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ABSTRACT

The ground terminals for the Satellite Technology Demonstration were more expensive to install than was anticipated because crews forced to make numerous visits to each site. Delays were caused by delinquent deliveries and by malfunctions in some of the subsystems. Insufficient time was allowed for trouble shooting, and consequently, additional maintenance was later required. Despite difficulties, broadcasts began on schedule, and downtime has been held to a minimum. (EMH)

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SATELLITE TECHNOLOGY DEMONSTRATION

FEDERATION OF ROCKY MOUNTAIN STATES, INC.

technical report

TR0421

STD INSTALLATION AND MAINTENANCE PROCEDURES

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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INTRODUCTION

This section examines the installation and maintenance procedures used for the Satellite Technology Demonstration (STD) and considers their application for similar telecommunications endeavors. Specifically included in the discussion are:

1. The framework within which the system had to be developed.
2. Anticipated installation and maintenance procedures.
3. The actual procedures that evolved in response to unforseen constraints.
4. Comments concerning the effectiveness and deficiencies of the system and recommendations for future similar endeavors.

PLANNING AND PROCEDURES

Preliminary plans called for installing two types of terminals -- Receive-Only Terminals (ROT's) and Intensive Terminals (IT's) -- at 69 locations in the Rocky Mountains. Installation tasks included: finding an appropriate location for the ROT's 10-foot parabolic antenna and the IT's helical antenna; putting up fences around the terminals; mounting the antennas; integrating the electronics; and, in general, leaving the site in a "ready" condition so that nontechnical persons could use and operate the terminals indefinitely. In addition, since the Experiment was "temporary," the terminals had to be installed in a way that would permit eventual restoration of the site.

Anticipated Installation and Maintenance Procedures

The STD submitted an installation proposal to the Denver Health, Education, and Welfare Department (DHEW) in October, 1972. It planned to use media technicians in the region to expedite maintenance and repairs.

But the DHEW wanted to reduce Project costs by developing a central staff to perform these tasks; by designating one crew to install and maintain all the terminals. This philosophy extended to purchasing and storage. The DHEW wanted the STD to coordinate all purchasing activities from its headquarters in Denver and to arrange for all spare parts to be stored in Denver.

The STD organized a three-man installation crew to make one or, at most, two visits per site. It allocated a minimum of 27 weeks -- based on a five-day work week and a one-day travel period between sites -- for the crew to make all 69 ROT installations by the end of March, 1974. This meant that the delivery of complete systems would have to begin in mid-September, 1973, and end in mid-March, 1974, in order to meet the April launch of the ATS-6.

To facilitate the installation process, the STD purchased a 27-foot mobile home (127 feet in length). This vehicle was the principal living quarters for the crew away from Denver.

The STD also purchased a 3/4-ton pickup truck that followed the crew from site to site. This truck was used either to transport hardware from the nearest shipping dock to the site or to haul spare parts from Denver to the site.

All of the terminal equipment used by the STD was experimental; thus, it was impossible for the STD to plan a maintenance program with any confidence. The goal of the program, however, was to make repairs in less than 24 hours.

Unforseen Problems

These two developments significantly altered the STD's planned installation procedures:

1. Delays in procuring the IT's.
2. Delays in receiving the ROT components.

In January, 1973, the Interagency Radio Advisory Committee (IRAC) denied the use of the IT's 2.25 GHz uplink frequency. This decision meant that the IT's had to be redesigned for use at VHF frequencies on the ATS-1 and the ATS-3. The STD, however, didn't procure the necessary transmitters until November, 1973. And custom modifications -- made by Broadcasting & Engineering (B & E) -- were not completed until August, 1974. This was three months after the launch of the ATS-6.

Added to delays in procuring the IT's were delays in receiving the ROT components. In July, 1973, the DHEW signed a contract with Westinghouse to buy 130 ROT's. The contract called for Westinghouse to complete the last ROT in March, 1974, so that the ROT installation would be finished by May, 1974.

But to make the installation in one trip, the crew needed a complete set of parts from Westinghouse. Unfortunately, this did not happen. Figure 1 shows that the ROT components came in three widely separated shipments: First came the mounting hardware for the reflector; then, the electronics; and finally, the segmented reflector.

In retrospect, it would have been better to ship all the parts to Denver and not to travel to a site until the shipment had been completed. B & E personnel, however, did not want to make any installations during the winter; they wanted to make as many as possible during the fall.

In September, 1973, the specifications for the antenna foundation still had not been established. The contractor wanted to use concrete pads, which were unacceptable to B & E because they would have been expensive to remove. A mutually-agreeable procedure for mounting the antennas was not established until November, 1973.

Thus, not only was it impossible to complete the ROT installation in one trip, but it also was impossible to make the site preparation in one trip. As a result, the crew installed the fencing between September and January, 1974, and the mounting timbers (which served as the antenna foundation) between December, 1973, and May, 1975.

Actual Installation Procedures

The first step in the installation process was finding an appropriate location for the terminals. Eight state coordinators helped in locating sites. Requirements for a location included:

1. Line-of-sight clearance with the ATS-6 (and with the ATS-3 in the case of an Intensive Terminal).
2. A cable run of fewer than 100 feet from the antenna to the classroom.
3. Compliance with all local building codes and environmental requirements.

The state coordinators referred questionable cases to the STD's staff for final resolution.

The second step in the installation process was fencing in the area around the site and mounting the timbers. Quick and easy removal of the fencing and timbers was built into the

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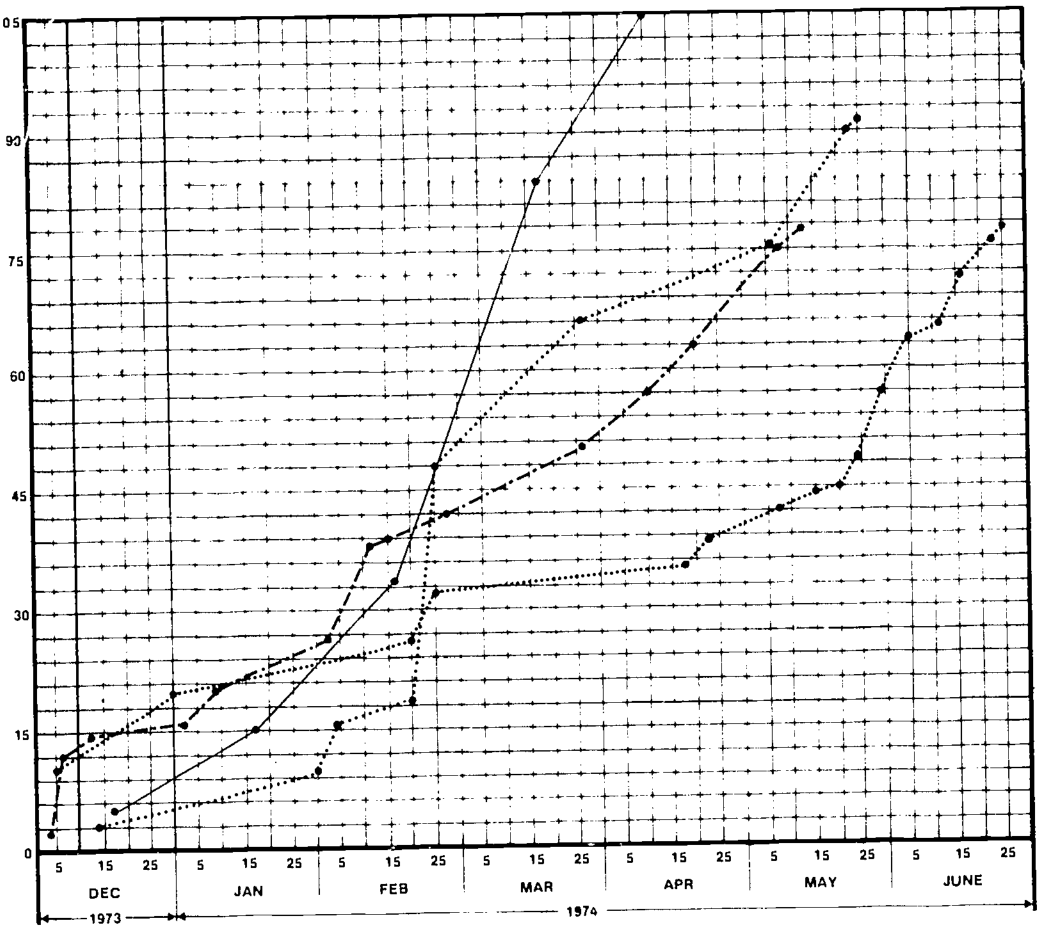

———————	CONTRACT SCHEDULE
···············	RECEIVERS
·················	REFLECTORS
-·-·-·-·-	MOUNTS FEEDS CABLES

NOT INCLUDED ARE ELEVATION MOTORS AND ASSOCIATED CABLES. FIRST UNIT RECEIVED OCTOBER, 1974.

FIGURE 1 HARDWARE DELIVERY

process. This was done by:

1. Hand-driving the fenceposts to a depth of 24 inches, then securing them with both top and bottom anchors.
2. Securing the timbers with an expanding-type anchor that was buried to a depth of five feet, flattened, and then backfilled.
3. Connecting the anchor to the timbers with a 5/8-inch diameter rod.

The procedure was altered slightly to accommodate different soil densities at different sites, but the overall results were excellent. There was not a single case of structural failure. The fencing and other outside hardware held up well during the Demonstration. Some isolated cases of vandalism, however, did cause minor structural damage.

A simple magnetic compass and an elevation protractor was used to make the initial pointing of the antenna. One site was outside the plus or minus 20-degree tolerance in azimuth, which meant that the timbers had to be relocated. The other sites were all within the plus or minus 20-degree tolerance.

The third step in the installation process was mounting the antennas. Here, there were several problems:

1. Production of the antenna reflectors was suspended, after it was discovered (in March, 1974) that these units were cracking in the field.
2. The antenna feeds which were installed initially had the wrong polarity. This problem was discovered in June, 1974, when system tests (using the ATS-6) revealed 26 dB of unwanted attenuation. All the antenna feeds were replaced within 10 days.
3. Motorized elevations were ordered for 89 of the 119 HET terminals. The first elevations did not arrive until October, 1974; all of these were totally unsatisfactory. The mechanism would lock in one position, and the net result was to decrease the effectiveness of the site equipment. It was necessary to return to the field with retrofits.

The modified Intensive Terminals also proved to be a problem:

1. They were not available for installation until August, 1974.

2. They did not work properly when first installed, because they were designed to interface with a computer system which had not been installed.
3. It was necessary to return to the field and modify the digital coordinator which controlled VHF transmissions to include a manual override switch.

As a result of these complications, installation of the STD terminals involved more site visits than anticipated: Only two trips per site were planned, but as many as seven trips were required. It was sometimes necessary to make separate visits to: (1) install fencing; (2) install timbers and mounting hardware; (3) install the ROT antenna and electronics; (4) install the VHF terminal; (5) retrofit the ROT antenna feed; (6) retrofit the digital coordinator; and (7) install the motorized elevation unit.

Despite the complications, all terminals were installed and made fully operational prior to actual program transmission.

Actual Maintenance Procedures

Failure reports were directed to the Network Coordinating Center's (NCC's) personnel, then forwarded to the maintenance team. At the conclusion of maintenance activities, the report was completed and filed. Included in the report were: time of failure; failure symptoms; repair action taken; and date and time of repair action. In all cases, maintenance and repairs were made at the site.

Maintenance procedures, like installation procedures, were beset with problems. Site operators occasionally used improper reporting channels and, at times, delayed the receipt of failure information by maintenance personnel. Errors by site operators occasionally resulted in false alarms; this problem usually occurred when the normal operator was absent. These errors may have been reduced, if there had been trained substitutes at the sites.

Efforts to repair inoperative sites were complicated by an inability to simulate a satellite signal. Test sets procured by the STD for precisely this purpose were unreliable and functionally ineffective. As a result, to confirm that troubleshooting efforts had been successful, it was necessary to remain at the site through part of the next day when a signal from the ATS-6 was available.

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The greatest single source of trouble was defective peripheral equipment (which was not the responsibility of the STD, but the responsibility of separate suppliers). A telephone survey showed that the equipment was unreliable when used to provide services to isolated population areas.

The survey also revealed, however, that most users were pleased with the video cassette recorder equipment and the color monitor; that they more readily accepted equipment problems than the engineering staff had anticipated. Indeed, the engineering staff was more concerned with malfunction problems than were the users.

CONCLUSIONS AND RECOMMENDATIONS

Installation of the terminals was more costly than planned, because the crew was forced to make more than the anticipated two visits per site: One visit, in fall, to install the fencing and antenna mounts before the onset of cold weather; one visit, in winter, to install the electronics. Only two trips per site would have been necessary if:

1. The contract to the prime supplier (Westinghouse Electric) had focused on the need to deliver complete systems, rather than on separate components.
2. All subsystems, including the ROT antenna feeds and elevation adjustments and the VHF digital coordinators, had worked properly when first installed, thus eliminating the need to retrofit these systems in the field.

Procurement delays not only caused installation problems, but also maintenance problems. There was insufficient time to insure that the Intensive Terminals were trouble-free before the beginning of programming. In retrospect, a 10-day "burn-in," or testing, period would have helped to spot weaknesses in the equipment. Troubleshooting (which often was done by telephone) would have been facilitated by:

1. Labeling connectors and providing better documentation of interface wiring.
2. Displaying critical parameters of the remote equipment.
3. Making trained personnel available at the NCC during operations.

Defective peripheral equipment resulted in further maintenance problems. Three things that would improve the reliability of commercial products are:

1. Improvement in vendor repair services, both in quality and speed.
2. Vendor training of users in preventative maintenance techniques, such as internal cleaning of the video cassette recorders.
3. Vendor development of more effective instruction manuals.

Despite logistic problems and equipment malfunctions, the STD's installation and maintenance procedures were successful: The broadcasts not only started on schedule, but also remained on schedule, due to minimal downtime during operations. Project personnel agree, however, that more time to offset procurement delays would have insured quick installation and smooth operation throughout the Demonstration.

If there is a lesson here for future planners, it is that there is never too much time. Time to plan, time to procure equipment, time to make repairs -- all these variables determine the ultimate success of any project.

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