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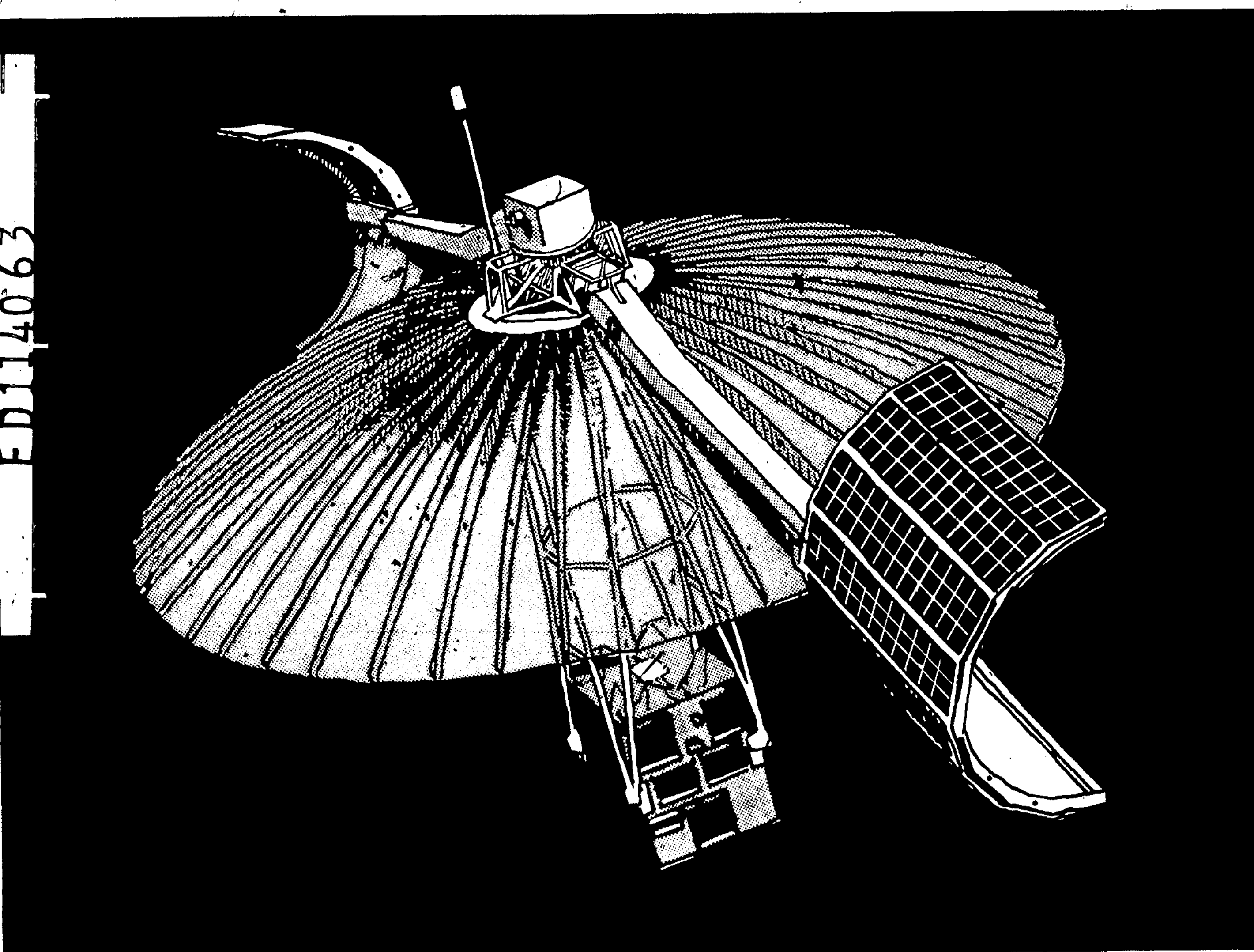
ABSTRACT

Appalachian Education Satellite Project (AESP), using the ATS-6 satellite, has designed a variety of multi-media learning activities intended to upgrade the quality of instruction in Appalachia. Four modes of communication (televised programs, four-channel audio review, four-channel data collection and analysis, and VHF-teletype relay system) were each evaluated according to the following criteria: uses, equipment requirements, organizational requirements and the quality of communication. This is the 5th of 12 volumes in the technical report series on AESP. (EMH)



Equipment Reliability

aesp
appalachian
education
satellite
project

Technical Report

number 5

PERFORMANCE OF AESP TRANSMISSION/RECEPTION EQUIPMENT

SUMMER AND FALL, 1974

Prepared by.

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July, 1975

The Technical Report Series of the Appalachian Education Satellite Project is edited and published by the RCC Evaluation Component at the University of Kentucky, Lexington, Kentucky.

The purpose of this series is to document and disseminate information about the design, implementation, and results of the AESP experiment.

William J. Bramble and Claudine Ausness

Editors

Technical Reports #1 to 12 in this series are entitled:

AESP Data Base Information: Rationale, Data Collection Procedure, Interpretation of Results.

An Experiment in Educational Technology: An Overview of the Appalachian Education Satellite Project.

Formative Evaluation Study for AESP Diagnostic and Prescriptive Reading Courses.

The Evaluation Design: Summer Courses, 1974.

Performance of AESP Transmission/Reception Equipment (Summer and Fall, 1974).

User Ratings of Instructional Activities: Diagnostic and Prescriptive Reading Instruction, Summer, 1974.

User Ratings of Instructional Activities: Career Education in the Elementary Grades, Summer, 1974.

User Achievement: Diagnostic and Prescriptive Reading Instruction Course, Summer, 1974.

User Achievement: Career Education in the Elementary Grades, Summer, 1974.

Cost Estimation Model for Alternative Course Formats and Delivery Modes.

Summative Evaluation of Career Education in the Secondary School Course, Fall, 1974.

Summative Evaluation of Diagnostic and Prescriptive Reading Instruction K-6 Course, Spring, 1975.

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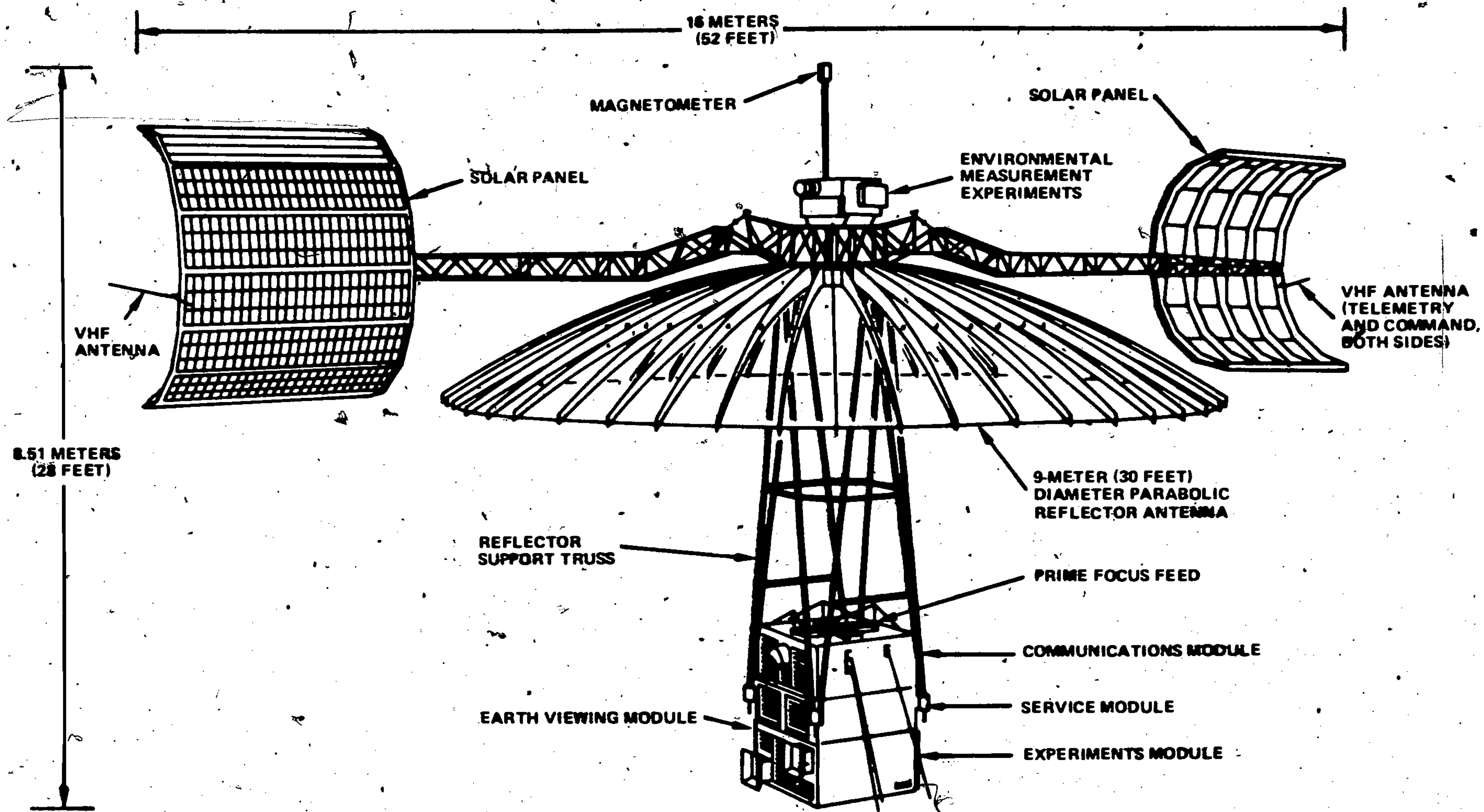
INTRODUCTION

The Applied Technology Satellite (ATS) demonstration is a project directed by the National Aeronautics Space Administration (NASA) to demonstrate the various functions satellites can perform. ATS-F/6, the final satellite in the series, was launched in May, 1974 (see satellite and launch and orbit sequence illustrations). The more than 20 experiments planned for ATS-6 included such varied activities as the collection of meterological data, the detection and routing of aircraft, and the operation of telecommunications relay systems.

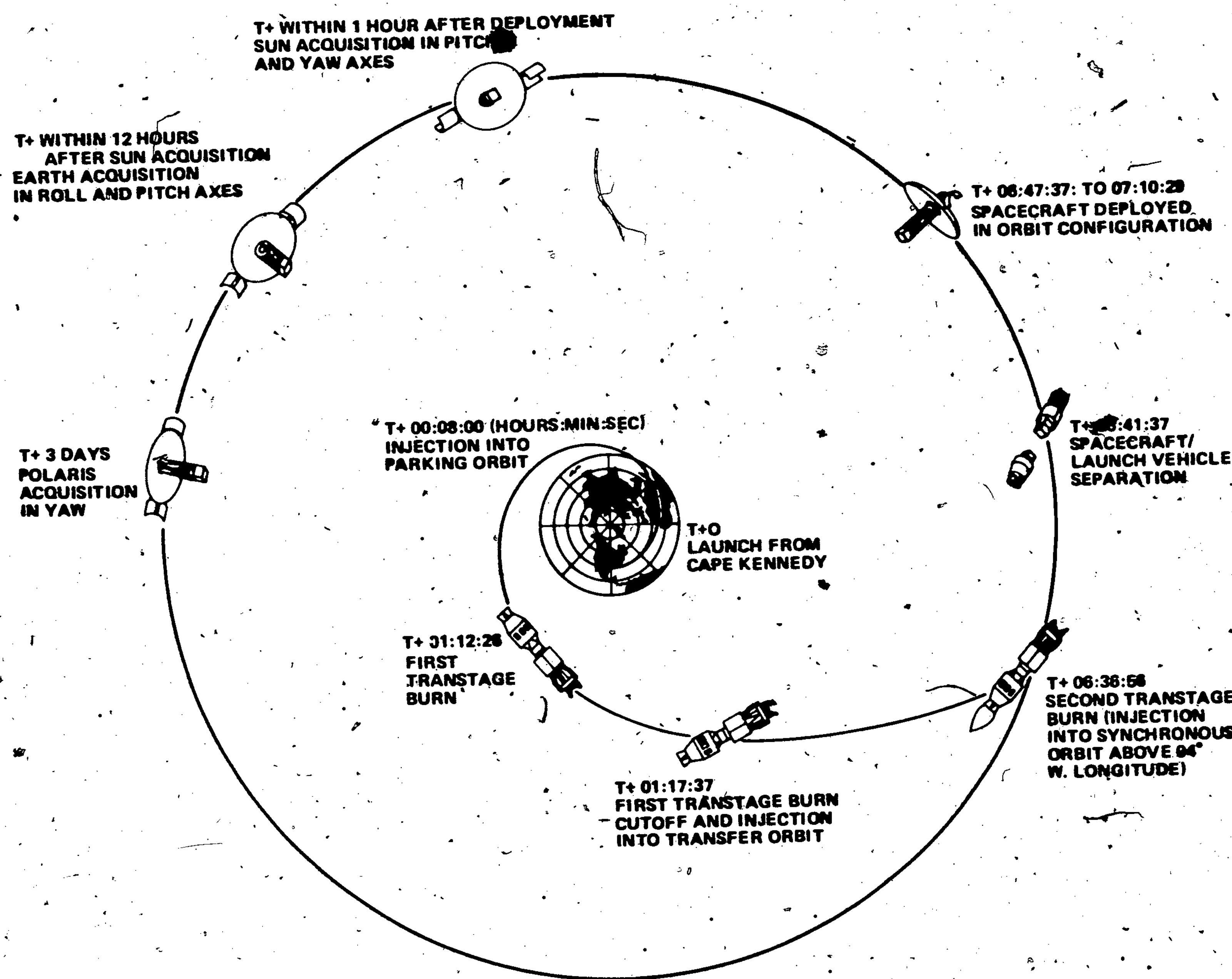
The Appalachian Education Satellite Project (AESP) was one of six educational telecommunications experiments on ATS-6. In order to demonstrate educational functions ATS-6 could perform, many of the learning activities in the AESP courses were designed to exploit different capabilities of ATS-6 used alone or in conjunction with another satellite in the ATS series, ATS-3, launched in 1967. The main uplink stations were at Rosman, North Carolina, Morrison outside Denver, Colorado, and at Goddard Space Flight Center in Maryland (see illustration of satellites and earth stations).

Identification of AESP Sites

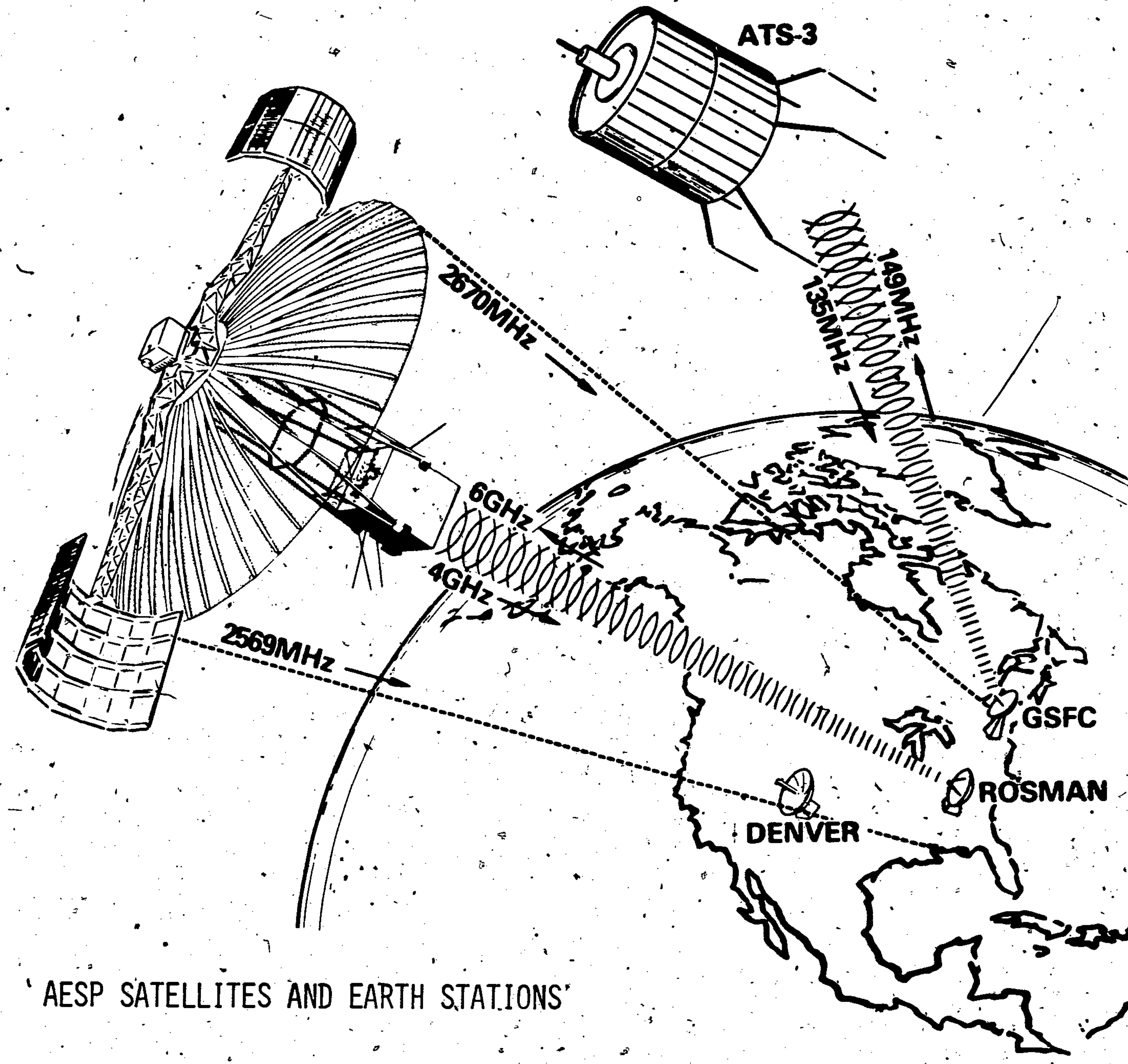
At each of the three points of the black triangles in Figure 1 is one of the 15 AESP reception sites. Often they were located at Regional Education Service Agency (RESAs). Ten of the sites were



ATS-F SPACECRAFT



ATS-F LAUNCH AND ORBIT SEQUENCE



AESP SATELLITES AND EARTH STATIONS

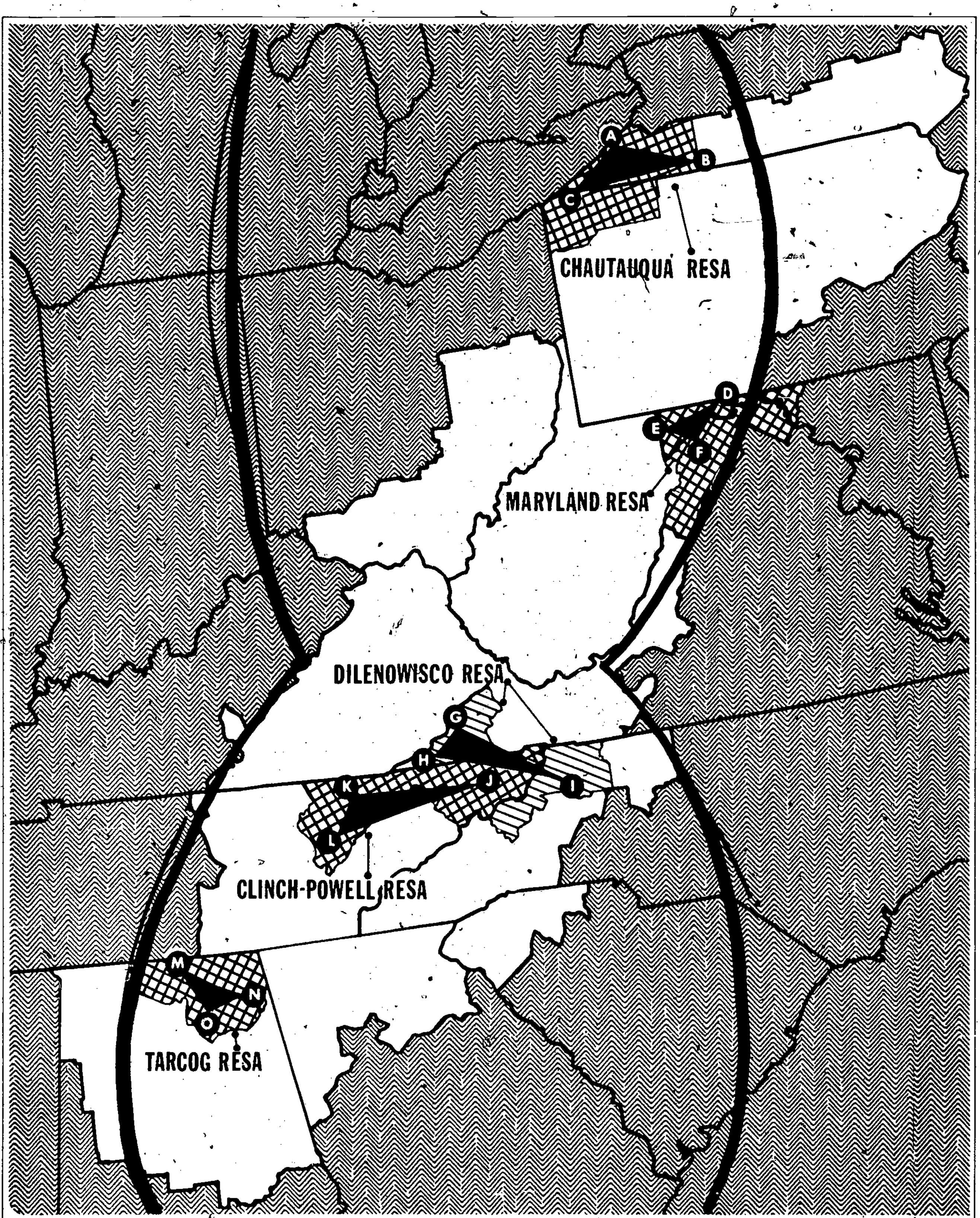


FIG. 1 MAP OF THE APPALACHIAN REGION SHOWING THE FIVE RESA CLUSTERS, RECEIVING TRIANGLES, AND APPROXIMATE SATELLITE FOOT PRINT.

A. Fredonia, N.Y.
B. Olean, N.Y.
C. Edinboro, Pa.
D. Cumberland, Md.
E. McHenry, Md.
F. Keyser, W. Va.
G. Norton, Va.
H. Stickleyville, Va.
I. Boone, N.C.
J. Johnson City, Tenn.
K. LaFollette, Tenn.
L. Coalfield, Tenn.
M. Huntsville, Ala.
N. Rainsville, Ala.
O. Guntersville, Ala.

receive-only terminals (ROT) that could only receive taped and live televised programs via ATS-6. One site in each triangle was an intensive terminal (IT) that could transmit and receive two-way radio via ATS-3, as well as receive television programs via ATS-6.

Organization of AESP

As indicated in Figure 2, the technical aspects of the AESP are under the direction of NASA and its subagents who supplied and controlled the satellites. The Federation of Rocky Mountain States (FRMS) Broadcast and Engineering Division (B & E) in Denver, Colorado, coordinated contact between NASA and the ground terminals in the Health Education Telecommunications Network (HET). AESP Engineering was responsible for ordering, installing, and maintaining the ground equipment at the fifteen Appalachian sites.

Scope of Technical Report 5

Many of the instructional modes were designed by the Resource Coordinating Center (RCC) in Lexington, Kentucky, to exploit the capabilities of ATS-6. Consequently, many of the learning activities depended on satellite transmission. This technical report describes the site reception equipment necessary for satellite interface and attempts to answer the question, "How effectively did the AESP ground equipment and technical procedures work?" This report provides information helpful in answering the following specific questions:

- What equipment was used to perform the different learning activities?
- How long did it take to set up each system?

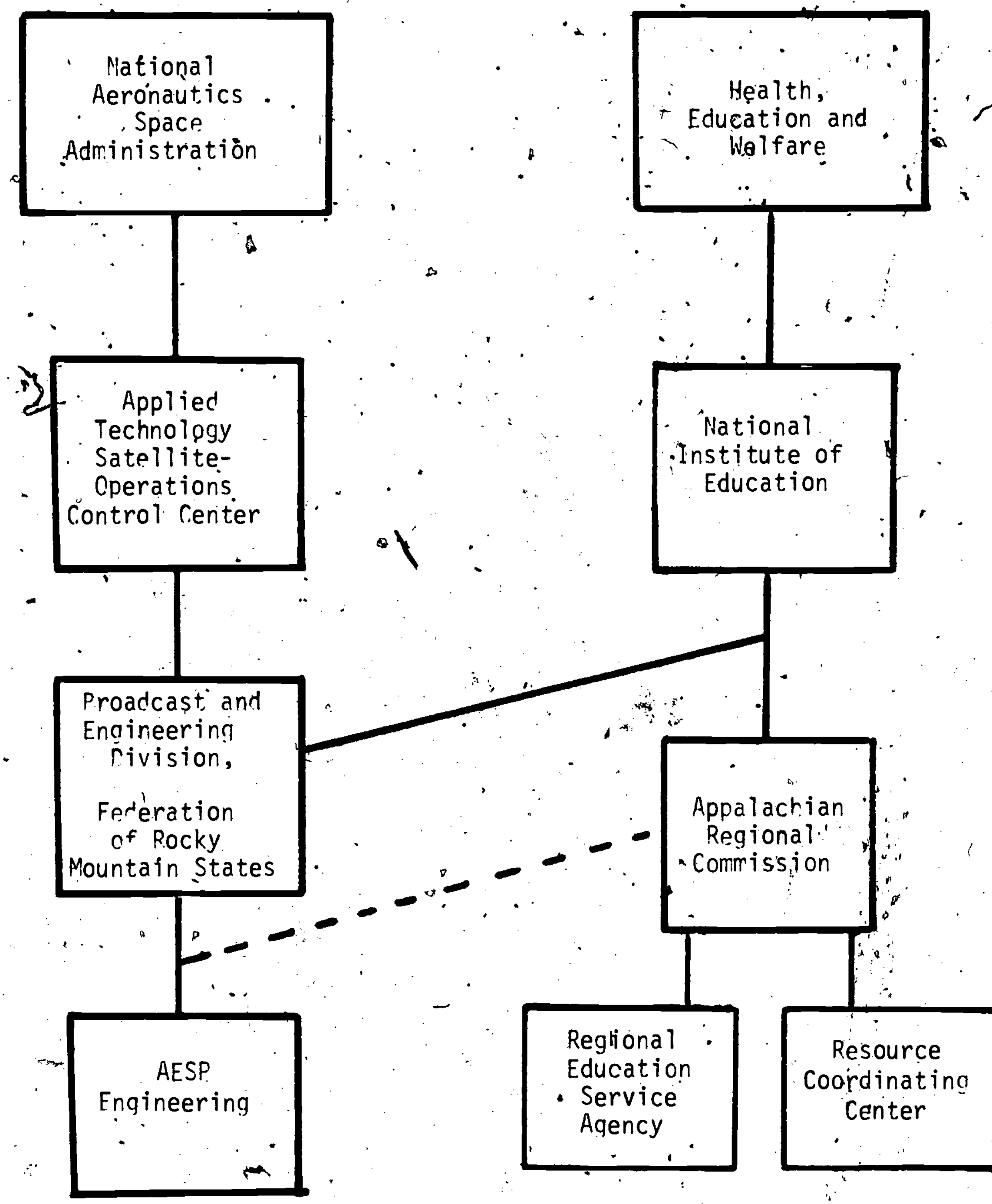


FIG. 2: ORGANIZATIONAL CHART FOR THE APPALACHIAN EDUCATION SATELLITE PROJECT

- How good was reception for each system?
- How well did the equipment in each system work?
- What types of problems occurred?
- What are some ways the project could be made more effective from a technical point of view?

METHOD

DATA COLLECTION AND ORGANIZATION

Sources of Information

The AESP Evaluation Component gathered information on how well the AESP site equipment operated over a six-month base period. This report is an attempt to coalesce the opinions of people familiar in different ways with the site equipment: 1) the site coordinators who monitored the equipment at the local sites; 2) the monitors of the equipment at the Resource Coordinating Center; 3) the engineering technicians responsible for installing and maintaining the equipment; and 4) the student users of the equipment.

Organization of Data

This report consists of five miniature reports on the effectiveness of the technical aspects of the AESP activities affected by satellite transmission:

1) Televised Programs: the effectiveness of the site equipment used to receive taped and live, televised programs delivered via ATS-6;
2) Four-Channel Audio Review: the effectiveness of the four-channel audio site equipment used to receive the four-channel instruction delivered via ATS-6;
3) Four-Channel Data Collection: the effectiveness of the site evaluation equipment triggered by satellite to electronically poll and code student responses to audio review questions;

4) VHF-Teletype Relay System: the effectiveness of the VHF and teletype systems as a means of relaying, via ATS-3, administrative and instructional information.

RESULTS

AESP DEMONSTRATIONS

Televised Programs

Use of Televised Programs

In 1974 the Appalachian Education Satellite Project produced pretaped and/or live television series for three courses. For use during the summer of 1974, 12 satellite-delivered, half-hour, pretaped television programs and 4 three-quarter-hour, live, interactive seminars were developed for both the diagnostic and prescriptive reading instruction (DPRI) course for K-3 teachers and the career education course for elementary teachers (CEE). For use during the fall of 1974, 16 hour-long, live, interactive seminars were developed for the career education course for secondary teachers (CES). These programs differed from graduate-level class presentations on a university campus in that they consisted largely of documentary film showing interviews with content experts and teachers and actual classroom applications of instructional procedures.

Identification of Delivery Route

To televise programs via the ATS-6 satellite, it was necessary to devise a means whereby the television signals could be delivered to the classroom sites from the RCC broadcast studio at the University of Kentucky in Lexington, Kentucky. As depicted in Figure 3, the television signals were transmitted from the studio over telephone lines to the access station in Rosman, North Carolina. From the access station the signals were uplinked to ATS-6 for relay to parabolic antenna systems at the sites.

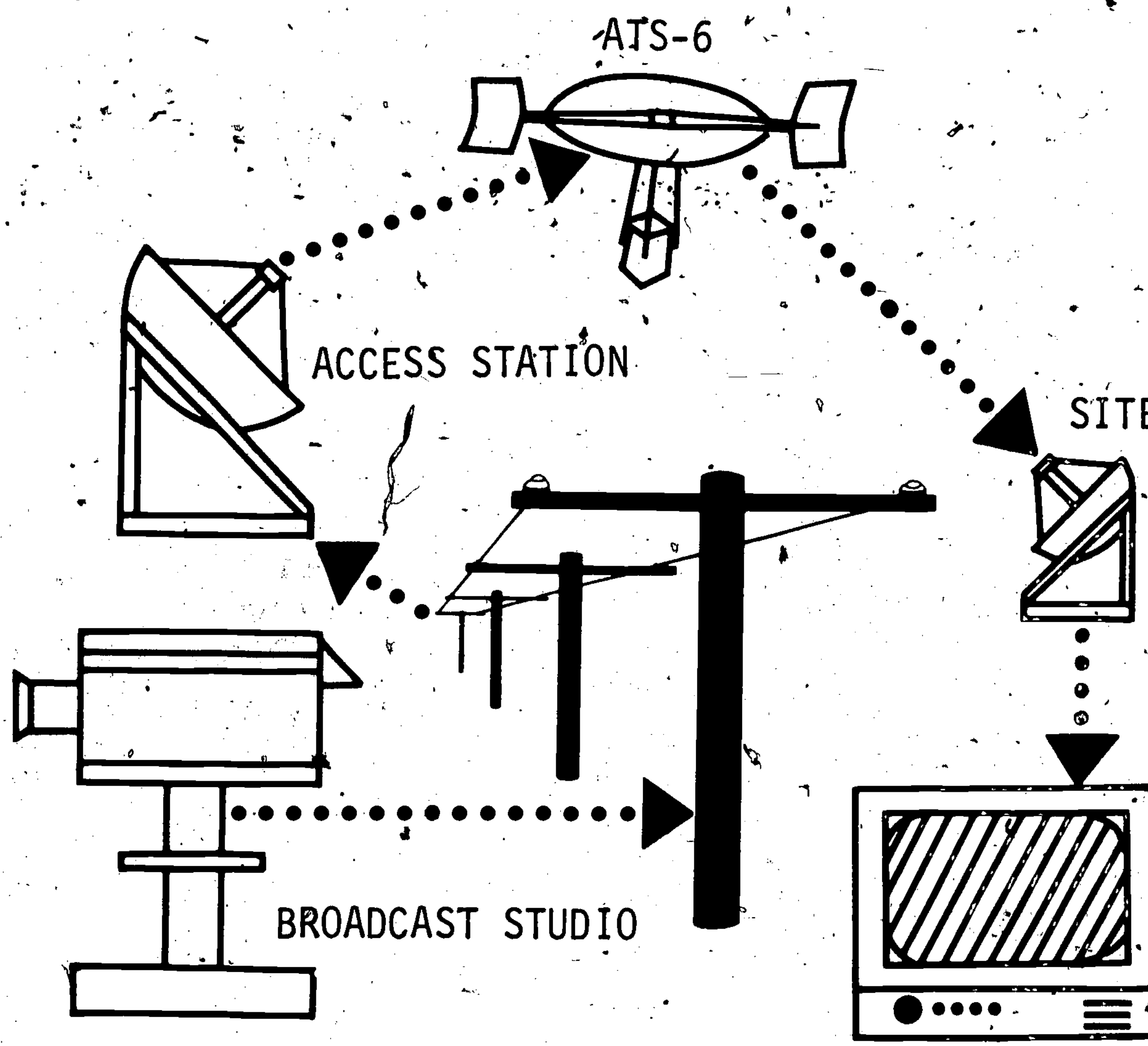


FIG. 3: AUDIO-VIDEO DELIVERY SYSTEM

Audio-Video and Two-Way Radio Antennas
at Intensive Site in Cumberland, Maryland

Indoor Equipment for Television Reception of Satellite Signals at Fredonia, New York

Identification of Television Reception Equipment

At each of the 15 sites, the television reception system consisted of an outdoor, 10-foot-in-diameter parabolic antenna positioned on an adjustable mount. In the picture of the reception equipment at the intensive site in Cumberland, Maryland, the parabolic antenna is the disk-shaped receiver. Mounted on the back of the parabolic antenna was a preamplifier that amplified the signal. The preamplifier was connected to the indoor receiver by a 100-foot coaxial cable. The solid state, 2.5 GHz H.P. (Hewlett-Packard) receiver converted the signals to a video baseband. In the picture of the class at the Fredonia, New York site, the H.P. receiver is the smaller box resting on the shelf above the television. Under the television is the video cassette player for recording programs, and through the window it is possible to discern the fence enclosing the antenna.

Installation of Television Reception Equipment

The two time lines in Figure 4 identify pertinent installation dates for the television reception equipment at the sites and for the landline between the PCC and the uplink at Rosman. The fact that there were no crisscross sections in Figure 4 indicates that the television reception system was installed at all sites before the first course began.

Site Coordinator Ratings of Television Reception

In Figures 5 and 6 are the site coordinator ratings of the quality of the television picture and sound for each session in the three courses. As indicated by the solid line in Figure 5 there was, averaged across sites, no more than barely perceptible distortion in

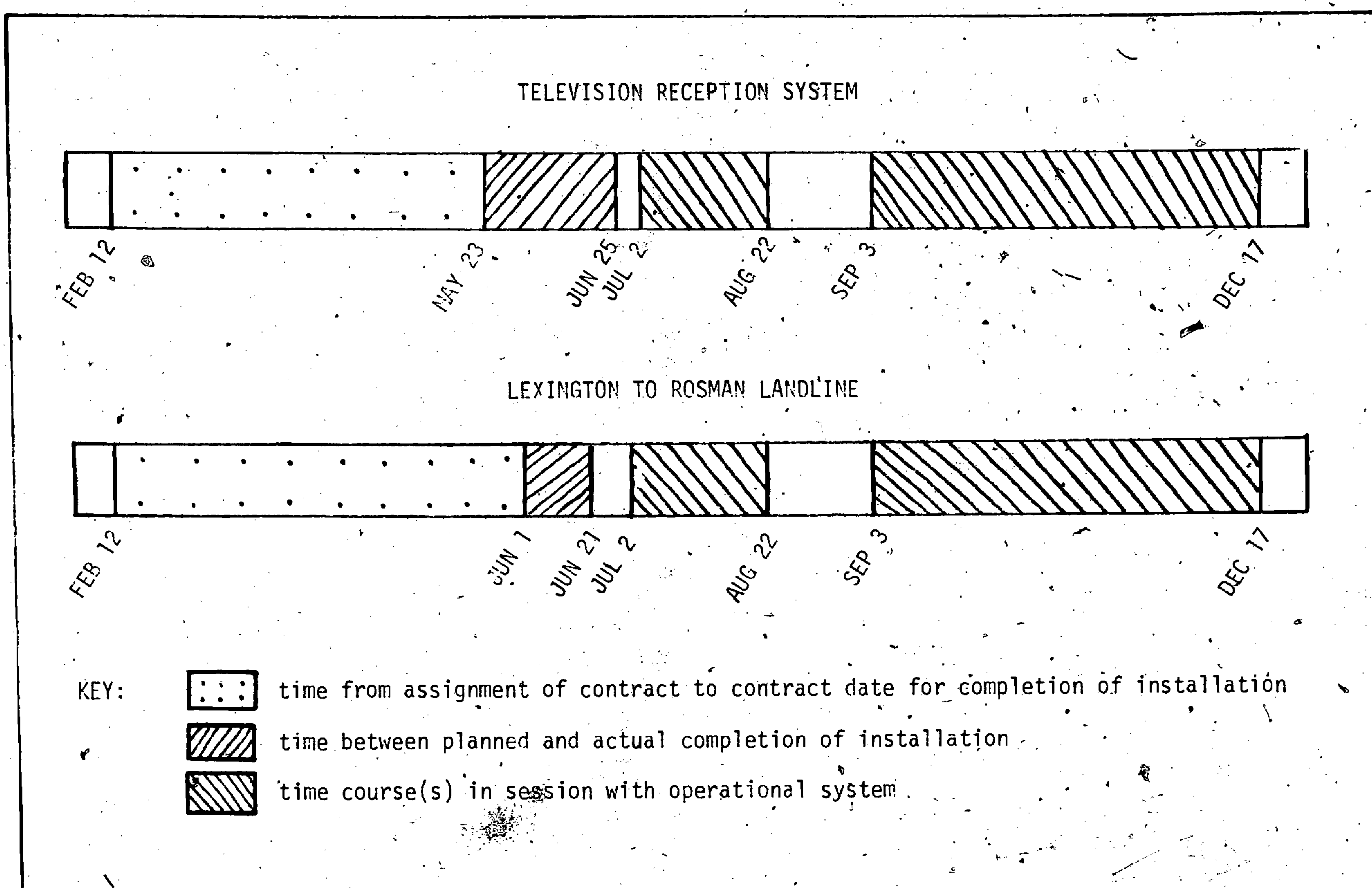
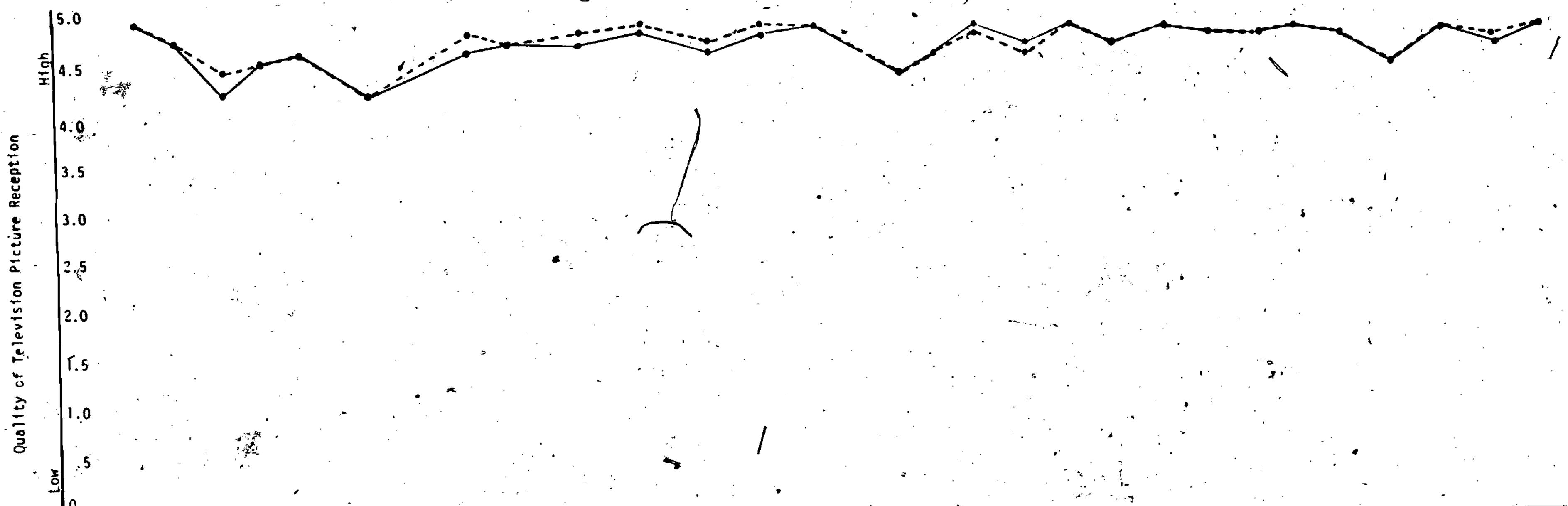


FIG. 4: INSTALLATION TIME LINE FOR TELEVISION RECEPTION EQUIPMENT



Dates	7/2	7/9	7/11	7/16	7/23	*7/25	**7/30	8/1	8/6	8/8	8/13	8/15	8/20	8/22	9/3 ***	9/10	9/17	9/24	10/1	10/8	10/15	10/22	10/29	11/5	11/12	11/19	11/26	12/03	12/10	12/17
Courses																														
DPRI			1 2			3 4 5 II		6 7		8 9 III		10 11		12 IV																
CEE	1 2	3 4		5 I	6 7		8 9		10 II		11 III		12 IV																	
CES															1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Key: Solid Line - Clarity of Television Picture

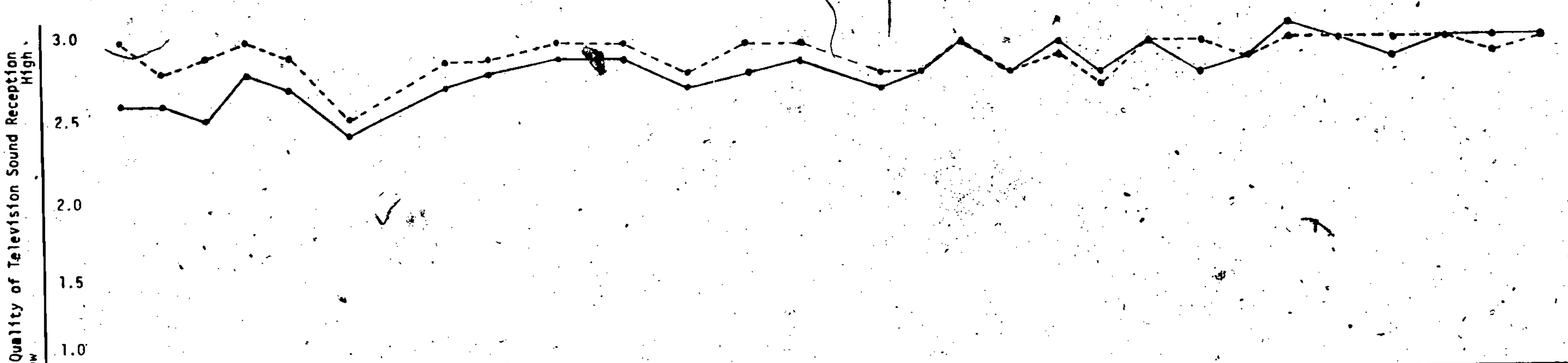
Broken Line - Unobtrusiveness of Television Picture Distortion

* Programs 3 and 4 and Seminar I, originally scheduled for July 18, rescheduled or deleted due to failure at the uplink station.

** No data for this date.

*** Seminar I, scheduled for September 3, deleted due to systemwide delivery problems.

FIG. 5: QUALITY OF TELEVISION PICTURE RECEPTION IN AESP COURSES



Dates	7/2	7/9	7/11	7/16	7/23	* 7/25	**7/30	8/1	8/6	8/8	8/13	8/15	8/20	8/22
Courses														
DPRI			1 2			3 4 5 II		6 7		8 9 III		10 11		12 IV
CEE	1 2	3 4		5 I	6 7		8 9		10 II		11 III		12 IV	
CES														

Dates	9/3	9/10	9/17	9/24	10/1	10/8	10/15	10/22	10/29	11/5	11/12	11/19	11/26	12/03	12/10	12/17
Courses	***															
DPRI																
CEE																
CES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Key: Solid Line: Clarity of Television Sound

Broken Line: Strength of Television Signal

* Programs 3 and 4 and Seminar I, originally scheduled for July 18, rescheduled or deleted due to failure at the uplink station.

** No data for this date.

*** Seminar I, scheduled for September 3, deleted due to systemwide delivery problems.

FIG. 6: QUALITY OF TELEVISION SOUND RECEPTION IN AESP COURSES

the television picture. The closer to 5 the rating, the less distortion was perceived. As shown by the broken line in Figure 5, what distortion there was was only slightly annoying. The closer to 5 the rating, the less objectionable the raters felt the distortion was. The fact that the broken line is usually higher rather than lower than the solid line indicates that site coordinators felt the distortion observed did not impair reception, since they tended to distinguish more distortion than they felt annoyance.

Similarly, the height of the solid line in Figure 6 indicates that, averaged across sites, the television sound was usually nearer to being readable with no difficulty (3 on a 3-point scale) than readable with some difficulty (2 or less on the 3-point scale). The broken line shows that the strength of the audio signal was usually closer to good (3) than fair (2). Signal strength tended to be rated slightly higher than readability.

No ratings for the quality of the reception are given for the two times there were system-wide breakdowns. The first time, July 18, trouble at the Rosman uplink to ATS-6 resulted in a failure to deliver on the scheduled day televised programs 3, 4 and seminar I in the reading course. The second time, September 3, 1974, trouble in the landline to Rosman resulted in the loss of the audio portion of televised seminar I in the fall career education course.

To be categorized as a go-situation, the televised picture had to be rated 3 or higher on the dimensions of perceptability of distortion and 4 or higher on annoyance attributed to the distortion; the television sound had to be rated 2 or higher on the dimensions of readability and signal strength. As shown in Figures 7 and 8, as many as

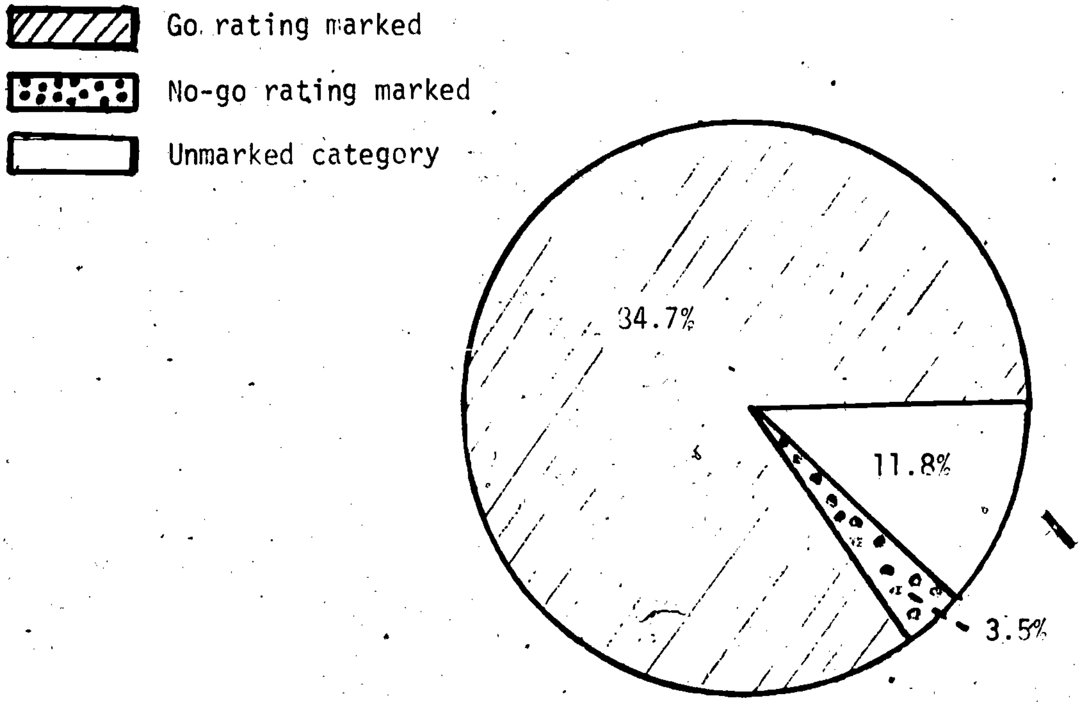


FIG. 7: PROPORTION OF SITES WITH ACCEPTABLE TELEVISION PICTURE

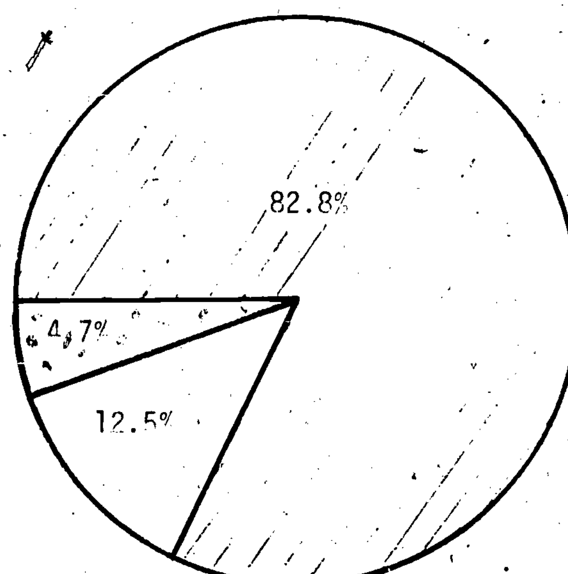


FIG. 8: PROPORTION OF SITES WITH ACCEPTABLE TELEVISION SOUND

96.5% of the sites had an acceptable television picture for the 24 pretaped and 24 live televised programs broadcast in 1974, and as many as 95.3% had acceptable television sound.

Student Ratings of Television Reception

In Tables 1 and 2 are the mean user ratings for several technical aspects of the television programs broadcast in the summer of 1974. An asterisk beside any mean indicates that the participants rated that program significantly better or worse than the overall mean for all pretaped or live programs on that particular characteristic. The programs are ranked from those receiving the highest to the lowest rating on each characteristic.

Frequency and Cause of Malfunctions

During the first six-month period when a total of 34 hours of televised programs was scheduled for transmission over ATS-6, 13 malfunctions in site television reception equipment were reported to AESP Engineering. Table 3 lists the cause and date of each malfunction at each site; the total number of times, across all sites, each type of malfunction occurred; and the television programs missed due to the malfunction. Sometimes a malfunction occurred and no television programs were missed, either because the malfunction did not make reception impossible or because repairs were made before the program began. Out of 720 program transmissions (48 programs times 15 sites), 18 programs (2.5%) were not received because site equipment malfunctioned.

Television Malfunctions/Equipment

One index to equipment reliability is the proportion of the total number of malfunctions in the television reception equipment

TABLE 1

USER RATINGS OF TECHNICAL QUALITY OF SUMMER DPRI TELEVISED PROGRAMS

Rank	TV Easy to hear	Program No.	Undistorted Sound	Program No.	Undistorted Picture	Program No.	Good Color	Program No.	Over-all Satisfaction	Program No.
Pre-Taped Programs										
1	4.30*	12	4.24*	9	4.41	10	4.58	8	4.51	9
2	4.26*	9	4.21*	12	4.34	8	4.45	12	4.42	12
3	4.18	8	4.00*	8	4.27	12	4.44	11	4.39	8
4	4.12	10	3.68	2	4.24	11	4.38	9	4.12	2
5	4.00	7	3.38	7	4.21	9	4.38	7	4.08	10
6	3.75	2	3.27	10	4.20	6	4.38	2	4.03	11
7	3.72	11	3.15	11	4.15	1	4.30	6	4.03	7
8	3.31	3	3.10	1	4.08	7	4.17	10	3.82*	1
9	3.27	1	2.75*	6	4.06	3	4.15	1	3.16*	3
10	3.18	6	2.75*	3	3.95	2	3.78*	3	3.10*	6
11	2.81*	5	2.08*	5	3.89	5	3.78*	5	3.03*	5
12	NB	4	NB	4	NB	4	NB	4	NB	4
Live Seminars										
1	4.68*	III	4.26	III	4.45	IV	4.52	IV	4.48*	IV
2	4.41*	IV	4.24	IV	4.41	III	4.29	III	4.27*	III
3	2.88*	II	2.34	II	3.56*	II	3.91	II	2.75*	II
4	NB	I	NB	I	NB	I	NB	I	NB	I

* Significantly different from grand mean for pre-taped/live programs at .05 level

NB = No Broadcast

TABLE 2

USER RATINGS OF TECHNICAL QUALITY OF SUMMER CAREER EDUCATION COURSES

Rank	TV Easy to hear	Program No.	Undistorted Sound	Program No.	Undistorted Picture	Program No.	Good Color	Program No.	Over-all Satisfaction	Program No.
Pre-Taped Programs										
1	4.83*	10	4.65*	2	4.77*	1	4.43*	10	4.60*	10
2	4.39*	1	4.17*	10	4.67*	10	4.40*	11	4.45*	2
3	4.35	2	4.00*	11	4.48	2	4.21	4	4.40*	11
4	4.34	11	4.00*	1	4.37	11	4.12	7	4.36*	1
5	4.24	12	3.97*	12	4.29	6	4.10	2	4.16*	12
6	3.79	7	3.22	7	4.23	7	4.09	12	4.00	6
7	3.79	5	3.20	9	4.10	12	4.09	1	3.83	4
8	3.78	6	3.00	6	4.03	3	4.00	3	3.75	7
9	3.78	8	2.79*	8	4.00	4	3.94	5	3.48*	5
10	3.79	9	2.73*	5	3.85	5	3.87	6	3.47*	3
11	3.35*	4	2.29*	4	3.82	8	3.75*	8	3.46*	8
12	3.17*	3	2.20*	3	3.77	9	3.37*	9	3.11*	9
Live Seminars										
1	4.73	III	4.53	III	4.80	III	4.59	III	4.72	III
2	4.50	IV	4.22	IV	4.44	I	4.47	IV	4.50	IV
3	4.38	I	4.06	I	4.32	II	4.39	II	4.42	I
4	4.36	II	3.43	II	4.28	IV	4.31	I	3.86*	II

* Significantly different from grand mean for pre-taped/live programs

NB = No Broadcast

TABLE 3

CAUSES OF MALFUNCTIONS IN SITE TELEVISION RECEPTION EQUIPMENT

Causes	Site	Date	Total Malfunctions/ Cause	TV Programs Missed
Defective Preamplifier	23	9/11 to 9/17	1	
Broken Coaxial Cable Assembly	13 13 13	7/10 to 7/11 9/7 to 9/19 10/1 to 10/8	3	DPRI 1 & 2 CES III CES VI & VII
Blown Fuse in H.P. Receiver	41	7/23	1	CES VII,
Blown Transistor in H.P. Receiver	53	10/15 to 10/18	1	CES VII
Broken Signal Strength Meter in H.P. Receiver	13 53	7/16 to 8/5 10/29	2	
Open Audio Cable Between TV and H.P. Receiver	11	10/15 to 10/22	1	CES VII
Defective BNC Connector to Video	21 23	11/26 to 11/27 7/9 to 7/17	2	CES XIII DPRI 1 & 2 CEE 1, 2, 3, 4, 5, I
Broken Remote Meter Cable	53	7/30	1	
Short in Encoder-Decoder	13	10/8	1	CES VI
TOTALS			13	18

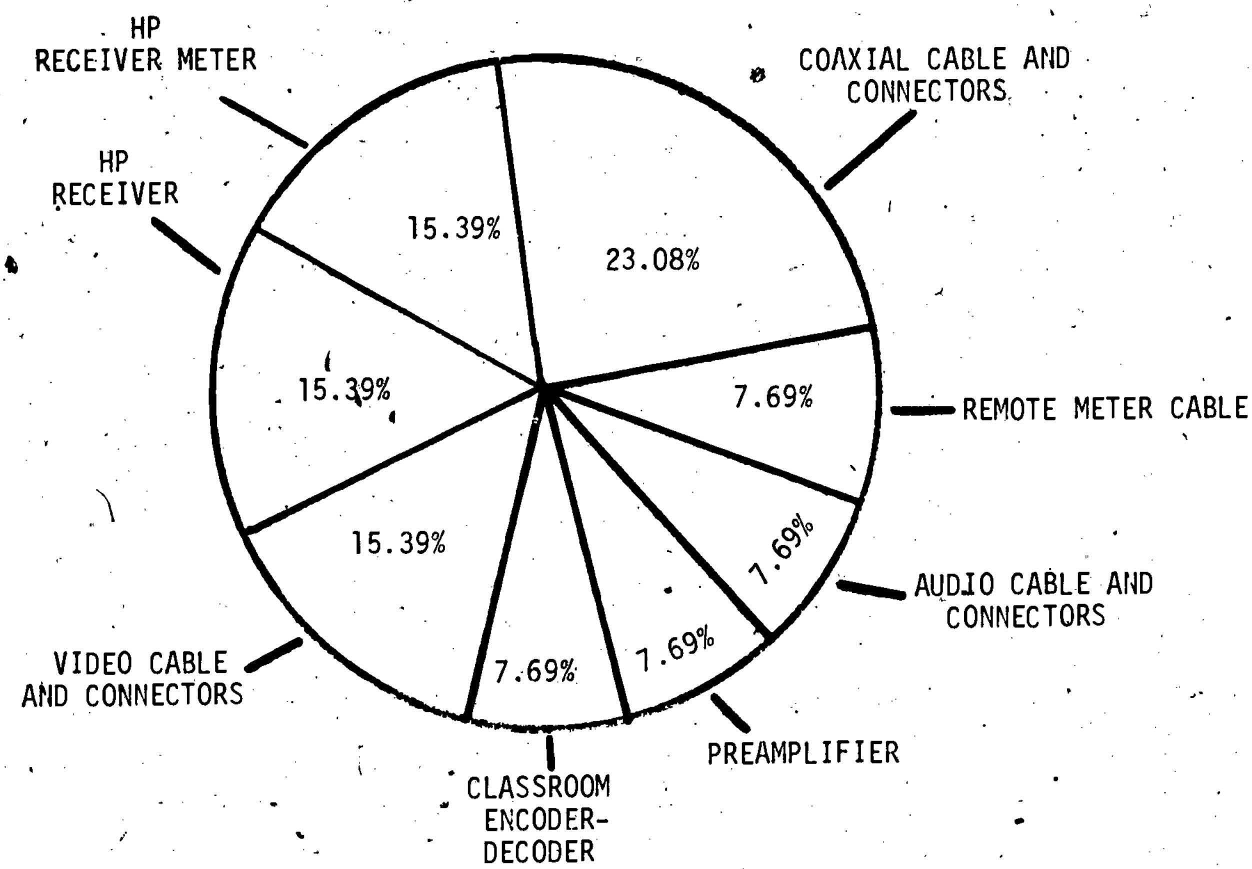


FIG. 9: PROPORTION OF MALFUNCTIONS IN TELEVISION RECEPTION SYSTEM BY EQUIPMENT

attributable to specific pieces of equipment in the system. This proportion is found by dividing the breakdown frequency of each piece of equipment in the system by the total number of malfunctions in the system. As indicated in Figure 9, the cables and connectors caused over half the problems. It should be pointed out that the H.P. receiver was not inoperative when the monitoring device on the receiver for measuring signal strength malfunctioned and that most H.P. receiver malfunctions simply involved blown fuses. Therefore, the weakest link in the system appears to be the cables and connectors that tended to break if repeatedly moved.

Severity of Disruption to the Educational Process

Based on the malfunctions reported to AESP Engineering, equipment failures in the television site reception system resulted in the loss of approximately 2.8% of the televised programs. This proportion was found by dividing the sum of program time lost at individual sites (14.25) by the product of the number of hours of programs transmitted times the number of sites (15 x 34). The higher proportion of times the site coordinators reported no-go situations for television, 4-5%, is due to the fact that these percentages included television set malfunctions and system-wide delivery failures, in addition to malfunctions in reception equipment at sites.

Procedures for Television Program Make-ups

If, for some reason, transmission was interrupted between the point of origination at the RCC in Lexington and the uplink in Rosman, B & E could transmit the programs to ATS-6 through the Morrison uplink station just outside Denver. However, since B & E did not receive back-up tapes for reading programs 3 and 4 prior to the broadcast date, they were unable to broadcast the summer reading programs when the first system-wide failure occurred. Instead, reading programs 3 and 4 were broadcast the following week along with the other program scheduled for that day (July 25), and seminar I was deleted. In the second system-wide failure involving a live career education seminar (September 3), the content that was to have been covered was simply presented in subsequent seminars.

Recommendations Based on Television Reception System Data

The following recommendations for improving the television reception system are based on an analysis of the data collected from the 15 AESP sites over a six-month period:

1) Mount the receiver directly on the receiving antenna so that the coaxial cable, responsible for the most malfunctions, could be replaced with a less expensive, less complicated, and lighter video cable that would place less strain on the connector.

2) Install the equipment permanently in one place to reduce the number of breaks in the connections due to movement of the equipment.

3) Provide landlines with automatic devices for switching the transmission to back-up lines should the original line malfunction.

4) Orient the antenna so that a natural or man-made obstacle is between the antenna and any competing transmission operating on the same frequency.

5) Periodically practice back-up transmission procedures to make sure an immediate substitution of the televised program could be made if it were necessary.

Four-Channel Audio Review

Use of Audio Review

To demonstrate one educational function that could make use of the four-channel audio capacity of ATS-6, 24 fifteen-minute audio reviews were developed and scheduled for broadcast in the summer of 1974. Each review consisted of four questions covering the content of the immediately preceding pretaped television program. As shown in the picture, over headphones the student first heard each question and four alternative answers and then selected the response he felt was most appropriate by depressing one of four buttons on his response pad. This keyed him into the audio channel on which an explanation appropriate to his response was given. In the picture, Werner Von Braun, Vice President of Engineering and Development at Fairchild Industries, is shown taking part in the audio review at the Cumberland, Maryland site.

Identification of the Audio Review Reception Equipment

The four-channel audio system is an extension of the television reception system: the four audio channels were transmitted as sub-carriers above the video spectrum. Consequently, the parabolic antenna, preamplifier and H.P. receiver were used both for audio-video and four-channel audio reception. However, just as the television set is a unique part of the audio-video reception system, so the classroom distribution cable and the individual response pads and headphones that allowed the participants to select and hear one of the four audio channels are unique parts of the audio review system. Shown in Figure 10 is the relationship between the different parts in the system: at each site 20 individual headsets and response pads were connected to a classroom distribution cable that ran between the rows of desks in the classroom to the H.P. receiver that separated the audio signals received by the outdoor parabolic antenna.

Installation of Four-Channel Audio Review Equipment

As indicated in Figure 11, the four-channel audio review equipment was operational at all 15 sites by July 27, 1974. The summer courses were then more than half over. Inadequate quality control by the manufacturer was one of the reasons for the delay. For instance, some of the input sockets from the response pads had to be remanufactured because they were so misshaped that not all the students could plug into the junction connector. There were no audio reviews in the fall course, since it consisted of live, interactive seminars rather than pretaped television programs.

Quality of Four-Channel Reception

There was not enough information at the time of this report to make reasonable conclusions about how clear and strong audio reception could be or how well the channel-selection mechanism might work. What can be said is that, due to improperly designed equipment, the voice quality was initially impaired by severe crosstalk from other channels, static, and weak signal strength. AESP Engineering eliminated most of the crosstalk between the channels, caused by the incompatible design

Werner Von Braun, Vice President of Engineering and Development for Fairchild Industries, Selecting Answer for Four-Channel Audio Review Question

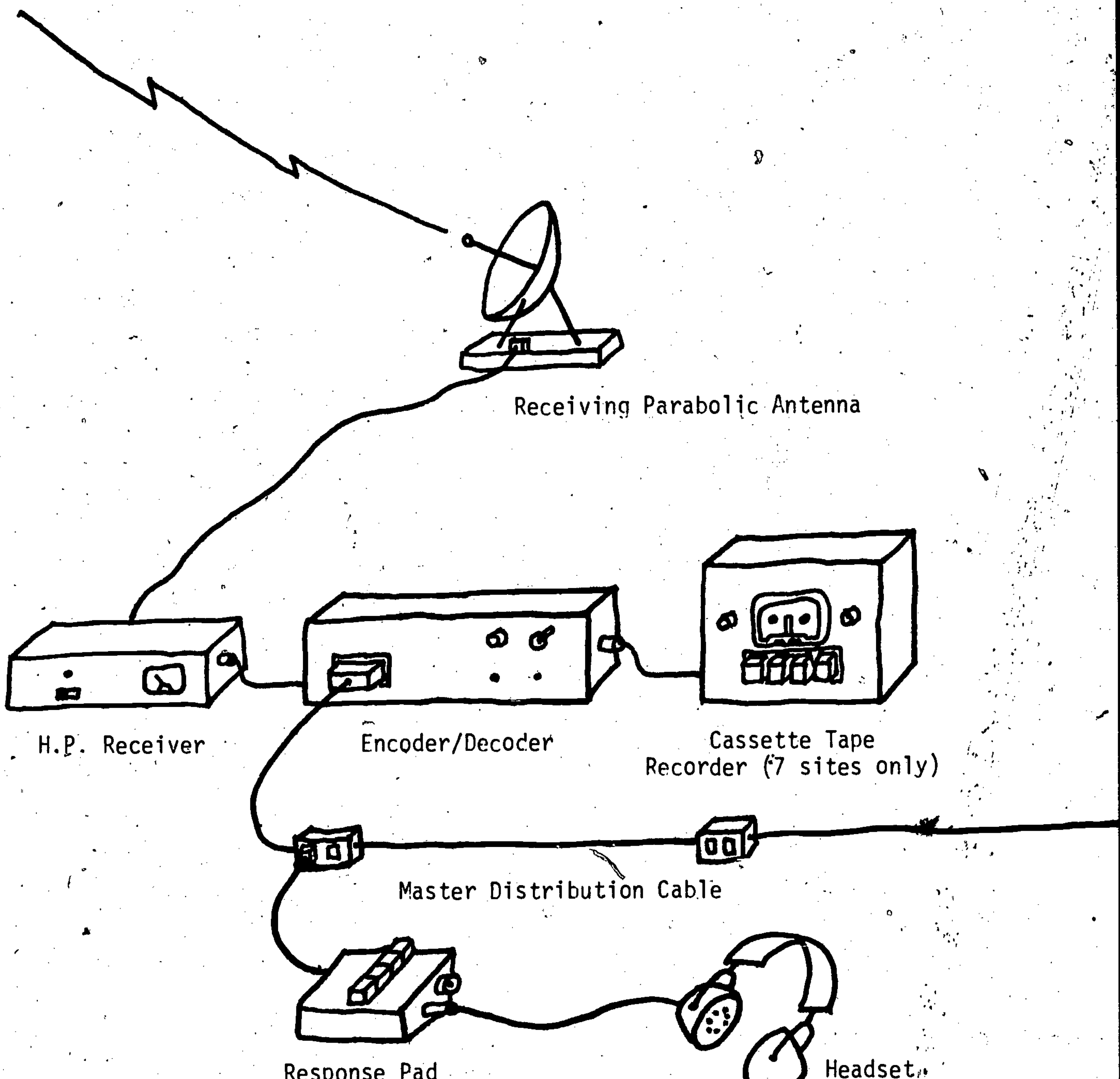


FIG. 10: FOUR-CHANNEL AUDIO REVIEW EQUIPMENT AT CLASSROOM SITES

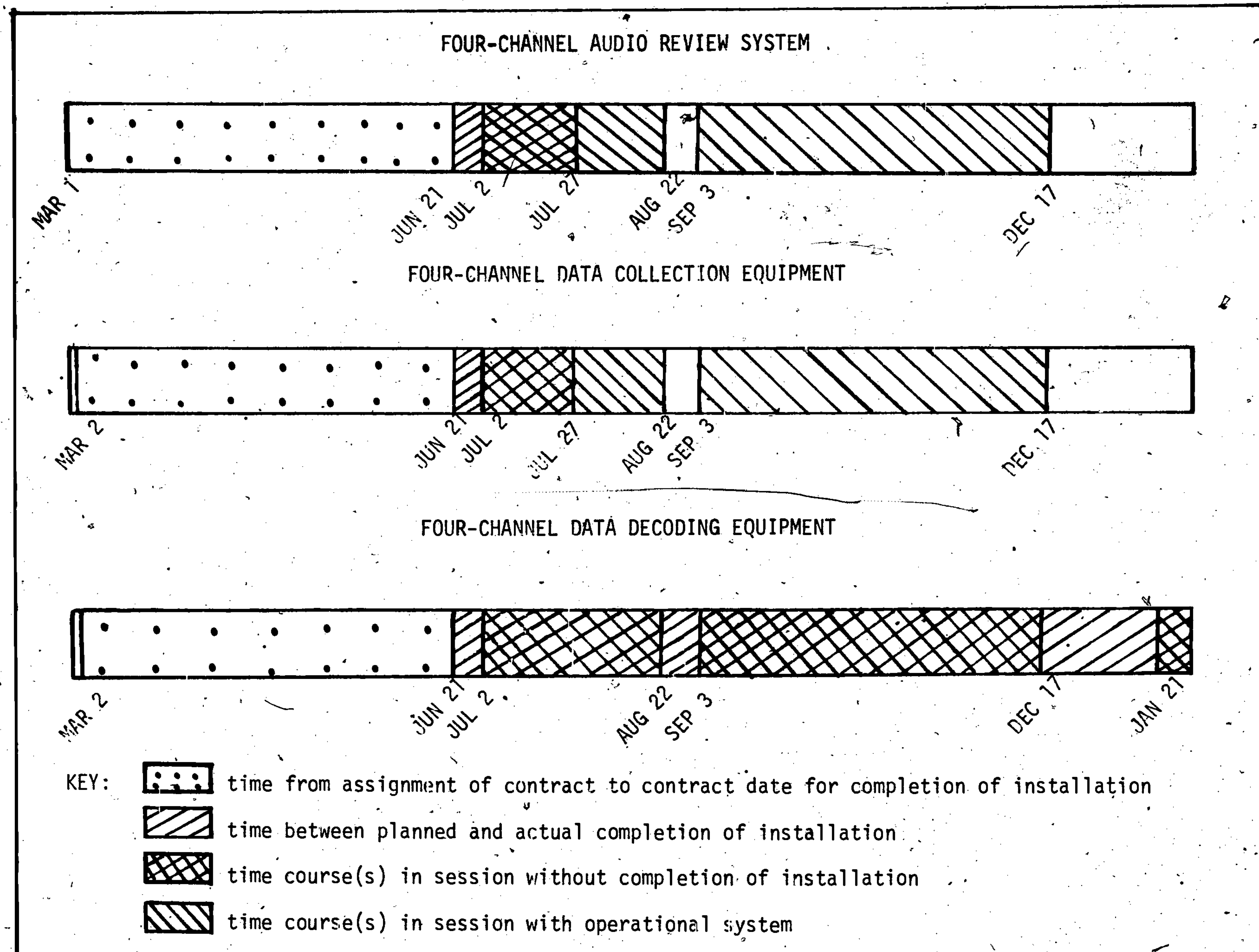


FIG. 11: FOUR-CHANNEL AUDIO SITE RECEPTION EQUIPMENT INSTALLATION SCHEDULE

of the H.P. receiver and the classroom disbritution-amplifier, by removing the individual ground on the classroom distribution-amplifier and replacing it with a common ground.

Recommendations Based on Four-Channel Audio Review Data

No conclusions about the basic soundness and reliability of the four-channel equipment can be made at this time, since little data were collected and what was collected was probably biased by the hostility of many site coordinators and students toward the system by the time it did become operational. Many of the students continued to receive printed copies of all or part of the review after the system was installed, since it was initially hard to understand what was said on the review. Consequently, the effectiveness of the audio format alone was never demonstrated, since students both heard and read the programs.

Four-Channel Data Collection and Analysis

A variation on the instructional use of the multi-channel capacity of ATS-6 for audio review is the addition of prerecorded signals on the tapes for the polling of student selections. Upon recognition of a command tone accompanying each audio review question delivered via ATS-6, the classroom encoder-decoder initiated a polling sequence of the student positions. In the picture of the students watching television, the encoder-decoder is the larger box under the H.P. receiver on the shelf above the television. The data obtained were coded by the classroom encoder-decoder by means of an audio tone that shifted frequencies in accordance with the information received. The data were then stored on cassette tapes in an adjoining tape recorder. The tapes were sent to the RCC where the data were translated by a master decoder.

The Appalachian Education Satellite Project's Evaluation Component requested this add-on to the four-channel audio review system to obtain accurate response frequencies in a system where correct answers were revealed to the students and also to try out what could be a useful system for formative evaluation. For instance, preliminary versions of taped programs could be piloted on sample audiences scattered throughout the region whose needs the programs were to meet. The audiences could be asked at selected points any dichotomous question, such as, "Do you understand what he has just talked about." or "Are you interested in what he is discussing?" In this way, portions of programs unclear or uninteresting to the target audience could be identified and reworked before they were fixed in final form.

Installation of Four-Channel Evaluation Equipment

For economic reasons only seven sites were provided with the additional evaluative four-channel audio equipment. As indicated in Figure 11, the four-channel audio evaluation equipment had not been made fully operational as of January, 1975. The classroom encoders for the electronic collection of four-channel audio responses had to be shipped to the sites before they were tested because the master decoder required to translate what was recorded on the encoders had not been constructed. When all the data equipment was installed and tapes were received at the RCC, difficulties were encountered in decoding the tapes. It was discovered that the problem lay in the way the data was recorded.

Initially, there was one synchronization bit and a whole chain of data. When the flutter of the tape recorder caused a data bit to drop out, synchronization was lost and subsequent data could not be recovered. It then became necessary to redesign the information encoding process. The classroom encoder-decoder was modified so that a synchronized word was associated with each data word. This way when there was flutter in the tape and the data bit was lost, the machine would synchronize itself on the next data bit.

Design Problems

Although the four-channel audio evaluation system was not operational during the summer courses, it is possible to identify some of the design problems that occurred. The main problem with the system was poor quality control. For instance, one of the things initially wrong was that the connections in the classroom encoders and the master decoder were poorly soldered. For this reason, any movement of the machines caused enough vibration to make data being coded or decoded uninterpretable. More distortion occurred when the data were recorded on tapes due to the magnification of the inherent flutter in the cassette recorder.

Recommendations Based on the Data

Based on the experience of working with the equipment and the manufacturer to make the system operational, there seem to be several ways the system could be altered to improve its potential reliability:

1) Add a device that allows the students to type in their student numbers, so that it is no longer necessary for students to use response pads matched to their student numbers if monitoring of individual response patterns is important.

2) Consider the advantages of a mechanical rather than electrical means for collecting, delivering and displaying the data: first; if a means was devised whereby students could punch their answers on paper tape as they selected them, the data could be transmitted immediately over ATS-3 using an already functioning teletype delivery system; secondly, a hard copy of the data would be automatically made, so the process of transcribing information off the decoder would not be necessary; thirdly, it would be less expensive to use teletype equipment already at all the sites rather than supply more than half of the sites who do not yet have encoders with the equipment.

VHF-Teletype Relay System

Uses of the VHF-Teletype Relay System

The AESP sought to demonstrate two educational uses of the capacity of ATS-3 to deliver voice and taped data: as an administrative device for connecting those producing, managing, evaluating and implementing centrally produced courses and as an instructional means whereby live, televised seminars could be interactive.

The need for reliable and economical lines of communication between course producers and users arises out of the basic economic advantage of centrally produced courses--that content experts do not have to be at sites. Since those administering courses are rarely content experts, professional evaluators, or technicians, the site coordinators often need to talk with someone who "knows" what to do--if the course is to run smoothly.

The VHF-teletype system was also used to approximate on live television programs the personalized atmosphere of the traditional classroom, by making it possible for students to ask their teachers and other experts questions. The moderator directed the questions coming in from the sites to members of the panel, which was made up of visiting content experts and teachers.

Relay Procedure

A relay system was set up between sites with landline and satellite delivery capabilities. Five of the 15 sites, the intensive sites, were equipped to transmit and receive radio signals via ATS-3. As depicted in Figure 12, voice and data mode communications were relayed from the five main sites to the broadcast studio via ATS-3. Questions and information requests from the 10 remaining ancillary sites were sent by landline teletype to the five main sites for relay over ATS-3.

Identification of VHF-Teletype Equipment

The aluminum, cordscrew-shaped, polarized antenna, depicted in the picture of the Cumberland, Maryland, outdoor reception equipment served as the common antenna for the transmission and reception of radio signals via ATS-3. Mounted on this "helical" antenna in a weather-proof enclosure was a transistorized, preamplifier-duplexer that amplified the received signal. Voice or taped data could be transmitted via satellite by means of the VHF console and teletype machine seen in the picture showing the Huntsville, Alabama, site coordinator calling in. The teletype machines at the intensive site had an

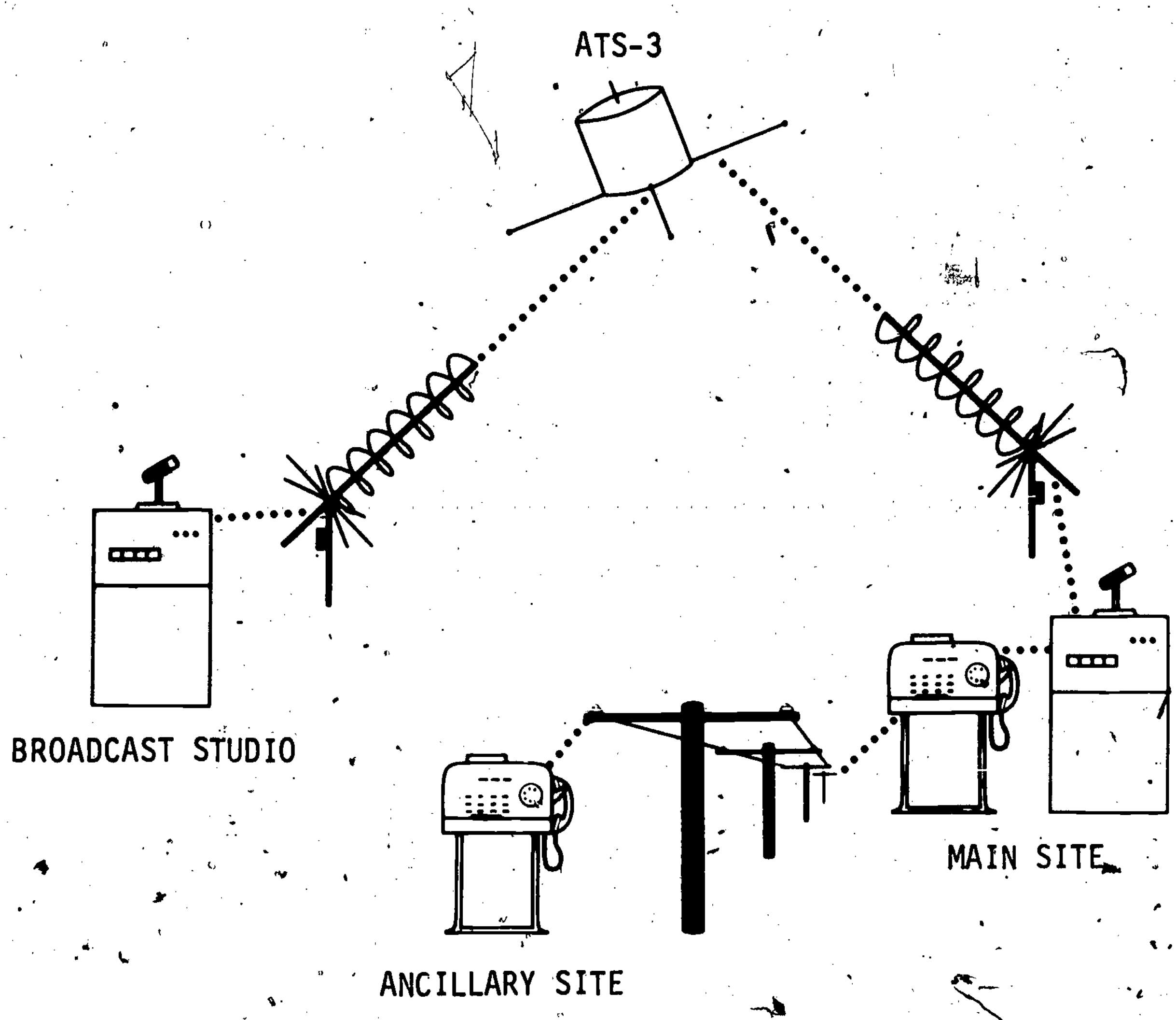
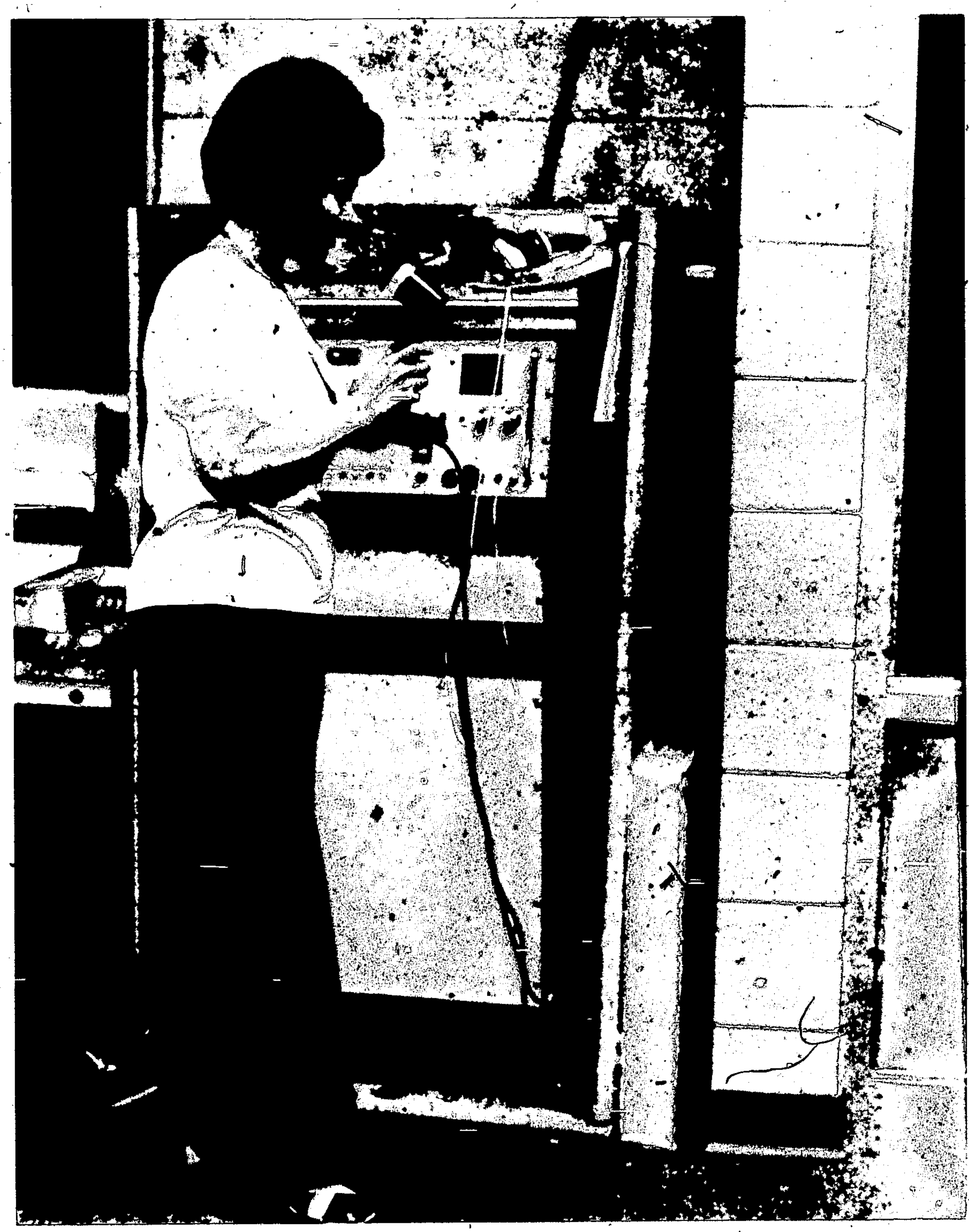


FIG. 12: VHF-TELETYPE RELAY SYSTEM



Huntsville, Alabama Site Transmitting
Seminar Questions Via VHF Satellite Delivery System

additional switch for the selection of landline or satellite delivery. The landline teletype system consisted of a conventional teletype machine and a data access arrangement.

Installation of VHF-Teletype Equipment

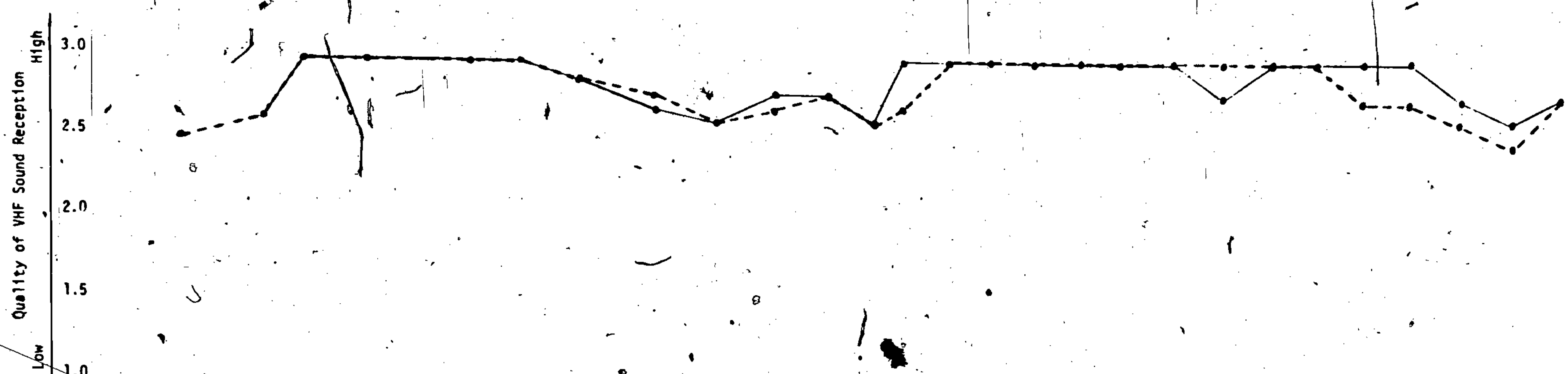
As shown in Figure 13, it was not until July 18, two weeks after the summer courses started, that the five main sites had reliable VHF voice capability. It was August 7, when the summer courses were more than half over, before all the main sites had VHF data (tape) capability. All 15 sites had operational landline teletype systems before the summer courses started (June 21). The main sites had operational tele-copier systems as early as April 1.

RCC Operator Ratings of Quality of Voice Reception

During the summer and fall courses, the RCC called the main sites almost every weekday and usually twice on seminar days, excluding the two-week break between the courses. The RCC operator rated the quality of the VHF transmissions from the five main sites acceptable 88.1 percent of the time. In Figure 14 are the ratings given each program day. For a voice transmission to be acceptable it had to be at least readable with fair signal strength. The sites differed in the percent of time their signals were rated acceptable: 90.7% for site 11; 89.2% for site 21; 89% for site 31; 87.9% for site 41; and 83.7% for site 51.

Site Coordinator Ratings of the Quality of VHF Voice Reception

Site coordinators reported the quality of VHF voice transmission acceptable 95 percent of the time (91% at site 11; 97% at site 21; 96% at site 31; 96% at site 41; and 90% at site 51). However, the quality



Dates	*7/2	7/9	*7/11	7/16	7/23	7/25	*7/30	8/1	8/6	8/8	8/13	8/15	8/20	8/22	9/3	9/10	9/17	9/24	10/1	10/8	10/15	10/22	10/29	11/5	11/12	11/19	11/26	12/03	12/10	12/17
Courses																														
QPRI			1 2			3 4 5 II		6 7		8 9 III		10 11		12 IV																
CEE	1 2	3 4		5 I	6 7		8 9		10 11		11 III		12 IV																	
CES															1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Key: Solid Line: Clarity of VHF Sound

Broken Line: Strength of VHF Signal

*No data for this date.

FIG. 14: QUALITY OF VHF SOUND RECEPTION IN AESP COURSES

of the reception in Lexington was substantially poorer than at the sites, being acceptable only 88.1 percent of the time. This was due to interference from police radios that made it necessary to relocate in November, 1974, the helical antenna between two buildings that acted as shields. Differences in the reported quality of reception at the individual sites may be due to differences in rater perceptions, different interpretations of the rating guidelines, varying approximations of proper antenna alignment, and/or different functioning levels of the site equipment. Various factors, singularly and in combination, could make a VHF transmission unacceptable: competing transmitters, antenna misalignment, loss of power in the transmitter, interference from experimenters using ATS-1 when atmospheric conditions caused multiple-path reflection of the signals, and degradation of the satellite signal due to heavy ionization in the atmosphere.

<u>Frequency and Cause of VHF-Teletype Malfunctions at Intensive Sites/Delivery Method</u>

At the intensive sites--the five main sites and the broadcast studio--there were 26 malfunctions in the communications system. As indicated in Table 4, seven of these malfunctions occurred in the equipment necessary for satellite delivery of voice and taped data; 12 were in the teletype terminal necessary for landline or satellite delivery of data and seven were in the equipment necessary for landline delivery of voice and data.

Malfunctions in VHF-Teletype Systems at Intensive Sites/Equipment and Mode

Identified in Figure 15 are the proportions of the malfunctions in the system attributable to different pieces of equipment. All seven malfunctions associated with satellite delivery affected the capability to transmit in the data mode, while only three of these malfunctions also affected the capability to transmit in the voice mode (the receiver and the coaxial cable). All malfunctions associated with landline delivery affected the ability to transmit in the data mode. Malfunctions in the teletype machine, used for the reception and delivery of data, regardless of whether it was transmitted by satellite or landline, accounted for nearly half of the malfunctions, while the other half of the malfunctions is almost evenly divided between equipment associated with satellite and with landline delivery.

Frequency and Cause of Teletype Malfunctions at the Ancillary Sites

The ancillary or receive-only sites were equipped to deliver and receive voice and data via landline. The causes, locations and dates of the 16 malfunctions that occurred at the ancillary sites are identified in Table 5.

Malfunctions in Teletype Systems at Ancillary Sites/Equipment and Mode

Identified in Figure 16 are the proportion of the 16 malfunctions in the landline teletype system attributable to different pieces of equipment. Nearly two-thirds of the malfunctions (10) occurred in equipment necessary for data transmissions only, and only one of the remaining malfunctions occurred in equipment that affected only the voice mode.

TABLE 4

CAUSES OF MALFUNCTIONS IN THE VHF-TELETYPE SYSTEM AT INTENSIVE SITES

Causes	11	21	31	41	51	Lexington	Total Malfunctions/Cause;	Seminars Missed
Broken Coaxial Cable Between Antenna and VHF Console					9/5 to 9/12		1	CES II
Internal Short in Receiver		9/10					1	
Maladjusted Control Card		9/4 to 9/10 10/9 to10/10					2	
Mistraped EIA Interface Between Teletype and VHF Console		10/10 to 10/15	6/26 to 7/5	10/25 to 10/29			3	
TOTAL SATELLITE DELIVERY EQUIPMENT MALFUNCTIONS							7	
Broken or Maladjusted Mechanical Aspects of Teletype	*11/27 to 11/29		*6/21 to 6/25 *8/5	*7/23 to 7/24	*7/15-16 *7/25 to 7/29	*8/12-13 *9/26 to 9/30	8	CEE III DPRI II
Inoperative Voice Option on Teletype Machine					7/1 to 7/12	9/23 to 9/24	2	
Blown Fuse in Teletype System					*7/23 to 7/24	*9/23 to 9/24	2	CES IV
TOTAL TELETYPE TERMINAL MALFUNCTION							12	
Broken D.A.A. (Data Access Arrangement)		11/27 10/16 to 10/18				9/6 to 9/12 8/19to 9/26 9/2 to 9/4	5	CES III CES III
Malfunctioning Data Set			8/15 to 8/20	6/23 to 6/25			2	CEE II
TOTAL LANDLINE DELIVERY							7	
TOTAL MALFUNCTION CAUSES							26	

* affect both landline and satellite delivery

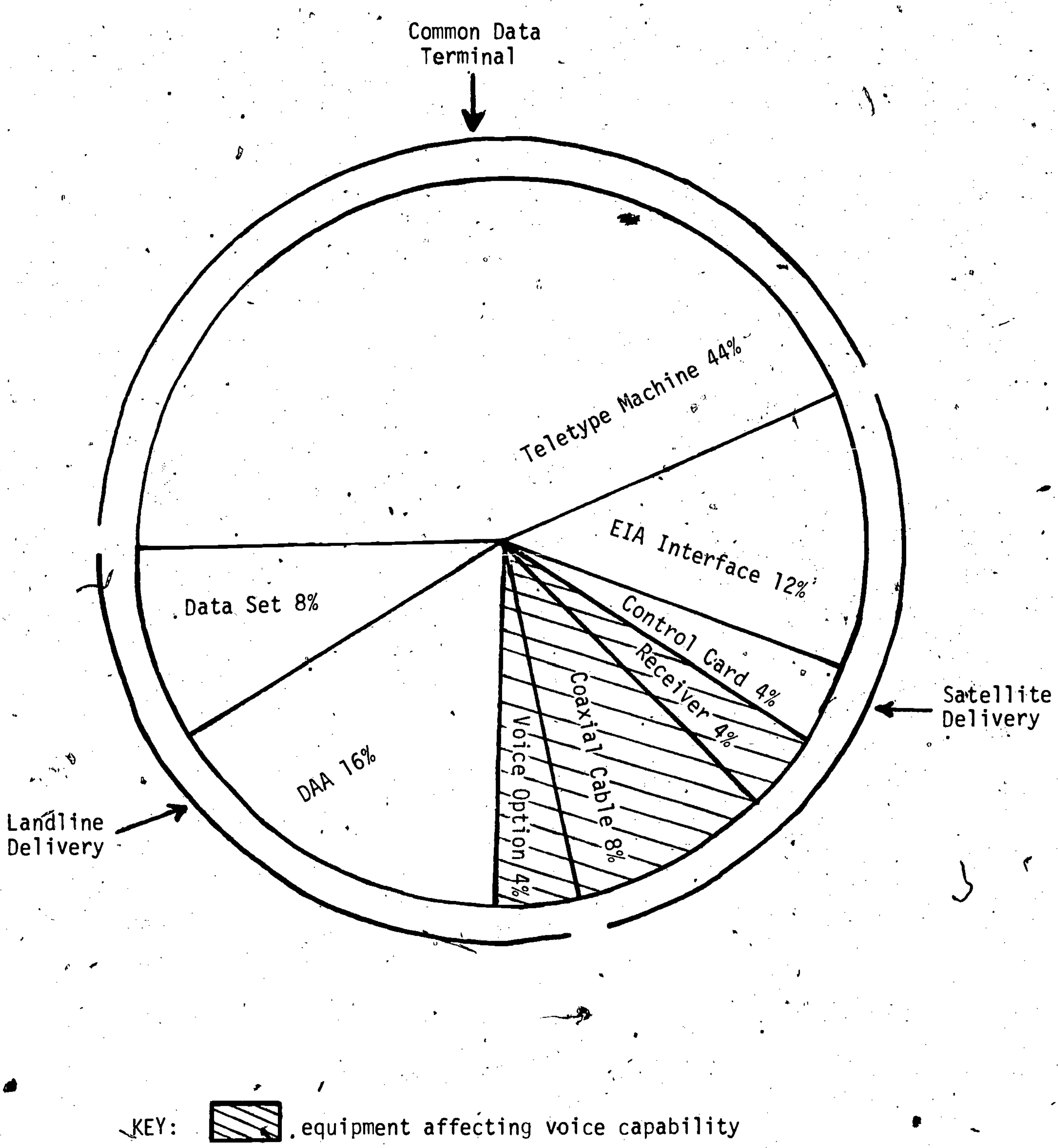


FIG. 15: PROPORTION OF MALFUNCTIONS IN THE VHF-TELETYPE EQUIPMENT AT INTENSIVE SITES

TABLE 5

CAUSES OF MALFUNCTIONS IN THE LANDLINE TELETYPE SYSTEM

AT THE ANCILLARY SITES

Causes	Site	Dates	Seminars Missed
Broken Mechanical Aspects of Teletype Machine	43	9/4 to 9/5	
Blown Fuse in Teletype Machine	42	7/19 to 7/23	
	52	7/23 to 7/24	
	53	9/30 to 10/2	CES V
Broken Telephone Cables	22	11/27	
Broken D.A.A. (Data Access Arrangement)	22	9/10 to 9/11	
	22	11/6 to 11/13 9/11 to 9/16	
	33	6/26 to 7/9	
	52	7/25 to 8/9	DPRI, II, III, CEE II
	52	7/9 to 7/19	CEE I
	53	7/25 to 8/1	DPRI II
Malfunctioning Data Set	32	6/25 to 6/26	
	32	7/1 to 7/2	
	53	7/9 to 7/16	CEE I
Inoperative Voice Option	42	8/9 to 8/10	

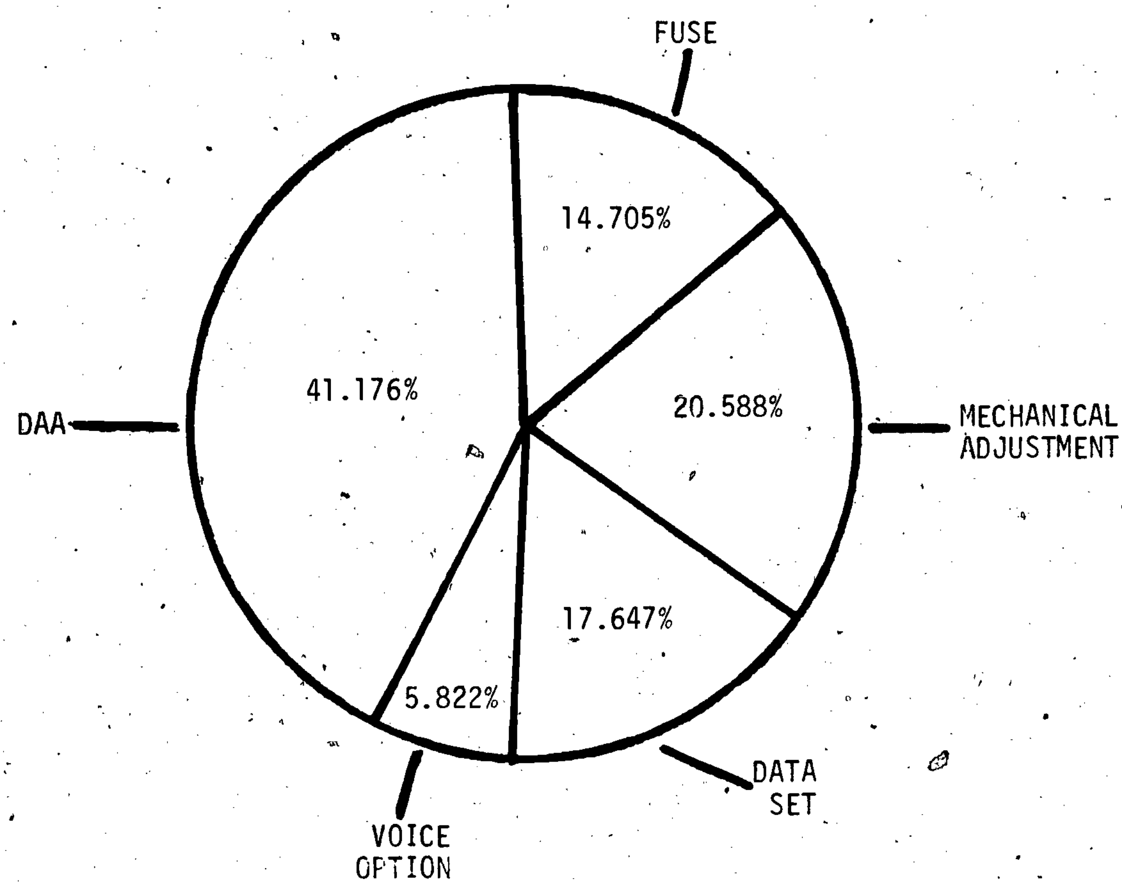


FIG. 16: PROPORTION OF MALFUNCTIONS IN THE TELETYPE SYSTEM AT THE ANCILLARY SITES

Severity of Malfunctions in Communications System

The VHF and teletype malfunctions disrupted communications to varying degrees, depending upon whether the system was inoperative or merely impaired, whether one or both of the two optional delivery modes at the main sites was inoperative, and whether the criterion for judging the severity of the malfunction was the number of days before the malfunction was repaired, or the number of seminars during which the system was inoperative.

As indicated by the starred dates in Table 4, at the six intensive sites 10 out of the 26 malfunctions disabled both landline and satellite delivery of data. However, all of the 26 malfunctions at the intensive sites rendered only one of the delivery modes inoperative at any one time. Therefore, the main sites were never without either VHF/landline voice or data options. At the ancillary sites there were 16 failures in the landline delivery system that made either data or voice transmission impossible, as indicated in Table 5. While more failures occurred at the main sites that used the communications system more, the main sites were totally without means of communication less often than the ancillary sites.

Effectiveness of VHF as an Administrative Device

If the function of the VHF system is to facilitate communications between the Resource Coordinating Center and the sites, one index to the effectiveness of the system is the number of attempted contacts with the main sites that were successful. The columns in Figure 17 show the proportions of the VHF transmissions for each main site that were readable, not readable, and not answered.

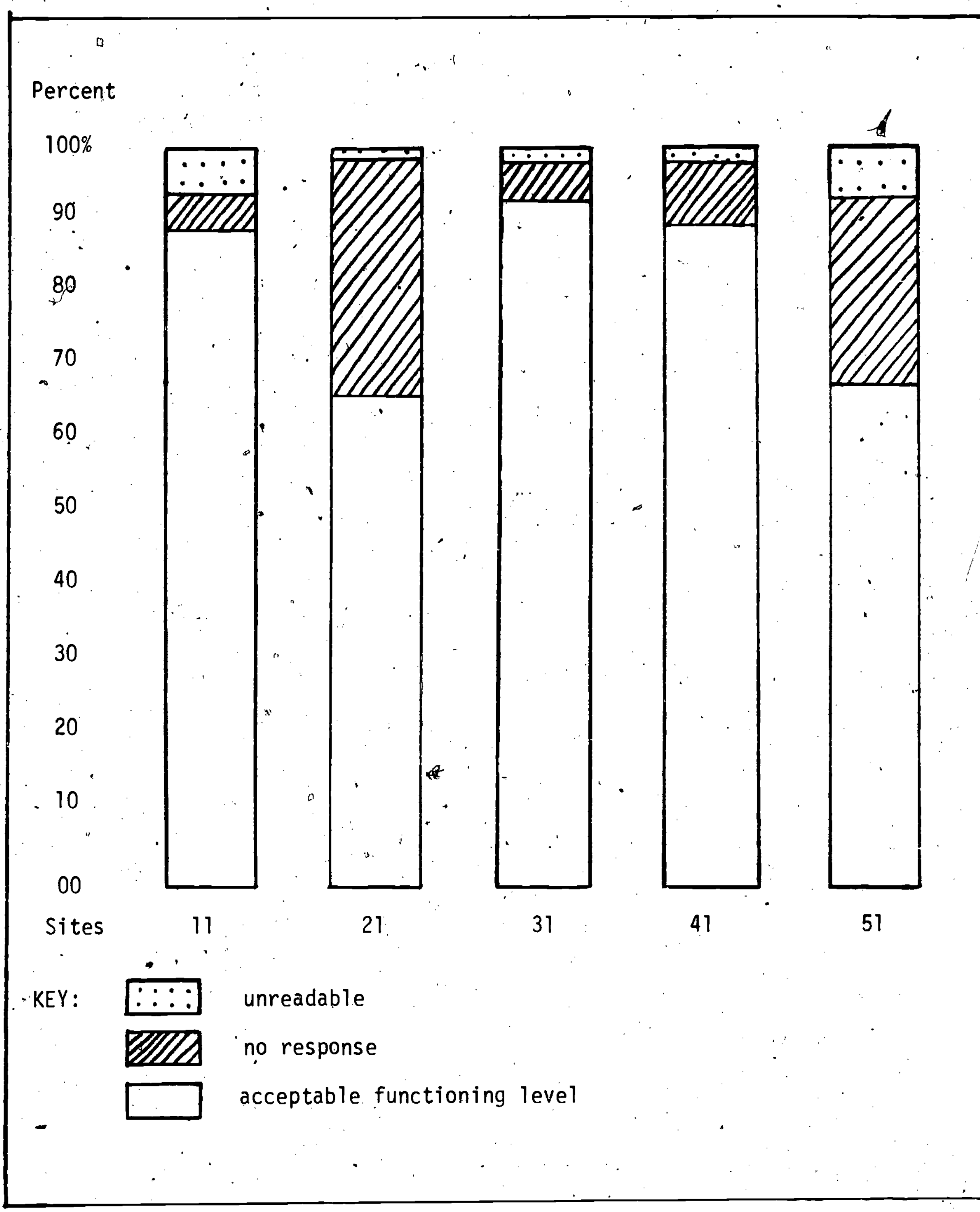


FIG. 17: RELIABILITY OF THE VHF SYSTEM AS A COMMUNICATIONS LINK

Effectiveness of VHF-Teletype Relay

From an instructional rather than an administrative point of view, the primary value of the communications relay system between the ancillary and main sites and the broadcast studio was the transmission of seminar questions via satellite. Another index to the reliability of the communications system, then, is the percent of times transmission was possible during seminars. Since there were 23 seminars broadcast and five relay networks, there was a total of 115 possible seminar-question relays between the ancillary sites and the main sites (landline) and the main site and the broadcast studio (satellite). Nine of those relays or 7.8% were disrupted by one or more of the three classroom sites experiencing malfunctions in the landline or satellite delivery equipment. Three times during seminars the broadcast studio was unable to receive or transmit via satellite or landline in the voice or data mode (3/23 = 13.04%).

Recommendations Based on VHF-Teletype Data

1) Install a twin element gas-filled protector, similar to the circuit protectors in the telephone system, to reduce the frequency of shorts in the Data Access Arrangement due to voltage transcients.

2) Provide an acoustic sound hood to reduce the noise of the teletype if it must be located in the classroom.

3) Install a telephone company supplied loop to the teletype machine that would make it possible for messages to be left when the machine was unattended.

CONCLUSIONS

Summary of Information on Equipment Operation

- The television reception systems at the 15 classroom sites and the landline from the broadcast studio to the access station were installed before the first televised program.
- There was, averaged across sites, little perceptable distortion in either the television picture or the sound.
- There were 13 malfunctions in the site television reception equipment in five-and-a-half months of use during which 48 televised programs were transmitted for a total of 34 hours.
- Less than 3 percent of the televised programs were not received by individual sites due to malfunctions in site reception equipment.
- On two out of 31 transmission days, malfunctions in the delivery system caused system-wide failures.
- The summer courses were more than half over before the four-channel instructional equipment was installed, and the four-channel evaluation equipment was still not operational when the fall course ended.

- At all 15 sites the landline teletype was installed before the first courses began, but the main sites did not have the additional capability to deliver by satellite until several weeks after the courses started.
- VHF voice reception met defined standards between 88% and 96% of the time, depending upon whether the ratings were made by the RCC operator or the site coordinators.
- Whether delivered by satellite or landline, the voice mode was more reliable than the data mode, since equipment specific to the data mode broke down more than six times as often as equipment peculiar to the voice mode.
- At the five main sites, equipment necessary for the delivery via satellite of voice and data was inoperative 19 times; and equipment necessary for the delivery via landline of voice and data was inoperative 19 times.
- During 23 seminar broadcasts, approximately 8 percent of the seminar question relays were hindered by malfunctions that rendered one or both delivery modes inoperative.

Recommendations

As the different systems were discussed, suggestions on ways to improve the efficiency of the equipment in the system were made. The following additional observations on AESP technical procedures are based on the experience of more than two years of project operation:

1) Instead of a precourse training course at some central location, a slide series would probably be a more efficient and less expensive means of training site coordinators in the skills necessary for efficient operation of the technical and evaluative aspects of the project.

2) A central communications officer at the RCC might better coordinate the activities of the hardware and software sections of the project than is now possible with the separation of these functions into discrete, autonomous units.

3) For new equipment, enough start-up time should always be provided to make possible the testing of the equipment prior to its actual use.

4) In order to shorten the time a system is inoperative due to the malfunctioning of a part, AESP Engineering should be provided with sufficient back-up components to lend to sites while repairs are being made.

5) Since it is likely that the same types of equipment malfunctions will occur again and again, standardized, pictorial instructions for remedying different types of problems should be developed for site coordinators. These instructions could be included in a manual that

the engineer could refer the site coordinator to, once the problem had been identified.

Since it takes time to test equipment and "work the bugs out," the first few months should be treated as a start-up period. For this reason, data from the second half-year of use would better indicate how the equipment might be expected to perform over an extended period. However, from data based on six or less months of operation, the preliminary conclusions in this report have been made in the hope that they will be helpful to those making decisions about ways to improve the technical aspects of the Appalachian Education Satellite Project and similar projects. Included in Technical Report 12 is summary information on the reliability of the equipment and technical procedures used during the spring reading course (1975).

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