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EVALUATION OF EDISON CONTINUOUS FIRE DETECTOR IN AN XB-45 NACELLE

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by

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SUMMARY

Continuous fire-detector sensing elements manufactured by the Thomas A. Edison Company, Inc., were installed and subjected to a limited number of fire tests in the aft compartment of an XB-45 airplane nacelle. The sensing elements were so located that they would facilitate installation and maintenance. Fire destruction of the XB-45 nacelle prevented making other installations in which the sensing elements would have been more advantageously located for detection of fire. The detection system successfully detected 24 of the 33 fires conducted, and no false alarms or malfunctions occurred.

INTRODUCTION

The Department of the Air Force requested that a continuous fire-detection system manufactured by the Thomas A. Edison Company, Inc., be subjected to test fires in the aft compartment of an XB-45 airplane nacelle. The purpose of the tests was to evaluate the fire-detection system when it was installed in a full-scale installation and to obtain information on its operating characteristics. It was planned to conduct a series of tests with sensing elements installed at various locations in the nacelle; however, destruction of the XB-45 nacelle prevented extensive testing. Therefore, the tests were limited to those on the first installation made. That installation consisted of two lengths of sensing element installed longitudinally in the aft compartment of the nacelle. Such installations are not recommended and severely penalize a continuous-detector system because the sensing elements were parallel to the natural flow of air through the nacelle. This installation was made because of the difficulty of installing continuous sensing element in the XB-45 nacelle transverse to the air flow without placing the sensing element in locations where it will be susceptible to damage during engine maintenance or change.

EQUIPMENT AND PROCEDURE

The aft compartment of an XB-45 nacelle was used as the fire zone for the tests. It contained a net volume of approximately 237 cubic feet and was 17.5 feet in length. In the XB-45 nacelle, the outlet ends of the jet-engine tail pipes are sufficiently recessed to cause an air-ejector action and thus induce air to pass through the aft compartment from the inlet louvers at the forward end of the compartment. During engine operation, fires in that compartment are greatly influenced by this induced air flow.

Continuous fire-sensing elements which occupy a line in the nacelle space are similar in shape to a wire. They are sensitive at any or all points along their length. The Edison continuous-type fire-detection system tested was composed of a control assembly and lengths of fire-sensing element.

See Fig. 1. The sensing element is of coaxial construction and consists of a single center conductor inserted into a steel-alloy tube of approximately 0.08 inch o.d. The space between the center and outer conductors contains a special heat-sensitive compound having a high resistance at normal temperatures, and thus insulates the center conductor from the grounded outer tube. When the temperature anywhere along the sensing element reaches a predetermined critical value (approximately 550° F), the compound at that point becomes a conductor and completes the circuit between the center conductor and ground. This causes current to flow to the alarm relay located in the control assembly and actuates the alarm. The system automatically clears when the temperature of the sensing element returns to normal. A test circuit provided a means to determine the integrity of the system. For the fire tests, one 20-foot length and one 15-foot length of sensing element were used. The 15-foot element was mounted on two-inch standoff brackets attached to the nacelle structural keel about six inches above the bottom of the keel. The 20-foot element was mounted on standoff brackets attached to the nacelle just above the longitudinal joint of the bottom access doors. The installation is shown in Fig. 2.

Since the nacelle structure was essentially symmetrical about a vertical longitudinal plane, tests were conducted on one side only. For these tests, the No. 3 engine side was used. The fire locations used in the testing are indicated in Table I and are shown in Fig. 3. These locations were selected as being representative of locations of potential fire hazard such as flammable-fluid leaks and engine failures.

The test sequence was as follows:

1. Establish the simulated operating conditions for the test.

2. Switch on test-fire ignitor.

3. Start the fuel flowing for test fire.

4. Stop the fuel flowing for the test fire after ten seconds or alarm from the fire-detection system, whichever occurred first.

The time required for the fire-detection system to alarm was recorded by an Esterline-Angus recorder. The time recorded was the period between the start of fuel flow to the test fire and the alarm given by the detection system.

The simulated operating conditions under which tests were conducted are as follows:

1. Aircraft operating at cruising speed, both turbojet engines operating at 90 per cent of maximum rated rpm, and ram air at a total pressure of one inch Hg supplied to the engine inlets.

2. Ground taxi, both turbojet engines operating at 60 per cent of maximum rated rpm, and air drawn by the engine compressors from the atmosphere.

3. Engine starting, both turbojet engines not operating, and consequently no air flow through the aft compartment.

RESULTS AND DISCUSSION

The results of full-scale tests are shown in Table I. The time shown is that required for the detector system to give an alarm from the beginning of fuel flow supplied for the test fire. No attempt was made to determine the clearing time for the detector system because of the difficulty in determining the duration of the test fires. The fire-detection system detected the test fires under the conditions of simulated operation in 24 of the 33 tests conducted. The detector system did not false-alarm or fail to clear after any of the tests. The sensing element and connectors were not damaged by the test fires or by vibration in the nacelle.

CONCLUSIONS

1. The detector system did not false-alarm or malfunction during the tests in the XB-45 nacelle and was not damaged by the test fires or by vibration.

2. Although better fire detection from the standpoint of speed and coverage could have been obtained with a transversely installed system than by the longitudinally installed system described in this report, the data indicates that the Edison continuous fire detectors operated effectively.

TABLE I

TIME REQUIRED FOR FIRE DETECTION
(Detector elements installed longitudinally
aft compartment, XB-45 nacelle)

Test No.	Test Conditions	Fire Location (See Fig. 3)	Alarm* Time (Seconds)
1	Engine Starting	G	12
2	Ground Taxi	G	3
3	Normal Cruising	G	3
4	Normal Cruising	G	2-1/4
5	Engine Starting	S	No Detection
6	Engine Starting	S	No Detection
7	Ground Taxi	S	5
8	Normal Cruising	S	5
9	Normal Cruising	S	4
10	Engine Starting	J	8-1/2
11	Ground Taxi	J	No Detection**
12	Normal Cruising	J	No Detection**
13	Engine Starting	X	11
14	Ground Taxi	X	5-3/4
15	Normal Cruising	X	No Detection
16	Normal Cruising	X	No Detection
17	Ground Taxi	Q	9-1/2
18	Normal Cruising	Q	8-3/4
19	Normal Cruising	Q	8-3/4
20	Engine Starting	V	11
21	Engine Starting	V	No Detection
22	Normal Cruising	V	6
23	Ground Taxi	W	7
24	Normal Cruising	W	4
25	Normal Cruising	W	4
26	Engine Starting	W	10
27	Engine Starting	U	No Detection
28	Ground Taxi	U	17
29	Normal Cruising	U	7
30	Normal Cruising	U	7
31	Engine Starting	T	No Detection
32	Ground Taxi	T	7
33	Normal Cruising	T	6-1/2

Average time for alarm was 7.2 seconds.

* Alarm time is based on the time between release of fuel and indication from the detector system.

** Test fires at this location were influenced by high velocity air flow.

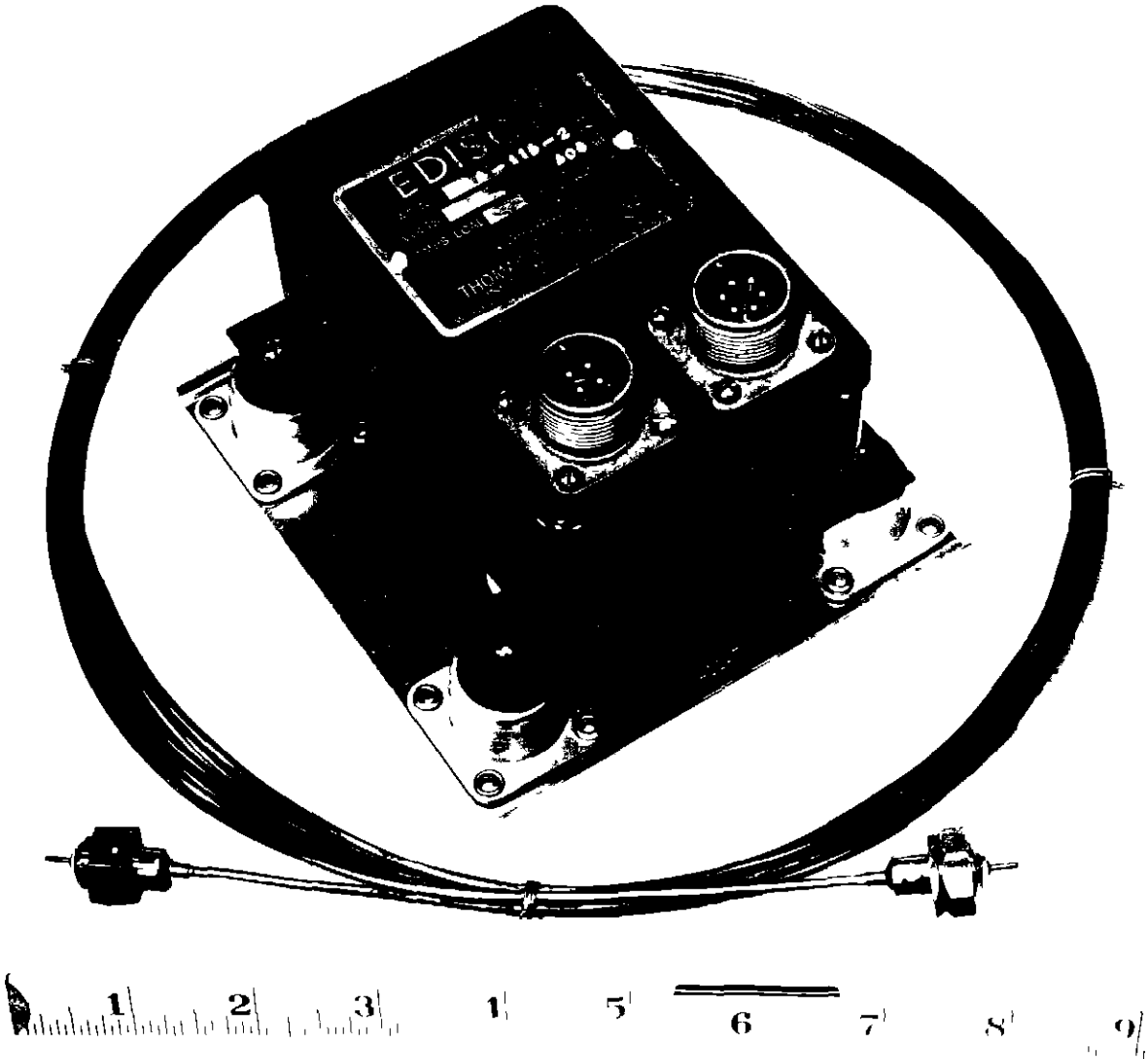

FIG 1 THE EDISON CONTINUOUS FIRE DETECTOR

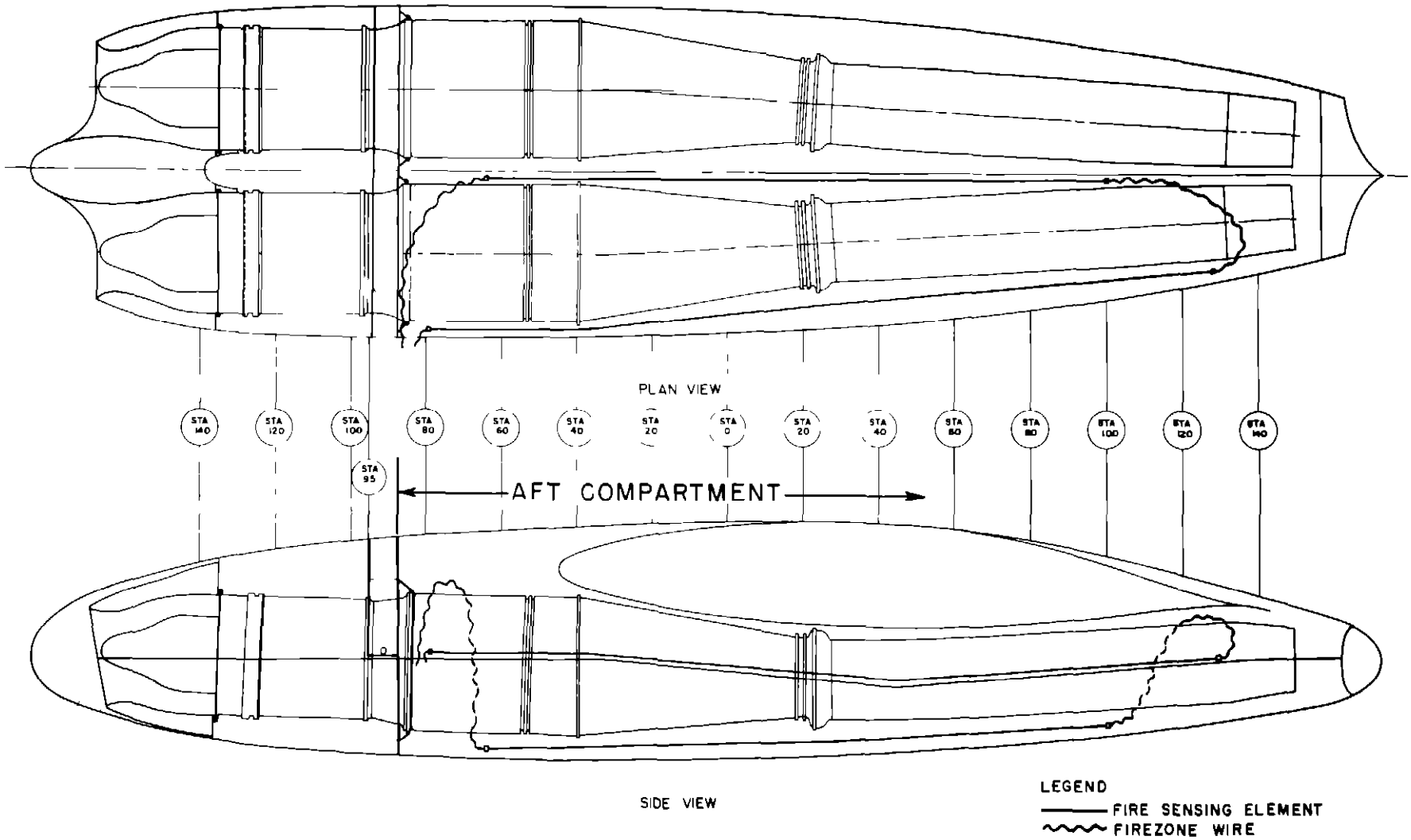

FIG 2 LOCATION OF CONTINUOUS-FIRE-DETECTOR SENSING ELEMENT IN XB-45 NACELLE, EDISON SYSTEM

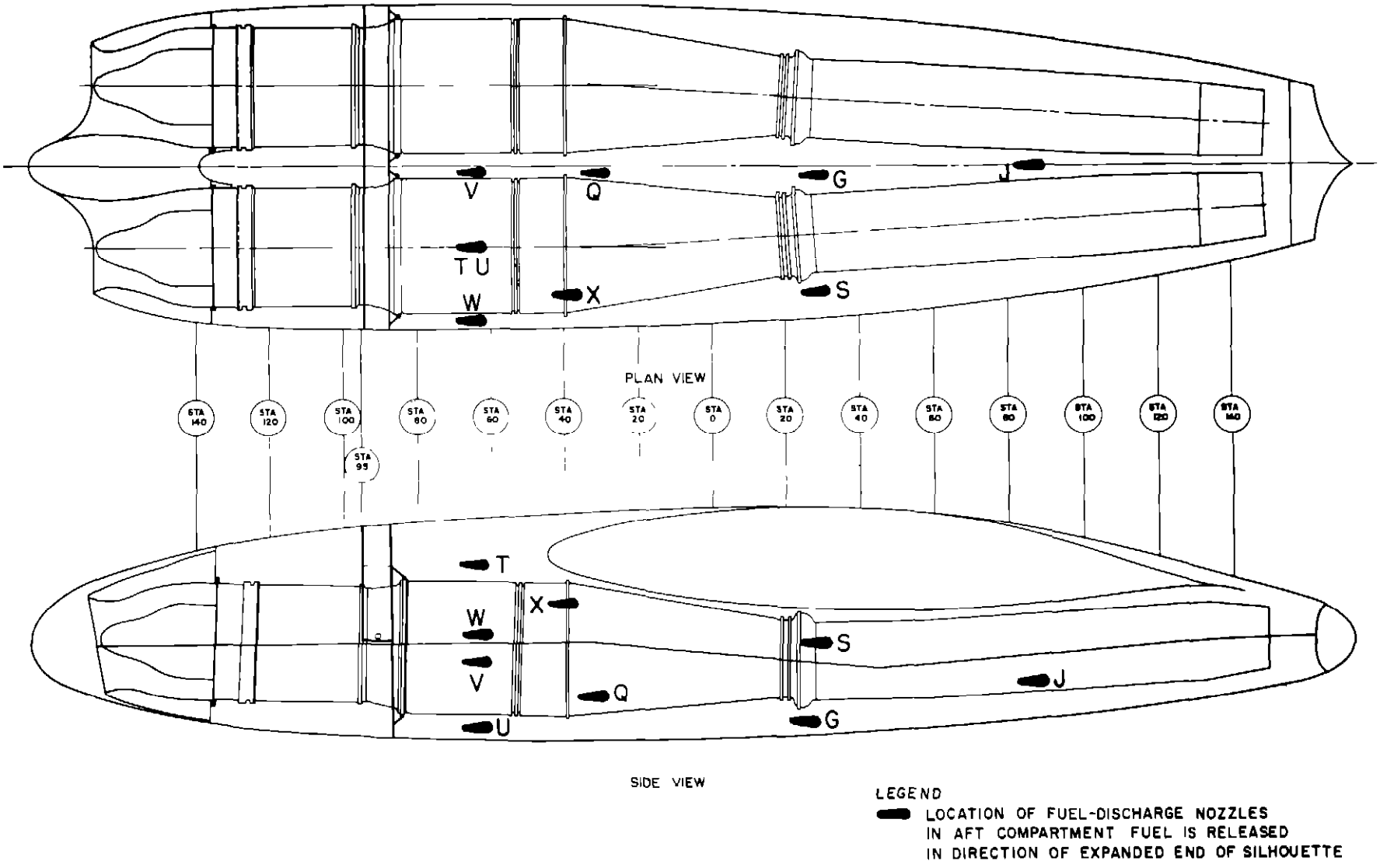

FIG. 3 FIRE NOZZLE LOCATIONS FOR DETECTOR TESTS, XB-45 NACELLE