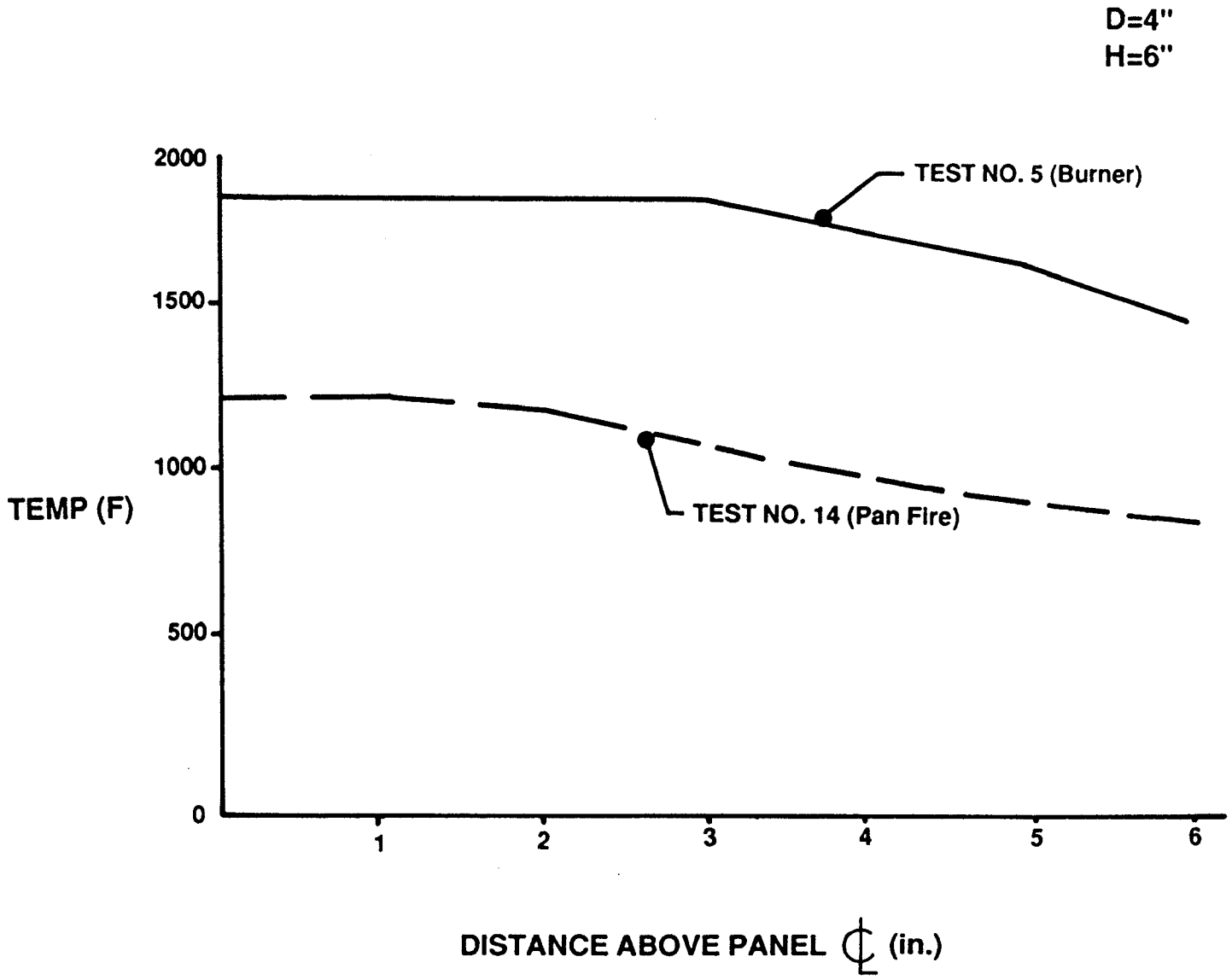

FIGURE 6-Temperature Profile for Test Nos. 5 and 14

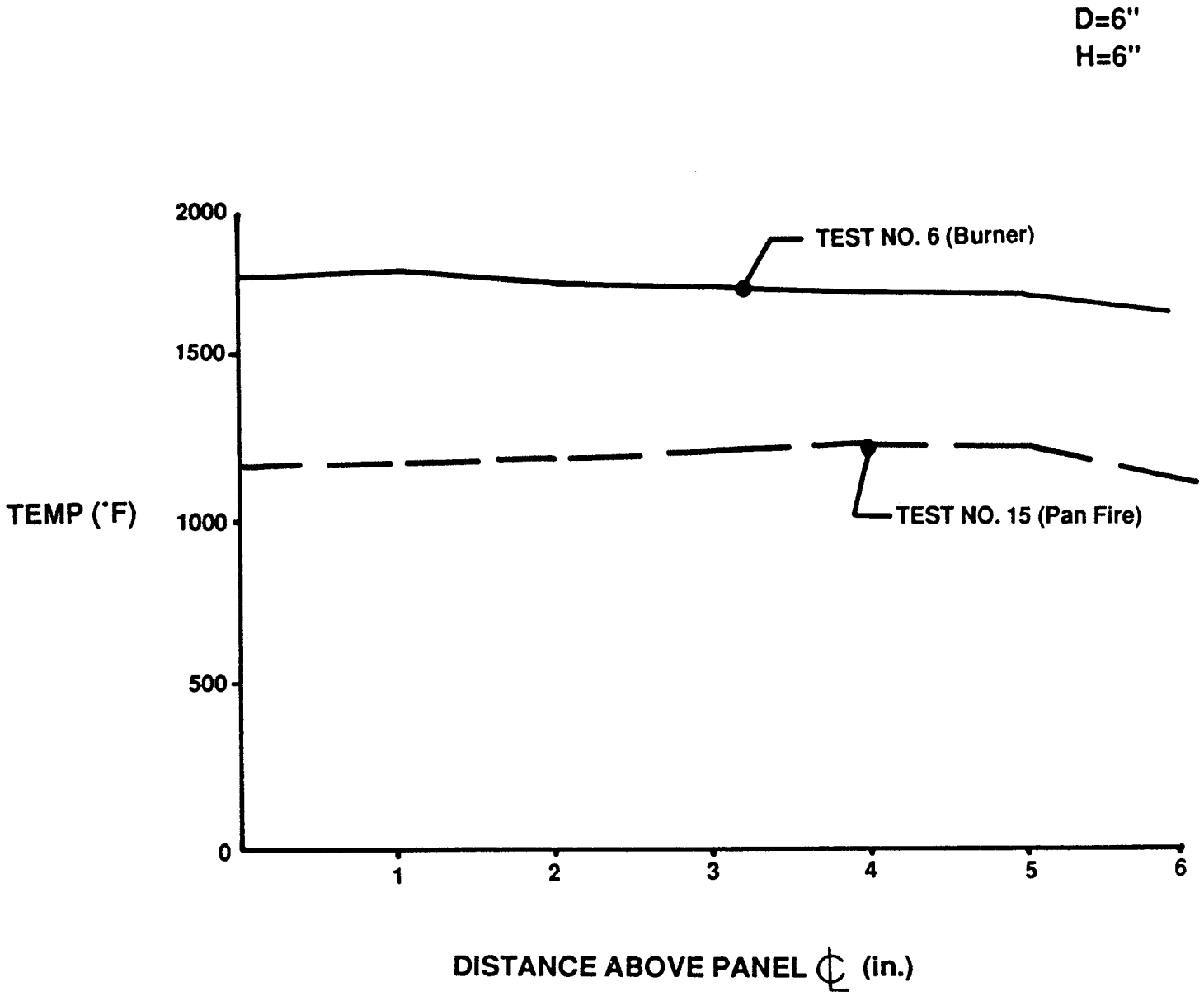

FIGURE 7-Temperature Profile for Test Nos. 5 and 16

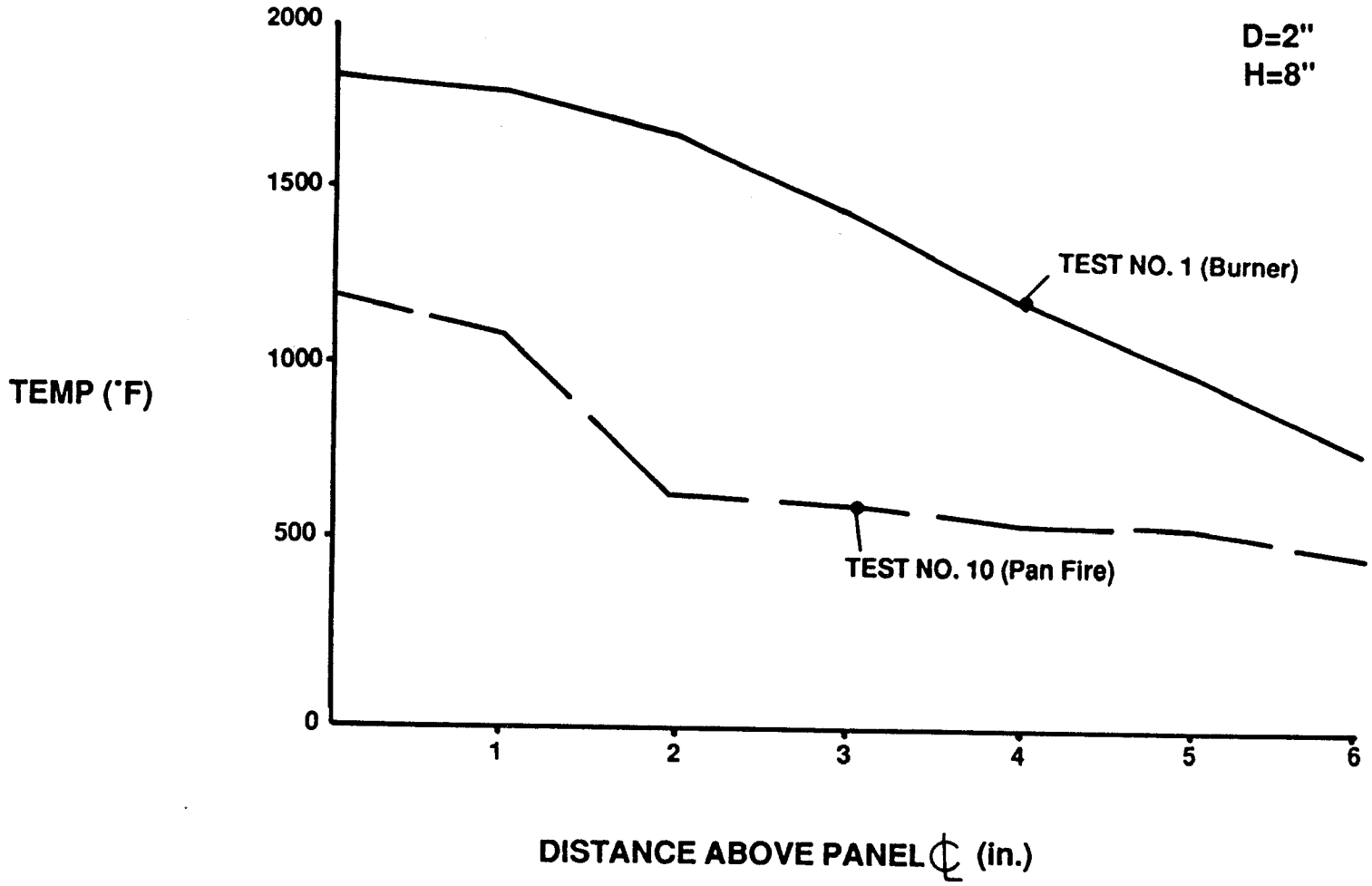

FIGURE 8-Temperature Profile for Test Nos. 1 and 10

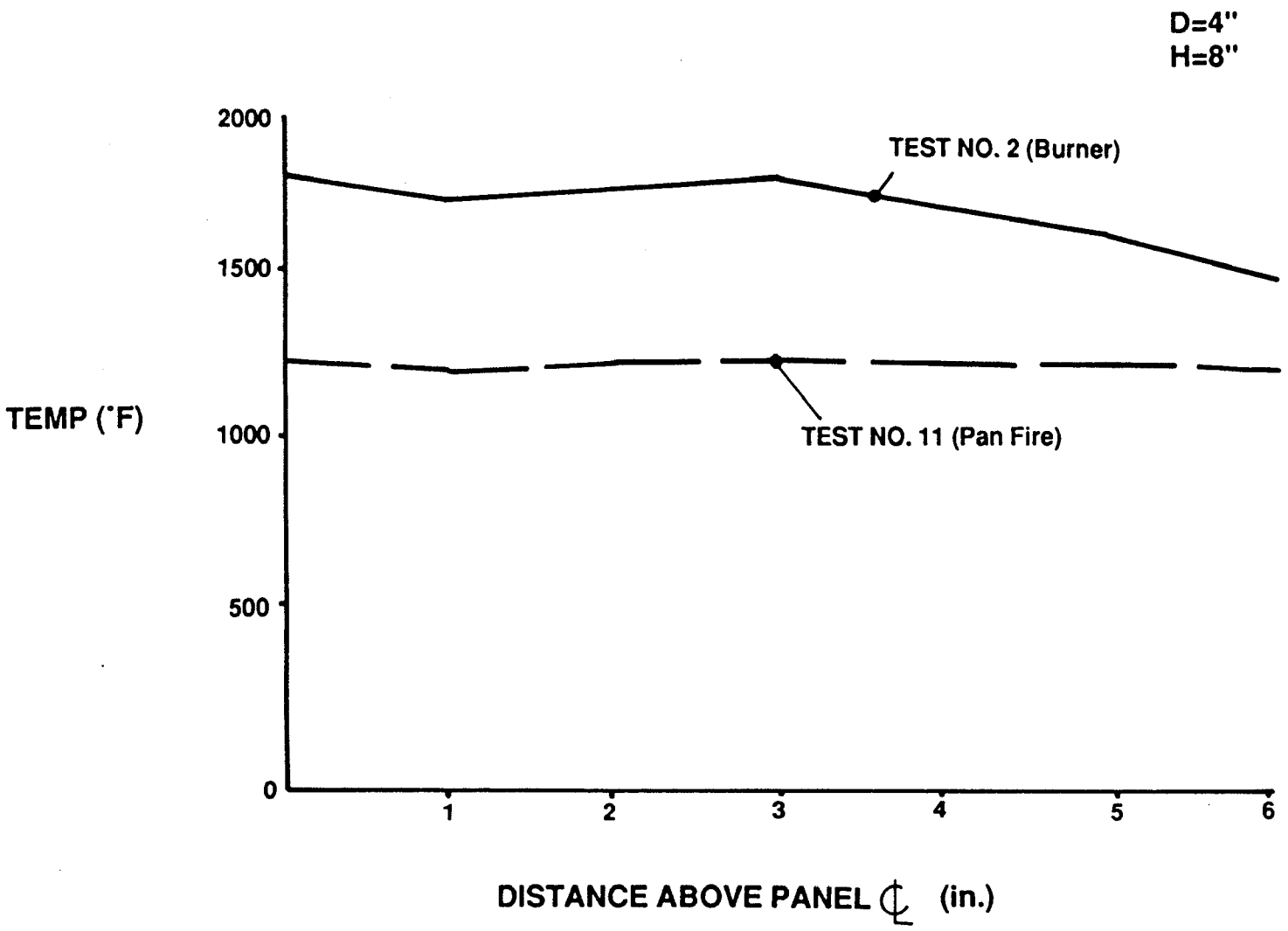

FIGURE 9-Temperature Profile for Test Nos. 2 and 11

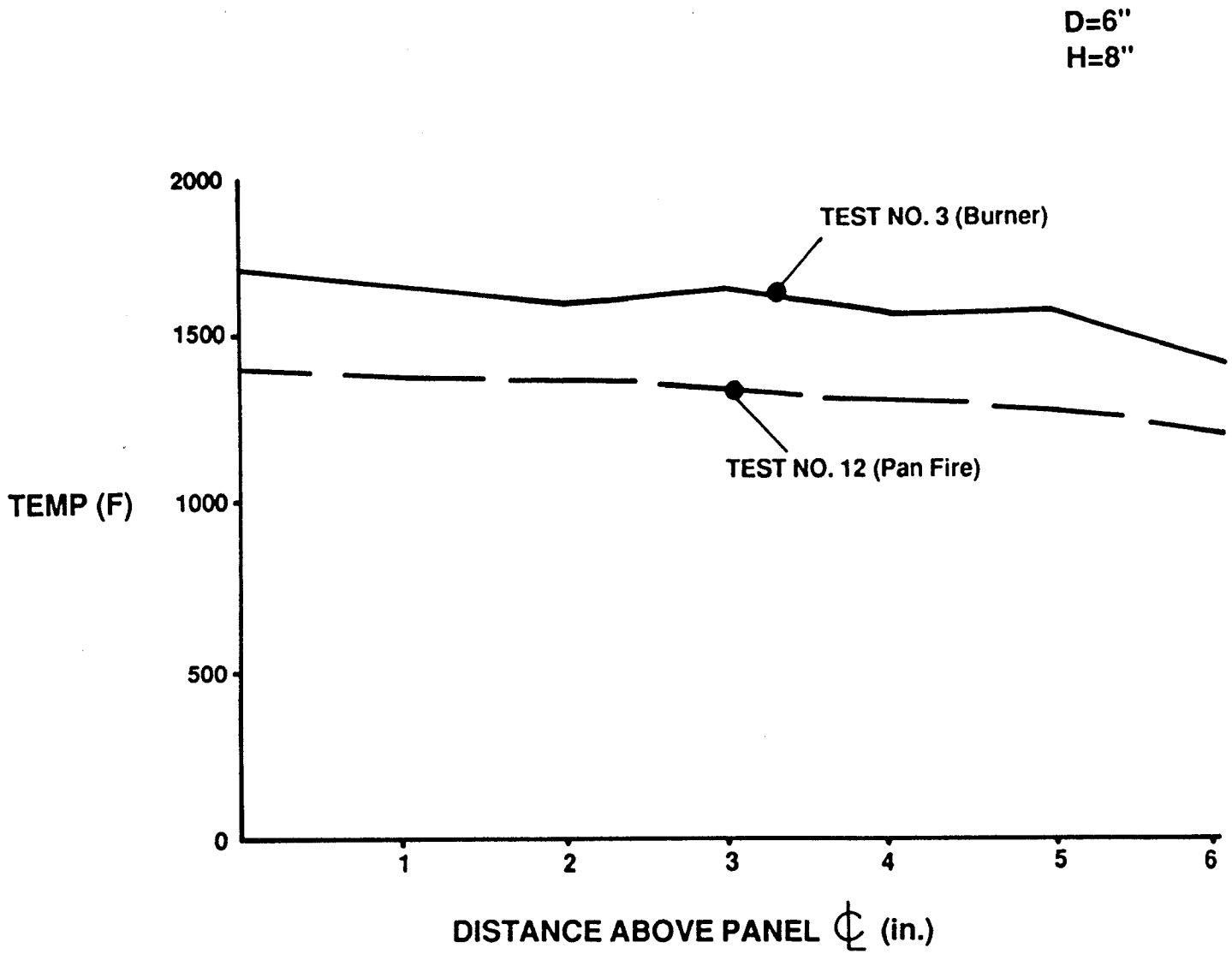

FIGURE 10-Temperature Profile for Test Nos. 3 and 12

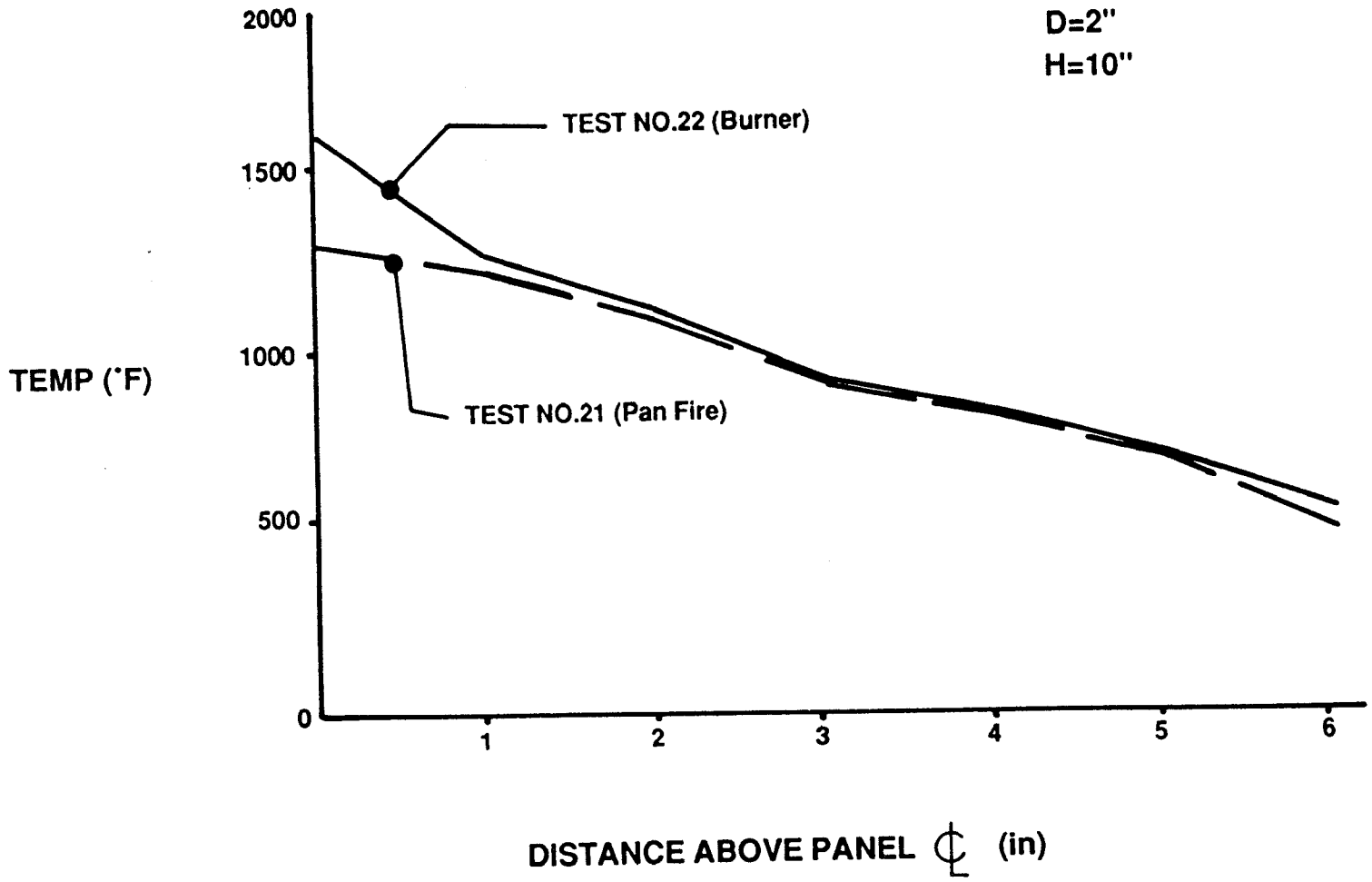

FIGURE 11-Temperature Profile for Test Nos. 21 and 22

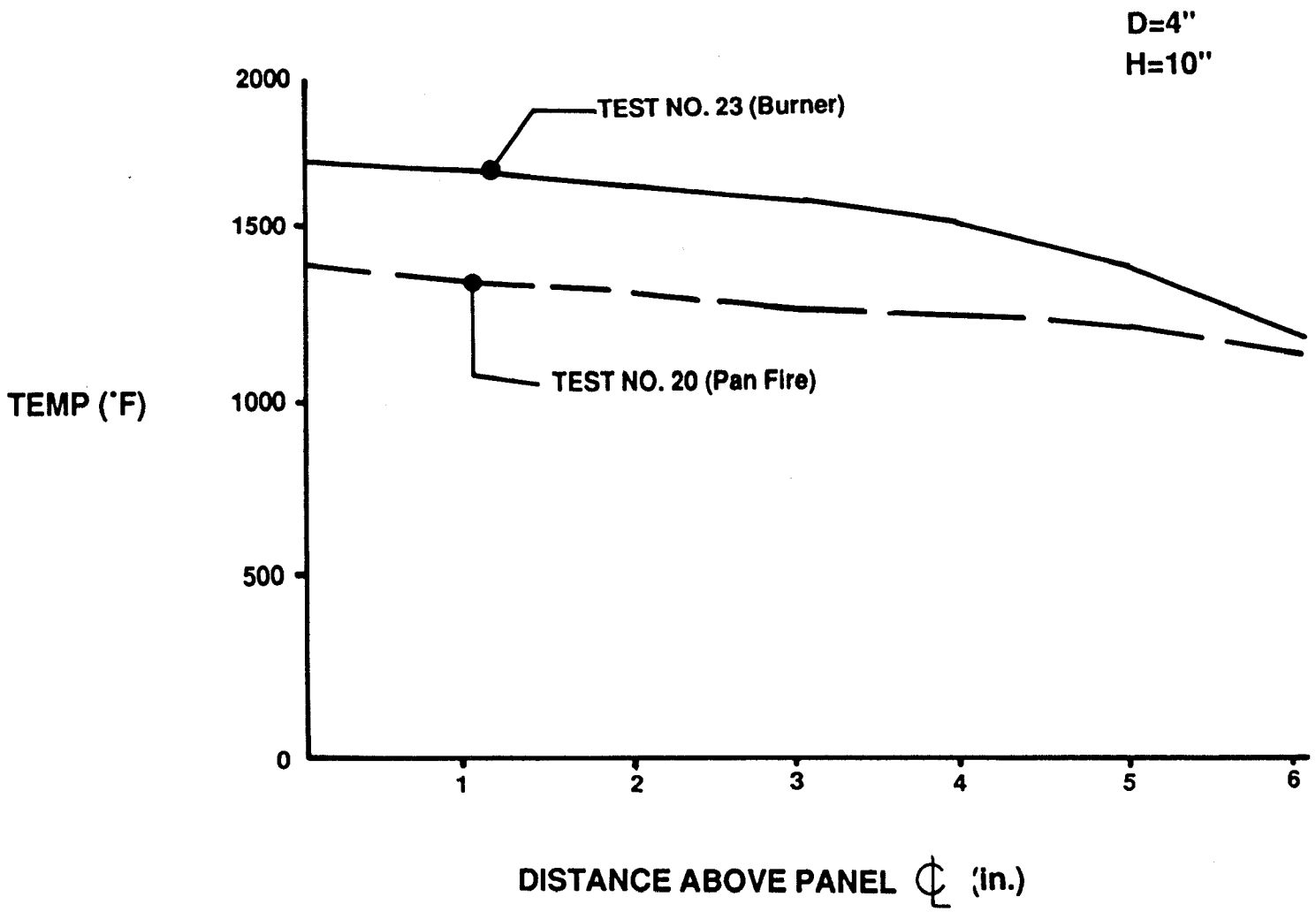

FIGURE 12-Temperature Profile for Test Nos. 20 and 23

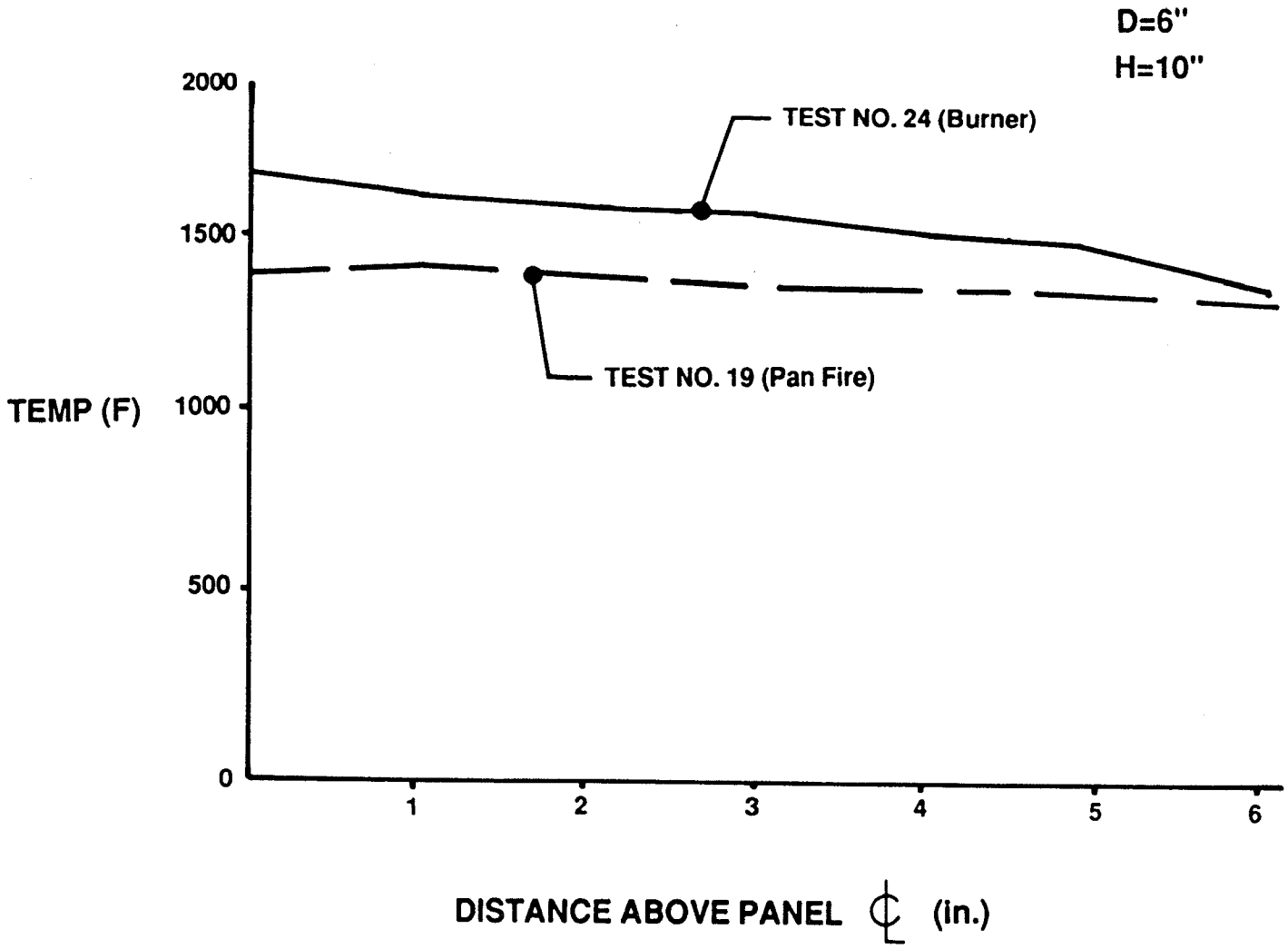

FIGURE 13-Temperature Profile for Test Nos. 19 and 24

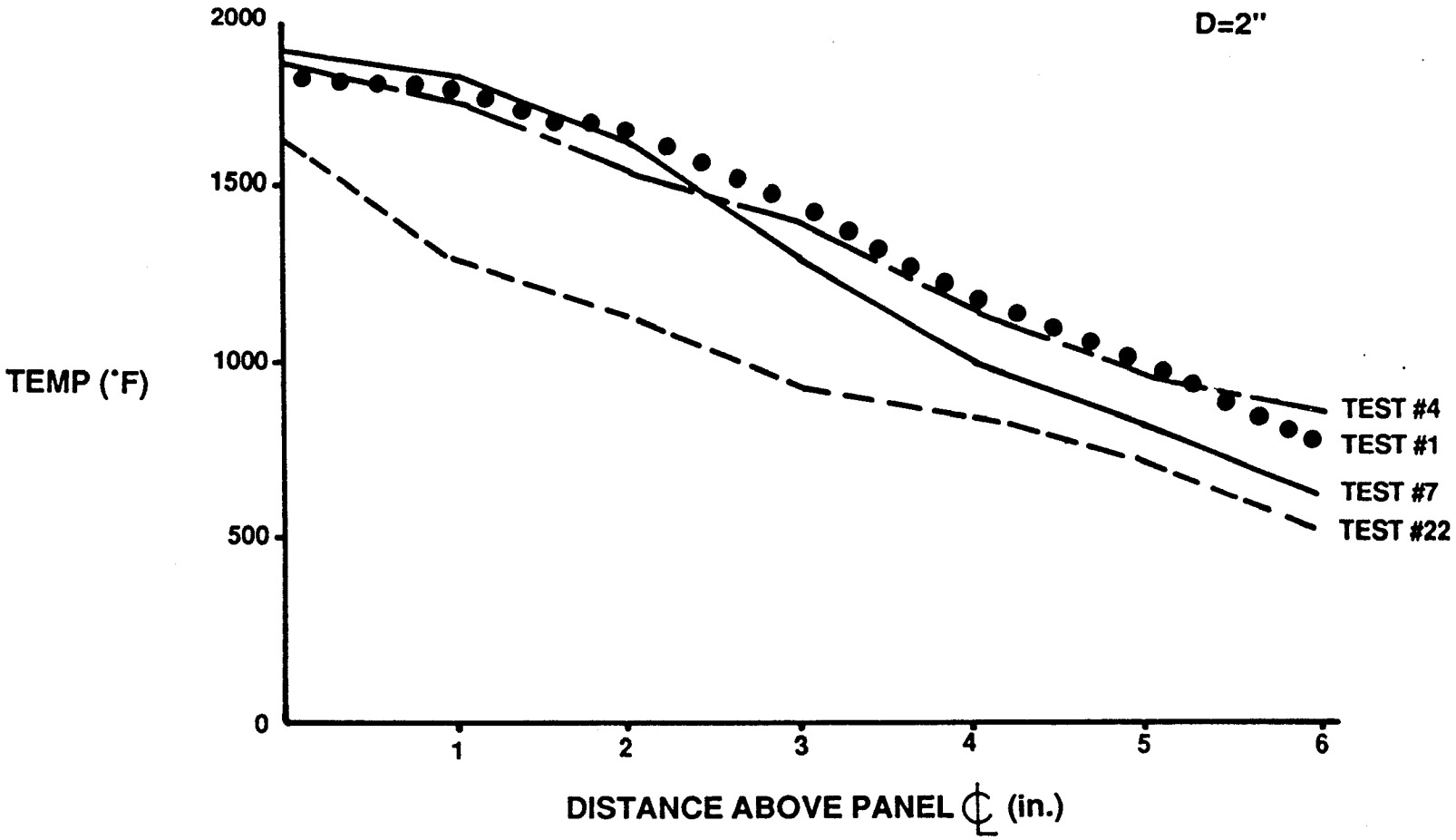

FIGURE 14-Comparison of Temperature Profiles for 2 Inch Diameter Test Panels Using Standard Burner

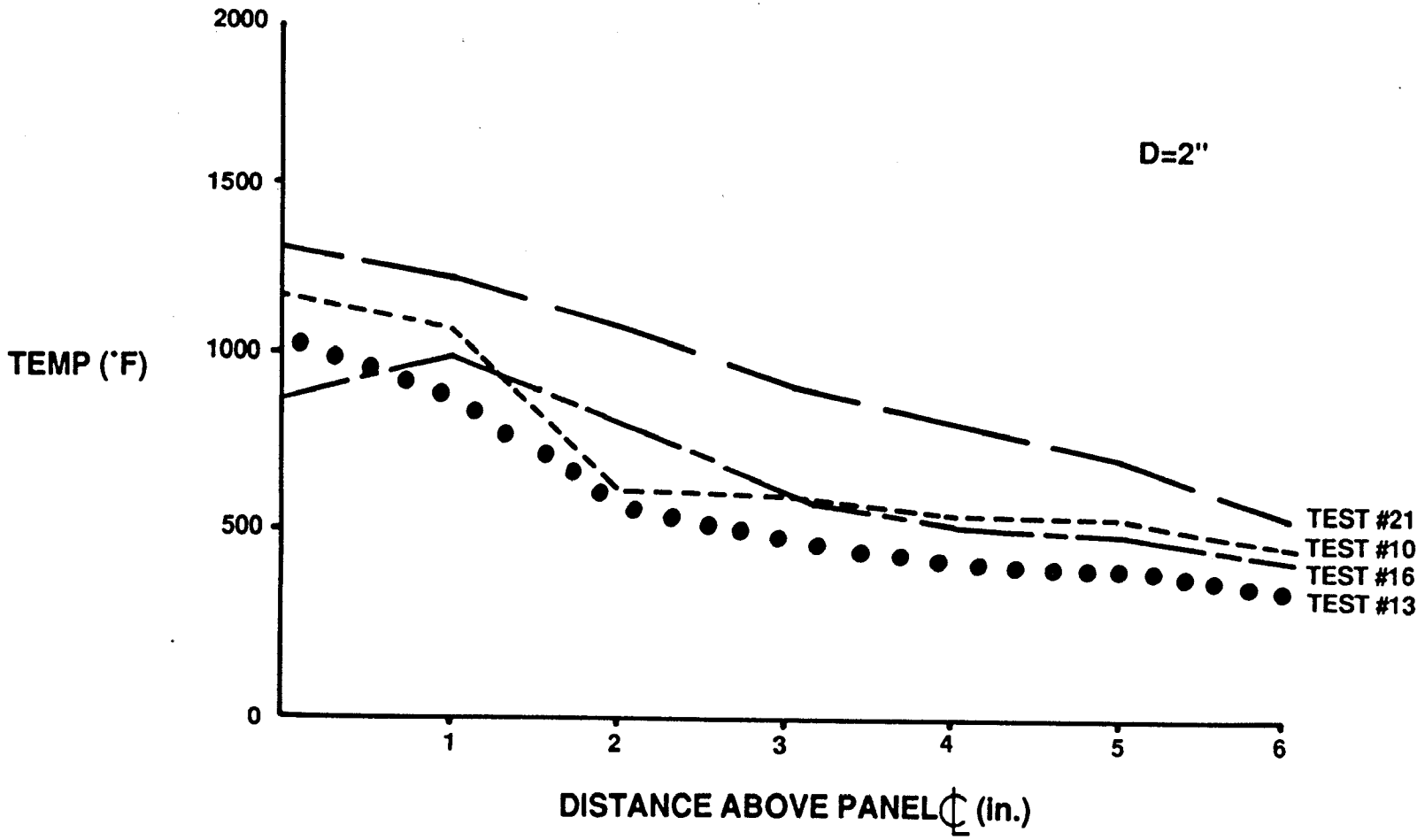

FIGURE 15-Comparison of Temperature Profiles for 2 Inch Diameter Test Panels Using Pan Fire