DSCS PTTI TRANSFER

by

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This will be a discussion on the background and the future of the Defense Satellite Communications Program. I am going to give an introduction to our satellite system, where we are and where we are going.

The Defense Satellite Communications Program is currently operating with what we call the Phase One Satellite. They are very unsophisticated little satellites with a total power output of three watts. They only weigh about 100 pounds; they are spin-stabilized. They have an oddball shape for an equatorial drifting satellite (Figure 1), but these were originally designed to go into polar orbit. We now have 26 of these in orbit, 21 of which are working. These satellites are not controllable; we get beacon telemetry out of them but we can't turn them on, we can't turn them off, and we can't move them. They just drift up there at a rate of about 25 degrees per day.

Figure 2 shows our largest terminal which is the FSC-9. It was designed back in the days of SYNCOM and has been converted progressively since then. It will operate with a Phase One bird or a Phase Two bird. It is quite heavy because of the 60-foot dishes. We have two FSC-9's; one at Camp Roberts, California, the other at Ft. Dix, New Jersey.

Figure 3 shows the MSC-46 which is the "work horse" of our satellite system. We have 14 of these. They have 40-foot dishes and it is possible to move them. We moved one in a little over a week in Asmara, although the time normally quoted is 30 days. We are in the process of moving another one from Wildwood, Alaska to Taegu, Korea.

The TSC-54 is shown in Figure 4. It has an 18-foot equivalent antenna and is highly transportable. It can be folded up and put in an aircraft in about two or three hours. We have had them operating within two hours after off-loading from the aircraft. These can be moved, of course, to anywhere that a C-141 or a C-133 equivalent can operate.

Our new generation satellite is shown in Figures 5a and 5b. This is the Triple-7 bird, our Phase Two satellite, which is quite a bit more sophisticated than the Phase One. It is 9 feet in diameter, about 13 feet tall, and weighs about 1150 pounds. It has two steerable antennas; each has a beam width of about two and one-half degrees. The horns in the middle are the earth coverage mode antennas. The satellite generates about 500 watts. Each of the transmitters is powered by a 20 watt TWT. The actual flux density put out by those narrow beam antennas right now exceeds the flux density allowed by the ITU, so it may have to be reduced. This could provide, between big antennas, as many as 1200 voice channels of communications. On the other hand, if the earth coverage antennas were dedicated to two airborne terminals with 32-inch dishes, it would take the entire satellite to communicate one 2400-bit data channel. This satellite will serve for analog communications, digital data users, and it will serve such things as the wideband imagery and the Compass Link photography being sent back from Vietnam. Not being in competition with the commercial satellite people, we can run many different types of signals through it. If we were to acquire the wideband services through COMSAT right now, we would have a hard time paying the bill. COMSAT is now charging companies such as IT&T and World Comm about $4,000.00 per voice channel per month.

Figure 6 shows the terminal configuration which we have at the present moment and it is a point-to-point network. We are not very efficient; Northwest Cape cannot talk to Kwaijalien, Northwest Cape talks to Guam. Saigon talks only to Hawaii. Hawaii, however, relays to Camp Roberts.

The first two Phase Two satellites were launched November 2 from the Eastern Test Range, and about eight hours after the launch we had lost both of them. During the day, we recovered the serial number 2 satellite. It was a combination of software problems (they put the "A" program in the "B" computer) and a hardware fault in the satellite. The second satellite was recovered three days later by analyzing the hardware fault. Right now the hardware faults are under control; they still exist but we know how to work around them and at this moment, they do not cause any significant decrease in reliability. We exepct to test both satellites over the Los Angeles area (105°W and 115°W) for approximately 60 days, at which time the best of the two satellites will be drifted to the west to a position at 173°E. The other satellite will be put over the Atlantic at 13°W. However, that second satellite will be subject to additional testing through our terminals at Fort Monmouth and Fort Dix. Two of these terminals are training models; two of them are engineering models. Fort Dix is part of the engineering system but later it will become the backup terminal for our CONUS East.

Figure 6 shows those sites at which we now have the PTTI capability, or cesium standards. We have directed all the services to procure cesium standards for all terminals for two reasons. First is the advantage of not having to fly these standards around the world for calibration, and second we have in our system a spread spectrum device whose performance can be improved by use of these standards.

Now that the satellite has been described, I would like to discuss some of its advantages. We can operate in any sort of a mode with this satellite. In other words, we can go from earth coverage to earth coverage, transmit on earth coverage and receive on narrow beam, and vice versa. It has adjustable power output and a secure command and telemetry channel. Our hardware problem is in that secure system but it is under control.

Another advantage of this satellite over our current satellites is that although it will be geostationary, we can reposition it at 30 degrees per day, which is absolutely linear. In other words, we can reposition it 30 times at 1° per day or 15 times at 2° per day. It does not start to break down in linearity until you get down to below a tenth of a degree per day in positioning. One reason for this is that the repositioning device is a pulse jet type of thruster operating on hydrazene so one tells it how many pulses to shoot out and it gives the delta V to drift into various stations. Also sufficient fuel for the east-west station keeping and slow repositioning is now on board for seven years vice five years specified. Therefore, if everything else works out as well as the Phase One birds we can have these satellites around for quite some time. We can switch between all of the components within the satellite and we can control the gains and we can switch everything around and steer these antennas in addition to steering the satellite.

Figure 7 shows a very high performance 60-foot antenna. It is not transportable but it is recoverable. It is designed so that a crew of riggers can dismantle it in about two weeks and re-erect in about a month. It is all bolted together, there is no welding that would have to be done. The only thing that is not recoverable is the concrete foundation.

To accompany this is a new medium terminal shown in Figure 8. It uses the same antenna design as the AN/TSC-54. In the background you see the electronic van, maintenance and supply van and an operations van.

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The vans for the heavy terminal look just like the vans for the medium terminal. As a matter of fact, you can see a pipeline coming out that contains the Servo control cable and the RF system. If you put a connector in the middle you can plug either antenna into either set of electronics. The basic difference between the two of them is the degree of redundancy in highpowered amplifiers and in some of the up and down converters. These terminals will be capable of transmitting as many as ten up channels and receiving twelve down channels, it is very versatile.

During this past summer, we conducted a serious study of what the post-1976 satellite would look like and no significant break throughs are expected between 1976 and 1978. However looking beyond that we see some very fancy satellites, possibly using the higher ranges - 15, 30, 40 gigahertz region - and we may have satellite-to-satellite link at EHF in the 60 gigahertz region.

This is the status of the Defense Satellite Communications System that will one day allow us to transfer time to all of our major bases around the world. The Navy is developing a family of shipboard terminals. The Air Force has developed an advanced development model of an airborne terminal.

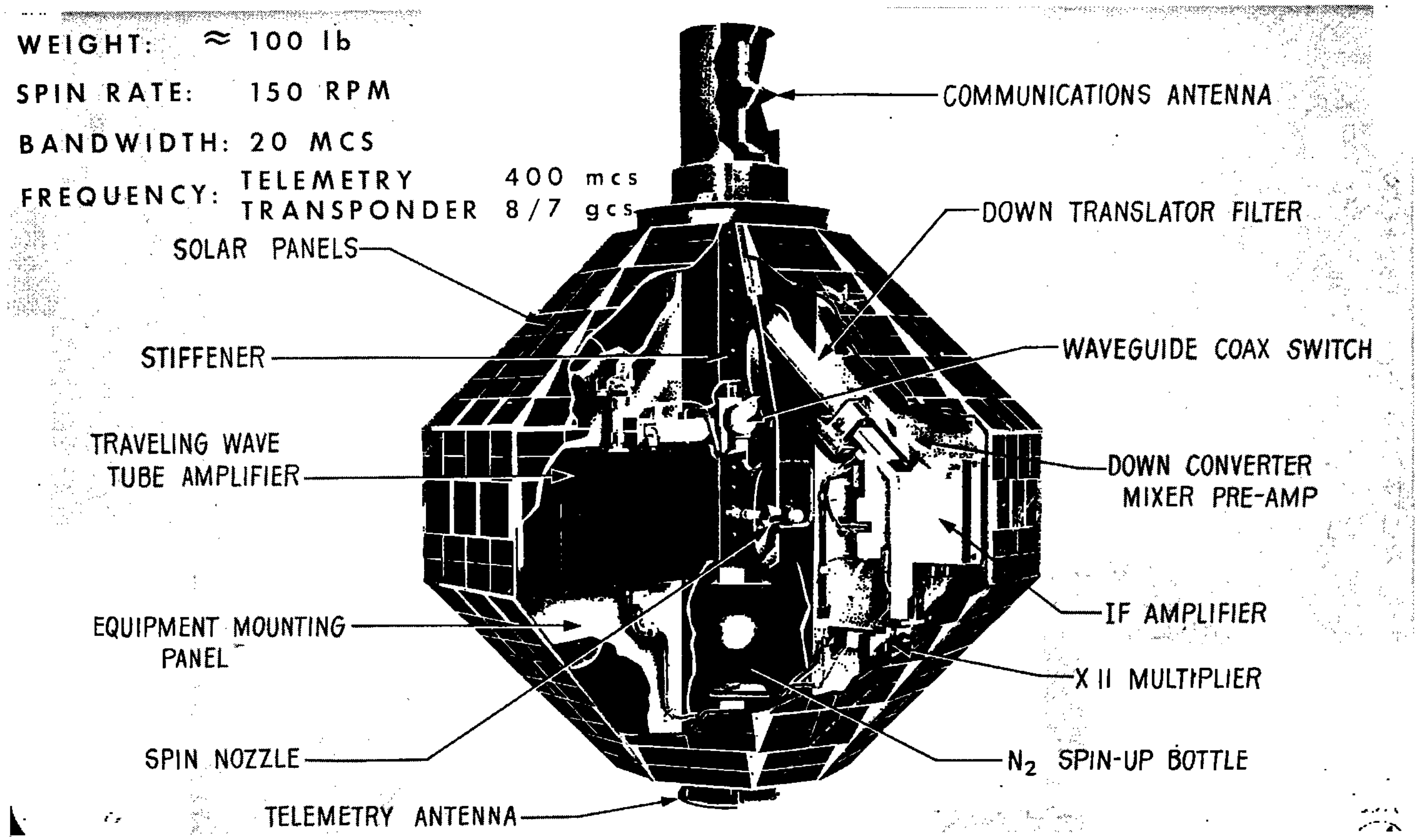

Figure 1. SPACE SUBSYSTEM - SATELLITE

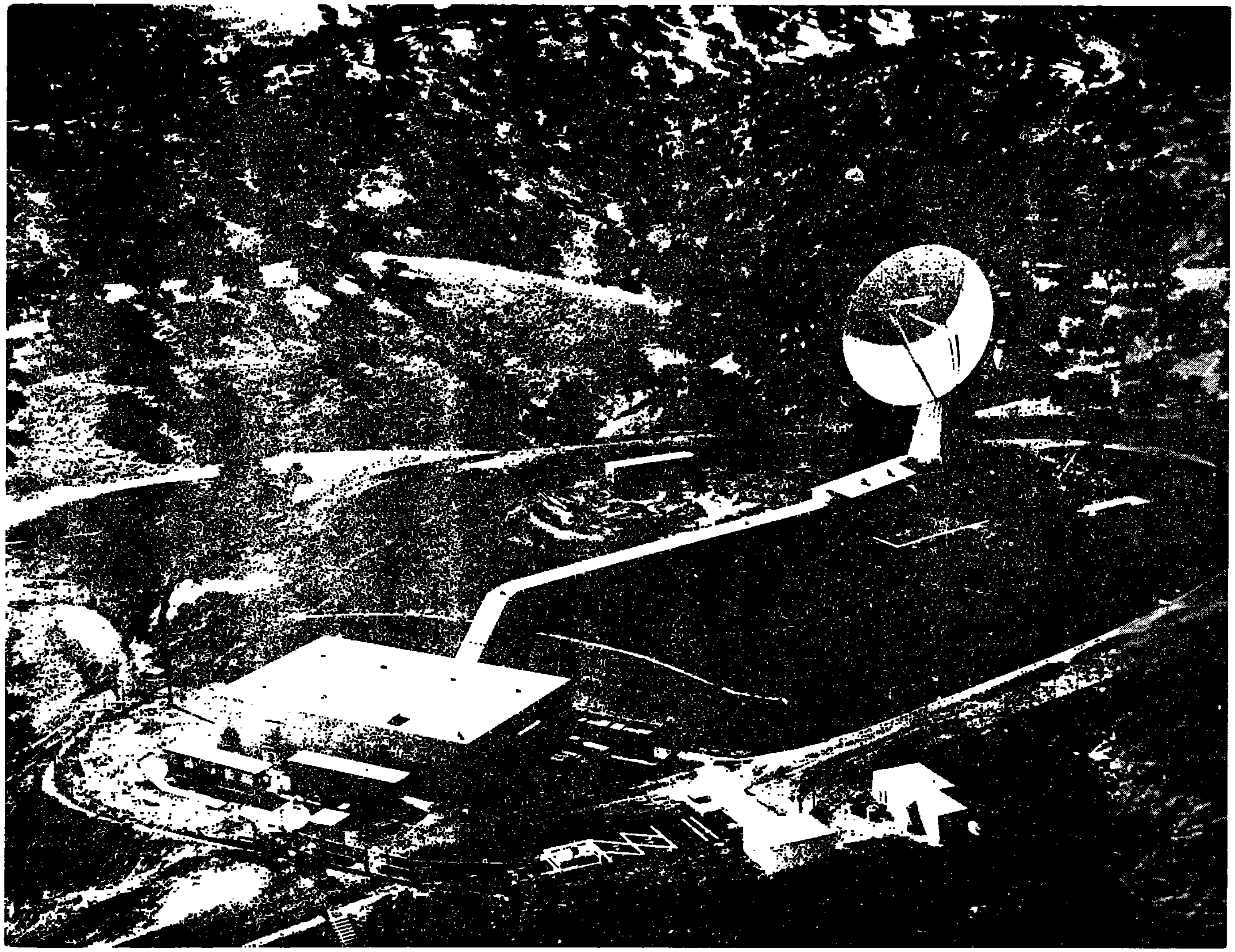

Figure 2. FSC-9 MODEL

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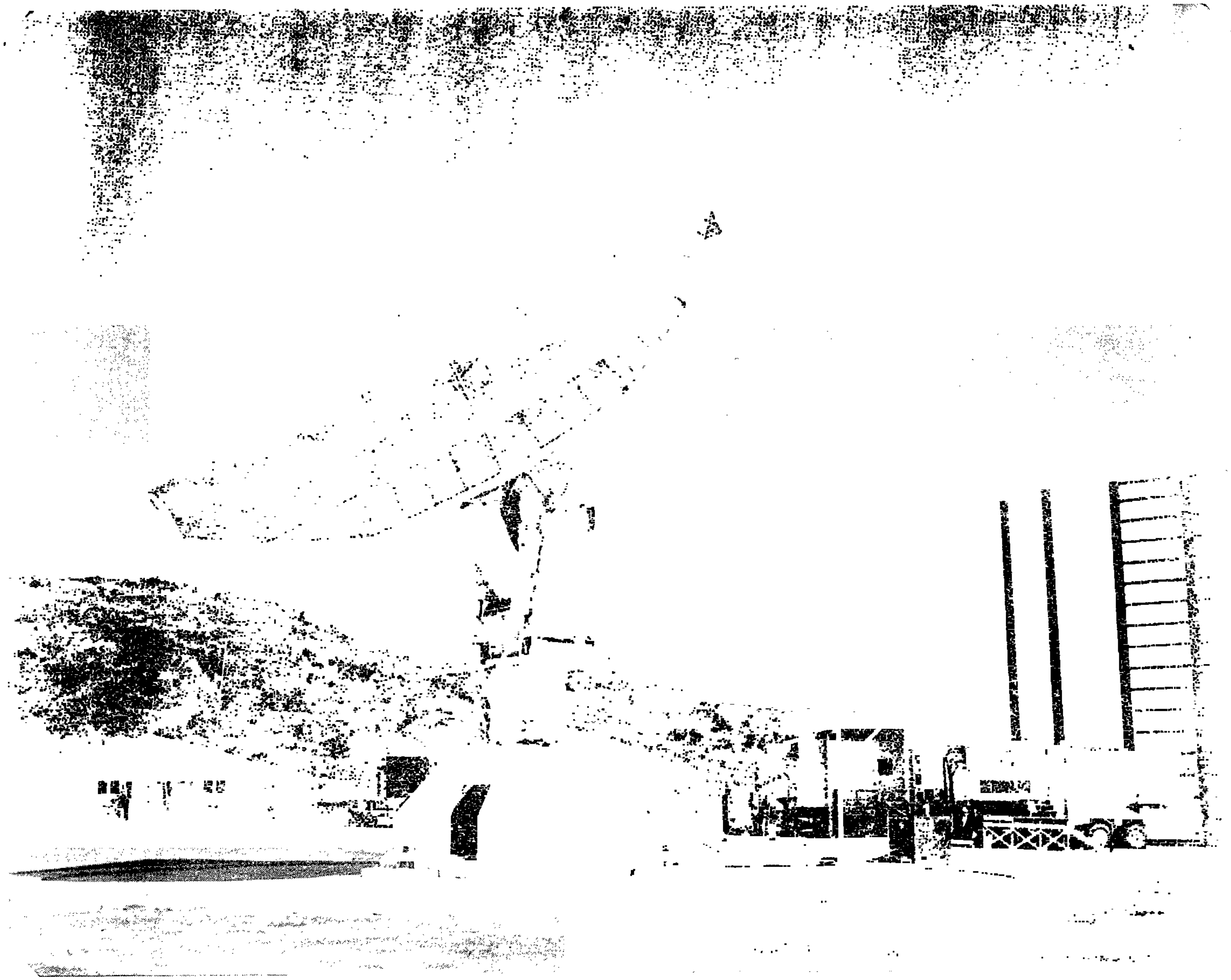

Figure 3. MSC-46 MODEL

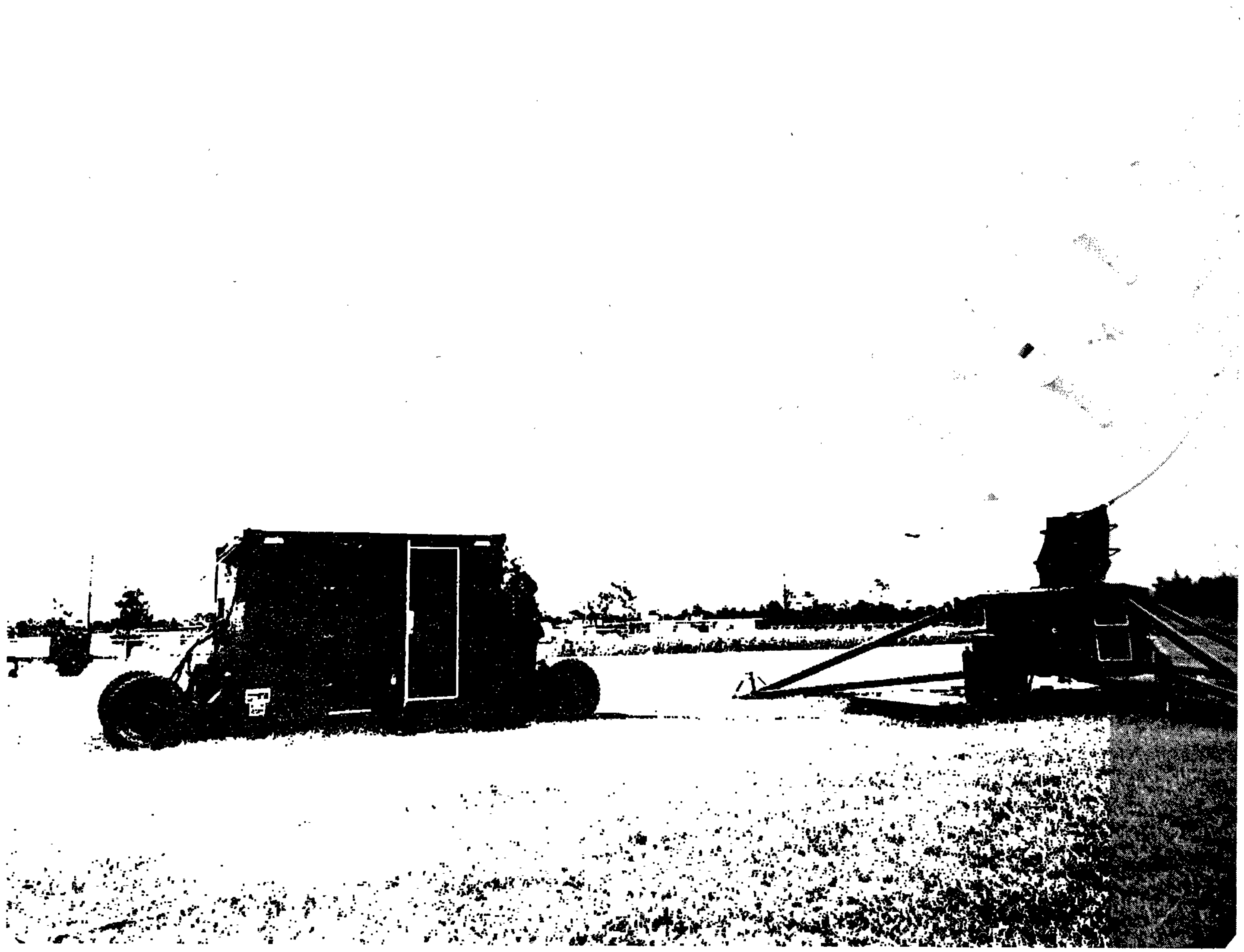

Figure 4. TSC-54 MODEL

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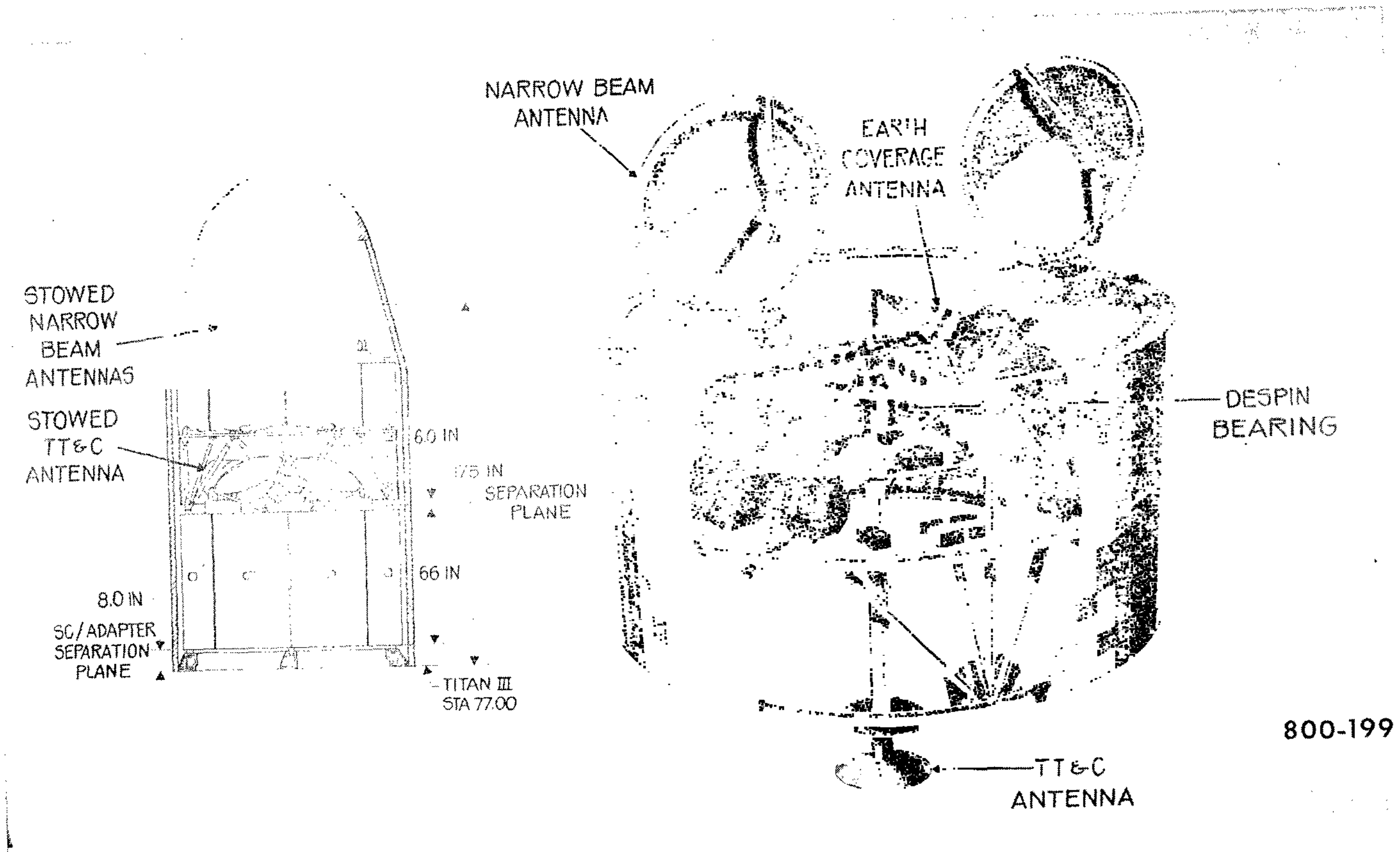

Figure 5a. INSIDE VIEW OF PHASE TWO SATELLITE

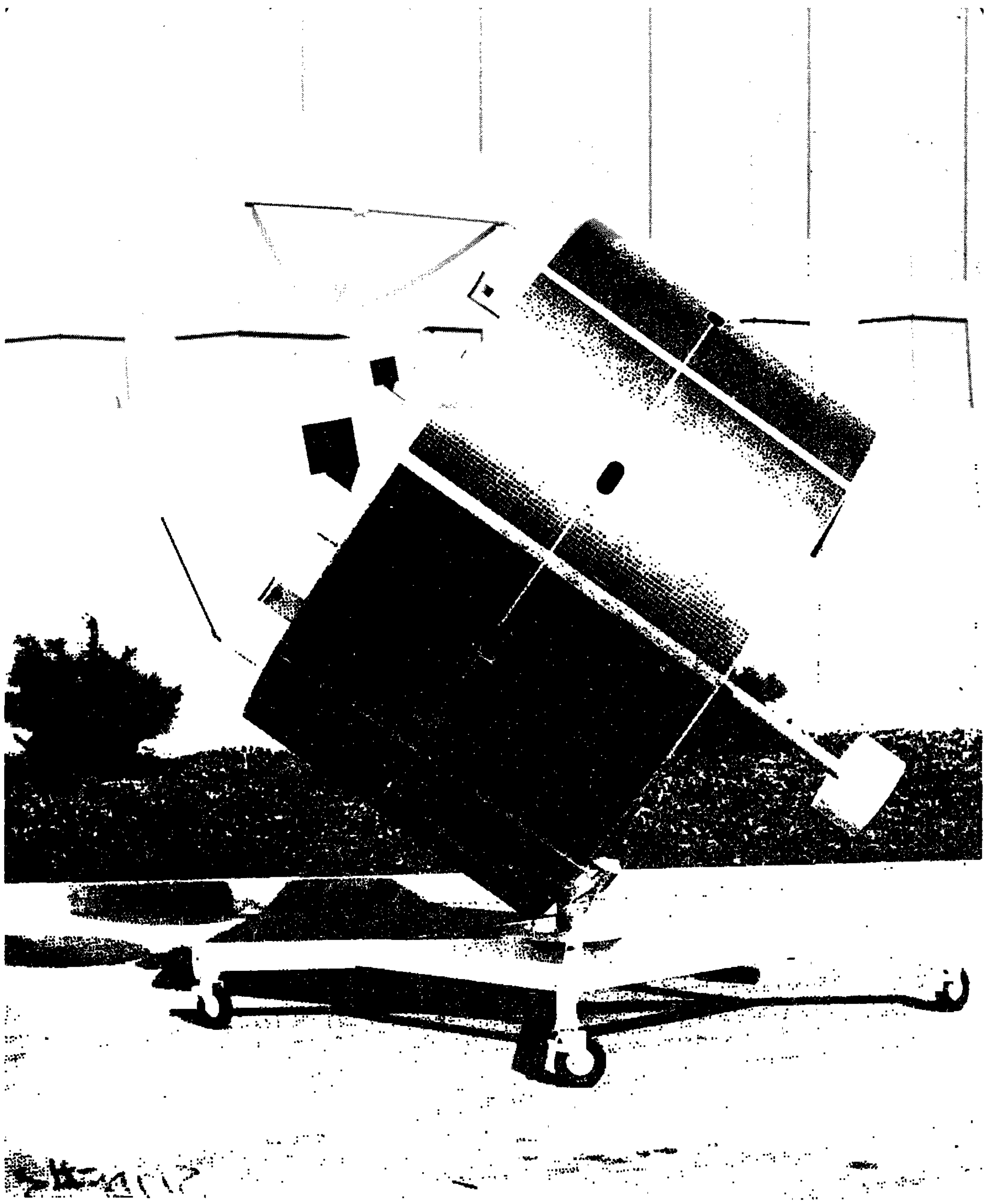

Figure 5b. OUTSIDE VIEW OF PHASE TWO SATELLITE

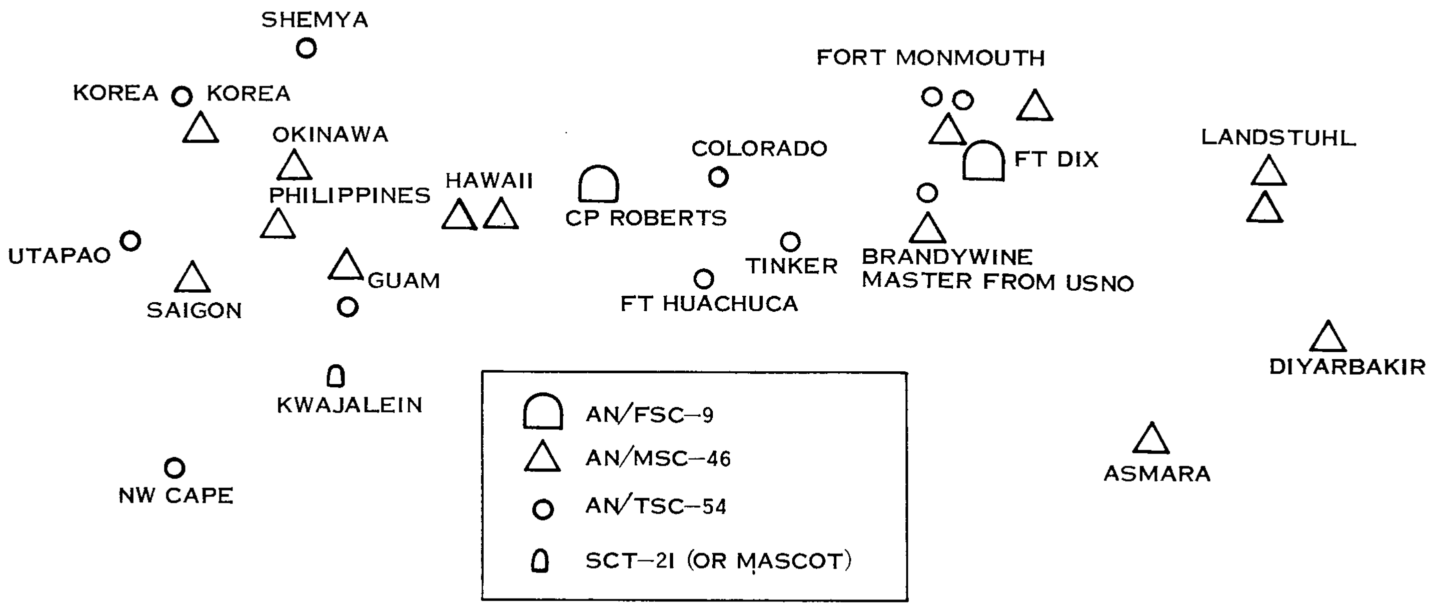

Figure 6. CONFIGURATION FOR PTTI OPERATIONS

Figure 7. HIGH PERFORMANCE 60-FOOT ANTENNA

Figure 8. MEDIUM TERMINAL COMPLEX

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DISCUSSION

CAPT ENRIGHT: I have a question for Dr. Winkler. Has anyone given consideration to the transfer of time internationally using INTELSTAT.

DR. WINKLER:, Yes, in fact we have had several long discussions with INTELSAT. It appears, that they would consider transferring time, but only at a very high dollar cost. Apparently the configuration and the dedication of the various channels is so fixed that it would cause very severe operational problems. I wonder if Mr. Gatterer would not have some additional information.

MR. GATTERER: I expect that Dr. Winkler's conversations with INTELSAT are far more recent than any that I've had. I've been in communication in the past with COMSAT, and convinced myself of the feasibility of using their system for time transfers. I do agree that it appeared quite expensive unless we made use of things that would be free, such as the pilot tones themselves. However, for a base band transfer, it is quite expensive. Nonetheless, my expectation is that the only thing better than Loran-C would be a broadband satellite transfer. The only way that I can see to improve over the good time-transfer capabilities of Loran-C is by using INTELSTAT. Therefore my expectation is that it would take place sometime in the future. Would you agree with that, Dr. Winkler?

DR. WINKLER: Not quite. I consider our immediate needs in DOD as somewhat more important at the moment. I feel that the Defense Satellite Communications System will satisfy most of our needs; certainly those which go to centers of activities located in strategic areas. In addition to that, we have a number of precise time requirements which are way outside any conventional operational area and must be satisfied by different means. I personally believe that approaches such as these indicated by Mr. Easton yesterday, or by Dr. Krishner will provide a truly worldwide capability. Possibly an improved tranist satellite will be provided which will allow a one-way dissemination of time to a user without any retransmission of signals. I also think that can be done relatively cheaply and you get around the complicated second step of distributing time from a ground terminal. In defense applications that is less of a problem than to go for international distribution. I have at least one promising thing in mind and that is that we may be able to make some time transfers with the British, using the DSCS, in the not too distant future. There is another implication, however, and I will come to that later in my talk about the UTC adjustments. That is, at any time we have to interface with international systems or systems operated by other nations, the question of which time scale is to be used and what kind of an operation will be adopted is a very important one.