10. THE TIROS SATELLITES

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This Workshop provides the opportunity to evaluate the performance of the Tiros meteorological satellite system as part of the NASA studies of the atmosphere and its motions. In addition, the three satellites launched have varied in degree of success. The usual difficulties that an experimental physicist or meteorologist may have in conducting atmospheric experiments have been encountered. However, these have been exaggerated by the unusual laboratory (space) in which the experiments are being conducted.

There has been no question for some time of the value of meteorological satellites. But the technology of the launch vehicles, the telemetry problem, that is, the problem of communicating the data from the satellite to the ground, and all the other practical considerations, including funds, have only recently permitted the realization of the desires of meteorologists and geophysicists to bring the entire earth under observation.

The point of view taken by NASA is that Tiros represents a series of experiments rather than a purely operational tool or the final answer in the problem of making measurements from outside the atmosphere. A close analysis of the infrared and reflected solar radiation data obtained by the Tiros satellites reveals the experimental nature. Not only does it take time to receive the data from the satellite but it also takes time to interpret these data in terms of the atmospheric phenomena.

The experimental Tiros system can really be broken down into four major elements: The launch vehicle; the spacecraft or satellite; the data acquisition, that is, the problems of acquiring the data from the satellite by the ground stations; and the data utilization, that is, the procedures by which the data are used. This paper is concerned with only the first three of these elements.

The launch vehicle.—The Thor-Delta used to launch the satellite is a three-stage vehicle: liquid, liquid, and solid; that is, the first two stages are liquid and the third stage is solid. It has been used to launch Tiros I, II, and III. The Tiros I launch vehicle was slightly different in terms of guidance and sequencing, but it had the same propulsive units. These three vehicles have placed the satellites in nominally 400-nautical-mile orbits with 100-minute periods and roughly 48° inclination. This means that the satellite latitude excursion is between 48° north and 48° south latitudes, corresponding roughly to the limits of the globe brought under observation.

Figure 10–1 shows the Thor booster being inserted in the launch stand prior to the launching of Tiros II. The first-stage Thor has a thrust of about 150,000 pounds. It is interesting that the Thor vehicle used to launch Tiros I

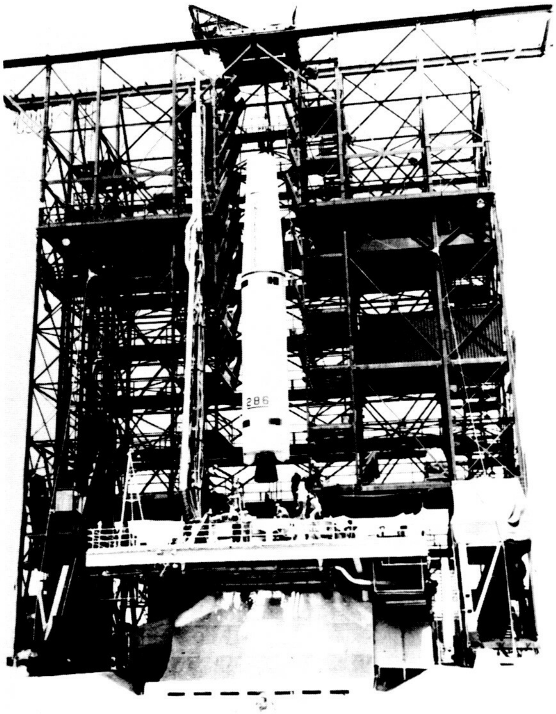

FIGURE 10–1. Placement of the Thor booster on the launch stand for the TIROS II launch from Cape Canaveral.

was extensively used as a training vehicle by the military services; finally, it was obtained by NASA and modified to the form used for the TIROS launches. This modified Thor successfully performed in the launch of the TIROS I satellite itself.

Figure 10–2 shows the vehicle on the launch stand. The launch vehicle stands about 90 feet high, it is about 8 feet in diameter, and at lift-off it weighs a little over 100,000 pounds. An impressive feature of the launch vehicle is the rate at which it consumes oxygen. It consumes oxygen during the boost phase at the same rate as about 6 million people.

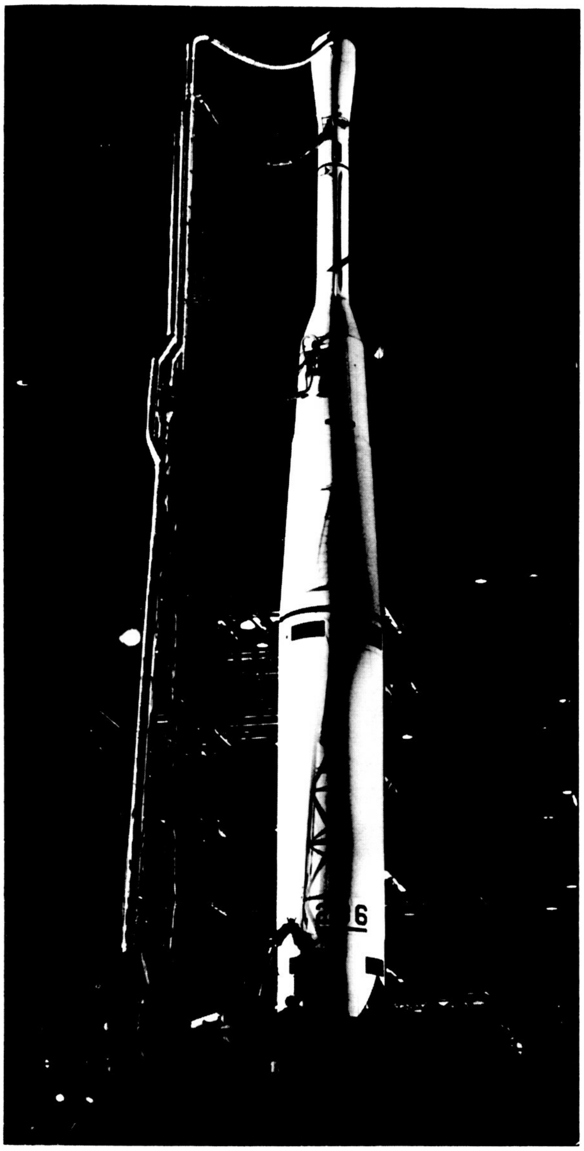

FIGURE 10–2. The Thor-Delta launch vehicle standing ready for launch in the early morning of November 23, 1960.

Table 10–I summarizes the satellite orbital parameters resulting from the successful launch-vehicle performances:

TABLE 10–I.—*Orbit Information*

	TIROS I	TIROS II	TIROS III
Period, min	99. 24	98. 26	100. 4
Average height, statute miles (km)	450 (720)	420 (676)	475 (760)
Apogee, statute miles (km)	461. 3 (740)	451. 5 (726)	509. 8 (820)
Perigee, statute miles (km)	436. 0 (702)	387. 8 (624)	457. 1 (736)
Eccentricity	0. 00287	0. 00727	0. 00593
Inclination, deg	48. 392	48. 530	47. 898

The spacecraft.—Figure 10–3 shows a familiar view of the satellite which is 42 inches in diameter and about 19 inches high. The satellite weighs about 280 pounds and contains a vast complex of optical, sensory, electronic, magnetic, and mechanical devices that serve the following functions: to detect, to store, and to transmit the data; to control the various functions; to provide memory (a clock) inside the satellite; to control the spin rate of the satellite because it is spin stabilized; to control the power; and to control the attitude to a certain extent. The attitude of the TIROS satellite is the most critical problem.

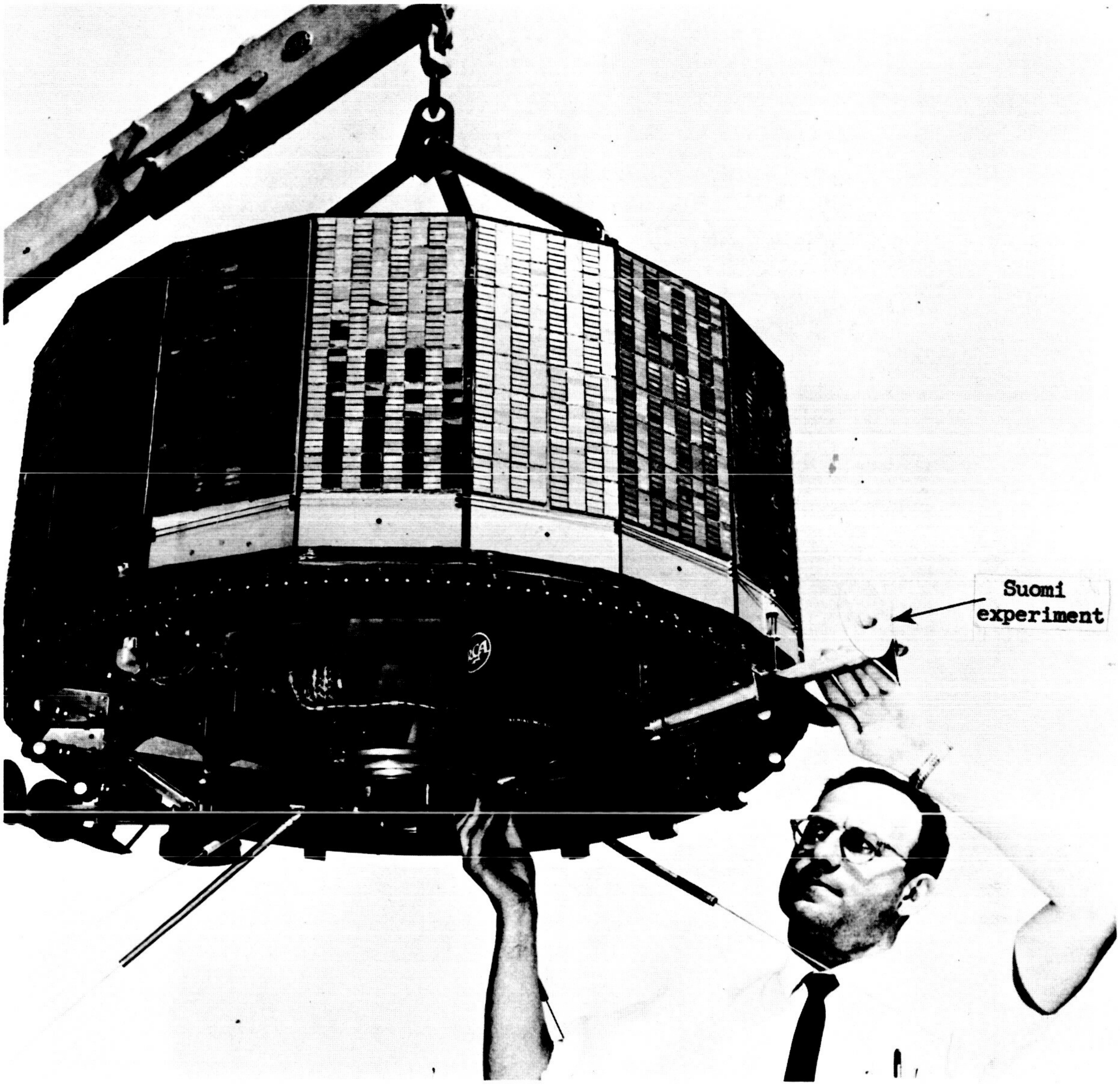

FIGURE 10–3. The TIROS satellite in the TIROS III configuration showing the base plate with cameras looking downward. The top is covered with solar cells.

Figure 10–4 shows a top view of the internal package. The main interest here is in the sensor systems. The tops of the television cameras can be seen in the figure: two wide-angle television systems (Nos. 5 and 30) and one of the big tape recorders (Nos. 3 and 19) on which the picture information is stored. The infrared radiation system (No. 12) and instruments