A COMPENDIUM OF OPTICAL INTERFEROMETER RESULTS ON SECEDE II

General Electric

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ARPA Order No. 1057

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Project Secede is an ARPA program aimed at solving certain defense related problems through the study of chemical releases in the ionosphere. The chemical of primary interest has been barium. The aspects of the release which are of most interest include the growth of the cloud and the evolution of its striated structure. Several test series of releases have been conducted the latest of which was Secede II.

The present report concerns data obtained during Secede II by an optical interferometer built and operated by M. A. biondi, R. Hake, and D. Sipler of the University of Pittsburgh with the support of R. Lambert and the General Electric Space Sciences Laboratory. The report consists of a number of data volumes and this one summary textual volume. Only the summary volume will receive general circulation; the data volumes will be distributed to only a few users and additional copies may be requested from the contracting officer. Data volumes exist for events Spruce, Olive, Redwood, and Plum.

Interferometer data on events Spruce, Olive, Redwood and Plum has been reduced and photographs of representative IO records on Spruce have been made. IO records of other events are absent presumably because of non-optimum adjustment of the system during those events. The interferometer data is presented in detail in the Event Data Books published separately while the IO records on Spruce are reproduced in this volume.

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</tr>
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<td>&amp;T</td>
<td>ROLE</td>
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A COMPENDIUM OF OPTICAL INTERFEROMETER RESULTS ON SECEDE II

I. M. Pikus
G. Liebling

Contractor: General Electric
Contract Number: F30602-71-C-0064
Effective Date of Contract: May 1970
Contract Expiration Date: January 1972
Amount of Contract: $252,979.00
Program Code Number: 2E20

Principal Investigator: Dr. I. M. Pikus
Phone: 215 962-2908

Project Engineer: Vincent J. Coyne
Phone: 315 330-3107

Contract Engineer: Richard A. Schneible
Phone: 315 330-3451

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This research was supported by the Defense Advanced Research Projects Agency of the Department of Defense and was monitored by Richard A. Schneible, RADC (OCSE), GAFB, NY 13440 under Contract F30602-71-C-0064.
PUBLICATION REVIEW

This technical report has been reviewed and is approved.

Walter A. Ryan
RADC Project Engineer

Richard Schneible
RADC Contract Engineer
I. BACKGROUND AND PERSPECTIVES

Project Secede is an ARPA program aimed at solving certain defense related problems through the study of chemical releases in the ionosphere. The chemical of primary interest has been barium. The aspects of the release which are of most interest include the growth of the cloud and the evolution of its striated structure. Several test series of releases have been conducted the latest of which was Secede II.

The present report concerns data obtained during Secede II by an optical interferometer built and operated by M. A. Biondi, R. Hake, and D. Sipler of the University of Pittsburgh with the support of R. Lambert and the General Electric Space Sciences Laboratory. The report consists of a number of data volumes and this one summary textual volume. Only the summary volume will receive general circulation; the data volumes will be distributed to only a few users and additional copies may be requested from the contracting officer. Data volumes exist for events Spruce, Olive, Redwood, and Plum.

Briefly, the series was held in the vicinity of Eglin Air Force Base, Florida, during January and early February 1971. The test matrix is shown in Table 1.

<table>
<thead>
<tr>
<th>EVENT</th>
<th>DATE</th>
<th>RELEASE TIME (CST)</th>
<th>ALTITUDE (km)</th>
<th>PAYLOAD WEIGHT (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUTMEG</td>
<td>16 Jan 71</td>
<td>1734:40</td>
<td>150</td>
<td>48</td>
</tr>
<tr>
<td>OLIVE</td>
<td>29 Jan 71</td>
<td>1753:57</td>
<td>185</td>
<td>352</td>
</tr>
<tr>
<td>PLUM</td>
<td>20 Jan 71</td>
<td>1747:06</td>
<td>185</td>
<td>48</td>
</tr>
<tr>
<td>QUINCE</td>
<td>2 Feb 71</td>
<td>1034:06</td>
<td>185</td>
<td>48</td>
</tr>
<tr>
<td>REDWOOD</td>
<td>1 Feb 71</td>
<td>1752:04</td>
<td>250</td>
<td>48</td>
</tr>
<tr>
<td>SPRUCE</td>
<td>1 Feb 71</td>
<td>1752:04</td>
<td>185</td>
<td>48</td>
</tr>
</tbody>
</table>
The instrument complex has been described in detail in Reference 1 and 2, but the salient characteristics are summarized as follows. Instrumentation consisted of three major devices: a two channel Fabry-Perot Interferometer (FP); a filter photometer; and an image orthicon system. The FP was used to obtain spectral line profiles by scanning wavelength (by changing driving gas pressure) while viewing in a fixed direction and to obtain spatial intensity profiles by scanning the cloud while maintaining a constant wavelength. The filter photometer was used to obtain light intensity over a relatively wide field of view integrated over an entire spectral line. Normally the photometer viewed the 4934A feature but had the capability of viewing the 5535, 6111, and 6142 lines as well. The IO system is described in Reference 2.

II. DATA REDUCTION

Interferometer data on events Spruce, Olive, Redwood and Plum has been reduced and photographs of representative IO records on Spruce have been made. IO records of other events are absent presumably because of non-optimum adjustment of the system during those events. The interferometer data is presented in detail in the Event Data Books published separately while the IO records on Spruce are reproduced in the next section of this volume.

The first element of the reduced interferometer data is a plot of azimuth and elevation for each scan. Instead of merely presenting a rectilinear presentation it was decided that the pointing information could better be arranged as a scan line which could be laid over a photograph of the cloud so to facilitate identification of structural features and comparison of digital records and densitometric results. A photograph is a representation of the projection of a 3-d scene on the plane (assuming no distortion) normal to the optical axis of the system. To compare the interferometer scan line with such a photograph it is necessary: a) to have had the camera and interferometer sufficiently close to each other that they viewed the cloud from nearly the same aspect and b) to present the scan line as a projection upon the same plane that is represented by the photograph. To accomplish this the scan line is presented in the gnomonic projection.
The gnomonic projection is the projection of a sphere upon a plane tangent to the sphere at a given point, as seen from the center of the sphere. An important property of this projection is the fact that all great circles are represented by straight lines.

In Figure 1 let the circle represent the meridional plane of the sphere (i.e. constant azimuth) on which the projection plane is tangent. Let the radius of the sphere be R. The point A, located an angular distance \( \alpha \) from the radius vector to the projection plane, \( A' \) is located at a distance \( f = R \tan \alpha \) from the point of tangency P. All points located at an angle of \( \alpha \) from the radius \( OP \) project onto a circle of radius \( R \tan \alpha \) on the projection plane, as shown in Figure 2. In that figure the Y axis is taken to be the projection of the meridian through the point of tangency while the X axis is the projection of the orthogonal great circle going through the same point. If we let

\[
\phi = \text{elevation of the mount (with the equator identical with horizon)}
\]

\[
\lambda = \text{azimuth measured from the meridian of tangency.}
\]

and \( \Phi_0 = \text{the elevation of the point of tangency} \)

Then a point located at \( (\phi, \lambda) \) on the sphere will be mapped into a point located at \( (x, y) \) on the plane of Figure 2 where

\[
\frac{x}{R} = \frac{\sin \lambda \cos \phi}{\sin \Phi_0 \sin \phi + \cos \Phi_0 \cos \lambda \cos \phi}
\]

and

\[
\frac{y}{R} = \frac{\cos \Phi_0 \sin \phi - \sin \Phi_0 \cos \lambda \cos \phi}{\sin \phi \sin \Phi_0 + \cos \phi \cos \Phi_0 \cos \lambda}
\]

Using these equations points on a sphere can be mapped onto the plane tangent at elevation \( \Phi_0 \) and azimuth \( \lambda = 0 \). Hence the series of points, specified by their azimuth and elevation values, at which optical data exist can be plotted on a plane representing the plane of tangency.

To compare the projected scan line with a photograph of the cloud it is necessary to know the azimuth and elevation of the point of tangency and the scale size.
(i.e. the value of R in the above equations). From this information, cloud photographs should be able to be reproduced which can be directly compared with the scan lines.

It will be noticed in the data books that the configuration of the scan grid varies with reference elevation. This preserves the scale factor, which bears a direct relationship to the magnification factor, so that a constant magnification can be achieved. That is, a given azimuthal interval will take less linear space at higher elevations than at low.

The scan line is presented at several scale factors, depending on the angular extent of the scan. The grid sizes used are: $6^\circ$ azimuth x $6^\circ$ elevation; $10^\circ$ x $10^\circ$, and $14^\circ$ x $14^\circ$. As plotted, the scale factors are:

- $6 \times 6$ grid; $1'' = 1^\circ$ subtense
- $10 \times 10$ grid; $1'' = 1.67$ subtense
- $14 \times 14$ grid; $1'' = 2.33$ subtense
III. IMAGE ORTHICON RECORDS

Photographs of 18 frames of the IO record on event Spruce follow. Although the quality of the originals has been degraded through the reproduction process, the striated structure of the developed cloud is apparent. The first line of the data block contains the time in hours, minutes, and seconds. These records can be compared with the digital records on Spruce although no attempt has been made for this summary report to render the scale accurately. Densitometric studies on these photographs are very difficult because of the non-linear transfer function involved in their reproduction. However, point values of intensity can be deduced from intensities on the video tape.

IV. FORM OF THE REDUCED DATA

As a sample, the reduced data from record 101 of event Spruce is included as Appendix 2. Although in the appendix the several frames of the record are separate sheets, the data books contain each record as an integral folded sheet which can be removed for detailed work. This particular record is shown as representative of many of the features of the reduced data which may be of interest.

First, the scan line is plotted on a 6° x 6° grid. On this record the scan line extends beyond the acceptable limits for the 6° x 6° grid thus it is next plotted on the 10° x 10° grid. The beginning of the scan is denoted by a square. Each 75th point is overstruck with an X. The data block contains the event name, record number, and time at the beginning and end of the record. It also contains other features which need some explanation. The reference coordinates given are the azimuth and elevation of the record point at the center of the scan line rounded off to the nearest degree. The point count contains the total number of points in the record and the number of points plotted. The number of points plotted is always smaller than the total number because: a) the first and last points are always discarded to avoid a commonly observed spurious deviation and b) those points for which the pressure setting of the FP interferometer deviate significantly from the mean pressure for the record are discarded.
mean pressure is determined by averaging the last ten points of the record left after the very last point is discarded.

On succeeding frames the measured data is plotted against path distance from the initial point measured in subtended degrees along the path. This has the effect of straightening out a linear scan. A specific point can be located roughly by estimating its position between two X marks or accurately by counting the points from the nearest X mark.

In the integral folded version of the record the data from specific channels are presented together so that, for example, the data from the 4934A channel of the FP are along the top half of the first part of the record. This means that in the appendix these data appear on the top half of each of the first 4 pages of the data presentation.

Data are presented for the FP 4934 channel the FP 6142 channel, the photometer channel, and for the point by point ratio of 4934 to photometer intensities.

The left hand axis of each plot is the intensity relative to the maximum intensity in that channel for the specific record. This has the effect of spreading the data more nearly over the entire usable area. The right hand axis is the absolute intensity as derived from calibration. The calibration procedure is described in detail below. The ratio of FP 4934 to the photometer intensity has no readily usable significance by itself but variations in this ratio over the scan are of some interest. For this reason the scale applied has no quantitative significance but is effectively arbitrary.

For each channel the maximum number of counts is printed out. This is the number of counts associated with the highest intensity point. Its main significance is to give an indication of the statistical ($\sqrt{n}$) fluctuation expected.

The data plotted have been reduced by the channel dark count determined during the specific event. For the second FP channel and for the late cloud developments in all channels, the data count ratio is not very much greater than the dark count rate.
V. APPLICATION OF THE REDUCED DATA

Many uses of the reduced data have been planned and others suggest themselves. The primary use will probably be a comparison of interferometer data with intensities derived densitometrically from photographs of the cloud. To accomplish such a comparison it is necessary to determine the points on the photograph to which the interferometer data apply. This can be done by using the overlays supplied in conjunction with photographs reproduced at the appropriate scale.

In many cases a series of spatial scans covers a nearly constant portion of the cloud and such a series can be useful in performing frame to frame correlations of structure. A preliminary examination of frames 68 to 71 of event Spruce, done before the reduced data were available in the present format, has yielded the qualitative conclusion that certain features do correlate from frame to frame over a period of a few minutes while certain other features may appear in one or two frames but shortly vanish from view. With the data in its present format more detailed study of the evolution of striae and their short term behavior, at least within the plane normal to the line of sight, is possible.

The cloud expansion in its early stages can be studied and non-symmetric models for the expansion process can be matched against the observed intensities over the various scans and scan directions used. Edge steepening can be further studied by using the data plots.

VI. CALIBRATION

The calibration in the field was accomplished using both a low brightness radioactive phosphor (LBS) which had been calibrated against a standard at ESSA some 6 months before use (Reference 3) and an electroluminescent source (ELS) of considerably greater brightness which was calibrated against the LBS on each run.
Calibration was accomplished at the end of each event (with the exception of Plum) and consisted of taking dark counts on all channels, photometer response to LBS, photometer response to ELS, and Fabry-Perot response to ELS.

The LBS was not large enough to fill the entire photometer aperture, so the effective LBS brightness for full aperture was reduced by the ratio of the areas. The LBS had a 2.75 inch active diameter, and the photometer aperture was 4.30 inches in diameter, so the ratio factor is 2.44.

The radiance of the cloud (above the atmosphere) as seen by the photometer can then be written:

\[ I_C = \frac{(N_{PC} - N_{PD})}{(N_{PL} - N_{PD})} \times \frac{I_L}{2.44 T_A} \]

where \( I_L \) is the LBS intensity, and \( T_A \) is the atmospheric transmission (in which the effect of the plate-glass observation window are included), and the subscripts on \( N \) indicate counting rates of the photometer (P) when looking at the clouds (C), the LBS source (L) or dark (D). The LBS intensity incident on the photometer is determined by multiplying the measured continuum radiance of the LBS per angstrom, \( i_L \), by the full-width-at-half-height of the particular interference filter, \( W_F \), in angstroms. The intensity then becomes

\[ I_C = \frac{(N_{PC} - N_{PD})}{(N_{PL} - N_{PD})} \times \frac{i_L W_F}{2.44 T_A} \]

Intensities derived thusly should be directly comparable with (filter) photographically derived cloud radiances if both correspond to the same viewing aspect of the cloud.

As Hake et al have pointed out (Reference 3), calculation of the radiance of the cloud from the FP signals is a more complicated matter because the continuum emission from the ELS is further attenuated by the action of the FP. For the purposes of this calibration it is assumed that the portion of the continuum emission passing
the FP is determined by the FP finesse \( F \) [\( F = \text{free spectral range (FSR)} \) divided by the the instrumental full-width-at-half-height] in the relation:

\[
i_E = \frac{I_E}{F}
\]

where \( i_E \) and \( I_E \) are ELS intensities. The lower case \( i_E \), as mentioned above, denotes intensity in some frequency interval. In the case above, the frequency interval is one FP passband:

\[
W_{FP} = \frac{\text{FSR}}{F}
\]

or

\[
W_{FP}(\text{Hz}) = cW_{FP}
\]

where \( \text{FSR} = (1/2)t \) is the free spectral range of the FP, \( t \) is the spacer length, and \( c \) is the speed of light. (The equation) is dimensionally correct only if it is realized that the ELS intensity \( I_E \) is effectively distributed over one FSR of the FP—i.e., \( I_E = \text{intensity/FSR (Hz)} \).

\( F \) was measured pre and post event at the laser wavelength, \( \lambda_{6328} \, \text{Å} \), and must be computed for the other wavelengths using FP parameters (plate flatness, primarily) established by the \( \lambda_{6328} \, \text{Å} \) measurement. If the pre and post event values differ significantly (> 1 unit), then linear interpolation should be used to give \( F \) for a particular time. The values determined for \( F \) are:

<table>
<thead>
<tr>
<th>Wavelength (Å)</th>
<th>( F(W_{FP}/\text{FSR}) )</th>
<th>( F(W_{FP}/\text{FSR}) )</th>
<th>( F(W_{FP}/\text{FSR}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>6328</td>
<td>17.0 measured</td>
<td>17.3 measured</td>
<td>19.0 measured</td>
</tr>
<tr>
<td>6142</td>
<td>18.4 computed</td>
<td>18.9 computed</td>
<td>20.3 computed</td>
</tr>
<tr>
<td>5535</td>
<td>18.4 computed</td>
<td>18.9 computed</td>
<td>20.4 computed</td>
</tr>
<tr>
<td>4934</td>
<td>16.6 computed</td>
<td>16.0 computed</td>
<td>17.7 computed</td>
</tr>
</tbody>
</table>
The effective ELS intensity for the FP is determined by calibration against the LBS using the photometer. The relationship is

\[ I_E = \frac{i_L W_F}{2.05} \times \frac{(N_{PE} - N_{PD})}{(N_{PL} - N_{PD})} \]

The factor 2.05 results from the aperture diameter of the FP being 100 mm instead of the 4.30 inches appropriate to the photometer.

The cloud radiance (above the atmosphere) as determined by FP at a particular point in the spectral line is

\[ i_C = i_E \times \frac{(N_{FC} - N_{FD})}{(N_{FE} - N_{FD})} \times \frac{1}{T_A T_{FP}} \]

where \( i_C \) is again the cloud radiance in a limited spectral width, the passband of the FP. \( T_{FP} \) is an FP transmission factor, that arises because the FP was calibrated through the wide field port (no telescope) but the cloud was observed through the telescope. \( T_{FP} \) has been taken to be 0.74, from an estimate that includes the obstruction by the secondary mirror and reflection losses from the two additional mirrors in the light path.

The dark counts have been determined to be

<table>
<thead>
<tr>
<th>EVENT</th>
<th>PHOTOMETER</th>
<th>FP 1</th>
<th>FP 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spruce</td>
<td>5.67</td>
<td>4.91</td>
<td>25.2 (15)</td>
</tr>
<tr>
<td>Olive</td>
<td>4.28</td>
<td>4.62</td>
<td>21.1 (15)</td>
</tr>
<tr>
<td>Redwood</td>
<td>3.09</td>
<td>3.58</td>
<td>17.08 (10)</td>
</tr>
</tbody>
</table>

On FP 2 the dark counts were so large and the signals generally so small that much of the data, after the dark count is subtracted, ends up negative and thus does not appear on the data plots. To avoid this loss of data points the dark count actually subtracted is arbitrarily chosen to be the values in parentheses above.
The radiancy values have been determined absolutely according to the following relationships.

**Spruce:**
- Photometer: $I = 8.25 \times 10^{-6} N^*$
- FP 1: $I = 2.47 \times 10^{-15} N^*$
- FP 2: $I = 1.1 \times 10^{-13} N^*$

**Redwood:**
- Photometer: $I = 8.45 \times 10^{-6} N^*$
- FP 1: $I = 2.84 \times 10^{-15} N^*$
- FP 2: $I = 1.89 \times 10^{-13} N^*$

**Olive:**
- Photometer: $I = 8.98 \times 10^{-6} N^*$
- FP 1: $I = 2.62 \times 10^{-15} N^*$
- FP 2: $I = 7.25 \times 10^{-13} N^*$

The units are for $I$ (photometer), erg/cm$^2$ sec sr. and for $I$ (FP), erg/cm$^2$ sec sr. Hz. $N^*$ is the difference between actual counts and dark counts each 0.1 sec.
REFERENCES

1. R. D. Hake, Jr., D. Sipler, M. A. Biondi, "Preliminary Optical Interferometer Results from Secede II", (U), Delivered at Preliminary Data Review Meeting at SRI, May 1971.


Figure 1

Figure 2
APPENDIX I

IMAGE ORTHICON PRINTS ON SPRUCE
APPENDIX II

SAMPLE DATA SPRUCE - #101
EVENT SPRUCE
RECORD NO. - 101
REF COORD -
AZ 243
EL 56
TIME
START 18M 5.13S
STOP 18M 54.44S
POINT COUNT -
TOTAL 498
PLOTTED 196
AVERAGE PRESSURE - 353
EVENT SPRUCE
RECORD NO. - 101
REF COORD -
AZ 243
EL 56
TIME
START 1EM 5.13S
STOP 1EM 54.44S
POINT COUNT -
TOTAL 498
PLOTTED 496
AVERAGE PRESSURE -
353
FABRY-PEROT 4934 CHANNEL
MAX COUNT = 608

CHANNEL  MAX
60

INTERMED - 2-SEC-SR-HZ

RELATIVE INTENSITY

RELATIVE INTENSITY

0 0.50 1.00 1.50 2.00
0 0.50 1.00 1.50 2.00

PHOTOMETER CHANNEL
MAX COUNT = 1382

INTENSITY - 2-SEC-SR

INTERMED - 2-SEC-SR-HZ

RELATIVE INTENSITY

RELATIVE INTENSITY

Path distance - subtended degrees
Intensity vs. path distance
FABRY PEROT 4934 CHANNEL  MAX COUNT = 659

INTENSITY - ERG/CM**2-SEC-SR-HZ

RELATIVE INTENSITY

0 0.2 0.4 0.6 0.8 1.0
2.0 2.5 3.0 3.5 4.0

PATH DISTANCE - SUSPENDED DEGREES
INTENSITY VS. PATH DISTANCE
APPENDIX III

PLOTTING PROGRAM
PROGRAM TO PLOT SEDDE DATA TAPES

WRITTEN BY G. LIEBLING - GENERAL ELECTRIC - AUG 1971

EXTERNAL TABLE1V
DIMENSION TITLE(12), LABEL(6,4), NQR(100), IDATA(26),
2 PRES(700), SEC(700), TMIN(700),
1 AZ(700), EL(700), ZMON(700), FP1(700), FP2(700),
3 RAZ(700), REL(700), RMON(700), RFP1(700), RFP2(700),
4 RSEC(700), RMIN(700), RATS(700),
5 PARRAY(700,4), NAME(3)

DIMENSION IXTAB(50), IYTAB(50), DIS(700), XTR(700), YTAB(700),
DIMENSION ASCALE(3), FMAX(3), HARTOP(3), MARBOT(3), NTC(3),
1 TVT(10, 3), ILAB(6,3)

EQUIVALENCE (PARRAY(1,1), RFP1(1)), (PARRAY(1,3), RFP2(1)),
1 (PARRAY(1,2), RMON(1)), (PARRAY(1,4), RATS(1))

EQUIVALENCE (IDA(1), IDA(1), (IDA(2), IDA(2)),
1 (IDA(3), IDA(3), (IDA(4), IDA(4)), (IDA(5), IDA(5)),
2 (IDA(6), IDA(6), (IDA(7), IDA(7)), (IDA(8), IDA(8)),
3 (IDA(9), IDA(9), (IDA(10), IDA(10), (IDA(11), IDA(11))

DATA ((LABEL(I,J), I = 1,6), J = 1,4)
1 5H , 6HABRY, 6HPEROT, 6H4934 C, 6HCHANNEL, 6H ;
2 6H , 6H P40, 6H49721, 6H CHAN, 6HANEL, 6H ;
3 6H , 6HABRY, 6HPEROT, 6H6142 C, 6HCHANNEL, 6H;
4 6HABRY, 6HPEROT, 6H4934 C, 6HCHANNEL, 6H/PHOTO, 6HMETER /

DATA ((ILAR(I,J), I = 1,6), J = 1,3)
1 /6HINTENS, 6HITY, -6HERG/CM, 6H2-SE, 6HCB-R-H, 6HZ ;
2 6HINTENS, 6HITY, -6HERG/CM, 6H*2-SE, 6HCB-R-H, 6HZ ;
3 6HINTENS, 6HITY, -6HERG/CM, 6H*2-SE, 6HCB-R-H, 6HZ ;

DATA PADS/0.0174533/
DATA IN, IOUT, ITF / 5, 6, 10 /

SCALE FACTORS FOR GRIDS
SCALE1 = 3,020
DEL1 = 3.0
DEL2 = 5.0
DEL3 = 7.0
MARG = 60
LINC = 30
LDRAW = LINC + 1
FLINC = LINC
ONE = 1,00

CALL GHSITV (2, 2)
CALL RITSTV (12, 20, TABLE1V)

READ (IN, 5050) TITLE
WRITE (IOUT, 6010) TITLE
READ (IN, 5050) NAME
READ (IN, 5140) NMARK1, NMARK2, NMARK3
READ (IN, 5160) ASCALE(1), ASCALE(3), ASCALE(2)
READ FILE NUMBER OF DESIRED FILE
READ (IN, 5100) NFILE

READ NUMBER OF RECORDS TO BE PROCESSED
AND INDEX NUMBER OF EACH RECORD-MAXIMUM 100 RECORDS
READ (IN, 5120) NRECS
READ (IN, 5120) (NOR(I), I = 1, NRECS)

SET UP LOOP TO PROCESS EACH RECORD
READ (ITP) IDATA
DO 750 NR = 1, NRECS
NREC = NOR(NR)
GO TO 205

READ ID FRAME
200 READ (ITP) IDATA
205 IF (IDAT1 = 97) 200, 210, 220

CHECK IF DESIRED FILE
C CHECK IF DESIRED RECORD
210 IF (IDAT2 = NFILE) 200, 220, 215

FILE HAS BEEN BYPASSED- ABORT JOB
215 WRITE (IOUT, 6100) NFILE, IDAT2
REWIND ITP
STOP

220 IF (IDAT3 = NREC) 200, 230, 225

DESIRE RECORD HAS BEEN PASSED- TRY NEXT RECORD
225 WRITE (IOUT, 6050) NREC
GO TO 750

DESIRE RECORD FOUND- START READING FRAMES
230 DO 300 NF = 1, 700
240 READ (ITP) IDATA
IF (IDAT1 = 97) 260, 250, 320

ENTIRE RECORD READ- NOW PROCESS DATA
250 NWDS = NF = 1
IF (NWDS .GE. 15) GO TO 320
WRITE (IOUT, 6040) NRFC
GO TO 750

STILL READING RECORD - CONTINUE
260 TEMP1 = IDAT4
TEMP2 = IDAT5
AZ(NF) = TEMP1 + (TEMP2 / 100.0)
TEMPI = IDAT6
TEMP2 = IDAT7
EL(NF) = TEMP2 + (TEMP2 / 100.0)
FMON(NF) = IDAT8
FP1(NF) = IDAT9
FP2(NF) = IDAT10
PRES(NF) = IDAT11
TEMPI = IDAT3
TEMP2 = IDAT2
SEC(NF) = TEMP2 + (TEMP1 / 100.0)
TMIN(NF) = IDAT1

300 CONTINUE
C IF THIS LOOP COMPLETED MUST HAVE READ 700 POINTS
C TOO MANY - DISREGARD RECORD
WRITE (IOUT, 6060) NREC
GO TO 750
C INVERT RECORD AND EXTRACT CONSTANT PRESSURE PART
C GET AVERAGE OF LAST TEN PRESSURE POINTS
320 N11 = NWDS - 10
N1 = NWDS + 1
N2 = NWDS + 2
APRES = 0.0
DO 330 I = N1, N1
330 APRES = APRES + PRES(I)
APRES = APRES / 10.0
C INVERT RECORD - REJECT FIRST AND LAST POINTS
NREJ = 0
NREV = 0
DO 370 IV = 1, N2
IREV = NWDS - IV
IF (ABS(PRES(IREV) - APRES) .LE. 4.0) GO TO 350
C IF 5 CONSECUTIVE POINTS REJECTED DISREGARD REST OF RECORD
NREJ = NREJ + 1
IF (NREJ - 5) 370, 400, 400
350 NREJ = 0
NREV = NREV + 1
RSEC (NREV) = SEC (IREV)
RMIN (NREV) = TMIN (IREV)
R2 (NREV) = AZ (IREV)
REL (NREV) = EL (IREV)
RMON (NREV) = FHON (IREV) - DARKPH
RFPI (NREV) = FP1 (IREV) - DARKF1
RFP2 (NREV) = FP2 (IREV) - DARKF2
370 CONTINUE
400 IF (NREV .GT. 5) GO TO 405
WRITE (IOUT, 6040) NREC
GO TO 750
C C NORMALIZE FABRY-PEROT INTENSITIES AND MONITOR
C FIRST FIND MAX VALUES
405 F1MAX = RFPI(I)
F2MAX = RFP2(I)
F4MAX = RHON(I)
DO 410 I = 1, NREV
IF (PMON(I) .GT. F4MAX) FMMAX = RHON(I)
410 IF (RFPI(I) .GT. F1MAX) F1MAX = RFPI(I)
IF (RFP2(I) .GT. F2MAX) F2MAX = RFP2(I)
FMAX(1) = F1MAX
FMAX(2) = FMMAX
01-05-72  13.724

PROGRAM TO PLOT SECEDE DATA TAPES

WRITTEN BY G. LIEBLING - GENERAL ELECTRIC - AUG 1971

FMAX(3) * F2MAX

C
ABSOLUTE INTENSITY SCALE
DO 413 I = 1, 3
ARSMAX = FMAX(I) * ASCALE(I)
ITEM = INT( ALOG10(ARSMAX) + 1.0)
UNITS = ARSMAX / 10.0 ** ITEM
SINC = 2.0
IF (UNITS .LT. 6.0) SINC = 1.0
IF (UNITS .LT. 3.0) SINC = 0.5
NTIC(I) = UNITS / SINC + 2.0
SINC = SINC * 10.0 ** ITEM
NTICR = NTIC(I)
NTIC1 = NTICR - 1
TVAL(I, I) = 0.0
TVAL(NTIC1, I) = ARSMAX
DO 413 J = 2, NTIC1
413 TVAL(J, I) = TVAL(J-1, I) * SINC

C
REINVERT ARRAYS
NREV2 = NREV / 2
DO 415 I = 1, NREV2
NFW = NREV2 + 1 - I
TEMP = RAZ(I)
RAZ(I) = RAZ(NFW)
RAZ(NFW) = TEMP
TEMP = REL(I)
REL(I) = REL(NFW)
REL(NFW) = TEMP
DO 415 J = 1, 3
TEMP = PARRAY(I, J)
PARRAY(I, J) = PARRAY(NFW, J)
PARRAY(NFW, J) = TEMP
415

C
NOW NORMALIZE, ALSO GET RATIO OF MONITOR TO FP1
DO 420 I = 1, NREV
RATS(I) = RFP1(I) / RMON(I)
RMON(I) = RMON(I) / FMAX
RFP1(I) = RFP1(I) / F1MAX
RFP2(I) = RFP2(I) / F2MAX
420

C
TAKE APPROPRIATE AVERAGE OF FP2 CHANNEL
NAVG = 5
IF (F2MAX .GE. 25.01) NAVG = 4
IF (F2MAX .GE. 50.01) NAVG = 3
IF (F2MAX .GE. 100.01) NAVG = 2
IF (F2MAX .GE. 200.01) NAVG = 1
IF (NAVG .EQ. 1) GO TO 424
FAVG = NAVG
NREVA = NREV - NAVG + 1
DO 422 I = 1, NREVA
SUM = 0.0
DO 421 J = 1, NAVG
IJ = I * J - 1
SUM = SUM + RFP2(IJ)
422 RFP2(I) = SUM / FAVG
NREVA = NREVA + 1
DO 423 I = NREVA, NREV
423 RFP2(I) = RFP2(I-1)
424 CONTINUE
C
C READY TO SET UP AZ EL PLOT ON 'GNOMONIC' PROJECTION
C DETERMINE CENTER COORD
IPASS = 1
NHALF = NREV / 2
AZCENT = AINT(RAZ(NHALF))
ELCENT = AINT(REL(NHALF))
IF ((RAZ(NHALF) - AZCENT) .GT. 0.5) AZCENT = AZCENT + 1.0
IF ((REL(NHALF) - ELCENT) .GT. 0.5) ELCENT = ELCENT + 1.0
AZCENR = AZCENT * RADS
ELCENR = ELCENT * RADS
C
C DETERMINE MIN AND MAX ANGLES AND DELTAS
AZMAX = 0.0
AZMIN = 0.0
ELMAX = 0.0
ELMIN = 0.0
DO 470 I = 1, NREV
TEMP = RAZ(I) - AZCENT
IF (TEMP - AZMAX) 430, 450, 425
425 AZMAX = TEMP
GO TO 450
430 IF (TEMP - AZMIN) 440, 450, 450
440 AZMIN = TEMP
450 TEMP = REL(I) - ELCENT
IF (TEMP - ELMAX) 460, 470, 455
455 ELMAX = TEMP
GO TO 470
460 IF (TEMP - ELMIN) 465, 470, 470
465 ELMIN = TEMP
470 CONTINUE
DELAZ = AZMAX - AZMIN
DELEL = ELMAX - ELMIN
DELANG = DELAZ
IF (DELEL .GT. DELAZ) DELANG = DELEL
C
C FIRST PLOT ON 6X6 DEG SCALE
SCALF = SCALE1
DEL = DEL1
C INSERT BLANK FRAME
PROGRAM TO PLOT SEEBEDE DATA TAPES

WRITTEN BY G. LIEBLING - GENERAL ELECTRIC - AUG 1971

CALL FRAMEV (3)

ELROT = ELCENT - DEL
FLTOP = ELCENT + DFL
AZLFT = AZCENT - DEL
AZRGT = AZCENT + DEL

CALL FRAMEV (2)
DSCALE = DEL * SCALE
ESCALE = - DSCALE

CALL GRIDPAPER - LEAVE 50 UNIT MARGINS
CALL XSCALV (FSCALE, DSSCALE, MARG, MARG)
CALL YSCALV ('-SCALE', DSSCALE, MARG, MARG)

CALL COORD (X1L, Y1L, AZCENT, ELCENT, AZLINE, ELROT)
CALL COORD (X2L, Y2L, AZCENT, ELCENT, AZLINE, ELTOP)

I1L = I1V (X1L)
I1L2 = I1V (X2L)
IY1L = IYV (Y1L)
IY1L2 = IYV (Y2L)

CALL LINEV (I1L, I1L1, I1L2, I1L2)

CALL COORD (X1T, Y1T, AZCENT, ELCENT, AZLINE, ELLINE)
IXTAR(J) = I1V (X1T)
IYTAR(J) = I1V (Y1T)

CALL LINEV (IXTAB(J-1), IYTAB(J-1), IXTAB(J), IYTAB(J))

CALL LABEL LAT LINE
IXL1 = IXTAB(1) - 46
PROGRAM TO PLOT SEBEDE DATA TAPES

WRITTEN BY G. LIEBLING - GENERAL ELECTRIC - AUG 1971

CALL LABLV (ELLINE, IX1, IYTAB(1), 6, 1, 4)
CALL DBLOCK (NAME, NREC, A1CENT, ELCENT, RM1(NREV), RSEC(NREV); 1
               RM1(1), RSEC(1), NWDS, NREV, ARES)

GRID DRAWN AND LABELED
CONVERT POINTS TO X-Y COORDINATES FOR PLOTTING

DO 560 I = 1, NREV
CALL COORD (XTAB(I), YTAB(I), A1CENT, ELCENT, R11(I), REL(I))

NOW PLOT
PLOT EVERY 75 POINT WITH SPECIAL SYMBOL

DO 565 I = 1, 75, NREV, 75
IX = NXV (XTAB(I))
IY = NYV (YTAB(I))
CALL RITE2V (IX, IY, 1000, 90, 1, 1, -1, 1, IX, IY, IERR)

PLOT FINISHED - REPLOT IF NECESSARY ON COMPRESSED SCALE
GO TO 570, 590, 590; IPASS

IF (DELANG .LE. (2.0 * DEL1)) GO TO 590
IF (DELANG .GT. (2.0 * DEL2)) GO TO 580
DELS = DEL2
IPASS = 3
GO TO 475

CONTINUE

PLOTTING OF GNOMONIC PROJECTIONS COMPLETED

NOW PLOT INTENSITIES

GENERATE TABLE OF LINEAR DISTANCES FROM FIRST POINT
DIS(1) = 0.0
DO 620 I = 2, NREV
       DINC = SORT ((XTAB(I) - XTAB(I-1)) ** 2 +
               (YTAB(I) - YTAB(I-1)) ** 2) * DSCL
       DIS(I) = DIS(I-1) + DINC
       IF ((FRM - AMRT(FRM)) .GT. 0.0) FRM = FRM + 1.0
       NFRAME = FRM

MARGINS
PROGRAM TO PLOT SEEDBE DATA TAPES

WRITTEN BY G. LIEBLING - GENERAL ELECTRIC - AUG 1971

C TOP HALF
MARTOP(1) = 1023 - 924
MARBOT(1) = 544

C BOTTOM HALF
MARTOP(2) = 1023 - 462
MARBOT(2) = 82
MARLEFT = 66
MARRIGHT = 1023 - 894

DO 690 IFM = 1, 3, 2
2 DEGREES / FRAME
DO 680 IFRAM = 1, NFRAME
CALL FRAMEV (2)
FRM = IFRAM
DLEFT = (FRM - 1) * 2.0
DRIGHT = FRM * 2.0
CALL PRINTV (33, 33, PATH DISTANCE - SUBTENDED DEGREES, 364, 60)
CALL PRINTV (27, 27, INTENSITY VS. PATH DISTANCE, 388, 40)

C 2 ARRAYS / FRAME
DO 680 IPL = 1, 2
C DRAW GRIM
CALL SETMHV (MARLEFT, MARRIGHT, MARBOT(IPL), MARTOP(IPL))
CALL GR1DIV (2, DLEFT, DRIGHT, 0.0, ONE, 0.5 TO 0.2, 0.0, 0.1 TO 4, 3)
LINE = MARBOT(IPL) + 26
CALL RITF2V (30, LINE, 1000, 180, 1, 18, 1, 18, 1)
LINE = 1044 - MARTOP(IPL)
IGH = IFM + IPL - 1
CALL PRINTV (36, LABEL(1, IGR), 100, LINE)
IF (IGH .EQ. 4) GOTO 636
CALL PRINTV (12, 12, MAX COUNT = 400, LINE)
CALL LAVUV (FMAX(IGR), 500, LINE, 4, 1, 4)
LINE = 1000 - MARTOP(IPL)
CALL RITF2V (000, LINE, 50, 0, 1, 18, 1, IGR, IERR)

C DRAW ABSOLUTE INTENSITY TIC MARKS
LSTOP = IXV(DRSTR)
LSTART = LSTOP - 3
LCHAR = LSTART + 10
NTIC = NTIC(IGR)
DO 625 NT = 1, NTIC
POS = TVAL(NT, IGR) / TVAL(NTIC, IGR)
IPOS = NYVEC(POS)
CALL LINEV (LSTART, IP0S, LSTOP, IP0S)

625 CONTINUE

C PLOT POINTS
CALL APLTV (TREV, DIS, PARRAY(1, IGR), 1, 1, 1, 42, IERR)
CALL APLTV (1, DIS, PARRAY(1, IGR), 1, 1, 1, 63, IERR)
IF (.TREV .LT. 75) GOTO 683
PROGRAM TO PLOT SEEBDE DATA TAPES

WRITTEN BY G. LIEBLING - GENERAL ELECTRIC - AUG 1971

DO 670 I = 75, NREV, 75
   IX = NXV (DIS(I))
   IY = NYV (PARRAY(I, IGR))
   IF (IX .EQ. 0 .OR. IY .EQ. 0) GO TO 670
   CALL RITE2V (IX, IY, 1000, 90, 1, 1, -1, 1HX, IERR)
   CONTINUE
670 CONTINUE
680 CONTINUE
690 CONTINUE
700 CONTINUE
C   END LOOP FOR ONE SCAN FRAME
WRITE (IOUT, 6070) NREC
750 CONTINUE
REWIND ITP
STOP
C
5050 FORMAT (12A6)
5100 FORMAT (12)
5120 FORMAT (10I5)
5140 FORMAT (3F10.3)
5160 FORMAT (3E10.3)
6010 FORMAT (1H1; 30X, 12A6 /)
6040 FORMAT (/ 35X 7HRECORD; 13; 3G8H SKIPPED - INSUFFICIENT POINTS )
6060 FORMAT (/ 35X 7HRECORD; 13; 28H SKIPPED - NOT FOUND ON TAPE )
6040 FORMAT (/ 35X 7HRECORD; 13; 26H SKIPPED - TOO MANY POINTS )
6070 FORMAT (/ 35X 7HRECORD; 13; 9H PLOTTED )
5170 FORMAT (:/// 6H FILE, 12, 17H BYPASSED - FILE, 12, 6H FOUND: 1 / 12H JOB ABORTED )
   END
SURROUNITE TO COMPUTE GNOMONIC PROJECTION COORDINATES FROM INPUT AZ AND EL

CCORD

SURROUNITE TO COMPUTE GNOMONIC PROJECTION COORDINATES FROM INPUT AZ AND EL

SURROUNITE COORD (X, Y, AZCENR, ELCENR, AZ, EL)
DATA RADS/0.01745331/
AZR = AZ * RADS
ELR = EL * RADS
SINL = SIN(AZR - AZCENR)
COSL = COS(AZR - AZCENR)
SINP = SIN(ELR)
COSP = COS(ELR)
SINPO = SIN(ELCENR)
COSPO = COS(ELCENR)

DENOM = SINPO * SINP + COSPO * COSP * COSL
X = (SINL * COSP) / DENOM
Y = (COSPO * SINP - SINPO * COSL * COSP) / DENOM
RETURN
END

546 WORDS OF MEMORY USED BY THIS COMPILATION
SUBROUTINE TO PRINT HOUSEKEEPING DATA BLOCK ON Gnomonic Projection Plots

SUBROUTINE TO PRINT HOUSEKEEPING DATA BLOCK ON GNOMONIC PROJECTION PLOTS

SUBROUTINE DRLOCK (NAME, NREC, AZCENT, ELCENT, RMSRT, RSSRT, RMSSTP, RSSSTP, NWDS, NREV, APRES)

EXTERNAL TABLV

DIMENSION NAME(3)

ILF = 790
IH = 980
IDEL = 20
MAR = 1023

CALL CHSIZV (2, 2)
CALL RITSTV (12, 20, TABLV)
CALL RITE2V (ILF, IH, MAR, 90, 1, 18, 1, NAME, IERR)

IH = IH - IDEL
CALL RITE2V (ILF, IH, MAR, 90, 1, 13, -1, 13HRECORD NO., -, IERR)

TEMP = NREC
CALL BNBCDV (TEMP, BCD, NDS)
CALL RITE2V (946, IH, MAR, 90, 1, NDS, 1, BCD, IERR)

IH = IH - IDEL
CALL RITE2V (ILF, IH, MAR, 90, 1, 11, -1, 11HREF COORD -, IERR)
IH = IH - IDEL
CALL RITE2V (ILF, IH, MAR, 90, 1, 5, -1, 5H AZ, IERR)
CALL BNBCDV (AZCENT, BCD, NDS)
CALL RITE2V (950, IH, MAR, 90, 1, NDS, 1, BCD, IERR)

IH = IH - IDEL
CALL RITE2V (ILF, IH, MAR, 90, 1, 5, -1, 5H EL, IERR)
CALL BNBCDV (ELCENT, BCD, NDS)
CALL RITE2V (950, IH, MAR, 90, 1, NDS, 1, BCD, IERR)

IH = IH - IDEL
CALL RITE2V (ILF, IH, MAR, 90, 1, 4, -1, 4HTIME, IERR)
IH = IH - IDEL
CALL RITE2V (ILF, IH, MAR, 90, 1, 18, -1, 18H START M., S; IERR)

CALL BNBCDV (RMSRT, BCD, NDS)
IST = 886
IF (NDS .EQ. 1) IST = 896
CALL RITE2V (IST, IH, MAR, 90, 1, NDS, 1, BCD, IERR)

TEMP = AINT (RSSRT)
CALL BNBCDV (TEMP, BCD, NDS)
IST = 934
IF (NDS .EQ. 1) IST = 946
CALL RITE2V (IST, IH, MAR, 90, 1, NDS, 1, BCD, IERR)

TEMP = RSSRT - TEMP
CALL BNBCDV (TEMP, BCD, NDS)
CALL RITE2V (970, IH, MAR, 90, 1, 2, 1, BCD, IERR)

IH = IH - IDEL
CALL RITE2V (ILF, IH, MAR, 90, 1, 18, -1, 18H STOP M., S; IERR)

CALL BNBCDV (RMSSTP, BCD, NDS)
01-05-72  13.751  SUBROUTINE TO PRINT HOUSEKEEPING DATA BLOCK
ON GNOMONIC PROJECTION PLOTS

IST = 886
IF (NDS .EQ. 1)  IST = 898
CALL RITE2V ( IST, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
TEMP = AINT (RSSTP)
CALL BNBCDV ( TEMP, BCD, NDS)
IST = 934
IF (NDS = 1)  IST = 946
CALL RITE2V ( IST, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
TEMP = RSSTP - TEMP
CALL BNBCDV ( TEMP, BCD, NDS)
CALL RITE2V ( 970, IH, MAR, 90, 1, 2, 1, BCD, IERR)
IH = IH - IDEL
CALL RITE2V ( ILF, IH, MAR, 90, 1, 13, -1, 13HPOINT COUNT - , IERR)
IH = IH - IDEL
CALL RITE2V ( ILF, IH, MAR, 90, 1, 7, -1, 7H TOTAL, IERR)
TEMP = NWDS
CALL BNBCDV ( TEMP, BCD, NDS)
CALL RITE2V ( 922, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
IH = IH - IDEL
CALL RITE2V ( ILF, IH, MAR, 90, 1, 9, -1, 9H PLOTTED, IERR)
TEMP = NREV
CALL BNBCDV ( TEMP, BCD, NDS)
CALL RITE2V ( 922, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
IH = IH - IDEL
CALL RITE2V ( ILF, IH, MAR, 90, 1, 18, -1, 18AVERAGE PRESSURE - , IERR)
IH = IH - IDEL
CALL BNBCDV ( APRES, BCD, NDS)
CALL RITE2V ( 926, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
RETURN
END

745 WORDS OF MEMORY USED BY THIS COMPILATION