#738

78-051A-06D PSPA-00113

PIONEER-VENUS

DIGITAL IMAGING DATA

Table of Contents

1. Introduction

2. Errata/Change Log

3. LINKS TO RELEVANT INFORMATION IN THE ONLINE NSSDC INFORMATION SYSTEM

4. Catalog Materials

    a. Associated Documents

    b. Core Catalog Materials

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1. INTRODUCTION:

The documentation for this data set was originally on paper, kept in NSSDC's Data Set Catalogs (DSCs). The paper documentation in the Data Set Catalogs have been made into digital images, and then collected into a single PDF file for each Data Set Catalog. The inventory information in these DSCs is current as of July 1, 2004. This inventory information is now no longer maintained in the DSCs, but is now managed in the inventory part of the NSSDC information system. The information existing in the DSCs is now not needed for locating the data files, but we did not remove that inventory information.

The offline tape datasets have now been migrated from the original magnetic tape to Archival Information Packages (AIP's).

A prior restoration may have been done on data sets, if a requestor of this data set has questions; they should send an inquiry to the request office to see if additional information exists.

2. ERRATA/CHANGE LOG:

NOTE: Changes are made in a text box, and will show up that way when displayed on screen with a PDF reader.

When printing, special settings may be required to make the text box appear on the printed output.

Version	Date	Person	Page	Description of Change
01				
02				

3 LINKS TO RELEVANT INFORMATION IN THE ONLINE NSSDC INFORMATION SYSTEM:

http://nssdc.gsfc.nasa.gov/nmc/

[NOTE: This link will take you to the main page of the NSSDC Master Catalog. There you will be able to perform searches to find additional information]

4. CATALOG MATERIALS:

a. Associated Documents To find associated documents you will need to know the document ID number and then click here. http://nssdcftp.gsfc.nasa.gov/miscellaneous/documents/

b. Core Catalog Materials

78-051A-06D PSPA-00113

PIONEER VENUS

CLOUD PHOTOPOLARIMETER (OCCP)

DIGITAL IMAGING DATA

THIS DATASET CONSISTS OF 15 TAPES. THE "D" TAPES ARE 9-TRACK 6250 BPI DENSITY, BINARY WHILE THE "C" TAPES ARE 3480 CARTRIDGES. THE FIRST 8 CARD IMAGE FILES OF EACH TAPE USES EBCDIC CHARACTER CODE. A USER SHOULD FRIST LIST THE INITIAL CARD IMAGE FILE WHICH PROVIDES THE COMPLETE INFORMATION ON THE TAPE FORMAT AND REMAINING FILES. A COMPLETE LISTING OF THE TWO PROGRAM SOURCE CODES(FILES #2 AND #4), AS WELL AS THE RESPECTIVE EXPLANATION TEXT FILES(#3 AND #5) HAVE BEEN INCLUDED IN THIS CATALOG. THE "D" AND "C" NUMBER ALONG WITH THEIR TIME SPANS ARE AS FOLLOWING:

D#	C#	FILES	TIMESPAN
D-103920	C-031208	108	02/21/80-04/14/80
D-103921	C-031209	104	04/14/80-05/10/80
D-103922	C-031210	101	05/10/80-06/03/80
D-103923	C-031211	101	06/04/80-12/29/80
D-103924	C-031212	110	01/27/82-03/06/82
D-103925	C-031213	111	03/06/82-04/03/82
D-103926	C-031214	112	04/03/82-04/29/82
D-103927	C-031215	108	04/30/82-05/04/83
D-103928	C-031216	112	05/04/83-06/12/83
D-103929	C-031217	112	06/13/83-03/14/85
D-103930	C-031218	112	03/14/85-04/25/85
D-103931	C-031219	112	04/26/85-06/01/85
D-103932	C-031220	112	06/01/85-08/06/86
D-103933	C-031221	112	08/06/86-06/13/88
D-103934	C-031222	40	06/13/88-03/20/90

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October 15, 1993

NSSDC/Code 633.9
Attn: Ed Bell
Goddard Space Flight Center
Greenbelt, MD 20771

Dear Mr. Bell:

Enclosed are five tapes designated OCPP05 through OCPP08 and OCPP19 which are to be added to the digital imaging data archive for the Pioneer Venus Orbiter Cloud Photopolarimeter (OCPP). Along with tapes OCPP09 through OCPP18 submitted in March of this year, they constitute all of the OCPP imaging data for the period from 02/21/80 through the end of the Pioneer Venus mission. (For your reference, I enclose a copy of my letter explaining the details of that submission in March.) Also enclosed is a printed listing of the catalog of the OCPP imaging data files on all of the tapes as well as a 3.5" diskette with the catalog in the form of a single MS-DOS format file.

Sincerely,

Larry D. Travis

Enclosures

cc: L. Lasher

NASA
National Aeronautics and
Space Administration
Goddard Space Flight Center

Goddard Institute for Space Studies
2880 Broadway
New York, N.Y. 10025
(212) 678-5500

March 4, 1993

NSSDC/Code 633.9
Attn: Ed Bell
Goddard Space Flight Center
Greenbelt, MD 20771

Dear Mr. Bell:

Enclosed are ten tapes which constitute somewhat more than half of the new digital version of the archive of Pioneer Venus Orbiter Cloud Photopolarimeter (OCPP) imaging data. The OCPP acquired two basic types of observations: images at a single, near-ultraviolet wavelength with a spatial resolution of approximately 30 km; and lower spatial resolution polarimetry maps at four wavelengths. Polarimetry map data has been archived on magnetic tapes (72 so far) that appear in the NSSDC catalog as entry 78-051A-06B, although the current catalog name for that data set is the potentially confusing "DIGITAL MAP IMAGES ON MAG TAPE". A better choice for that data set name would be "POLARIMETRY MAP DATA". I note that the time span for that data set is incorrectly listed as 7812-8605 rather than the actual 7812-8804. The NSSDC catalog entry 78-051A-06D seems to represent a projection that I made in response to a NSSDC survey several years ago for additional submissions intended for the archive data set designated by 78-051A-06B.

The original form of submission for the OCPP imaging data was 4" x 5" monochrome negatives and is represented by the 420 negatives listed under NSSDC catalog entry 78-051A-06C. Subsequently, it was decided to convert to a digital archive of the OCPP imaging data. Although a prototype tape of this digital format of the imaging data was sent to Paul Butterworth for review about two years ago, the present delivery represents the first formal submission of this new OCPP archival product. Of course, it should be assigned a distinct NSSDC catalog entry. I believe that an appropriate name for this data set would be "DIGITAL IMAGING DATA".

Also enclosed is a catalog listing of the OCPP images on these tapes (designated using tape numbers OCPP09 through OCPP18) by respective tape and file numbers as well as a single page of archive description and instructions for the potential user. As is explained on that sheet, the intent was for each tape to be a self-contained segment of the archive, independent of the other tapes and providing the user not only with the data, but also on the tape in the first eight "card image" text files, a complete description of the data and the means to use it without recourse to any other source of data or documentation. The remainder of this archive data set will be on nine more tapes (OCPP01 - OCPP08 and OCPP19) that should be submitted in several months. I should also note that I expect that several more tapes of polarimetry data

will be submitted over that same time frame to complete the OCPP polarimetry data archive under NSSDC catalog entry 78-051A-06B.

Thanks in advance for your help in getting this OCPP imaging data archive set up.

Sincerely,

Larry D. Travis

Enclosures

cc: L. Lasher

PIONEER VENUS ORBITER CLOUD PHOTOPOLARIMETER

IMAGING ARCHIVE TAPE

DESCRIPTION AND INSTRUCTIONS

Using a spin-scan imaging approach, the Pioneer Venus Orbiter Cloud Photopolarimeter (OCPP) acquired images of the clouds of Venus in the near ultraviolet with a spatial resolution of approximately 30 km. The images were generated by sampling the incident radiance as the OCPP telescope line of sight was swept across the disk of the planet by spacecraft rotation to create scan lines, while the motion of the spacecraft in its nearly polar orbit provided the cross-scan translation to build up a full-disk image over a period of about four hours.

Digital imaging data from the OCPP for the Pioneer Venus Mission have been archived on magnetic tapes with approximately 100 images per tape, organized with a separate tape file for each image. Preceding these image data files on each tape are eight card image files written with EBCDIC character code and using fixed block record format (RECFM=FB), logical record length of 80 bytes (LRECL=80), and block size of 4000 bytes (BLKSIZE=4000). The first of these eight files explains the tape format and organization and gives a detailed description of the contents of the remaining seven card image files. Those files contain the complete source codes (in standard Fortran 77) for two programs which read the imaging data files and perform the basic data reduction including the "navigation" of the image pixels, namely, the specification of the planetary latitude and longitude corresponding to the center of the pixel as well as the scattering geometry. The other card image files include two ancillary files containing Pioneer Venus Orbiter spacecraft orbital elements and attitude information, two additional text files intended to be read and printed out by the two programs to provide further explanation on program function and use, and an image catalog for the specific data archived on each tape.

The intent of the archive format is to have each tape represent a self-contained segment of the archive, independent of the other tapes and providing the user with a complete description of the data and the means to use it without recourse to any other source of data or documentation. The original archive tapes are 2400-ft open reels, 9-track, and 6250-bpi density, and use EBCDIC character code for the eight card image files at the beginning of the tape. A user should first list the initial card image file, which provides the complete information on the tape format and remaining files. Listings of the two program source codes (files #2 and #4) and the respective explanation text files (#3 and #5) may also assist the user in preparing to process the imaging data.

DSC #138 78-051A-06D

Printed from disk

PIONEER VENUS ORBITER CLOUD PHOTOPOLARIMETER (OCPP)
IMAGING DATA CATALOG

IMAGE NO.	TAPE NO.	FILE NO.	IMAGE START YR	DOY	TIME	IMAGE END YR	DOY	TIME
0807	OCPP09	9	82	27	11:32	82	27	15:00
0810	OCPP09	10	82	35	09:53	82	35	13:50
0811	OCPP09	11	82	35	19:20	82	35	21:33
0812	OCPP09	12	82	36	14:45	82	36	17:54
0813	OCPP09	13	82	36	18:21	82	36	21:36
0814	OCPP09	14	82	37	04:43	82	37	07:39
0815	OCPP09	15	82	37	07:53	82	37	11:38
0816	OCPP09	16	82	37	12:58	82	37	16:59
0817	OCPP09	17	82	37	18:23	82	37	21:37
0818	OCPP09	18	82	38	11:02	82	38	12:32
0819	OCPP09	19	82	38	13:02	82	38	17:01
0820	OCPP09	20	82	38	18:26	82	38	21:40
0821	OCPP09	21	82	39	04:47	82	39	07:42
0822	OCPP09	22	82	39	07:59	82	39	11:44
0823	OCPP09	23	82	39	13:05	82	39	17:04
0824	OCPP09	24	82	39	18:28	82	39	21:40
0825	OCPP09	25	82	40	08:01	82	40	11:47
0826	OCPP09	26	82	40	13:08	82	40	17:07
0827	OCPP09	27	82	40	18:29	82	40	21:42
0828	OCPP09	28	82	41	04:50	82	41	07:41
0829	OCPP09	29	82	41	08:05	82	41	11:51
0830	OCPP09	30	82	41	13:11	82	41	17:10
0831	OCPP09	31	82	41	18:34	82	41	21:44
0832	OCPP09	32	82	42	08:07	82	42	11:52
0833	OCPP09	33	82	42	13:14	82	42	17:12
0834	OCPP09	34	82	42	18:33	82	42	21:44
0835	OCPP09	35	82	43	04:41	82	43	07:29
0836	OCPP09	36	82	43	08:10	82	43	11:56
0837	OCPP09	37	82	43	13:16	82	43	17:14
0838	OCPP09	38	82	43	18:35	82	43	21:46
0839	OCPP09	39	82	44	08:11	82	44	11:57
0840	OCPP09	40	82	44	13:19	82	44	17:16
0841	OCPP09	41	82	44	18:36	82	44	21:46
0842	OCPP09	42	82	45	04:41	82	45	07:32
0843	OCPP09	43	82	45	08:14	82	45	12:00
0844	OCPP09	44	82	45	13:21	82	45	17:18
0845	OCPP09	45	82	45	18:38	82	45	21:47
0846	OCPP09	46	82	46	08:15	82	46	12:02
0847	OCPP09	47	82	46	13:22	82	46	17:20
0848	OCPP09	48	82	46	18:39	82	46	21:47
0849	OCPP09	49	82	47	04:43	82	47	07:34
0850	OCPP09	50	82	47	08:18	82	47	12:03
0851	OCPP09	51	82	47	13:25	82	47	17:22
0852	OCPP09	52	82	47	18:40	82	47	21:48
0853	OCPP09	53	82	48	08:19	82	48	12:04
0854	OCPP09	54	82	48	13:27	82	48	17:24
0855	OCPP09	55	82	48	18:41	82	48	21:50
0856	OCPP09	56	82	49	04:46	82	49	07:37
0857	OCPP09	57	82	49	08:21	82	49	12:07
0858	OCPP09	58	82	49	13:28	82	49	17:25

'78-051A-06D #738

THE PIONEER VENUS ORBITER CLOUD PHOTOPOLARIMETER (OCPP) FUNCTIONS BOTH AS A SPIN-SCAN IMAGING SYSTEM WHICH OBTAINS 30-KM RESOLUTION IMAGES OF THE NEAR ULTRAVIOLET CLOUD FEATURES OF VENUS AND AS A POLARIMETER WHICH CAN PROVIDE MAPS AT FOUR DIFFERENT WAVELENGTHS WITH A RESOLUTION OF APPROXIMATELY 500 KM. SCAN LINES OF BOTH THE IMAGES AND POLARIMETRY MAPS ARE GENERATED BY SAMPLING THE INCIDENT RADIANCE AS THE OCPP TELESCOPE IS SWEPT ACROSS THE DISK OF THE PLANET BY THE SPACECRAFT ROTATION (NOMINAL SPACECRAFT SPIN PERIOD IS 12-13 SECONDS). THE MOTION OF THE SPACECRAFT IN ITS NEARLY POLAR ORBIT PROVIDES THE CROSS-SCAN TRANSLATION, PERMITTING A FULL-DISK IMAGE OR POLARIMETRY MAP TO BE BUILT-UP OVER A PERIOD OF ORDER FOUR HOURS.

IN THE IMAGING MODE, EACH SCAN LINE CONSISTS OF 1016 8-BIT DATA NUMBERS REPRESENTING THE PIXELS OF THAT SCAN LINE, PRECEDED BY 64 BITS OF INSTRUMENT HOUSEKEEPING AND STATUS DATA. THE PIXEL DATA NUMBERS INCLUDE A DARK LEVEL OFFSET OF 15 DN, SO THE INTENSITY IS LINEARLY PROPORTIONAL TO THE PIXEL DATA NUMBER MINUS 15. UNDER NORMAL CIRCUMSTANCES, ONE SCAN LINE OF IMAGE DATA IS ACQUIRED EACH SPIN PERIOD OF THE SPACECRAFT. WHEN THE TELEMETRY RATE IS INSUFFICIENT TO READ OUT THE FULL 8192 BITS OF OCPP DATA, THE LOST PIXELS AT THE END OF THE SCAN ARE SET TO ZERO BY THE PIONEER PROJECT SOFTWARE THAT GENERATES THE EXPERIMENT DATA RECORDS. MANY IMAGES THUS HAVE SCAN LINES WITH SOMEWHAT FEWER THAN 1016 VALID PIXELS. THE OCPP CAN BE COMMANDED TO USE TWO SPIN PERIODS TO READ OUT THE DATA (ALTERNATE ROLL READ OUT MODE COMMANDED ON) TO COMPENSATE FOR LOWER TELEMETRY RATES. THIS REDUCES OR ELIMINATES LOST PIXELS AT THE END OF THE SCAN LINES AT THE EXPENSE OF HALVING THE TOTAL NUMBER OF SCAN LINES IN THE IMAGE AND THUS REDUCING THE CROSS-SCAN RESOLUTION.

THE ORBIT OF THE PIONEER VENUS SPACECRAFT HAS AN INCLINATION OF APPROXIMATELY 105 DEGREES, A PERIOD CLOSE TO 24 HOURS, AND A RELATIVELY HIGH ECCENTRICITY. OCPP IMAGING IS PERFORMED DURING THE APPROXIMATELY 18-HR PERIOD CENTERED ON APOAPSIS (POINT IN THE ORBIT FURTHEST FROM THE PLANET) WHEN THE SPACECRAFT IS FAR ENOUGH AWAY FROM THE PLANET AND MOVING SLOWLY ENOUGH FOR THE OPTIMUM APPLICATION OF THE SPIN-SCAN TECHNIQUE WITHIN THE CONSTRAINTS OF THE MISSION, SPACECRAFT TELEMETRY RATE, AND THE OCPP INSTRUMENT DESIGN. THE NOMINAL ORIENTATION OF THE POSITIVE SPIN AXIS OF THE SPACECRAFT IS WITHIN A FEW DEGREES OF THE SOUTH ECLIPTIC POLE DIRECTION, SO SCAN LINES CROSS THE DISK OF THE PLANET FROM WEST TO EAST. THE OCPP TELESCOPE ARTICULATION IS IN A PLANE CONTAINING THE SPACECRAFT SPIN AXIS, WITH A DISCRETE SET OF COMMANDABLE POSITIONS OR LOOK ANGLES (THE POSITIVE SPIN AXIS DIRECTION IS A LOOK ANGLE OF ZERO DEGREES). DURING THE 18-HOUR IMAGING PERIOD, THE SPACECRAFT IS MOVING NORTHWARD, WITH THE LOOK ANGLE TO THE DISK CENTER CHANGING FROM APPROXIMATELY 130 TO 70 DEGREES. THE PROCEDURE FOR OBTAINING A FULL-DISK IMAGE INVOLVES SELECTING A FIXED LOOK ANGLE APPROPRIATE FOR THE GIVEN PORTION OF THE ORBIT. AS THE SPACECRAFT MOVES NORTHWARD IN ITS ORBIT, THE VIEWING DIRECTION WILL BE TRANSLATED RELATIVE TO THE PLANET UNTIL A SCAN LINE WILL JUST CONTACT THE SOUTHERN LIMB. AFTER A PERIOD OF 3 TO 4.5 HOURS (DEPENDING ON THE LOCATION IN THE ORBIT), THE VIEWING DIRECTION WILL HAVE BEEN SHIFTED BY AN AMOUNT EQUAL TO THE ANGULAR DIAMETER OF THE PLANET, AND THE LAST SCAN LINE ON THE DISK AT THE NORTHERN LIMB WILL BE ACQUIRED.

THIS PROGRAM READS A SET OF RECORDS FROM A SINGLE FILE WHICH CONTAINS THE DATA CORRESPONDING TO A SINGLE IMAGE IN THE OCPP IMAGE CATALOG. EACH OF THESE RECORDS IS COMPOSED OF THE 1024-BYTE DATA SEGMENT CORRESPONDING TO ONE SCAN LINE OF THE IMAGE, PRECEDED BY A TIME TAG OF THREE 4-BYTE INTEGERS: YEAR, DAY OF YEAR (DOY), AND TIME OF DAY IN MILLISECONDS. THE PROGRAM GENERATES ONE LINE OF PRINTED OUTPUT FOR EACH SCAN LINE WHICH SUMMARIZES THE INSTRUMENT STATUS AND SOME GENERAL CHARACTERISTICS OF THE IMAGE INTENSITY DATA.

DESCRIPTION OF PRINTOUT

EACH PRINTED LINE PROVIDES A LIMITED SUMMARY OF THE IMAGING DATA FOR A SINGLE SCAN LINE, ALONG WITH AN INDICATION OF THE RANGE OF PLANETARY COORDINATES AND SCATTERING GEOMETRY CORRESPONDING TO THE PIXELS IN THAT SCAN LINE. FOLLOWING THE SCAN LINE NUMBER IS THE SPACECRAFT UNIVERSAL TIME CORRESPONDING TO THE TRANSMISSION OF THE FIRST BIT OF THE SYNCHRONIZATION CODE IDENTIFYING THE START OF THAT "ROLL" OF DATA. BECAUSE OF THE CONVENTION THAT ANGLES WHICH SPECIFY ROTATIONAL POSITION ABOUT THE SPACECRAFT SPIN AXIS ARE CALLED ROLL ANGLES, THESE DATA SEGMENTS CORRESPONDING TO IMAGE SCAN LINES ARE FREQUENTLY CALLED A ROLL OF OCPP DATA. FOLLOWING THE TIME TAG ARE SUMMARY DIAGNOSTICS OF THE SCAN LINE INTENSITY DATA NUMBERS. THIS SUMMARY IS DESIGNED TO MAKE THE LOCATION IN TIME AND ROLL POSITION OF THOSE IMAGING PIXELS WHICH ARE ON THE THE BRIGHT DISK OF THE PLANET READILY APPARENT WITH JUST A CURSORY INSPECTION OF THE OUTPUT. NOTE THAT THE 15-DN DARK LEVEL OFFSET IS NOT SUBTRACTED FROM THE INTENSITY DATA NUMBERS FOR THIS SURVEY. THE FIRST STEP IN THIS SURVEY FOR EACH SCAN LINE IS THE DETERMINATION OF WHETHER ANY PIXELS MATCH OR EXCEED THE THRESHOLD LEVEL (CURRENTLY SET IN THE PROGRAM AT 22 DN), AND IF SO, WHAT ARE THE FIRST AND LAST SECTOR NUMBERS CORRESPONDING TO SUCH A SPAN OF PIXELS WHICH THEREFORE PRESUMABLY LIE ON THE BRIGHT DISK. THE STATISTICS ON THE INTENSITY DATA NUMBERS FOR A GIVEN SCAN LINE USE THE RANGE FROM FIVE PIXELS BEFORE THE FIRST SECTOR MEETING THE THRESHOLD REQUIREMENT TO FIVE PIXELS FOLLOWING THE LAST SUCH SECTOR. THE DEFAULT MAXIMUM RANGE IS OF COURSE 1-1016, AND THIS IS USED FOR THOSE SCAN LINES FOR WHICH NO PIXELS HAVE INTENSITY DATA NUMBERS MEETING THE THRESHOLD REQUIREMENTS.

MAXIMUM SEC INT: THE MAXIMUM INTENSITY DATA NUMBER FOUND (INT) AND THE SECTOR AT WHICH IT OCCURRED (SEC). IF MORE THAN ONE PIXEL HAS THE SAME MAXIMUM INTENSITY VALUE, THE INDICATED SECTOR NUMBER IS THE LAST SUCH OCCURRENCE.

AVG INT: AVERAGE INTENSITY DATA NUMBER VALUE. NOTE THAT FOR SCAN LINES OFF THE DISK, THE AVERAGE INTENSITY IS OFTEN LESS THAN THE 15-DN OFFSET VALUE BECAUSE OF ZERO-FILL INTENSITY VALUES AT THE END OF THE SCAN LINE.

MAX DERIV SEC VALUE: MAXIMUM DERIVATIVE (VALUE) DEFINED AS THE LARGEST DIFFERENCE IN DN VALUES FOR A PAIR OF SUCCESSIVE PIXELS AND THE SECTOR NUMBER (SEC) CORRESPONDING TO THE FIRST PIXEL OF THAT PAIR. THIS FIELD IS PARTICULARLY USEFUL IN IDENTIFYING THE BRIGHT LIMB LOCATION. IN CONTRAST TO THE RELATIVELY SMOOTHER INCREASE OR DECREASE OF INTENSITY VALUES CORRESPONDING TO THE TERMINATOR SIDE OF THE DISK, THE BRIGHT LIMB SHOULD EXHIBIT THE SHARPEST CHANGE IN INTENSITY AND BE LOCATED BY THE MAXIMUM DERIVATIVE SECTOR. OCCASIONALLY, THE MAXIMUM DERIVATIVE IDENTIFIES A SHORT SEGMENT OF SPURIOUS DATA CAUSED BY AN ENERGETIC PARTICLE STRIKING THE IMAGING DETECTOR. SUCH AN ENERGETIC PARTICLE EVENT CAN RESULT IN A SHARP SPIKE OF UNNATURALLY HIGH INTENSITY VALUE (SOMETIMES SATURATED AT 255 DN) FOLLOWED BY AN UNDERSHOOT BEFORE RECOVERING TO NORMAL VALUES, USUALLY AFTER FOUR TO TEN SECTORS. FORTUNATELY, THESE ENERGETIC PARTICLE EVENTS ARE RELATIVELY INFREQUENT, TYPICALLY NO MORE THAN TEN PER IMAGE.

INT OVER THRESHOLD 1ST SEC LAST SEC: FIRST AND LAST SECTORS MEETING THE THRESHOLD REQUIREMENTS. IF NO PIXELS ARE FOUND WHICH MEET THE REQUIREMENTS, THE PROGRAM GENERATES ASTERISKS IN THIS FIELD. ALTHOUGH THESE SECTOR VALUES ORDINARILY DEFINE THE APPROXIMATE POSITIONS OF THE BRIGHT LIMB AND THE TERMINATOR OF THE DISK, ENERGETIC PARTICLE EVENTS AS DESCRIBED ABOVE CAN CAUSE THE THRESHOLD LOCATION TO BE WELL OFF THE DISK.

LATITUDE RANGE: THE MINIMUM AND MAXIMUM LATITUDES VIEWED BY THE PIXELS OF THE SCAN LINE. LATITUDES AND LONGITUDES ARE BASED UPON A REFERENCE PLANE PARALLEL TO THE 1950 EPOCH ECLIPTIC AND PASSING THROUGH THE INSTANTANEOUS CENTER OF VENUS. THUS, NEGATIVE LATITUDES ARE POSITIONS WITHIN 90 DEGREES OF THE PROJECTION OF THE SOUTH ECLIPTIC POLE ONTO THE PLANET.

LONGITUDE RANGE: THE MINIMUM AND MAXIMUM LONGITUDES VIEWED BY THE PIXELS OF THE SCAN LINE. LONGITUDES INCREASE IN A COUNTER-CLOCKWISE SENSE AS VIEWED FROM THE NORTH ECLIPTIC POLE.

ZENITH ANGLE MINIMA: THE MINIMUM OBSERVER (SPACECRAFT) AND SOLAR ZENITH ANGLES FOR THE PIXELS OF THE SCAN LINE AND THE CORRESPONDING SECTORS AT WHICH THE MINIMA OCCUR. NOTE THAT THE SECTOR NUMBER FOR THE MINIMUM OBSERVER ZENITH ANGLE THUS DEFINES THE INSTANTANEOUS CENTRAL MERIDIAN OF THE PLANET AS VIEWED BY THE SPACECRAFT.

NAVIGATION OF THE PIONEER VENUS OCPP IMAGING DATA

MANY POTENTIAL USES OF THE PIONEER VENUS OCPP IMAGING DATA REQUIRE THAT THE PIXELS OF EACH SCAN LINE BE TAGGED WITH THE PLANETARY LATITUDE AND LONGITUDE WHICH CORRESPOND TO THE CENTER OF THE PIXEL AS WELL AS THE SCATTERING GEOMETRY INFORMATION, NAMELY, COSINE OF THE OBSERVER (SPACECRAFT) ZENITH ANGLE, COSINE OF THE SOLAR ZENITH ANGLE, AND DIFFERENCE BETWEEN THE OBSERVER AND SOLAR DIRECTION AZIMUTHAL ANGLES. THIS PROGRAM PERFORMS SUCH NAVIGATION USING THE SPACECRAFT ORBITAL ELEMENTS INPUT FROM ONE ACCOMPANYING DATA FILE, THE SPACECRAFT ATTITUDE AND SPIN PERIOD FROM ANOTHER ACCOMPANYING DATA FILE, AND INFORMATION ABOUT THE IMAGING TIMING AND SCAN LOCATION THAT IS INPUT SEPARATELY TO THE PROGRAM. THIS LATTER INFORMATION IS DERIVED FROM AN EXAMINATION OF THE ROLL BY ROLL SUMMARY GENERATED BY THE PIONEER VENUS OCPP IMAGE SCAN PROGRAM (WHICH ACCOMPANIES THIS PROGRAM AND THE ASSOCIATED DATA FILES) TO DETERMINE THE TIME OF FIRST OR LAST (AS APPROPRIATE) CONTACT OF THE VENUS DISK AND THE SCAN ELEMENT NUMBER CORRESPONDING TO THAT CONTACT.

HOW DOES ONE ACTUALLY DETERMINE THE APPROPRIATE CONTACT TIME AND CORRESPONDING SCAN ELEMENT? ASSUMING THAT THE OBSERVING SEQUENCE FOR A GIVEN OCPP IMAGE WAS SUCH THAT THE ENTIRE DISK WAS OBTAINED, THEN THE COLUMN FROM THE IMAGE SCAN LISTING SHOWING THE MAXIMUM INTENSITY FOR EACH SCAN LINE WILL EXHIBIT THE INCREASE IN INTENSITY (IN DN) FROM THE DARK LEVELS (15 DN PLUS ABOUT 3 TO 5 DN OF NOISE) TO THE HIGHER VALUES ON THE ILLUMINATED DISK NEAR THE BEGINNING OF THE IMAGE DATA FILE AND THE CORRESPONDING DECREASE NEAR THE END. SINCE IN GENERAL, THE DISK IS NOT COMPLETELY ILLUMINATED FOR A GIVEN IMAGE OBSERVATION GEOMETRY, ONE OF THESE POINTS CORRESPONDS TO A TRUE BRIGHT LIMB OF VENUS AND THE OTHER IS ACTUALLY A TERMINATOR REGION (ALBEIT, OFTEN NOT FAR FROM THE TRUE LIMB). IT IS THE TRUE LIMB POINT THAT SHOULD DESIGNATE THE APPROPRIATE CONTACT TIME, AND IT CAN USUALLY BE DISTINGUISHED BY COMPARING THE RATE OF INCREASE (DECREASE) IN INTENSITY OVER A SUCCESSION OF ADJACENT SCAN LINES; THE MORE RAPID INCREASE (DECREASE) CORRESPONDS TO THE BRIGHT LIMB AND YIELDS THE FIRST (LAST) CONTACT TIME. THE SCAN ELEMENT CORRESPONDING TO THE CONTACT CAN USUALLY BE RATHER EASILY SPECIFIED BY TAKING THE AVERAGE OF THE FIRST AND LAST SECTORS OVER THRESHOLD FOR SEVERAL SCAN LINES NEAR THE CONTACT POINT. THUS, THE INPUT EXPECTED BY SUBROUTINE CONTAC IN THIS NAVIGATION PROGRAM IS THE YEAR, DAY OF YEAR, AND TIME (HH:MM:SS) OF THE CONTACT, FOLLOWED BY A CODE TO IDENTIFY WHETHER THE CONTACT IS FIRST (CODE 1) OR LAST (CODE 2), THE SCAN ELEMENT NUMBER OF THE CONTACT, AND THE ROLL CODE (INDICATED IN THE COLUMN IMMEDIATELY FOLLOWING THE MODE=IMG COLUMN IN THE IMAGE SCAN PROGRAM LISTING) THAT WAS IN EFFECT AT THE TIME OF CONTACT. THE IMAGE CATALOG FILE FOR EACH TAPE OF OCPP IMAGE DATA FILES LISTS DEFAULT VALUES (WHEN AVAILABLE) FOR THESE CONTACT INPUT PARAMETERS FOR EACH IMAGE. A COMPARISON OF THESE VALUES WITH

THE LISTINGS FROM THE IMAGE SCAN PROGRAM RUNS FOR A NUMBER OF IMAGES MAY BE INSTRUCTIVE IN ILLUSTRATING THE CHARACTERISTICS OF THIS DETERMINATION AS MADE BY THE OCPP SCIENCE TEAM. IN SOME CASES THE DATA FOR A PARTICULAR IMAGE IS PARTIAL DISK COVERAGE AND DOES NOT INCLUDE THE ACTUAL CONTACT. FOR THOSE CASES, THIS IMAGE NAVIGATION PROGRAM MUST BE GIVEN A SIMULATED SET OF CONTACT PARAMETERS IN ORDER TO PROCEED. THERE IS NO OBVIOUS STANDARD APPROACH FOR GENERATING SUCH A SIMULATED SET OF CONTACT PARAMETERS, SO WE LEAVE IT TO THE DATA USER TO SELECT AN APPROPRIATE TECHNIQUE IF NAVIGATION OF SUCH IMAGES IS DEEMED NECESSARY. WE NOTE THAT ITERATION OF SIMULATED PARAMETERS BASED UPON THE QUALITY OF THE FIT OF THE NAVIGATION TO THE IMAGE LIMB AND TERMINATOR IS A METHOD THAT THE OCPP SCIENCE TEAM HAS EMPLOYED IN A VERY LIMITED NUMBER OF CASES.

Tape OCPP05
D-103920

```
C
C                P I O N E E R   V E N U S   O C P P
C                I M A G E   S C A N   P R O G R A M
C
C           VERSION LAST MODIFIED - SEPTEMBER 7, 1990
C
C     THIS PROGRAM READS NROLL RECORDS OF OCPP DATA FROM A SINGLE
C     TAPE FILE.  THESE DATA CONSTITUTE A SINGLE VENUS IMAGE IN THE
C     OCPP IMAGE CATALOG, AND THE NUMBER OF RECORDS IS VARIABLE
C     DEPENDING ON THE PARTICULAR IMAGE.  EACH RECORD IS COMPOSED
C     OF A 1024-BYTE DATA SEGMENT PRECEDED BY FOUR 4-BYTE INTEGERS:
C     THE RECORD NUMBER (OR EQUIVALENTLY, THE IMAGE SCAN LINE NUMBER)
C     FOLLOWED BY THE TIME OF ACQUISITION OF THE DATA AT THE START OF
C     THAT RECORD IN INTEGER FORMAT FOR THE ELEMENTS, YEAR (4-DIGIT),
C     DAY-OF-YEAR (DOY), AND TIME OF DAY (IN MILLISECONDS).  EACH OF
C     THE 1024-BYTE DATA SEGMENTS CORRESPONDS TO THE IMAGING DATA
C     ACQUIRED BY THE OCPP DURING ONE SPIN PERIOD (OR TWO, IF THE
C     OCPP IS COMMANDED TO USE ALTERNATE ROLL READOUT) OF THE PIONEER
C     VENUS ORBITER SPACECRAFT.  BECAUSE OF THE CONVENTION THAT
C     ANGLES SPECIFYING ROTATION ABOUT THE SPACECRAFT SPIN AXIS ARE
C     CALLED ROLL ANGLES, WE FREQUENTLY REFER TO THESE DATA SEGMENTS
C     AS "ROLLS" OF OCPP DATA.  WHEN THE OCPP HAS BEEN COMMANDED SO
C     THAT THE SWATH CROSSES THE DISK OF THE PLANET, EACH ROLL THUS
C     CONSTITUTES ONE SCAN LINE OF THE IMAGE.  SPACECRAFT ORBITAL
C     MOTION SHIFTS THE POSITION OF ADJACENT SCAN LINES AND THUS
C     PROVIDES THE RASTER IN THE CROSS-SCAN DIRECTION, PERMITTING
C     A FULL DISK IMAGE OF VENUS TO BE FORMED OVER A PERIOD OF 3 TO
C     4.5 HOURS.
C
      DIMENSION BIT(8),INT(1016),CRLS(6),WCRLS(6),DIN(1024),R(1040),
     *APS(32),MODES(4)
      DOUBLE PRECISION TIME,TIME0
      INTEGER BIT,WDC,HH,YEAR,DOY
      CHARACTER*1 BLANK,PLUS,MINUS,CRLS,WCRLS,ISIGN,DIN,R
      CHARACTER*2 APS,WAP
      CHARACTER*4 MODES,WMODE
      DATA CRLS/'C','R','A','I','L','S'/,APS/' 0','M1',' 2','M2',
     *' 4','M3',' 6','M4',' 8','R1','10','R2','12','R3','14','G1','16',
     *'G2','18','G3','20','B1','22','B2','24','B3','26','U1','28',
     *'U2','30','U3'/,MODES/' STD',' POL',' IMG',' LSC'/,BLANK/' '/,
     *PLUS/'+'/,MINUS/'-'/
      EQUIVALENCE(R(1),NRL),(R(5),YEAR),(R(9),DOY),(R(13),ITIME),
     *(R(17),DIN(1))
C
C     FIRST, PRINT OUT EXPLANATION OF PRINTED OUTPUT OF THIS ROLL BY
C       ROLL SUMMARY OF THE OCPP IMAGING DATA
      CALL EXPLN
C
      SPNPER=12.5
C     SPNPER, SPACECRAFT SPIN PERIOD USED IN DETECTING LOST ROLLS,
C       SET AT 12.5 SEC.  ALTHOUGH ACTUAL SPIN PERIOD VARIES, THIS
C       FIXED VALUE IS SUFFICIENT FOR THE PURPOSE HERE.
      ITHR=22
C     ITHR, THE IMAGING INTENSITY THRESHOLD (IN DN, INCLUDING THE
C       DARK LEVEL OFFSET WHICH IS OF AVERAGE VALUE 15 DN) USED FOR
C       DETECTING WHEN A ROLL OF DATA APPARENTLY CROSSES THE
C       PLANETARY DISK, AND IF SO, THEN WHICH PORTION OF THE ROLL
      LNCNT=0
C     LNCNT, PRINTED OUTPUT LINE COUNT INITIALIZED TO 0
```

```
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C           * * * *   M A I N   L O O P   * * * *
C     EACH PASS THROUGH THE LOOP READS ONE RECORD CORRESPONDING TO
C     ONE ROLL OF OCPP IMAGING DATA, DECODES THE HOUSEKEEPING (I.E.,
C     INSTRUMENT MODES AND STATUS), AND GENERATES ONE PRINTED LINE
C     OF OUTPUT DISPLAYING THE TIME TAG, HOUSEKEEPING, AND A BRIEF
C     SUMMARY OF STATISTICS FOR THE 1016 DATA NUMBERS CORRESPONDING
C     TO THE PIXELS (OR SECTORS) IN THAT SCAN LINE OF IMAGING DATA.
      DO 190 NROLL=1,3000
      READ(12,8001,END=200) R
      TIME=ITIME/1000.D0
      IF(LNCNT.EQ.0) THEN
C        PRINT THE PAGEHEADER WHEN LNCNT=0 (55 LINES/PAGE ARE
C        SPECIFIED BY SETTING LNCNT BACK TO 0 WHEN LNCNT.GE.55
C        THROUGH AN IF TEST AT THE END OF THE MAIN LOOP).
         WRITE(6,9000)
         WRITE(6,9001) YEAR,DOY
         WRITE(6,9002)
         WRITE(6,9003)
         WRITE(6,9004)
      END IF
      LNCNT=LNCNT+1
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     USE THE TIME TAGS FOR SUCCESSIVE ROLLS TO CHECK FOR DATA GAPS
C     OF ONE OR MORE ROLLS AND IF FOUND, GENERATE LOST ROLLS MESSAGE.
      IF(NROLL.GT.1) THEN
         IF(TIME.LT.TIME0) TIME0=TIME0-86400.
         IRLOST=(TIME-TIME0)/(SPNPER*(1+IALRLR))-0.5
         IF(IRLOST.GE.1) THEN
            WRITE(6,9005) IRLOST
            LNCNT=LNCNT+3
         END IF
      END IF
      TIME0=TIME
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     START OF SECTION WHICH DECODES THE OCPP HOUSEKEEPING DATA,
C     WHICH IS CONTAINED IN THE FIRST 8 BYTES OF THE 1024-BYTE
C     INSTRUMENT DATA RECORD FOR EACH ROLL
      CALL BITS(BIT,DIN(3))
      IMODE=2*BIT(3)+BIT(4)+1
      IGAIN=8*BIT(5)+4*BIT(6)+2*BIT(7)+BIT(8)
      CALL BITS(BIT,DIN(4))
      IRI=BIT(1)
      ITSD=BIT(2)
      ILKENC=32*BIT(3)+16*BIT(4)+8*BIT(5)+4*BIT(6)+2*BIT(7)+BIT(8)
      CALL BITS(BIT,DIN(5))
      IAP=16*BIT(1)+8*BIT(2)+4*BIT(3)+2*BIT(4)+BIT(5)+1
      ILSR=BIT(6)
      IALRLR=BIT(7)
      IDC=BIT(8)
      CALL BITS(BIT,DIN(6))
      IFINE=16*BIT(1)+8*BIT(2)+4*BIT(3)+2*BIT(4)+BIT(5)
      ISSTR=BIT(6)
      ITINHB=BIT(7)
      ICAL=BIT(8)
      IRL=ICHAR(DIN(7))
      DO 100 J=1,6
  100 WCRLS(J)=CRLS(J)
      IF(ICAL.EQ.0) WCRLS(1)=BLANK
      IF(IRI.EQ.0) WCRLS(2)=BLANK
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      IF(IALRLR.EQ.0) WCRLS(3)=BLANK
      IF(ITINHB.EQ.0) WCRLS(4)=BLANK
      IF(ILSR.EQ.0) WCRLS(5)=BLANK
      IF(ISSTR.EQ.0) WCRLS(6)=BLANK
      WMODE=MODES(IMODE)
      RLDEG=IRL*360.0/256.0
      WAP=APS(IAP)
      WDC=180
      IF(IDC.EQ.1) WDC=270
      HH=TIME/3600.0
      MM=(TIME-3600*HH)/60.0
      XSS=TIME-3600*HH-60*MM
      ISIGN=PLUS
      IF(ITSD.EQ.0) ISIGN=MINUS
      ALDEG=0.0
      IF(ILKENC.GE.1.AND.ILKENC.LT.4) ALDEG=41.5+ILKENC*1.5
      IF(ILKENC.GE.4) ALDEG=52.0+ILKENC*1.5
      ITEMP=ICHAR(DIN(8))
      VV=-ITEMP/25.5
      TEMP=-29.845-20.401*VV-4.9782*VV*VV-0.87287*VV**3-0.075670*VV**4
     *-0.0025736*VV**5
      IF(ITEMP.EQ.0) TEMP=-100.0
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     START OF SECTION WHICH GENERATES STATISTICS ON THE 1016 8-BIT
C     INTENSITIES (LAST 1016 BYTES OF THE DATA RECORD FOR THE ROLL).
C     THE INTEGER ARRAY, INT, IS CREATED TO HOLD THE 1016 INTENSITIES
C     IN THE RAW DATA NUMBER FORMAT AND IN THE SECTOR ORDER NUMBER
C     AS ACQUIRED BY THE INSTRUMENT.  FOR IMAGE PROCESSING BEYOND THE
C     ROLL BY ROLL SUMMARY OF THE PRESENT PROGRAM, STORE THE ARRAY
C     INT FOR EACH ROLL.  NOTE THAT INT DATA NUMBER VALUES INCLUDE THE
C     DARK LEVEL OF 15 DN; I.E., INTENSITY IS LINEARLY PROPORTIONAL
C     TO INT-15.
      DO 110 J=1,1016
  110 INT(J)=ICHAR(DIN(J+8))
C     FIND THE SECTOR NUMBER (JFIRST) FOR WHICH THE INTENSITY FIRST
C     MEETS THE THRESHOLD REQUIREMENTS, SEARCHING FROM THE BEGINNING
C     OF THE SCAN LINE.  THE REQUIREMENT IS MET ONLY WHEN THE VALUE
C     OF THE INTENSITY EQUALS OR EXCEEDS ITHR AND THE PIXEL FOLLOWING
C     IN THE SCAN LINE HAS A VALUE AT LEAST AS LARGE AS WELL.
      DO 120 J=1,1015
      IF(INT(J).GE.ITHR.AND.INT(J+1).GE.INT(J)) THEN
         JFIRST=J
         GO TO 130
      END IF
  120 JFIRST=10000
  130 CONTINUE
C     FIND THE SECTOR NUMBER (JLAST) FOR WHICH THE INTENSITY LAST
C     MEETS THE THRESHOLD REQUIREMENTS.
      DO 140 J=1016,2,-1
      IF(INT(J).GE.ITHR.AND.INT(J-1).GE.INT(J)) THEN
         JLAST=J
         GO TO 150
      END IF
  140 JLAST=10000
  150 CONTINUE
C     DEFINE START AND END SECTOR VALUES (JS AND JE, RESPECTIVELY)
C     FIVE UNITS OUTSIDE OF THE THRESHOLD POINTS SUBJECT TO THE
C     RESTRICTION THAT THEY LIE IN THE RANGE 1 - 1016.  THESE START
C     AND END SECTOR VALUES ARE USED BELOW AS THE LIMITS DEFINING THE
C     PORTION OF THE ROLL WHICH CORRESPONDS TO THE PLANETARY DISK.
```

```
      JS=JFIRST-5
      JE=JLAST+5
      IF(JS.LT.1.OR.JS.GE.1016) JS=1
      IF(JE.GT.1016) JE=1016
C     FIND SECTOR WHICH CORRESPONDS TO THE MAXIMUM DERIVATIVE IN THE
C     SCAN LINE OF INTENSITIES, I.E., THE LARGEST DIFFERENCE IN DN
C     VALUES FOR A PAIR OF SUCCESSIVE SECTORS.
      MAXDER=0
      JMAXD=10000
      JEFDC=JE
      IF(JEFDC.GT.1015) JEFDC=1015
      DO 160 J=JS,JEFDC
      IDA=IABS(INT(J+1)-INT(J))
      IF(IDA.GT.MAXDER) THEN
         MAXDER=IDA
         JMAXD=J
      END IF
  160 CONTINUE
C     DETERMINE THE MAXIMUM AND MINIMUM INTENSITY, THE SECTOR AT
C     WHICH THE MAXIMUM OCCURS, THE AVERAGE INTENSITY AND STANDARD
C     DEVIATION, AND COUNT THE NUMBER OF SECTORS FOR WHICH THE
C     INTENSITY IS 0 (NSEC0) OR 255 (NSECM).  THE SUM OF NSEC0 AND
C     NSECM IS DISPLAYED IN THE SUMMARY PRINT LINE FOR THE ROLL AS
C     THE NUMBER OF SECTORS LOST DUE TO SATURATION (255) OR DATA
C     GAPS (0) WITHIN THE ROLL.
      NUMP=JE-JS+1
      SUMI=0.0
      SUMIS=0.0
      MAXI=0
      NSEC0=0
      NSECM=0
      DO 170 J=JS,JE
      INTJ=INT(J)
      SUMI=SUMI+INTJ
      SUMIS=SUMIS+INTJ**2
      IF(INTJ.EQ.0) NSEC0=NSEC0+1
      IF(INTJ.EQ.255) NSECM=NSECM+1
      IF(INTJ.GE.MAXI) THEN
         MAXI=INTJ
         JMAX=J
      END IF
  170 CONTINUE
      NSECL=NSEC0+NSECM
      MINI=MAXI
      DO 180 J=JS,JE
      IF(INT(J).LT.MINI) MINI=INT(J)
  180 CONTINUE
      AVGI=SUMI/NUMP
      SIGI=SQRT(SUMIS/NUMP-AVGI**2)
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     PRINT SINGLE LINE OF SUMMARY INFORMATION FOR THE ROLL.
      WRITE(6,9006) HH,MM,XSS,WMODE,IRL,RLDEG,ILKENC,ALDEG,ISIGN,
     *IFINE,IGAIN,WAP,WDC,(WCRLS(J),J=1,6),TEMP,NSECL,JMAX,MAXI,MINI,
     *AVGI,SIGI,JMAXD,MAXDER,JFIRST,JLAST
      IF(LNCNT.GE.55) LNCNT=0
  190 CONTINUE
C     * * * * *   E N D   O F   M A I N   L O O P   * * * * * * * * * *
  200 CONTINUE
 8001 FORMAT(13(80A1))
 9000 FORMAT(1H1)
```

```
 9001 FORMAT(1H ,21X,'PIONEER VENUS OCPP IMAGING DATA  ***  ROLL BY',
     *' ROLL SUMMARY',10X,'YEAR',I5,6X,'DOY',I4)
 9002 FORMAT(1H )
 9003 FORMAT(1H ,6X,'S/C UT',11X,'ROLL     LOOK ANGLE',27X,'SECS  ',
     *'MAXIMUM  MIN  AVG   STD   MAX DERIV  INT OVER THRESHOLD')
 9004 FORMAT(1H ,5X,'SYNC BIT 1 MODE  RL  DEG  LK  DEG  FINE GS AP',
     *' DC  CRAILS  TEMP  LOST  SEC INT  INT  INT   DEV   SEC VALUE',
     *'  1ST SEC   LAST SEC')
 9005 FORMAT(' ','********************'/,' * ',I4,' ROLLS ',
     *'LOST  *'/,' ********************')
 9006 FORMAT(1H ,2X,2I3,F7.3,1X,A4,I4,F6.1,I3,F6.1,A1,I3,I4,1X,A2,I4,
     *1X,6A1,1X,F5.1,I6,I5,I4,I5,F6.1,F6.2,1X,I4,I5,5X,I4,6X,I4)
      STOP
      END
      SUBROUTINE BITS(BIT,CHAR)
C     THIS SUBROUTINE RETURNS THE INTEGER ARRAY, BIT, WITH EACH OF
C     ITS EIGHT ELEMENTS SET TO EITHER 0 OR 1 ACCORDING TO THE BIT
C     PATTERN OF THE 1-BYTE VARIABLE, CHAR.  BIT(1) IS SET FOR THE
C     HIGH-ORDER BIT OF CHAR, AND BIT(8) FOR THE LOW-ORDER BIT.
      DIMENSION BIT(8)
      CHARACTER*1 CHAR
      LOGICAL L
      INTEGER BIT
      INTCHR=ICHAR(CHAR)
      DO 100 N=1,8
  100 BIT(N)=0
      L=BTEST(INTCHR,7)
      IF(L) BIT(1)=1
      L=BTEST(INTCHR,6)
      IF(L) BIT(2)=1
      L=BTEST(INTCHR,5)
      IF(L) BIT(3)=1
      L=BTEST(INTCHR,4)
      IF(L) BIT(4)=1
      L=BTEST(INTCHR,3)
      IF(L) BIT(5)=1
      L=BTEST(INTCHR,2)
      IF(L) BIT(6)=1
      L=BTEST(INTCHR,1)
      IF(L) BIT(7)=1
      L=BTEST(INTCHR,0)
      IF(L) BIT(8)=1
      RETURN
      END
      SUBROUTINE EXPLN
C     THIS SUBROUTINE READS A FILE WHICH CONTAINS A BRIEF SUMMARY OF
C     THE NATURE OF THE OCPP IMAGING DATA AND A DETAILED DESCRIPTION
C     OF THE PRINTOUT GENERATED BY THIS PROGRAM.  THE INPUT FILE IS
C     IN CARD IMAGE FORMAT; THESE RECORDS ARE PRINTED OUT PRIOR TO
C     THE MAIN LISTING OF THE IMAGING DATA SUMMARY.
      DIMENSION C(80)
      CHARACTER*1 C
      WRITE(6,9001)
      DO 100 I=1,56
      READ(20,8001) C
      WRITE(6,9002) C
  1   CONTINUE
      WRITE(6,9000)
      DO 110 I=1,55
      READ(20,8001) C
```

```
      WRITE(6,9002) C
110   CONTINUE
      WRITE(6,9000)
      DO 120 I=1,58
      READ(20,8001) C
      WRITE(6,9002) C
120   CONTINUE
      WRITE(6,9000)
      DO 190 I=1,500
      READ(20,8001,END=200) C
      WRITE(6,9002) C
190   CONTINUE
200   CONTINUE
8001  FORMAT(80A1)
9000  FORMAT(1H1)
9001  FORMAT(1H1,6X,'P I O N E E R  V E N U S  O C P P  I M A G E',
     *'  S C A N  P R O G R A M',//)
9002  FORMAT(1H ,3X,80A1)
      RETURN
      END
```

```
C
C                P I O N E E R   V E N U S   O C P P
C           I M A G E   N A V I G A T I O N   P R O G R A M
C
C           VERSION LAST MODIFIED - SEPTEMBER 7, 1990
C
C      THIS PROGRAM READS NROLL RECORDS OF OCPP DATA FROM A SINGLE
C      TAPE FILE.  THESE DATA CONSTITUTE A SINGLE VENUS IMAGE IN THE
C      OCPP IMAGE CATALOG, AND THE NUMBER OF RECORDS IS VARIABLE
C      DEPENDING ON THE PARTICULAR IMAGE.  EACH RECORD IS COMPOSED
C      OF A 1024-BYTE DATA SEGMENT PRECEDED BY FOUR 4-BYTE INTEGERS:
C      THE RECORD NUMBER (OR EQUIVALENTLY, THE IMAGE SCAN LINE NUMBER)
C      FOLLOWED BY THE TIME OF ACQUISITION OF THE DATA AT THE START OF
C      THAT RECORD IN INTEGER FORMAT FOR THE ELEMENTS, YEAR (4-DIGIT),
C      DAY-OF-YEAR (DOY), AND TIME OF DAY (IN MILLISECONDS).  EACH OF
C      THE 1024-BYTE DATA SEGMENTS CORRESPONDS TO THE IMAGING DATA
C      ACQUIRED BY THE OCPP DURING ONE SPIN PERIOD (OR TWO, IF THE
C      OCPP IS COMMANDED TO USE ALTERNATE ROLL READOUT) OF THE PIONEER
C      VENUS ORBITER SPACECRAFT.  BECAUSE OF THE CONVENTION THAT
C      ANGLES SPECIFYING ROTATION ABOUT THE SPACECRAFT SPIN AXIS ARE
C      CALLED ROLL ANGLES, WE FREQUENTLY REFER TO THESE DATA SEGMENTS
C      AS "ROLLS" OF OCPP DATA.  WHEN THE OCPP HAS BEEN COMMANDED SO
C      THAT THE SWATH CROSSES THE DISK OF THE PLANET, EACH ROLL THUS
C      CONSTITUTES ONE SCAN LINE OF THE IMAGE.  SPACECRAFT ORBITAL
C      MOTION SHIFTS THE POSITION OF ADJACENT SCAN LINES AND THUS
C      PROVIDES THE RASTER IN THE CROSS-SCAN DIRECTION, PERMITTING
C      A FULL DISK IMAGE OF VENUS TO BE FORMED OVER A PERIOD OF 3 TO
C      4.5 HOURS.
C
C      IN ADDITION TO THE FILE WHICH CONTAINS THE ROLL-BY-ROLL OCPP
C      IMAGING DATA, THIS PROGRAM READS A FILE WHICH CONTAINS THE
C      ORBITAL ELEMENTS FOR THE PIONEER VENUS ORBITER SPACECRAFT.
C      THIS FILE IS IN CARD IMAGE FORMAT, ONE CARD IMAGE (RECORD) PER
C      ORBIT, WITH THE SIX ORBITAL ELEMENTS FOLLOWING THE ORBIT NUMBER
C      AND THE YEAR, DAY OF YEAR (DOY), AND THE TIME OF DAY (UT) OF
C      PERIAPSIS (CLOSEST APPROACH OF THE SPACECRAFT TO VENUS WITHIN
C      THE ORBIT).  THE PROGRAM ALSO READS ANOTHER CARD IMAGE FORMAT
C      FILE WHICH CONTAINS THE SPACECRAFT SPIN AXIS ATTITUDE COORDI-
C      NATES (LATITUDE AND LONGITUDE) AND THE SPACECRAFT SPIN PERIOD
C      IN SECONDS.  ON EACH CARD IMAGE, THESE DATA FOLLOW THE YEAR,
C      DOY, AND TIME OF DAY FOR WHICH THE ATTITUDE AND SPIN PERIOD IS
C      APPLICABLE.  UNLIKE THE ORBITAL ELEMENTS FILE, THERE MAY BE
C      SEVERAL SUCH RECORDS FOR A SINGLE ORBIT AS NECESSARY TO
C      ADEQUATELY SPECIFY ATTITUDE AND SPIN PERIOD CHANGES.
C
C      THE ATTITUDE AND SPIN PERIOD INFORMATION AND THE SPACECRAFT
C      ORBITAL ELEMENTS ARE USED BY THIS PROGRAM ALONG WITH INPUT
C      INFORMATION ABOUT THE IMAGE TIMING AND SCAN LOCATION TO
C      "NAVIGATE" THE IMAGING DATA, NAMELY, TO TAG EACH PIXEL OF EACH
C      SCAN LINE WITH THE PLANETARY LATITUDE AND LONGITUDE WHICH COR-
C      RESPOND TO THE CENTER OF THE PIXEL AS WELL AS THE SCATTERING
C      GEOMETRY: COSINE OF THE OBSERVER (SPACECRAFT) ZENITH ANGLE,
C      COSINE OF THE SOLAR ZENITH ANGLE, AND DIFFERENCE BETWEEN THE
C      OBSERVER AND SOLAR DIRECTION AZIMUTHAL ANGLES.  THESE FIVE
C      PARAMETERS ARE STORED IN THE 1016-ELEMENT ARRAYS: LAT, LON,
C      ZMU, ZMU0, AND PMP0, RESPECTIVELY, FOR A GIVEN SCAN LINE AND
C      THUS NAVIGATE THE CORRESPONDING IMAGE PIXELS REPRESENTED BY
C      THE OCPP INTENSITIES (DATA NUMBER VALUES) IN ARRAY INT.  SINCE
C      THESE SINGLY-DIMENSIONED ARRAYS ARE RE-USED WITH EACH NEW SCAN
C      LINE, FURTHER USE OF THE NAVIGATED OCPP DATA REQUIRES STORING
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C     THESE ARRAYS ON DISK, TAPE, ETC., OR MODIFYING THE PRESENT
C     PROGRAM TO SAVE THESE DATA IN DOUBLY-DIMENSIONED ARRAYS.
C
C     NOTE THAT THE COORDINATE SYSTEM USED THROUGHOUT IS BASED UPON
C     THE 1950 EPOCH ECLIPTIC AS THE REFERENCE PLANE.  THUS, THE
C     LATITUDE AND LONGITUDE OF THE SPACECRAFT SPIN AXIS ARE
C     SPECIFIED RELATIVE TO A PLANE PARALLEL TO THE 1950 EPOCH
C     ECLIPTIC, PASSING THROUGH THE INSTANTANEOUS CENTER OF THE
C     SPACECRAFT.  SIMILARLY, THE LATITUDE AND LONGITUDE OF A GIVEN
C     IMAGE PIXEL IS RELATIVE TO A PLANE PARALLEL TO THE 1950 EPOCH
C     ECLIPTIC, PASSING THROUGH THE INSTANTANEOUS CENTER OF VENUS.
C     THUS, THE SPECIFIED PIXEL LATITUDE AND LONGITUDE ARE REFERENCED
C     TO THE FIXED CELESTIAL POSITIONS, NOT VENUS BODY-FIXED.  NOTE,
C     HOWEVER, THAT THE POLES OF THIS ECLIPTIC-BASED SYSTEM ARE IN
C     FACT WITHIN SEVERAL DEGREES OF THE SPIN AXIS OF VENUS.
C
      DIMENSION BIT(8),INT(1016),DIN(1024),R(1040)
      COMMON/NAVINF/ ZMU(1016),ZMU0(1016),PMP0(1016),LAT(1016),
     *LON(1016),LATMAX,LATMIN,LONMAX,LONMIN,OZAMIN,SZAMIN,JOZA,JSZA
      REAL*4 LAT,LON,LATMAX,LATMIN,LONMAX,LONMIN
      DOUBLE PRECISION TIME,ZTIME
      INTEGER BIT,HH,YEAR,DOY
      CHARACTER*1 DIN,R
      EQUIVALENCE(R(1),NRL),(R(5),YEAR),(R(9),DOY),(R(13),ITIME),
     *(R(17),DIN(1))
C
C     FIRST, PRINT OUT EXPLANATION OF PRINTED OUTPUT OF THIS ROLL BY
C     ROLL SUMMARY OF THE OCPP IMAGING DATA
      CALL EXPLN
C
      ITHR=22
C     ITHR, THE IMAGING INTENSITY THRESHOLD (IN DN, INCLUDING THE
C     DARK LEVEL OFFSET WHICH IS OF AVERAGE VALUE 15 DN) USED FOR
C     DETECTING WHEN A ROLL OF DATA APPARENTLY CROSSES THE PLANETARY
C     DISK, AND IF SO, THEN WHICH PORTION OF THE ROLL
      LNCNT=0
C     LNCNT, PRINTED OUTPUT LINE COUNT INITIALIZED TO 0
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C           * * * *   M A I N   L O O P   * * * *
C     EACH PASS THROUGH THE LOOP READS ONE RECORD CORRESPONDING TO
C     ONE ROLL OF OCPP IMAGING DATA, DECODES THE HOUSEKEEPING (I.E.,
C     INSTRUMENT MODES AND STATUS) AS NECESSARY FOR THE NAVIGATION
C     OF THE IMAGING DATA, AND GENERATES ONE PRINTED LINE OF OUTPUT
C     DISPLAYING THE SCAN LINE NUMBER, TIME TAG, A BRIEF SUMMARY OF
C     STATISTICS FOR THE DATA NUMBERS CORRESPONDING TO THE PIXELS
C     (OR SECTORS) IN THAT SCAN LINE OF IMAGING DATA, AND AN INDICA-
C     TION OF THE RANGE OF PLANETARY LATITUDES AND LONGITUDES FOR
C     THE PIXELS OF THAT SCAN LINE BASED UPON THE NAVIGATION PER-
C     FORMED BY SUBROUTINE NAV.  ALSO SHOWN ARE THE MINIMUM OBSERVER
C     AND SOLAR ZENITH ANGLES FOR THAT SCAN AS WELL AS THE SECTOR
C     NUMBERS CORRESPONDING TO THOSE MINIMA.
      DO 190 NROLL=1,3000
      READ(12,8001,END=200) R
      TIME=ITIME/1000.D0
      ZTIME=86400.0*DOY+TIME
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     START OF SECTION WHICH DECODES THE OCPP HOUSEKEEPING DATA,
C     WHICH IS CONTAINED IN THE FIRST 8 BYTES OF THE 1024-BYTE
C     INSTRUMENT DATA RECORD FOR EACH ROLL
```

```
      CALL BITS(BIT,DIN(3))
      IGAIN=8*BIT(5)+4*BIT(6)+2*BIT(7)+BIT(8)
      CALL BITS(BIT,DIN(4))
      ITSD=BIT(2)
      ILKENC=32*BIT(3)+16*BIT(4)+8*BIT(5)+4*BIT(6)+2*BIT(7)+BIT(8)
      CALL BITS(BIT,DIN(5))
      ILSR=BIT(6)
      IRL=ICHAR(DIN(7))
      HH=TIME/3600.0
      MM=(TIME-3600*HH)/60.0
      XSS=TIME-3600*HH-60*MM
      ALDEG=0.0
      IF(ILKENC.GE.1.AND.ILKENC.LT.4) ALDEG=41.5+ILKENC*1.5
      IF(ILKENC.GE.4) ALDEG=52.0+ILKENC*1.5
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     AFTER THE FIRST ROLL OF DATA HAS BEEN READ IN AND NECESSARY OCPP
C     HOUSEKEEPING INFORMATION OBTAINED, CALL SUBROUTINE CONTAC WHICH
C     DETERMINES THOSE NAVIGATION PARAMETERS WHICH ARE CONSTANT OVER
C     THE ENTIRE IMAGE.  THOSE PARAMETERS ARE PASSED TO SUBROUTINE NAV
C     (WHICH PERFORMS THE SCAN LINE AND PIXEL DEPENDENT COMPUTATIONS)
C     THROUGH THE NAMED COMMON BLOCK, CONTV.
C
      IF(NROLL.EQ.1) THEN
         CALL CONTAC(ILSR,ITSD,ALDEG,IOK)
         IF(IOK.EQ.0) STOP
      END IF
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     START OF SECTION WHICH GENERATES STATISTICS ON THE 1016 8-BIT
C     INTENSITIES (LAST 1016 BYTES OF THE DATA RECORD FOR THE ROLL).
C     THE INTEGER ARRAY INT IS CREATED TO HOLD THE 1016 INTENSITIES
C     IN THE RAW DATA NUMBER FORMAT AND IN THE SECTOR ORDER NUMBER
C     AS ACQUIRED BY THE INSTRUMENT.  NOTE THAT THE DATA NUMBER
C     VALUES OF THE ARRAY INT INCLUDE THE DARK LEVEL OF 15 DN; I.E.,
C     INTENSITY IS LINEARLY PROPORTIONAL TO INT-15.
C
      DO 110 J=1,1016
  110 INT(J)=ICHAR(DIN(J+8))
C     FIND THE SECTOR NUMBER (JFIRST) FOR WHICH THE INTENSITY FIRST
C     MEETS THE THRESHOLD REQUIREMENTS, SEARCHING FROM THE BEGINNING
C     OF THE SCAN LINE.  THE REQUIREMENT IS MET ONLY WHEN THE VALUE
C     OF THE INTENSITY EQUALS OR EXCEEDS ITHR AND THE PIXEL FOLLOWING
C     IN THE SCAN LINE HAS A VALUE AT LEAST AS LARGE AS WELL.
      DO 120 J=1,1015
      IF(INT(J).GE.ITHR.AND.INT(J+1).GE.INT(J)) THEN
         JFIRST=J
         GO TO 130
      END IF
  120 JFIRST=10000
  130 CONTINUE
C     FIND THE SECTOR NUMBER (JLAST) FOR WHICH THE INTENSITY LAST
C     MEETS THE THRESHOLD REQUIREMENTS.
      DO 140 J=1016,2,-1
      IF(INT(J).GE.ITHR.AND.INT(J-1).GE.INT(J)) THEN
         JLAST=J
         GO TO 150
      END IF
  140 JLAST=10000
  150 CONTINUE
C     DEFINE START AND END SECTOR VALUES (JS AND JE, RESPECTIVELY)
```

```
C      FIVE UNITS OUTSIDE OF THE THRESHOLD POINTS SUBJECT TO THE
C      RESTRICTION THAT THEY LIE IN THE RANGE 1 - 1016.  THESE START
C      AND END SECTOR VALUES ARE USED BELOW AS THE LIMITS DEFINING THE
C      PORTION OF THE ROLL WHICH CORRESPONDS TO THE PLANETARY DISK.
       JS=JFIRST-5
       JE=JLAST+5
       IF(JS.LT.1.OR.JS.GE.1016) JS=1
       IF(JE.GT.1016) JE=1016
C      FIND SECTOR WHICH CORRESPONDS TO THE MAXIMUM DERIVATIVE IN THE
C      SCAN LINE OF INTENSITIES, I.E., THE LARGEST DIFFERENCE IN DN
C      VALUES FOR A PAIR OF SUCCESSIVE SECTORS.
       MAXDER=0
       JMAXD=10000
       JEFDC=JE
       IF(JEFDC.GT.1015) JEFDC=1015
       DO 160 J=JS,JEFDC
       IDA=IABS(INT(J+1)-INT(J))
       IF(IDA.GT.MAXDER) THEN
          MAXDER=IDA
          JMAXD=J
       END IF
  160  CONTINUE
C      DETERMINE THE MAXIMUM INTENSITY AND THE SECTOR AT WHICH IT
C      OCCURS AS WELL AS THE AVERAGE INTENSITY OVER THE PORTION OF
C      THE ROLL FROM SECTOR JS TO SECTOR JE.
       NUMP=JE-JS+1
       SUMI=0.0
       MAXI=0
       DO 170 J=JS,JE
       INTJ=INT(J)
       SUMI=SUMI+INTJ
       IF(INTJ.GE.MAXI) THEN
          MAXI=INTJ
          JMAX=J
       END IF
  170  CONTINUE
       AVGI=SUMI/NUMP
C      * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C      THE FOLLOWING CALL TO SUBROUTINE NAV FOR EACH ROLL OF OCPP
C      IMAGING DATA COMPLETES THE NAVIGATION DETERMINATION BY USING THE
C      TIME (ZTIME) AT WHICH THE ROLL OF DATA WAS ACQUIRED, THE COMMANDED
C      STARTING ROLL POSITION (IRL), THE INDICATOR OF NORMAL VERSUS LOW
C      SAMPLE RATE (ILSR), AND INFORMATION PASSED THROUGH COMMON FROM
C      SUBROUTINE CONTAC TO COMPUTE THE LATITUDE, LONGITUDE, AND THE
C      SCATTERING GEOMETRY PARAMETERS FOR EACH PIXEL OF THE SCAN LINE.
C
       CALL NAV(ZTIME,IRL,ILSR,JS,JE)
C
C      * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C      PRINT A SINGLE LINE OF SUMMARY INFORMATION FOR THE ROLL.
C      FOR FURTHER PROCESSING OF THE NAVIGATED IMAGE DATA, THIS
C      PROGRAM SHOULD BE MODIFIED AT THIS POINT TO EITHER WRITE THE
C      ARRAYS: INT, LAT, LON, ZMU, ZMU0, AND PMP0 (OR SOME SUBSET OR
C      CONVERTED VERSIONS OF SAME) TO DISK, TAPE, ETC., OR STORE IN
C      NEW DOUBLY-DIMENSIONED ARRAYS FOR USE AFTER THE MAIN LOOP
C      PROCESSING HAS BEEN COMPLETED (FOLLOWING STATEMENT NUMBER 200).
C
       IF(LNCNT.EQ.0) THEN
          PRINT THE PAGEHEADER WHEN LNCNT=0 (55 LINES/PAGE ARE
          SPECIFIED BY SETTING LNCNT BACK TO 0 WHEN LNCNT.GE.55
```

```
C        THROUGH AN IF TEST AT THE END OF THE MAIN LOOP).
         WRITE(6,9000)
         WRITE(6,9001) YEAR,DOY
         WRITE(6,9002)
         WRITE(6,9003)
         WRITE(6,9004)
       END IF
       LNCNT=LNCNT+1
       WRITE(6,9005) NROLL,HH,MM,XSS,JMAX,MAXI,AVGI,JMAXD,MAXDER,JFIRST,
      *JLAST,LATMIN,LATMAX,LONMIN,LONMAX,OZAMIN,JOZA,SZAMIN,JSZA
       IF(LNCNT.GE.55) LNCNT=0
  190 CONTINUE
C     * * * * *   E N D   O F   M A I N   L O O P   * * * * * * * * * *
  200 CONTINUE
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C                MAIN ROUTINE FORMAT STATEMENTS:
C
 8001 FORMAT(13(80A1))
 9000 FORMAT(1H1)
 9001 FORMAT(1H ,16X,'NAVIGATED PIONEER VENUS OCPP IMAGING DATA  ***  ',
     *'ROLL BY ROLL SUMMARY',10X,'YEAR',I5,6X,'DOY',I4)
 9002 FORMAT(1H )
 9003 FORMAT(1H ,'SCAN     S/C UT',5X,'MAXIMUM  AVG   MAX DERIV  INT',
     *' OVER THRESHOLD  LATITUDE RANGE  LONGITUDE RANGE   ZENITH',
     *' ANGLE MINIMA')
 9004 FORMAT(1H ,'LINE    SYNC BIT 1  SEC INT  INT   SEC VALUE  1ST',
     *' SEC   LAST SEC',35X,'OBS   SEC   SOLAR  SEC')
 9005 FORMAT(1H ,I4,1X,2I3,F7.3,I5,I4,F6.1,2I5,5X,I4,6X,I4,5X,F5.1,2X,
     *F5.1,3X,F6.1,3X,F5.1,3X,F4.1,I5,4X,F4.1,I5)
       STOP
       END
       SUBROUTINE CONTAC(ILSR,ITSD,ALDEG,IOK)
C      THIS SUBROUTINE DETERMINES IMAGE NAVIGATION PARAMETERS WHICH
C      ARE CONSTANT OVER THE ENTIRE IMAGE AND PASSES THOSE PARAMETERS
C      THROUGH THE NAMED COMMON BLOCK, CONTV, TO SUBROUTINE NAV, WHICH
C      IS CALLED FOR EACH SCAN LINE TO DETERMINE THE NAVIGATION FOR
C      EACH PIXEL.  AT THE BEGINNING OF THIS SUBROUTINE, INPUT PARAMETERS
C      DEFINING THE CONTACT TIME AND ITS LOCATION ARE READ IN (PRESENTLY,
C      DSRN=5, CARD INPUT).  FOLLOWING THAT, ORBITAL ELEMENTS ARE READ IN
C      FROM DSRN=20 UNTIL THE TWO SETS OF ORBITAL ELEMENTS FOR THE TWO
C      ORBITS THAT BRACKET THE CONTACT TIME ARE ACCESSED, AND THESE ARE
C      LINEARLY INTERPOLATED IN TIME TO GIVE THE ORBITAL ELEMENTS USED IN
C      THE NAVIGATION DETERMINATION.  A CALL TO SUBROUTINE ATTSPN YIELDS
C      THE SPACECRAFT ATTITUDE AND SPIN PERIOD USING AN ACCOMPANYING
C      DATA FILE READ IN BY THAT SUBROUTINE WITH DSRN=15.  THE ORBITAL
C      ELEMENTS ARE USED TO DETERMINE SPACECRAFT POSITION AND ALONG WITH
C      ATTITUDE AND CONTACT INPUT PARAMETERS YIELD THE LOOK ANGLE AND
C      ROLL ANGLE TO THE VENUS DISK CENTER AT THE TIME OF CONTACT.
C
       IMPLICIT REAL*8 (A-H,O-Z)
       INTEGER TCEN,TPER,DOY
       REAL*8 LAMBDA,INCLIN,JD
       COMMON/CONTV/ TCEN,TPER,TLKOBS,CROLL,CLATAX,CLONAX,SPNPER,
      *SSLAT1,SSLON1,SSLAT2,SSLON2,STLK,CTLK,SATLAT,CATLAT
       COMMON/ORBP/ R(9000),F(9000),A,ECC,INCLIN,OMEGA,T,P,LAMBDA,
      *RADCON,PI,TWOPI,COSI,SINI,ETA
       DIMENSION VLOOKS(300)
       PI=3.1415926535897932D0
       TWOPI=2.0*PI
```

```
      RADCON=PI/180.0
      IOK=0
      T=0.0
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     READ IN (DSRN=5) IMAGE CONTACT TIME AND LOCATION PARAMETERS:
C       EIGHT PARAMETERS, ALL INTEGERS:
C         IYEAR (TWO DIGITS, 78-92), CONTACT TIME YEAR
C         IDOY, CONTACT TIME DAY-OF-YEAR
C         IHH, CONTACT TIME HOUR (24-HOUR CLOCK)
C         IMM, CONTACT TIME MINUTES
C         ISS, CONTACT TIME SECONDS
C         ITCODE, CONTACT CODE (1-FIRST CONTACT, 2-LAST CONTACT)
C         ICMSEC, SECTOR (SCAN ELEMENT) # CORRESPONDING TO CONTACT
C         IRLC, OCPP ROLL CODE IN EFFECT AT THE TIME OF CONTACT
C
      READ(5,8001) IYEAR,IDOY,IHH,IMM,ISS,ITCODE,ICMSEC,IRLC
      WRITE(6,9000) IYEAR,IDOY,IHH,IMM,ISS,ITCODE,ICMSEC,IRLC
      IF(ITCODE.NE.1.AND.ITCODE.NE.2) THEN
         WRITE(6,9001) ITCODE
         RETURN
      END IF
      CTIME=3600*IHH+60*IMM+ISS
      TCONT=86400*IDOY+CTIME
      NDAY=(IYEAR-78)*365+IDOY
      IF(IYEAR.GT.80) NDAY=NDAY+1
      IF(IYEAR.GT.84) NDAY=NDAY+1
      IF(IYEAR.GT.88) NDAY=NDAY+1
      CTIME=NDAY+CTIME/86400.D0-(ITCODE/6.0-0.25)
      ATIME=CTIME-0.958333D0
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     THE FOLLOWING SECTION READS THE PIONEER VENUS SPACECRAFT ORBITAL
C     ELEMENTS FROM THE ACCOMPANYING DATA FILE USING DSRN=20.  THAT
C     FILE HAS ONE CARD IMAGE RECORD FOR EACH ORBIT SPECIFYING THE
C     ORBITAL ELEMENTS AT THE TIME OF PERIAPSIS, OR CLOSEST APPROACH.
C     RECORDS ARE READ UNTIL THE PAIR OF ORBITS (SEPARATED BY ABOUT
C     24 HOURS) WHICH BRACKET THE TIME OF THE IMAGE (BASED UPON THE
C     CONTACT TIME INPUT ABOVE) ARE FOUND.  LINEAR INTERPOLATION IN
C     TIME IS USED TO GENERATE ORBITAL ELEMENTS APPROPRIATE FOR THE
C     NAVIGATION OF THE IMAGE DATA.  EACH CARD IMAGE RECORD CONTAINS
C     THE FOLLOWING ENTRIES IN ORDER:
C       NORB, ORBIT NUMBER
C       IYYDOY, YEAR AND DAY-OF-YEAR OF PERIAPSIS (FORMATTED AS A SINGLE
C         INTEGER SUCH AS 78035, WHERE YEAR=78 AND DOY=035)
C       IPTIME, PERIAPSIS TIME (24-HOUR CLOCK, FORMATTED AS AN INTEGER
C         WITHOUT COLONS, HHMMSS)
C       A, SEMI-MAJOR AXIS IN KM
C       ECC, ECCENTRICITY
C       FINCL, INCLINATION IN DEGREES
C       OMEGA, ARGUMENT OF PERIAPSIS IN DEGREES
C       ETA, LONGITUDE OF ASCENDING NODE IN DEGREES
C       PERH, PERIOD IN HOURS
C     THE ABOVE VARIABLE NAMES FOLLOWED BY A 1 OR 2 CORRESPOND TO THE
C     RESPECTIVE ELEMENTS FOR THE PAIR OF ORBITS.
C
      DO 100 N=1,6000
      READ(20,*,END=110) NORB1,IYYDOY,IPTIME,A1,ECC1,FINCL1,OMEGA1,
     *ETA1,PERH1
      IYY=IYYDOY/1000
      NDOY=IYYDOY-1000*IYY
      LDAY=(IYY-78)*365+NDOY
```

```
      IF(IYY.GT.80) LDAY=LDAY+1
      IF(IYY.GT.84) LDAY=LDAY+1
      IF(IYY.GT.88) LDAY=LDAY+1
      IPTH=IPTIME/10000
      IPTI=IPTIME-10000*IPTH
      IPTM=IPTI/100
      IPTS=IPTI-100*IPTM
      TP=IPTH+(IPTM+IPTS/60.0)/60.0
      BTIME=LDAY+TP/24.0
      IF(BTIME.GE.ATIME) GO TO 120
  100 CONTINUE
  110 WRITE(6,9002) IYEAR,IDOY
      RETURN
  120 TPER=86400*NDOY+3600*TP
      READ(20,*) NORB2,IYYDOY,IPTIME,A2,ECC2,FINCL2,OMEGA2,ETA2,PERH2
      IYY2=IYYDOY/1000
      NDOY2=IYYDOY-1000*IYY2
      AVGPER=(PERH1+PERH2)/48.0
      DEL=(CTIME-BTIME)/AVGPER
      A=A1+(A2-A1)*DEL
      ECC=ECC1+(ECC2-ECC1)*DEL
      INCLIN=FINCL1+(FINCL2-FINCL1)*DEL
      OMEGA=OMEGA1+(OMEGA2-OMEGA1)*DEL
      ETA=ETA1+(ETA2-ETA1)*DEL
      PERH=PERH1+(PERH2-PERH1)*DEL
      P=PERH*3600.D0
      WRITE(6,9003) NORB1,IYY,NDOY,NORB2,IYY2,NDOY2,A,ECC,INCLIN,
     *OMEGA,ETA,P
      INCLIN=INCLIN*RADCON
      COSI=DCOS(INCLIN)
      SINI=DSIN(INCLIN)
      OMEGA=OMEGA*RADCON
      ETA=ETA*RADCON
      LAMBDA=DARSIN(DSIN(OMEGA)*SINI)
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
      IHOUR=IHH-4*ITCODE+6
      JDOY=IDOY
      IF(IHOUR.LT.0) THEN
         IHOUR=IHOUR+24
         JDOY=JDOY-1
      ELSE IF(IHOUR.GE.24) THEN
         IHOUR=IHOUR-24
         JDOY=JDOY+1
      END IF
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     CALL SUBROUTINE ATTSPN TO READ PIONEER VENUS SPACECRAFT ATTITUDE
C     AND SPIN PERIOD INFORMATION AND INTERPOLATE IN TIME TO GENERATE
C     LATITUDE AND LONGITUDE (CLATAX AND CLONAX) OF THE SPACECRAFT SPIN
C     AXIS DIRECTION AND THE SPIN PERIOD (IN SECONDS) CORRESPONDING TO
C     THE TIME OF THE IMAGE.  THE ATTITUDE AND SPIN PERIOD INFORMATION
C     ARE CONTAINED IN AN ACCOMPANYING DATA FILE IN CARD IMAGE FORMAT AS
C     DESCRIBED IN SUBROUTINE ATTSPN.  THIS FILE IS READ USING DSRN=15.
C
      CALL ATTSPN(IYEAR,JDOY,IHOUR,IMM,CLATAX,CLONAX,SPNPER)
      WRITE(6,9004) CLATAX,CLONAX
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     THE FOLLOWING SECTION USES THE ORBITAL ELEMENTS DETERMINED ABOVE
C     WITH SUBROUTINES ORBIT AND SATPOS TO FIND THE POSITION OF THE
C     PIONEER VENUS SPACECRAFT AT THE TIME CORRESPONDING TO THE IMAGE
C     CONTACT.  THIS POSITION, THE ATTITUDE, AND THE CONTACT SECTOR
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C     (ICMSEC) ARE USED WITH SUBROUTINE LKRL TO DETERMINE THE LOOK ANGLE
C     AND ROLL ANGLE TO THE VENUS DISK CENTER AT THE TIME OF CONTACT.
C     THIS INFORMATION IS PASSED TO SUBROUTINE NAV FOR COMPLETION OF
C     THE NAVIGATION OF INDIVIDUAL PIXELS OF EACH SCAN LINE.
C
      CALL ORBIT
      CLATAX=CLATAX*RADCON
      CLONAX=CLONAX*RADCON
      NPTS=P/300.0+1
      DO 130 I=1,NPTS
      ATIME=(I-1)*300.0
      CALL SATPOS(ATIME,XSAT,YSAT,ZSAT,RSAT,DFSAT)
      CLATV=DARCOS(ZSAT/RSAT)-PI/2.0
      CLONV=DATAN2(YSAT,XSAT)+ETA-PI
      CALL LKRL(CLATV,CLONV,CLATAX,CLONAX,VLOOK,VROLL)
  130 VLOOKS(I)=VLOOK
      TIME=TCONT-TPER
      CALL SATPOS(TIME,XSAT,YSAT,ZSAT,RSAT,DFSAT)
      CLATV=DARCOS(ZSAT/RSAT)-PI/2.0
      CLONV=DATAN2(YSAT,XSAT)+ETA-PI
      CALL LKRL(CLATV,CLONV,CLATAX,CLONAX,VLOOK,VROLL)
      SECSTP=0.17578125D0/SPNPER
      IF(ILSR.EQ.1) SECSTP=SECSTP*1.25
      CROLL=1.40625D0*IRLC+36.0-1.60214*TIME/86400.D0+ICMSEC*
     *SECSTP-VROLL
      ANGRAD=DARSIN(6130.0/RSAT)/RADCON
      IF(ITCODE.EQ.2) THEN
         ALCLK=VLOOK+ANGRAD
         DO 140 I=14,274
         IF(VLOOKS(I).LT.ALCLK) GO TO 150
  140    CONTINUE
         WRITE(6,9005) ALCLK
         RETURN
  150    TIME=((VLOOKS(I-1)-ALCLK)/(VLOOKS(I-1)-VLOOKS(I))+I-2.0)*300.0
         TCEN=TPER+TIME
         CALL SATPOS(TIME,XSAT,YSAT,ZSAT,RSAT,DFSAT)
         CLATV=DARCOS(ZSAT/RSAT)-PI/2.0
         CLONV=DATAN2(YSAT,XSAT)+ETA-PI
      ELSE IF (ITCODE.EQ.1) THEN
         AFCLK=VLOOK-ANGRAD
         DO 160 I=14,274
         IF(VLOOKS(I).LT.AFCLK) GO TO 170
  160    CONTINUE
         WRITE(6,9006) AFCLK
         RETURN
  170    TIME=((VLOOKS(I-1)-AFCLK)/(VLOOKS(I-1)-VLOOKS(I))+I-2.0)*300.0
         TCEN=TPER+TIME
         CALL SATPOS(TIME,XSAT,YSAT,ZSAT,RSAT,DFSAT)
         CLATV=DARCOS(ZSAT/RSAT)-PI/2.0
         CLONV=DATAN2(YSAT,XSAT)+ETA-PI
      END IF
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     THE FOLLOWING SECTION USES SUBROUTINE PVENUS TO FIND THE SUBSOLAR
C     LATITUDE AND LONGITUDE BOTH 2.5 HOURS BEFORE AND AFTER THE TIME
C     ESTIMATED FOR THE OBSERVATION OF DISK CENTER FOR THE IMAGE.
C     THESE VALUES ARE PASSED TO SUBROUTINE NAV FOR INTERPOLATION BY
C     TIME TO PROVIDE THE SOLAR GEOMETRY INFORMATION PORTION OF THE
C     NAVIGATION.
C
      FDOY=TCEN/86400.D0
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```
      IDOY=FDOY
      TOD=FDOY-IDOY
      NDAYS=(IYEAR-79)*365+IDOY-1
      IF(IYEAR.GT.80) NDAYS=NDAYS+1
      IF(IYEAR.GT.84) NDAYS=NDAYS+1
      IF(IYEAR.GT.88) NDAYS=NDAYS+1
      JD=2443874.5D0+NDAYS+TOD-0.10416667D0
      CALL PVENUS(JD,FV,RV,THV,PHV,XV,YV,ZV)
      SSLON1=PHV-PI
      IF(SSLON1.LT.0.D0) SSLON1=SSLON1+TWOPI
      SSLAT1=THV-PI/2.0
      JD=JD+0.20833333D0
      CALL PVENUS(JD,FV,RV,THV,PHV,XV,YV,ZV)
      SSLON2=PHV-PI
      IF(SSLON2.LT.0.D0) SSLON2=SSLON2+TWOPI
      SSLAT2=THV-PI/2.0
      CALL LKRL(CLATV,CLONV,CLATAX,CLONAX,TLKOBS,VROLL)
      TLKOBS=TLKOBS*RADCON
      STLK=DSIN(TLKOBS)
      CTLK=DCOS(TLKOBS)
      CATLAT=DCOS(CLATAX)
      SATLAT=DSIN(CLATAX)
      IOK=1
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 8001 FORMAT(6X,I2,6X,I3,1X,3(1X,I2),12X,I1,9X,I3,11X,I3)
 9000 FORMAT(1H0,/,1X,'THIS STATEMENT IS BEING GENERATED AT THE START',
     *' OF SUBROUTINE CONTAC, JUST AFTER THE FORTRAN READ WHICH IS ',
     *'INTENDED TO INPUT THE',/,' IMAGE CONTACT INFORMATION NECESSARY',
     *' TO PERFORM THE IMAGE NAVIGATION.  THE INPUT PARAMETERS THUS',
     *' ACCEPTED ARE:',//,5X,'CONTACT TIME:  YEAR=',I2,'  DOY=',I3,
     *'  TIME OF DAY: ',2(I2,':'),I2,//,5X,'CONTACT CODE (1-FIRST',
     *', 2-LAST), CODE=',I1,//,5X,'SCAN LINE ELEMENT (SECTOR) NUMBER',
     *' CORRESPONDING TO CONTACT, SECTOR=',I3,//,5X,'OCPP ROLL CODE',
     *' IN EFFECT AT THE TIME OF CONTACT, ROLL=',I3,//,1X,'PLEASE',
     *' VERIFY THAT THE CORRECT CONTACT PARAMETERS HAVE BEEN READ',
     *' INTO SUBROUTINE CONTAC.',//)
 9001 FORMAT(1H0,'TIME CODE IS NOT VALID:  ITCODE=',I5)
 9002 FORMAT(1H0,'NO ENTRY FOUND IN FILE OF PIONEER VENUS ORBITAL',
     *' ELEMENTS FOR INPUT YEAR=',I2,'  DOY=',I3,//)
 9003 FORMAT(1H0,'PIONEER VENUS ORBITAL ELEMENTS INTERPOLATED FROM',
     *' ELEMENTS FOR ORBITS:',I8,' (YEAR 19',I2,', DOY ',I3,')  AND',
     *I6,' (YEAR 19',I2,', DOY ',I3,')',//,31X,'SEMIMAJOR AXIS, A=',
     *F8.1,' KM',//,31X,'ECCENTRICITY, ECC =',F9.6,//,31X,
     *'INCLINATION, INCLIN =',F8.3,//,31X,'ARGUMENT OF PERIAPSIS',
     *', OMEGA =',F8.3,//,31X,'LONGITUDE OF ASCENDING NODE, ETA =',
     *F7.3,//,31X,'PERIOD, P =',F8.1,' SEC',/)
 9004 FORMAT(1H0,40X,'SPACECRAFT ATTITUDE USED:',//,31X,'CELESTIAL',
     *' LATITUDE OF S/C POSITIVE SPIN AXIS DIRECTION, CLATAX =',F7.2,
     *//,31X,'CELESTIAL LONGITUDE OF S/C POSITIVE SPIN AXIS DIRECTION',
     *', CLONAX =',F7.2,/)
 9005 FORMAT(1H0,'LAST CONTACT LOOK ANGLE ',F7.2,'  NOT FOUND')
 9006 FORMAT(1H0,'FIRST CONTACT LOOK ANGLE ',F7.2,'  NOT FOUND')
      RETURN
      END
      SUBROUTINE NAV(ZTIME,IRL,ILSR,JS,JE)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER TCEN,TPER
      REAL*4 ZMU,ZMU0,PMP0,LAT,LON,LATMAX,LATMIN,LONMAX,LONMIN,
     *OZAMIN,SZAMIN
      REAL*8 LAMBDA,INCLIN
```

```
      COMMON/ORBP/ R(9000),F(9000),A,ECC,INCLIN,OMEGA,TPEPOC,PERIOD,
     *LAMBDA,RADCON,PI,TWOPI,COSI,SINI,ALONAN
      COMMON/CONTV/ TCEN,TPER,TLKOBS,CROLL,CLATAX,CLONAX,SPNPER,
     *SSLAT1,SSLON1,SSLAT2,SSLON2,STLK,CTLK,SATLAT,CATLAT
      COMMON/NAVINF/ ZMU(1016),ZMU0(1016),PMP0(1016),LAT(1016),
     *LON(1016),LATMAX,LATMIN,LONMAX,LONMIN,OZAMIN,SZAMIN,JOZA,JSZA
      RADIUS=6130.D0
      SECSTP=0.17578125D0*RADCON/SPNPER
      IF(ILSR.EQ.1) SECSTP=SECSTP*1.25
      ATIME=ZTIME-TPER
      CALL SATPOS(ATIME,XSAT,YSAT,ZSAT,RSAT,DFSAT)
      CLATV=DARCOS(ZSAT/RSAT)-PI/2.0
      CLONV=DATAN2(YSAT,XSAT)+ALONAN-PI
      CALL LKRL(CLATV,CLONV,CLATAX,CLONAX,VLOOK,VROLL)
      SCLK=DSIN(VLOOK*RADCON)
      CCLK=DCOS(VLOOK*RADCON)
      SVLAT=DSIN(CLATV)
      CVLAT=DCOS(CLATV)
      SLATVP=-SVLAT*SATLAT+CVLAT*CATLAT*DCOS(CLONAX-CLONV)
      SDELTA=CATLAT*DSIN(CLONAX-CLONV)/DSQRT(1.D0-SLATVP**2)
      CDELTA=DSQRT(1.D0-SDELTA**2)
      DELTA=DARSIN(SDELTA)
      FACTI=(ZTIME-TCEN+9000.0)/18000.0
      SSLAT=FACTI*(SSLAT2-SSLAT1)+SSLAT1
      SSLON=FACTI*(SSLON2-SSLON1)+SSLON1
      STERM=DSIN(CLONV-SSLON)
      CTERM=DCOS(CLONV-SSLON)
      SSSLAT=DSIN(SSLAT)
      CSSLAT=DCOS(SSLAT)
      CALPC=-SVLAT*SSSLAT-CVLAT*CSSLAT*DCOS(CLONV-SSLON)
      CPROD=CTLK*CCLK
      SPROD=STLK*SCLK
      BROLL=(1.40625D0*IRL+36.0-1.60214*ATIME/86400.0-VROLL-CROLL)
     **RADCON
      RSATS=RSAT**2
      RADVS=RADIUS**2
      DOR=RSAT/RADIUS
      CTHPR=DSQRT(1.D0-RADVS/RSATS)
      DO 100 J=1,1016
      LAT(J)=0
      LON(J)=0
      PMP0(J)=0
      ZMU(J)=-2.0
      ZMU0(J)=-2.0
  100 CONTINUE
      DO 110 J=JS,JE
      PSI=BROLL+J*SECSTP
      CTHP=CPROD+SPROD*DCOS(PSI)
      IF(CTHP.GE.CTHPR) THEN
         STHPS=1.D0-CTHP**2
         X=RSAT*CTHP-DSQRT(RADVS-RSATS*STHPS)
         XOR=X/RADIUS
         XMU=DOR*CTHP-XOR
         CRHO=DOR-XOR*CTHP
         SZETA=STLK*DSIN(PSI)
         CZETA=(CTLK-CTHP*CCLK)/SCLK
         SBETA=-SVLAT*CRHO-CVLAT*XOR*(CZETA*CDELTA+SZETA*SDELTA)
         BETA=DARSIN(SBETA)
         CDLAM=(CRHO+SBETA*SVLAT)/CVLAT
         SDLAM=XOR*(SZETA*CDELTA-CZETA*SDELTA)
```

```
      DLAM=DATAN2(SDLAM,CDLAM)
      ALAM=CLONV+DLAM+PI
      XMU0=SBETA*SSSLAT+CSSLAT*(SDLAM*STERM-CDLAM*CTERM)
      CALP=(RSAT*CALPC-RADIUS*XMU0)/X
      CPMP0=(XMU0*XMU-CALP)/(DSQRT((1.D0-XMU0**2)*(1.D0-XMU**2)))
      LAT(J)=BETA/RADCON
      LON(J)=ALAM/RADCON
      PMP0(J)=DARCOS(CPMP0)/RADCON
      ZMU(J)=XMU
      ZMU0(J)=XMU0
    END IF
110 CONTINUE
    LATMAX=-100.0
    LATMIN=1000.0
    LONMAX=-100.0
    LONMIN=10000.0
    OZAMIN=100.0
    SZAMIN=100.0
    JOZA=0
    JSZA=0
    DO 120 J=JS,JE
    IF(ZMU(J).GE.0.0) THEN
       IF(LAT(J).GT.LATMAX) LATMAX=LAT(J)
       IF(LAT(J).LT.LATMIN) LATMIN=LAT(J)
       IF(LON(J).GT.LONMAX) LONMAX=LON(J)
       IF(LON(J).LT.LONMIN) LONMIN=LON(J)
       OZA=DARCOS(ZMU(J))/RADCON
       IF(OZA.LT.OZAMIN) THEN
          OZAMIN=OZA
          JOZA=J
       END IF
       SZA=DARCOS(ZMU0(J))/RADCON
       IF(SZA.LT.SZAMIN) THEN
          SZAMIN=SZA
          JSZA=J
       END IF
    END IF
120 CONTINUE
    RETURN
    END
    SUBROUTINE ORBIT
    COMPUTES THE TRUE ANOMALY, F, AND THE RADIAL DISTANCE, R, IN KM
    FOR IPOINT POINTS ON 12-SEC TIME CENTERS FOR AN ORBIT SPECIFIED
    BY THE SEMI-MAJOR AXIS, A, AND THE ECCENTRICITY, ECC.

    IMPLICIT REAL*8 (A-H,O-Z)
    REAL*8 LAMBDA,INCLIN,M
    COMMON/ORBP/ R(9000),F(9000),A,ECC,INCLIN,OMEGA,T,P,LAMBDA,
   *RADCON,PI,TWOPI,COSI,SINI
    RTERM=A*(1.0-ECC**2)
    ETERM=DSQRT((1.0+ECC)/(1.0-ECC))
    EZERO=0.0D0
    IPOINT=P/12.0+1
    DO 200 I=1,IPOINT
    M=TWOPI*((I-1)*12.0-T)/P
    E=M+ECC*DSIN(EZERO)
    DO 100 N=1,100
    G=E-ECC*DSIN(E)-M
    DE=-G/(1.0D0-ECC*DCOS(E))
    E=E+DE
```

```
      IF(DABS(DE).LT.1.0D-12) GO TO 110
  100 CONTINUE
  110 EZERO=E
      ED2=E/2.0D0
      X1=ETERM*DSIN(ED2)
      X2=DCOS(ED2)
      XF=2.D0*DATAN2(X1,X2)
      IF(XF.LT.0.D0) XF=XF+TWOPI
      F(I)=XF
      R(I)=RTERM/(1.0D0+ECC*DCOS(XF))
  200 CONTINUE
      RETURN
      END
      SUBROUTINE SATPOS(ATIME,XSAT,YSAT,ZSAT,RI,DFI)
C     COMPUTES FOR TIME=ATIME THE RADIAL DISTANCE, RI, IN KM AND TRUE
C     ANOMALY, DFI, IN DEG AND THE CARTESIAN COORDINATES IN A VENUS
C     CENTERED ECLIPTIC SYSTEM WITH THE ASCENDING NODE OF THE S/C
C     ORBIT DEFINING THE +X AXIS.
C
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*8 LAMBDA,INCLIN
      COMMON/ORBP/ R(9000),F(9000),A,ECC,INCLIN,OMEGA,T,P,LAMBDA,
     *RADCON,PI,TWOPI,COSI,SINI
      XTIME=ATIME-T
      NPER=XTIME/P
      IF(NPER.LT.0) THEN
         XTIME=XTIME+(NPER+1)*P
      ELSE
         XTIME=XTIME-NPER*P
      END IF
      ITIME=XTIME/12.0D0
      DTIME=XTIME-12.0D0*ITIME
      ITIME=ITIME+1
      RI=R(ITIME)+(R(ITIME+1)-R(ITIME))*DTIME/12.0D0
      FI=F(ITIME)+(F(ITIME+1)-F(ITIME))*DTIME/12.0D0
      SUM=FI+OMEGA
      COSSUM=DCOS(SUM)
      SINSUM=DSIN(SUM)
      COSTH=SINI*SINSUM
      SINTH=DSQRT(1.D0-COSTH**2)
      PHI=DARCOS(COSSUM/SINTH)
      IF(SUM.GE.PI.AND.SUM.LE.TWOPI) PHI=TWOPI-PHI
      PHIS=TWOPI-PHI
      XSAT=RI*SINTH*DCOS(PHIS)
      YSAT=RI*SINTH*DSIN(PHIS)
      ZSAT=RI*COSTH
      DFI=FI/RADCON
      RETURN
      END
      SUBROUTINE LKRL(CLATV,CLONV,CLATAX,CLONAX,VLOOK,VROLL)
:     COMPUTES THE LOOK ANGLE, VLOOK, AND ROLL ANGLE, VROLL, FOR AN
:     OBJECT LOCATED AT CELESTIAL LATITUDE CLATV AND LONGITUDE CLONV,
:     WITH S/C SPIN AXIS POINTING TOWARDS COORDINATES CLATAX, CLONAX.
!
      IMPLICIT REAL*8 (A-H,O-Z)
      RADCON=1.74532925199433D-2
      DL=CLONAX-CLONV
      CDL=DCOS(DL)
      SBA=DSIN(CLATAX)
      CBA=DSQRT(1.D0-SBA**2)
```

```
      SBV=DSIN(CLATV)
      CBV=DSQRT(1.D0-SBV**2)
      SD=SBV*SBA+CBV*CBA*CDL
      CD=DSQRT(1.D0-SD*SD)
      CAP=CBV*DSIN(DL)/CD
      SAP=(-SBV*CBA+CBV*SBA*CDL)/CD
      AP=DATAN2(SAP,CAP)/RADCON
      CLA=DCOS(CLONAX)
      SDG=CBA*CLA
      CDG=DSQRT(1.D0-SDG**2)
      CAGP=DSIN(CLONAX)/CDG
      SAGP=SBA*CLA/CDG
      VROLL=AP-DATAN2(SAGP,CAGP)/RADCON
      IF(VROLL.LT.0.0) VROLL=VROLL+360.0
      IF(VROLL.GE.360.0) VROLL=VROLL-360.0
      VLOOK=90.0-DARSIN(SD)/RADCON
      RETURN
      END
      SUBROUTINE ATTSPN(YEAR,DOY,HOUR,MIN,CELLAT,CELLON,SPNPER)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER YEAR,DOY,HOUR
      RADCON=1.74532925199433D-2
      CELLAT=-90.0
      CELLON=0.0
      SPNPER=12.0
      NDAYS=(YEAR-78)*365
      IF(YEAR.GT.80) NDAYS=NDAYS+1
      IF(YEAR.GT.84) NDAYS=NDAYS+1
      IF(YEAR.GT.88) NDAYS=NDAYS+1
      XTIME=(NDAYS+DOY)*1440.0+HOUR*60.0+MIN
      PIONEER VENUS SPACECRAFT ATTITUDE AND SPIN PERIOD DATA ARE READ
      FROM AN ACCOMPANYING FILE OF CARD IMAGE RECORDS.  ATTITUDE IS
      SPECIFIED BY THE LATITUDE AND LONGITUDE OF THE DIRECTION OF THE
      SPIN AXIS.  EACH CARD IMAGE RECORD HAS THE FOLLOWING ENTRIES
      IN ORDER:
        IYEAR, YEAR (TWO DIGITS, 78-92)
        IDOY, DAY-OF-YEAR
        IHH, HOUR (24-HOUR CLOCK)
        IMM, MINUTES
        CLAT, LATITUDE OF SPIN AXIS DIRECTION IN DEGREES
        CLON, LONGITUDE OF SPIN AXIS DIRECTION IN DEGREES
        SPER, SPIN PERIOD IN SECONDS
      THE DATA FILE IS READ UNTIL A PAIR OF RECORDS HAVE TIMES THAT
      BRACKET THE DESIRED TIME AS SPECIFIED BY YEAR, DOY, HOUR, AND
      MIN IN THE SUBROUTINE ARGUMENT LIST.
      READ(15,*) IYEAR,IDOY,IHH,IMM,CLAT1,CLON1,SPER1
      NDAYS=(IYEAR-78)*365
      IF(IYEAR.GT.80) NDAYS=NDAYS+1
      IF(IYEAR.GT.84) NDAYS=NDAYS+1
      IF(IYEAR.GT.88) NDAYS=NDAYS+1
      TIME1=(NDAYS+IDOY)*1440.0+IHH*60.0+IMM
      DO 100 I=1,10000
      READ(15,*,END=110) IYEAR,IDOY,IHH,IMM,CLAT2,CLON2,SPER2
      NDAYS=(IYEAR-78)*365
      IF(IYEAR.GT.80) NDAYS=NDAYS+1
      IF(IYEAR.GT.84) NDAYS=NDAYS+1
      IF(IYEAR.GT.88) NDAYS=NDAYS+1
      TIME2=(NDAYS+IDOY)*1440.0+IHH*60.0+IMM
      IF(TIME2.GE.XTIME) GO TO 120
      TIME1=TIME2
```

```
      CLAT1=CLAT2
      CLON1=CLON2
      SPER1=SPER2
  100 CONTINUE
  110 WRITE(6,9001) XTIME,YEAR,DOY,HOUR,MIN
      RETURN
  120 CBL=DCOS(CLAT1*RADCON)
      XL=CBL*DCOS(CLON1*RADCON)
      YL=CBL*DSIN(CLON1*RADCON)
      CBU=DCOS(CLAT2*RADCON)
      XU=CBU*DCOS(CLON2*RADCON)
      YU=CBU*DSIN(CLON2*RADCON)
      FRAC=(XTIME-TIME1)/(TIME2-TIME1)
      X=FRAC*(XU-XL)+XL
      Y=FRAC*(YU-YL)+YL
      CELLON=DATAN2(Y,X)/RADCON
      IF(CELLON.LT.0.0) CELLON=CELLON+360.0
      CELLAT=-DARCOS(DSQRT(X*X+Y*Y))/RADCON
      SPNPER=FRAC*(SPER2-SPER1)+SPER1
 9001 FORMAT(1H0,' NO ENTRY FOUND FOR TIME: ',F15.1,'   YEAR=',I2,
     *'  DOY=',I3,2X,2I3)
      RETURN
      END
      SUBROUTINE PVENUS(RJD,F,R,THETA,PHI,XVENUS,YVENUS,ZVENUS)
C     THIS SUBROUTINE RETURNS THE HELIOCENTRIC POSITION OF VENUS IN
C     THE SAME COORDIDATE SYSTEM USED THROUGHOUT THIS NAVIGATION
C     PROGRAM, NAMELY, THE X-Y REFERENCE PLANE IS THE 1950 ECLIPTIC.
C     THE DETERMINATION OF THE POSITION OF VENUS IS MADE FOR THE
C     JULIAN DATE, RJD, INPUT TO THE SUBROUTINE AS THE FIRST ITEM IN
C     THE CALL ARGUMENT LIST.
C
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*8 INCL,M,PI/3.141592653589793D0/,TWOPI/6.283185307179586D0/,
     *RADCON/1.74532925199433D-2/
      DATA A0,A1,A2,B0,B1,B2,C0,C1,C2/-6.484673874D-3,-7.151971424D-3,
     *-7.819317456D-3,-6.069867289D-5,-6.695276936D-5,-7.32068658D-5,
     *9.2240651D-2,9.1687963D-2,9.1135276D-2/
      AFACT=(RJD-2443000.5D0)/1000.D0
      IF(AFACT.GT.1.D0) GO TO 10
      AA=(A1-A0)*AFACT + A0
      BB=(B1-B0)*AFACT + B0
      CC=(C1-C0)*AFACT + C0
      GO TO 20
   10 AFACT=AFACT-1.D0
      AA=(A2-A1)*AFACT + A1
      BB=(B2-B1)*AFACT + B1
      CC=(C2-C1)*AFACT + C1
   20 A=0.7233316D0*149.6D6
      D=RJD-2415020.0D0
      T=D/36525.0D0
      ECC=0.00682069D0-4.774D-5*T+0.91D-7*T**2
      INCL=(3.393630556D0+1.005833D-3*T-9.722D-7*T**2)*RADCON
      ASNODE=(75.779647222D0+0.89985D0*T+4.1D-4*T**2)*RADCON
      PERL=(130.163833333D0+1.408036111D0*T-9.76389D-4*T**2)*RADCON
      OMEGA=PERL-ASNODE
C*************************************************************
C                                                            *
C     PRECESS ORBITAL ELEMENTS OF DATE TO EPOCH 1950.0       *
C *         SEE EXPL. SUPPLEMENT TO EPHEMERIS, P. 37         *
C *                                                          *
```

```
      IF(L) BIT(7)=1
      L=BTEST(INTCHR,0)
      IF(L) BIT(8)=1
      RETURN
      END
      SUBROUTINE EXPLN
C     THIS SUBROUTINE READS A FILE WHICH CONTAINS A BRIEF SUMMARY OF
C     THE NATURE OF THE OCPP IMAGING DATA, A DETAILED DESCRIPTION OF
C     THE PRINTOUT GENERATED BY THIS PROGRAM, AN EXPLANATION OF THE
C     NAVIGATION PROCESS, AND INSTRUCTIONS FOR THE REQUISITE NAGVIGA-
C     TION INFORMATION INPUT.  THE CARD IMAGE RECORDS OF THIS FILE
C     ARE PRINTED OUT PRIOR TO THE MAIN LISTING OF THE NAVIGATION
C     PROGRAM DATA SUMMARY.
      DIMENSION C(80)
      CHARACTER*1 C
      WRITE(6,9001)
      DO 100 I=1,57
      READ(30,8001) C
      WRITE(6,9002) C
  100 CONTINUE
      WRITE(6,9000)
      DO 110 I=1,53
      READ(30,8001) C
      WRITE(6,9002) C
  110 CONTINUE
      WRITE(6,9000)
      DO 120 I=1,60
      READ(30,8001) C
      WRITE(6,9002) C
  120 CONTINUE
      WRITE(6,9000)
      DO 130 I=1,22
      READ(30,8001) C
      WRITE(6,9002) C
  130 CONTINUE
 8001 FORMAT(80A1)
 9000 FORMAT(1H1)
 9001 FORMAT(1H1,'P I O N E E R  V E N U S  O C P P  I M A G E',
     *'  N A V I G A T I O N  P R O G R A M',//)
 9002 FORMAT(1H ,3X,80A1)
      RETURN
      END
```

D103920
dump from record 9

HEX DUMP OF IN

FILE 1 RECORD 1 4000 BYTES

(0)	40404040	D7C9D6D5	C5C5D940	E5C5D5E4	E240D6C3	D7D740C9	D4C1C7C9	D5C740C4	C1E3C140	E3C1D7C5
(40)	40405C5C	5C4040C3	D9C5C1E3	C9D6D540	C4C1E3C5	40F0F361	F1F161F9	F3404040	40404040	40404040
(80)	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040
(120)	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040
(160)	E3C8C9E2	40E3C1D7	C540C3D6	D5E3C1C9	D5E240E3	C8C540C3	D6D4D7D3	C5E3C540	C4C9C7C9	E3C1D340
(200)	C4C1E3C1	40C6D6D9	40F1F0F0	40D7C9D6	D5C5C5D9	40E5C5D5	E4E240D6	C3D7D740	40404040	40404040
(240)	C9D4C1C7	C5E240C3	D6E5C5D9	C9D5C740	E3C8C540	D7C5D9C9	D6C47A40	F1F9F8F0	6B40C4C1	E860D6C6
(280)	60E8C5C1	D9404DC4	D6E85D40	F0F5F26B	40F0F27A	F2F340E4	E340E3C8	D9D6E4C7	C8404040	40404040
(320)	F1F9F8F0	6B40C4D6	E840F1F0	F46B40F0	F77AF4F0	40E4E34B	4040E3C8	C540C4C1	E3C140C6	D6D940C5
(360)	C1C3C840	C9D4C1C7	C540C9E2	40E2E3D6	D9C5C440	C9D540C1	40E2C5D7	C1D9C1E3	C5404040	40404040
(400)	C6C9D3C5	40D6D540	E3C8C9E2	40E3C1D7	C56B40C2	C5C7C9D5	D5C9D5C7	40E6C9E3	C840C6C9	D3C540D5
(440)	E4D4C2C5	D940F940	C1D5C440	C5D5C4C9	D5C740E6	C9E3C840	C6C9D3C5	40404040	40404040	40404040
(480)	D5E4D4C2	C5D940F1	F0F84B40	40E3C8C5	40C5C9C7	C8E340E3	C1D7C540	C6C9D3C5	E240D7D9	C5C3C5C4
(520)	C9D5C740	E3C8C540	C9D4C1C7	C540C4C1	E3C140C6	C9D3C5E2	40C3D6D5	E3C1C9D5	40404040	40404040
(560)	E3C8C540	D7D9C5E2	C5D5E340	C5E7D7D3	C1D5C1E3	D6D9E840	C6C9D3C5	40C6D6D3	D3D6E6C5	C440C2E8
(600)	40C6D6D9	E3D9C1D5	40E2D6E4	D9C3C540	C3D6C4C5	E240C6D6	D940E3E6	D6404040	40404040	40404040
(640)	D7D9D6C7	D9C1D4E2	40E4E2C5	C440E3D6	40D7D9D6	C3C5E2E2	40E3C8C5	40C9D4C1	C7C540C4	C1E3C140
(680)	C6C9D3C5	E240C1D3	D6D5C740	E6C9E3C8	40C1D5C3	C9D3D3C1	D9E840C4	C1E3C140	40404040	40404040
(720)	C6C9D3C5	E240E4E2	C5C440C9	D540E3C8	C1E340D7	D9D6C3C5	E2E2C9D5	C76B40E3	E6D640C1	C4C4C9E3
(760)	C9D6D5C1	D340C5E7	D7D3C1D5	C1E3D6D9	E840C6C9	D3C5E26B	40C1D5C4	40C1D540	40404040	40404040
(800)	C9D4C1C7	C540C3C1	E3C1D3D6	C740C6D6	D940E3C8	C540C9D4	C1C7C5E2	40D6D540	E3C8C9E2	40E3C1D7
(840)	C54B4040	C2C5D3D6	E640C9E2	40C140D4	D6D9C540	E2D7C5C3	C9C6C9C3	40404040	40404040	40404040
(880)	C4C5E2C3	D9C9D7E3	C9D6D540	D6C640C5	C1C3C840	C6C9D3C5	40C1D5C4	40C9E3E2	40C3C8C1	D9C1C3E3
(920)	C5D9C9E2	E3C9C3E2	4B404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040
(960)	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040
(1000)	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040
(1040)	C6C9D3C5	407BF17A	4040E3C8	C540D7D9	C5E2C5D5	E340C6C9	D3C56B40	C4C5E2C3	D9C9C2C9	D5C740E3
(1080)	C8C540D6	E5C5D9C1	D3D340E3	C1D7C540	C6C9D3C5	40E2E3D9	E4C3E3E4	D9C54B40	40404040	40404040
(1120)	C3C1D9C4	40C9D4C1	C7C540C9	D540C6D6	D9D4C1E3	40E6C9E3	C840D3D6	C7C9C3C1	D340D9C5	C3D6D9C4
(1160)	40D3C5D5	C7E3C8E2	40D6C640	F8F040C2	E8E3C5E2	40C1D5C4	40C6C9D3	C5404040	40404040	40404040
(1200)	C2D3D6C3	D2E240D6	C640F4F0	F0F040C2	E8E3C5E2	4B404040	40404040	40404040	40404040	40404040
(1240)	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040
(1280)	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040
(1320)	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040	40404040
(1360)	C6C9D3C5	407BF27A	4040C6D6	D9E3D9C1	D540F7F7	40E2D6E4	D9C3C540	C3D6C4C5	40C6D6D9	40E3C8C5
(1400)	40D7C9D6	D5C5C5D9	40E5C5D5	E4E240D6	C3D7D740	C9D4C1C7	C540E2C3	C1D54040	40404040	40404040
(1440)	D7D9D6C7	D9C1D44B	4040E3C8	C9E240D7	D9D6C7D9	C1D440D9	C5C1C4E2	40C1D540	C9D4C1C7	C540C6C9
(1480)	D3C540C1	D5C440C7	C5D5C5D9	C1E3C5E2	40C140E2	E4D4D4C1	D9E840D3	C9E2E3C9	D5C74040	40404040
(1520)	E6C9E3C8	40D6D5C5	40D3C9D5	C540D6C6	40D7D9C9	D5E3C5C4	40D6E4E3	D7E4E340	C6D6D940	C5C1C3C8
(1560)	40E2C3C1	D540D3C9	D5C540D6	C640E3C8	C540C9D4	C1C7C54B	4040C5C1	C3C840D3	C9D5C540	40404040
(1600)	E2E4D4D4	C1D9C9E9	C5E240E3	C8C540C9	D5E2E3D9	E4D4C5D5	E340E2E3	C1E3E4E2	40C1D5C4	40E2D6D4
(1640)	C540C7C5	D5C5D9C1	D340C3C8	C1D9C1C3	E3C5D9C9	E2E3C9C3	E240D6C6	40E3C8C5	40404040	40404040
(1680)	C9D5E3C5	D5E2C9E3	E840C4C1	E3C140D5	E4D4C2C5	D9E240C6	D6D940E3	C8C1E340	C9D4C1C7	C540E2C3
(1720)	C1D540D3	C9D5C54B	4040E3C8	C9E240D3	C1E3E3C5	D940C9D5	C6D6D9D4	C1E3C9D6	D5404040	40404040
(1760)	C9E240C9	D5E3C5D5	C4C5C440	E3D640C9	D5C4C9C3	C1E3C540	E6C8C9C3	C840C9D4	C1C7C9D5	C740D7C9
(1800)	E7C5D3E2	40C1D9C5	40D6D540	E3C8C540	C2D9C9C7	C8E340C4	C9E2D240	D6C640E3	C8C54040	40404040
(1840)	D7D3C1D5	C5E340C1	D5C440E3	D640C1E2	E2C9E2E3	40E3C8C5	40E4E2C5	D940C9D5	40C4C5E3	C5D9D4C9
(1880)	D5C9D5C7	40E3C8C5	40C3D6D4	D7D3C5E3	C5D5C5E2	E240C1D5	C440E3C8	C5404040	40404040	40404040
(1920)	D6E5C5D9	C1D3D340	D8E4C1D3	C9E3E840	D6C640E3	C8C540C9	D4C1C7C5	40D6C2E2	C5D9E5C1	E3C9D6D5
(1960)	4B4040C9	D540D9E4	D5D5C9D5	C740E3C8	C9E240D7	D9D6C7D9	C1D46B40	E3C8C540	40404040	40404040
(2000)	E4E2C5D9	40D4E4E2	E340E2E4	D7D7D3E8	40D1D6C2	40C3D6D5	E3D9D6D3	40D3C1D5	C7E4C1C7	C540D6D9
(2040)	40E3C8C5	40C5D8E4	C9E5C1D3	C5D5E340	E3D640E2	D7C5C3C9	C6E840E3	C8C54040	40404040	40404040
(2080)	E2D7C5C3	C9C6C9C3	40E3C1D7	C540C6C9	D3C540E3	D640C2C5	40D9C5C1	C440E4E2	C9D5C740	C4C1E3C1
(2120)	40E2C5E3	40D9C5C6	C5D9C5D5	C3C540D5	E4D4C2C5	D9404DC4	E2D9D55D	40F1F240	D6D94040	40404040
(2160)	D4D6C4C9	C6E840E3	C8C540C6	D6D9E3D9	C1D540D9	C5C1C440	E2E3C1E3	C5D4C5D5	E36B40D9	C5C1C44D
(2200)	F1F26BF8	F0F0F16B	C5D5C47E	F2F0F05D	40D96B40	D5C5C1D9	40E3C8C5	40404040	40404040	40404040
(2240)	C2C5C7C9	D5D5C9D5	C740D6C6	40E3C8C5	40D4C1C9	D540D3D6	D6D740D6	C640E3C8	C540D7D9	D6C7D9C1