Cassini Radio and Plasma Wave Science

RPWS Standard Products Archive Volume Software Interface Specification

(RPWS Archive Volume SIS)

IO-AR-019
Version 1.0
March 2004

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Table of Contents

1. Preface

This document describes the format and content of the CAS RPWS Standard Products Archive Collection on DVD-R media.

2. Introduction

2.1 Content Overview

The Cassini Radio and Plasma Wave Science (RPWS) instrument is a collection of sensors and receivers on the Cassini Orbiter that acquire plasma wave, radio wave, thermal plasma, and dust data that address several of the primary Cassini objectives for studies of the Saturnian system and certain targets of opportunity during the cruise to Saturn (including Venus, Earth, Jupiter, and the solar wind). This software interface specification (SIS) covers only the required archive data products including CODMAC Level 2 and/or 3 (NASA Level 1A and/or 1B) data sets. The RPWS team anticipates archiving some higher level products as resources permit; these will be specified in a separate SIS or a future revision to this one.

Table 1. Data Products included in this document:

Standard Data Product ID	**Data Set ID**
RPWS_KEY_PARAMETERS_BROWSE RPWS_KEY_PARAMETERS	CO-V/E/J/S/SS-RPWS-4-SUMM-KEY60S-V1.0
RPWS_RAW_COMPLETE	CO-V/E/J/S/SS-RPWS-2-REFDR-ALL-V1.0
RPWS_LOW_RATE_BROWSE RPWS_RPWS_LOW_RATE_FULL	CO-V/E/J/S/SS-RPWS-3-RDR-LRFULL-V1.0
RPWS_WIDEBAND_BROWSE RPWS_WIDEBAND_FULL	CO-V/E/J/S/SS-RPWS-2-REFDR-WBRFULL-V1.0
RPWS_WAVEFORM_BROWSE RPWS_WAVEFORM_FULL	CO-V/E/J/S/SS-RPWS-2-REFDR-WFRFULL-V1.0

The following provide brief summaries of the data sets listed in Table 1:

Key Parameters Browse (RPWS_KEY_PARAMETERS_BROWSE) consists of Portable Network Graphics (PNG) frequency-time spectrogram images of the Key Parameters data set and serves as a guide to the spectral information in the Key Parameters data set.

Key Parameters (RPWS_KEY_PARAMETERS) is a data set which contains a summary of the RPWS spectral information as a function of time with parameters which have been agreed to between RPWS and other Magnetosphere and Plasma Science (MAPS) instruments as being

suitable for the RPWS contribution to the MAPS Key Parameter Data Set. This parameter set is in the form of an ASCII flat file including the amplitude (electric and magnetic field spectral densities) of waves in 10 logarithmically-spaced frequency bands per decade with 1-minute temporal resolution and is generated by averaging full resolution measurements falling within the frequency and time bins.

Raw Complete (RPWS_RAW_COMPLETE) consists of decompressed and edited telemetry packets including all telemetry data from the RPWS. These data are included in the archive to preserve the original telemetry data, but are not expected to be used for any but exceptional circumstances. We expect the Low Rate Browse and other Standard data products to include all of the RPWS data in a much more accessible form. As such, the Raw Complete data set will be accompanied only by minimal PDS labels and with documentation, included, which provides information on how to read and use this data set. The Low Rate Browse data serves as a guide to the data included in this data set.

Low Rate Browse (RPWS_LOW_RATE_BROWSE) consists of Portable Network Graphics (PNG) frequency-time spectrogram images of the Low Rate Full Resolution Calibrated data set.

Low Rate Full Resolution Calibrated (RPWS_LOW_RATE_FULL) is a data set including all spectral density measurements acquired by the RPWS in units of electric or magnetic field spectral density.

Wideband Browse (RPWS_WIDEBAND_BROWSE) consists of Portable Network Graphics (PNG) frequency-time spectrogram images of the wideband observations acquired by the RPWS. Subsets of this data set will include data in the 10- and 80-kHz wideband receiver data (baseband) and high-frequency wideband receiver data acquired via frequency translation through the High Frequency Receiver from frequencies between 125 kHz and 16 MHz.

Wideband Full Resolution Uncalibrated (RPWS_WIDEBAND_FULL) data are the full resolution waveform data from the RPWS Wideband Receiver in uncalibrated form. This data set will include procedures, code examples, and the necessary information to derive calibrated electric or magnetic fields from the uncalibrated data.

Waveform Browse (RPWS_WAVEFORM_BROWSE) data are of Portable Network Graphics (PNG) frequency-time spectrogram images of the 5-Channel Waveform Receiver observations acquired by the RPWS.

Waveform Full Resolution Uncalibrated (RPWS_WAVEFORM_FULL) data are the full resolution waveform data from the RPWS Wideband Receiver in uncalibrated form. This data set will include procedures, code examples, and the necessary information to derive calibrated electric and magnetic field spectral densities from the uncalibrated data.

More information on these data sets can be found in the sample data set information templates in

Appendices B - E.

This software interface specification describes the format, content, and generation of the Cassini RPWS Standard Product Archive Volumes. Section 3, Archive Volume Generation, describes the procedure for transferring data products to the archive media. Section 4, Archive Volume Contents, describes the structure of the archive volumes and the contents of each file. Section 5, Archive Volume Format, describes the file formats used on the archive volumes. Finally, Section 6, Support Staff and Cognizant Persons, lists the individuals responsible for generating the archive volumes.

2.2 Scope

The specifications in this document apply to all Cassini RPWS standard product archive volumes that are produced on DVD-R media for the Cassini cruise and tour.

2.3 Applicable Documents

1. *Cassini Program Data Management Plan*, April 1999, JPL D-12560, Rev B.

2. *Cassini/Huygens Program Archive Plan for Science Data*, August 3, 2000, JPL D-15976, Version 1.

3. D. A., Gurnett, W. S. Kurth, D. L. Kirchner, G. B. Hospodarsky, T. F. Averkamp, P. Zarka, A. Lecacheux, R. Manning, A. Roux, P. Canu, N. Cornilleau-Wehrlin, P. Galopeau, A. Meyer, R. Bostrom, G. Gustafsson, J.-E. Wahlund, L. Aahlen, H. O. Rucker, H. P. Ladreiter, W. Macher, L. J. C. Woolliscroft, H. Alleyne, M. L. Kaiser, M. D. Desch, W. M. Farrell, C. C. Harvey, P. Louarn, P. J. Kellogg, K. Goetz, and A. Pedersen, The Cassini Radio and Plasma Wave Science Investigation, *Space Sci. Rev.*, in press, 2003.

4. *Planetary Science Data Dictionary Document*, August 28, 2002, Planetary Data System, JPL D-7116, Rev. E.

5. *Planetary Data System Data Preparation Workbook*, February, 1995, Version 3.1, JPL D-7669, Part 1.

6. *Planetary Data System Standards Reference*, October 15, 2002, Version 3.5. JPL D07669, Part 2.

2.4 Audience

This specification is useful to those who wish to understand the format and content of the Cassini RPWS Standard Product Archive Collection. Typically, these individuals would be software

engineers, data analysts, or planetary scientists.

3. Archive Volume Generation

3.1 Data Transfer and Validation Methods

The Cassini RPWS Standard Product Archive Collection is produced by the Cassini RPWS investigation team centered at The University of Iowa with other sites including Goddard Space Flight Center; the University of Minnesota; the Observatoire de Paris in Meudon, France; CETP in Velizy, France; University of Sheffield, Sheffield, UK; Swedish Institute of Space Physics, Uppsala, Sweden; the Academy of Sciences in Sweden; and University of Oslo, Oslo, Norway. The archiving activity is carried out in cooperation with the PDS Planetary Plasma Interactions (PPI) Node at the University of California, Los Angeles and the Outer Planets subnode of the PPI at The University of Iowa. The Cassini archiving is funded by the Cassini project through a contract between The University of Iowa and the Jet Propulsion Laboratory. The PPI activities are funded by the Planetary Data System.

The Archive Collection will include data acquired during the Cassini cruise to Saturn, including the two Venus flybys, the Earth and Jupiter flybys, and interplanetary cruise as well as data acquired during the prime mission in Saturn orbit. The archive validation procedure described in this section applies to volumes generated during all phases of the mission. At least the first two or possibly three data volumes will be validated in detail via the PDS peer review procedure, but it is anticipated that once any issues raised by that peer review are resolved, subsequent volumes will be validated as to format and content by the PPI node and for scientific integrity and completeness through the use of the data by the RPWS science team and others.

A single archive volume set of Cassini RPWS data is produced for the entire Cassini mission. When sufficient data for a new archive volume are ready for validation, the RPWS team will deliver a DVD-R volume with the data to the PPI Node of the PDS. The volume will include PDS documentation (label) files and ancillary products (index tables, HTML access files, etc.). Each volume of standard products, documentation, and ancillary products is stored on a recordable digital versatile disk (DVD-R) generated by the RPWS team. All data formats are based on the Planetary Data System standards as documented in the PDS Standards Reference [section 2.3-6, Applicable Documents].

The RPWS Team will produce three copies of each DVD-R. One will be sent to the PPI node at UCLA, one to the PDS Central Node at JPL, and the third copy will be kept at The University of Iowa. These three copies are used for validation at The University of Iowa, PPI, and the Central Node. Upon successful validation of a volume, the data are considered released to the PDS. The PDS-PPI is then responsible for duplicating the approved volume as PDS requires for both distribution and the deep archive at NSSDC.

Distribution of the RPWS standard product archive volumes is the responsibility of the PDS.

The PPI maintains a mailing list of scientists interested in receiving these data. Users can add or remove themselves from the Cassini RPWS distribution list through a web page maintained at the PPI. The NSSDC may choose to order (and pay for) additional copies at the time PDS generates them or orders copies from a vendor. The NSSDC and the PDS are each separately responsible for making additional future copies to meet the needs of their user communities.

In the event that a volume is found to contain errors, the reviewers can recommend one of two courses of action: fix the disk or publish as is with a note in the ERRATA.TXT file. If the errors are minor, typically minor errors in the documentation, the volume can be published if the appropriate notes are added to the volume's errata file and the error(s) are corrected on subsequent volumes. If the errors are major, typically involving errors in the data themselves, then the volume must be corrected, re-generated, and sent back out for review.

3.2. Data Product Sizes and Delivery Dates

Table 2 summarizes sizes and delivery rates for the Cassini RPWS Standard Products.
It should be noted that the Cassini/Huygens Program Archive Plan for Science Data specifies the schedule for archive product delivery. Essentially, all cruise and approach products up until SOI are due on 1 July 2005 and subsequent tour data will be delivered in three-month increments every quarter.

Table 2: RPWS Standard Product Sizes and Delivery Rates

Standard Data Product ID	Product Size (cruise/tour)	Production Rate (cruise/tour)	Time to Fill one 4.5 Gbyte Volume (cruise/tour)	Volumes for Mission (cruise/tour)
RPWS_KEY_PARAMETERS_BROWSE	150 kB/150 kB	1/day / 1/day		
RPWS_KEY_PARAMETERS	150 kB/150 kB	1/day / 1/day		
RPWS_RAW_COMPLETE	var (20 MB)	1/hr / 1/hr		
RPWS_LOW_RATE_BROWSE	150 kB/150 kB	1/day / 1/day		
RPWS_LOW_RATE_FULL	3 MB/15 MB	1/hr / 1/hr		
RPWS_WIDEBAND_BROWSE	150 kB/150 kB	1/day / 1/hr		
RPWS_WIDEBAND_FULL	var (10 MB)	var / 1/hr		
RPWS_WAVEFORM_BROWSE	n/a / 150 kB	n/a / 1/day		
RPWS_WAVEFORM_FULL	n/a / 15 MB	n/a / 1/day		
Totals			2 mo / 1 mo	24 / 48

The current plan is for each RPWS Standard Product Archive Volume to contain at most ~4.7

Gbytes of data, including documentation and ancillary files, based on the storage capacity of DVD-R media. Some volumes may be under-filled to keep the time intervals covered by a given volume at reasonable sizes and to cover standard intervals (e.g. 1 year or 1 month). We anticipate including all of the data types in Tables 1 and 2 for a given interval on the same volume.

According to the archive schedule, we estimate approximately 4 DVD-R volumes will encompass the cruise phase and be delivered by 1 July 2005. We anticipate delivering approximately 3 DVD-Rs per quarter, thereafter. The most recent data in a delivery will be approximately 1 year old, the time required to generate and validate the delivered data.

3.3 Interface Media Characteristics

All DVD volumes in the Cassini RPWS Standard Product Archive Collection will conform to the Digital Versatile Disk UDF-ISO Bridge format (with ISO-9660 level 2 compatibility).

3.4 Backup and Duplicates

UCLA keeps three copies of each DVD-R volume. One volume is the archive copy and is placed in an on-line drive at UCLA in order to make the data web accessible. The second copy is a backup that can be used if a DVD-R becomes lost or damaged. The third copy is a copy to be kept offsite from UCLA. UCLA will make copies of the one DVD-R provided by the University of Iowa to fulfill these needs. Another copy is sent to the NSSDC. The University of Iowa will keep at least one copy of each DVD-R.

3.5 Labeling and Identification

Each Cassini RPWS DVD-R bears a volume ID using the last two components of the volume set ID [PDS Standards Reference, 2002]. The RPWS volume set is comprised of one sequence of volumes with the volume set ID of USA_NASA_PDS_CORPWS_0nnn. The RPWS volumes will be members of the MISSION TO SATURN volume series.

4. Archive Volume Contents

This section describes the contents of the Cassini RPWS Standard Product Archive Collection volumes, including the file names, file contents, and file types. RPWS team members are responsible for providing all the files except where otherwise noted. The complete directory structure is shown in Appendix A. All the ancillary files described herein appear on each RPWS volume, except where noted.

4.1 Root Directory Contents

The following files are contained in the Root Directory.

File Name	File Contents
AAREADME.TXT	This file completely describes the volume organization and contents (PDS label attached).
AAREADME.HTM	Hypertext version of AAREADME.TXT
AAREADME.LBL	A PDS detached label that describes AAREADME.HTM
ERRATA.TXT	A cumulative listing of comments and updates concerning all RPWS Standard Data Products on all RPWS digital versatile disk volumes in the volume set published so far.
VOLDESC.CAT	A description of the contents of this volume in a PDS format readable by both humans and machines.

4.2 INDEX Directory Contents

The following files are contained in the Index Directory.

File Name	File Contents
INDXINFO.TXT	A description of the contents of this directory
CUMINDEX.TAB	A table listing all RPWS products published so far in this volume set, including the data on this volume.
CUMINDEX.LBL	A PDS detached label that describes CUMINDEX.TAB
INDEX.TAB	A table listing all RPWS products on this volume
INDEX.LBL	A PDS detached label that describes INDEX.TAB

4.3 DOCUMENT Directory Contents

The following files are contained in the Document Directory.

File Name	File Contents
DOCINFO.TXT	A description of the contents of this directory
VOLSIS.HTM	The Archive Volume SIS (this document) as hypertext
VOLSIS.TXT	The Archive Volume SIS (this document) in ASCII format
VOLSIS.PDF	The Archive Volume SIS (this document) in Adobe Acrobat format

VOLSIS.WPD	The Archive Volume SIS (this document) in Wordperfect format
VOLSIS.LBL	A PDS detached label that describes the HTM, WPD, and PDF versions of the VOLSIS document.
RPWSINST.HTM	A description of the RPWS instrument based on the Space Science Reviews article listed in section 2.3, Applicable Documents in hypertext format.
RPWSINST.WPD	A description of the RPWS instrument based on the Space Science Reviews article listed in section 2.3, Applicable Documents in Wordperfect format.
RPWSINST.PDF	A description of the RPWS instrument based on the Space Science Reviews article listed in section 2.3, Applicable Documents in Acrobat format.
RPWSINST.LBL	A PDS detached label that describes HTM, WPD, and PDF versions of the RPWSINST document.
RPWSUG.HTM	RPWS Flight Software User's Guide in hypertext format
RPWSUG.PDF	RPWS Flight Software User's Guide in Acrobat format
RPWSUG.SXW	RPWS Flight Software User's Guide in StarOffice format
RPWSUG.LBL	A PDS detached label that describes HTM, PDF, and SXW versions of the RPWSUG document.
RPWSCAL.HTM	A description of the RPWS calibration process, calibration parameters and related information in hypertext format.
RPWSCAL.PDF	A description of the RPWS calibration process, calibration parameters and related information in Acrobat format.
RPWSCAL.WPD	A description of the RPWS calibration process, calibration parameters and related information in Wordperfect format.
RPWSCAL.LBL	A PDS detached label that describes the HTM, PDF, and WPD versions of the RPWSCAL document.
WBRWFR.TXT	Information on accessing and calibrating WBR and WFR data.

4.4 CATALOG Directory Contents

The following files are contained in the Catalog Directory.

File Name	File Contents
CATINFO.TXT	A description of the contents of this directory
KEYDS.CAT	PDS data set catalog description of the Key Parameter data set
RAWDS.CAT	PDS data st catalog description of the Raw Complete data set.
LRFULLDS.CAT	PDS data set catalog description of the Low Rate Full data set
WBFULLDS.CAT	PDS data set catalog description of the Wideband Full data set
WFFULLDS.CAT	PDS data set catalog description of the Waveform Full data set
CO_HOST.CAT	PDS instrument host (spacecraft) catalog description of the Cassini Orbiter spacecraft (To be provided by the Cassini Project).
RPWSINST.CAT	PDS instrument catalog description of the RPWS instrument.
MISSION.CAT	PDS mission catalog description of the Cassini mission (To be provided by the Cassini Project).
PERSON.CAT	PDS personnel catalog description of RPWS Team members and PPI Node members involved with the generation of the RPWS data products.
REF.CAT	RPWS-related references mentioned in other *.CAT files. (To be provided by the Cassini Project).

4.5 BROWSE Directory Contents and Naming Conventions

The Browse directory contains frequency-time spectrogram images of the full-resolution numerical data for the Key Parameters, Low Rate, Wideband, and Waveform data sets and ancillary information files produced by the RPWS team. The image files, in Portable Network Graphics (PNG) format, from the various data sets are stored in separate subdirectories on the main data directory.

4.5.1 Required Files

In the BROWSE directory there is a file named BROWINFO.TXT that is an ASCII text

description of the contents of the directory and its subdirectories. Text documentation files will have attached PDS labels. One detached PDS label file will describe all of the image files in the BROWSE directory and its subdirectories, and has the suffix ".LBL".

4.5.2 BROWSE/RPWS_KEY_PARAMETERS Directory Contents

Low Rate Browse (RPWS_KEY_PARAMETERS_BROWSE) consists of Portable Network Graphics (PNG) frequency-time spectrogram images of the low rate key parameter spectral information observed by the RPWS. There will be two image files for each day for which data exists. One will include the electric field spectrogram and the other will include the magnetic field spectrogram. File names will be of the form Tyyyyddd_E_KPB.PNG and Tyyyyddd_B_KPB.PNG where yyyyddd is the date of the data.

4.5.3 BROWSE/RPWS_LOW_RATE_FULL Directory Contents

Low Rate Browse (RPWS_LOW_RATE_BROWSE) consists of Portable Network Graphics (PNG) frequency-time spectrogram images of the low rate spectral information observed by the RPWS. There will be two image files for each day for which data exists. One will include the electric field spectrogram and the other will include the magnetic field spectrogram. File names will be of the form Tyyyyddd_E_LRB.PNG and Tyyyyddd_B_LRB.PNG where yyyyddd is the date of the data.

4.5.4 BROWSE/RPWS_WIDEBAND_FULL Directory Contents

Wideband Browse (RPWS_WIDEBAND_BROWSE) consists of Portable Network Graphics (PNG) frequency-time spectrogram images of the wideband observations acquired by the RPWS. Subsets of this data set will include data in the 10- and 80-kHz wideband receiver data (baseband) and high-frequency wideband receiver data acquired via frequency translation through the High Frequency Receiver from frequencies between 125 kHz and 16 MHz. Since these data are typically acquired for brief intervals with long time intervals in between, there will be one file for each acquisition interval. File names will be of the form Tyyyyddd_hhmm_xxxKHZ_WBRFR.PNG where yyyyddd_hhmm is the starting date and time of the included data and xxx refers to the analysis band such as 10K, 75K, 125K, 8025K. The 10-kHz and 75-kHz files will be segregated into separate directories. The frequency-translated data will be in another separate directory, although this directory will include any analysis band other than 10- or 75-kHz.

4.5.5 BROWSE/RPWS_WAVEFORM_FULL Directory Contents

Waveform Browse (RPWS_WAVEFORM_BROWSE) data are of Portable Network Graphics (PNG) frequency-time spectrogram images of the 5-Channel Waveform Receiver observations acquired by the RPWS. There will be one file per day for each analysis bandwidth (26 Hz or 2.5

kHz). File names will be of the form Tyyyyddd_26HZ_WFRFR.PNG or Tyyyyddd_2_5KHZ_WFRFR.PNG where yyyyddd is the date of the data.

4.6 DATA Directory Contents and Naming Conventions

The Data directory contains the actual data products and ancillary information files produced by the RPWS team. The data files from the various data sets are stored in separate subdirectories on the main data directory.

4.6.1 Required Files

The DATA directory contains a description of the contents of all of the subdirectories in a file called DATAINFO.TXT. Text documentation files will have attached PDS labels and data files will have detached labels. Detached PDS label files have the same root name as the file they describe, but have the suffix ".LBL". In directories where there are multiple files with the same internal table structure, the table column description is included in a single format file (.FMT) that is referenced by a pointer within the PDS label files. This prevents the needless repetition of information that is not changing within the PDS label files. In directories where uncalibrated data are provided, files required for calibrating the data are included (.CAL).

4.6.2 DATA/RPWS_RAW_COMPLETE Directory Contents

Raw Complete (RPWS_RAW_COMPLETE) is a data set which includes all RPWS telemetry data in a reformatted telemetry packet form. Since much of the RPWS data is compressed on the spacecraft, this data set includes uncompressed data so that a user would not have to determine how to correctly uncompress several different types of data using different compression schemes. Also, since the RPWS telemetry packets include a secondary level of organization we refer to as minipackets (an RPWS minipacket includes telemetry from a single RPWS receiver for a given interval of time, usually a measurement cycle), and since the minipackets can be segmented - split across original telemetry packets, we have unsegmented these and made sure that all the data for a given minipacket is in one cohesive structure. Because of these simplifications, the reformatted telemetry packets are not fixed length and are not well-suited to description by PDS labeling standards. Also, since all of these data are archived in either calibrated or at least further reformatted into fixed-length records with standard PDS labeling elsewhere, we have included only minimal PDS labels for these records. Documentation (the RPWS Software Users Guide) included in the DOCUMENT directory provide information on how to extract and use data from this data set, should that extraordinary circumstance arise. There will be one file per hour (for hours during which data exist with file names of the form Tyyyyddd_hh_RAW.PKT where yyyyddd_hh is the year and day of year of the data and hh is the hour of the day of the data.

4.6.3 DATA/RPWS_KEY_PARAMETERS Directory Contents

Key Parameters (RPWS_KEY_PARAMETERS) is a data set which contains a summary of the RPWS spectral information as a function of time with parameters which have been agreed to between RPWS and other MAPS instruments as being suitable for the RPWS contribution to the MAPS Key Parameter Data Set. This parameter set is in the form of an ASCII flat file including the amplitude (electric and magnetic field spectral densities) of waves in 10 logarithmically-spaced frequency bands per decade of frequency with 1-minute temporal resolution and is generated by averaging full resolution measurements falling within the frequency and time bins. There will be one file per day for days when data exist. File names will be of the form RPWS_KEY__yyyyddd_v.TAB where yyyyddd is the date of the data and v is the version. Note that this version represents the number of times the file has been written and is not to be confused with the PDS product version or data set version.

4.6.4 DATA/RPWS_LOW_RATE_FULL Directory Contents

Low Rate Full Resolution Calibrated (RPWS_LOW_RATE_FULL) is a data set including all spectral density measurements acquired by the RPWS in units of electric or magnetic field spectral density. For days when data exist, there will be a minimum of 3 files per day. One of these files will include data from the Low Frequency Receiver (LFR), one will include data from the Medium Frequency Receiver (MFR), and one will include data from the High Frequency Receiver (HFR). There may be a fourth file which includes data from the Medium Frequency Digital Receiver (MFDR). This last data source is similar to that from the LFR except that is derived from the 2.5-kHz mode of the waveform receiver and can be used to replace or supplement the data from the MFR. Each file will contain a binary table with columns for time (both SCET and SCLK), sensor, and an array of spectral densities for the set of frequency channels described in the file header. When mode changes result in a change in this set of channels, a different file for that receiver will be used. This is most likely for the HFR, since the HFR has extensive flexibility. File names will be of the forms

Tyyyyddd_LFRn.DAT,
Tyyyyddd_MFRn.DAT,
Tyyyyddd_HFRn.DAT, and
Tyyyyddd_MFDRn.DAT

for the four types of files described above, respectively. In each, yyyyddd is the date of the data. For each ‘n’ is incremented from 0 for each different set of channel configurations for that receiver.

4.6.5 DATA/RPWS_WIDEBAND_FULL Directory Contents

Wideband Full Resolution Uncalibrated (RPWS_WIDEBAND_FULL) data are the full resolution waveform data from the RPWS Wideband Receiver in uncalibrated form. This data set will include procedures, code examples, and the necessary information to derive calibrated electric or

magnetic field spectral densities from the uncalibrated data. There will be at least one file for each hour when data exist. Data having different analysis frequency bands will be in separate files. Further, different files will be used when the number of samples in a time series is different within the same hour. This is so each file will have fixed-length records. File names will be of the forms:

Tyyyyddd_hh_10KHZn_WBRFR.DAT
Tyyyyddd_hh_75KHZn_WBRFR.DAT
Tyyyyddd_hh_xxxKHZn_WBRFR.DAT

where yyyyddd is the date of the data, hh is the hour of the data, and xxx is the frequency band when frequency translated data are used, such as 125, 8025, etc. The n differentiates between files with different record lengths as follows:

n	Record Data Length (bytes)
1	1024
2	2048
4	4096
6	6144
8	8192
9	20480
D	Dust waveform (1024 bytes)

In addition to the above data lengths, there are 32 bytes of status in each record.

4.6.6 DATA/RPWS_WAVEFORM_FULL Directory Contents

Waveform Full Resolution Uncalibrated (RPWS_WAVEFORM_FULL) data are the full resolution waveform data from the RPWS Wideband Receiver in uncalibrated form. This data set will include procedures, code examples, and the necessary information to derive calibrated electric and magnetic field spectral densities from the uncalibrated data. There will be one file per day for each of the two analysis bandwidths (25 Hz or 2.5kHz). Different files will be used when the number of samples in the time series is different, so as to have fixed-length records in the files. File names will be of the forms

Tyyyyddd_26HZ_WFFRn.DAT and
Tyyyyddd_2_5KHZ_WFFRn.DAT

where yyyyddd is the date of the data. The n differentiates between files with different record lengths as follows:

n	Record Data Length (bytes)
1	1024
2	2048
4	4096

6	6144
8	8192
9	20480

In addition to the above data lengths, there are 32 bytes of status in each record. Note that in this data set, data from all of the sensors (whether 1, 2, 3, or 5) are contained in the same file; a parameter in each record gives the sensor for that particular waveform time series.

4.6.7 DATA/ANCILLARY Directory Contents

The primary contents of this directory will be instrument operation and sequence information which is useful in finding and using the data in this archive. For each sequence, there will be an overview TXT file which will list the set of Instrument Expanded Blocks (IEBs) used in the sequence and a brief, one line, description of each IEB and a pointer to a TXT file providing a detailed description of the IEB. For each sequence there will also be a TAB file containing a set of Spacecraft Event Time (SCET) time tags, IEB Trigger number or other RPWS command mnemonic or short description of a series of commands (e.g. a series of IEB load commands) which can be used to understand which IEB was invoked at which times.

Note that we assume that the full set of SPICE kernels are being archived by NAIF; we do not propose to duplicate those archives within the RPWS archive.

4.7 EXTRAS Directory Contents

This directory contains volume navigation HTML files or other files which facilitate the use of the volume, but which are not considered part of the archive, itself.

5. Archive Volume Format

This section describes the format of Cassini RPWS Standard Product Archive Volumes. Data that comprise the RPWS Standard Product Archives will be formatted in accordance with Planetary Data System specifications [Planetary Science Data Dictionary, 2002; PDS Data Preparation Workbook, 1995; PDS Standards Reference, 2002].

5.1 Disk Format

All DVD volumes in the Cassini RPWS Standard Product Archive Collection will conform to the Digital Versatile Disk UDF-ISO Bridge format (with ISO-9660 level 2 compatibility).

5.2 File Formats

The following section describes file formats from the kinds of files contained on archive volumes.

For more information, see the PDS Data Preparation Workbook [1995], Appendix B.

5.2.1 Document File Format

Document files with the .TXT suffix exist in most directories. They are ASCII files with embedded PDS labels. All TXT document files consist of variable-length records (lines), terminated with carriage return (ASCII 13) and line feed (ASCII 10) character pairs. This is the standard Microsoft text file format and can be easily accommodated by MacOS, UNIX, and other common operating systems.

In general, documents are provided in ASCII text format. However, if the document contained in the DOCUMENT directory contains formatting and figures that cannot be rendered as ASCII text, then the document is also given in hypertext format. The hypertext file contains ASCII text plus hypertext markup language (HTML) commands that enable it to be viewed in a web browser such as Netscape or Internet Explorer. Hypertext documents may reference ancillary files such as images that are incorporated into the document by the web browser. All image files in this archive will be in PNG format. Native formats for most documents are also provided, such as Corel Wordperfect. Adobe Acrobat versions of most documents are also provided.

5.2.2 Tabular File Format

Tabular files (.TAB extension) exist in the INDEX, RPWS_KEY_PARAMETERS, and ANCILLARY directories. Tabular files are ASCII files formatted for direct reading into many database management systems on various computers. Fields normally are separated by commas or whitespace, and character fields are enclosed in double quotation marks (“). Character fields are padded with spaces to keep quotation marks in the same columns of successive records. Character fields are left justified, and numeric fields are right justified. The “start byte” and “bytes” values listed in the labels do not include the commas between fields or the quotation marks surrounding character fields. The records are of fixed length, and the last two bytes of each record contain the ASCII carriage return and line feed characters. This allows a table to be treated as a fixed length record file on computers that support this file type and as a text file with embedded line delimiters on those that don’t.

All tabular files are described by detached PDS label files. A detached PDS label file has the same name as the data file it describes, with the extension .LBL; for example, the file INDEX.TAB is accompanied by the detached label file INDEX.LBL in the same directory.

5.2.3 PDS Label Format

All data files in the RPWS Standard Product Archive Collection have PDS labels [Planetary Science Data Dictionary, 2002; PDS Standards Reference, 2002]. These labels all are detached from the data files (same file name prefix, .LBL suffix).

A PDS label, whether embedded or detached from its associated file, provides descriptive information about the associated file. The PDS label is an object-oriented structure consisting of sets of 'keyword = value' declarations. The object to which the label refers (e.g. IMAGE, TABLE, etc.) is denoted by a statement of the form:

^object = location

in which the carat character (^, also called a pointer in this context) indicates where to find the object. In a PDS label, the location denotes the name of the file containing the object, along with the starting record or byte number, if there is more than one object in the file. For example:

^HEADER=("98118.DAT",1)
^TABLE=("98118.DAT",1025 <BYTES>)

indicates that the HEADER object begins at record 1 and that the TABLE object begins at byte 1025 of the file 98118.DAT. The file 98118.DAT must be located in the same directory as the detached label file.

Below is a list of the possible formats for the ^object definition in labels in this product.

^object = n
^object = n <BYTES>
^object = "filename.ext"
^object = ("filename.ext", n)
^object = ("filename.ext", n <BYTES>)

where

n is the starting record or byte number of the object, counting from the beginning of the file (record 1, byte 1),
<BYTES> indicates that the number given is in units of bytes (the default is records),
filename is the up-to-27-character, alphanumeric upper-case file name,
ext is the up-to-3-character upper-case file extension.

All detached labels are ASCII text files with lines terminated with carriage return (ASCII 13) and line feed (ASCII 10) character pairs. Some may be padded out with spaces to form 80-byte fixed-length records. These text formats may be easily read on all common operating systems.

5.2.4 Catalog File Format

Catalog files (suffix .CAT) exist in the Root and Catalog directories. They are formatted in an object-oriented structure consisting of sets of 'keyword = value' declarations.

5.2.5 Index File Format

The Index file format is an ASCII table containing information about the data products included in this volume and a cumulative list for the collection including this volume. It includes information such as the Volume ID, Product ID, start SCET, path relative to the root of the volume, data set ID, and RPWS receiver which produces the data. A format description file for the Index file is given in Appendix G.

5.2.6 Science Data File Formats

5.2.6.1 RPWS_KEY_PARAMETERS_BROWSE Data Product Format

These will be PNG formatted images of frequency-time spectrograms of the key parameters data with one electric and one magnetic spectrogram per day for which there are data.

5.2.6.2 RPWS_KEY_PARAMETERS Data Product Format

This is an ASCII flat file table with a time tag followed by averages in frequency and time for both electric and magnetic field spectral densities. There are 70 (TBD) electric and 40 (TBD) magnetic channels and the time resolution is 1-minutes. These characteristics are not definite until the MAPS working group have concluded their discussion of the MAPS key parameters. The table will consist of a time (SCET) column followed by ~ 70 electric field spectral density values and ~40 magnetic field spectral densities. The record header will define the center frequencies of these channels. The time will refer to the beginning time of the averaging interval. A more detailed file format is given in Appendix B in the RPWSKEY.FMT file. A data quality flag is also included. If this flag is 0, then the confidence in the data included in this record is high. If the flag is 1, then there is some question about the data in the record, and they should be used with caution.

5.2.6.3 RPWS_RAW_COMPLETE Data Product Format

The Raw Complete data files are variable length binary formatted files with a complex structure including embedded minipackets segregating telemetry from the various RPWS receivers into separate substructures. The format is given in the Software Users Guide included in the DOCUMENT directory.

5.2.6.4 RPWS_LOW_RATE_BROWSE Data Product Format

These will be PNG formatted images of frequency-time spectrograms of the low-rate survey data with one electric and one magnetic spectrogram per day for which there are data.

5.2.6.5 RPWS_LOW_RATE_FULL Data Product Format

There will be four different types of files included in this data set as described in section 4.6.3. Each will be a binary table which has time columns (SCET and SCLK), a sensor column, and an array of spectral densities. The header in each file will list the center frequencies of the channels for which spectral densities are given. Each record will include a complete set of spectral densities for the set of channels indicated, with the time being the start time of the data acquisition for the spectral densities. A detailed file format is given in Appendix D embedded in the sample RPWS_LOW_RATE_FULL label file.

5.2.6.6 RPWS_WIDEBAND_BROWSE Data Product Format

These will be PNG formatted images of frequency-time spectrograms of the wideband data. There will be one image for each contiguous set of WBR observations in a given frequency range (i.e. 10 kHz, 75 kHz, or specific frequency selection of HF-WBR data).

5.2.6.7 RPWS_WIDEBAND_FULL Data Product Format

This is a binary time series data set. Each record will include time information (SCET and SCLK, sensor, and gain state (required for calibration) as well as a time series of waveform measurements. A detailed description of the file format is in Appendix E in RPWSWBRFR.FMT.

5.2.6.8 RPWS_WAVEFORM_BROWSE Data Product Format

These will be PNG formatted images of 5-channel frequency-time spectrograms of the waveform data. There will be one image including all five channels for each day as long as there is only one set of channels selected for that day. For days where the channel selections change, there will be an image for each selected set of channels. For example, if a particular day has a two-hour interval of delta-n/n observations from Titan but the rest of the day has the more typical Ex, Ez, Bx, By, Bz set, then two images will be produced. One will cover the entire day except for the 2-hour Titan observation and the other will be a two-hour set of frequency-time spectrograms representing the delta-n/n observations.

5.2.6.9 RPWS_WAVEFORM_FULL Data Product Format

This is a binary time series data set. Each record will include time information (SCET and SCLK, sensor, and gain state (required for calibration) as well as a time series of waveform measurements. A detailed description of the file format is in Appendix F in RPWSWFRFR.FMT.

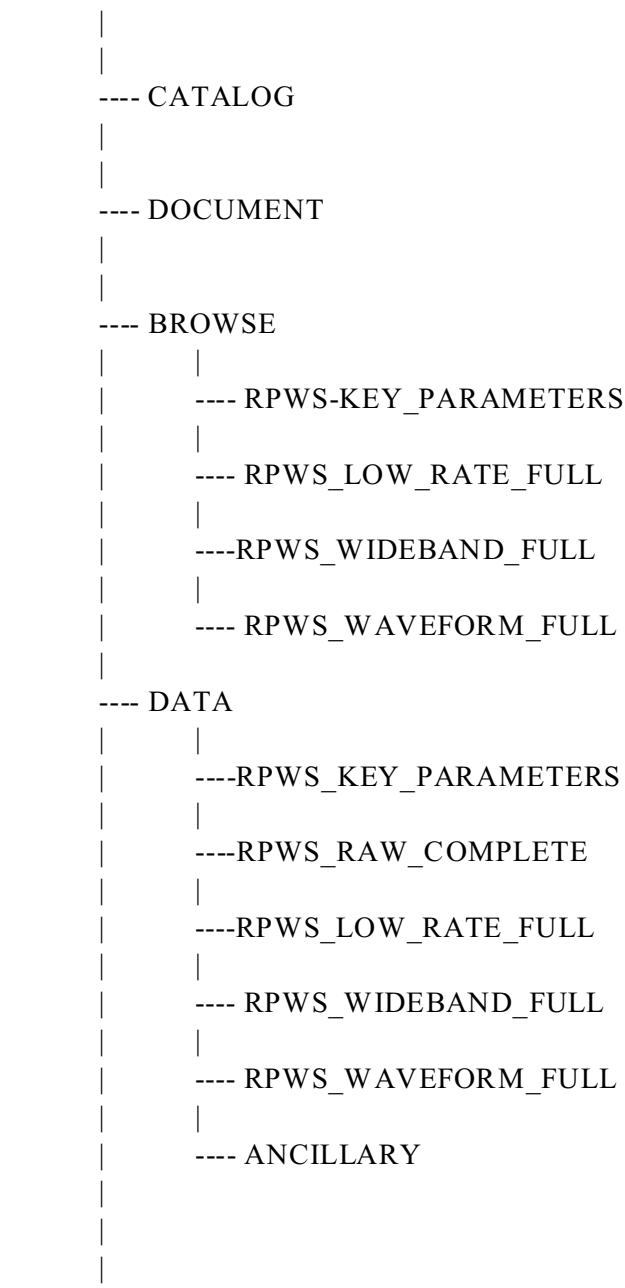
6. Support Staff and Cognizant Persons

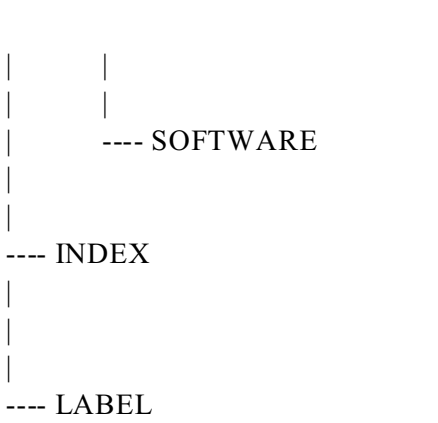
Table 3: RPWS Archive Collection Support Staff

Cassini RPWS Team			
Dr. Donald A. Gurnett	Dept. Of Physics & Astronomy The University of Iowa Iowa City, IA 52242	319-335-1697	donald-gurnett@uiowa.edu
Dr. William S. Kurth	Dept. Of Physics & Astronomy The University of Iowa Iowa City, IA 52242	319-335-1926	william-kurth@uiowa.edu
Mr. Larry J. Granroth	Dept. Of Physics & Astronomy The University of Iowa Iowa City, IA 52242	319-335-2536	larry-granroth@uiowa.edu
UCLA - PPI			
Mr. Steven P. Joy	UCLA-IGPP 405 Hilgard Ave. Los Angeles, CA 90095-1567	310-826-3506	sjoy@igpp.ucla.edu

Appendix A. Directory Structure

The following directory structure is applicable to each Cassini RPWS Standard Product Archive Volume. In the cases where all data product types are not acquired during a given time interval covered by a volume, the relevant directories will simply be empty except for the INFO.TXT file. The directories are discussed in detail in the text of this document, except for EXTRAS, which contains the HTML interface accessible through AAREADME.HTM.




---- EXTRAS
|
|
|
---- SOFTWARE
|
|
---- INDEX
|
|
|
---- LABEL

Appendix B: Sample Labels for RPWS_KEY_PARAMETERS

Data Set Information Catalog File: KEYDS.CAT

```
PDS_VERSION_ID          = PDS3
LABEL_REVISION_NOTE     = "
  2003-01-12, William Kurth (U. IOWA), initial;
  2003-06-26, William Kurth (U. IOWA), general revision;
  2004-02-10, William Kurth (U. IOWA), fixed liens;"
RECORD_TYPE             = STREAM

OBJECT                  = DATA_SET
  DATA_SET_ID             = "CO-V/E/J/S/SS-RPWS-4-SUMM-KEY60S-V1.0"

  OBJECT                  = DATA_SET_INFORMATION
    DATA_SET_NAME           = "
      CASSINI V/E/J/S/SS RPWS SUMMARY KEY PARAMETER 60S V1.0"
    DATA_SET_COLLECTION_MEMBER_FLG = "N"
    DATA_OBJECT_TYPE        = TABLE
    ARCHIVE_STATUS          = IN_PEER_REVIEW
    START_TIME              = 1997-298T00:00:00.000Z
    STOP_TIME               = NULL
    DATA_SET_RELEASE_DATE   = 2003-06-30
    PRODUCER_FULL_NAME      = "DR. WILLIAM S. KURTH"
    DETAILED_CATALOG_FLAG   = "N"
    DATA_SET_TERSE_DESC     = "
      The Cassini Radio and Plasma Wave Science (RPWS) resampled
      summary key parameter data set includes summary spectral
      information calibrated in units of spectral density for the
      entire Cassini mission."

    ABSTRACT_DESC           = "
      The Cassini Radio and Plasma Wave Science (RPWS) calibrated
      summary key parameter data set includes reduced temporal and
      spectral resolution spectral information calibrated in units of
      spectral density for the entire Cassini mission.  This data set
      includes calibrated values binned and averaged within 1 minute by
      0.1 decade spectral channels for all times during the mission
      including the two Venus flybys, the Earth flyby, the Jupiter
      flyby, interplanetary cruise, and the entire Saturn tour.  Data
      for this data set are acquired by the RPWS Low Frequency Receiver
      (LFR), Medium Frequency Receiver (MFR), and High Frequency
      Receiver (HFR).  Data are presented in a set of
      fixed-record-length tables.  This data set is intended to provide
      numerical summary data which can be used in conjunction with other
      Cassini fields and particles key parameter data sets to establish
      trends, select events, or simply as a browse data set for the
      Cassini RPWS archive.  This data set should be among the first
      used by a user of any of the RPWS archive as it will lead one to
      information required to search for more detailed or highly
      specialized products."

    CITATION_DESC           = "Kurth, W.S., T.F. Averkamp, and
      L.J. Granroth, CASSINI V/E/J/S/SS RPWS SUMMARY KEY PARAMETER
      60S V1.0, CO-V/E/J/S/SS-RPWS-4-SUMM-KEY60S-V1.0, NASA
      Planetary Data System, 2004."

    DATA_SET_DESC           = "
```

Data Set Overview

The Cassini Radio and Plasma Wave Science (RPWS) calibrated summary key parameter data set includes reduced temporal and spectral resolution spectral information calibrated in units of spectral density for the entire Cassini mission. This data set includes calibrated values binned and averaged within 1 minute by 0.1 decade spectral channels for all times during the mission including the two Venus flybys, the Earth flyby, the Jupiter flyby, interplanetary cruise, and the entire Saturn tour. Data for this data set are acquired by the RPWS Low Frequency Receiver (LFR), Medium Frequency Receiver (MFR), and High Frequency Receiver (HFR). Data are presented in a set of fixed-record-length tables. This data set is intended to provide numerical summary data which can be used in conjunction with other Cassini fields and particles key parameter data sets to establish trends, select events, or simply as a browse data set for the Cassini RPWS archive. This data set should be among the first used by a user of any of the RPWS archive as it will lead one to information required to search for more detailed or highly specialized products.

Parameters

This data set comprises electric and magnetic field spectral densities for each sensor, binned and averaged (median) into moderate resolution frequency and time bins. We use 10 spectral channels per decade logarithmically spaced in frequency, usually from 1 Hz to 16 MHz, and a 1-minute time step.

Processing

Data in this data set were processed by the use of a number of software programs which assemble segmented mini-packets in the raw telemetry packets into complete sets, de-compress the data that were compressed by one of a number of compression algorithms by the RPWS flight software onboard, apply conversion lookup tables or algorithms to convert telemetry data numbers into physical units, make any corrections required for antenna capacitive loading or other effects, bin the measurements into frequency and time bins, and then determine the median of all measurements within a bin. These data are calibrated using the best calibration tables and algorithms available at the time the data were archived. See chapters 5 - 11 of the RPWSCAL document in the DOCUMENT directory for details on how the data included in this data set were calibrated. Should a significant improvement in calibration become available, an erratum will be noted in the erratum section. Later versions of data products may contain better calibrations. It should be noted, however, that since measurements from different sensors are binned (via finding the median measurement in the bin) the resulting spectrum is an amalgamation of different sensors oriented in different directions. Hence, the detailed interpretation of this data set is not necessarily straight-forward. If the user is interested in the best calibrated value with a minimum of interpretational issues, the Low Rate Full resolution data product would be the best source of information.

```
Data
====
  The RPWS key parameter data set includes tables of wave spectra as a
  function of time using measurements from each of the various
  receivers of the RPWS, including the LFR, MFR, and HFR.  Each table
  will contain fixed-length records including columns for time and
  spectral densities for each channel.


Ancillary Data
==============
  Ancillary data included with this data set collection include a
  series of files that describe the modes of the RPWS as a function of
  time and provide a time-ordered listing of Instrument Expanded Block
  (IEB) trigger commands (the mode by which the RPWS is reconfigured).
  Also a detailed description of each of the modes (or IEBs) is
  provided.

  Other data which are ancillary to this data set but which are
  archived separately from this collection are the Navigation and
  Ancillary Information Facility's SPICE kernels describing the
  position and attitude of Cassini and various solar system bodies as
  a function of time.


Coordinate System
=================
  The data in this data set are measurements of wave electric and
  magnetic fields measured by the RPWS electric and magnetic sensors.
  These fields are presented as detected by the sensors and are not
  rotated into any other coordinate system.  If desired the SPICE
  kernels can be used with the SPICE toolkit to convert from the
  spacecraft frame to virtually any frame which may be of use in
  analyzing these data.  However, for many purposes, the wave
  amplitudes are extremely useful and may be entirely adequate with no
  coordinate transformations at all.


Software
========
  Since the data are provided in text files as fully calibrated
  amplitudes, no example software is provided for reading these data.
  However, a platform-independent Java (TM) application is provided in
  EXTRAS/SOFTWARE/KEY_BROWSE.JAR which can read these data and produce
  spectrograms with user-selectable options.  See README.TXT in the
  same directory for further information.


Media/Format
============
  These data are supplied to the Planetary Data System on DVD-R media
  using formats and standards of the PDS for such media."

  CONFIDENCE_LEVEL_NOTE   = "


Confidence Level Overview
=========================
  This data set contains all low rate key parameter data for the
  Cassini RPWS instrument for the intervals described In the product
```

label files. Every effort has been made to ensure that all data returned to JPL from the spacecraft are included and that the calibration is accurate. A column in each record indicates whether the confidence in the data in that record is high (0) or not (9). The middle band of the MFR (Band 2, 180 - 1500 Hz) has shown a tendency to have an increased noise level by as much as 10 dB at times, although there is no current explanation for this or known factor which would enable this condition to be predicted. In some instrument modes data are collected in the high band of the WFR which can be used to replace the data in MFR Band 2, although this replacement has not been done for this data set. The replacement data are included in the low resolution, fully calibrated data set, however.

Review
======

The RPWS calibrated summary key parameter data will be reviewed internally by the Cassini RPWS team prior to release to the PDS. The data set will also be peer reviewed by the PDS.

Data Coverage and Quality
=========================

All data in the intervals described in the product label files are included, to the best of our knowledge and attempts to determine completeness. In general, the instrument was operated only briefly during early tour for the following intervals:

1.	Antenna deployment	1997-10-25T00:00 - 1997-10-26T05:30
2.	Venus 1 flyby	1998-04-26T12:54 - 1998-05-08T19:21*
3.	Instrument Checkout	1998-12-30T09:10 - 1999-01-19T05:40
4.	Venus 2 flyby	1999-06-24T09:08 - 1999-06-24T21:20
5.	Earth flyby	1999-08-13T17:39 - 1999-09-14T22:20

*Actual interval for science data is much shorter than this.

Beginning in February of 2000 the instrument was operated more-or-less continuously; two gaps of the order of six weeks were incurred for the purposes of loading new attitude control and command and data system flight software, gaps of a few days each were incurred approximately twice per year because of Huygens Probe testing, and gaps of several days in duration occurred during solar conjunction periods prior to 2002. Remaining gaps are due to spacecraft anomaly resolution or simply to downlink gaps, some of which were imposed by limitations on DSN station availability.

Limitations
===========

The only known measurement quality issue is occasional elevated noise levels (by a few to 10 dB) in the second band of the MFR. During tour, it is anticipated that data from the Waveform Receiver (WFR) sometimes referred to as the medium frequency digital receiver (MFDR) can be substituted for these in the full resolution data product (RPWS LOW RATE FULL)."

END_OBJECT = DATA_SET_INFORMATION

OBJECT = DATA_SET_TARGET

```
    TARGET_NAME             = VENUS
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = EARTH
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = JUPITER
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = SATURN
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = SOLAR_SYSTEM
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_HOST
    INSTRUMENT_HOST_ID      = CO
    INSTRUMENT_ID           = RPWS
  END_OBJECT              = DATA_SET_HOST

  OBJECT                  = DATA_SET_REFERENCE_INFORMATION
    REFERENCE_KEY_ID        = "GURNETTETAL2003"
  END_OBJECT              = DATA_SET_REFERENCE_INFORMATION

END_OBJECT              = DATA_SET
END
```

Sample RPWS_KEY_PARAMETERS Label File

```
PDS_VERSION_ID                = PDS3

DESCRIPTION                   = "RPWS_KEY__1999230_0 contains Cassini Radio
                                 and Plasma (RPWS) key parameter data for the
                                 time period between 1999-230T00:00:00.000 and
                                 1999-231T00:00:00.000 and includes the
                                 following targets:
                                 EARTH , SOLAR SYSTEM ."

/* pds label for a rpws spectogram */
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 1175
FILE_RECORDS                  = 1385

/* pointers to start records of objects in file, std ref3.5:5.3.3.2 */
^LRKEY_FREQUENCY_TABLE        = ("RPWS_KEY__1999230_0.TAB",1)
^LRKEY_SPECTRAL_DENSITY_TABLE = ("RPWS_KEY__1999230_0.TAB",2)

/* identification data elements - data product labels, std ref3.5:5.3.4.1 */
DATA_SET_ID                   = "CO-V/E/J/S/SS-RPWS-4-SUMM-KEY60S-V1.0"
PRODUCT_ID                    = "RPWS_KEY__1999230_0_V1"
PRODUCT_TYPE                  = DATA
INSTRUMENT_HOST_NAME          = "CASSINI ORBITER"
INSTRUMENT_HOST_ID            = CO
INSTRUMENT_NAME               = "RADIO AND PLASMA WAVE SCIENCE"
INSTRUMENT_ID                 = RPWS
MISSION_PHASE_NAME            = {"EARTH ENCOUNTER",
                                 "INTERPLANETARY CRUISE",
                                 "VENUS 2 - EARTH CRUISE"}
TARGET_NAME                   = {"EARTH","SOLAR SYSTEM"}
START_TIME                    = 1999-230T00:00:00.000
STOP_TIME                     = 1999-231T00:00:00.000
SPACECRAFT_CLOCK_START_COUNT  = "1/1313626007:150"
SPACECRAFT_CLOCK_STOP_COUNT   = "1/1313712408:040"
PRODUCT_CREATION_TIME         = 2004-03-03
STANDARD_DATA_PRODUCT_ID      = RPWS_KEY_PARAMETERS

/* descriptive data elements */
OBJECT                        = LRKEY_FREQUENCY_TABLE
  INTERCHANGE_FORMAT          = ASCII
  ROW_BYTES                   = 1175
  ROWS                        = 1
  COLUMNS                     = 3

  OBJECT                      = COLUMN
    NAME                      = BEGIN_TIME
    DATA_TYPE                 = TIME
    START_BYTE                = 1
    BYTES                     = 21
    DESCRIPTION               = "Spacecraft Event Time for the beginning of
                                 the day."
  END_OBJECT                  = COLUMN

  OBJECT                      = COLUMN
    NAME                      = DATA_QUALITY_FLAG
    DATA_TYPE                 = ASCII_INTEGER
    START_BYTE                = 23
    BYTES                     = 1
    DESCRIPTION               = "Data quality flag. 0=good & 9=bad."
  END_OBJECT                  = COLUMN
```

```
  OBJECT                       = COLUMN
    NAME                       = FREQUENCY
    DATA_TYPE                  = ASCII_REAL
    START_BYTE                 = 24
    BYTES                      = 1150
    ITEMS                      = 115
    ITEM_BYTES                 = 10
    UNIT                       = "HZ"
    DESCRIPTION                = "Frequency of the spectral density data."
  END_OBJECT                   = COLUMN

END_OBJECT                     = LRKEY_FREQUENCY_TABLE

OBJECT                         = LRKEY_SPECTRAL_DENSITY_TABLE
  INTERCHANGE_FORMAT           = ASCII
  ROW_BYTES                    = 1175
  ROWS                         = 1384
  COLUMNS                      = 4

  OBJECT                       = COLUMN
    NAME                       = SCET
    DATA_TYPE                  = TIME
    START_BYTE                 = 1
    BYTES                      = 21
    DESCRIPTION                = "Spacecraft Event Time for the spectral
                                  density measurements. This is the center of
                                  the 1-minute time period within which the
                                  median value of the spectral density for this
                                  time and frequency range was determined."
  END_OBJECT                   = COLUMN

  OBJECT                       = COLUMN
    NAME                       = DATA_QUALITY_FLAG
    DATA_TYPE                  = ASCII_INTEGER
    START_BYTE                 = 23
    BYTES                      = 1
    DESCRIPTION                = "Data quality flag. 0=good & 9=bad."
  END_OBJECT                   = COLUMN

  OBJECT                       = COLUMN
    NAME                       = ELECTRIC_SPECTRAL_DENSITIES
    DATA_TYPE                  = ASCII_REAL
    START_BYTE                 = 24
    BYTES                      = 730
    ITEMS                      = 73
    ITEM_BYTES                 = 10
    UNIT                       = "V**2/M**2/HZ"
    DESCRIPTION                = "Calibrated spectral densities from the
                                  electric antennas."
  END_OBJECT                   = COLUMN

  OBJECT                       = COLUMN
    NAME                       = MAGNETIC_SPECTRAL_DENSITIES
    DATA_TYPE                  = ASCII_REAL
    START_BYTE                 = 754
    BYTES                      = 420
    ITEMS                      = 42
    ITEM_BYTES                 = 10
    UNIT                       = "NT**2/HZ"
    DESCRIPTION                = "Calibrated spectral densities from the
                                  magnetic sensors."
  END_OBJECT                   = COLUMN
```

```
END_OBJECT                    = LRKEY_SPECTRAL_DENSITY_TABLE


END
```

Appendix C: Sample Labels for RPWS_RAW_COMPLETE

Data Set Information Catalog File: RAWDS.CAT

```
PDS_VERSION_ID          = PDS3
LABEL_REVISION_NOTE     = "
  2003-06-29, William Kurth (U. IOWA), initial;
  2004-02-10, William Kurth (U. IOWA), fixed liens;"
RECORD_TYPE             = STREAM

OBJECT                  = DATA_SET
  DATA_SET_ID             = "CO-V/E/J/S/SS-RPWS-3-REFDR-ALL-V1.0"

  OBJECT                  = DATA_SET_INFORMATION
    DATA_SET_NAME           = "
      CASSINI V/E/J/S/SS RPWS RAW COMPLETE TLM PACKETS V1.0"
    DATA_SET_COLLECTION_MEMBER_FLG = "N"
    DATA_OBJECT_TYPE        = TABLE
    ARCHIVE_STATUS          = IN_PEER_REVIEW
    START_TIME              = 1997-298T00:00:00.000Z
    STOP_TIME               = NULL
    DATA_SET_RELEASE_DATE   = 2003-06-30
    PRODUCER_FULL_NAME      = "DR. WILLIAM S. KURTH"
    DETAILED_CATALOG_FLAG   = "N"
    DATA_SET_TERSE_DESC     = "
      The Cassini Radio and Plasma Wave Science (RPWS) raw complete data
      set includes all RPWS telemetry data for the entire Cassini
      mission."

    ABSTRACT_DESC           = "
      The Cassini Radio and Plasma Wave Science (RPWS) raw complete data
      set includes all RPWS telemetry data for the entire Cassini
      mission.  This data set includes raw telemetry values for each
      frequency channel for each sensor for all times during the mission
      including the two Venus flybys, the Earth flyby, the Jupiter
      flyby, interplanetary cruise, and the entire Saturn tour.  Data
      for this data set are acquired from the RPWS Low Frequency
      Receiver (LFR), Medium Frequency Receiver (MFR), Medium Frequency
      Digital Receiver (MFDR) (which can be used to replace MFR band 2
      data), High Frequency Receiver (HFR), Sounder, and Langmuir Probe
      (LP).  Data are decompressed and internal receiver minipackets are
      unsegmented.  This data set is intended to preserve the telemetry
      data and is to be used only as a last resort.  Other RPWS archived
      data sets are designed to be complete and more easily used.
      Browse data sets associated with the other data sets provide a
      graphical search of the data included in this data set.  This data
      set should be the last used by a user of any of the RPWS archive
      as it is in the least user-friendly form."

    CITATION_DESC           = "Kurth, W.S., W.T. Robison, and L.J.
      Granroth, CASSINI V/E/J/S/SS RPWS RAW COMPLETE TLM PACKETS V1.0,
      CO-V/E/J/S/SS-RPWS-3-REFDR-ALL-V1.0, NASA Planetary Data System,
      2004."

    DATA_SET_DESC           = "


  Data Set Overview
```

==========

The Cassini Radio and Plasma Wave Science (RPWS) raw complete data set includes all RPWS telemetry data for the entire Cassini mission. This data set includes raw telemetry values for each frequency channel for each sensor for all times during the mission including the two Venus flybys, the Earth flyby, the Jupiter flyby, interplanetary cruise, and the entire Saturn tour. Data for this data set are acquired from the RPWS Low Frequency Receiver (LFR), Medium Frequency Receiver (MFR), Medium Frequency Digital Receiver (MFDR) (which can be used to replace MFR band 2 data), High Frequency Receiver (HFR), Sounder, and Langmuir Probe (LP). Data are decompressed and internal receiver minipackets are unsegmented. This data set is intended to preserve the telemetry data and is to be used only as a last resort. Other RPWS archived data sets are designed to be complete and more easily used. Browse data sets associated with the other data sets provide a graphical search of the data included in this data set. This data set should be the last used by a user of any of the RPWS archive as it is in the least user-friendly form.

Parameters

==========

This data set includes all measurements from each sensor, frequency channel, and time step for which data were acquired by the RPWS.

Processing

==========

Data in this data set were processed by the use of a number of software programs which assemble segmented mini-packets in the raw telemetry packets into complete sets and de-compress the data that were compressed by one of a number of compression algorithms by the RPWS flight software onboard. Information included in the Software Users Guide included in the DOCUMENT directory on this volume provides information necessary to extract and use these data.

Data

====

The data included in this data set are the complete set of RPWS telemetry.

Ancillary Data

==========

Ancillary data included with this data set collection include a series of files that describe the modes of the RPWS as a function of time and provide a time- ordered listing of Instrument Expanded Block (IEB) trigger commands (the mode by which the RPWS is reconfigured). Also a detailed description of each of the modes (or IEBs) is provided.

Other data which are ancillary to this data set but which are archived separately from this collection are the Navigation and Ancillary Information Facility's SPICE kernels describing the position and attitude of Cassini and various solar system bodies as a function of time.

Coordinate System
==========
The data in this data set are measurements of wave electric and magnetic fields measured by the RPWS electric and magnetic sensors. These fields are presented as detected by the sensors and are not rotated into any other coordinate system. If desired the SPICE kernels can be used with the SPICE toolkit to convert from the spacecraft frame to virtually any frame which may be of use in analyzing these data. However, for many purposes, the wave amplitudes are extremely useful and may be entirely adequate with no coordinate transformations at all.

Software
========
No software is provided to be used with this data set.

Media/Format
==========
These data are supplied to the Planetary Data System on DVD-R media using formats and standards of the PDS for such media."

CONFIDENCE_LEVEL_NOTE = "

Confidence Level Overview
==========
This data set contains all the telemetry data for the Cassini RPWS instrument for the interval described In the label files for the individual data files. Every effort has been made to ensure that all data returned to JPL from the spacecraft are included.

Review
======
The RPWS raw complete data will be reviewed internally by the Cassini RPWS team prior to release to the PDS. The data set will also be peer reviewed by the PDS.

Data Coverage and Quality
==========
All data in the stated interval are included, to the best of our knowledge and attempts to determine completeness. In general, the instrument was operated only briefly during early tour for the following intervals:

1. Antenna deployment 1997-10-25T00:00 - 1997-10-26T05:30
2. Venus 1 flyby 1998-04-26T12:54 - 1998-05-08T19:21*
3. Instrument Checkout 1998-12-30T09:10 - 1999-01-19T05:40
4. Venus 2 flyby 1999-06-24T09:08 - 1999-06-24T21:20
5. Earth flyby 1999-08-13T17:39 - 1999-09-14T22:20

*Actual interval for science data is much shorter than this.

Beginning in February of 2000 the instrument was operated more-or-less continuously; two gaps of the order of six weeks were incurred for the purposes of loading new attitude control and command and data system flight software, gaps of a few days each

```
    were incurred approximately twice per year because of Huygens Probe
    testing, and gaps of several days in duration occurred during solar
    conjunction periods prior to 2002. Remaining gaps are due to
    spacecraft anomaly resolution or simply to downlink gaps, some of
    which were imposed by limitations on DSN station availability.


  Limitations
  ===========
    The only known measurement quality issue is occasional elevated
    noise levels (by a few to 10 dB) in the second band of the MFR.
    During tour, it is anticipated that data from the Waveform Receiver
    (WFR) sometimes referred to as the medium frequency digital receiver
    (MFDR) can be substituted for these."

  END_OBJECT              = DATA_SET_INFORMATION

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = VENUS
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = EARTH
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = JUPITER
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = SATURN
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = SOLAR_SYSTEM
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_HOST
    INSTRUMENT_HOST_ID      = CO
    INSTRUMENT_ID           = RPWS
  END_OBJECT              = DATA_SET_HOST

  OBJECT                  = DATA_SET_REFERENCE_INFORMATION
    REFERENCE_KEY_ID        = "GURNETTETAL2003"
  END_OBJECT              = DATA_SET_REFERENCE_INFORMATION

END_OBJECT              = DATA_SET
END
```

Sample RPWS_RAW_COMPLETE Label File

```
PDS_VERSION_ID          = PDS3

/* File characteristics */

RECORD_TYPE             = UNDEFINED
FILE_RECORDS            = 4838
DESCRIPTION             = "T1999230_01_RAW.PKT contains raw Cassini
    Radio and Plasma Wave (RPWS) telemetry data for the time period
    between 1999-230T01:00:00.000 and 1999-230T02:00:00.000 that
    includes the following targets: EARTH,
                                    SOLAR SYSTEM."

/* Data object pointers */

^RPWS_RAW_ROW_PREFIX_TABLE  = ("T1999230_01_RAW.PKT", 1)
^RPWS_RAW_PACKET_TABLE      = ("T1999230_01_RAW.PKT", 1)

/* Identification */

DATA_SET_ID             = "CO-V/E/J/S/SS-RPWS-2-REFDR-ALL-V1.0"
DATA_SET_NAME           = "
              CO V/E/J/S/SS RPWS 2 REFDR RAW SCIENCE TELEMETRY V1.0"
PRODUCT_ID              = "T1999230_01_RAW_V1"
PRODUCT_CREATION_TIME   = 2004-03-03
START_TIME              = 1999-230T01:00:00.000Z
STOP_TIME               = 1999-230T02:00:00.000Z
SPACECRAFT_CLOCK_START_COUNT = "1/1313629607:156"
SPACECRAFT_CLOCK_STOP_COUNT  = "1/1313633207:162"
PRODUCT_TYPE                 = DATA
STANDARD_DATA_PRODUCT_ID     = RPWS_RAW_COMPLETE
MISSION_PHASE_NAME           = {"EARTH ENCOUNTER",
                                "INTERPLANETARY CRUISE",
                                "VENUS 2 - EARTH CRUISE"}
TARGET_NAME                  = {"EARTH",
                                "SOLAR SYSTEM"}
SOFTWARE_VERSION_ID          = "RPWS_HR_AR V5.3"

/* Instrument description */

INSTRUMENT_HOST_NAME    = "CASSINI ORBITER"
INSTRUMENT_HOST_ID      = CO
INSTRUMENT_NAME         = "RADIO AND PLASMA WAVE SCIENCE"
INSTRUMENT_ID           = RPWS

/* Record header */

OBJECT                  = RPWS_RAW_ROW_PREFIX_TABLE
  NAME                    = RPWS_RAW_ROW_PREFIX_TABLE
  INTERCHANGE_FORMAT      = BINARY
  ROWS                    = 4838
  COLUMNS                 = 1
  ROW_BYTES               = 268
  START_BYTE              = 1
  ROW_SUFFIX_BYTES        = 65536
```

```
  DESCRIPTION             = "ROW_SUFFIX_BYTES is
    variable length.  See RPWS Users Guide.
    This table describes the structure of the
    record header attached to each row of raw data."
  ^STRUCTURE              = "RPWS_RAW_ROW_PREFIX.FMT"
END_OBJECT              = RPWS_RAW_ROW_PREFIX_TABLE

/* Data samples */

OBJECT                  = RPWS_RAW_PACKET_TABLE
  NAME                    = RPWS_RAW_PACKET_TABLE
  INTERCHANGE_FORMAT      = BINARY
  ROWS                    = 4838
  COLUMNS                 = 1
  ROW_BYTES               = 65536
  START_BYTE              = 269
  ROW_PREFIX_BYTES        = 268
  DESCRIPTION             = "Variable length and
    variable format table.  See RPWS Users Guide
    for details.  This is the RPWS logical
    transport packet.  Each record is the result of a
    complete data collection cycle of one of the
    receivers within the instrument."
  ^STRUCTURE              = "RPWS_RAW_MINIPACKET.FMT"

END_OBJECT              = RPWS_RAW_PACKET_TABLE

END
```

RPWS_RAW_ROW_PREFIX.FMT

```
/*****************************************************************************/
/* RPWS_RAW_ROW_PREFIX.FMT                                                   */
/*                                                                           */
/* 07 JUL 2003 First issue                                                   */
/*                                                                           */
/* RPWS_RAW_ROW_PREFIX.FMT                                                   */
/* describes a portion of the structure of the row prefix table              */
/*   (record header) for the Cassini RPWS RAW archive files                  */
/*   (sometimes called the "U" files)                                        */
/*****************************************************************************/

OBJECT                  = COLUMN
  NAME                    = RECORD_BYTES
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 1
  BYTES                   = 4
  DESCRIPTION             = "total record length - 4.
    In other words, the number of octets in the record NOT including
    this length word."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = RECORD_TYPE
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 5
  BYTES                   = 4
  DESCRIPTION             = "Indicates the receiver from which
    this data record originated."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = RECORD_STATUS
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 9
  BYTES                   = 4
  DESCRIPTION             = "See RPWS Users Guide."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = LENGTH_DATA_START
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 61
  BYTES                   = 4
  DESCRIPTION             = "Data octet count - 3
    prior to decompression."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = LENGTH_DATA_LENGTH
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 65
  BYTES                   = 4
  DESCRIPTION             = "Data octet count - 3"
END_OBJECT              = COLUMN
```

RPWS_RAW_MINIPACKET.FMT

```
/*****************************************************************************/
/*  RPWS_RAW_MINIPACKET.FMT                                                  */
/*                                                                           */
/* 21 NOV 2003 update RECORD_TYPE(STIM)                                      */
/* 07 JUL 2003 First issue                                                   */
/*                                                                           */
/* RPWS_RAW_MINIPACKET.FMT                                                   */
/* describes the structure of the RPWS minipacket                            */
/* Cassini RPWS RAW archive files (sometimes calles the "U" files)           */
/*                                                                           */
/* Describing the raw data formats is beyond the scope of PDS labels.        */
/* Please refer to the RPWS USers Guide for details required to extract      */
/* data and status from the raw data files.                                  */
/*****************************************************************************/

OBJECT                  = COLUMN
  NAME                    = RECORD_HEADER
  DATA_TYPE               = BIT_STRING
  START_BYTE              = 1
  BYTES                   = 2
  DESCRIPTION             = "Minipacket Header"

  OBJECT                  = BIT_COLUMN
    NAME                  = RECORD_TYPE
    BIT_DATA_TYPE         = MSB_INTEGER
    START_BIT             = 1
    BITS                  = 4
    DESCRIPTION           = "Minipacket ID.
        0000 =  STIM data
        0001 =  MFR  data
        0010 =  HFR  data
        0100 =  LP   data
        1000 =  WFR  data
        0111 =  LFDR data
        1011 =  DUST data (not impl. as of FSW V2.6)
        1100 =  BFDL status (not impl. as of FSW V2.6)
        1101 =  MRO  data
        1110 =  WBR  data
        1111 =  FILL fill"
  END_OBJECT              = BIT_COLUMN

  OBJECT                  = BIT_COLUMN
    NAME                  = MINIPACKET_LENGTH
    BIT_DATA_TYPE         = MSB_INTEGER
    START_BIT             = 5
    BITS                  = 12
    DESCRIPTION           = "Minipacket Length - 3.
      Number of octets in the minipack minus 3
      (add three to this to get overall length)."
  END_OBJECT              = BIT_COLUMN

END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = RECORD_TYPE
  DATA_TYPE               = LSB_UNSIGNED_INTEGER
  START_BYTE              = 3
  BYTES                   = 2
  DESCRIPTION             = "RTI counter"
  COMMENT_TEXT            = "Note this is an LSB INTEGER"
```

```
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = RECORD_STATUS_AND_DATA
  DATA_TYPE               = CHARACTER
  START_BYTE              = 5
  BYTES                   = 65536
  DESCRIPTION             = "VARIABLE LENGTH FIELD
    See RPWS Users Guide.
    Each receiver assigns status bits as required
    (variable number of octets)."
END_OBJECT              = COLUMN
```

Appendix D: Sample labels for RPWS_LOW_RATE_FULL

Data Set Information Catalog File: LRFULLDS.CAT

```
PDS_VERSION_ID          = PDS3
LABEL_REVISION_NOTE     = "
  2003-01-12, William Kurth (U. IOWA), initial;
  2003-06-26, William Kurth (U. IOWA), general revision;
  2004-02-10, William Kurth (U. IOWA), fixed liens;"
RECORD_TYPE             = STREAM

OBJECT                  = DATA_SET
  DATA_SET_ID             = "CO-V/E/J/S/SS-RPWS-3-RDR-LRFULL-V1.0"

  OBJECT                  = DATA_SET_INFORMATION
    DATA_SET_NAME           = "
      CASSINI V/E/J/S/SS RPWS CALIBRATED LOW RATE FULL RES V1.0"
    DATA_SET_COLLECTION_MEMBER_FLG = "N"
    DATA_OBJECT_TYPE        = TABLE
    ARCHIVE_STATUS          = IN_PEER_REVIEW
    START_TIME              = 1997-298T00:00:00.000Z
    STOP_TIME               = NULL
    DATA_SET_RELEASE_DATE   = 2003-06-30
    PRODUCER_FULL_NAME      = "DR. WILLIAM S. KURTH"
    DETAILED_CATALOG_FLAG   = "N"
    DATA_SET_TERSE_DESC     = "
      The Cassini Radio and Plasma Wave Science (RPWS) calibrated full
      resolution data set includes all spectral information calibrated
      in units of spectral density for the entire Cassini mission."

    ABSTRACT_DESC           = "
      The Cassini Radio and Plasma Wave Science (RPWS) calibrated full
      resolution data set includes all spectral information calibrated
      in units of spectral density for the entire Cassini mission.  This
      data set includes calibrated values for each frequency channel for
      each sensor for all times during the mission including the two
      Venus flybys, the Earth flyby, the Jupiter flyby, interplanetary
      cruise, and the entire Saturn tour.  Data for this data set are
      acquired from the RPWS Low Frequency Receiver (LFR), Medium
      Frequency Receiver (MFR), Medium Frequency Digital Receiver (MFDR)
      (which can be used to replace MFR band 2 data) and High Frequency
      Receiver (HFR).  Data are presented in a set of tables organized
      so as to have fixed-length records for ease in data handling.
      This data set is intended to be the most comprehensive and
      complete data set included in the Cassini RPWS archive.  A browse
      data set is included with these data which provides for a
      graphical search of the data using a series of thumbnail and
      full-sized spectrograms which lead the user to the particular data
      file(s) of interest.  This data set should be among the first used
      by a user of any of the RPWS archive as it will lead one to
      information required to search for more detailed or highly
      specialized products."

    CITATION_DESC           = "Kurth, W.S., R.A. Johnson, and L.J.
      Granroth, CASSINI V/E/J/S/SS RPWS CALIBRATED LOW RATE FULL RES
      V1.0, CO-V/E/J/S/SS-RPWS-3-RDR-LRFULL-V1.0, NASA Planetary Data
      System, 2004."

    DATA_SET_DESC           = "
```

Data Set Overview

The Cassini Radio and Plasma Wave Science (RPWS) calibrated full resolution data set includes all spectral information calibrated in units of spectral density for the entire Cassini mission. This data set includes calibrated values for each frequency channel for each sensor for all times during the mission including the two Venus flybys, the Earth flyby, the Jupiter flyby, interplanetary cruise, and the entire Saturn tour. Data for this data set are acquired from the RPWS Low Frequency Receiver (LFR), Medium Frequency Receiver (MFR), Medium Frequency Digital Receiver (MFDR) (which can be used to replace MFR band 2 data) and High Frequency Receiver (HFR). Data are presented in a set of tables organized so as to have fixed-length records for ease in data handling. This data set is intended to be the most comprehensive and complete data set included in the Cassini RPWS archive. A browse data set is included with these data which provides for a graphical search of the data using a series of thumbnail and full-sized spectrograms which lead the user to the particular data file(s) of interest. This data set should be among the first used by a user of any of the RPWS archive as it will lead one to information required to search for more detailed or highly specialized products.

Parameters

This data set comprises electric and magnetic field spectral densities for each sensor, frequency channel, and time step for which data were acquired by the RPWS.

Processing

Data in this data set were processed by the use of a number of software programs which assemble segmented mini-packets in the raw telemetry packets into complete sets, de-compress the data that were compressed by one of a number of compression algorithms by the RPWS flight software onboard, apply conversion lookup tables or algorithms to convert telemetry data numbers into physical units, and make any corrections required for antenna capacitive loading or other effects. See chapters 5 - 11 of the RPWSCAL document in the DOCUMENT directory for details on how the data included in this data set were calibrated. These data are calibrated using the best calibration tables and algorithms available at the time the data were archived. Should a significant improvement in calibration become available, an erratum will be noted in the erratum section. Later versions of the products may contain better calibrations.

Data

The RPWS calibrated full resolution data set includes several binary tables of wave spectra as a function of time from each of the various receivers of the RPWS, including the LFR, MFR, MFDR, and HFR. Each table will contain fixed-length records including columns for time, sensor, and spectral densities for each channel in that receiver. The HFR can be reconfigured for a wide range of spectral resolutions and frequency ranges which has the effect of changing the number of channels, hence, record length. Therefore, for each

day, a different file will be used for different modes of the HFR which have different numbers of channels, hence, record lengths.

Ancillary Data
==============
Ancillary data included with this data set collection include a series of files that describe the modes of the RPWS as a function of time and provide a time- ordered listing of Instrument Expanded Block (IEB) trigger commands (the mode by which the RPWS is reconfigured). Also a detailed description of each of the modes (or IEBs) is provided.

Other data which are ancillary to this data set but which are archived separately from this collection are the Navigation and Ancillary Information Facility's SPICE kernels describing the position and attitude of Cassini and various solar system bodies as a function of time.

Coordinate System
=================
The data in this data set are measurements of wave electric and magnetic fields measured by the RPWS electric and magnetic sensors. These fields are presented as detected by the sensors and are not rotated into any other coordinate system. If desired the SPICE kernels can be used with the SPICE toolkit to convert from the spacecraft frame to virtually any frame which may be of use in analyzing these data. However, for many purposes, the wave amplitudes are extremely useful and may be entirely adequate with no coordinate transformations at all.

Software
========
Sample code is provided with these data which demonstrates how to read these files in order to build a set of time-ordered wave spectra. For some uses it may be necessary to convert from the supplied spectral density units to units of power flux or electric or magnetic field. Sample code and algorithms are also included to perform these conversions. The sample code and algorithms are found in the EXTRAS/SOFTWARE directory.

Media/Format
============
These data are supplied to the Planetary Data System on DVD-R media using formats and standards of the PDS for such media."

CONFIDENCE_LEVEL_NOTE = "

Confidence Level Overview
=========================
This data set contains all low rate full resolution calibrated data for the Cassini RPWS instrument for the interval described above. Every effort has been made to ensure that all data returned to JPL from the spacecraft is included and that the calibration is accurate. The middle band of the MFR (Band 2, 180 - 1500 Hz) has shown a tendency to have an increased noise level by as much as 10

dB at times, although there is no current explanation for this or known factor which would enable this condition to be predicted. In some instrument modes data are collected in the high band of the WFR which can be used to replace the data in MFR Band 2; these replacement data are referred to as MFDR data.

Review
======
The RPWS full resolution low rate data will be reviewed internally by the Cassini RPWS team prior to release to the PDS. The data set will also be peer reviewed by the PDS.

Data Coverage and Quality
=========================
All data in the stated interval are included, to the best of our knowledge and attempts to determine completeness. In general, the instrument was operated only briefly during early tour for the following intervals:

1. Antenna deployment 1997-10-25T00:00 - 1997-10-26T05:30
2. Venus 1 flyby 1998-04-26T12:54 - 1998-05-08T19:21*
3. Instrument Checkout 1998-12-30T09:10 - 1999-01-19T05:40
4. Venus 2 flyby 1999-06-24T09:08 - 1999-06-24T21:20
5. Earth flyby 1999-08-13T17:39 - 1999-09-14T22:20

*Actual interval for science data is much shorter than this.

Beginning in February of 2000 the instrument was operated more-or-less continuously; two gaps of the order of six weeks were incurred for the purposes of loading new attitude control and command and data system flight software, gaps of a few days each were incurred approximately twice per year because of Huygens Probe testing, and gaps of several days in duration occurred during solar conjunction periods prior to 2002. Remaining gaps are due to spacecraft anomaly resolution or simply to downlink gaps, some of which were imposed by limitations on DSN station availability.

Limitations
===========
The only known measurement quality issue is occasional elevated noise levels (by a few to 10 dB) in the second band of the MFR. During tour, it is anticipated that data from the Waveform Receiver (WFR) sometimes referred to as the medium frequency digital receiver (MFDR) can be substituted for these."

END_OBJECT = DATA_SET_INFORMATION

OBJECT = DATA_SET_TARGET
TARGET_NAME = VENUS
END_OBJECT = DATA_SET_TARGET

OBJECT = DATA_SET_TARGET
TARGET_NAME = EARTH
END_OBJECT = DATA_SET_TARGET

OBJECT = DATA_SET_TARGET
TARGET_NAME = JUPITER

```
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = SATURN
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = SOLAR_SYSTEM
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_HOST
    INSTRUMENT_HOST_ID      = CO
    INSTRUMENT_ID           = RPWS
  END_OBJECT              = DATA_SET_HOST

  OBJECT                  = DATA_SET_REFERENCE_INFORMATION
    REFERENCE_KEY_ID        = "GURNETTETAL2003"
  END_OBJECT              = DATA_SET_REFERENCE_INFORMATION

END_OBJECT              = DATA_SET
END
```

Sample RPWS_LOW_RATE_FULL Label File

```
PDS_VERSION_ID                = PDS3
/* label standards identifiers PDS Version 3.5 */

DESCRIPTION = "T1999230_HFR1.DAT contains fully calibrated, full resolution
     Cassini Radio and Plasma Wave (RPWS) low rate data for the time period
     between 1999-230T00:00:00.000 and 1999-231T00:00:00.000 and includes
     the following targets: EARTH,SOLAR SYSTEM."



/* pds label for a rpws low rate full */
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 256
FILE_RECORDS                  = 533

/* pointers to start records of objects in file, std ref3.5:5.3.3.2 */
^LRFULL_TABLE                 = ("T1999230_HFR1.DAT",1)
^TIME_TABLE                   = ("T1999230_HFR1.DAT",2)
^FREQUENCY_TABLE              = ("T1999230_HFR1.DAT",3)
^SPECTRAL_DENSITY_TABLE       = ("T1999230_HFR1.DAT",4)

/* identification data elements - data product labels, std ref3.5:5.3.4.1 */
DATA_SET_ID                   = "CO-V/E/J/S/SS-RPWS-3-RDR-LRFULL-V1.0"
STANDARD_DATA_PRODUCT_ID      = RPWS_LOW_RATE_FULL
PRODUCT_TYPE                  = DATA
PRODUCT_ID                    = "T1999230_HFR1_V1"
INSTRUMENT_HOST_NAME          = "CASSINI ORBITER"
INSTRUMENT_HOST_ID            = CO
INSTRUMENT_NAME               = "RADIO AND PLASMA WAVE SCIENCE"
INSTRUMENT_ID                 = RPWS
SECTION_ID                    = HFR
MISSION_PHASE_NAME            = {"EARTH ENCOUNTER","VENUS 2 - EARTH CRUISE",
                                 "INTERPLANETARY CRUISE"}
TARGET_NAME                   = {"EARTH","SOLAR SYSTEM"}
START_TIME                    = 1999-230T00:00:00.000Z
STOP_TIME                     = 1999-231T00:00:00.000Z
SPACECRAFT_CLOCK_START_COUNT  = "1/1313626007:150"
SPACECRAFT_CLOCK_STOP_COUNT   = "1/1313712408:040"
PRODUCT_CREATION_TIME         = 2003-10-17


NOTE = "
/*************************************************************************/
/*                          Record Structure                             */
/*       +-----------------------------------------------------------+ */
/* ROW 1 | LRFULL_TABLE (FILE_ID RECORD_LENGTH NUMBER_OF_RECORDS ETC) | */
/*       +------+------+--------+---------------+-----+---------------+ */
/* ROW 2 | SCLK | SCET | SPARE  | TIME_OFFSET_0 | ... | TIME_OFFSET_N | */
/*       +------+------+--------+---------------+-----+---------------+ */
/* ROW 3 | SCLK | SCET | SPARE  |  FREQUENCY_0  | ... |  FREQUENCY_N  | */
/*       +------+------+--------+---------------+-----+---------------+ */
/* ROW 4 | SCLK | SCET | SENSOR |   DENSITY_0   | ... |   DENSITY_N   | */
/*       +------+------+--------+---------------+-----+---------------+ */
/*  ...  | .... | .... | ...... | ............. | ... | ............. | */
/*       +------+------+--------+---------------+-----+---------------+ */
/* ROW M | SCLK | SCET | SENSOR |   DENSITY_0   | ... |   DENSITY_N   | */
/*       +------+------+--------+---------------+-----+---------------+ */
```

```
/* BYTE  1      7      13       17                                        */
/*                                                                       */
/*                                                                       */
/*  TIME_OFFSET - The number of seconds from the beginning of the data   */
/*          acquisition when the individual sample was captured.         */
/*                                                                       */
/*  SCLK - The spacecraft clock marking the beginning of the data        */
/*         acquisition.                                                  */
/*                                                                       */
/*  SCET - The spacecraft event time marking the beginning of the data   */
/*          acquisition, UTC.                                            */
/*                                                                       */
/*  SENSOR - Identifies which antenna sampled the data.                  */
/*                                                                       */
/*  DENSITY - Calibrated spectral density, either electric or magnetic.  */
/*                                                                       */
/************************************************************************/
"


/* descriptive data elements */
OBJECT                          = LRFULL_TABLE
  NAME                          = LRFULL_TABLE
  INTERCHANGE_FORMAT            = BINARY
  ROW_BYTES                     = 256
  ROWS                          = 1
  COLUMNS                       = 8
  ^STRUCTURE                    = "LRFULL_TABLE.FMT"
END_OBJECT                      = LRFULL_TABLE

OBJECT                          = TIME_TABLE
  NAME                          = TIME_TABLE
  INTERCHANGE_FORMAT            = BINARY
  ROW_BYTES                     = 256
  ROWS                          = 1
  COLUMNS                       = 6
  ^STRUCTURE                    = "RPWS_SCLK_SCET.FMT"
  OBJECT                        = COLUMN
    NAME                        = TIME
    DATA_TYPE                   = IEEE_REAL
    START_BYTE                  = 17
    BYTES                       = 240
    ITEMS                       = 60
    ITEM_BYTES                  = 4
    UNIT                        = SECOND
    DESCRIPTION                 = "Time offset of individual samples
                                   in corresponding columns relative
                                   to time tag of each row."
  END_OBJECT                    = COLUMN
END_OBJECT                      = TIME_TABLE

OBJECT                          = FREQUENCY_TABLE
  NAME                          = FREQUENCY_TABLE
  INTERCHANGE_FORMAT            = BINARY
  ROW_BYTES                     = 256
  ROWS                          = 1
  COLUMNS                       = 6
  ^STRUCTURE                    = "RPWS_SCLK_SCET.FMT"
  OBJECT                        = COLUMN
    NAME                        = FREQUENCY
```

```
    DATA_TYPE                = IEEE_REAL
    START_BYTE               = 17
    BYTES                    = 240
    ITEMS                    = 60
    ITEM_BYTES               = 4
    UNIT                     = HERTZ
    DESCRIPTION              = "Frequency of spectral densities in
                               corresponding columns."
  END_OBJECT                 = COLUMN
END_OBJECT                   = FREQUENCY_TABLE

OBJECT                       = SPECTRAL_DENSITY_TABLE
  NAME                       = SPECTRAL_DENSITY_TABLE
  INTERCHANGE_FORMAT         = BINARY
  ROW_BYTES                  = 256
  ROWS                       = 530
  COLUMNS                    = 7
  ^STRUCTURE                 = "LRFC_DATA_QUALITY.FMT"
  OBJECT                     = COLUMN
    NAME                     = SPECTRAL_DENSITY
    DATA_TYPE                = IEEE_REAL
    START_BYTE               = 17
    BYTES                    = 240
    ITEMS                    = 60
    ITEM_BYTES               = 4
    UNIT                     = {"VOLT**2/M**2/HZ", "NANOTESLA**2/HZ "}
    DESCRIPTION              = "Calibrated spectral densities from one
                               of several sensors.  Units for Ex, Eu
                               Ev, Ew, Hf sensors are
                               VOLT**2/M**2/HZ.  Units for Bx, By,
                               Bz sensors are NANOTESLA**2/HZ"
  END_OBJECT                 = COLUMN
END_OBJECT                   = SPECTRAL_DENSITY_TABLE

END
```

RPWS_SCLK_SCET.FMT

```
/*************************************************************************/
/* RPWS_SCLK_SCET.FMT                                                    */
/* describes the structure of the spacecraft clock and spacecraft        */
/* event time objects common to many Cassini RPWS archive files.         */
/*************************************************************************/

OBJECT                  = COLUMN
  NAME                    = SCLK_SECOND
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 1
  BYTES                   = 4
  DESCRIPTION             = "Spacecraft clock counter increments each
    second, beginning at approximately 1958-01-01T00:00:00Z."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = SCLK_PARTITION
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 5
  BYTES                   = 1
  VALID_MINIMUM           = 0
  VALID_MAXIMUM           = 255
  DESCRIPTION             = "Spacecraft clock partition.
    A value of ZERO or ONE indicates the first partition
    (i.e. the spacecraft clock has not been reset)."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = SCLK_FINE
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 6
  BYTES                   = 1
  VALID_MINIMUM           = 0
  VALID_MAXIMUM           = 255
  DESCRIPTION             = "Spacecraft clock modulo 256 counter
    increments 256 times per second.  Since the RTI increments from
    0 through 7 in this same interval, SCLK_FINE / 32 yields the
    RTI count.
    For RPWS, SCLK_FINE is maintained within the instrument to an
    accuracy of one RTI period.  Time tags should occur only with
    the following values for SCLK_FINE : 0, 32, 64, 96, 128, 160,
    192, and 224"
END_OBJECT              = COLUMN

/*************************************************************************/
/*  Note about archive product time-tags:                                */
/*      We should be masking (removing) the lower 5 bits                 */
/*      of SCLK_FINE prior to using SPICE to calculate SCET.             */
/*                                                                       */
/*      RPWS time keeping occurs only with a resolution of the           */
/*      RTI period (ignore the sub-RTI counter we use with the           */
/*      WBR, the sub-RTI timing is included in the WBR minipacket).      */
/*      Both HRP and LRP use bit 0 to indicate a CDS clock               */
/*      update has not occurred in the last second (should always        */
/*      be clear on LRP and always set on HRP).                          */
/*      Both LRP and HRP use bits 1-4 to hold a CDS packet count.        */
/*      LRP sets this counter to 0 while HRP start this count            */
```

```
/*      at 1, incrementing with each packet that is processed         */
/*      within any RTI period (in other words, HRP resets this        */
/*      counter to 1 when the RTI interrupt occurs).                  */
/*                                                                    */
/*      This has the side-effect that all SCLK values delivered by    */
/*      RPWS are unique.  This also makes query by SCLK or SCET       */
/*      return data in an unambiguous order.                          */
/*                                                                    */
/*      BUT!!! It is necessary to clear bits 0-4 of the SCLK_FINE     */
/*      in order to get back to the intended (correct) time.          */
/********************************************************************/

OBJECT                  = COLUMN
  NAME                    = SCET_DAY
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 7
  BYTES                   = 2
  DESCRIPTION             = "Spacecraft event time days since
    1958-01-01T00:00:00Z"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = SCET_MILLISECOND
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 9
  BYTES                   = 4
  VALID_MINIMUM           = 0
  VALID_MAXIMUM           = 86401999
  DESCRIPTION             = "Spacecraft event time millisecond
    of day allowing for up to two leap seconds."
END_OBJECT              = COLUMN

/* END OF RPWS_SCLK_SCET.FMT */
```

LRFULL_TABLE.FMT

```
/*                   */
/* LRFULL_TABLE.FMT */
/*                   */
OBJECT                  = COLUMN
     NAME               = FILE_ID
     DATA_TYPE          = CHARACTER
     START_BYTE         = 1
     BYTES              = 8
     DESCRIPTION        = "'CORPWS01' for the file id."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
     NAME               = RECORD_LENGTH
     DATA_TYPE          = MSB_UNSIGNED_INTEGER
     START_BYTE         = 9
     BYTES              = 4
     DESCRIPTION        = "The length of each record in bytes."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
     NAME               = RECORDS
     DATA_TYPE          = MSB_UNSIGNED_INTEGER
     START_BYTE         = 13
     BYTES              = 4
     DESCRIPTION        = "The total number of records."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
     NAME               = RECEIVER_TYPE
     DATA_TYPE          = MSB_UNSIGNED_INTEGER
     START_BYTE         = 17
     BYTES              = 4
     DESCRIPTION        = "Logical RPWS Instrument ID Number."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
     NAME               = MINI_PACKET_HEADER
     DATA_TYPE          = MSB_BIT_STRING
     START_BYTE         = 25
     BYTES              = 24
     DESCRIPTION        = "The mini-packet header which is representative
                           for the data contained in the file."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
     NAME               = SCET
     DATA_TYPE          = CHARACTER
     START_BYTE         = 49
     BYTES              = 16
     DESCRIPTION        = "The standard JPL spacecraft event time description:
                           yyyy-doyThh:mm, seconds and milliseconds are
                           assumed zero.  This is half of the SCLK/SCET
                           pair produce by the SPICE kernel for the beginning
                           of each day."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
     NAME               = SCLK
     COLUMN_NUMBER      = 5
     DATA_TYPE          = CHARACTER
```

```
      START_BYTE          = 65
      BYTES               = 16
      DESCRIPTION         = "The standard JPL spacecraft clock time description:
                            ssssssssss.fff.  This is half of the SCLK/SCET
                            pair produce by the SPICE kernel for the beginning
                            of each day."
END_OBJECT                = COLUMN
```

Appendix E: Sample labels for RPWS_WIDEBAND_FULL

Data Set Information Catalog File: WBFULLDS.CAT

```
PDS_VERSION_ID          = PDS3
LABEL_REVISION_NOTE     = "
  2003-01-12, William Kurth (U. IOWA), initial;
  2003-06-26, William Kurth (U. IOWA), general revision;
  2004-02-10, William Kurth (U. IOWA), fixed liens;"
RECORD_TYPE             = STREAM

OBJECT                  = DATA_SET
  DATA_SET_ID             = "CO-V/E/J/S/SS-RPWS-2-REFDR-WBRFULL-V1.0"

  OBJECT                  = DATA_SET_INFORMATION
    DATA_SET_NAME           = "
          CASSINI V/E/J/S/SS RPWS EDITED WIDEBAND FULL RES V1.0"
    DATA_SET_COLLECTION_MEMBER_FLG = "N"
    DATA_OBJECT_TYPE        = TIME_SERIES
    ARCHIVE_STATUS          = IN_PEER_REVIEW
    START_TIME              = 1997-298T00:00:00.000Z
    STOP_TIME               = NULL
    DATA_SET_RELEASE_DATE   = 2003-06-30
    PRODUCER_FULL_NAME      = "DR. WILLIAM S. KURTH"
    DETAILED_CATALOG_FLAG   = "N"
    DATA_SET_TERSE_DESC     = "
      The Cassini Radio and Plasma Wave Science (RPWS) edited full
      resolution wideband (WBR) data set includes all wideband waveform
      data for the entire Cassini mission."

    ABSTRACT_DESC           = "
      The Cassini Radio and Plasma Wave Science (RPWS) edited full
      resolution data set includes all wideband waveform data for the
      entire Cassini mission.  This data set includes uncalibrated
      values for each wideband channel for each sensor for all times
      during the mission including the second Venus flyby, the Earth
      flyby, the Jupiter flyby, interplanetary cruise, and the entire
      Saturn tour.  Data for this data set are acquired from the RPWS
      Wideband Receiver (WBR).  Data are presented in a set of time
      series organized so as to have fixed-length records for ease in
      data handling.  Data from the different WBR modes (i.e. 10-kHz,
      80-kHz, and frequency-translated 80-kHz data)  are segregated into
      separate files.  This data set includes all wideband data acquired
      by the RPWS.  A browse data set is included with these data which
      provides for a graphical search of the data using a series of
      thumbnail and full-sized spectrograms which lead the user to the
      particular data file(s) of interest. The wideband data provide the
      highest resolution data from the RPWS instrument in the form of a
      set of waveform series.  These data can be used in their original
      time domain in order to look for solitary features such as dust
      impacts or electrostatic solitary waves.  Or, they can be
      transformed into the frequency domain in order to examine the
      detailed time and spectral evolution of plasma waves or radio
      emissions."

    CITATION_DESC           = "Kurth, W.S., W.T. Robison, and L.J.
      Granroth, CASSINI V/E/J/S/SS RPWS EDITED WIDEBAND FULL RES V1.0,
      CO-V/E/J/S/SS-RPWS-2-REFDR-WBRFULL-V1.0, NASA Planetary Data
```

System, 2004."

DATA_SET_DESC = "

Data Set Overview
=================

The Cassini Radio and Plasma Wave Science (RPWS) edited full resolution data set includes all wideband waveform data for the entire Cassini mission. This data set includes uncalibrated values for each wideband channel for each sensor for all times during the mission including the second Venus flyby, the Earth flyby, the Jupiter flyby, interplanetary cruise, and the entire Saturn tour. Data for this data set are acquired from the RPWS Wideband Receiver (WBR). Data are presented in a set of time series organized so as to have fixed-length records for ease in data handling. Data from the different WBR modes (i.e. 10-kHz, 80-kHz, and frequency-translated 80-kHz data) are segregated into separate files. This data set includes all wideband data acquired by the RPWS. A browse data set is included with these data which provides for a graphical search of the data using a series of thumbnail and full-sized spectrograms which lead the user to the particular data file(s) of interest. The wideband data provide the highest resolution data from the RPWS instrument in the form of a set of waveform series. These data can be used in their original time domain in order to look for solitary features such as dust impacts or electrostatic solitary waves. Or, they can be transformed into the frequency domain in order to examine the detailed time and spectral evolution of plasma waves or radio emissions.

Parameters
==========

This data set comprises time series of data numbers related to the potential difference at the preamp input to the RPWS. The data numbers can be calibrated with the use of supplied algorithms and calibration factors to generate a time series of electric or magnetic field waveforms in units of Volts/meter or nanoTesla. Because of the enhanced sensitivity of the electric antennas, most data in this data set are acquired using the Ex dipole antenna. The waveforms can be acquired in one of three modes:

1. 10-kHz baseband mode: 0.06 - 10.5 kHz, 36 microsecond sampling rate
2. 75-kHz baseband mode: 0.8 - 75 kHz, 4.5 microsecond sampling rate
3. 75-kHz frequency translation mode; 25-kHz bandwidth down-converted to the frequency range of 50 to 75 kHz, 4.5 microsecond sampling rate.

In the third mode, the frequency range analyzed is selectable from a range of 125 kHz to 16 MHz.

Typically, data are acquired in time series with length of a multiple of 512 8-bit samples, usually with this length set to 2048 samples. For the 10-kHz mode, this results in time series of duration about 74 msec and for the 75-kHz mode, the duration of the waveform series is typically about 9 msec. A new waveform series can be acquired as often as once per 125 msec. Hence, the duty cycle for this mode can be very small (e.g. 9 msec out of 125 msec

or about 7 percent for the 75 kHz mode or closer to 50 percent for the 10-kHz mode) with typical sample lengths.

Processing
==========

Data in this data set were processed by the use of a number of software programs which assemble segmented mini-packets in the raw telemetry packets into complete sets and de-compress the data that were compressed by one of several possible compression algorithms. These data may be calibrated using supplied calibration factors and algorithms as well as sample code provided.

Data
====

The RPWS full resolution wideband data set is organized by receiver mode and time series sample length in order to generate files with fixed record lengths. Each time series is a record in a file with header information on time, sensor, and receiver gain (required for calibration). Separate files will be maintained for each instrument mode and time series length.

Ancillary Data
==============

Ancillary data included with this data set collection include a series of files that describe the modes of the RPWS as a function of time and provide a time-ordered listing of Instrument Expanded Block (IEB) trigger commands (the mode by which the RPWS is reconfigured). Also a detailed description of each of the modes (or IEBs) is provided.

Other data which are ancillary to this data set but which are archived separately from this collection are the Navigation and Ancillary Information Facility's SPICE kernels describing the position and attitude of Cassini and various solar system bodies as a function of time.

Coordinate System
=================

The data in this data set are measurements of wave electric and magnetic fields measured by the RPWS electric and magnetic sensors. These fields are presented as detected by the sensors and are not rotated into any other coordinate system. If desired the SPICE kernels can be used with the SPICE toolkit to convert from the spacecraft frame to virtually any frame which may be of use in analyzing these data. However, for many purposes, the wave amplitudes are extremely useful and may be entirely adequate with no coordinate transformations at all.

Software
========

Sample code is provided with these data which demonstrates how to read these files in order to build a set of waveform time series. Algorithms and sample code is provided which convert from data number to either electric or magnetic field strength (units of volt/meter or nanoTesla). Sample code and algorithms are also

included to perform these conversions. The sample code and algorithms are found in the EXTRAS/SOFTWARE directory. A description of how to access and calibrate these data is included in WBRWFR.TXT in the DOCUMENT directory. Also see the RPWSCAL document in the same directory.

Media/Format
============
These data are supplied to the Planetary Data System on DVD-R media using formats and standards of the PDS for such media."

CONFIDENCE_LEVEL_NOTE = "

Confidence Level Overview
=========================
This data set contains all wideband data for the Cassini RPWS instrument for the interval described above. Every effort has been made to ensure that all data returned to JPL from the spacecraft is included and that the calibration information is accurate.

Review
======
The RPWS full resolution wideband data will be reviewed internally by the Cassini RPWS team prior to release to the PDS. The data set will also be peer reviewed by the PDS.

Data Coverage and Quality
=========================
All data in the stated interval are included, to the best of our knowledge and attempts to determine completeness. In general, these data were acquired during early tour for the following intervals:

1. Antenna deployment 1997-10-25T00:00 - 1997-10-26T05:30
2. Instrument Checkout 1998-12-30T09:10 - 1999-01-19T05:40
3. Venus 2 flyby 1999-06-24T09:08 - 1999-06-24T21:20
4. Earth flyby 1999-08-13T17:39 - 1999-09-14T22:20

*Actual interval for science data is much shorter than this.

Beginning in February of 2000 the instrument was operated more-or-less continuously; two gaps of the order of six weeks were incurred for the purposes of loading new attitude control and command and data system flight software, gaps of a few days each were incurred approximately twice per year because of Huygens Probe testing, and gaps of several days in duration occurred during solar conjunction periods prior to 2002. Remaining gaps are due to spacecraft anomaly resolution or simply to downlink gaps, some of which were imposed by limitations on DSN station availability. During the time interval after February 2000, the wideband data were acquired during such times when the onboard solid state recorder and the downlink capability could support the high data volumes required for these data. Typically, the data are acquired for brief intervals every several days or weeks during the interplanetary cruise phase and more regularly but still just briefly every few hours or so during tour. A user would find events of interest in the more continuous low rate data and consult the ancillary sequence

```
    information provided to determine the existence of wideband data in
    an appropriate mode for that event.  Further, a graphical browse
    data set is supplied with the archive to allow the user to look at
    frequency-time spectrograms directly in order to find events or
    phenomena of interest.  This browse system will point the user to
    the data files containing the data of interest.


  Limitations
  ===========
    None known at this time."

  END_OBJECT              = DATA_SET_INFORMATION

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = VENUS
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = EARTH
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = JUPITER
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = SATURN
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = SOLAR_SYSTEM
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_HOST
    INSTRUMENT_HOST_ID      = CO
    INSTRUMENT_ID           = RPWS
  END_OBJECT              = DATA_SET_HOST

  OBJECT                  = DATA_SET_REFERENCE_INFORMATION
    REFERENCE_KEY_ID        = "GURNETTETAL2003"
  END_OBJECT              = DATA_SET_REFERENCE_INFORMATION

END_OBJECT              = DATA_SET
END
```

Sample RPWS_WIDEBAND_FULL Label File

```
PDS_VERSION_ID          = PDS3

/* File characteristics */

RECORD_TYPE             = FIXED_LENGTH
RECORD_BYTES            = 2080
FILE_RECORDS            = 8891
DESCRIPTION             = "T1999230_02_10KHZ2_WBRFR.DAT contains Cassini
    Radio and Plasma Wave (RPWS) wideband data for the time period between
    1999-230T02:00:00.000 and 1999-230T03:00:00.000 that includes the
    following targets: EARTH,
                       SOLAR SYSTEM."


/* Data object pointers */

^WBR_ROW_PREFIX_TABLE   = ("T1999230_02_10KHZ2_WBRFR.DAT", 1)
^TIME_SERIES            = ("T1999230_02_10KHZ2_WBRFR.DAT", 1)

/* Identification */

DATA_SET_ID             = "CO-V/E/J/S/SS-RPWS-2-REFDR-WBRFULL-V1.0"
DATA_SET_NAME           = "
               CO V/E/J/S/SS RPWS 2 REFDR WBR FULL RESOLUTION V1.0"
PRODUCT_ID              = "T1999230_02_10KHZ2_WBRFR_V1"
PRODUCT_CREATION_TIME   = 2004-03-03
START_TIME              = 1999-230T02:00:00.000Z
STOP_TIME               = 1999-230T03:00:00.000Z
SPACECRAFT_CLOCK_START_COUNT = "1/1313633207:162"
SPACECRAFT_CLOCK_STOP_COUNT  = "1/1313636807:168"
NATIVE_START_TIME           = -11786335.817
NATIVE_STOP_TIME            = -11782735.817
NOTE                        = "NATIVE_TIME is NAIF 'et' (ephemeris
  time or barycentric dynamical time) as used in the spice kernel."
PRODUCT_TYPE                = DATA
STANDARD_DATA_PRODUCT_ID    = RPWS_WIDEBAND_FULL
MISSION_PHASE_NAME          = {"EARTH ENCOUNTER",
                               "INTERPLANETARY CRUISE",
                               "VENUS 2 - EARTH CRUISE"}
TARGET_NAME                 = {"EARTH",
                               "SOLAR SYSTEM"}
SOFTWARE_VERSION_ID         = "RPWS_HR_AR V5.3"

/* Instrument description */

INSTRUMENT_HOST_NAME    = "CASSINI ORBITER"
INSTRUMENT_HOST_ID      = CO
INSTRUMENT_NAME         = "RADIO AND PLASMA WAVE SCIENCE"
INSTRUMENT_ID           = RPWS
SECTION_ID              = WBR

/* Data Object Structure */
/************************************************************/
/*      1                  32 33                 x1      x2   */
/*     +--------------------+---------------------+-------+  */
/*     |                    |                     |       |  */
/*  1  | ROW_PREFIX_TABLE -->| TIME_SERIES ------->| SPARE |  */
/*     |                    |                     |       |  */
/*     +--------------------+---------------------+-------+  */
/*     |                    |                     |       |  */
```

```
/*     | ROW_PREFIX_TABLE -->| TIME_SERIES ------->| SPARE |  */
/*  2  |                     |                     |       |  */
/*     +---------------------+---------------------+-------+  */
/*     |                     |                     |       |  */
/*  3  | ROW_PREFIX_TABLE -->| TIME_SERIES ------->| SPARE |  */
/*     |                     |                     |       |  */
/*     +---------------------+---------------------+-------+  */
/*  . . .                                                     */
/*     +---------------------+---------------------+-------+  */
/*     |                     |                     |       |  */
/*  y  | ROW_PREFIX_TABLE -->| TIME_SERIES ------->| SPARE |  */
/*     |                     |                     |       |  */
/*     +---------------------+---------------------+-------+  */
/*                                                           */
/*     8-bit octet are numbered across the top.              */
/*         No header records, all records are in the         */
/*         same format.                                      */
/*     Record Number is down the left edge.                  */
/*                                                           */
/*  x1 is ROW_BYTES+32 (ITEMS)                               */
/*  x2 is RECORD_BYTES                                       */
/*  y  is FILE_RECORDS (ROWS)                                */
/*                                                           */
/***********************************************************/

/* Record header */

OBJECT                  = WBR_ROW_PREFIX_TABLE
  NAME                    = WBR_ROW_PREFIX_TABLE
  INTERCHANGE_FORMAT      = BINARY
  ROWS                    = 8891
  COLUMNS                 = 19
  ROW_BYTES               = 32
  ROW_SUFFIX_BYTES        = 2048
  DESCRIPTION             = "This table describes the structure of the
    record header attached to each row of time series data."
  ^STRUCTURE              = "RPWS_WBR_WFR_ROW_PREFIX.FMT"
END_OBJECT              = WBR_ROW_PREFIX_TABLE

/* Data samples */

OBJECT                  = TIME_SERIES
  NAME                    = WBR_TIME_SERIES
  INTERCHANGE_FORMAT      = BINARY
  ROWS                    = 8891
  COLUMNS                 = 1
  ROW_BYTES               = 2048
  ROW_PREFIX_BYTES        = 32
  SAMPLING_PARAMETER_NAME = TIME
  SAMPLING_PARAMETER_UNIT = SECOND
  SAMPLING_PARAMETER_INTERVAL = 0.000036
  DESCRIPTION             = "This time series consists of
    uncalibrated samples gathered during a 1 hour time span from one
    or more detectors.  Time interval between TIME_SERIES is
    variable."

  OBJECT                  = COLUMN
    NAME                    = WBR_SAMPLE
    DATA_TYPE               = UNSIGNED_INTEGER
    START_BYTE              = 33
    BYTES                   = 2048
    ITEMS                   = 2048
```

```
    ITEM_BYTES              = 1
    OFFSET                  = -127.5
    VALID_MINIMUM           = 0
    VALID_MAXIMUM           = 255
    DESCRIPTION             = "The 8-bit unsigned uncalibrated
      waveform samples range from 0 to 255.  Zero
      amplitude is nominally 127.5 with 127 being just
      below and 128 just above zero amplitude."
  END_OBJECT              = COLUMN

END_OBJECT              = TIME_SERIES

END
```

RPWS_WBR_WFR_ROW_PREFIX.FMT

```
/************************************************************************/
/* /opt/project/cassini/src/archive/RPWS_WBR_WFR_ROW_PREFIX.FMT       */
/*                                                                      */
/* 23 JUN 2003 update                                                   */
/*      Corrected                                                       */
/*              RTI field is MSB_INTEGER (was LSB)                      */
/*                                                                      */
/* 29 APR 2003 update                                                   */
/*      Added                                                           */
/*              HFR/H1 -> WBR/HF status bit                             */
/*              HFR/H2 -> WBR/HF status bit                             */
/*              FSW version field                                       */
/*      Corrected                                                       */
/*              EU current status bit position                          */
/*              EV current status bit position                          */
/*                                                                      */
/* RPWS_WBR_WFR_ROW_PREFIX.FMT                                          */
/* describes the structure of the row prefix table (record header)      */
/* for the Cassini RPWS WBR and WFR archive files.  Some fields are     */
/* valid for only one of the two receivers as noted.  Fields that       */
/* are not used are always loaded with ZERO.                            */
/*                                                                      */
/* RPWS_SCLK_SCET.FMT contains spacecraft clock and spacecraft event    */
/* time column descriptions common to several tables.                   */
/************************************************************************/

^STRUCTURE              = "RPWS_SCLK_SCET.FMT"

OBJECT                  = COLUMN
  NAME                    = RECORD_BYTES
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 13
  BYTES                   = 2
  DESCRIPTION             = "Number of octets in the entire RECORD.
    This count includes header, time series, and optional fill."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = SAMPLES
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 15
  BYTES                   = 2
  DESCRIPTION             = "Number of valid data samples in the time
    series portion of each record.  Note that WBR samples are 1 byte
    each and WFR samples are 2 bytes each."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = DATA_RTI
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 17
  BYTES                   = 2
  DESCRIPTION             = "RPWS minipacket collection time.  This
    modulo 65536 counter increments 8 times per second and is derived
    from the low-order 13 bits of SCLK_SECOND and 3-bit RTI when the
    data acquisition began."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
```

```
NAME                    = VALIDITY_FLAG
DATA_TYPE               = MSB_BIT_STRING
START_BYTE              = 19
BYTES                   = 1

OBJECT                  = BIT_COLUMN
  NAME                    = MSF
  BIT_DATA_TYPE           = BOOLEAN
  START_BIT               = 1
  BITS                    = 1
  DESCRIPTION             = "This bit is used to indicate validity of
    header fields SUB_RTI, HFR_XLATE, LP_DAC_0, and LP_DAC_1.
      0 = Fields do not contain valid data
      1 = Fields may contain valid data"
END_OBJECT              = BIT_COLUMN

OBJECT                  = BIT_COLUMN
  NAME                    = WBR
  BIT_DATA_TYPE           = BOOLEAN
  START_BIT               = 2
  BITS                    = 1
  DESCRIPTION             = "This bit is used to indicate WBR data
      is in this record.
      0 = not WBR data
      1 = WBR data"
END_OBJECT              = BIT_COLUMN

OBJECT                  = BIT_COLUMN
  NAME                    = WFR
  BIT_DATA_TYPE           = BOOLEAN
  START_BIT               = 3
  BITS                    = 1
  DESCRIPTION             = "This bit is used to indicate WFR data
      is in this record.
      0 = not WFR data
      1 = WFR data"
END_OBJECT              = BIT_COLUMN

OBJECT                  = BIT_COLUMN
  NAME                    = VALID_WALSH_DGF
  BIT_DATA_TYPE           = BOOLEAN
  START_BIT               = 4
  BITS                    = 1
  DESCRIPTION             = "This bit is used to indicate that the
    WALSH_DGF field contains valid data (WFR only).
      0 = WALSH_DGF not in use (contents invalid)
      1 = WALSH_DGF contains valid data"
END_OBJECT              = BIT_COLUMN

OBJECT                  = BIT_COLUMN
  NAME                    = VALID_SUB_RTI
  BIT_DATA_TYPE           = BOOLEAN
  START_BIT               = 5
  BITS                    = 1
  DESCRIPTION             = "This bit is used to indicate that the
    SUB_RTI field contains valid data (WBR only).
      0 = SUB_RTI not in use (contents invalid)
      1 = SUB_RTI contains valid data"
END_OBJECT              = BIT_COLUMN

OBJECT                  = BIT_COLUMN
  NAME                    = VALID_HFR_XLATE
```

```
    BIT_DATA_TYPE           = BOOLEAN
    START_BIT               = 6
    BITS                    = 1
    DESCRIPTION             = "This bit is used to indicate that the
      HFR_XLATE field contains valid data (WBR only)
        0 = HFR_XLATE not in use (contents invalid)
        1 = HFR_XLATE contains valid data"
  END_OBJECT              = BIT_COLUMN

  OBJECT                  = BIT_COLUMN
    NAME                    = VALID_LP_DAC_0
    BIT_DATA_TYPE           = BOOLEAN
    START_BIT               = 7
    BITS                    = 1
    DESCRIPTION             = "This bit is used to indicate that the
      LP_DAC_0 field contains valid data
        0 = LP_DAC_0 not in use (contents invalid)
        1 = LP_DAC_0 contains valid data"
  END_OBJECT              = BIT_COLUMN

  OBJECT                  = BIT_COLUMN
    NAME                    = VALID_LP_DAC_1
    BIT_DATA_TYPE           = BOOLEAN
    START_BIT               = 8
    BITS                    = 1
    DESCRIPTION             = "This bit is used to indicate that the
      LP_DAC_1 field contains valid data (WFR only)
        0 = LP_DAC_1 not in use (contents invalid)
        1 = LP_DAC_1 contains valid data"
  END_OBJECT              = BIT_COLUMN

END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = STATUS_FLAG
  DATA_TYPE               = MSB_BIT_STRING
  START_BYTE              = 20
  BYTES                   = 1

  OBJECT                  = BIT_COLUMN
    NAME                    = AGC_ENABLE
    BIT_DATA_TYPE           = BOOLEAN
    START_BIT               = 1
    BITS                    = 1
    DESCRIPTION             = "Automatic gain control enable
        0 = AGC disabled
        1 = AGC enabled
      This status bit was added in the V2.6 FSW release.  Prior to
      2002-12-21 this status bit was always zero. (WBR only)"
  END_OBJECT              = BIT_COLUMN

  OBJECT                  = BIT_COLUMN
    NAME                    = FINE_TIME_QUALITY
    BIT_DATA_TYPE           = BOOLEAN
    START_BIT               = 2
    BITS                    = 1
    DESCRIPTION             = "This bit indicates the accuracy of the
      SUB_RTI field that appears in the status field.  It is ONLY
      MEANINGFUL when MORE_STATUS_FOLLOWS bit is set to ONE.
        0 = SUB_RTI is accurate to approximately 1 millisecond
        1 = SUB_RTI is accurate to approximately 10 milliseconds
      This status bit was added in the V2.6 FSW release.  Prior to
```

```
    2002-12-21 this status bit was always zero. (WBR only)"
END_OBJECT              = BIT_COLUMN

OBJECT                  = BIT_COLUMN
  NAME                    = TIMEOUT
  BIT_DATA_TYPE           = BOOLEAN
  START_BIT               = 3
  BITS                    = 1
  DESCRIPTION             = "This bit is used to indicate that the
    time series is corrupt due to a timeout condition that occurred in
    the instrument hardware.
      0 = time series is correctly acquired
      1 = time series is corrupt and should be discarded
    This status bit was added in the V2.6 FSW release.  Prior to
    2002-12-21 this status bit was always zero. (WBR only)"
END_OBJECT              = BIT_COLUMN

OBJECT                  = BIT_COLUMN
  NAME                    = SUSPECT
  BIT_DATA_TYPE           = BOOLEAN
  START_BIT               = 4
  BITS                    = 1
  DESCRIPTION             = "This bit is used to indicate that the
    time series is probably corrupt, it did not pass validity tests.
      0 = time series is correctly acquired
      1 = time series is may be corrupt; may be best to discard.
    This status bit is an indication of a problem introduced by
    the ground software."
END_OBJECT              = BIT_COLUMN

OBJECT                  = BIT_COLUMN
  NAME                    = HFR_H2
  BIT_DATA_TYPE           = BOOLEAN
  START_BIT               = 5
  BITS                    = 1
  DESCRIPTION             = "This bit is used to indicate that
    the WBR HF input is connected to the HFR/H2 down converter.
    0 indicates that HFR/H2 is not connected to the WBR HF
      antenna input
    1 indicates that HFR/H2 is connected to the WBR HF antenna
      input."
END_OBJECT              = BIT_COLUMN

OBJECT                  = BIT_COLUMN
  NAME                    = HFR_H1
  BIT_DATA_TYPE           = BOOLEAN
  START_BIT               = 6
  BITS                    = 1
  DESCRIPTION             = "This bit is used to indicate that
    the WBR HF input is connected to the HFR/H1 down converter.
    0 indicates that HFR/H1 is not connected to the WBR HF
      antenna input
    1 indicates that HFR/H1 is connected to the WBR HF antenna
      input."
END_OBJECT              = BIT_COLUMN

OBJECT                  = BIT_COLUMN
  NAME                    = EU_CURRENT
  BIT_DATA_TYPE           = BOOLEAN
  START_BIT               = 7
  BITS                    = 1
  DESCRIPTION             = "This bit is used to indicate that the
```

```
      EU antenna is measuring current (WFR only).
      0 indicates voltage measurement
      1 indicates current measurement."
  END_OBJECT              = BIT_COLUMN

  OBJECT                  = BIT_COLUMN
    NAME                    = EV_CURRENT
    BIT_DATA_TYPE           = BOOLEAN
    START_BIT               = 8
    BITS                    = 1
    DESCRIPTION             = "This bit is used to indicate that the
      EV antenna is measuring current (WFR only).
      0 indicates voltage measurement
      1 indicates current measurement."
  END_OBJECT              = BIT_COLUMN

END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = FREQUENCY_BAND
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 21
  BYTES                   = 1
  DESCRIPTION             = "Frequency band of these samples:
    0 = 26 Hz, 10 millisecond sample period          (WFR only)
    1 = 2.5 KHz, 140 microsecond sample period       (WFR only)
    2 = 10 KHz filter, 4.5 microsecond sample period (WBR only)
    3 = 80 KHz filter, 36 microsecond sample period  (WBR only)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = GAIN
  DATA_TYPE               = MSB_BIT_STRING
  START_BYTE              = 22
  BYTES                   = 1
  DESCRIPTION             = "Composite gain setting"

  OBJECT                  = BIT_COLUMN
    NAME                    = WALSH_DGF
    BIT_DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BIT               = 3
    BITS                    = 2
    DESCRIPTION             = "Walsh compression factor (WFR only)
      0 = gain level 0 dB
      1 = gain level 6 dB
      2 = gain level 12 dB
      3 = gain level 18 dB"
  END_OBJECT              = BIT_COLUMN

  OBJECT                  = BIT_COLUMN
    NAME                    = ANALOG_GAIN
    BIT_DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BIT               = 6
    BITS                    = 3
    DESCRIPTION             = "Analog gain setting, 0 dB - 70 dB
      in 10 dB steps:
      0 = gain level 00 dB
      1 = gain level 10 dB
      2 = gain level 20 dB
      3 = gain level 30 dB
      4 = gain level 40 dB    (WBR only)
      5 = gain level 50 dB    (WBR only)
```

```
      6 = gain level 60 dB    (WBR only)
      7 = gain level 70 dB    (WBR only)"
  END_OBJECT              = BIT_COLUMN

END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = ANTENNA
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 23
  BYTES                   = 1
  DESCRIPTION             = "Antenna selection:
     0 = Ex, electric dipole X-direction
     1 = Eu, electric U-direction (aka Ex+) (WFR only)
     2 = Ev, electric V-direction (aka Ex-) (WFR only)
     3 = Ew, electric W-direction (aka Ez)
     4 = Bx, magnetic X-direction
     5 = By, magnetic Y-direction           (WFR only)
     6 = Bz, magnetic Z-direction           (WFR only)
     8 = HF, HFR downconvert                (WBR only)
    11 = LP, Langmuir probe sphere
    15 = unknown, antenna cannot be determined"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = AGC
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 24
  BYTES                   = 1
  DESCRIPTION             = "Value read from signal level integrator.
    Used to make decision about gain level selection for the next time
    series. (WBR only)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = HFR_XLATE
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 25
  BYTES                   = 1
  DESCRIPTION             = "Translation Frequency when HFR is selected
    as a signal source (see ANTENNA column).  The translation table may
    be found in the Users Guide/Software Operations Manual for RPWS.  In
    general, odd numbers indicate HFR/H1 is selected with frequency in
    25 KHz steps, and even numbers indicate HFR/H2 is selected with
    frequency in 50 KHz steps with an offset of 4.025 MHz."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = SUB_RTI
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 26
  BYTES                   = 1
  DESCRIPTION             = "Sub-RTI timing.  When WBR is not
    running synchronized with the RTI signal, this field contains
    additional timing information.  This field is the number of
    milliseconds into the RTI period that the data acquisition
    begins.  (WBR only)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = LP_DAC_0
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
```

```
  START_BYTE              = 27
  BYTES                   = 1
  DESCRIPTION             = "Voltage on Langmuir probe sphere DAC when
    LP is selected as a signal source (see ANTENNA column).  Additional
    status from either housekeeping or a concurrent LP data set is
    required to obtain the relay/multiplexer setting in order to
    determine the actual voltage setting.  The Users Guide/Software
    Operations Manual for RPWS must be consulted for complete details."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = LP_DAC_1
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 28
  BYTES                   = 1
  DESCRIPTION             = "Voltage on Langmuir probe cylinder DAC
    when LP is selected as a signal source (see ANTENNA column).
    Additional status from either housekeeping or a concurrent LP
    data set is required to obtain the relay/multiplexer setting
    in order to determine the actual voltage setting.  The Users
    Guide/Software Operations Manual for RPWS must be consulted
    for complete details. (WFR only)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                    = FSW_VER
  DATA_TYPE               = MSB_UNSIGNED_INTEGER
  START_BYTE              = 29
  BYTES                   = 1
  DESCRIPTION             = "Flight Software Version.
    This value indicates which version of flight software was loaded into
    the RPWS instrument when this data record was produced.
    Valid values are as follows:
      202 indicates FSW V2.2
      203 indicates FSW V2.3
      204 indicates FSW V2.4
      205 indicates FSW V2.5
      206 indicates FSW V2.6"
END_OBJECT              = COLUMN

/* END OF RPWS_WBR_WFR_ROW_PREFIX.FMT */
```

RPWS_SCLK_SCET.FMT

(See Appendix D)

Appendix F: Sample labels for RPWS_WAVEFORM_FULL

Data Set Information Catalog File: WFFULLDS.CAT

```
PDS_VERSION_ID          = PDS3
LABEL_REVISION_NOTE     = "
  2003-01-12, William Kurth (U. IOWA), initial;
  2003-06-26, William Kurth (U. IOWA), general revision;
  2004-02-10, William Kurth (U. IOWA), fixed liens;"
RECORD_TYPE             = STREAM

OBJECT                  = DATA_SET
  DATA_SET_ID             = "CO-V/E/J/S/SS-RPWS-2-REFDR-WFRFULL-V1.0"

  OBJECT                  = DATA_SET_INFORMATION
    DATA_SET_NAME           = "
          CASSINI V/E/J/S/SS RPWS EDITED WAVEFORM FULL RES V1.0"
    DATA_SET_COLLECTION_MEMBER_FLG = "N"
    DATA_OBJECT_TYPE        = TIME_SERIES
    ARCHIVE_STATUS          = IN_PEER_REVIEW
    START_TIME              = 1997-298T00:00:00.000Z
    STOP_TIME               = NULL
    DATA_SET_RELEASE_DATE   = 2003-06-30
    PRODUCER_FULL_NAME      = "DR. WILLIAM S. KURTH"
    DETAILED_CATALOG_FLAG   = "N"
    DATA_SET_TERSE_DESC     = "
      The Cassini Radio and Plasma Wave Science (RPWS) edited full
      resolution waveform (WFR) data set includes all waveform data for
      the entire Cassini mission."

    ABSTRACT_DESC           = "
      The Cassini Radio and Plasma Wave Science (RPWS) edited full
      resolution data set includes all waveform data for the entire
      Cassini mission.  This data set includes uncalibrated values for
      each waveform channel for each sensor for all times during the
      mission including the second Venus flyby, the Earth flyby, the
      Jupiter flyby, interplanetary cruise, and the entire Saturn tour.
      Data for this data set are acquired from the RPWS Waveform
      Receiver (WFR).  Data are presented in a set of time series
      organized so as to have fixed-length records for ease in data
      handling.  Data from the different WFR modes (i.e. 2.5-kHz and 26
      Hz modes)  are segregated into separate files.  This data set
      includes all waveform data acquired by the RPWS.  A browse data
      set is included with these data which provides for a graphical
      search of the data using a series of thumbnail and full-sized
      spectrograms which lead the user to the particular data file(s) of
      interest.  The waveform data provide the highest resolution data
      from the RPWS instrument in the form of a set of waveform series
      for these two bandwidths and can be used, when data from two
      electric and three magnetic sensors are available, to perform
      wave-normal analyses on various plasma wave phenomena.  These data
      can be used in their original time domain in order to look for
      solitary features such as dust impacts or electrostatic solitary
      waves.  Or, they can be transformed into the frequency domain in
      order to examine the detailed time and spectral evolution of
      plasma waves or radio emissions or to do the wave-normal analysis.
      Usually, this data set includes time series measurements from more
      than one (up to five) sensors at a time and the samples are made
```

```
    simultaneously for all five sensors."

  CITATION_DESC           = "Kurth, W.S., W.T. Robison, and L.J.
    Granroth, CASSINI V/E/J/S/SS RPWS EDITED WAVEFORM FULL RES V1.0,
    CO-V/E/J/S/SS-RPWS-2-REFDR-WFRFULL-V1.0, NASA Planetary Data
    System, 2004."

  DATA_SET_DESC                 = "

Data Set Overview
=================
  The Cassini Radio and Plasma Wave Science (RPWS) edited full
  resolution data set includes all waveform data for the entire
  Cassini mission.  This data set includes uncalibrated values for
  each waveform channel for each sensor for all times during the
  mission including the second Venus flyby, the Earth flyby, the
  Jupiter flyby, interplanetary cruise, and the entire Saturn tour.
  Data for this data are acquired from the RPWS Waveform Receiver
  (WFR).  Data are presented in a set of time series organized so as
  to have fixed-length records for ease in data handling.  Data from
  the different WFR modes (i.e. 2.5-kHz and 26 Hz modes)  are
  segregated into separate files.  This data set includes all waveform
  data acquired by the RPWS.  A browse data set is included with these
  data which provides for a graphical search of the data using a
  series of thumbnail and full-sized spectrograms which lead the user
  to the particular data file(s) of interest. The waveform data
  provide the highest resolution data from the RPWS instrument in the
  form of a set of waveform series for these two bandwidths and can be
  used, when data from two electric and three magnetic sensors are
  available, to perform wave-normal analyses on various plasma wave
  phenomena.  These data can be used in their original time domain in
  order to look for solitary features such as dust impacts or
  electrostatic solitary waves.  Or, they can be transformed into the
  frequency domain in order to examine the detailed time and spectral
  evolution of plasma waves or radio emissions or to do the
  wave-normal analysis.  Usually, this data set includes time series
  measurements from more than one (up to five) sensors at a time and
  the samples are made simultaneously for all five sensors.


Parameters
==========
  This data set comprises time series of data numbers related to the
  potential difference at the preamp input to the RPWS.  The data
  numbers can be calibrated with the use of supplied algorithms and
  calibration factors to generate a time series of electric or
  magnetic field waveforms in units of volts/meter or nanotesla.
  Because the primary purpose of the WFR is to support wave-normal
  analyses, the typical configuration of this receiver uses the
  5-sensor combination mentioned above.  The waveforms can be acquired
  in one of two modes:

  1.  2.5-kHz mode: 0.003 - 2.5 kHz, 140 microsecond sampling rate
  2.  26-Hz mode: 1 - 26 Hz, 10 msec sampling rate

  For each mode, one, two, three, or five individual sensors can be
  selected.  The samples are made simultaneously on each of the
  sensors so as to preserve information on the phase relationships
  between signals on the various sensors.
```

Typically, data are acquired in time series with length of a multiple of 512 12-bit samples, usually with this length set to 2048 samples. For the 2.5-kHz mode, this results in time series of duration about 287 msec and for the 26-Hz mode, the duration of the waveform series is typically about 20 s. A new waveform series can be acquired as often as once per approximately 20 seconds but typically once every several minutes. Hence, the duty cycle for this mode can be very small (e.g. 287 msec out of 300 sec or about 0.1 percent for the 2.5 kHz mode or about 7 percent for the 26-Hz mode) with typical sample lengths. In some instrument modes the WFR is exercised at a much higher duty cycle, at rates of once or twice per minute, improving the duty cycle considerably.

Processing

Data in this data set were processed by the use of a number of software programs which assemble segmented mini-packets in the raw telemetry packets into complete sets and de-compress the data that were compressed by one of several possible onboard compression schemes. These data may be calibrated using supplied calibration factors and algorithms as well as sample code provided.

Data

The RPWS full resolution waveform data set is organized by receiver mode and time series sample length in order to use files with fixed record lengths. Each time series is a record in a file with header information on time, sensor, and receiver gain (required for calibration). Separate files will be maintained for each instrument mode and sample length.

Ancillary Data

Ancillary data included with this data set collection include a series of files that describe the modes of the RPWS as a function of time and provide a time- ordered listing of Instrument Expanded Block (IEB) trigger commands (the mode by which the RPWS is reconfigured). Also a detailed description of each of the modes (or IEBs) is provided.

Other data which are ancillary to this data set but which are archived separately from this collection are the Navigation and Ancillary Information Facility's SPICE kernels describing the position and attitude of Cassini and various solar system bodies as a function of time.

Coordinate System

The data in this data set are measurements of wave electric and magnetic fields measured by the RPWS electric and magnetic sensors. These fields are presented as detected by the sensors and are not rotated into any other coordinate system. If desired the SPICE kernels can be used with the SPICE toolkit to convert from the spacecraft frame to virtually any frame which may be of use in analyzing these data. However, for many purposes, the wave amplitudes are extremely useful and may be entirely adequate with no

coordinate transformations at all. Wave normal analysis typically requires that the wave data and vector magnetic field from the MAGNETOMETER instrument be used in a common coordinate system.

Software
========
Sample code is provided with these data which demonstrates how to read these files in order to build a set of waveform time series. Algorithms and sample code are provided which convert from data number to either electric or magnetic field strength (units of volt/meter or nanotesla). The sample code and algorithms are found in the EXTRAS/SOFTWARE directory. A description of how to access and calibrate these data is included in WBRWFR.TXT in the DOCUMENT directory. Also see the RPWSCAL document in the same directory.

Media/Format
============
These data are supplied to the Planetary Data System on DVD-R media using formats and standards of the PDS for such media."

CONFIDENCE_LEVEL_NOTE = "

Confidence Level Overview
=========================
This data set contains all waveform data for the Cassini RPWS instrument for the interval described in the product label files. Every effort has been made to ensure that all data returned to JPL from the spacecraft is included and that the calibration information is accurate.

Review
======
The RPWS full resolution waveform data will be reviewed internally by the Cassini RPWS team prior to release to the PDS. The data set will also be peer reviewed by the PDS.

Data Coverage and Quality
=========================
All data in the stated interval are included, to the best of our knowledge and attempts to determine completeness. In general, these data were acquired during early tour for the following intervals:

1. Antenna deployment 1997-10-25T00:00 - 1997-10-26T05:30
2. Instrument Checkout 1998-12-30T09:10 - 1999-01-19T05:40
3. Venus 2 flyby 1999-06-24T09:08 - 1999-06-24T21:20
4. Earth flyby 1999-08-13T17:39 - 1999-09-14T22:20

*Actual interval for science data is much shorter than this.

Beginning in February of 2000 the instrument was operated more-or-less continuously; two gaps of the order of six weeks were incurred for the purposes of loading new attitude control and command and data system flight software, gaps of a few days each were incurred approximately twice per year because of Huygens Probe testing, and gaps of several days in duration occurred during solar

```
    conjunction periods prior to 2002. Remaining gaps are due to
    spacecraft anomaly resolution or simply to downlink gaps, some of
    which were imposed by limitations on DSN station availability.
    During the time interval after February 2002, the wideband data were
    acquired during such times when the onboard solid state recorder and
    the downlink capability could support the high data volumes required
    for these data.  Typically, waveform data are not acquired during
    the interplanetary cruise phase.  However, they are acquired more
    regularly at low duty cycles during tour and near some of the
    planetary flybys en route.  A user would find events of interest in
    the more continuous low rate data and consult the ancillary sequence
    information provided to determine the existence of waveform data in
    an appropriate mode for that event.  Further, a graphical browse
    data set is supplied with the archive to allow the user to look at
    frequency-time spectrograms directly in order to find events or
    phenomena of interest.  This browse system will point the user to
    the data files containing the data of interest.


  Limitations
  ===========
    None known at this time."

  END_OBJECT              = DATA_SET_INFORMATION

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = VENUS
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = EARTH
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = JUPITER
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = SATURN
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_TARGET
    TARGET_NAME             = SOLAR_SYSTEM
  END_OBJECT              = DATA_SET_TARGET

  OBJECT                  = DATA_SET_HOST
    INSTRUMENT_HOST_ID      = CO
    INSTRUMENT_ID           = RPWS
  END_OBJECT              = DATA_SET_HOST

  OBJECT                  = DATA_SET_REFERENCE_INFORMATION
    REFERENCE_KEY_ID        = "GURNETTETAL2003"
  END_OBJECT              = DATA_SET_REFERENCE_INFORMATION

END_OBJECT              = DATA_SET
END
```

Sample RPWS_WAVEFORM_FULL Label File

```
PDS_VERSION_ID          = PDS3

/* File characteristics */

RECORD_TYPE             = FIXED_LENGTH
RECORD_BYTES            = 2080
FILE_RECORDS            = 19
DESCRIPTION             = "T1999230_2_5KHZ2_WFRFR.DAT contains Cassini
    Radio and Plasma Wave (RPWS) waveform data for the time period between
    1999-230T00:00:00.000 and 1999-231T00:00:00.000 that includes the
    following targets: EARTH,
                       SOLAR SYSTEM."


/* Data object pointers */

^WFR_ROW_PREFIX_TABLE   = ("T1999230_2_5KHZ2_WFRFR.DAT", 1)
^TIME_SERIES            = ("T1999230_2_5KHZ2_WFRFR.DAT", 1)

/* Identification */

DATA_SET_ID             = "CO-V/E/J/S/SS-RPWS-2-REFDR-WFRFULL-V1.0"
DATA_SET_NAME           = "
              CO V/E/J/S/SS RPWS 2 REFDR WFR FULL RESOLUTION V1.0"
PRODUCT_ID              = "T1999230_2_5KHZ2_WFRFR_V1"
PRODUCT_CREATION_TIME   = 2004-03-03
START_TIME              = 1999-230T00:00:00.000Z
STOP_TIME               = 1999-231T00:00:00.000Z
SPACECRAFT_CLOCK_START_COUNT = "1/1313626007:150"
SPACECRAFT_CLOCK_STOP_COUNT  = "1/1313712408:040"
NATIVE_START_TIME           = -11793535.817
NATIVE_STOP_TIME            = -11707135.817
NOTE                        = "NATIVE_TIME is NAIF 'et' (ephemeris
  time or barycentric dynamical time) as used in the spice kernel."
PRODUCT_TYPE                = DATA
STANDARD_DATA_PRODUCT_ID    = RPWS_WAVEFORM_FULL
MISSION_PHASE_NAME          = {"EARTH ENCOUNTER",
                               "INTERPLANETARY CRUISE",
                               "VENUS 2 - EARTH CRUISE"}
TARGET_NAME                 = {"EARTH",
                               "SOLAR SYSTEM"}
SOFTWARE_VERSION_ID         = "RPWS_HR_AR V5.3"

/* Instrument description */

INSTRUMENT_HOST_NAME    = "CASSINI ORBITER"
INSTRUMENT_HOST_ID      = CO
INSTRUMENT_NAME         = "RADIO AND PLASMA WAVE SCIENCE"
INSTRUMENT_ID           = RPWS
SECTION_ID              = WFR

/* Data Object Structure */
/************************************************************/
/*      1                  32 33                 x1      x2   */
/*     +--------------------+--------------------+-------+  */
/*     |                    |                    |       |  */
/*  1  | ROW_PREFIX_TABLE -->| TIME_SERIES ------->| SPARE |  */
/*     |                    |                    |       |  */
/*     +--------------------+--------------------+-------+  */
/*     |                    |                    |       |  */
```

```
/*     | ROW_PREFIX_TABLE -->| TIME_SERIES ------->| SPARE |  */
/*  2  |                     |                     |       |  */
/*     +---------------------+---------------------+-------+  */
/*     |                     |                     |       |  */
/*  3  | ROW_PREFIX_TABLE -->| TIME_SERIES ------->| SPARE |  */
/*     |                     |                     |       |  */
/*     +---------------------+---------------------+-------+  */
/*  . . .                                                     */
/*     +---------------------+---------------------+-------+  */
/*     |                     |                     |       |  */
/*  y  | ROW_PREFIX_TABLE -->| TIME_SERIES ------->| SPARE |  */
/*     |                     |                     |       |  */
/*     +---------------------+---------------------+-------+  */
/*                                                           */
/*     8-bit octet are numbered across the top.              */
/*         No header records, all records are in the         */
/*         same format.                                      */
/*     Record Number is down the left edge.                  */
/*                                                           */
/*  x1 is ROW_BYTES+32 (ITEMS)                               */
/*  x2 is RECORD_BYTES                                       */
/*  y  is FILE_RECORDS (ROWS)                                */
/*                                                           */
/*************************************************************/

/* Record header */

OBJECT                  = WFR_ROW_PREFIX_TABLE
  NAME                    = WFR_ROW_PREFIX_TABLE
  INTERCHANGE_FORMAT      = BINARY
  ROWS                    = 19
  COLUMNS                 = 19
  ROW_BYTES               = 32
  ROW_SUFFIX_BYTES        = 2048
  DESCRIPTION             = "This table describes the structure of the
    record header attached to each row of time series data."
  ^STRUCTURE              = "RPWS_WBR_WFR_ROW_PREFIX.FMT"
END_OBJECT              = WFR_ROW_PREFIX_TABLE

/* Data samples */

OBJECT                  = TIME_SERIES
  NAME                    = WFR_TIME_SERIES
  INTERCHANGE_FORMAT      = BINARY
  ROWS                    = 19
  COLUMNS                 = 1
  ROW_BYTES               = 2048
  ROW_PREFIX_BYTES        = 32
  SAMPLING_PARAMETER_NAME = TIME
  SAMPLING_PARAMETER_UNIT = SECOND
  SAMPLING_PARAMETER_INTERVAL = 0.000140
  DESCRIPTION             = "This time series consists of
    uncalibrated samples gathered during a 24 hour time span from one
    or more detectors.  Time interval between TIME_SERIES is
    variable."

  OBJECT                  = COLUMN
    NAME                    = WFR_SAMPLE
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 33
    BYTES                   = 2048
    ITEMS                   = 1024
```

```
    ITEM_BYTES              = 2
    OFFSET                  = -2047.5
    VALID_MINIMUM           = 0
    VALID_MAXIMUM           = 4095
    DESCRIPTION             = "The 16-bit unsigned uncalibrated
      waveform samples range from 0 to 4095.  Zero
      amplitude is nominally 2047.5 with 2047 being just
      below and 2048 just above zero amplitude."
  END_OBJECT              = COLUMN

END_OBJECT              = TIME_SERIES

END
```

RPWS_WBR_WFR_ROW_PREFIX.FMT

(See Appendix E)

RPWS_SCLK_SCET.FMT

(See Appendix D)

Appendix G: Sample Index Labels

INDEX.LBL

```
PDS_VERSION_ID          = PDS3
/************************/
/* File Characteristics */
/************************/
RECORD_TYPE             = FIXED_LENGTH
RECORD_BYTES            = 272
FILE_RECORDS            = 1025
/************************/
/* Data object pointers */
/************************/
^INDEX_TABLE            = ("INDEX.TAB",2)
/******************/
/* Identification */
/******************/
VOLUME_ID               = CORPWS_0002
DATA_SET_ID             = { "CO-V/E/J/S/SS-RPWS-4-SUMM-KEY60S-V1.0",
                            "CO-V/E/J/S/SS-RPWS-2-REFDR-ALL-V1.0",
                            "CO-V/E/J/S/SS-RPWS-3-RDR-LRFULL-V1.0",
                            "CO-V/E/J/S/SS-RPWS-2-REFDR-WBRFULL-V1.0",
                            "CO-V/E/J/S/SS-RPWS-2-REFDR-WFRFULL-V1.0" }
PRODUCT_CREATION_TIME   = 2003-12-19
MISSION_NAME            = "CASSINI-HUYGENS"
SPACECRAFT_NAME         = "CASSINI ORBITER"
TARGET_NAME             = {"EARTH",
                           "SOLAR SYSTEM"}
MISSION_PHASE_NAME      = {"EARTH ENCOUNTER",
                           "INTERPLANETARY CRUISE",
                           "VENUS 2 - EARTH CRUISE"}
DESCRIPTION             = "INDEX.TAB is an index of all of the PDS
  label files corresponding to all of the archived Cassini RPWS
  data on this volume.  The first line of the index file contains
  individual OBJECT names from the OBJECT=INDEX_TABLE that follows.
  Some of these names may be truncated to fit the defined column
  width."
SOFTWARE_VERSION_ID     = "P3.6/L2.5"
/************************/
/* Data Object Structure */
/************************/
OBJECT                  = INDEX_TABLE
  INTERCHANGE_FORMAT      = ASCII
  ROWS                    = 1025
  ROW_BYTES               = 272
  COLUMNS                 = 9
  INDEX_TYPE              = SINGLE
  DESCRIPTION             = "The following fields are
    extracted from the individual label files on this
    and previous volumes."

  OBJECT                  = COLUMN
    NAME                    = VOLUME_ID
    DATA_TYPE               = CHARACTER
    START_BYTE              = 2
    BYTES                   = 11
    DESCRIPTION             = "Volume ID in the form CORPWS_0nnn.
      In the CUMINDEX.TAB this identifies the volume on which
      the indicated dataset resides."
  END_OBJECT              = COLUMN
```

```
OBJECT                   = COLUMN
  NAME                     = STANDARD_DATA_PRODUCT_ID
  DATA_TYPE                = CHARACTER
  START_BYTE               = 16
  BYTES                    = 20
  DESCRIPTION              = "The general data product name"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
  NAME                     = DATA_SET_ID
  DATA_TYPE                = CHARACTER
  START_BYTE               = 39
  BYTES                    = 40
  DESCRIPTION              = "The data set ID from the label"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
  NAME                     = PRODUCT_ID
  DATA_TYPE                = CHARACTER
  START_BYTE               = 82
  BYTES                    = 30
  DESCRIPTION              = "The data product ID"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
  NAME                     = START_TIME
  DATA_TYPE                = TIME
  START_BYTE               = 115
  BYTES                    = 22
  DESCRIPTION              = "Spacecraft Event Time (SCET) of the
    begining of the period in the form yyyy-dddThh:mm:ss.sssZ"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
  NAME                     = STOP_TIME
  DATA_TYPE                = TIME
  START_BYTE               = 140
  BYTES                    = 22
  DESCRIPTION              = "Spacecraft Event Time (SCET) of the
    end of the period in the form yyyy-dddThh:mm:ss.sssZ"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
  NAME                     = SPACECRAFT_CLOCK_START_COUNT
  DATA_TYPE                = CHARACTER
  START_BYTE               = 165
  BYTES                    = 16
  DESCRIPTION              = "Spacecraft Clock (SCLK) of the
    begining of the period in the form p/sssssssss:fff
      where:
        p indicates the partition number;
        sssssssss is the SCLK second counter;
        fff is the SCLK fine counter (256 counts per second)"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
  NAME                     = FILE_SPECIFICATION_NAME
  DATA_TYPE                = CHARACTER
  START_BYTE               = 184
  BYTES                    = 73
  DESCRIPTION              = "POSIX-compliant full path to the PDS label
```

```
      file that describes the binary file containing instrument data.
      The path is relative to the root of the archive volume."
  END_OBJECT              = COLUMN

  OBJECT                  = COLUMN
    NAME                    = PRODUCT_CREATION_TIME
    DATA_TYPE               = TIME
    START_BYTE              = 260
    BYTES                   = 10
    DESCRIPTION             = "Product creation date"
  END_OBJECT              = COLUMN

END_OBJECT              = INDEX_TABLE

END
```

Appendix H. Sample Ancillary Files

Example Mode (IEB Trigger) Summary Table for the C15 Sequence

```
PDS_VERSION_ID       = PDS3
RECORD_TYPE          = STREAM
OBJECT               = TEXT
  PUBLICATION_DATE     = 2003-06-20
    NOTE                 = "
        ESB_IEB.TXT describes the set of Instrument Expanded Blocks (IEBs)
        and individual commands used in the Earth Swing-By (ESB) sequence,
        and also a short description of each."
END_OBJECT           = TEXT
END

C15 (ESB) RPWS Triggers

Trigger 0
  Power On All Receivers (HFR, MFR, LP, WFR, WBR)
Trigger 1
  Internally defined Basic Mode with HFR "Composite Mode Survey" (CMS)
  For more info, see TRIG_01.TXT
Trigger 28
  200 bps Interplanetary Cruise with Direction Finding on HFR Bands ABC
  For more info, see TRIG_28.TXT
Trigger 80
  1 kbps Direction-Finding Survey with 2.5 KHz WFR
  For more info, see TRIG_80.TXT
Trigger 8C
  Earth Swing-By: AKR Polarization, Fast 2.5KHz WFR, 10KHz WBR (~30 kbps)
  For more info, see TRIG_8C.TXT
Trigger 90
  2 kbps Magnetotail Basic Survey with 2.5 KHz WFR
  For more info, see TRIG_90.TXT
Trigger 92
  Earth Swing-By: Sounder Checkout (~500 bps)
  For more info, see TRIG_92.TXT
Trigger 94
  Earth Swing-By: Langmuir Probe Checkout (~30 kbps)
  For more info, see TRIG_94.TXT

C15 RPWS Commands

73PS_RPWS,OFF
  Power RPWS off
73PS_RPWS,ON
  Power RPWS on
73RT_SLEEP,ACTIVE
  ACTIVE MODE: Processors awake, ready to power up Receivers
73RT_SLEEP,SLEEP
  SLEEP MODE: Receivers powered off, Processors low-power mode
73MEM_TWEAK,HRP,BYTE,0x0052,0x0082,W08I
  Prepare WBR to use EZ sensor
73IEB_LOAD
  Load Internal Expanded Block (IEB) memory
73WRAP,(0x4310,0x1500)
  Perform Checksum on newly loaded IEB memory
73MEM_TWEAK,LRP,BYTE,0x0014,0x00C0,TWEK
  Command needed for IEB verification via memory readout
73MRO,LRP,HSK,8000,800F
  Command needed for IEB verification via memory readout
73MRO,LRP,HSK,BF00,BF1C
  Command needed for IEB verification via memory readout
73MEM_TWEAK,LRP,BYTE,0x0014,0x0040,TWEK
  Command needed for IEB verification via memory readout
73WFR_MODE_CNTL,HOLD,LBAND,NOCOMPRESS
  Set WFR Band to the 1-25 Hz mode (i.e., Low Band)
```

Example Time Ordered Listing of RPWS commands in the C15 Sequence

```
1999-225T17:38:00.000    "73PS_RPWS,ON                                    "
1999-225T17:40:00.000    "73RT_SLEEP,ACTIVE                               "
1999-225T17:43:00.000    "TRIGGER    0                                    "
1999-225T17:43:30.000    "73MEM_TWEAK,HRP,BYTE,0x0052,0x0082,W08I         "
1999-225T17:44:00.000    "TRIGGER    1                                    "
1999-225T17:44:31.000    "73IEB_LOAD    GEO IEB                           "
1999-225T17:44:52.000    "73WRAP,(0x4310,0x1500)                          "
1999-225T17:45:52.000    "73MEM_TWEAK,LRP,BYTE,0x0014,0x00C0,TWEK         "
1999-225T17:46:02.000    "73MRO,LRP,HSK,8000,800F                         "
1999-225T17:46:12.000    "73MRO,LRP,HSK,BF00,BF1C                         "
1999-225T17:46:52.000    "73MEM_TWEAK,LRP,BYTE,0x0014,0x0040,TWEK         "
1999-230T01:33:10.000    "TRIGGER   8C                                    "
1999-230T02:50:10.000    "TRIGGER   92                                    "
1999-230T03:25:02.000    "TRIGGER   94                                    "
1999-230T05:23:10.000    "TRIGGER   80                                    "
1999-237T06:30:00.000    "TRIGGER   28                                    "
1999-243T02:30:00.000    "73RT_SLEEP,SLEEP                                "
1999-244T03:10:00.000    "73RT_SLEEP,ACTIVE                               "
1999-244T03:10:30.000    "TRIGGER    0                                    "
1999-244T03:11:00.000    "TRIGGER   28                                    "
1999-254T16:31:00.000    "TRIGGER   90                                    "
1999-255T22:00:00.000    "73WFR_MODE_CNTL,HOLD,LBAND,NOCOMPRESS           "
1999-257T21:40:00.000    "73PS_RPWS,OFF
```

Example Description of Mode (IEB Trigger) 80 as implemented in the C15 Sequence

```
PDS_VERSION_ID       = PDS3
RECORD_TYPE          = STREAM
OBJECT               = TEXT
  PUBLICATION_DATE     = 2003-06-20
    NOTE                 = "
        TRIG_80.TXT describes the RPWS instrument configuration for the
        High Frequency Receiver (HFR), the Medium Frequency Receiver (MFR),
        the Low Frequency Receiver (LFR), the Waveform Receiver (WFR), the
        Wideband Receiver (WBR), the Langmuir Probe (LP), the Sounder, and
        the onboard Dust detection algorithm when using Trigger 80."
END_OBJECT           = TEXT
END

Sequence: C15 (ESB)
Trigger 80 (Direction-Finding Survey)

     This mode is designed to provide a Survey with fast temporal resolution
and standard spectral resolution for periods during Earth Swing-by.
Periodic Waveform measurements are made. The entire RPWS frequency range
(1 Hz - 16 MHz) is covered.

Receiver      Frequency Range         Sensors         Time between Snapshots
--------      ----------------    --------------      ----------------------
  LFR            1 - 25 Hz            EX, BX              32 seconds
  MFR          25 Hz - 12 KHz         EW, BZ              32 seconds
  HFR         3.6 KHz - 16 MHz      EU, EV, EW           32 seconds
  WFR          .1  - 2.5 KHz      EX,EW,BX,BY,BZ         320 seconds


The HFR is in direction-finding mode for its entire frequency range from
3.6 KHz to 16 MHz. Thus, measurements are made on all three monopoles EU,
EV and EW.

This mode is defined by:

          Correlations   Channels        Integ.              Size Frequency
Band Ant. Auto-  Cross-  per Band   df   Period  Rep   Steps kHz  Start - Stop
---- ---- -----  ------  --------   --   ------  ---   ----- ---- ------------
ABC  2E   y         y       8       y    250     1                3.6-319 kHz
H1   2E   y         y       1       y    80      1     76    50   325k-4.1MHz
H2   2E   y         y       1       y    80      1     61    200  4.0M-16MHz

Bands ABC require 1.69 sec to complete, H1 requires 13.06 sec, and H2 requires
10.50 sec for a total of 25.25 sec per sweep. However, to allow time for LFR
and MFR snapshots to occur without interference, one complete sweep is done
every 32 seconds. To avoid the interference from the DF mode, the MFR uses
the EW antenna.
```

Appendix I. Acronym List

CAS	Cassini
CETP	Centre d'etudes des Environnements Terrestre et Planetaires
CODMAC	Committee on Data Management and Computation
DVD	Digital Versatile Disk
HFR	High frequency receiver
HTML	Hypertext markup language
JPL	Jet Propulsion Laboratory
LFR	Low frequency receiver
MAPS	Magnetosphere and Plasma Science
MFDR	Medium frequency digital receiver
MFR	Medium frequency receiver
NASA	National Aeronautics and Space Administration
NSSDC	National Space Science Data Center
PDS	Planetary Data System
PNG	Portable Network Graphics
PPI	Planetary Plasma Interactions
RPWS	Radio and Plasma Wave Science
SCET	Spacecraft event time
SCLK	Spacecraft clock
SIS	Software Interface Specification
UCLA	University of California, Los Angeles