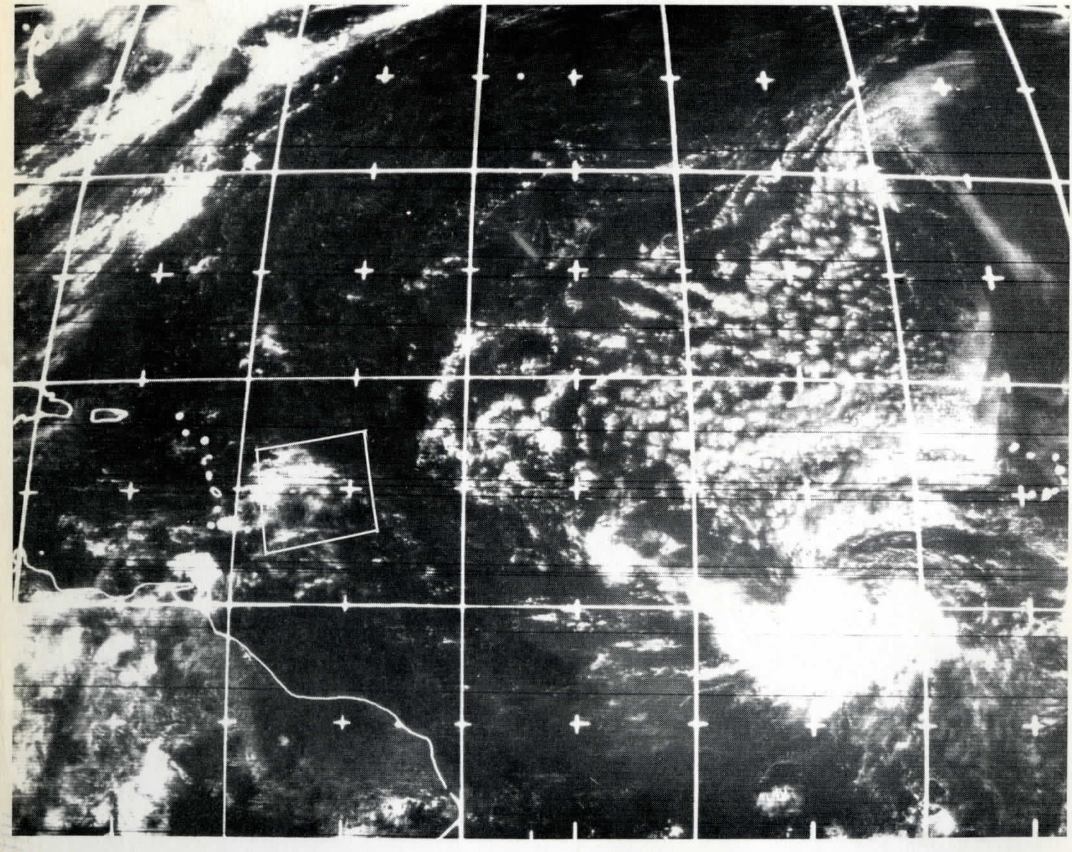
Radiation Experiment in the Vicinity of Barbados

Final Report
NSF Grant GA. 12603
April, 1970

SPACE SCIENCE AND ENGINEERING CENTER
THE UNIVERSITY OF WISCONSIN



COVER PHOTOGRAPH

One of the reasons for conducting this radiation experiment in the tropics was to determine the absorption of solar radiation in the atmosphere and then to parameterize this absorption by means of earth radiance values measured by earth orbiting satellite. This photograph shows the great variability of cloud organization in the tropics and the need for such parameterization if our study shows it is feasible.

The picture was obtained by ATS-III on July 26, 1969 at 1351 GMT and was recorded in analog form on magnetic tape at the NASA ground station at Rosman, North Carolina. The picture negative was obtained from the analog tape through a precision display device at the Space Science and Engineering Center, University of Wisconsin. The grid was produced by the National Environmental Satellite Center of ESSA. The lower left corner of the picture is at 0°N, 70°W and the solid white lines are at 10° latitude - longitude intervals. An excellent registration of the grid was obtained on the Windward Island chain and also the coast of Africa (not shown in this enlargement).

The BOMEX array, in which most of our flights were obtained, is shown as a square (500 km on a side) between 40 and 50°W longitude.

200-193

PRINCIPAL INVESTIGATOR

Kirby J. Hanson

CO-INVESTIGATORS

Stephen Cox*
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Space Science and Engineering Center
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RADIATION EXPERIMENT IN THE VICINITY OF BARBADOS

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CONTENTS

I. INTRODUCTION

From the low-resolution radiometer experiments on the first generation satellites, it has been learned that more solar energy is absorbed by the earth atmosphere system in the tropics than was previously thought.[1,2] This is based solely on satellite measurements, which gives no indication of whether this additional energy is absorbed primarily in the ocean or in the atmosphere. It is important to know where this absorption occurs because it has been generally thought that solar energy absorption by the atmosphere is a relatively small term among the other atmospheric energy terms. However, this assumption is based on early theoretical calculations and has not been verified experimentally.

Because of the possibility that solar energy absorption may be larger than previously thought, a review paper titled "Scientific Objectives and Data Requirements for Radiation Studies during BOMEX," was written for the BOMEX planning staff in March, 1968 by the four investigators of this report. This review paper is included in the appendix for background information.

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[1] House, F. B., 1965: Radiation Balance of the Earth from a Satellite, Ph. D. thesis, Department of Meteorology, Univ. of Wisconsin.

[2] Vonder Haar, T. H., 1968: Variations of the Earth's Radiation Budget, in Meteorological Satellite Instrumentation and Data Processing, Final Report on NASW-65, 1958-68, Department of Meteorology, University of Wisconsin.

As a result of this earlier paper, the BOMEX Project Office in January 1969 began to make plans to include an aircraft-based, solar radiation program in the BOMEX experiment. As a part of the radiation program, a real time satellite data receiving system was developed to receive cloud pictures on Barbados for operational planning of aircraft flights. On April 1, 1969, the Wisconsin Radiation Program of BOMEX was funded jointly by NSF and ESSA under grants GA-12603 and E22-113-68(G).

A field program was carried out on Barbados from May 1 - July 31, 1969. The operational results of this program and the instrumentation are described in this report. The scientific results are not completed because data processing has just begun. However, some data (calculated from notes obtained on the flights) are presented in a following section. A proposal has been forwarded to NSF for funds to complete the data reduction.

II. FIELD PROGRAM RESULTS DURING BOMEX

The objective of the Wisconsin Radiation Program in BOMEX was to obtain direct measurements of the absorption of solar radiation in the atmosphere. Two basic modes of observation were used in order to obtain these measurements. One mode was to fly multiple aircraft in a vertical array in order to measure the absorption directly. A second mode was to fly a vertical profile with a single aircraft. These two modes of observation are discussed separately in the following paragraphs.

The first mode of observation was to fly multiple aircraft in a configuration as shown in the example of Figure 1. This illustrates that two aircraft with nearly identical speeds have taken off from Barbados and rendezvoused at a cruising altitude of perhaps 4,000 ft. At this altitude they have flown formation as close as possible, perhaps a horizontal separation of 500 to 1,000 ft., over parallel flight tracks for perhaps 5 minutes. This provided a comparison between the sensors of each aircraft. At the end of this comparison leg, the aircraft have separated and flown at two different altitudes, one directly over the other as shown in Figure 1. This configuration is the data taking leg. At the end of this data leg, the aircraft have again rendezvoused at a convenient altitude, perhaps 4,000 ft., at which time they have repeated their

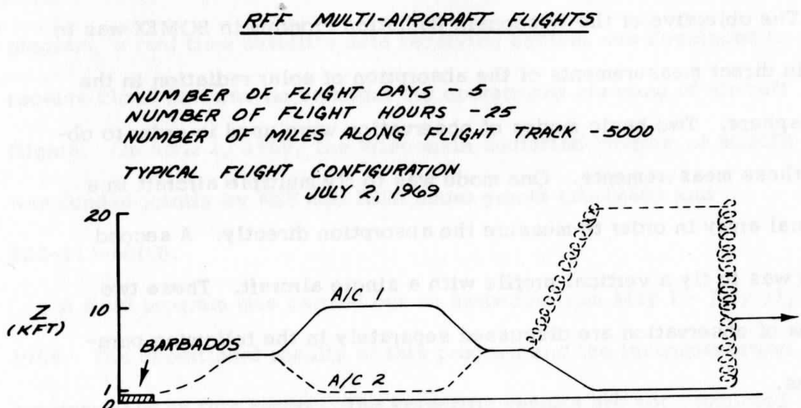

Figure 1. Typical flight configuration (mode 1) for obtaining direct measurements of solar radiation absorption. The RFF aircraft were used in this flight configuration because of their nearly matched speeds and capability for long flight.

formation flight for a comparison of the instruments. At the termination of this comparison leg the aircraft again have separated for another data taking leg. This procedure provides a comparison of the instrument before and after each data leg.

The RFF aircraft of ESSA were used in this first mode of observation (Figure 1). Two DC-6 and one DC-4 aircraft of the Research Flight Facility (RFF) were instrumented with Eppley precision pyranometers. These aircraft flew missions supporting the Wisconsin Radiation Experiment on 6 days during BOMEX. A total of 25 useful hours were flown covering approximately 5,000 miles of flight track. An RFF DC-6 is shown in Figure 2 in typical formation flight of a sensor comparison leg. A wide range of cloud types and organizations were sampled in the first mode of observation.

A second mode of observation was to fly vertical profiles using a single aircraft. The Queen Air aircraft of NCAR was used for this purpose. Typical flight configuration is shown in Figure 3. This shows how the flight track was planned to allow the Queen Air to drift westward while flying a vertical profile from 20,000 to 200 ft. We obtained vertical profiles on 19 days with the Queen Air. On a normal day two or three vertical profiles could be obtained. Data from these vertical profiles will provide much greater vertical resolution on the absorption in an atmospheric column than do data obtained in the first mode using

Figure 2. A DC-6 of the Research Flight Facility of ESSA is shown on a flight mission for the University of Wisconsin Radiation Measurement Program. Precision radiation sensors were installed on top and bottom of this and other RFF aircraft. The normal mode of observation was to fly one aircraft directly over the other separated by many thousand feet, in order to measure the absorption of sunlight and the layer of atmosphere between the two aircraft. Measurements from 1 to 12,000 feet were obtained in this manner.

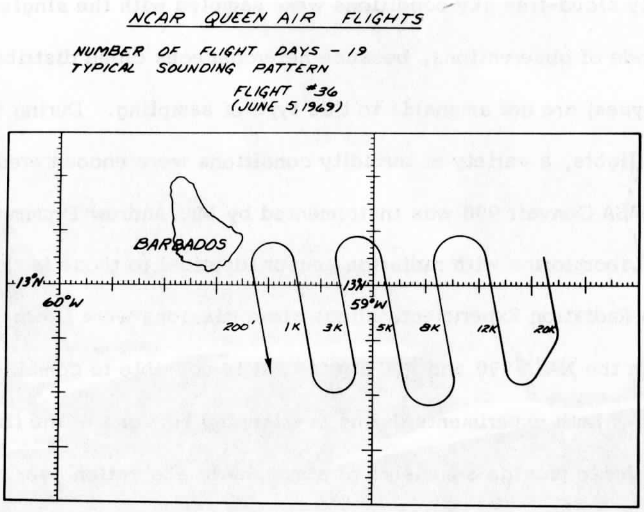

Figure 3. Typical flight configuration (mode 2) for obtaining vertical profiles with a single aircraft. The NCAR Queen Air aircraft was used exclusively in this configuration.

the RFF aircraft. An illustration of the Queen Air aircraft is shown in Figure 4.

Mainly cloud-free sky conditions were sampled with the single aircraft mode of observations, because heterogeneous cloud distributions (cr types) are not amenable to this type of sampling. During such clear sky flights, a variety of turbidity conditions were encountered.

The NASA Convair 990 was instrumented by Mr. Andrew Drummond of Eppley Laboratories with radiation sensor identical to those in the Wisconsin Radiation Experiment. Since some missions were flown jointly with the NASA 990 and RFF aircraft, it is possible to combine the data from both experiments during overlapping portions of the flight track in order to provide a measure of atmospheric absorption over a wider vertical range. Mr. Drummond has kindly indicated he would make the NASA data available for analysis during those times of interest. A picture of the NASA 990 is shown in Figure 5.

Figure 4. The Queen Air aircraft of NCAR. This aircraft was instrumented with Eppley pyranometers on top and bottom of the aircraft. The upper instrument was mounted on top of the fuselage between the two small air scoopers. The lower instrument was mounted on the rear (flat) deck just forward of the tail assembly.

Figure 5. The NASA Convair 990 aircraft on which Eppley Laboratory has installed up and down-facing precision pyranometers. The radiation program, under Messrs. Drummond and Hickey, conducted a small number of joint flights with the (Wisconsin Radiation Program) RFF aircraft flights during BOMEX.

III. INSTRUMENTATION

1. Radiation Program

Each of the three RFF aircraft and the NCAR Queen Air were instrumented with an Eppley high precision pyranometer on top and bottom of the aircraft. This pyranometer, shown in Figure 6, has double ground hemispheres to improve the cosine and azimuthal response of the instrument. The instrument is also temperature compensated to within ± 1% over the range -20 to +40°C. The instrument on top of the aircraft was used in an upright position, whereas the instrument below the aircraft was used in an inverted position. Figure 7 shows an example of the installation of an Eppley pyranometer on the lower side of a DC-6. The instrument has been mounted on a pylon about 12 inches from the fuselage in order that the instrument would not "see" portions of the aircraft. Those parts of the aircraft which were still visible from the instrument were painted black, as shown in the top right of Figure 7. There was a minor problem with desiccate collecting in the hemispheres of the lower sensor due to vibration of the aircraft causing shredding of the otherwise coarse desiccate material. This situation was corrected by placing cloth filters around the desiccate holders.

A simplified block diagram of the pyranometer recording system is shown in Figure 8. On the left side of the illustration are the pyrano-

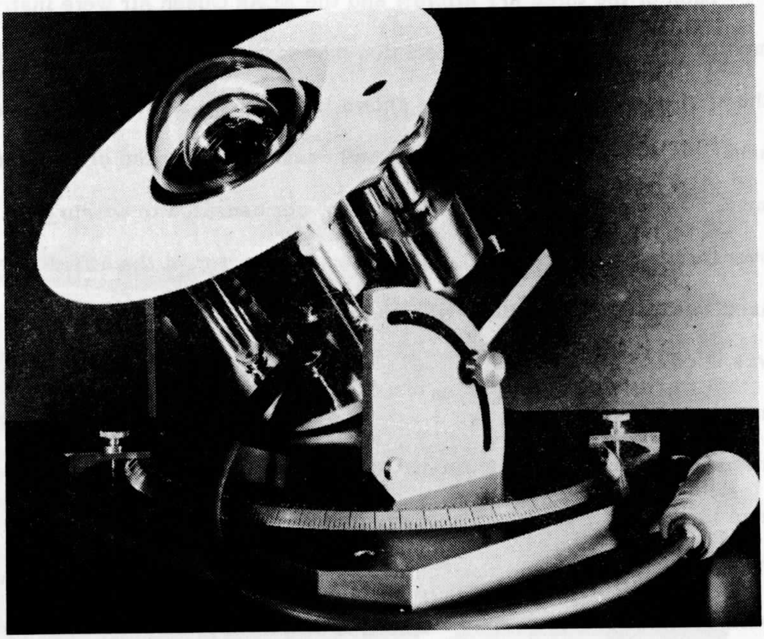

Figure 6. Eppley precision pyranometer to measure solar irradiance from the hemisphere above the sensor. These instruments were used on the RFF aircraft, the Queen Air of NCAR and the NASA 990. The instrument is temperature compensated.

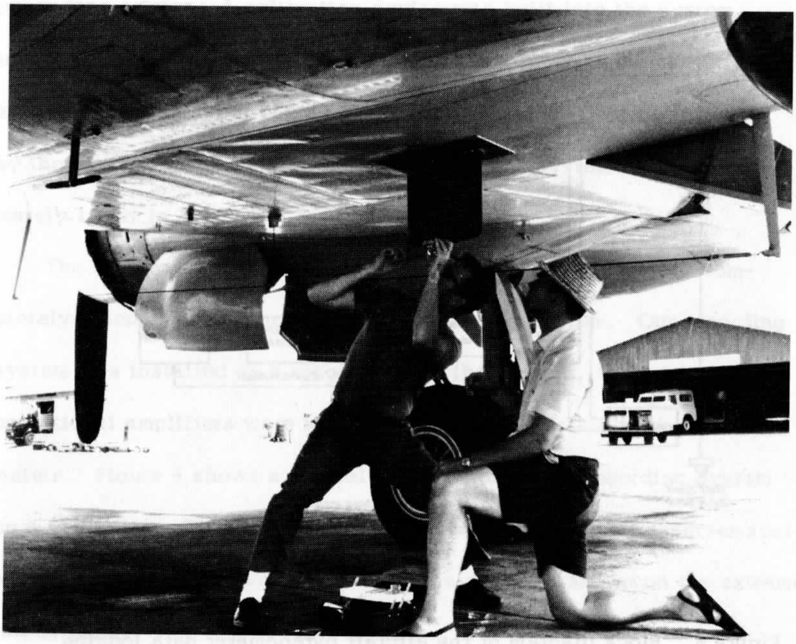

Figure 7. An Eppley precision pyranometer is being installed on the bottom of an RFF DC-6 aircraft.

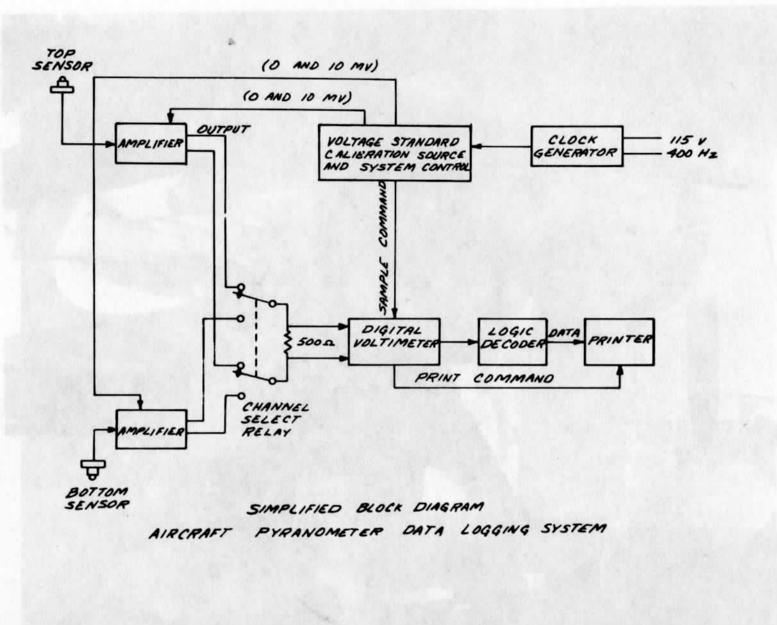

Figure 8. Block diagram of the aircraft pyranometer data logging system which was used on three RFF aircraft to record the data from the Eppley pyranometers of the Wisconsin Radiation Experiment.

meter sensors. The output of these sensors is applied to an operational amplifier, then to a digital voltmeter, a logic decoder and a paper tape printer. A calibration device was built into the system to apply, periodically, a standard 10 millivolt input to the operational amplifiers. The output of this calibration signal was also printed out by the paper tape printer. The resolution of the system was approximately 1 part in 2, 500.

The Wisconsin Radiation Experiment recording system was completely independent of the RFF digital recording system. Our recording system was installed as a single unit on the aircraft, although the operational amplifiers were located as near as possible to the pyranometers. Figure 9 shows a typical installation of our recording system on a RFF DC-6. The equipment was located in front of an observer seat which had a small window adjacent to the seat, as shown on the extreme left of Figure 9.

2. Real-time Satellite Data Receiving System

A real-time satellite data receiving system was also established at BOMEX Field Headquarters to support the radiation program. This equipment was installed in early May, 1969 and operated through July, 1969. Figure 10 shows the installation of the remotely controlled APT antenna on the roof of the BOMEX Operations Building on Barbados. Figure 11 shows the modified APT receiving set used to record the data.

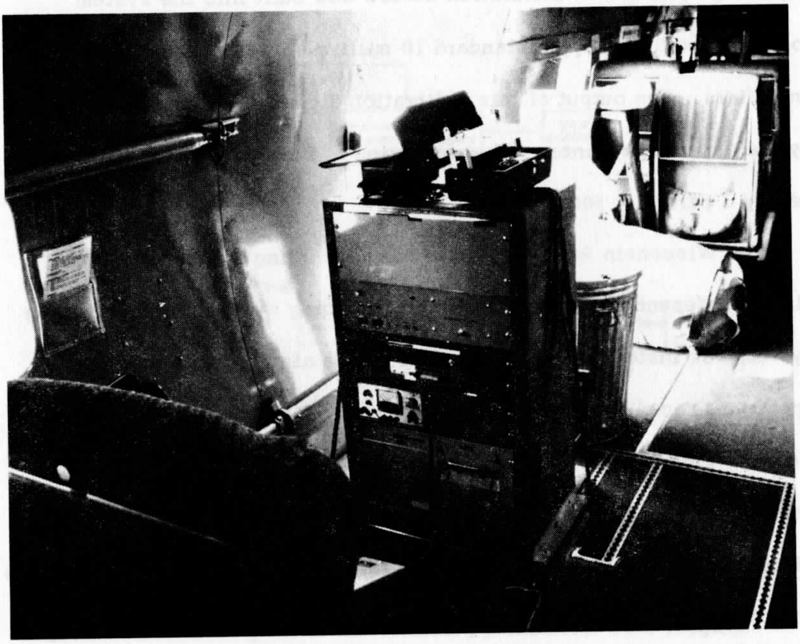

Figure 9. The data logging system for the Wisconsin Radiation Experiment installed on an RFF DC-6 aircraft.

Figure 10. The APT (satellite receiving) antenna being installed on the BOMEX Operations Building on Barbados during May, 1969. This antenna is remotely controlled by operators within the building using computer computations of the orbital position of the satellites. The ESSA satellites in 0900 and 1500 local time orbits were read-out daily, as well as the NIMBUS III satellite at noon and midnight local time. Pictures were also received from the ATS-III satellite which was nearly stationary over Barbados but drifting slowly eastward during the BOMEX observation period.

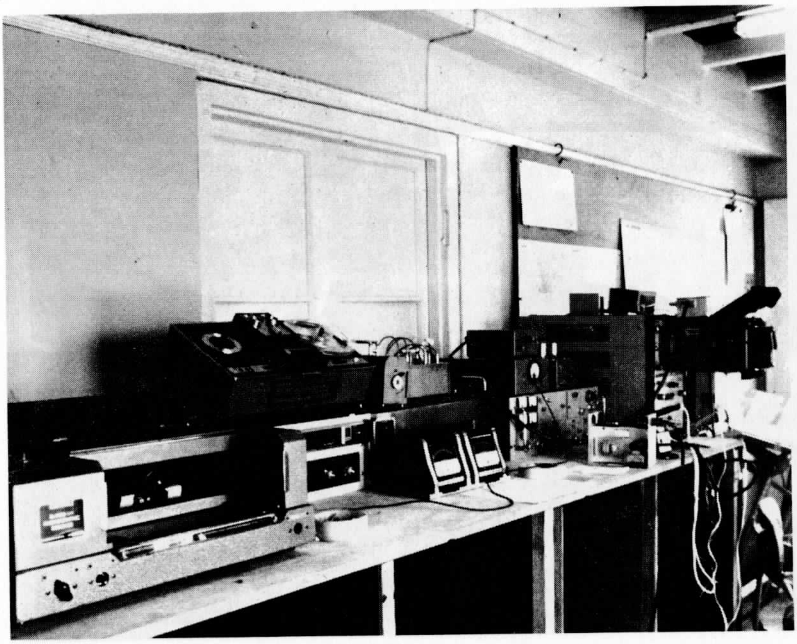

Figure 11. The University of Wisconsin satellite receiving system installed in the BOMEX operations building on Barbados. This equipment was operated during May, June and July, 1969, received the passing satellite data and stored them on magnetic tape. The data were played back on a photo recorder to produce the final satellite picture. These satellite pictures served as the basis for real time decisions on sending aircraft into the BOMEX array.

A block diagram of the APT receiving equipment is shown in Figure 12. The tunable cavity was tuned to the transmitting frequency of each ESSA or NIMBUS satellite and also to the VHF frequency of ATS-III, by means of the reference transmitter. The synchronous detector was necessary to eliminate high-frequency noise on the satellite signal. The normal operating procedure on Barbados was to record the picture on tape in real-time using the synchronous detector and then produce pictures with the photorecorders by playback from the tape, immediately after the satellite pass.

The synchronous detector is shown in greater detail in Figure 13 because it is a unique feature of the receiving system. The synchronous detector receives a noisy AM signal of 2400 Hz carrier frequency and 1600 Hz bandwidth from the receiver. The phase locked loop produces a clean carrier which is locked to the incoming satellite carrier frequency. This is mixed with the noisy AM signal in the demodulator to produce a video signal which contains high-frequency noise. The signal is low pass filtered to produce a clean video signal, which then modulates, the clean carrier to produce an improved AM signal which is recorded.

Real-time satellite pictures were received from the ESSA satellites, from NIMBUS and from a retransmission of the ATS-III picture obtained at the NASA ground station at Rosman, North Carolina. All of these

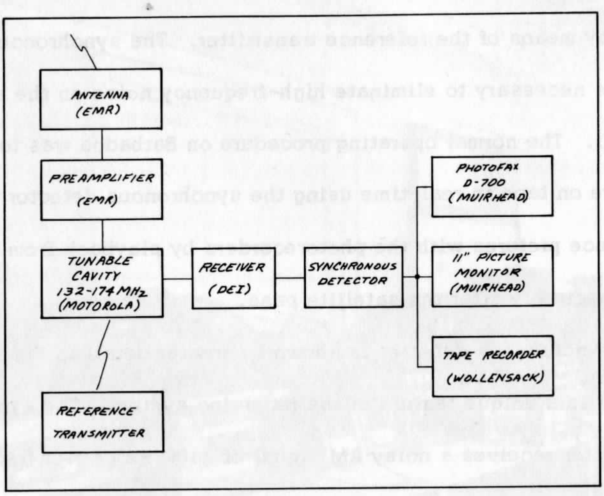

Figure 12. Block diagram of the satellite data receiving system installed on Barbados.

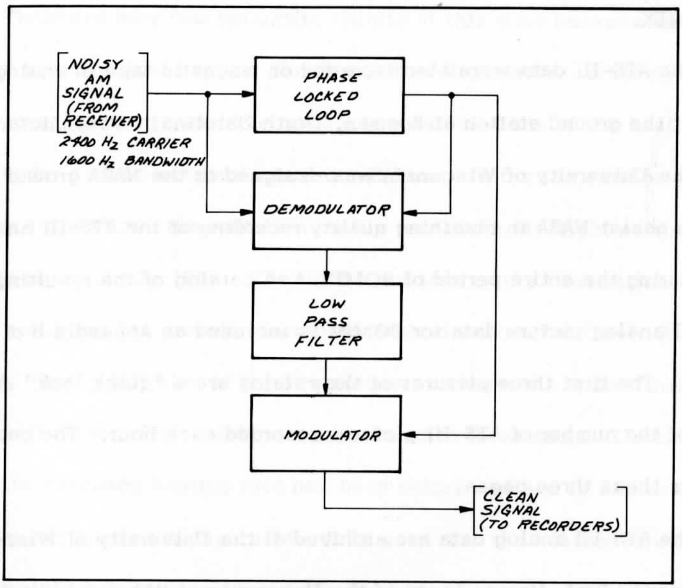

Figure 13. Block diagram of the synchronous detector portion of the satellite data receiving system which was used on Barbados.

pictures (approximately 500) were received at our ground station on Barbados, gridded and made available to other scientific experimenters in BOMEX.

The ATS-III data were also recorded on magnetic tape in analog form at the ground station at Rosman, North Carolina. A technician from the University of Wisconsin was assigned to the NASA ground station to assist NASA in obtaining quality recording of the ATS-III analog data during the entire period of BOMEX.* A catalog of the resulting ATS-III analog picture data for BOMEX is included as Appendix B of this report. The first three pictures of the catalog are a "quick look" summary of the number of ATS-III pictures recorded each hour. The catalog follows these three pages.

The ATS-III analog data are archived at the University of Wisconsin because Prof. Verner Suomi of the University of Wisconsin is the principal investigator of the ATS-III SSCC experiment. Data can be obtained (at cost of reproduction) by writing to the Space Science and Engineering Center, University of Wisconsin, Madison.

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*Funding for this technician was provided by the BOMEX Project Office, under ESSA Contract E-137-70(N).

IV. PRELIMINARY SCIENTIFIC RESULTS

There are very few scientific results at this time because analysis of the data has just begun. However, from flight notes of the pyranometer measurements we have made a few calculations of the heating rate under certain meteorological conditions. In the top section of Figure 14 is shown the radiation profile for Queen Air flight number 56, obtained on July 3, 1969. The right hand side of the illustration shows as a solid line the downward irradiance obtained on that Queen Air flight. In the left side of the illustration is shown the upward irradiance as a solid line. These data are normalized to local noon. Using these data the resulting heating rate has been calculated and is shown in the bottom left section of Figure 14. It is seen that the heating rate of approximately 0.1 degrees centigrade per hour is observed from the surface to near 700 millibars. At this time there was a dust layer from about 8,500 to 12,000 feet which caused a marked change in the upward and downward irradiance profiles, but did not increase the heating rate. In Figure 15 this dust layer can be seen extending from near the coast of Africa to the area north of South America. Presumably it is drifting westward toward the Lesser Antilles. Flight No. 56 was obtained approximately 50 miles south of Barbados on the leading (western) edge of the visible dust layer in Figure 15.

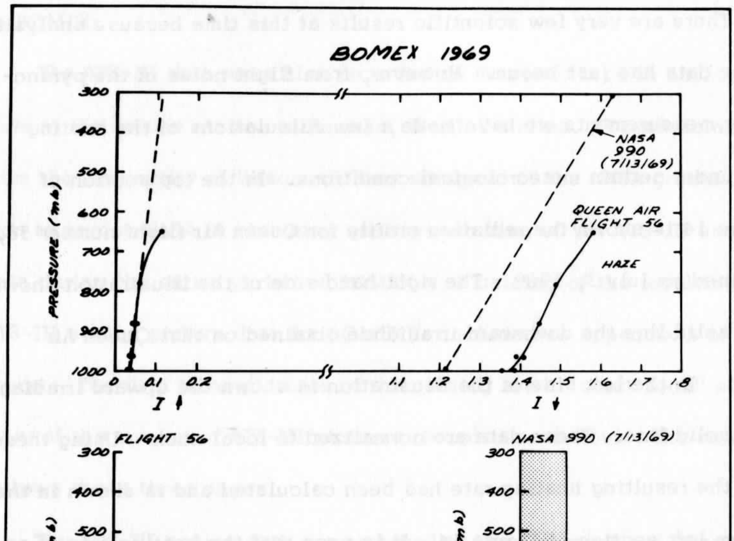

Figure 14. Irradiance and heating rate profiles obtained on flights of the NCAR Queen Air and NASA 990 near Barbados in July, 1969.

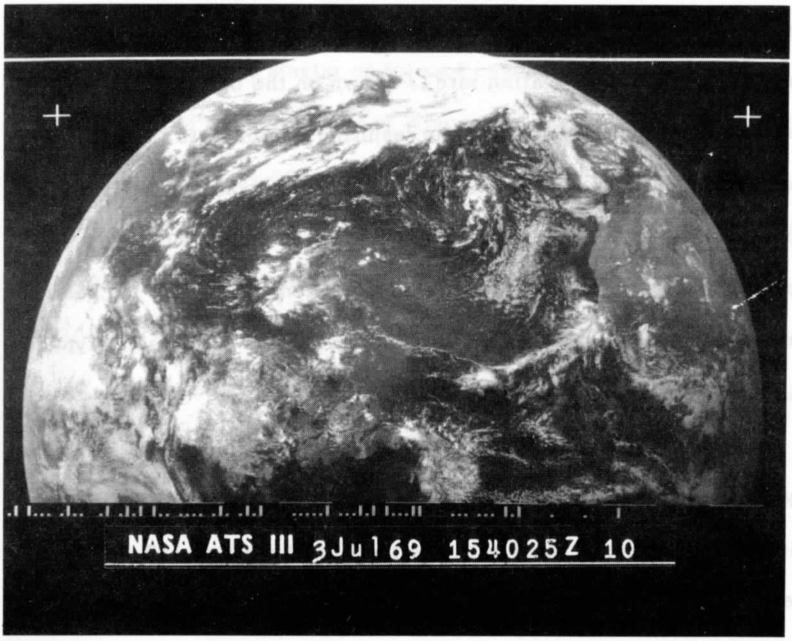

Figure 15. ATS-III picture on July 3, 1969. The coast of Africa is visible in the right hand portion of the picture. The broad semibright area visible in the central Atlantic Ocean is apparently a dust layer from Africa which is drifting westward with the trade winds.

A two-level radiation profile was obtained by the NASA Convair 990 on July 13, 1969.* This is shown as a dash line in the top of Figure 14. Measurements were obtained at or near 300 and 1,000 millibars. The calculated heating rate is shown on the bottom right of Figure 14. It can be seen that the resulting heating rate is near 0.13 centigrade per hour, again, normalized to local noon. There is no information on the vertical distribution of heating between these two levels, however. Nevertheless, this flight tends to verify the heating rate obtained by the Queen Air with Eppley sensors of the same type but a completely different data recording system.

The NASA 990 profile on July 13 indicates the fractional absorption by the atmosphere was 21% (not including O_3 absorption). This is higher than London's zonal estimate for 0 to 20 north of 14%. It remains to be seen whether the absorption of 21% is typical of other conditions near the Barbados and also of other areas of the tropics. The suggestion of the data analysed so far is that the absorption may be higher than previously thought, at least in regions of high turbidity, if not other areas as well.

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*Eppley Laboratory Program of Messrs. Drummond and Hickey.

V. STUDENTS SUPPORTED BY THIS GRANT

Mr. John Young, a Master of Science candidate in the Department of Meteorology of the University of Wisconsin, was partially supported on this grant during the period of BOMEX and was on Barbados during nearly all of the experiment. Mr. Young supervised the APT Station and the Air Force (AWS) personnel who operated the station. He also assisted in the observational phase of the aircraft radiation program.

VI. EQUIPMENT

1. Equipment Purchased on NSF Grant GA-12603

	Quantity	US Serial Number(s)
Defense Electronics Receiver RF 136-TR-711	1	11386
Voltmeter Digitec	2	11315 11316
Plug in Voltmeter, Digitec Model 251-1	2	11317 11318
Tunable Cavity 132 to 174 MHz Motorola TU312H (damaged in transit returning from Barbados)	1	-

2. Equipment Obtained on Loan from ESSA (NESC)

Muirhead Photofax Receiver	D-700-SM No. 355129 NASA 47477
Muirhead Photofax Power Supply	D-700-SS No. 356313 NASA 47478
Muirhead Mufax 11" Picture	D-610-S No. 252592 NASA 47476

3. Equipment Purchased by ESSA (BOMEX Project Office) for Wisconsin Radiation Program

	Quantity	SSEC No.
Photo-Receiver (Modified for DRIR Adapter) with Polaroid Pack Camera Model No. 111AD S/N 12 (Camera missing and apparently stolen on Barbados)	1	194
Tape Recorder (with cabling) Model No. 111T S/N 5731-5330	1	195
Optional 4" x 5" Camera Back and Adapter Model No. 111B	1	196
Double Rotator Antenna Model No. 100 D S/N 112	1	197
DRIR Adapter S/M 104	1	198

VII. CORRESPONDENCE REGARDING PERMANENT EQUIPMENT

THE UNIVERSITY OF WISCONSIN
Research Administration—Financial

750 University Avenue
Madison, Wisconsin 53706

Telephone 608-262-3822

May 23, 1969

Mr. Louis Levin
Executive Associate Director
National Science Foundation
Washington, D. C. 20550

C O P Y

Re: NSF GA-12603
U. W. 144-9722

Dear Mr. Levin:

Attached herewith is a proposed budget revision for subject grant submitted for your approval. The reasons for the categorical changes are discussed in the Revision Comments. No additional funds are being requested.

Please review and advise us if Foundation approval is granted.

Sincerely yours,

Len Van Ess, Director

KVE:AJH:sb

cc: Dr. Kirby Hanson✓
Dean R. B. Doremus

BUDGET REVISION COMMENTS

The original proposal asked NSF to support the purchase of a photo recorder which was necessary for reception of APT and WEFAX satellite pictures on the island of Barbados during the period of BOMEX. This satellite data capability was intended to support our radiation program as well as other scientific programs in BOMEX. The original proposal budgeted $10,100 as Direct Costs to the Grant for this photo recorder.

After receiving this Grant we were unable to obtain, commercially, an adequate photo recorder. We were fortunate in being able to make arrangements with ESSA for the loan of a D-700 photo recorder which met our needs but had to be modified and interfaced with our EMR-APT equipment. Thus, there is a reduction in the amount of funds requested on Direct Costs to Grant, and an increase in the amount of funds requested for engineer and technician salaries. In addition, the EMR-APT receiver was not adequate for operation on Barbados and a new high quality receiver was purchased on this Grant. These costs are included in the Direct Costs to Grant section of the budget.

The remainder of the budget is relatively unchanged from the original budget proposal. At the present time, costs are in good agreement with the proposed budget figures.

NATIONAL SCIENCE FOUNDATION *Copy*

Washington, D.C. 20550

June 3, 1969

Mr. Kirby Hanson
Space Science and Engineering Center
University of Wisconsin, Madison
1225 West Dayton Street
Madison, Wisconsin 53706

Dear Kirby:

The National Science Foundation authorizes the changes in Grant GA-12603 that were proposed in Len Van Ess's letter of May 23. I have just returned from Barbados and I understand the need for the changes. Furthermore, I think they will help the program very much.

We hear that ATS-III is not working too well. I worry how much that might affect the fourth phase of BOMEX. I hope not much, but I am afraid that it might be quite serious.

Steve has a good operation running at the airport in Barbados. His output is being used quite a bit by Josh Holland in determining flight patterns to be flown. Steve is having little time for his own research, but he seems to be fairing pretty well.

I hope the rest of the experimental period goes as well as the first one.

Best regards,

/s/ Gene
Eugene W. Bierly
Program Director for Meteorology
Atmospheric Sciences Section

cc: Len Van Ess, U of Wisc
NSF Grants Ofc

VIII. ACKNOWLEDGMENTS

This program was funded jointly by NSF and ESSA grants GA-12603 and E22-113-68(G).

Many individuals in ESSA helped to make this program possible. Dr. Kuettner and Dr. Glaser of the BOMEX Project Office were instrumental in establishing the program in BOMEX, and were extremely helpful as the program was developed and carried out. Without the help of many others of the BOMEX staff, it would not have been possible to conduct the program. We would like to thank all of the BOMEX staff for their assistance during BOMEX.

The Research Flight Facility (RFF) of ESSA provided aircraft support for our program. Because of the short time between receipt of program funds by the University of Wisconsin and the beginning of BOMEX, it was necessary for RFF to install our radiation sensor during the break periods between Field Observation Phases. This placed a very difficult burden on RFF, and for their effort to support us we are extremely grateful. In particular we wish to thank Mr. Howard Mason, Director of RFF, and also Dr. James McFadden for their efforts in making the program successful.

NCAR personnel were extremely helpful to our program. They generously provided aircraft support and radiation sensors for the Queen Air aircraft.

The radiation sensors for the RFF aircraft were obtained by the ESSA Research Laboratories. We are grateful for their financial support. The National Environmental Satellite Center of ESSA provided, on loan, a Muirhead D-700 photorecorder for use on Barbados.

The BOMEX Project Office provided support for our effort to obtain high quality recording of ATS-III data at Rosman, North Carolina. This was funded on ESSA Contract E-137-70(N).

The ATS Project Office, NASA, at Goddard Space Flight Center and the NASA Ground Station at Rosman, North Carolina supported the real time satellite data coverage for this program by developing the hardware for retransmission of ATS-III data to Barbados through a VHF channel on ATS-III.

Many individuals in the Space Science and Engineering Center are responsible for the success of the program. Mr. Jim Maynard provided both engineering and technician support throughout the entire program. Mr. Terry Schwalenberg engineered the APT modifications. We are grateful to all those individuals at SSEC who contributed to the success of this program.

APPENDIX A

Scientific Objectives and Data Requirements

for Radiation Studies During BOMEX

SCIENTIFIC OBJECTIVES AND DATA REQUIREMENTS

FOR

RADIATION STUDIES DURING BOMEX[1]

by[2]

Stephen Cox　　Verner Suomi
Kirby Hanson　　Tom Vonder Haar

CONTENTS

The purpose of this document is to summarize our thoughts on the scientific objectives and data requirements for radiation experiments during the BOMEX program. We have not considered at this time the additional questions of what instrumentation should be employed and who will carry out the work.

Scientific Objectives: Radiation Studies

A considerable amount has been written in GARP documents concerning the scientific objectives of radiation studies in the tropics. An excellent discussion

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[1] Submitted to BOMEX Project Office, ESSA, March, 1968.

[2] Authors have made equal contributions to this document.

is contained in the GARP Report.[1] The important underlying factor in those considerations is that a relationship exists between radiative and dynamical processes operating within the atmosphere. It is generally known that certain atmospheric variables represent the mechanisms through which the radiative forcing function and air motions are related. These variables are: the distribution and amount of cloud, water vapor, ozone, dust and haze; the temperature distribution; and the state of the lower boundary of the atmosphere. Although we know the relationship exists and the variables involved, we do not have an adequate understanding of how these variables effectively modulate atmospheric heating and cooling by radiation.

In view of this fact, it is indeed surprising that so few measurements exist in which radiation was measured simultaneously with the important atmospheric variables. As indicated in the GARP Report,[2] "this kind of (simultaneous) experiment is essential as a final check on radiation theory." An example of the importance of this check on theory is the need to determine the vertical distribution of absorption in the atmosphere. With clear sky, we know how the energy is distributed; however, with clouds there is multiple scattering and the problem becomes extremely complex. There is no way of checking the theory except by observations. It is vital to studies of the tropics that the vertical distribution of absorption with clouds be verified because the atmospheric stability depends critically on where the energy is absorbed.

There are a number of other useful objectives such measurements would serve. One is that radiation measurements within the atmosphere are essential in attempts to determine the radiative heating or cooling from indirect (satellite) measurements. The success of such indirect measurements depends very critically on knowing the angular and spectral dependence of radiation reflected or emitted outward from the atmosphere. Complete radiation measurements during BOMEX clearly would fill this need.

Another useful objective is to obtain measured radiation values which will serve as controls on calculated radiation values in numerical models. Comparisons of this sort are invaluable in testing radiation approximating equations in numerical models.

There is perhaps an additional opportunity available for BOMEX—it is radiation climatology obtained in a different way. Both long and short wave radiation budgets in the tropics are mainly controlled by clouds. This is especially so for a restricted region of the tropics such as the Barbados area. The sampling problems for a truly representative radiation climatology are very severe—

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[1] Global Atmospheric Research Programme (GARP), Report of the Study Conference held at Stockholm, 28 June—11 July 1967. ICSU/IUGG-Committee on Atmospheric Sciences, COSPAR, WMO.

[2] Op. cit., p. 46.

perhaps not obtainable when the constraint of a reasonable budget is imposed. One would get enormously better radiation climatology if good radiation data on cloud systems were available. In order to compile the data on cloud systems, radiation measurements should be made not only as a function of time, but according to the presence or absence of identifiable cloud systems. Then a radiation climatology may be constructed by combining the radiation data, classified by cloud system, and satellite photographs of cloud systems. This technique will allow compilation of a radiation climatology even after the completion of BOMEX and over larger area than the proposed BOMEX data network.

Ideally we would like to see an effort made in BOMEX toward a complete radiation program together with simultaneous measurements of the important variables mentioned earlier. Although this task may be larger than possible for BOMEX, an attempt to obtain a "closed solution" radiation experiment during BOMEX will be valuable in itself, for it will provide the experience and problem definition for more sophisticated radiation experiments in the future of the GARP program.

Radiation Program

The overall objectives of a radiation program within BOMEX will be satisfied to a degree that depends on the resources committed to these goals. With this in mind, the remainder of this section contains a discussion of the various practical options regarding the content and distribution of the radiation observing net. They were derived with primary emphasis on the scientific requirements, although economic factors played a secondary role in the definition of the options.

Figures 1a and 1b contain a schematic description of the four major options that were examined. Both the solar and infrared observing networks are considered in each case. In this figure, the fundamental difference between the possible options is in the capability for measuring the vertical variation of the radiation parameters. In short, Option 1 provides observations throughout the entire atmosphere, and Option IV provides data only at the upper and lower boundaries. Since the spatial coverage will be limited to a large extent by the available facilities and the temporal sampling by operational and manpower considerations, these points are given special attention in the next section.

1. Vertical Distribution of Observations

Before considering the details and tradeoffs of the four options, some comments on the choice of the levels of observation noted at the left of Figure 1a are necessary.

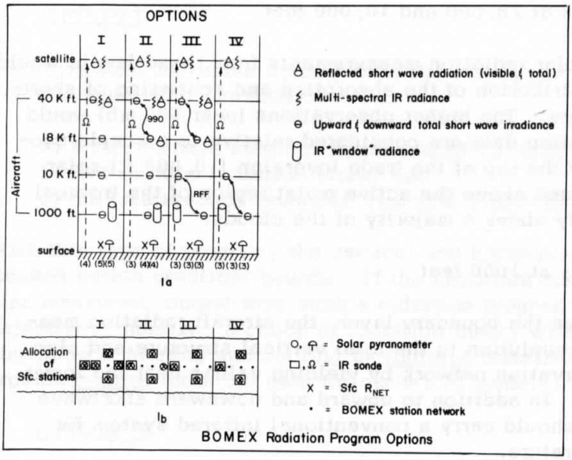

Fig. 1

a) Satellite observations

Radiation measurements from satellites would complement aircraft and surface observations, but the lack of satellite data would not adversely affect the radiation program considered in this document. To be useful, such satellite observations must have high spatial resolution and thus sensors flown on the ATS and NIMBUS satellite could provide the data. ATS-III (launched November 1967) and NIMBUS-B (scheduled for spring 1968) will carry a variety of total and narrow spectrum sensors useful for obtaining quantitative radiation measurements as well as video depictions of day and nighttime cloud cover. If the lifetimes of these satellites extend into the BOMEX time period, all data reduction techniques will have been optimized and the measurements would be available to users in a satisfactory format. Under the assumption that some type of satellite data will be available, it is included in each of the four program options, but did not influence the choice of the other observations.

b) Aircraft measurements at 40,000 feet

A well-equipped aircraft (such as NASA's 990) flown near 40,000 feet would provide a wealth of solar and infrared radiation data near the upper boundary of the troposphere. From this altitude, bi-directional reflectance measurements over the clear ocean and cloudy regions within the BOMEX observational network would be most valuable. Together with satellite observations, these data could be used to examine the radiation regime in the tropical stratosphere.

c) Aircraft measurements at 18,000 and 10,000 feet

Upward and downward solar radiation measurements from these levels would yield data on the vertical distribution of the absorption and scattering of short-wave energy by the atmosphere. The higher observations (near 500 mb) would be useful when tropical radiation data are considered relative to a simple two-layer numerical model. Near the top of the trade inversion (10,000 ft) solar radiation data could be obtained above the active moist region of the tropical troposphere and most probably above a majority of the clouds.

d) Aircraft measurements at 1000 feet

At this lower level, above the boundary layer, the aircraft radiation measurements significantly add resolution to the total vertical structure and also complement the surface observation network by yielding values near the lower boundary over a wide region. In addition to upward and downward shortwave measurements, this aircraft should carry a conventional infrared system for measuring sea surface temperature.

e) Surface observations

These measurements fit ideally into the BOMEX plan of air-sea interaction studies. At land and shipboard locations both IR and solar radiation instruments would measure the net radiation budget at the surface. Aside from their use in total surface energy budget work, the surface measurements and satellite (or high altitude aircraft) data will provide the net radiation budget of the atmosphere alone.

f) Balloon-borne radiometersondes

Nocturnal radiometersonde ascents offer a proven capability for obtaining the upward and downward total IR radiation profiles. These measurements are used to examine net radiation divergence and atmospheric cooling in various layers and can be used to infer the existence of thin layers of cloud and particulates. When combined with solar radiation observations at several altitudes the total atmospheric cooling by radiation can be examined within each layer.

2. Possible Options

The observations suggested for various levels and the recommended distribution of surface measurements within the BOMEX array are shown in Figures 1a and 1b in the form of four options. These options represent different measurement configurations that may be analyzed in order to assess the scientific return from a radiation program in BOMEX against the costs involved in obtaining the observations.

OPTION I

This most inclusive option, from the standpoint of scientific data and resources committed, includes:

a) a full vertical stack of instrumented aircraft,
b) five surface radiation sites, and
c) radiometersonde launches from four locations.

With this type of program, the vertical and horizontal radiation coverage is optimized within practical bounds. If the important meteorological variables were also measured, output from such a radiation program would satisfy the stated objectives, namely: a check of radiation theory with observations; to determine atmospheric heating and cooling by indirect (satellite) measurements; and to provide control radiation data for numerical models.

OPTION II

A reduction in the radiation program as detailed under Option I includes:

a) elimination of the aircraft at the 18,000 foot level, with the option of flying a high-altitude aircraft at this level,
b) a reduction in radiometersonde facilities to three, and
c) surface radiation measurements at only four sites.

Under Option II, the primary objectives would still be attained, but to a lesser extent. For example, the vertical variation of solar radiation above 10,000 feet could not be studied as well, and the infrared soundings would no longer bound a closed grid. The placement of the balloon sites under this option anticipates primarily a north-south orientation of weather phenomena across the BOMEX array.

OPTION III

The diminished program under this option:

a) cuts the number of instrumented aircraft to two (from a maximum of four in Option I), but retains a low and a high altitude capability,
b) reduces the number of surface and radiometersonde facilities to three.

Although a sufficient climatology of the BOMEX area is still attainable under this option, the vertical resolution is considerably reduced. In addition, the flexibility of the radiation program to seek out and observe specific phenomena is hampered. The surface and balloon program presented in Option III is the minimum required to adequately cover the BOMEX array.

OPTION IV

The radiation observing network listed under this option is the lower bound on a system that can still be called a useful radiation program. Eliminated from the previous option is the high altitude aircraft. Thus, no information on the vertical variation of solar radiation can be observed above 10,000 feet and since the remaining aircraft will be used extensively at 1000 feet for near-surface observations we have essentially the shortwave energy measurements only at the upper (from a satellite) and lower boundaries of the atmosphere. Of course, if the single aircraft were unavailable during any time period, even the crude climatology would contain gaps. As mentioned above, three surface and radiometersonde sites represent a minimum network also. This option is insufficient for the stated objectives.

Density of Observations

In order to determine the amount of equipment and manpower required to collect the radiation data, we must examine the required temporal and spatial density of the measurements. Table 1 divides the radiation data required by the program objectives into two convenient categories: phenomenological, with the goal of studying the radiative character of various spatial scales of tropical weather patterns, and climatological, with its purpose of establishing mean radiation budget parameters for the maritime tropical location. The reason a distinction has been made between the two categories is that a rigid schedule, tailored to climatological requirements, may deny data coverage of an interesting situation. There must be the option of real time control of data collected on a noncontinuous basis, namely the balloon soundings and aircraft. The phenomenology category refers to all situations where the real-time decision regarding when, where, and how often, aircraft and balloons are flown to observe phenomena of interest.

1. Time Sampling

We recommend that the solar and net radiation at the surface be collected continuously. Since the primary investment is in the instrumentation and recording systems and not in operation and maintenance, a large amount of data will not cost significantly more than a small amount. It would be desirable to have surface radiation data integrated over five minute intervals.

For the shortwave and infrared data as a function of height, the cost of acquiring frequent data is a primary consideration. Unlike the surface data where the initial equipment was the primary investment, the cost of additional operation of aircraft and support personnel becomes important. Here again the climatology-phenomenology designation becomes useful. For shortwave radiation as a function of height, we recommend the radiation detectors be in operation whenever the aircraft is airborne during daylight hours—this fulfills the

Table 1

Temporal Distribution

	Climatological	Phenomenological
Satellite, Shortwave and infrared	Whenever satellite observations are available	Whenever satellite observations are available
Infrared as a function of height	1 ascent/station-day W/3 periods of nocturnal serial ascents	Serial ascents through selected situations
Shortwave as a function of height	Whenever aircraft are airborne	Have ability to divert aircraft to area of special interest between 0900-1500 for two days out of each week
Net radiation at surface	Continuous	
Shortwave radiation at surface	Continuous	

climatological requirement. The phenomenology requirement is somewhat more restrictive. We recommend that the aircraft be available to divert to areas of special interest between 0900 and 1500LST for two days each week.

Infrared data as a function of height will be gathered by balloon-borne radiometers. Even though the cost of an individual instrument is small, when we talk about hundreds of soundings, the total cost is significant. In order to fulfill the climatological requirements we suggest one radiation sonde ascent per station per day with several periods of serial ascents to determine the presence or absence of variations on the order of hours. If chosen discriminately, the serial ascents mentioned above could also serve as serial ascents through interesting phenomena. If desired or dictated by economy, the climatological soundings could be scheduled approximately every 36 hours instead of every 24 hours or scheduled as a function of cloud systems.

Since it is unlikely that we will be able to dictate satellite coverage of experiment area, we can only specify that we receive data, both infrared and solar reflected, as often as possible. If ATS-III is still operational, it may be possible to make use of the back-to-back scan mode of the spin scan camera, thus allowing almost continuous daytime photographic coverage of the Barbados area.

2. Spatial Sampling

So far we have discussed the temporal density of radiation observations. Now let us turn to the spatial density. Figure 1b represents the suggested network of surface and radiation sonde data stations, the most desirable at left and the right. The positions of surface data stations were determined with two requirements in mind. First, we desire maximum North-South to detect significant latitudinal differences in radiative effects. Second, we wish to have adequate spatial resolution to complement the air-sea interaction study, the primary goal of the BOMEX experiment.

The spatial density of the aircraft data requires special consideration. While the data requirements will vary depending on the phenomenon of interest, in general we recommend the aircraft stacked vertically and coordinated so that measurements are taken at different levels at the same time. Optimally we would prefer an aircraft at 1000 feet (already indicated in BOMEX Bulletin) at 10,000 feet (already assigned in BOMEX Bulletin), at 20,000 (additional) and at 40,000 feet (NASA Convar 990). In lieu of this optimum configuration, the same aircraft could fly the 10,000 foot and 20,000 foot legs sequentially. Figure 1a represents the feasible configurations for aircraft radiation measurements. The wavy arrow indicates the use of a single aircraft to make measurements sequentially at two levels.

The spatial density of satellite data is again perhaps beyond your control, however let us stress that the maximum density available be utilized.

APPENDIX B

Catalog of ATS-III Analog

(Magnetic Tape) pictures During BOMEX*

*Data are archived at the Space Science and Engineering Center, University of Wisconsin, Madison.

GREENWICH HOUR

GREENWICH DAY

		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
MAY 1	121																										121
MAY 2	122											4	4	5	1		2	3	4	2		2	4	4	1		122
MAY 3	123										1	2	4	4	1		3	4	4	1		2	1	3	1		123
MAY 4	124																3	3	4	1		3	1	4	1		124
MAY 5	125										1	2	4	2	1		3	3	4	2		2	2	3	1		125
MAY 6	126										1	3	4	3	1		3	3	5	1		1	4	3	1		126
MAY 7	127										2	3	4	1				2	4	4	5	3	1	3	1		127
MAY 8	128										2		2		2		3	3	1								128
MAY 9	129										1	1	3		1		1	2	4	3							129
MAY 10	130										2	1	2				4	2	4	1		3					130
MAY 11	131																		4	1		2	1	4	1		131
MAY 12	132											2	1	2	1		3	2	4	1							132
MAY 13	133											2	1				2	2									133
MAY 14	134										1	2						1	4	1			1	4	1		134
MAY 15	135										1	3	4	3	1		2	3	3	4	4	4	3	4	1		135
MAY 16	136												4	3	2												136
MAY 17	137										1	5	5	5	4	5	5	5	4	5	5	5	4	5	2		137
MAY 18	138										1	5	3		1							2	1	3	1		138
MAY 19	139												4	1	1		3	1	2	2			2	2	2		139
MAY 20	140																3	2	3	2		3	2	4	1		140
MAY 21	141										2	3	4	3	1		3	2	4	2		2	2	4	1		141
MAY 22	142										2	3	4		1												142
MAY 23	143										2	3	4		1		3	2	3	2			2	4	1		143
MAY 24	144																										144
MAY 25	145																										145
MAY 26	146																										146
MAY 27	147																										147
MAY 28	148											2	4	3													148
MAY 29	149																										149
MAY 30	150																										150
MAY 31	151																		2								151
		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	

ANALOG RECORDINGS AVAILABLE FROM BOMEX TIME PERIOD

GREENWICH HOUR

GREENWICH DAY		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
JUNE 1	152														1	2	1	2			1		1				152
JUNE 2	153												1	1							1		1				153
JUNE 3	154											1	1						3	1		2	1	2	2		154
JUNE 4	155										1	2	3	1	1			2	2	2		2	2	4	1		155
JUNE 5	156											3	3		1		1	4	3	1		2	3				156
JUNE 6	157																	2	4	1		2	4				157
JUNE 7	158											1		1	1		1	3	3	2		1	1	6	2		158
JUNE 8	159											2	2	1	1		2	3	4	1		1	3	4	1		159
JUNE 9	160										2		4		1		4	2	4	1				3	2		160
JUNE 10	161											2	4		1		1	3				1	3	4	2		161
JUNE 11	162											2	4		1		2	3	3	2		2	3	4	1		162
JUNE 12	163										2	1	3		1	1	4	3	4	4	5	5	3	3	5		163
JUNE 13	164	4	2									1	1		1		2	1	2				3	3	2		164
JUNE 14	165											4	4		1		1	1	2	1		2	4	4	1		165
JUNE 15	166										2	3	4	2	1			2	2	1		2	4	4	2		166
JUNE 16	167										2	4	4		1		1	2									167
JUNE 17	168										2	4	4	1	1		2	1	2	1		2	4	4	2		168
JUNE 18	169										2	2	4		1		2	1	2	1		2	3	4	2		169
JUNE 19	170										2	3	6		1		2	1	2	1		2	3	4	2		170
JUNE 20	171										2	3	3		1		1	1	2	1		2	3	4	2		171
JUNE 21	172										2	3	4		1		2		4			1	4	3	1		172
JUNE 22	173										1	4	4		1		1	2	2	1		2	3	3	2		173
JUNE 23	174										2	4	3		1		2	1	2	1		2	4	4	2		174
JUNE 24	175										1	3	4		1		1	1	2	1		1					175
JUNE 25	176										2	4	4			1	1		4	3	4	5	2	4	4	2	176
JUNE 26	177										2	2	4		1		2	1	2			2	2	4	2		177
JUNE 27	178										1	4			1		3	3	4	5	5	5	1	4	5	1	178
JUNE 28	179										1	4	4		1		2	1	2			2	3	4	2		179
JUNE 29	180											3	4		1		2	1	2	1		3	2	4	2		180
JUNE 30	181										2	4	4		1		2	1	2	1		1	2	4	2		181
		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	

ANALOG RECORDINGS AVAILABLE FROM BOMEX TIME PERIOD

GREENWICH HOUR

GREENWICH DAY		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
JULY 1	182										2	4	4		4	1	2	1	2	1							182
JULY 2	183										1	4	4		1		1	2	2	1		2	3	4	2		183
JULY 3	184											4	4		1		1	1	2	1		3	3	3	1		184
JULY 4	185	1									1	5	3		1		1	2	2	1		2	2	4	2		185
JULY 5	186										1	5	3		1		2	1	2	1		2	3	4	2		186
JULY 6	187										1	5	3		1		2	1	2	1		2	3	4	2		187
JULY 7	188											5	3		1		1	2	2	1		3	3	3	1		188
JULY 8	189	1															1	2	2	1		2	4	2	1		189
JULY 9	190																										190
JULY 10	191										1	5	5	2	2						2	5	5	4	2		191
JULY 11	192										1	5	4	2		5	4	5	4	2	3	5	5	4	1		192
JULY 12	193										3	4	5	2	5	4	5	3	4	2	3	4	6	4	1		193
JULY 13	194											4	5	6	3	4	5	4	4	2	3	1					194
JULY 14	195																										195
JULY 15	196														3	5	4	5	4	2	3	1	4	4	2		196
JULY 16	197																					1	3	5	3		197
JULY 17	198											3	5	4	5	4	2				3	4	4	2			198
JULY 18	199											2	4	1	6	4	4		1	1	4	4	3				199
JULY 19	200					2																			2		200
JULY 20	201											2	5	3	4	5	5	4	1				3	4	2		201
JLUY 21	202										3	5	4	3	5	5											202
JULY 22	203											4	5	3	4	4	4	5	1								203
JULY 23	204					2	4	2			2	4	5	4	3	5	4	5	3								204
JULY 24	205											5	4	3	5	5	3	1			3	4	1	2	2		205
JULY 25	206																										206
JULY 26	207											3	5	2	5	4	5	2		1	3	5	5	4	2		207
JULY 27	208											3	4	2	5	4	4	5	2	2	3	5	5	5	1		208
JULY 28	209										2	5	3	2	5	4	5	5	2	2	3	1					209
JULY 29	210										1	5	4	4	5	4						3	4	5	2		210
JULY 30	211										1	5	5	2	3	5	5	4	4	5	5	3	5	5	1		211
JULY 31	212										2	5	5	2	5	5	4	5	4	5	4	5					212

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

ANALOG RECORDINGS AVAILABLE FROM BOMEX TIME PERIOD

ATS-III
ANALOG DATA ON TAPES
BOMEX TIME PERIOD

Reel & Track No.	Day	GMT Time Hr.	Min.	Sequence No.	Remarks
Reel 1					
Track F1	122/9	09	33	1	
	122/9	09	48	2	
	122/9	10	02	3	
	122/9	10	17	4	
	122/9	10	32	5	
	122/9	10	47	6	
	122/9	11	01	7	
	122/9	11	17	8	
	122/9	11	41	9	
	122/9	11	55	10	
	122/9	11	57	11	
Track R2	122/9	12	11	12	
	122/9	12	26	13	
	122/9	12	41	14	
	122/9	15	11	15	
	122/9	15	26	16	
	122/9	15	40	17	
	122/9	15	35	18	
	122/9	16	10	19	
	122/9	16	31	20	
	122/9	16	46	21	
Track F3	122/9	17	05	22	
	122/9	17	20	23	
	122/9	17	35	24	
	122/9	17	49	25	
	122/9	20	08	26	
	122/9	20	23	27	
	122/9	20	37	28	
	122/9	20	52	29	
	122/9	21	07	30	
Track R4	122/9	21	22	31	
	122/9	21	36	32	
	122/9	21	51	33	
	122/9	22	06	34	
	122/9	22	21	35	
	122/9	22	35	36	
Track F5	123/9	09	24	1	
	123/9	09	39	2	
	123/9	09	54	3	
	123/9	10	34	4	

Reel & Track No.	Day	GM Time Hr.	Min	Sequence No.	Remarks
	123/9	10	48	5	
	123/9	11	03	6	
	123/9	11	18	7	
	123/9	11	32	8	
	123/9	11	47	9	
	123/9	12	02	10	
	123/9	12	16	11	
	123/9	12	31	12	
Track R6	123/9	14	59	14	
	123/9	15	14	15	
	123/9	15	29	16	
	123/9	15	57	17	
	123/9	16	13	18	
	123/9	16	28	19	
	123/9	16	42	20	
	123/9	16	57	21	
	123/9	17	12	22	
	123/9	17	26	23	
	123/9	17	41	24	
Track F7	123/9	20	11	25	
	123/9	20	25	26	
	123/9	21	19	27	
	123/9	21	37	28	
	123/9	21	52	29	
	123/9	22	06	31	
	123/9	22	34	32	

Reel 2

Reel & Track No.	Day	Hr.	Min	Sequence No.	Remarks
Track F1	No Data on Track 1				
Track R2	124/9	14	59	12	
	124/9	15	14	13	
	124/9	15	28	14	
	124/9	15	57	15	
	124/9	16	12	16	
	124/9	16	27	17	
	124/9	16	41	18	
	124/9	16	56	19	
	124/9	17	11	20	
	124/9	17	25	21	
	124/9	17	40	22	
Track F3	124/9	19	58	23	
	124/9	20	13	24	
	124/9	20	28	25	
	124/9	21	27	26	

Reel & Track No.	Day	GMT Time Hr.	GMT Time Min.	Sequence No.	Remarks
	124/9	21	42	27	
	124/9	21	57	28	
	124/9	22	11	29	
	124/9	22	26	30	
	124/9	22	41	31	
	125/9	09	28	1	
	125/9	09	43	2	
Track R4	125/9	10	23	3	
	125/9	10	37	4	
	125/9	10	52	5	
	125/9	11	07	6	
	125/9	11	22	7	
	125/9	11	47	8	
	125/9	12	17	9	
	125/9	12	42	10	
	125/9	14	52	11	
Track F5	125/9	15	07	12	
	125/9	15	21	13	
	125/9	15	36	14	
	125/9	16	02	15	
	125/9	16	17	16	
	125/9	16	32	17	
	125/9	16	47	18	
	125/9	17	02	19	
	125/9	17	17	20	
	125/9	17	32	21	
	125/9	17	46	22	
Track R6	125/9	19	59	23	
	125/9	20	14	24	
	125/9	20	30	25	
	125/9	21	24	26	
	125/9	21	24	27	Incorrect time
	125/9	22	04	28	
	125/9	22	27	29	
	125/9	22	42	30	
	126/9	09	25	1	
	126/9	09	40	2	
	126/9	10	08	3	
Track F7	126/9	10	27	4	
	126/9	10	42	5	
	126/9	10	56	6	
	126/9	11	11	7	
	126/9	11	26	8	
	126/9	11	40	9	
	126/9	12	15	10	
	126/9	12	29	11	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	126/9	12	48	12	
	126/9	14	51	13	
	126/9	15	06	14	
Track R1	126/9	15	21	15	Track 1 recorded in reverse.
	126/9	15	35	16	
	126/9	16	01	17	
	126/9	16	16	18	
	126/9	16	30	19	
	126/9	16	45	20	
	126/9	17	00	21	
	126/9	17	15	22	
	126/9	17	29	23	
	126/9	17	44	24	
Reel 3					
Track F1	126/9	20	19	25	Picture starts at line 320
	126/9	20	30	26	
	126/9	21	03	27	Lost video twice during picture
	126/9	21	13	28	
	126/9	21	28	29	
	126/9	21	42	30	Several bad lines
	126/9	22	05	31	
	126/9	22	20	32	Interm. video at line 900
	126/9	22	40	33	Lost video line 650
Track R2	127/9	09	10	1	
	127/9	09	25	2	
	127/9	09	40	3	
	127/9	10	14	4	
	127/9	10	28	5	
	127/9	10	43	6	
	127/9	10	58	7	
	127/9	11	13	8	
	127/9	11	27	9	
	127/9	12	07	10	
Track F3	127/9	15	46	11	
	127/9	16	17	12	
	127/9	16	32	13	
	127/9	16	46	14	
	127/9	17	01	15	
	127/9	17	16	16	
	127/9	17	30	17	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	127/9	17	45	18	
	127/9	18	00	19	
	127/9	18	14	20	
	127/9	18	30	21	
	127/9	18	44	22	
	127/9	18	59	23	1200 line picture
Track R4	127/9	19	14	24	
	127/9	19	29	25	
	127/9	19	44	26	
	127/9	19	58	27	
	127/9	20	13	28	
	127/9	21	15	29	
	127/9	21	30	30	
	127/9	21	45	31	
	127/9	22	00	32	
	127/9	22	47	33	

Reel & Track No.	Day	Hr.	Min.	Sequence No.	Remarks
Reel 4					
Track F1	128/9	09	25	1	
	128/9	09	04	2	
	128/9	11	14	3	
	128/9	11	29	4	
	128/9	12	35	5	
	128/9	12	51	6	
	128/9	14	54	7	
	128/9	15	09	8	
	128/9	15	24	9	
	128/9	15	39	10	
Track R2	128/9	15	53	11	
	128/9	16	08	12	
	128/9	16	36	13	
	129/9	09	19	1	
	129/9	09	42	2	
	129/9	10	39	3	
	129/9	10	54	4	
	129/9	11	09	5	
	129/9	12	41	6	
	129/9	15	16	7	
	129/9	15	33	8	
	129/9	16	02	9	
Track F3	129/9	16	39	10	
	129/9	16	53	11	
	129/9	17	08	12	
	129/9	17	23	13	
	129/9	17	37	14	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	129/9	17	52	15	
	129/9			16	
	130/9	09	12	1	
	130/9	09	27	2	
	130/9	09	41	3	
	130/9	10	40	4	
	130/9	10	55	5	
Track R4	130/9	14	41	6	
	130/9	14	56	7	
	130/9	15	10	8	
	130/9	15	25	9	
	130/9	15	40	10	
	130/9	16	06	11	
	130/9	16	38	12	
	130/9	16	52	13	
	130/9	17	72	14	
	130/9	17	22	15	
	130/9	17	36	16	
	130/9	19	59	17	
	130/9	20	14	18	
	130/9	20	29	19	
Track F5	131/9	16	44	1	
	131/9	16	59	2	
	131/9	17	13	3	
	131/9	17	28	4	
	131/9	17	43	5	
	131/9	20	04	6	
	131/9	20	18	7	
	131/9	20	33	8	
Track R6	131/9	21	42	9	
	131/9	21	56	10	
	131/9	22	11	11	
	131/9	22	26	12	
	131/9	22	41	13	
	132/9	09	34	1	
	132/9	09	45	2	
	132/9	11	16	3	
	132/9	11	31	4	
	132/9	11	45	5	
	132/9	12	38	6	
Track F7	132/9	14	58	7	
	132/9	15	13	8	
	132/9	15	27	9	
	132/9	15	42	10	
	132/9	16	09	11	
	132/9	16	36	12	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	132/9	16	50	13	
	132/9	17	06	14	
	132/9	17	21	15	
	132/9	17	35	16	
Reel 5					
Track F1	133/9	09	08	1	
	133/9	09	24	2	
	133/9	09	38	3	
Track R2	133/9	15	02	4	
	133/9	15	17	5	
	133/9	15	32	6	
	133/9	15	46	7	
Track F3					Switched to Track 4 during picture 6
Track F4	136/9	10	39	6	
	136/9	10	52	7	
	136/9	11	05	8	
	136/9	11	17	9	
	136/9	11	30	10	
	136/9	11	42	11	
	136/9	12	28	12	
	136/9	12	41	13	
	136/9	12	53	14	
Track 5	No video				
Track 6	No recording				
Track 7	No recording				
Reel 6					
Track F3	134/9	09	17	1	
	134/9	09	32	2	
	134/9	09	47	3	
	134/9	16	13	4	
	134/9	16	45	5	
	134/9	17	00	6	
	134/9	17	13	7	
	134/9	17	28	8	
	134/9	17	43	9	
	134/9	21	15	10	
	134/9	21	43	11	
	134/9	21	58	12	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track R4	134/9	22	14	13	Start line 150
	134/9	22	28	14	
	134/9	22	42	15	
Track F5	135/9	09	11	1	
	135/9	09	30	2	
	135/9	09	45	3	
	135/9	09	59	4	
	135/9	10	37	5	
	135/9	10	51	6	
	135/9	11	06	7	
	135/9	11	21	8	
	135/9	11	36	9	
	135/9	11	51	10	
Track R6	135/9	12	05	11	
	135/9	12	35	12	
	135/9	15	00	13	
	135/9	15	15	14	
	135/9	15	30	15	
	135/9	15	45	16	
	135/9	15	59	17	
	135/9	16	49	18	
	135/9	17	04	19	
	135/9	17	19	20	
	135/9	17	33	21	
	135/9	17	48	22	
Track F1	135/9	18	04	23	No picture recorder
	135/9	18	19	24	No picture recorder
	135/9	18	34	25	
	135/9	18	49	26	
	135/9	19	03	27	
	135/9	19	18	28	
	135/9	19	33	29	
	135/9	19	48	30	
	135/9	20	05	31	
	135/9	20	20	32	
	135/9	20	35	33	
	135/9	20	50	34	
Track R2	135/9	21	04	35	
	135/9	21	45	36	
	135/9	21	59	37	
	135/9	22	14	38	
	135/9	22	29	39	
	135/9	22	45	40	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Reel 7					
Track F1	137/9	09	17	1	
	137/9	09	30	2	
	137/9	09	42	3	
	137/9	09	55	4	
	137/9	10	07	5	
	137/9	10	20	6	
	137/9	10	34	7	
	137/9	10	47	8	
	137/9	11	00	9	
	137/9	11	12	10	
	137/9	11	25	11	
	137/9	11	38	12	
	137/9	11	50	13	
Track R2	137/9	12	03	14	
	137/9	12	15	15	
	137/9	12	28	16	
	137/9	12	41	17	
	137/9	12	53	18	
	137/9	13	06	19	
	137/9	13	19	20	
	137/9	13	31	21	
	137/9	13	44	22	
	137/9	13	56	23	
	137/9	14	09	24	
	137/9	14	22	25	
	137/9	14	34	26	
	137/9	14	47	27	
Track F3	137/9	14	59	28	
	137/9	15	12	29	
	137/9	15	25	30	
	137/9	15	37	31	
	137/9	15	50	32	
	137/9	16	02	33	
	137/9	16	15	34	
	137/9	16	28	35	
	137/9	16	40	36	
	137/9	16	53	37	
	137/9	17	06	38	
	137/9	17	19	39	
	137/9	17	31	40	
	137/9	17	44	41	
Track R4	137/9	17	57	42	
	137/9	18	09	43	
	137/9	18	22	44	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	137/9	18	34	45	
	137/9	18	47	46	
	137/9	19	00	47	
	137/9	19	12	48	
	137/9	19	25	49	
	137/9	19	32	50	
	137/9	19	50	51	
	137/9	20	03	52	
	137/9	20	15	53	
	137/9	20	02	54	
	137/9	20	41	55	
Track F5	137/9	20	53	56	
	137/9	21	06	57	
	137/9	21	19	58	
	137/9	21	32	59	
	137/9	21	45	60	
	137/9	21	58	61	
	137/9	22	10	62	
	137/9	22	23	63	
	137/9	22	36	64	
	137/9	22	48	65	
	138/9	09	20	1	
	138/9	09	32	2	
	138/9	09	45	3	
	138/9	09	57	4	
Track R6	138/9	10	10	5	
	138/9	10	14	6	
	138/9	11	04	7	
	138/9	11	13	8	
	138/9	11	26	9	
	138/9	12	47	10	First 250 lines missing
	138/9	20	10	11	
	138/9	20	25	12	
	138/9	20	39	13	
	138/9	21	49	14	
	138/9	22	04	15	
	138/9	22	19	16	
Track F7	138/9	22	34	17	
	139/9	10	54	1	
	139/9	11	06	2	
	139/9	11	19	3	
	139/9	12	08	4	
	139/9	12	49	5	
	139/9	15	01	6	
	139/9	15	13	7	
	139/9	15	26	8	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	139/9	15	39	9	
Reel 8					
Track F1	139/9	10	53	10	
	139/9	17	05	11	
	139/9	17	18	12	
	139/9	17	31	13	
	139/9	17	43	14	
	139/9	20	41	17	
	139/9	20	54	18	
	139/9	22	07	20	
	139/9	22	19	21	
	139/9	22	32	22	
	139/9	22	44	23	
	140/9	15	02	1	
	140/9	15	14	2	
Track R2	140/9	15	27	3	
	140/9	15	40	4	
	140/9	15	55	5	
	140/9	16	55	6	
	140/9	17	08	7	
	140/9	17	21	8	
	140/9	17	34	9	
	140/9	17	47	10	
	140/9	20	00	11	
	140/9	20	15	12	
	140/9	20	28	13	
	140/9	20	40	14	
	140/9	20	53	15	
Track F3	140/9	21	51	16	First 500 lines missing
	140/9	22	04	17	
	140/9	22	17	18	
	140/9	22	29	19	
	140/9	22	42	20	
	141/9	09	16	1	
	141/9	09	29	2	
	141/9	09	41	3	
	141/9	09	54	4	
	141/9	10	66	5	
	141/9	10	45	6	
	141/9	10	58	7	
	141/9	11	11	8	
Track R4	141/9	11	23	9	
	141/9	11	36	10	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	141/9	11	48	11	
	141/9	12	01	12	
	141/9	12	48	13	
	141/9	15	00	14	
	141/9	15	13	15	
	141/9	15	26	16	
	141/9	15	38	17	
	141/9	15	53	18	
	141/9	16	40	19	
	141/9	16	53	20	
Track F5	141/9	17	06	21	
	141/9	17	18	22	
	141/9	17	31	23	
	141/9	17	44	24	
	141/9	20	16	25	
	141/9	20	28	26	
	141/9	20	41	27	
	141/9	20	53	28	
	141/9	21	48	29	
	141/9	22	00	30	
	141/9	22	13	31	
	141/9	22	26	32	
	141/9	22	38	33	
Track R6	142/9	09	13	1	
	142/9	09	25	2	
	142/9	09	38	3	
	142/9	09	53	4	
	142/9	10	05	5	
	142/9	10	48	6	
	142/9	11	01	7	
	142/9	11	13	8	
	142/9	11	26	9	
	142/9	12	51	10	
	143/9	09	11	1	
	143/9	09	24	2	
Track F7	143/9	09	37	3	
	143/9	09	52	4	
	143/9	10	01	5	
	143/9	10	51	6	
	143/9	11	03	7	
	143/9	11	16	8	
	143/9	11	29	9	
	143/9	12	56	10	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Reel 9					
Track F3	143/9	14	59	11	
	143/9	15	12	12	
	143/9	15	25	13	
	143/9	15	37	14	
	143/9	15	52	15	
	143/9	16	52	16	
	143/9	17	04	17	
	143/9	17	17	18	
	143/9	17	30	19	
	143/9	17	42	20	
	143/9	20	40	21	Start line 90
	143/9	20	56	22	
	143/9	21	46	23	
	143/9	21	59	24	
Track R4	143/9	22	12	25	Start line 200
	143/9	22	24	26	
	143/9	22	37	27	
	148/9	10	12	1	
	148/9	10	24	2	
	148/9	10	39	3	
	148/9	10	52	4	
	148/9	11	05	5	
	148/9	11	18	6	
	148/9	11	31	7	
	148/9	11	43	8	
	148/9	11	56	9	MDA lost lock at line 720
	151/9	17	13	1	Less than 50 lines
	151/9	17	23	2	Video N. G.
Track F1	152/9	13	29	2	
	152/9	13	51	3	
	152/9	14	16	4	
	152/9	14	42	5	
	152/9	15	33	6	
	152/9	15	58	7	
	152/9	19	19	8	
	152/9	20	38	9	
Track R2	153/9			1	
	153/9	11	43	2	Bad skew
	153/9	19	15	3	Bad skew, restart
	153/9	19	22	3	
	153/9	20	37	4	
	154/9	09	48	1	
	154/9	10	49	2	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track F5	154/9	16	53	7	
	154/9	17	06	8	
	154/9	17	19	9	
	154/9	17	40	10	
	154/9	20	04	11	
	154/9	20	22	12	
	154/9	20	40	13	
	154/9	21	58	14	
	154/9	22	16	15	
	154/9	22	32	16	
	154/9	22	47	17	
	155/9	09	25	1	
Track R6	155/9	09	47	2	
	155/9	10	07	3	
	155/9	10	43	4	
	155/9	11	00	5	
	155/9	11	20	6	
	155/9	11	35	7	
	155/9	12	45	8	
	155/9	15	43	11	
	155/9	16	03	12	
	155/9			13	Lost picture
	155/9	17	00	14	
	155/9	17	17	15	
	155/9	17	33	16	Interference, lines 0-450
Track F7	155/9	17	47	17	
	155/9	20	10	18	
	155/9	20	28	19	
	155/9	20	44	20	
	155/9	20	59	21	
	155/9	21	30	22	
	155/9	21	43	23	Picture started late
	155/9	21	59	24	
	155/9	22	14	25	
	155/9	22	30	26	

Reel 10

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track F1	156/9	09	36	6	
	156/9	09	53	7	
	156/9	10	11	8	
	156/9	10	47	9	
	156/9	11	03	10	
	156/9		19	11	
	156/9	12	44	12	
	156/9	15	50	13	Interference lines 100-300

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	156/9	15	22	14	
	156/9	15	38	15	
	156/9	15	53	16	
	156/9	16	11	17	
	156/9	16	51	18	Out of tape at line 1000
Track R2	156/9	17	06	19	
	156/9	17	22	20	
	156/9	17	49	21	
	156/9	20	12	22	
	156/9	20	27	23	
	156/9	20	43	24	
	156/9	20	59	25	
	156/9	21	15	26	
	157/9	16	01	1	
	157/9	16	16	2	
	157/9	16	47	3	
	157/9	17	00	4	
	157/9	17	14	5	Lost picture
Track F2	157/9	17	27	6	
	157/9	17	40	7	
Track F3	157/9	20	06	8	
	157/9	20	15	9	
	157/9	20	31	10	
	157/9	20	44	11	
	157/9	20	56	12	
	157/9	21	20	13	
	158/9	10	00	1	
	158/9	11	30	2	
	158/9	12	48	3	No video
	158/9	15	09	4	
	158/9	15	30	5	
	158/9	15	44	6	
	158/9	16	00	7	
Track R4	158/9	16	43	8	Bad video
	158/9	16	56	9	Bad video
	158/9	17	19	10	Bad video
	158/9	17	41	11	Bad video
	158/9	17	33	12	Bad video
	158/9	20	11	12	Restart
	158/9	20	25	13	
	158/9	20	38	14	
	158/9	21	52	15	
	158/9	21	40	16	
	158/9	21	41	17	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	158/9	21	54	18	
	158/9	22	06	19	
	158/9	22	19	20	
Track F5	158/9	22	32	21	
	158/9	22	45	22	
	159/9	09	30	1	
	159/9	09	45	2	
	159/9	11	03	3	
	159/9	11	16	4	
	159/9	11	33	5	
	159/9	12	46	6	
	159/9	15	06	7	
	159/9	15	18	7	
	159/9	15	32	9	
	159/9	15	48	10	
	159/9	16	03	11	
Track R6	159/9	16	55	12	
	159/9	16	56	13	
	159/9	17	10	14	
	159/9	17	22	15	
	159/9	17	37	16	
	159/9	20	26	17	
	159/9	20	39	18	
	159/9	20	51	19	
	159/9	21	04	20	
	159/9	21	41	21	
	159/9	21	54	22	
	159/9	22	15	23	
Track F7	159/9	22	28	24	
	159/9	22	41	25	
	160/9	09	16	1	
	160/9	09	28	2	

Reel 11

Reel & Track No.	Day	Hr.	Min.	Sequence No.	Remarks
Track F1	160/9	10	45	4	
	160/9	10	58	5	
	160/9	11	12	6	
	160/9	11	25	7	
	160/9	12	44	8	No video
	160/9	14	51	9	
	160/9	15	03	10	
	160/9	15	16	11	
	160/9	15	28	12	
	160/9	15	41	13	
	160/9	15	56	14	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	160/9	16	43	15	
	160/9	17	03	16	
	160/9	17	16	17	
	160/9	17	20	18	
Track R2	160/9	17	43	19	
	160/9	21	51	22	
	160/9	22	22	23	
	160/9	22	24	24	
	160/9	22	36	25	
	160/9	22	49	26	
	161/9	09	34	1	
	161/9	09	48	2	
	161/9	10	50	3	
Track F3	161/9	11	03	4	
	161/9	11	15	5	
	161/9	11	28	6	Lost picture
	161/9	12	43	7	First part bad
	161/9	15	19	8	No line start
	161/9	15	31	9	
	161/9	15	44	10	
	161/9	15	59	11	
	161/9	20	29	14	
	161/9	20	53	15	
	161/9	20	54	16	
	161/9	21	07	17	
	161/9	21	44	18	
Track R4	161/9	21	56	19	
	161/9	22	09	20	
	161/9	22	22	21	
	161/9	22	35	22	
	161/9	22	48	23	
	162/9	09	31	1	
	162/9	09	46	2	
	162/9	10	44	3	
	162/9	10	57	4	
	162/9	11	10	5	
	162/9	11	23	6	
Track F5	162/9	12	42	7	
	162/9	15	01	8	No line start
	162/9	15	40	9	
	162/9	15	26	10	
	162/9	15	39	11	
	162/9	15	54	12	
	162/9	16	53	13	
	162/9	17	06	14	
	162/9	17	18	15	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	162/9	17	31	16	
	162/9	17	45	17	
	162/9	20	15	18	
	162/9	20	28	19	
Track R6	162/9	20	43	20	Equip. reset 8 min. into picture
	162/9	20	51	20	
	162/9	21	04	21	
	162/9	21	52	22	
	162/9	21	59	22	
	162/9	22	11	23	
	162/9	22	24	24	
	162/9	22	37	25	
	163/9	09	16	1	
	163/9	09	29	2	
	163/9	09	44	3	
	163/9	10	54	4	
Track F7	163/9	11	07	5	
	163/9	11	19	6	
	163/9	12	51	7	
	163/9	14	26	8	
	163/9	14	39	9	
	163/9	14	52	10	
	163/9	15	04	11	
	163/9	15	17	12	
	163/9	15	30	13	
	163/9	15	45	14	
	163/9	16	00	15	

Reel 12

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track F1	163/9	16	50	16	
	163/9	17	03	17	
	163/9	17	16	18	
	163/9	17	29	19	
	163/9	17	41	20	
	163/9	17	54	21	
	163/9	18	07	22	
	163/9	18	20	23	
	163/9	18	32	24	
	163/9	18	45	25	
	163/9	18	58	26	
	163/9	19	12	27	
	163/9	19	25	28	
Track R2	163/9	19	38	29	
	163/9	19	50	30	
	163/9	20	03	31	
	163/9	20	16	32	
	163/9	20	29	33	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	163/9	20	42	34	
	163/9	20	57	35	
	163/9	21	10	36	
	163/9	21	57	37	
	163/9	22	10	38	
	163/9	22	23	39	
Track F3	163/9	22	36	40	
	163/9	22	49	41	
	163/9	23	01	42	
	163/9	23	14	43	
	163/9	22	27	44	
	163/9	23	39	45	
	163/9	23	52	46	
	164/9	00	05	1	
	164/9	00	18	2	
	164/9	00	30	3	
	164/9	00	43	4	
	164/9	10	07	5	
Track R4	164/9	10	55	6	
	164/9	11	07	7	
	164/9	11	20	8	
	164/9	12	50	9	
	164/9	14	55	10	
	164/9	15	21	11	
	164/9	15	46	12	
	164/9	16	52	13	
	164/9	17	18	14	
Track F5	164/9	20	46	15	
	164/9	21	00	16	
	164/9	21	13	17	
	164/9	21	54	18	
	164/9	22	07	19	No annotation, lost video
	164/9	22	21	20	
	164/9	22	33	21	
	164/9	22	46	22	
	165/9	09	30	1	
	165/9	09	39	2	
	165/9	09	57	3	
	165/9	10	12	4	
Track R6	165/9	10	41	5	
	165/9	10	56	6	
	165/9	11	08	7	
	165/9	11	23	8	
	165/9	12	44	8	
	165/9	15	18	9	
	165/9	15	44	10	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	165/9	16	44	11	
	165/9	17	09	12	
Track F7	165/9	17	35	13	
	165/9	20	10	14	
	165/9	20	22	15	
	165/9	20	35	16	
	165/9	20	48	17	
	165/9	21	03	18	
	165/9	21	15	19	
	165/9	21	50	20	
	165/9	22	03	21	
	165/9	22	15	22	
	165/9	22	28	23	
	165/9	22	42	24	

Reel 13

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track F1	166/9	09	15	1	
	166/9	09	28	2	
	166/9	09	40	3	
	166/9	09	54	4	
	166/9	10	09	5	
	166/9	10	50	6	
	166/9	11	03	7	
	166/9	11	15	8	
	166/9	11	28	9	
	166/9	11	41	10	
	166/9	11	56	11	
	166/9	12	42	12	
Track R2	166/9	15	31	13	
	166/9	15	57	14	
	166/9	16	42	15	
	166/9	17	08	16	
	166/9	17	33	17	
	166/9	20	10	18	
	166/9	20	23	19	
	166/9	20	36	20	
Track F3	166/9	20	49	21	
	166/9	21	03	22	
	166/9	21	16	23	Bad annotation at line 955
	166/9	21	44	24	
	166/9	21	57	25	
	166/9	22	10	26	Bad annotation at line 850
	166/9	22	23	27	
	166/9	22	35	28	
	166/9	22	48	29	
	167/9	09	11	1	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	167/9	09	24	2	
	167/9	09	37	3	
Track R4	167/9	09	50	4	
	167/9	10	05	5	
	167/9	10	17	6	
	167/9	11	00	7	
	167/9	11	01	8	
	167/9	11	13	9	
	167/9	11	26	10	
	167/9	12	42	11	
	167/9	15	05	12	
Track F5	167/9	15	31	13	
	167/9	15	56	14	
	167/9	16	47	15	
	167/9	17	13	16	
	167/9	20	16	17	
	167/9	20	29	18	
	167/9	20	43	19	
	167/9	20			
Track R6	167/9	21	11	21	
	167/9	21	46	22	
	167/9	21	59	23	
	167/9	22	11	24	
	167/9	22	24	25	
	167/9	22	37	26	
	168/9	09	10	1	
	168/9	09	22	2	
	168/9	09	35	3	
	168/9	09	48	4	
	168/9	10	02	5	
	168/9	10	15	6	
	168/9	10	41	7	
Track F7	168/9	10	54	8	
	168/9	11	06	9	
	168/9	11	19	10	
	168/9	11	32	11	
	168/9	12	43	12	
	168/9	15	01	13	
	168/9	15	27	14	
	168/9	15	52	15	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Reel 14					
Track F1	168/9	16	43	16	
	168/9	17	09	17	
	168/9	17	34	18	
	168/9	20	10	19	
	168/9	20	23	20	
	168/9	20	35	21	
	168/9	20	48	22	
	168/9	21	03	23	
	168/9	21	16	24	
	168/9	21	40	25	
Track R2	168/9	21	53	26	
	168/9	22	06	27	
	168/9	22	19	28	
	168/9	22	31	29	
	168/9	22	44	30	
	169/9	09	28	1	
	169/9	09	28	2	
	169/9	09	53	3	
	169/9	10	08	4	
	169/9	10	40	5	
	169/9	10	52	6	
	169/9	11	04	7	
	169/9	11	17	8	
Track F3	169/9	12	42	9	
	169/9	15	01	10	
	169/9	15	26	11	
	169/9	15	52	12	
	169/9	16	42	13	
	169/9	17	08	14	
	169/9	17	33	15	
Track R4	169/9	20	07	16	
	169/9	20	20	17	
	169/9	20	32	18	
	169/9	20	59	19	
	169/9	21	00	20	
	169/9	21	46	21	
	169/9	21	58	22	
	169/9	22	11	23	
	169/9	22	24	24	
	169/9	22	36	25	
	169/9	22	49	26	
	170/9	09	11	1	
Track F5	170/9	09	23	2	
	170/9	09	36	3	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	170/9	09	49	4	
	170/9	10	34	5	
	170/9	10	16	6	
	170/9	10	41	7	
	170/9	10	53	8	
	170/9	11	06	9	
	170/9	11	19	10	
	170/9	11	25	11	
Track R6	170/9	12	45	12	No video
	170/9	15	02	13	
	170/9	15	27	14	
	170/9	15	53	15	
	170/9	16	42	16	
Track F7	170/9	17	07	17	
	170/9	17	33	18	
	170/9	20	14	19	
	170/9	20	26	20	
	170/9	20	39	21	
	170/9	20	54	22	
	170/9	21	07	23	
	170/9	21	41	24	
	170/9	21	54	25	
	170/9	22	07	26	
	170/9	22	19	27	
	170/9	22	32	28	
	170/9	22	45	29	Tape ran out at 300 lines

Reel 15

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track F1	171/9	09	12	1	
	171/9	09	24	2	
	171/9	09	37	3	
	171/9	09	50	4	
	171/9	10	08	5	
	171/9	10	44	6	
	171/9	11	06	7	
	171/9	11	19	8	
	171/9	12	45	9	
	171/9	15	00	10	
Track R2	171/9	15	45	11	
	171/9	16	40	12	
	171/9	17	05	13	
	171/9	17	31	14	
	171/9	20	17	15	
	171/9	20	29	16	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	171/9	20	42	17	
Track F3	171/9	20	57	18	
	171/9	21	10	19	
	171/9	21	43	20	
	171/9	21	55	21	
	171/9	22	08	22	
	171/9	22	21	23	
	171/9	22	33	24	
	171/9	22	46	25	
	172/9	09	13	1	
	172/9	09	26	2	
	172/9	09	39	3	
	172/9	09	52	4	
Track R4	172/9	10	07	5	
	172/9	10	40	6	
	172/9	10	53	7	
	172/9	11	05	8	
	172/9	11	18	9	
	172/9	12	40	10	
	172/9	15	04	11	
	172/9	15	29	12	
	172/9	16	55	13	
Track F5	172/9	16	44	14	
	172/9	17	10	15	
	172/9	16	35	16	
	172/9	20	17	17	
	172/9	20	30	18	
	172/9	20	43	19	
	172/9	20	58	20	
	172/9	21	10	21	
	172/9	21	59	22	
	172/9	22	12	23	
Track R6	172/9	22	24	24	
	172/9	22	37	25	
	173/9	09	19	1	
	173/9	09	32	2	
	173/9	09	44	3	
	173/9	09	59	4	
	173/9	10	12	5	
	173/9	10	43	6	
	173/9	10	56	7	
	173/9	11	09	8	
	173/9	11	22	9	
	173/9	12	40	10	
	173/9	15	17	11	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track F7	173/9	15	43	12	
	173/9	16	08	13	
	173/9	16	40	14	
	173/9	17	05	14B	
	173/9	17	31	15	
	173/9	20	13	16	
	173/9	20	25	17	
	173/9	20	38	18	
	173/9	20	53	19	
	173/9	21	05	20	
Track F1	173/9	21	56	21	Tape ran out, new tape started on picture 22
	173/9	22	09	22	
	173/9	22	22	23	
	173/9	22	35	24	
	173/9	22	47	25	
	174/9	09	10	1	
	174/9	09	23	2	
	174/9	09	36	3	
	174/9	09	48	4	
	174/9	10	03	5	
	174/9	10	16	6	

Reel 16					
Track F1	174/9	10	40	7	
	174/9	10	53	8	
	174/9	11	06	9	
Track R2	174/9	11	19	10	
	174/9	12	48	11	
	174/9	15	03	12	
	174/9	15	28	13	
	174/9	15	54	14	
	174/9	16	41	15	
	174/9	17	06	16	
	174/9	17	32	17	
Track F3	174/9	20	05	18	
	174/9	20	18	19	
	174/9	20	30	20	
	174/9	20	43	21	
	174/9	20	58	22	
	174/9	21	11	23	
	174/9	21	39	24	
	174/9	21	52	25	
	174/9	22	05	26	
	174/9	22	17	27	
	174/9	22	30	28	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	174/9	22	43	29	
	175/9	09	25	1	
Track R4	175/9	09	40	2	
	175/9	09	53	3	
	175/9	10	08	4	
	175/9	10	40	5	
	175/9	10	52	6	
	175/9	11	05	7	
	175/9	11	19	8	
	175/9	12	40	9	
	175/9	15	06	10	
	175/9	15	47	11	
Track F5	175/9	16	43	12	
	175/9	17	08	13	
	175/9	17	34	14	
	175/9	20	29	15	
	176/9	09	11	1	
	176/9	09	23	2	
	176/9	09	36	3	
	176/9	09	49	4	
	176/9	10	04	5	
	176/9	10	18	6	
Track R6	176/9	10	44	7	Bad start
	176/9	10	57	8	
	176/9	11	10	9	
	176/9	11	25	10	
	176/9	14	45	11	
	176/9	16	45	12	
	176/9	16	58	13	
	176/9	17	11	14	
	176/9	17	24	15	
Track F7	176/9	17	37	16	
	176/9	17	49	17	
	176/9	18	02	18	
	176/9	14	15	19	
	176/9	18	42	20	
	176/9	18	54	21	
	176/9	19	07	22	
	176/9	19	20	23	
	176/9	19	33	24	
	176/9	19	45	25	
	176/9	19	58	26	
	176/9	20	11	27	
	176/9	20	23	28	
	176/9	20	36	29	
	176/9	20	49	30	Out of tape, line 750

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Reel 17					
Track F1	176/9	21	45	31	
	176/9	21	58	32	
	176/9	22	10	33	
	176/9	22	23	34	
	176/9	22	39	35	
	176/9	22	52	36	
	176/9	23	05	37	
	176/9	23	17	38	
	176/9	23	30	39	
	176/9	23	43	40	
	177/9	09	17	1	
	177/9	09	29	2	
	177/9	09	42	3	
	177				
Track R2	177/9	09	57	4	
	177/9	10	40	5	
	177/9	10	52	6	
	177/9	11	05	7	
	177/9	11	18	8	
	177/9	12	49	9	
	177/9	15	01	10	
	177/9	15	26	11	
	177/9	15	52	12	
Track F3	177/9	16	53	13	No video till line 200 Restart
	177/9	17	19	14	
	177/9	20	11	15	
	177/9	20	23	16	
	177/9	20	36	17	
	177/9	20	51	18	
	177/9	21	41	19	
	177/9	21	54	20	
	177/9	22	07	21	
Track R4	177/9	22	19	22	
	177/9	22	33	23	
	177/9	22	46	24	
	178/9	09	17	1	
	178/9	09	30	2	
	178/9	09	42	3	
	178/9	09	57	4	
	178/9	10	10	5	
	178/9	12	42	6	
	178/9	15	01	7	
	178/9	15	13	8	
	178/9	15	26	9	
	178/9	15	39	10	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track F5	178/9	15	51	11	
	178/9	16	06	12	
	178/9	16	41	13	
	178/9	16	53	14	
	178/9	17	06	15	
	178/9	17	19	16	
	178/9	17	31	17	
	178/9	17	44	18	
	178/9	17	57	19	
	178/9	18	10	20	
	178/9	18	22	21	
	178/9	18	35	22	
	178/9	18	47	23	
	178/9	19	00	24	
	178/9	19	13	25	Ran out of tape
Track R6	178/9	19	25	26	
	178/9	19	38	27	
	178/9	19	51	28	
	178/9	20	04	29	
	178/9	20	16	30	
	178/9	20	29	31	
	178/9	20	42	32	
	178/9	21	43	33	
	178/9	21	57	34	
	178/9	22	10	35	
	178/9	22	23	36	
	178/9	22	35	37	
	178/9	22	48	38	
Track F7	178/9	23	01	39	
	178/9	23	13	40	
	178/9	23	26	41	
	178/9	23	39	42	
	179/9	09	22	1	
	179/9	09	34	2	
	179/9	09	47	3	
	179/9	10	01	4	
	179/9	10	14	5	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Reel 18					
Track F1	179/9	10	44	6	
	179/9	10	56	7	
	179/9	11	09	8	
	179/9	11	22	9	
	179/9	12	43	10	
	179/9	15	00	11	
	179/9	15	26	12	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	179/9	15	51	13	
	179/9	16	42	14	
Track R2	179/9	17	24	15	Reset halfway through
	179/9	20	08	16	
	179/9	20	20	17	
	179/9	20	33	18	
	179/9	20	48	19	
	179/9	21	01	20	
	179/9	21	42	21	
	179/9	21	55	22	
	179/9	22	07	23	
	179/9	22	20	24	
	179/9	22	33	25	
	179/9	22	46	26	
Track F3	180/9	09	50	1	
	180/9	10	05	2	
	180/9	10	17	3	
	180/9	10	42	4	
	180/9	10	54	5	
	180/9	11	07	6	
	180/9	11	20	7	
	180/9	12	45	8	
	180/9	15	01	9	
	180/9	15	26	10	
Track R4	180/9	15	51	11	
	180/9	16	42	12	
	180/9	17	08	13	
	180/9	17	33	14	
	180/9	20	03	15	
	180/9	20	15	16	
	180/9	20	28	17	
	180/9	20	41	18	
	180/9	20	55	19	
Track F5	180/9	21	41	20	
	180/9	21	54	21	
	180/9	22	07	22	
	180/9	22	19	23	
	180/9	22	32	24	
	180/9	22	45	25	
	181/9	09	05	1	
	181/9	09	18	2	
	181/9	09	30	3	
	181/9	09	43	4	
	181/9	09	58	5	
	181/9	10	11	6	
	181/9	10	45	7	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track R6	181/9	10	58	8	
	181/9	11	10	9	
	181/9	11	23	10	
	181/9	12	42	11	
	181/9	15	01	12	
	181/9	15	26	13	
	181/9	16	01	14	
	181/9	16	41	15	
Track F7	181/9	17	06	16	
	181/9	17	32	17	
	181/9	20	21	18	
	181/9	20	34	19	
	181/9	20	53	20	
	181/9	21	43	21	
	181/9	21	55	22	
	181/9	22	08	23	
	181/9	22	21	24	
	181/9	22	34	25	
	181/9	22	46	26	

Reel & Track No.	Day	Hr.	Min.	Sequence No.	Remarks
Reel 19					
Track F1	182/9	09	09	1	
	182/9	09	22	2	
	182/9	09	35	3	
	182/9	09	47	4	
	182/9	10	02	5	
	182/9	10	15	6	
	182/9	10	43	7	
	182/9	10	55	8	
	182/9	11	08	9	
	182/9	11	21	10	
	182/9	12	41	11	
	182/9	12	54	12	
	182/9	13	19	13	Lost video, restart
	182/9	13	34	13	
Track R2	182/9	13	27	14	Lost lock line 1800
	182/9	14	54	15	
	182/9	15	19	16	
	182/9	15	45	17	
	182/9	16	46	18	
	182/9	17	12	19	
	182/9	17	37	20	
Track F3	183/9	09	19	1	
	183/9	09	32	2	
	183/9	09	45	3	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	183/9	10	00	4	
	183/9	10	13	5	
	183/9	10	43	6	
	183/9	10	56	7	
	183/9	11	09	8	
	183/9	11	22	9	
	183/9	12	41	10	
	183/9	15	06	11	Discontinued line 1700
	183/9	15	31	12	Discontinued line 1700
Track R4	183/9	16	00	13	
	183/9	16	48	14	
	183/9	17	14	15	
	183/9	17	39	16	
	183/9	20	12	17	
	183/9	20	24	18	
	183/9	20	37	19	
	183/9	20	50	20	
Track F5	183/9	21	05	21	
	183/9	21	41	22	
	183/9	21	54	23	
	183/9	22	05	24	
	183/9	22	19	25	
	183/9	22	32	26	
	183/9	22	45	27	
	184/9	09	37	1	
	184/9	09	50	2	
	184/9	10	05	3	
	184/9	10	18	4	
	184/9	10	43	5	
	184/9	10	50	6	
	18				
Track R6	184/9	11	09	7	
	184/9	11	21	8	
	184/9	12	41	9	
	184/9	15	27	10	
	184/9	16	18	11	
	184/9	16	43	12	
	184/9	17	09	13	
	184/9	17	34	14	
Track F7	184/9	20	20	15	
	184/9	20	21	16	
	184/9	20	45	17	
	184/9	20	59	18	
	184/9	21	14	19	
	184/9	21	50	20	
	184/9	20	04	21	
	184/9	22	05	22	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	184/9	22	17	23	
	184/9	22	30	24	
	184/9	24	43	25	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Reel 20					
Track F1	185/9	09	23	1	
	185/9	09	35	2	
	185/9	09	48	3	
	185/9	10	01	4	
	185/9	10	14	5	
	185/9	10	27	6	
	185/9	10	40	7	
	185/9	10	54	8	
	185/9	11	07	9	
	185/9	12	41	10	
	185/9	15	08	11	
	185/9	15	33	12	Ran out of tape
Track R2	185/9	15	59	13	
	185/9	16	41	14	
	185/9	17	07	15	
	185/9	17	32	16	
	185/9	20	08	17	
	185/9	20	21	18	
	185/9	20	34	19	
	185/9	20	47	20	
	185/9	21	40	21	
	185/9				
Track F3	185/9	21	53	22	
	185/9	22	06	23	
	185/9	22	19	24	
	185/9	22	31	25	
	185/9	22	44	26	
	186/9	09	21	1	
	186/9	09	34	2	
	186/9	09	46	3	
	186/9	09	59	4	
	186/9	10	12	5	
	186/9	10	25	6	
	186/9	10	38	7	
Track R4	186/9	10	53	8	
	186/9	11	05	9	
	186/9	12	44	10	
	186/9	14	58	11	
	186/9	15	24	12	
	186/9	15	49	13	
	186/9	16	42	14	
	186/9	17	08	15	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track F5	186/9	17	34	16	
	186/9	20	09	17	
	186/9	20	21	18	
	186/9	20	35	19	
	186/9	20	49	20	
	186/9	21	04	21	
	186/9	21	42	22	
	186/9	21	55	23	
	186/9	22	09	24	
	186/9	22	22	25	
	186/9	22	35	26	
	186/9	22	47	27	
Track R6	187/9	09	19	1	
	187/9	09	31	2	
	187/9	09	44	3	
	187/9	09	57	4	
	187/9	10	10	5	
	187/9	10	22	6	
	187/9	10	35	7	
	187/9	10	50	8	
	187/9	11	03	9	
	187/9	12	41	10	
	187/9	14	59	11	
	187/9	15	25	12	
	187/9	15	51	13	
	187/9	16	42	14	
	187/9	17	07	15	
	187/9	17	33	16	
Reel 21					
Track F1	187/9	20	10	17	
	187/9	20	22	18	
	187/9	20	35	19	
	187/9	20	48	20	
	187/9	21	03	21	
	187/9	21	41	22	
	187/9	21	54	23	
	187/9	22	06	24	
	187/9	22	19	25	
	187/9	22	32	26	
	187/9	22	44	27	
	188/9	09	33	1	
	188/9	09	46	2	
Track R2	188/9	09	58	3	
	188/9	10	11	4	
	188/9	10	24	5	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	188/9	10	37	6	
	188/9	10	51	7	
	188/9	11	04	8	
	188/9	12	43	9	
	188/9	15	59	10	
	188/9	15	25	11	
	188/9	15	50	12	Ran out of tape
Track F3	188/9	16	42	13	
	188/9	17	07	14	
	188/9	17	33	15	
	188/9	20	02	16	
	188/9	20	14	17	
	188/9	20	27	18	
	188/9	20	40	19	
	188/9	20	33	20	
	188/9	21	07	21	
	188/9	21	40	22	
Track R4	188/9	21	53	23	
	188/9	25	05	24	
	188/9	22	18	25	
	188/9	22	31	26	
	189/9	15	08	1	
	189/9	15	34	2	
	189/9	15	59	3	
	189/9	16	44	4	
Track F5	189/9	17	11	5	
	189/9	17	35	6	
	189/9	20	10	7	
	189/9	20	23	8	
	189/9	20	35	9	
	189/9	20	48	10	
	189/9	21	03	11	
	189/9	21	16	12	
	189/9	21	37	13	Started line 13
	189/9	22	45	14	
Track R6	191/9	09	18	1	
	191/9	09	31	2	
	191/9	09	44	3	
	191/9	09	56	4	
	191/9	10	09	5	
	191/9	10	22	6	
	191/9	10	35	7	
	191/9	10	47	8	
	191/9	11	00	9	
	191/9	11	13	10	
	191/9	11	26	11	
	191/9	11	39	12	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track F7	191/9	12	04	13	
	191/9	12	30	14	
	191/9	12	55	15	
Reel 22					
Track F1	191/9	19	06	16	
	191/9	19	19	17	
	191/9	19	32	18	
	191/9	19	45	19	
	191/9	19	56	20	
	191/9	20	10	21	
	191/9	20	23	22	
	191/9	20	36	23	
	191/9	20	49	24	
	191/9	21	24	25	
	191/9	21	15	26	
	191/9	21	28	27	
	191/9	21	41	28	
Track R2	191/9	21	54	29	
	191/9	22	07	30	
	191/9	22	19	31	
	191/9	22	32	32	
	191/9	22	46	33	
	192/9	09	10	1	
	192/9	09	23	2	
	192/9	09	35	3	
	192/9	09	48	4	
	192/9	10	01	5	
	192/9	10	14	6	
Track F3	192/9	10	27	7	
	192/9	10	39	8	
	192/9	10	52	9	
	192/9	11	05	10	
	192/9	11	18	11	
	192/9	11	31	12	
	192/9	11	43	13	
	192/9	13	36	14	
	192/9	13	49	15	
	192/9	14	01	16	
	192/9	14	14	17	
	192/9	14	17	18	
Track R4	192/9	14	40	19	
	192/9	14	52	20	
	192/9	15	05	21	
	192/9	15	10	22	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	192/9	15	31	23	
	192/9	15	43	24	
	192/9	15	50	25	
	192/9	16	09	26	
	192/9	16	22	27	
	192/9	16	35	28	
	192/9	16	47	29	
	192/9	17	00	30	
	192/9	17	26	31	
Track F5	192/9	17	51	32	
	192/9	18	17	33	
	192/9	18	43	34	
	192/9	19	08	35	
	192/9	19	21	36	
	192/9	19	34	37	
	192/9	19	47	38	
	192/9	19	59	39	
	192/9	20	12	40	
	192/9	20	25	41	
Track R6	192/9	20	38	42	
	192/9	20	51	43	
	192/9	21	04	44	
	192/9	21	16	45	
	192/9	21	29	46	
	192/9	21	42	47	
	192/9	21	59	48	
	192/9	22	11	49	
	192/9	22	24	50	
	192/9	22	37	51	
	193/9	09	06	1	
Track F7	193/9	09	19	2	
	193/9	09	31	3	
	193/9	09	24	4	
	193/9	09	57	5	
	193/9	10	10	6	
	193/9	10	23	7	
	193/9	10	35	8	
	193/9	10	48	9	
	193/9	11	01	10	
	193/9	11	14	11	
	193/9	11	27	12	
	193/9	11	39	13	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Reel 23					
Track F1	193/9	12	21	15	Picture no good
	193/9	12	34	16	Picture no good
	193/9	12	47	17	
	193/9	13	00	18	
	193/9	13	13	19	
	193/9	13	25	20	
	193/9	13	38	21	
	193/9	13	51	22	
	193/9	14	04	23	
	193/9	14	17	24	
	193/9	14	30	25	
	193/9	14	42	26	
	193/9	14	55	27	
	193/9	15	08	28	
Track R2	193/9	15	21	29	
	193/9	15	34	30	Short approx. 1000 lines
	193/9	15	46	31	
	193/9	16	23	32	
	193/9	16	36	33	
	193/9	16	49	34	
	193/9	17	01	35	
	193/9	17	27	36	
	193/9	17	53	37	
	193/9	18	18	38	
Track F3	193/9	18	44	39	
	193/9	19	10	40	
	193/9	19	22	41	
	193/9	19	35	42	
	193/9	19	48	43	
	193/9	21	01	44	
	193/9	20	14	45	
	193/9	20	27	46	
	193/9	20	40	47	
	193/9	20	53	48	
	193/9	21	06	49	
	193/9	21	19	50	
Track R4	193/9	21	31	51	
	193/9	21	44	52	
	193/9	21	51	53	
	193/9	22	10	54	
	193/9	21	23	55	
	193/9	22	35	54	
	194/9	09	41	1	
	194/9	09	54	2	
	194/9	10	06	3	
	194/9	10	19	4	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	194/9	10	32	5	
	194/9	10	45	6	
Track F5	194/9	10	58	7	
	194/9	11	10	8	
	194/9	11	23	9	
	194/9	11	36	10	
	194/9	11	49	11	
	194/9	12	02	12	
	194/9	12	16	13	
	194/9	12	29	14	
	194/9	12	42	15	
	194/9	12	54	16	
	194/9	13	07	17	
	194/9	12	20	18	
				19	Not recorded
Track R6	194/9	13	45	20	
	194/9	13	58	21	
	194/9	14	11	22	
	194/9	14	24	23	
	194/9	14	36	24	
	194/9	14	49	25	
	194/9	15	02	26	
	194/9	15	15	27	
	194/9	15	28	28	
	194/9	15	41	29	
	194/9	15	54	30	
	194/9	16	07	31	
	194/9	16	19	32	
	194/9	16	32	33	
Track F7	194/9	16	45	34	
	194/9	16	58	35	
	194/9	17	23	36	
	194/9	17	49	37	
	194/9	18	15	38	
	194/9	18	40	39	
	194/9	19	06	40	
	194/9	19	19	41	
	194/9	19	31	42	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Reel 24					
Track F1	196/9			15	Not recorded
	196/9	12	53	16	
	196/9	13	06	17	
	196/9	13	18	18	
	196/9	13	31	19	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	196/9	13	44	20	
	196/9	13	57	21	
	196/9	14	10	22	
	196/9	14	23	23	
	196/9	14	36	24	
	196/9	14	49	25	
	196/9	15	02	26	
	196/9	15	14	27	
	196/9	15	27	28	
	196/9	15	40	29	
Track R2	196/9	15	53	30	
	196/9	16	05	31	
	196/9	16	18	32	
	196/9	16	31	33	
	196/9	16	44	34	
	196/9	16	57	35	
	196/9	17	22	36	
	196/9	17	48	37	
	196/9	18	14	38	
Track F3	196/9	18	39	39	
	196/9	19	05	40	
	196/9	19	18	41	
	196/9	20	22	42	
	196/9	20	35	43	
	196/9	20	48	44	
	196/9	21	02	45	
	196/9	21	15	46	
	196/9	21	28	47	
	196/9	21	41	48	
	196/9	21	53	49	
	196/9	22	06	50	
Track R4	196/9	22	19	51	
	196/9	22	32	52	
	196/9	22	45	53	
	197/9	20	29	1	
	197/9	22	42	2	
	197/9	20	55	3	
	197/9	21	07	4	
	197/9	21	20	5	
	197/9	21	33	6	
	197/9	21	46	7	
	197/9	21	52	8	
Track F5	197/9	22	11	9	
	197/9	22	24	10	
	197/9	22	37	11	
	197/9	22	49	12	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	198/9	09	59	1	
	198/9	10	12	2	
	198/9	10	25	3	
	198/9	10	37	4	
	198/9	10	50	5	
	198/9	11	03	6	
	198/9	11	15	7	
	198/9	11	28	8	
Track R6	198/9	11	41	9	
	198/9	11	54	10	
	198/9	12	07	11	
	198/9	12	22	12	
	198/9	12	35	13	
	198/9	12	48	14	
	198/9	13	01	15	
	198/9	13	13	16	
	198/9	13	26	17	
	198/9	13	39	18	
	198/9	13	52	19	
	198/9	14	05	20	
	198/9	14	17	21	
Track F7	198/9	14	30	22	
	198/9	14	43	23	
	198/9	19	01	24	
	198/9	19	14	25	
	198/9	19	26	26	
	198/9	19	39	27	
	198/9	19	52	28	
	198/9	20	05	29	
	198/9	20	17	30	
	198/9	20	30	31	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Reel 25					
Track F1	198/9	20	56	33	
	198/9	21	08	34	
	198/9	21	21	35	
	198/9	21	34	36	
	198/9	21	47	37	
	199/9	10	08	1	
	199/9	10	21	2	
	199/9	10	34	3	
	199/9	16	47	4	
	199/9	11	00	5	
	199/9	11	12	6	
	199/9	11	25	7	
	199/9	11	38	8	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	199/9	12	51	9	
Track R2	199/9	12	34	10	
	199/9	12	47	11	
	199/9	13	00	12	
	199/9	13	13	13	
	199/9	13	25	14	
	199/9	13	38	15	
	199/9	13	51	16	
	199/9	14	04	17	
	199/9	14	18	18	
	199/9	14	31	19	
	199/9	14	43	20	
	199/9	14	56	21	
	199/9	15	09	22	
Track F3	199/9	18	18	23	
	199/9	18	35	24	
	199/9	19	01	25	
	199/9	19	14	26	
	199/9	19	26	27	
	199/9	19	39	28	
	199/9	19	52	29	
	199/9	20	05	30	
	199/9	20	18	31	
	199/9	20	30	32	
Track R4	199/9	20	43	33	
	199/9	20	56	34	
	200/9	04	17	1	
	200/9	04	18	2	
	200/9			3	
	200/9	22	30	3	
	200/9	22	43	4	
	201/9	09	50	1	
	201/9	10	20	2	
	201/9	10	32	3	
	201/9	10	45	4	
	201/9	10	58	5	
Track F5	201/9	11	11	6	
	201/9	11	24	7	
	201/9	11	38	8	
	201/9	12	17	9	
	201/9	12	29	10	
	201/9	12	47	11	
	201/9	12	55	12	
	201/9	13	08	13	
	201/9	14	21	14	
	201/9	13	03	15	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	201/9	13	47	16	
	201/9	14	00	17	
	201/9	14	12	18	
Track R6	201/9	14	25	19	
	201/9	14	38	20	
	201/9	14	51	21	
	201/9	15	03	22	
	201/9	15	16	23	
	201/9	15	29	24	
	201/9	15	42	25	
	201/9	15	54	27	
	201/9	16	07	26	
	201/9	16	20	28	
	201/9	16	33	29	
	201/9	21	02	30	
Track F7	201/9	21	15	31	
	201/9	21	27	32	
	201/9	21	40	33	
	201/9	21	52	34	
	201/9	22	06	35	
	201/9	22	18	36	
	201/9	22	31	37	
	201/9	22	44	38	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Reel 26					
Track F1	202/9	08	59	1	
	202/9	09	12	2	
	202/9	09	25	3	
	202/9	09	38	4	
	202/9	09	51	5	
	202/9	10	04	6	
	202/9	10	16	7	
	202/9	10	29	8	
	202/9	10	42	9	
	202/9	10	55	10	
	202/9	11	08	11	
	202/9	11	20	12	
	202/9	11	33	13	
	202/9	11	46	14	
Track R2	202/9	12	18	15	
	202/9	12	31	16	
	202/9	12	43	17	
	202/9	12	55	18	
	202/9	13	08	19	
	202/9	13	21	20	
	202/9	13	33	21	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	202/9	13	46	22	
	202/9	13	59	23	
	202/9	14	12	24	
	202/9	14	25	25	
Track F3	203/9	09	40	1	
	203/9	09	53	2	
	203/9	10	06	3	
	203/9	10	19	4	
	203/9	10	31	5	
	203/9	10	44	6	
	203/9	10	57	7	
	203/9	11	10	8	
	203/9	11	23	9	
	203/9	11	35	10	
	203/9	11	48	11	
	203/9	12	00	12	
	203/9	12	33	13	
Track R4	203/9	12	45	14	
	203/9	12	58	15	
	203/9	13	21	16	
	203/9	13	37	17	
	203/9	13	50	18	
	203/9	14	02	19	
	203/9	14	15	20	
	203/9	14	41	21	
	203/9	14	54	22	
	203/9	15	06	23	
Track F5	203/9	15	18	24	
	203/9	15	32	25	
	203/9	15	45	26	
	203/9	15	50	27	
	203/9	16	11	28	
	203/9	16	25	29	
	203/9	16	38	30	
	204/9	04	04	1	
	204/9	04	21	2	Abort
	204/9	04	37	2	Abort
	204/9	04	47	2	
	204/9	05	00	3	
Track R6	204/9	05	26	4	
	204/9	05	45	5	
	204/9	06	06	6	
	204/9	09	11	7	
	204/9	09	24	8	
	204/9	09	43	9	
	204/9	09	55	10	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	204/9	10	08	11	
	204/9	10	21	12	
	204/9	10	34	13	
	204/9	10	47	14	
	204/9	10	59	15	
Track F7	204/9	11	12	16	
	204/9	11	25	17	
	204/9	11	38	18	

Reel 27

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track F1	204/9	12	17	19	
	204/9	12	29	20	
	204/9	12	42	21	
	204/9	12	53	22	
	204/9	13	08	23	
	204/9	12	22	24	
	204/9	13	34	25	
	204/9	13	47	26	
	204/9	14	00	27	
	204/9	14	13	28	
	204/9	14	26	29	
	204/9	14	39	30	
	204/9	14	51	31	
	204/9	15	05	32	
Track R2	204/9	15	18	33	
	204/9	15	32	34	
	204/9	15	45	35	
	204/9	15	57	36	
	204/9	16	12	37	
	204/9	16	24	38	
	204/9	16	37	39	
	204/9	16	50	40	
	204/9	17	03	41	
	205/9	09	30	1	
	205/9	09	43	2	
	205/9	09	56	3	
	205/9	10	09	4	
Track F3	205/9	10	22	5	
	205/9	10	35	6	
	205/9	10	47	7	
	205/9	11	00	8	
	205/9	11	13	9	
	205/9	11	30	10	
	205/9	11	43	11	
	205/9	12	15	12	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	205/9	12	35	14	
	205/9	12	48	15	
	205/9	13	01	16	
	205/9	13	13	17	
	205/9	13	26	18	
Track R4	205/9	13	39	19	
	205/9	13	52	20	
	205/9	14	05	21	
	205/9	14	17	22	
	205/9	14	29	23	
	205/9	14	41	24	
	205/9	14	54	25	
	205/9	15	07	26	
	205/9	15	70	27	
	205/9	19	03	28	
	205/9	19	15	29	
	205/9	19	29	30	
	205/9	19	42	31	
Track F5	205/9	19	54	32	
	205/9	20	07	33	
	205/9	20	20	34	
	205/9	20	33	35	
	205/9	22	11	36	
	205/9	22	24	37	
	205/9	22	36	38	
	205/9	22	50	39	
	207/9	10	00	1	
	207/9	10	13	2	
Track R6	207/9	10	26	3	
	207/9	10	38	4	
	207/9	10	51	5	
	207/9	11	04	6	
	207/9	11	17	7	
	207/9	11	29	8	
	207/9	11	42	9	
	207/9	12	21	10	
	207/9	12	34	11	
	207/9	12	47	12	
	207/9	13	00	13	
Track F7	207/9	13	13	14	
	207/9	13	25	15	
	207/9	13	38	16	
	207/9	13	51	17	
	207/9	14	04	18	
	207/9	14	17	19	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
	207/9	14	30	20	
	207/9	14	42	21	
	207/9	14	55	22	
	207/9	15	08	23	
	207/9	15	21	24	
	207/9	15	34	25	No good
	207/9			26	
	207/9	16	01	27	

Reel & Track No.	Day	Hr.	Min.	Sequence No.	Remarks
Reel 28					
Track F1	207/9	18	14	29	
	207/9	18	40	30	
	207/9	19	05	31	
	207/9	19	18	32	
	207/9	19	31	33	
	207/9	19	44	34	
	207/9	19	57	35	
	207/9	20	09	36	
	207/9	20	22	37	
	207/9	20	35	38	
	207/9	20	47	39	
	207/9	21	00	40	
Track R2	207/9	21	13	41	
	207/9	21	27	42	
	207/9	21	40	43	
	207/9	21	53	44	
	207/9	22	06	45	
	207/9	22	19	46	
	207/9	22	31	47	
	207/9	22	44	48	
	208/9	10	04	1	
	208/9	10	17	2	
	208/9	10	29	3	
Track F3	208/9	10	42	4	
	208/9	10	55	5	
	208/9	11	08	6	
	208/9	11	21	7	
	208/9	11	33	8	
	208/9	11	46	9	
	208/9	12	36	10	
	208/9	12	49	11	
	208/9	13	02	12	
	208/9	13	15	13	
	208/9	13	28	14	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Track R4	208/9	13	40	15	
	208/9	13	53	16	
	208/9	14	06	17	
	208/9	14	19	18	
	208/9	14	42	19	
	208/9	14	55	20	
	208/9	15	07	21	
	208/9	15	20	22	
	208/9	15	33	23	
	208/9	15	46	24	
	208/9	15	59	25	
	208/9	16	11	26	
	208/9	16	24	27	
	208/9	16	37	28	Ran out of tape
Track F5	208/9	17	16	29	
	208/9	17	41	30	
	208/9	18	07	31	
	208/9	18	38	32	
	208/9	19	04	33	
	208/9	19	17	34	
	208/9	19	30	35	
Track R6	208/9	19	42	36	
	208/9	19	55	37	
	208/9	20	08	38	
	208/9	20	21	39	
	208/9	20	34	40	
	208/9	20	46	41	
	208/9	20	59	42	
	208/9	21	12	43	
	208/9	21	25	44	
	208/9	21	38	45	
	208/9	21	51	46	
	208/9	22	00	47	
	208/9	22	16	48	
Track F7	208/9	22	29	49	
	208/9	22	41	50	
	209/9	09	12	1	
	209/9	09	25	2	
	209/9	09	38	3	
	209/9	09	50	4	
	209/9	10	03	5	
	209/9	10	16	6	
	209/9	10	28	7	
	209/9	10	41	8	
	209/9	10	54	9	

Reel & Track No.	Day	GM Time Hr.	Min.	Sequence No.	Remarks
Reel 29					
Track F1	209/9				Tape change
	209/9	11	20	11	
	209/9	11	33	12	
	209/9	11	54	13	
	209/9	12	32	14	
	209/9	12	45	15	
	209/9	12	58	16	
	209/9	13	10	17	
	209/9	13	23	18	
	209/9	13	36	19	
	209/9	13	49	20	
	209/9	14	02	21	
	209/9	14	14	22	
	209/9	14	32	23	
Track R2	209/9	14	45	24	
	209/9	14	50	25	
	209/9	15	11	26	
	209/9	15	24	27	
	209/9	15	37	28	
	209/9	15	49	29	
	209/9	16	02	30	
	209/9	16	15	31	
	209/9	16	28	32	
	209/9	16	41	33	
Track F3	209/9	17	19	34	
	209/9	17	45	35	
	209/9	18	10	36	
	209/9	18	36	37	
	209/9	19	14	38	
	209/9	19	27	39	
	209/9	19	40	40	
Reel 30					
Track F1	210/9	09	26	1	
	210/9	09	38	2	
	210/9	09	51	3	
	210/9	10	04	4	
	210/9	10	17	5	
	210/9	10	29	6	
	210/9	10	42	7	
	210/9	10	55	8	
	210/9	11	08	9	
	210/9	11	21	10	
	210/9	11	33	11	

Reel & Track No.	Day	Time Hr.	Min.	Sequence No.	Remarks
	210/9	11	46	12	
	210/9	12	25	13	
	210/9	12	38	14	
Track R2	210/9	12	53	15	
	210/9	13	09	16	
	210/9	13	22	17	
	210/9	13	35	18	
	210/9	13	47	19	
	210/9	14	00	20	
	210/9	14	13	21	
	210/9	14	26	22	
Track F3	210/9	20	01	23	
	210/9	20	13	24	
	210/9	20	26	25	
	210/9	20	39	26	
	210/9	20	52	27	
	210/9	21	05	28	
	210/9	21	18	29	
	210/9	21	30	30	
Track R4	210/9	21	43	31	
	210/9	21	56	32	
	210/9	22	09	33	
	210/9	22	22	34	
	210/9	22	34	35	
	210/9	22	47	36	
	211/9	09	22	1	
	211/9	09	35	2	
	211/9	09	47	3	
	211/9	10	00	4	
	211/9	10	13	5	
	211/9	10	26	6	
Track F5	211/9	10	38	7	
	211/9	10	51	8	
	211/9	11	04	9	
	211/9	11	17	10	
	211/9	11	29	11	
	211/9	11	32	12	
	211/9	12	21	13	
	211/9	12	33	14	
	211/9	12	46	15	
	211/9	13	01	16	
	211/9	12	33	17	
	211/9	13	45	18	
Track R6	211/9	13	58	19	
	211/9	14	11	20	

Reel & Track No.	Day	Time Hr.	Time Min.	Sequence No.	Remarks
	211/9	14	24	21	
	211/9	14	37	22	
	211/9	14	50	23	
	211/9	15	02	24	
	211/9	15	15	25	
	211/9	15	28	26	
	211/9	15	41	27	
	211/9	15	54	28	
	211/9	16	06	29	
	211/9	16	19	30	
	211/9	16	32	31	
Track F7	211/9	16	45	32	
	211/9	16	58	33	
	211/9	17	18	34	
	211/9	17	31	35	
	211/9	17	43	36	
	211/9	17	56	37	
	211/9	18	09	38	
	211/9	18	22	39	
	211/9	18	35	40	
	211/9	18	47	41	
	211/9	19	00	42	
	211/9	19	13	43	
	211/9	19	26	44	

Reel & Track No.	Day	Time Hr.	Time Min.	Sequence No.	Remarks
Reel 31					
Track F1	211/9	19	51	46	
	211/9	20	04	47	
	211/9	20	17	48	
	211/9	20	30	49	
	211/9	20	42	50	
	211/9	20	55	51	
	211/9	21	08	52	
	211/9	21	21	53	
	211/9	21	34	54	
	211/9	21	47	55	
	211/9	21	59	56	
	211/9	22	12	57	
	211/9	22	25	58	
Track R2	211/9	22	38	59	
	212/9	09	08	1	
	212/9	09	21	2	
	212/9	09	33	3	
	212/9	09	46	4	
	212/9	09	59	5	
	212/9	10	12	6	

Reel & Track No.	Day	Time Hr.	Min.	Sequence No.	Remarks
	212/9	10	25	7	
	212/9	10	37	8	
	212/9	10	50	9	
	212/9	11	03	10	
Track F3	212/9	11	15	11	
	212/9	11	28	12	
	212/9	14	12	13	
	212/9	12	19	14	
	212/9	12	32	15	
	212/9	12	45	16	
	212/9	12	58	17	
	212/9	13	11	18	
	212/9	13	23	19	
	212/9	13	36	20	
	212/9	13	49	21	
	212/9	14	02	22	
Track R4	212/9	14	15	23	
	212/9	14	13	24	
	212/9	14	42	25	
	212/9	14	55	26	
	212/9	15	08	27	
	212/9	15	21	28	
	212/9	15	34	29	
	212/9	15	46	30	
	212/9	15	59	31	
	212/9	16	12	32	
	212/9	16	25	33	
	212/9	16	39	34	
	212/9	16	52	35	
	212/9	17	05	36	
Track F5	212/9	17	18	37	
	212/9	17	31	38	
	212/9	17	43	39	
	212/9	17	56	40	
	212/9	18	09	41	
	212/9	18	22	42	
	212/9	18	35	43	
	212/9	18	47	44	
	212/9	19	02	45	
	212/9	19	17	46	
	212/9	19	30	47	
	212/9	19	43	48	
Track R6	212/9	19	55	49	
	212/9	20	09	50	
	212/9	20	21	51	

Reel & Track No.	Day	Time Hr.	Min.	Sequence No.	Remarks
	212/9	20	34	52	
	214/9	14	41	1	
	214/9	14	54	2	
	214/9	15	07	2	
	214/9	15	22	3	
	214/9	15	22	4	
	214/9	15	35	5	
	214/9	15	50	6	
	214/9	16	03	7	
Track F7	214/9	16	16	8	
	214/9	16	28	9	
	214/9	16	41	10	
	214/9	16	54	11	
	214/9	17	07	12	
	214/9	17	19	13	
	214/9	17	32	14	
	214/9	17	45	15	
	214/9	17	58	16	
	214/9	18	10	17	