National Aeronautics and Space Administration
Goddard Earth Science
Data Information and Services Center (GES DISC)

README Document for the Nimbus-4 Backscatter Ultraviolet Spectrometer (BUV) Level-1 Radiance Data (RUT) Product

BUVN4L1RUT

Last Revised 06/22/2017

Goddard Earth Sciences Data and Information Services Center (GES DISC)
http://disc.gsfc.nasa.gov
NASA Goddard Space Flight Center
Code 610.2
Greenbelt, MD 20771 USA

Prepared By:

James E. Johnson	10/05/2015
Name GES DISC GSFC Code 610.2	Date

Reviewed By:

Name	mm/dd/yyyy
Name GSFC Code xxx	Date
Name	mm/dd/yyyy
Name GSFC Code xxx	Date

Goddard Space Flight Center
Greenbelt, Maryland

Revision History

Revision Date	***Changes***	***Author***
10/05/2015	Original	James E. Johnson
06/22/2017	Updated URLs in sections 5 and 6	James E. Johnson

Table of Contents

1. Introduction

This document provides basic information on using the old Nimbus-4 Backscatter Ultraviolet Spectrometer (BUV) Level-1 radiance data product or RUT (also called U-tape).

1.1 Data Product Description

The BUV Level-1 Radiance Data, or RUT, product contains the radiances, quality flags, geolocation, orbital, and housekeeping information. Each file typically contains one orbit of data. Radiances are measured every 32 seconds at 12 wavelengths of 255.5, 273.5, 283.0, 287.6,, 292.2, 297.5, 301.9, 305.8, 312.5, 317.3, 331.2, 339.8 nm. The data are available from April 10, 1970 (day of year 100) through May 6, 1977 (day of year 126).

This product was previously available from the NASA National Space Science Data Center (NSSDC) under the name Backscatter Ultraviolet Spectrometer (BUV) Radiance Values, also known as the RUT or U-Tape product, with the identifier ESAC-00055 (old id 70-025A-05B).

1.1.1 The Backscatter Ultraviolet Spectrometer

The Backscatter Ultraviolet Spectrometer (BUV) was designed to monitor the vertical distribution and total column amount of atmospheric ozone on a global scale by measuring the intensity of ultraviolet radiation backscattered by the atmosphere in the 250 to 340 nm spectral region. The primary instrumentation consisted of a double monochromator containing all reflective optics and a photomultiplier detector. The double monochromator was composed of two Ebert-Fastie-type monochromators in tandem. Each monochromator had a 52 x 52-mm grating with 2400 lines per mm. Light from a 0.05-sr solid angle (subtending approximately a 222 km^2 area on the earth's surface from a satellite height of approximately 1100 km) entered the nadir-pointing instrument through a depolarizing filter. A motor-driven cam step rotated the gratings to monitor the intensity of 12 ozone absorption wavelengths. The detector was a photomultiplier tube. For background readings, a filter photometer measured the reflected UV radiation in an ozone-free absorption band at 380 nm.

The Nimbus-4 BUV mission was succeeded by the SBUV instrument flown later on the Nimbus-7 satellite, and subsequently the SBUV/2 instruments on a series of NOAA Polar orbiting Operational Environmental satellites. The BUV experiment was successful and returned data from April 10, 1970 through May 6, 1977. The instrument operated mostly continuously until July 1972 when the Nimbus-4 spacecraft solar array partially failed. After this time data collection had to be curtailed, particularly in the later years.

The original principal investigator for the BUV experiment was Dr.Donald F. Heath.

1.1.2 Nimbus-4 Overview

The Nimbus-4 satellite was successfully launched on April 8, 1970. The spacecraft included nine experiments: (1) an Image Dissector Camera System (IDCS) for providing daytime cloud cover pictures, both in real-time and recorded modes (2) a Temperature-Humidity Infrared Radiometer (THIR) for measuring daytime and nighttime surface and cloudtop temperatures, as well as the water vapor content of the upper atmosphere, (3) an Backscatter Ultraviolet Spectrometer (BUV) for measuring the emission spectra of the earth/atmosphere system, (4) a Satellite Infrared Spectrometer (SIRS) for determining the vertical profiles of temperature and water vapor in the atmosphere, (5) a Monitor of Ultraviolet Solar Energy (MUSE) for detecting solar UV radiation, (6) a Backscatter Ultraviolet (BUV) detector for monitoring the vertical distribution and total amount of atmospheric ozone on a global scale, (7) a Filter Wedge Spectrometer (FWS) for accurate measurement of IR radiance as a function of wavelength from the earth/atmosphere system, (8) a Selective Chopper Radiometer (SCR) for determining the temperatures of six successive 10-km layers in the atmosphere from absorption measurements in the 15-micrometer CO_2 band, and (9) an Interrogation, Recording, and Location System (IRLS) for locating, interrogating, recording, and retransmitting meteorological and geophysical data from remote collection stations.

The orbit of the satellite can be characterized by the following:

- circular orbit at 1100 km
- inclination of 80 degrees
- period of an orbit is about 107 minutes
- orbits cross the equator at 26 degrees of longitude separation
- sun-synchronous

1.2 Algorithm Background

The Nimbus-4 BUV data were generated from the spacecraft telemetry, attitude and orbital data. The data were originally processed on IBM 360 computers using a 32-bit architecture. The intensity of UV radiation at 12 wavelengths between 250 and 340 nm are measured by the monochromator and photomultiplier detector along with geolocation, ancillary and housekeeping data. This product is an intermediate step in the ozone processing system. Further information on the BUV data processing can be found in the Nimbus-4 Users' Guide Section 7.

1.3 Data Disclaimer

The data should be used with care and one should first read the User's Guide to the Nimbus-4 Backscatter Ultraviolet Experiment Data Sets, section 4 describing the Radiance Data, as well as the Nimbus-4 User's Guide, section 7 describing the BUV experiment. Users should cite this data product in their research.

2. Data Organization

The Nimbus-4 Backscatter Ultraviolet Spectrometer Level-1 Radiance Data (RUT) spans the time period from April 10, 1970 to May 6, 1977. Each file typically contains one orbit of data.

2.1 File Naming Convention

The data product files are named according to the following convention:

<Platform>-<Instrument>_<Level>-<Type>_<Date>_<Orbit>_<Tape>.<Suffix>

where:

- Instrument = name of the instrument (always BUV)
- Platform = name of the platform or satellite (always Nimbus4)
- Level = processing level of data (always L1)
- Type = the data type indentifier (always RUT)
- Date = Data start date and time in UTC in format <YYYY>m<MMDD>t<hhmm> where
    1. YYYY = 4 digit year (1970 or 1971)
    2. MM = 2 digit month (01-12)
    3. DD = 2 digit day of month (01-31)
    4. hh = 2 digit hour of day (01-23)
    5. mm = 2 digit minute of hour (01-59)
- Orbit = orbit number when the data were collected (preceded by the letter 'o')
- Tape = tape number (DR primary tape, DS backup tape plus 3 digit number)
- Suffix = the file format (always dat, indicating binary data)

`File name example: Nimbus4-BUV_L1-RUT_1970m0410t222609_o00035_DR131.TAP`

2.2 File Format and Structure

The data are stored as they were originally written in IBM binary (big-endian) record oriented structured files. The files were written on the original 1600 bpi 9-track tapes using a FORTRAN block format, each with a size of a maximum of 25 400 byte (100 4-byte words) records. The first record is the header, which is followed by a series of data records containing the radiances measured by the photometer and monochromator at 12 wavelengths. Along with geolocation information. The data records are followed by two different structured trailer records.

Figure 1: BUV Level-1 RUT File Structure

Records	Object
1	Header Record
2 – N-2	Data Records
N-1	Trailer Record 1
N	Trailer Record 2

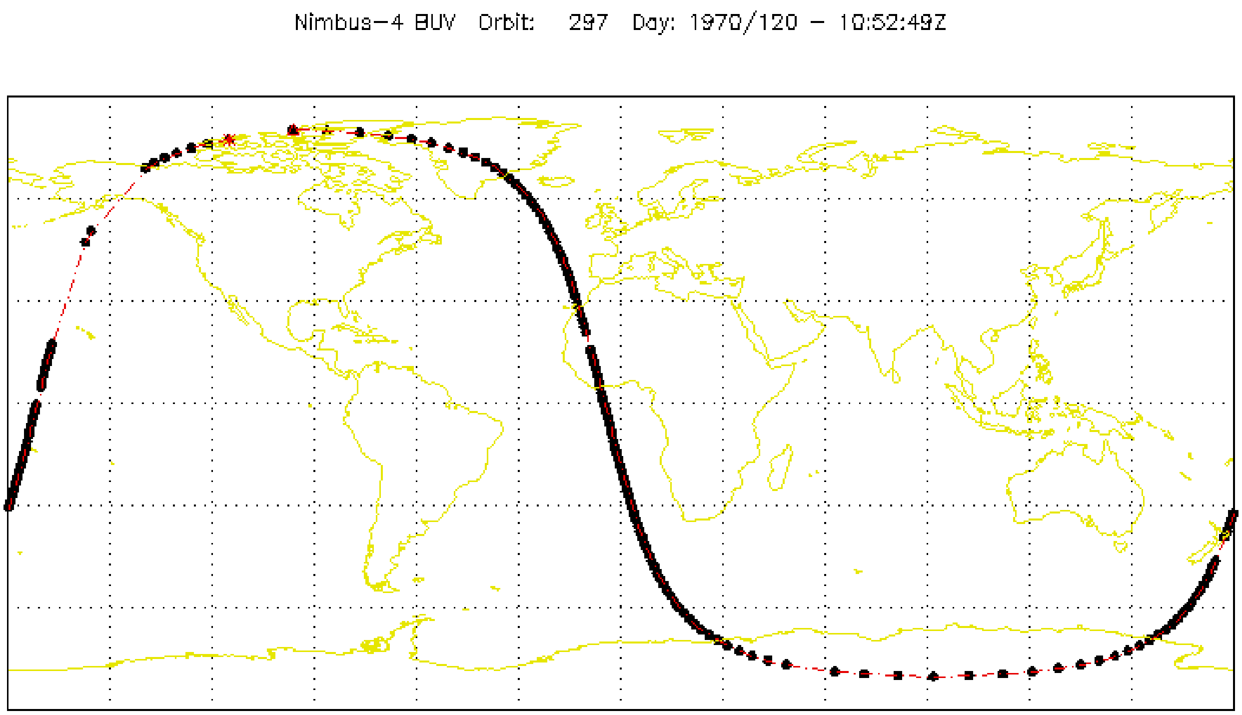
2.3 Key Science Data Fields

The primary science data fields in this data product are the radiances from the photometer and monochromator expressed in resolution units of the digitizer, or U-values defined as

$$U=100 \log E$$

Where E is the event rate, which is the photomultiplier cathode current divided by the electronic charge. A wavelength-dependent calibration factor relates the cathode current to the radiance.

Figure 2: Typical data coverage for a Nimbus-4 BUV Level-1 RUT orbit file.



3. Data Contents

The granularity of this data collection is one orbit (approximately 107 minutes).

3.1 Data Records

The Level-1 RUT data files contain a single header record, a series of data records, and two separate trailer records, each of size 400 bytes (100 4-byte words). See the Nimbus-4 BUV Data Products User's Guide – Section 4 for a description of the Radiance Data (U-Tape) data file format. A sample FORTRAN program to read the data files can be found in the Appendix.

Table 3-1-1: Header Record

Word	Field Name	Units	Type	Comments
1	Logical sequence number	-	R*4	always 1.0
2	Spare	-	R*4	set to 0.0
3-4	Unique number of Input Tape	-	R*8	EBCDIC text
5-8	Day and date of Job Run.	-	2R*8	EBCDIC text
9-10	Job I.D.	-	R*8	EBCDIC text
11	Day of first good scan of orbit on file	-	R*4	(1-366)
12	GMT of first good scan	s	R*4	
13	Latitude for first scan	degrees	R*4	(-90 to +90)
14	Longitude for first scan	degrees	R*4	westward (0-360)
15	Week number of start of orbit	s	R*4	
16	Orbit number		R*4	
17-18	Program name	-	R*8	EBCDIC text
19-20	Version date	-	R*8	EBCDIC text
21-22	Version number	-	R*8	EBCDIC text
23	β_0, Photometer		R*4	
24	β_0, Monochromator		R*4	
25-26	Date of Job Run	-	R*8	EBCDIC text
27-100	Spares	-	74R*4	= -77.

Table 3-1-2: Data Record

Word	Field Name	Units	Type	Comments
1	Logical sequence number	-	R*4	
2	Orbit number	-	R*4	
3	Day of year at start of scan	-	R*4	(1-366)
4	Time of day at start of scan	s	R*4	(0-86400)
5	Logical record number of PDB data file	-	R*4	
6	View latitude at start of scan	degrees	R*4	-90 to +90
7	View longitude at start of scan	degrees	R*4	westward (0-360)
8	View latitude at end of scan	degrees	R*4	-90 to +90
9	View longitude at end of scan	degrees	R*4	westward (0-360)
10	Solar zenith angle at start of scan	degrees	R*4	
11	Azimuth angle at start of scan	degrees	R*4	
12	Spare	-	R*4	set to -77.
13	Solar zenith angle at end of scan	degrees	R*4	
14	Azimuth angle at end of scan	degrees	R*4	
15	Spare	-	R*4	set to -77.
16	Photometer average U-value at 255.5 nm		R*4	
17	Monochromator average U-value at 255.5 nm		R*4	
18	Screening flag		R*4	(bit encoded)
19-51	Same as 16-18 but for λ = 273.5, 283.0, … 339.8 nm		33R*4	
52	12 flag bits if each wavelength is proper or not		R*4	(bit encoded)
53	View latitude at start of scan	degrees	R*4	-90 to +90
54	View longitude at start of scan	degrees	R*4	westward (0-360)
55	Altitude at beginning of scan	km	R*4	
56	Performance check for 1st major frame		R*4	
57	Performance check for 2nd major frame		R*4	
58	Resistor indicators for channels 1-6		R*4	(bit encoded)

59	Resistor indicators for channels 7-12		R*4	(bit encoded)
60	Spare	-	R*4	set to -77.
61	Day/Night/Twilight Code		R*4	0/2/1 respectively
62	Data Type		R*4	0=Data; 1=MCSA
63-74	Monochromator pulse counts for each wavelength	counts/sec	12R*4	
75-86	Photometer pulse counts for each wavelength	counts/sec	12R*4	
87-92	Energetic Particle Counts		6R*4	
93-100	Spares	-	8R*4	set to -77.

Table 3-1-3: First Trailer Record

Word	Field Name	Units	Type	Comments
1	Logical sequence number	-	R*4	negative
2	Orbit number	-	R*4	
3	Day of last scan on file	-	R*4	(1-366)
4	Time of last scan on file	s	R*4	(0-86400)
5	Latitude of last scan	degrees	R*4	-90 to +90
6	Longitude of last scan	degrees	R*4	westward (0-360)
7	Number of PDB records (scans) read		R*4	
8	Number of U-Tape records (scans) written		R*4	
9-10	Unique number of the input tape	-	R*8	EBCDIC text
11	Total scans read		R*4	
12	Good data scans		R*4	
13	Good diffuser scans		R*4	
14	Good MCSA scans		R*4	
15	Good data zenith angle < 88.0		R*4	
16	Total scans rejected		R*4	
17	Backward time steps		R*4	
18	Diffuser missing		R*4	

19	MCSA frame missing		R*4	
20	Non-data, non-MCSA, non-diffuser		R*4	
21	Scans following MCSB, C or E		R*4	
22	Tape read errors		R*4	
23	Unable to correct zenith angle (attitude)		R*4	
24-30	Not used		7R*4	Set to 0.0
31	Moving diffuser plate		R*4	
32	Wavelength CAM error		R*4	
33	Moving CAM error		R*4	
34	Photometer H.V. non high/low		R*4	
35	Monochromator H.V. non high/low		R*4	
36-40	Not used		5R*4	Set to 0.0
41-100	Spares		60R*4	Set to -77.

Table 3-1-3: Second Trailer Record

Word	**Field Name**	**Units**	**Type**	**Comments**
1-10	Avg. values of housekeeping functions 16101-16112		10R*4	
11-20	Std. dev of the 10 housekeeping functions		10R*4	
21-30	Min. of the 10 housekeeping functions		10R*4	
31-40	Max. of the 10 housekeeping functions		10R*4	
41-50	Number of data points for 10 housekeeping functions		10R*4	
51-100	Spares	-	50R*4	Set to -77.

3.2 Metadata

The metadata are contained in a separate XML formatted file having the same name as the data file with .xml appended to it.

Table 3-2: Metadata attributes associated with the data file.

Name	Description
LongName	Long name of the data product.
ShortName	Short name of the data product.
VersionID	Product or collection version.
GranuleID	Granule identifier, i.e. the name of the file.
Format	File format of the data file.
CheckSumType	Type of checksum used.
CheckSumValue	The value of the calculated checksum.
SizeBytesDataGranule	Size of the file or granule in bytes.
InsertDateTime	Date and time when the granule was inserted into the archive. The format for date is YYYY-MM-DD and time is hh-mm-ss.
ProductionDateTime	Date and time the file was produced in format YYYY-MM-DDThh:mm:ss.ssssssZ
RangeBeginningDate	Begin date when the data was collected in YYYY-MM-DD format.
RangeBeginningTime	Begin time of the date when the data was collected in hh-mm-ss format.
RangeEndingDate	End date when the data was collected in YYYY-MM-DD format.
RangeEndingTime	End time of the date when the data was collected in hh-mm-ss format.
GPolygon: PointLatitude	Latitudes of the polygon (rectangle) points that represent the satellite coverage. Each point is identified by its latitude and longitude pair.
GPolygon: PointLongitude	Longitudes of the polygon (rectangle) points that represent the satellite coverage. Each point is identified by its latitude and longitude pair.
PlatformShortName	Short name or acronym of the platform or satellite
InstrumentShortName	Short name or acronym of the instrument
SensorShortName	Short name or acronym of the sensor
OrbitNumber	Number of the orbit in the file
Elapsed_Min_Time	Duration in minutes of data collected during an orbit

4. Reading the Data

The data are written in a binary record-oriented format. Using the record format specification in the section above, users can write software to read the data files. Please note that the data were originally written using a big-endian format, therefore users on little-endian machines will need to swap bytes for the words. Also, the floating point data were written using IBM 360 machines, and must be converted if reading on a machine that understands IEEE floats (integers are not affected).

A sample FORTRAN program is included in the Appendix section which will read the data files. Additionally three FORTRAN functions are included to perform byte swapping, conversion from IBM float to IEEE float, and translation of EBCDIC to ASCII text.

5. Data Services

5.1 GES DISC Search

The GES DISC provides a keyword, spatial, temporal and advanced (event) searches through its unified search and download interface:

https://disc.gsfc.nasa.gov/

5.2 Documentation

The data product landing pages provide information about this data product, as well as links to download the data files and relevant documentation:

https://disc.gsfc.nasa.gov/datacollection/BUVN4L1RUT_001.html

5.3 Direct Download

This data product is available for users to download directly using HTTPS:

https://acdisc.gesdisc.eosdis.nasa.gov/data/Nimbus4_BUV_Level1/BUVN4L1RUT.001/

6. More Information

6.1 Contact Information

Name: GES DISC Help Desk
URL: https://disc.gsfc.nasa.gov/
E-mail: gsfc-help-disc@lists.nasa.gov
Phone: 301-614-5224
Fax: 301-614-5228
Address: Goddard Earth Sciences Data and Information Services Center
Attn: Help Desk
Code 610.2
NASA Goddard Space Flight Center
Greenbelt, MD 20771, USA

6.2 References

D. F. Heath, and A. J. Kruger, "The Nimbus-4 User's Guide - Section 7: The Backscatter Ultraviolet Spectrometer (BUV) Experiment", NASA Goddard Space Flight Center, March 1970, Pages 149-172

Ozone Processing Team, "User's Guide to the Nimbus-4 Backscatter Ultraviolet Experiment Data Sets – Section 4: Radiance Data", NASA Goddard Space Flight Center, Technical Memorandum 78069, Jan. 1978, Pages 24-33

7. Appendices

Acknowledgements

The Nimbus data recovery task at the GES DISC is funded by NASA's Earth Science Data and Information System program.

Acronyms

EOS: Earth Observing System

ESDIS: Earth Science and Data Information System

GES DISC: Goddard Earth Sciences Data and Information Services Center

GSFC: Goddard Space Flight Center

BUV: Backscatter Ultraviolet Spectrometer

RUT: Radiance U-Tape Data Product

L1: Level-1 Data

NASA: National Aeronautics and Space Administration

QA: Quality Assessment

U-Values: Radiance in resolution units of the digitizer

UT: Universal Time

FORTRAN Code

```
C-----------------------------------------------------------------------
C ^NAME: READ_BUV_RUT
C
C ^DESCRIPTION:
C     This program opens and reads a Nimbus-4 BUV level-1 RUT data file
C     and prints the contents of the file to the screen. Data files
C     consist of a single header, a number of data, and a final trailer
C     record, each of size 400 bytes (100 4-byte words). See the User's
C     Guide for the Nimbus-4 Backscatter Ultraviolet Experiment - Section 4
C     Radiance Data (or U-Tape) which gives the product file specification.
C
C ^MAJOR VARIABLES:
C     FNAME  - name of input file
C
C ^NOTES:
C     Compile: gfortran -xxx -o READ_BUV_RUT.EXE READ_BUV_RUT.FOR
C
C ^ORGANIZATION: NASA/GSFC, Code 610.2
C
C ^AUTHOR:  James Johnson
C
C ^ADDRESS: james.johnson@nasa.gov
C
C ^CREATED: October 13, 2015
C-----------------------------------------------------------------------

      CHARACTER          FNAME*1024    ! Name of input file
      CHARACTER          BLOCK(10000)  ! Blocks are maximum 25 100 4-byte words
      CHARACTER          BUFF(4)       ! Buffer to hold 4-byte word
      INTEGER*4          WORD          ! 4-byte word
      INTEGER*4          BLKSIZ        ! Block size header
      EQUIVALENCE        (BUFF, WORD)

C     Get the name of the input data file to read
      PRINT *, 'Enter the name of the input file:'
      READ (5,'(A)') FNAME

C     Open the specified input file
      OPEN (UNIT=1, FILE=FNAME, STATUS='OLD', ACCESS='DIRECT',
     &      FORM='UNFORMATTED', RECL=1, ERR=99, IOSTAT=IOS)

C     Initialize N (block number) and IOFF (byte offset)
      N=1
      IOFF=0

C     Loop through the file reading all blocks of data
   10 DO

C       Read first 4-byte word or block size
        DO I=1,4
          READ (1, REC=I+IOFF, ERR=91, IOSTAT=IOS) BUFF(I)
        END DO
        IOFF = I+IOFF-1
        BLKSIZ = WORD
```

```
        IF (BLKSIZ .GT. 0) THEN

C       Next read the block of data
          DO I=1,BLKSIZ
            READ (1, REC=I+IOFF, ERR=92, IOSTAT=IOS) BLOCK(I)
          END DO
          IOFF=I+IOFF-1
          CALL RECBLK(BLOCK, BLKSIZ, N)

        END IF

C       Finally read last 4-byte word (should match first block size)
        DO I=1,4
          READ (1, REC=I+IOFF, ERR=93, IOSTAT=IOS) BUFF(I)
        END DO
        IOFF=I+IOFF-1

        IF (BLKSIZ .NE. WORD) THEN
          PRINT '("BLKSIZ: ",I10," != ",I10)', BLKSIZ, WORD
        END IF

C       END OF FILE MARKER
        IF (BLKSIZ .EQ. 0 .AND. WORD .EQ. 0) GOTO 90

        N=N+1

      END DO

C     Close the input file
   90 CLOSE(1)
      GOTO 100
   91 PRINT '("ERROR: READ FIRST WORD, IOSTAT: ",I5)', IOS
      GOTO 100
   92 PRINT '("ERROR: READ BLOCK ",I4,", IOSTAT: ",I5)', N, IOS
      GOTO 100
   93 PRINT '("ERROR: READ LAST WORD, IOSTAT = ",I5)', IOS
      GOTO 100
   99 PRINT '("ERROR: OPENING FILE, IOSTAT: ",I6)', IOS

  100 STOP
      END
```

```
C-----------------------------------------------------------------------
C ^SUBROUTINE: RECBLK
C
C     This subroutine will extract records from the block of data
C-----------------------------------------------------------------------

      SUBROUTINE RECBLK(BLOCK, IBLKSZ, N)

      INTEGER*4          BLOCK(25*100) ! Blocks are maximum 25 100 4-byte words
      INTEGER*4          IREC(100)     ! Record is 100 4-byte words
      LOGICAL            LTR2          ! Second Trailer Record flag

      DATA IRECSZ /400/

      NRECS = IBLKSZ/IRECSZ

      DO I=1,NRECS

        IREC = BLOCK((I-1)*100+1:I*100)

C       Check the logical sequence number in word 1
        IF (.NOT. LTR2) RNUM = R4IBM(I4SWAP(IREC(1)))
        IF (RNUM .EQ. 1) THEN
          CALL PRHREC(IREC, N)
        ELSE IF (RNUM .GT. 1) THEN
          CALL PRDREC(IREC, N)
        ELSE IF (RNUM .LT. 0) THEN
          IF (.NOT. LTR2) THEN
            CALL PRLRC1(IREC, N)
            LTR2 = .TRUE.
          ELSE
            CALL PRLRC2(IREC, N)
          END IF
        ELSE
          PRINT '("UNKNOWN RECORD TYPE: ", I3,X,I11)', ITYPE, N
        END IF

      END DO

      RETURN
      END
```

```
C----------------------------------------------------------------------
C ^SUBROUTINE: PRHREC
C
C     This subroutine will print the header record to the screen
C----------------------------------------------------------------------

      SUBROUTINE PRHREC(IREC, N)

      INTEGER*4          IREC(100)     ! Data record
      INTEGER*4          IEBC(4)       ! Temporary array for EBC text
      CHARACTER          EBCTMP(16)    ! Temporary EBCDIC character
      CHARACTER          ASCVAL*16     ! Array for ASCII text
      CHARACTER          EBC2ASC       ! Function to convert EBC to ASCII
      EQUIVALENCE        (IEBC,EBCTMP)

C Words 3-4, 5-8, 9-10, 17-18, 19-20, and 25-26 contain EBCDIC text data.
C All other words are in IBM floating-point format (REAL*4). Any word in the
C record may contain -77., indicating fill data.

      PRINT '("HEADER RECORD")'
      DO 100 I=1,100

        IF ( (I .GE.  3 .AND. I .LE.  4) .OR.
     &       (I .GE.  5 .AND. I .LE.  8) .OR.
     &       (I .GE.  9 .AND. I .LE. 10) .OR.
     &       (I .GE. 17 .AND. I .LE. 18) .OR.
     &       (I .GE. 19 .AND. I .LE. 20) .OR.
     &       (I .GE. 21 .AND. I .LE. 22) .OR.
     &       (I .GE. 25 .AND. I .LE. 26) ) THEN
          IF (I .NE.  3 .AND. I .NE.  5 .AND. I .NE.  9 .AND.
     &        I .NE. 17 .AND. I .NE. 19 .AND.
     &        I .NE. 21 .AND. I .NE. 25) GOTO 100
          IF (I .EQ. 5) THEN
            IEBC = IREC(I:I+3)
            DO 10 J=1,16
              ASCVAL(J:J) = EBC2ASC(ICHAR(EBCTMP(J)))
   10       CONTINUE
            PRINT '("WORD ",I3," = ",A16)', I,ASCVAL                ! Two Real*8
          ELSE
            IEBC = IREC(I:I+1)
            DO 20 J=1,8
              ASCVAL(J:J) = EBC2ASC(ICHAR(EBCTMP(J)))
   20       CONTINUE
            PRINT '("WORD ",I3," = ",A8)', I,ASCVAL                 ! One Real*8
          END IF
        ELSE
          PRINT '("WORD ",I3," = ",G12.6)', I,R4IBM(I4SWAP(IREC(I)))
        END IF

  100 CONTINUE
      PRINT '("")'

      RETURN
      END
```

```
C---------------------------------------------------------------------
C ^SUBROUTINE: PRDREC
C
C     This subroutine will print the data records to the screen
C---------------------------------------------------------------------

      SUBROUTINE PRDREC(IREC, N)

      INTEGER*4          IREC(100)     ! Data record

C All words are in IBM floating-point format (REAL*4). Any word in the
C record may contain -77., indicating fill data.

      PRINT '("DATA RECORD")'
      DO 100 I=1,100

        PRINT '("WORD ",I3," = ",G12.6)', I,R4IBM(I4SWAP(IREC(I)))

  100 CONTINUE
      PRINT '("")'

      RETURN
      END

C---------------------------------------------------------------------
C ^SUBROUTINE: PRLRC1
C
C     This subroutine will print the first trailer record to the screen
C---------------------------------------------------------------------

      SUBROUTINE PRLRC1(IREC, N)

      INTEGER*4          IREC(100)     ! Data record
      INTEGER*4          IEBC(4)       ! Temporary array for EBC text
      CHARACTER          EBCTMP(16)    ! Temporary EBCDIC character
      CHARACTER          ASCVAL*16     ! Array for ASCII text
      CHARACTER          EBC2ASC       ! Function to convert EBC to ASCII
      EQUIVALENCE        (IEBC,EBCTMP)

C Words 9-10 contain EBCDIC text data. All other words are in IBM
C floating-point format (REAL*4). Any word in the record may contain -77.,
C indicating fill data.

      PRINT '("1ST TRAILER RECORD")'
      DO 100 I=1,100

        IF ( (I .GE.  9 .AND. I .LE. 10) ) THEN
          IF (I .NE.  9) GOTO 100
          IEBC = IREC(I:I+1)
          DO 10 J=1,8
            ASCVAL(J:J) = EBC2ASC(ICHAR(EBCTMP(J)))
   10     CONTINUE
          PRINT '("WORD ",I3," = ",A8)', I,ASCVAL                 ! One Real*8
        ELSE
          PRINT '("WORD ",I3," = ",G12.6)', I,R4IBM(I4SWAP(IREC(I)))
        END IF

  100 CONTINUE
      PRINT '("")'

      RETURN
      END
```

```
C---------------------------------------------------------------------
C ^SUBROUTINE: PRLRC2
C
C     This subroutine will print the second trailer record to the screen
C---------------------------------------------------------------------

      SUBROUTINE PRLRC2(IREC, N)

      INTEGER*4          IREC(100)     ! Data record

C All words are in IBM floating-point format (REAL*4). Any word in the
C record may contain -77., indicating fill data.

      PRINT '("2ND TRAILER RECORD")'
      DO 100 I=1,100

        PRINT '("WORD ",I3," = ",G12.6)', I,R4IBM(I4SWAP(IREC(I)))

  100 CONTINUE
      PRINT '("")'

      RETURN
      END

C---------------------------------------------------------------------
C ^SUBROUTINE: IBLKID
C
C     This subroutine will decode the block identifier (word 1)
C---------------------------------------------------------------------

      SUBROUTINE IBLKID(IWORD, IBLKNO, ILASTB, ILASTF, IRECID)
                                                       !  bits
          IBLKNO = ISHFT(IWORD,-20)                    !  1-12 Block Number
          ILASTB = IAND(IWORD,'1000000000000000'B)     !    17 Last Block of File
          ILASTF = IAND(IWORD,'0100000000000000'B)     !    18 Last File of Tape
          IRECID = ISHFT(ISHFT(IWORD,18),-26)          ! 19-24 Record Identifier

      RETURN
      END

C---------------------------------------------------------------------
C ^FUNCTION: I4SWAP
C
C     This subroutine will swap the bytes of a data element
C---------------------------------------------------------------------

      FUNCTION I4SWAP(INPUT)

      INTEGER*4          IWORD          ! Input 4-byte word
      INTEGER*4          IDROW          ! Byte-swapped 4-byte word
      CHARACTER          DATBUF(4)      ! Input data buffer
      CHARACTER          SWPBUF(4)      ! Output swapped buffer
      EQUIVALENCE        (IWORD, DATBUF)
      EQUIVALENCE        (IDROW, SWPBUF)

      IWORD = INPUT
      DO 10 K=1,4
        SWPBUF(K) = DATBUF(4-K+1)
   10 CONTINUE
      I4SWAP = IDROW

      RETURN
      END
```

```
C-----------------------------------------------------------------------
C ^FUNCTION: R4IBM
C
C     This function will convert an input word to an IBM float
C-----------------------------------------------------------------------

      FUNCTION R4IBM(IWORD)

      INTEGER*4      IDROW              ! reverse the bits of input word
      REAL*8         A /16.0/           ! base number
      INTEGER*4      B /64/             ! exponent offset
      REAL*8         C /0.0/            ! fraction offset
      INTEGER*1      S                  ! sign flag
      INTEGER*2      E                  ! binary exponent
      REAL*8         F                  ! binary fraction
      REAL*8         M                  ! mantissa
      REAL*8         V                  ! float value
      INTEGER*4      I                  ! counter

      S = ISHFT(IWORD, -31)

      E = 0
      DO 10 I=0,6
        E = E + IAND(ISHFT(IWORD,-24),ISHFT(1,I))
   10 END DO

      IDROW = 0
      DO 11 I=0,31
        IF (IAND(IWORD,ISHFT(1,I)) .NE. 0) THEN
          IDROW = IOR(IDROW,(ISHFT(1,31-I)))
        END IF
   11 END DO

      F = 0.0
      DO 12 I=0,31
        IF (ISHFT(IAND(ISHFT(IDROW,-8),ISHFT(1,I)),1) .NE. 0) THEN
          F = F + 1 / FLOAT(ISHFT(IAND(ISHFT(IDROW,-8),ISHFT(1,I)),1))
        END IF
   12 END DO

      M = C + F                         ! calculate the mantissa
      V = (-1)**S * M * A**(E - B)      ! calculate the float value
      IF (ABS(V) .LT. 2.0**(-149)) THEN
        V = (-1)**S * 0.0               ! avoid underflow
      END IF

      R4IBM = V
      RETURN
      END
```

```
C-----------------------------------------------------------------------
C ^FUNCTION: EBC2ASC
C
C     This function will convert an EBCDIC character to ASCII
C-----------------------------------------------------------------------

      CHARACTER FUNCTION EBC2ASC(N)

      INTEGER            EBCTAB(256)

C  EBCDIC to ASCII table
      DATA EBCTAB/
     & 000,001,002,003,156,009,134,127,151,141,142,011,012,013,014,015, ! 0
     & 016,017,018,019,157,133,008,135,024,025,146,143,028,029,030,031, ! 1
     & 128,129,130,131,132,010,023,027,136,137,138,139,140,005,006,007, ! 2
     & 144,145,022,147,148,149,150,004,152,153,154,155,020,021,158,026, ! 3
     & 032,160,161,162,163,164,165,166,167,168,213,046,060,040,043,124, ! 4
     & 038,169,170,171,172,173,174,175,176,177,033,036,042,041,059,094, ! 5
     & 045,047,178,179,180,181,182,183,184,185,229,044,037,095,062,063, ! 6
     & 186,187,188,189,190,191,192,193,194,096,058,035,064,039,061,034, ! 7
     & 195,097,098,099,100,101,102,103,104,105,196,197,198,199,200,201, ! 8
     & 202,106,107,108,109,110,111,112,113,114,203,204,205,206,207,208, ! 9
     & 209,126,115,116,117,118,119,120,121,122,210,211,212,091,214,215, ! A
     & 216,217,218,219,220,221,222,223,224,225,226,227,228,093,230,231, ! B
     & 123,065,066,067,068,069,070,071,072,073,232,233,234,235,236,237, ! C
     & 125,074,075,076,077,078,079,080,081,082,238,239,240,241,242,243, ! D
     & 092,159,083,084,085,086,087,088,089,090,244,245,246,247,248,249, ! E
     & 048,049,050,051,052,053,054,055,056,057,250,251,252,253,254,255/ ! F
C       0   1   2   3   4   5   6   7   8   9   A   B   C   D   E   F

      EBC2ASC = CHAR(EBCTAB(N+1))

      RETURN
      END
```