European Space Agency
Research and Science Support Department
Planetary Missions Division

ROSETTA- Standard Radiation Environment Monitor (SREM)

To Planetary Science Archive Interface Control Document

Issue 1.2

15 June 2020

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Distribution List

Recipient	Organisation	Recipient

Change Log

Date	Sections Changed	Reasons for Change
20/08/2018	Draft	
15/07/2019	All	Updated following the Rosetta ENH Archive Review comments.
15/06/2020	2.2 and its subsections, 2.4.1, 3.3.1 and its subsections, 4.1.1, and Appendices	Updates requested during the Rosetta CLS Enhanced Archive Review

TBD ITEMS

Section	Description

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1 Introduction

1.1 Purpose and Scope

The purpose of this EAICD (Experimenter to (Science) Archive Interface Control Document) is two-fold. First it provides users of the SREM instrument with a description of the data products provided and how they were generated, including data sources and destinations. Secondly, it is the official interface between the SREM instrument team and the PSA/PDS archiving authority for the Rosetta mission.

The document includes information on how data were processed, formatted, labeled and uniquely identified. It also discusses general naming schemes for data volumes, data sets, data and label files. Standards used to generate the product are explained. Software that may be used to access the product is explained further on. The design of the data set structure and the data product is given. Examples of these are given in the appendix.

1.2 Archiving Authorities

The Planetary Data System Standard is used as archiving standard by:

- NASA for U.S. planetary missions, implemented by PDS
- ESA for European planetary missions, implemented within the Science Directorate of ESA

ESA implements an online science archive, the PSA, to support and ease data ingestion to offer additional services to the scientific user community and science operations teams as e.g. search queries that allow searches across instruments, missions and scientific disciplines several data delivery options as direct download of data products, linked files and data sets ftp download of data products, linked files and data sets.

The PSA aims for online ingestion of logical archive volumes and will offer the creation of physical archive volumes on request.

1.3 Intended Readership

The staff of the archiving authority (Planetary Science Archive, ESA, RSSD, design team) and any potential user of the SREM data.

1.4 Applicable/Reference Documents

[1] Planetary Data System Preparation Workbook, February 1, 1995, Version 3.1, JPL, D-7669, Part1.
[2] Planetary Data System Standards Reference, January 8, 2003, Version 3.6, JPL.
[3] Sandberg et al., Unfolding and Validation of SREM Fluxes, IEEE Transactions on Nuclear Science 59 (2012) 1105, DOI: 10.1109/TNS.2012.2187216.
[4] Sandberg, I, Bühler, P. and Daglis, I., SREM and REM Data Consolidation Final Report, July 2017, SREMDC_FINAL_REPORT.PDF v1.0.
[5] Honig, T., Witasse, O. G., Evans, H., Nieminen, P., Kuulkers, E., Taylor, M. G. G. T., Heber, B., Guo, J., and Sanchez-Cano, B.: Multi-point galactic cosmic ray measurements between 1 and 4.5 AU over a full solar cycle, Ann. Geophys., 37, 903–918, https://doi.org/10.5194/angeo-37-903-2019, 2019.
[6] Hajdas, W., Proton Calibration Test Report for Rosetta SREM, SREM-PCTR-PSI-002, December 2000.
[7] Wyrwoll, V., Luedeke, S., Evans, H. and Poppe, B., Validation of flux models to characterize the radiation environment in space based on current Rosetta-data, 17th European Conference on

Radiation and Its Effects on Components and Systems (RADECS), Geneva, Switzerland, pp. 1-4. doi: 10.1109/RADECS.2017.8696188, 2017.
[8] Mohammadzadeh A. et al., The ESA Standard Radiation Environment Monitor Program First Results From PROBA-I and INTEGRAL, IEEE Transactions on Nuclear Science, VOL. 50, NO. 6, December 2003.

1.5 Contact Names and Addresses

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1.6 Acronyms and Abbreviations

CODMAC	Committee on Data Management and Computation
ESA	European Space Agency
ESTEC	European Space Research and Technology Centre
PDS	Planetary Data System
PSA	Planetary Science Archive
PSI	Paul Scherrer Institut
SEPEM	Solar Energetic Particle Environment Modelling
SREM	Standard Radiation Environment Monitor
SVD	Singular Value Decomposition

2 Overview of Instrument Design, Data Handling Process and Product Generation

The Standard Radiation Environment Monitor is developed and manufactured by Contraves Space AG in cooperation with the Paul Scherrer Institut (PSI) under a development contract of the European Space Agency (ESA).

SREM performs a wide range of radiation monitoring functions in orbit, and downloads the results via the host spacecraft telemetry to a user on ground. It is designed as standard equipment compatible with all common spacecraft interfaces and mission constraints.

2.1 Scientific Objectives

SREM is the second generation of instruments in a program that was established by ESA's European Space Research and Technology Centre (ESTEC) to:

- Provide minimum intrusive radiation detectors for space applications;
- Provide radiation hazard alarm function to instruments on board spacecraft;
- Assist in investigation activities related to possible radiation related anomalies observed on spacecraft;
- Assist in in-flight technology demonstration activities.

2.2 Data Handling Process

The SREM data can be found in CDF format via the web page of the Paul Scherrer Institute (PSI): http://srem.web.psi.ch/

The calibration of the CDF data has been performed in collaboration with Ioannis Daglis and Ingmar Sandberg using a dedicated unfolding technique over pre-defined energies. The unfolding technique is based on the regularized Singular Value Decomposition (SVD) method. More details of the method can be found in Sandberg et al 2012 [3] and below.

Note that the Mohammadzadeh, 2003 [8] paper referenced in the MISSION.CAT provides the first public description of the SREM instrument, and the on ground calibrations applied to it. Ten identical SREM units were built, of which one was the Rosetta unit. The paper includes the results from the first data taken by the PROBA-1 and INTEGRAL spacecraft units, demonstrating the detectors response to solar particle events and the trapped proton and electron belts. Sandberg et al 2012 [3] documents the SVD method used to deconvolve SREM raw count rate data to a series of channels with physical units. This method is applied to all of the SREM datasets, including the Rosetta/SREM dataset. At the time of publication, the INTEGRAL unit provided the largest SREM dataset measured at 1 AU without the influence of geomagnetic shielding, allowing for comprehensive cross calibration and validation against the Solar Energetic Particle Environment Modelling (SEPEM) reference dataset (http://dev.sepem.oma.be/). Combined with the manufacturing consistency between the units, as demonstrated through the ground test campaigns and the Geant4 response function analyses, the deconvolution and cross calibration techniques developed for the INTEGRAL unit and described in [3] and [8] are directly applicable to the Rosetta unit.

The fluxes have then been rescaled according to cross-calibration studies between fluxes before a rescaling step against selected reference datasets. SEPEM Reference Dataset v2.0 (i.e. GOES/EPS fluxes cross-calibrated with IMP-8/GME) has been selected as reference for proton fluxes, while RBSP/MAGEIS spin averaged datasets were selected as a reference for electron fluxes. As indicated in SREMDC_Final_Report.PDF [4] (available in the DOCUMENT directory), as a result of this process, the highest energy flux levels derived for the electron data were not reliable. Thus, it was decided to reject entirely these products in the production of the CDF Level 2 (CODMAC Level 5) data. As such, only 10 energy channels are made available for electron fluxes in the CDF L2 (CODMAC Level 5) dataset. These are #1-#10 in the table on page 48 of the SREMDC Final Report (Sandberg et al, 2017) [4], which is available in the DOCUMENT directory.

2.2.1 Calibration Factors and Response Functions

The conversion of count rates to flux for the SREM units is not possible to represent using simple geometric factors and no standard deviation can be provided for the flux data as a result of the conversion. The conversion uses the Single Value Decomposition (SVD) technique detailed in Sandberg et al. 2012 [3].

The Rosetta/SREM 3D response functions are provided in the DOCUMENT directory as the two files RESPONSE_WO_SAT_ELECTRONS.ASC (response function without saturated electrons) and RESPONSE_WO_SAT_PROTONS.ASC (response function without saturated protons). These response functions do not include the spacecraft mass, and are generated from Geant4 Monte-Carlo simulations of the instrument. They provide the efficiency of the instrument to register a particle measurement as a count given the particle's energy, and angle of incidence. While the response functions were calculated omitting the spacecraft mass model, it would affect the counts registered from particles principally incident from the rear of the instrument, and would affect the RF at the higher energies (E>100 MeV protons) [7]. The effect of including the spacecraft mass on the rear side of the instrument (Rosetta SREM was mounted on an external panel) results in a reduction in the RF above these energies. As the energy spectrum of energetic particles in space tends to fall significantly with energy, the final difference is not expected to be large (< 20%). For instruments encased within a spacecraft (such as the PROBA1/SREM) the effect is greater, but it would not greatly impact the Rosetta case.

2.2.2 Cross Calibration

The proton measurements from Rosetta/SREM and INTEGRAL/IREM have been compared extensively during solar proton events. Comparisons of Rosetta/SREM with other instruments (particularly STEREO/HET) depends greatly on the solar longitude of the measurement locations. Longer term trends and cross-calibration has been carried out in Honig et al., 2019 [5], where SREM detectors on INTEGRAL, Rosetta, Herschel, Planck and Proba-1 are cross-calibrated. The reader is referred to that paper for more information.

All of the SREM units were individually tested in the PSI PIF facility both to validate the calculated Response functions and determine the active area of the sensor diodes. This ground calibration activity demonstrated a high level of consistency between instruments. See the Proton Calibration Test Report for Rosetta SREM (W. Hajdas, 2000) [6] for details. This report is included in the DOCUMENT directory.

2.2.3 Dead Time Response

Dead time correction for the instrument was characterised in the PSI Proton Calibration exercise, detailed in Section 7 of the Proton Calibration Test Report [6] provided in the DOCUMENT directory. The peak count rate (dead time corrected) from the raw data files is from the TC3 channel: 97885 on 2005-03-04 22:18:59. This is within the stated accuracy specified in the report.

Dead time measurement was done using the same set-up as for detector area determination. The proton flux however was varied up to 1.0E+05 $p^+/cm^2/s$. The data is provided in the table on page 12 of the test report [6] in the DOCUMENT directory. Measurements were done using 10 sec long time intervals.

The beam was subsequently switched off and new flux value was set. The flux normalization data were collected simultaneously – two plastic detectors and main beam current scalers were saved for data analysis purposes. For particle fluxes below 1.0E+05 $p^+/cm^2/s$ the dead time pulser correction is linear and does not exceed 20% as it is defined in detector specifications. For higher fluxes, the correction becomes non-linear and one should use TCi scaler values and a non-linear fit results from the calibration data. Figures and details of this process are available in the Test Report [6].

2.3 PSA/PDS Archive Product Generation

The PDS3 compliant data products for the long-term archive were generated by Francisco Vallejo, converting directly from the CDF equivalents. The PDS3 data sets were constructed by Maud Barthelemy and David Heather.

2.4 Overview of Data Products

Two CODMAC processing levels of data are included in the PSA / PDS archives.

IMPORTANT: some of the documentation provided and referenced within these PDS3 data sets (e.g. Sandberg et al., 2012 [3] and Sandberg et al, 2017 [4]) are copies of those written in support of the original CDF data. This means that they use the original processing level definitions used for the CDF files. **These are different to the CODMAC data processing level definitions required by PDS3 and used in the metadata to describe these data sets.**

The processing levels for both the original SREM CDF data and their PDS 'CODMAC' equivalent are described below:

SREM (CDF) Level	COMDAC (PDS) Level	Description
0	2	'Raw' data provided as count rates along with standard deviation.
2	5	Derived data provided as electron and proton fluxes along with a quality factor.

2.4.1 *In-Flight Data Products Summary*

Raw CODMAC L2 data

These are raw SREM count-rate data converted from the equivalent SREM Level 0 CDF products, and provided in an ASCII table format. Standard deviations are also provided.

Derived CODMAC L5 data:

These are SREM omni-directional fluxes provided at particular effective energies, converted from the equivalent SREM Level 2 CDF products.

Differential fluxes have first been derived from the Level 0 CDF count rate data using a dedicated unfolding technique over pre-defined energies. The unfolding technique is based on the regularized Singular Value Decomposition (SVD) method described in Sandberg et al, 2012 [3] and Sandberg et al, 2017 [4]. The fluxes have then been rescaled according to cross-calibration studies between fluxes before a rescaling step against selected reference datasets (see Section 2.2 and the DATASET.CAT for further details). No standard deviation can be provided for the flux data as a result of the conversion.

A quality value is also provided alongside the fluxes, giving recommendations on their use, as described in the table below.

FQDO_Quality	Comment	Recommendation
FQDO_Quality=0	SREM count-rate data determined by charged particle fluxes Q.	Use FQDO
FQDO_Quality=1	SREM count-rate data most likely determined by charged particle fluxes Q.	Use FQDO with some caution
FQDO_Quality=2	SREM count-rate contaminated by various sources. None criterion is satisfied	Do not use FQDO
FQDO_Quality=3	SREM count-rate dominated by fluxes of non-Q particles.	Do not use FQDO
FQDO_Quality=5	SREM count-rate data dominated by background (cosmic, detector electronics)	Do not use FQDO

Where:
FQDO_Quality: Flux Q Differential Omnidirectional_Quality where (Q=P,E)
FPDO: Flux Proton Differential Omnidirectional
FEDO: Flux Electron Differential Omnidirectional

The above table is adapted from Sandberg et al, 2017 [4], a copy of which is available in the DOCUMENT directory.

Note on data quality flags:

It should be noted that a large number of the data are flagged with non-zero FPDO quality, but that all FEDO quality flags are >1, as there are no data considered uncontaminated. This is a result of Rosetta being far from electron or proton dominated environments (other than the Earth fly-bys and solar proton events).

The Rosetta radiation environment consisted pre-dominantly of Galactic Cosmic Rays (GCR), with the occasional solar energetic particle event (SEPE) and the even more rare transit of the Earth's trapped particle belts. The FPDO and FEDO (flux Proton/Electron Differential Omnidirectional) calibrated measurements are derived from the SVD method, as documented in Sandberg, 2012 [3], and are appropriate for the SEPE and trapped particle belt measurements only. Hence, the dataset will consist primarily of GCR measurements, and the associated CODMAC L5 dataset quality flags would be set accordingly. As published by Wyrwoll et al. [7] paper and Honing et al. [5], the raw count rate dataset is very effective for GCR analyses.

3 Archive Format and Content

This chapter contains general rules for the SREM data sets. The format and convention used for naming directories and files is specified below.

3.1 Format and Conventions

The data sets provided are fully compliant with the PDS standards and the recommendations provided by the Rosetta archiving authorities, such that:

- Each logical archive volume contains one SREM PDS data set;
- One data set is provided for each separate mission phase during cruise, and one for each Medium Term Planning (MTP) during the comet escort and mission extension phases;
- A different data set is provided for each processing level.

3.1.1 Data Set ID Formation

The following convention is used for the formation of the SREM DATA_SET_ID:

DATA_SET_ID = "<INSTRUMENT_HOST_ID>-<TARGET_ID>-<INSTRUMENT_ID>-<PROCESSING LEVEL>-<MISSION PHASE>-<DESCRIPTION>-<VERSION>"

Example: "***RO-C-SREM-5-EXT3-MTP34-V1.0***"

Where, in the above example:

INSTRUMENT_HOST_ID	=	'RO' for Rosetta Orbiter.
TARGET_ID	=	'X' for 'Other', as SREM is monitoring the spacecraft environment.
INSTRUMENT_ID	=	'SREM' for the short identifier of the instrument.
PROCESSING LEVEL	=	'5' for CODMAC Level 5 (equivalent to SREM CDF Level 2); see Section 2.4 for processing level descriptions.
MISSION PHASE	=	'EXT3' for the third mission extension.
DESCRIPTION	=	'MTP34' for the 34^{th} Medium Term Planning period contained in the data set.
VERSION	=	'V1.0' for the first version of this data set.

3.1.2 Filenaming Convention

The following convention is used for the formation of the SREM data product filenames:

SREM_L<N>_YYYYMMDD.EXT

Where:

N	=	2 for CODMAC Level 2 (equivalent to SREM CDF Level 0) or 5 for CODMAC Level 5 (equivalent to SREM CDF Level 2); see Section 2.4 for processing level descriptions.
YYYYMMDD	=	the date (year, month, day)
EXT	=	the extension (LBL for a data product label or TAB for the data table itself).

Example: ***SREM_L5_20160903.TAB***

Where, in the above example:
We have a SREM CODMAC Level 5 data table from 03 September 2016.

3.2 Data Validation

The PDS3 data sets have been validated using the DVAL validation tool built by PSA, and have also been validated by PDS. The data sets underwent a review in Autumn 2018 and all issues raised at that time have been addressed.

As noted in Section 2.2, the electron data set was cross-calibrated with RBSP/MAGEIS spin averaged data. It has been noted that as a result of this process the highest energy flux levels derived were not reliable. Thus, it was decided to reject entirely these products in the production of the Level 2 CDF data. As such, only 10 energy channels are made available in the CDF Level 2 (COMDAC Level 5) dataset, #1-#10 in the table on page 48 of SREMDC Final Report (Sandberg et al, 2017) [4].

3.3 Content

This section contains information common to all data sets produced for the SREM archive.

3.3.1 Directories

3.3.1.1 Root Directory

The top-level structure of the ROOT directory contains:

- AAREADME.TXT: This file describes the complete data volume. It provides an overview of what can be found in the data set.
- VOLDESC.CAT: This file contains and describes the PDS3 VOLUME object, and provides a pointer to the CATALOG files where further high-level information can be found (Section 3.3.1.2).

3.3.1.2 Catalog Directory

This directory contains the CATINFO.TXT, which briefly describes the directory contents, and the following catalog files:

- *DATASET.CAT*: summarises and provides key information on the data set contents.
- *INST_SREM.CAT*: contains information on the SREM instrument.

- *INSTHOST.CAT*: contains information on the Rosetta Orbiter and Lander, hosting the SREM instrument. This file is common to all Rosetta data sets.
- *MISSION.CAT*: contains information of the Rosetta mission. This file is common to all Rosetta data sets.
- *PERS_SREM.CAT*: contains information on people involved in the creation of the data sets.
- *REF.CAT*: contains information on the reference documentation for the entire Rosetta mission. This file is common to all Rosetta data sets, and therefore contains references for all instruments.
- *SOFTWARE.CAT*: template required by the PSA. No software is provided for the SREM data sets.

3.3.1.3 Index Directory

The INDEX directory contains the data product index that lists all the data products in the DATA directory: INDEX.TAB and its label INDEX.LBL. It also contains the INDXINFO.TXT, briefly describing the directory contents.

3.3.1.4 Document Directory

The DOCUMENT directory contains the DOCINFO.TXT describing the directory contents, and supporting documentation for the data set. The following documents/files are present in all SREM data sets:

EAICD_SREM.PDF:	This document.
SREMDC_FINAL_REPORT_V1.0.PDF:	SREM and REM Data Consolidation Final Report, July 2017 (Sandberg et al 2017 [4]).
PROTON_CALIB_TEST_REPORT.PDF:	Ground proton calibration test report for Rosetta
RESPONSE_WO_SAT_ELECTRONS.ASC:	ASCII file containing the response function without saturated electrons for SREM on Rosetta.
RESPONSE_WO_SAT_PROTONS.ASC:	ASCII file containing the response function without saturated protons for SREM on Rosetta.
ROSETTA_SREM_LOCATION.PDF:	Diagrams showing the location of SREM onboard the Rosetta spacecraft.

3.3.1.5 Extras Directory

The EXTRAS directory contains the original CDF files used for the conversion to PDS format. These files can also be downloaded from the PSI web site:

http://srem.web.psi.ch/cgibin/srem_data_sec.cgi

Note that the processing level definition for the CDF files is different to that used for the PDS compliant data, as mentioned in Section 2.4. SREM CDF Level 0 files correspond to the PDS (CODMAC) Level 2 data, while the SREM CDF Level 2 files correspond to the PDS (CODMAC) Level 5 data.

The correspondence between the CDF files and their CODMAC PDS data equivalents is easily tracked through the filenames as summarized below.

For CODMAC L2 data:
EXTRAS/SREMROSETTA_PACC_[DATE].CDF corresponds to *DATA/SREM_L2_[DATE].TAB*

For CODMAC L5 data:
EXTRAS/SREMROSETTA_PACC_[DATE]_L2.CDF corresponds to *DATA/SREM_L5_[DATE].TAB*

3.3.1.6 Data Directory

The DATA directory contains the actual SREM DATA products. All SREM data are provided in the form of plain ASCII tables (*.TAB files), with separate detached PDS labels (*.LBL files). The data have been converted to a PDS compliant format from the original CDF files (which are provided in the EXTRAS directory). The structure and content of the data products are described further in Section 4.

4 Detailed Interface Specifications

4.1 Data Product Design

As required by the PDS3 Standards, each data product (*.TAB) is accompanied by its own detached label (*.LBL) that contains the metadata describing the product and its structure.

4.1.1 Raw data (CODMAC Level 2, CDF Level 0)

The raw SREM data are provided as count rates (1/sec) measured at the middle of the time interval (centered), and have standard deviations included in the same data file. The LBL file contains metadata with information about the instrument, mission, any important instrument parameters or measurement parameters, start and stop time of the measurement, and the pointer to the TAB object. Within each data label there is also a table showing a list of the SREM energy channels and the corresponding energy ranges of detected electrons and protons, extracted from Sandberg et al, 2012 [3].

An example of a Level 2 label file is provided in Appendix A1.

The data file is in the form of an ASCII table (*.TAB) and contains:

- A single row with text headers defining each column in the subsequent data table.
- A SREM_COUNT_RATES_TABLE structured as follows:

Time	***Count rates (1/sec)***	***Standard deviations***
A time tag per measurement, at the center of the observation.	Count rate values for each of the 15 SREM energy bins.	15 standard deviation values corresponding to the count rates in the previous table. Standard deviation has been calculated as square root of the count rate.

IMPORTANT NOTES:

- As noted above, the time values provided mark the center time of the observation.
- The PDS keyword MISSING_CONSTANT, which is provided in every LBL file, indicates the value (-1.0E31) used in the data table if no measurement data is available. Any zero values in the data tables are real measurements.

4.1.2 Derived data (CODMAC Level 5, CDF Level 2)

The derived data are given as protons and electrons energy values and associated quality values, with measurements provided at the middle of the time interval (centered). The LBL file contains metadata with information about the instrument, mission, any important instrument parameters or measurement parameters, start and stop time of the measurement, and the pointer to the TAB object.

An example of a Level 5 label file is provided in Appendix A2.

The data file is in the form of an ASCII table (*.TAB) and contains:

- A first row with text headers defining each column in the subsequent data table. For each column containing the proton and electron energy measurements, the central energy value of the channel in MeV is used.
- A SREM_DATA_TABLE structured as follows:

Time	***Proton Energy Values***	***Proton Energy Quality***	***Electron Energy Values***	***Electron Energy Quality***
A time tag per measurement, at the center of the observation	13 proton energy values in MeV	An indication of the quality of the proton measurements	10 electron energy values in MeV	An indication of the quality of the electron measurements

IMPORTANT NOTES:

- As noted above, the time values provided mark the center time of the observation.
- The PDS keyword MISSING_CONSTANT, which is provided in every LBL file, indicates the value (-1.0E31) used in the data table if no measurement data is available. Any zero values in the data tables are real measurements.
- The quality values used are described in Section 2.4.1 and also provided directly within the DESCRIPTION field of each LBL file.
- As noted in Section 2.2, the electron data set was cross-calibrated with RBSP/MAGEIS spin averaged data. It has been noted that as a result of this process the highest energy flux levels derived were not reliable. Thus, it was decided to reject entirely these products in the production of the Level 2 CDF data. As such, only 10 energy channels are made available in the CDF Level 2 (COMDAC Level 5) dataset, #1-#10 in the table on page 48 of SREMDC Final Report (Sandberg et al, 2017) [4].

5 Appendices

5.1 Appendix A1: Level 2 label sample

Below is an example of a PDS CODMAC Level 2 label file for SREM.

```
PDS_VERSION_ID               = "PDS3"
RECORD_TYPE                  = FIXED_LENGTH
RECORD_BYTES                 = 475
FILE_RECORDS                 = 530

^SREM_COUNT_RATES_TABLE        = ("SREM_L2_20160902.TAB", 2)

DATA_SET_ID                  = "RO-X-SREM-2-EXT3-MTP034-V1.0"
PRODUCT_ID                   = "SREM_L2_20160902"
PRODUCT_CREATION_TIME        = 2020-06-16T08:18:36.416
PROCESSING_LEVEL_ID          = "2"
DATA_PROVIDER_NAME           = {"HUGH EVANS","PETTERI NIEMINEN",
                                "IOANNIS DAGLIS"}

INSTRUMENT_HOST_ID           = "RO"
INSTRUMENT_HOST_NAME         = "ROSETTA-ORBITER"
INSTRUMENT_ID                = "SREM"
INSTRUMENT_NAME              = "STANDARD RADIATION ENVIRONMENT MONITOR"
MISSION_ID                   = "ROSETTA"
MISSION_NAME                 = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME           = "ROSETTA EXTENSION 3"
START_TIME                   = 2016-09-02T00:00:14.234
STOP_TIME                    = 2016-09-02T23:59:42.762
SPACECRAFT_CLOCK_START_COUNT = "1/0431395125.32489"
SPACECRAFT_CLOCK_STOP_COUNT  = "1/0431481493.65248"
TARGET_NAME                  = "67P/CHURYUMOV-GERASIMENKO 1 (1969 R1)"

DESCRIPTION                  = "SREM count rates measured at the middle of
                                the time interval (centered). Standard
                                deviations (using square root of the count
                                rates) are also provided. Note that these
                                PDS CODMAC Level 2 products are equivalent
                                to the original CDF Level 0 products."

SOFTWARE_VERSION_ID          = "SPARTA 1.3-SNAPSHOT"

OBJECT                       = SREM_COUNT_RATES_TABLE
  ROWS                       = 529
  COLUMNS                    = 3
  ROW_BYTES                  = 475
  INTERCHANGE_FORMAT         = ASCII
  DESCRIPTION                = "SREM count rates measured at the middle of
                                the time interval (centered)."
  OBJECT                     = COLUMN
    NAME                     = "TIME"
    DATA_TYPE                = TIME
    START_BYTE               = 1
    BYTES                    = 23
    FORMAT                   = "A23"
    UNIT                     = "ms"
    DESCRIPTION              = "Time records of the SREM measurements,
                                corresponding to the middle of the
                                observation interval (centered)"
  END_OBJECT                 = COLUMN
  OBJECT                     = COLUMN
    NAME                     = "COUNT RATES"
    DATA_TYPE                = ASCII_REAL
    START_BYTE               = 25
    BYTES                    = 224
    ITEMS                    = 15
```

```
    ITEM_BYTES               = 14
    ITEM_OFFSET              = 15
    FORMAT                   = "E14.7"
    UNIT                     = "1/sec"
    MISSING_CONSTANT         = -1.0E31
    DESCRIPTION              = "Count rate values for each of the 15
                                SREM energy bins. The following table
                                provides a list of the 15 SREM channels
                                and the corresponding energy ranges of
                                detected protons and electrons.

                          |======|==========|==========|==========|============|
                          | SREM | Proton Energy [Mev] | Electron Energy [MeV] |
                          |------|----------|----------|----------|------------|
                          | Bin  | Emin     | Emax     | Emin     | Emax       |
                          |======|==========|==========|==========|============|
                          | TC1  | 27       | infinity | 2.00     | infinity   |
                          |------|----------|----------|----------|------------|
                          | S12  | 26       | infinity | 2.08     | infinity   |
                          |------|----------|----------|----------|------------|
                          | S13  | 27       | infinity | 2.23     | infinity   |
                          |------|----------|----------|----------|------------|
                          | S14  | 24       | 542      | 3.20     | infinity   |
                          |------|----------|----------|----------|------------|
                          | S15  | 23       | 434      | 8.18     | infinity   |
                          |======|==========|==========|==========|============|
                          | TC2  | 49       | infinity | 2.80     | infinity   |
                          |------|----------|----------|----------|------------|
                          | S25  | 48       | 270      | -        | -          |
                          |------|----------|----------|----------|------------|
                          | C1   | 43       | 86       | -        | -          |
                          |------|----------|----------|----------|------------|
                          | C2   | 52       | 278      | -        | -          |
                          |------|----------|----------|----------|------------|
                          | C3   | 76       | 450      | -        | -          |
                          |------|----------|----------|----------|------------|
                          | C4   | 164      | infinity | 8.10     | infinity   |
                          |======|==========|==========|==========|============|
                          | TC3  | 12       | infinity | 0.80     | infinity   |
                          |------|----------|----------|----------|------------|
                          | S32  | 12       | infinity | 0.75     | infinity   |
                          |------|----------|----------|----------|------------|
                          | S33  | 12       | infinity | 1.05     | infinity   |
                          |------|----------|----------|----------|------------|
                          | S34  | 12       | infinity | 2.08     | infinity   |
                          |======|==========|==========|==========|============|

                          Table Extracted from Sandberg et al, Unfolding and
                          Validation of SREM Fluxes, IEEE Transactions on Nuclear
                          Science 59 (2012) 1105, DOI:  10.1109/TNS.2012.2187216"
  END_OBJECT                 = COLUMN
  OBJECT                     = COLUMN
    NAME                     = "DEVIATION_COUNT RATES"
    DATA_TYPE                = ASCII_REAL
    START_BYTE               = 250
    BYTES                    = 224
    ITEMS                    = 15
    ITEM_BYTES               = 14
    ITEM_OFFSET              = 15
    FORMAT                   = "E14.7"
    MISSING_CONSTANT         = -1.0E31
  END_OBJECT                 = COLUMN
END_OBJECT                   = SREM_COUNT_RATES_TABLE
END
```

5.2 Appendix A2: Level 5 Label Sample

Below is an example of a PDS CODMAC Level 5 label file for SREM.

```
PDS_VERSION_ID                = "PDS3"
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 606
FILE_RECORDS                  = 529

^SREM_DATA_TABLE              = ("SREM_L5_20160903.TAB",2)

DATA_SET_ID                   = "RO-X-SREM-5-EXT3-MTP034-V1.0"
PRODUCT_ID                    = "SREM_L5_20160903"
PRODUCT_CREATION_TIME         = 2020-06-16T14:22:38.569
PROCESSING_LEVEL_ID           = "5"
DATA_PROVIDER_NAME            = {"HUGH EVANS","PETTERI NIEMINEN",
                                 "IOANNIS DAGLIS"}

INSTRUMENT_HOST_ID            = "RO"
INSTRUMENT_HOST_NAME          = "ROSETTA-ORBITER"
INSTRUMENT_ID                 = "SREM"
INSTRUMENT_NAME               = "STANDARD RADIATION ENVIRONMENT MONITOR"
MISSION_ID                    = "ROSETTA"
MISSION_NAME                  = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME            = "ROSETTA EXTENSION 3"
START_TIME                    = 2016-09-03T00:02:23.262
STOP_TIME                     = 2016-09-03T23:58:42.790
SPACECRAFT_CLOCK_START_COUNT = "1/0431481654.32476"
SPACECRAFT_CLOCK_STOP_COUNT  = "1/0431567833.65239"
TARGET_NAME                   = "67P/CHURYUMOV-GERASIMENKO 1 (1969 R1)"

DESCRIPTION                   = "
                  SREM omni directional fluxes at particular effective
                  energies based on calibration of the CDF L0 (PDS L2)
                  data, as described in the SREMDC_Final_Report.PDF.
                  Energy channel units are MeV."

SOFTWARE_VERSION_ID           = "SPARTA 1.3-SNAPSHOT"

OBJECT                        = SREM_DATA_TABLE
  ROWS                        = 528
  COLUMNS                     = 5
  ROW_BYTES                   = 606
  INTERCHANGE_FORMAT          = ASCII
  DESCRIPTION                 = "
                 SREM omni directional fluxes at particular effective
                 energies based on calibration of the CDF L0 (PDS L2) data,
                 as described in the SREMDC_Final_Report.PDF. Note that the
                 final Rosetta archive only contains the L0 and L2 data
                 described within that document (which are equivalent to the
                 PDS CODMAC level 2 and 5 data respectively).
                 Measurements are provided at the middle of the interval
                 (centered).

                 FPDO:         Flux Proton Differential Omnidirectional
                 FEDO:         Flux Electron Differential Omnidirectional
                 FQDO_Quality: Flux Q Differential Omnidirectional_Quality
                               where (Q=P,E)
                 Where:
                 ---------------|-------------------------|------------------
                 FQDO_Quality   | Comment                 | Recommendation
                 ---------------|-------------------------|------------------
                 FQDO_Quality=0 | SREM count-rate data    | Use FQDO
                                | determined by charged   |
                                | particle fluxes Q.      |
                 ---------------|-------------------------|------------------
                 FQDO_Quality=1 | SREM count-rate data    | Use FQDO with
```

```
                | most likely determined   | some caution
                | by charged particle      |
                | fluxes Q.                |
----------------|--------------------------|------------------
FQDO_Quality=2  | SREM count-rate          | Do not use FQDO
                | contaminated by          |
                | various sources. None    |
                | criterion is satisfied   |
----------------|--------------------------|------------------
FQDO_Quality=3  | SREM count-rate          | Do not use FQDO
                | dominated by fluxes of   |
                | non-Q particles.         |
----------------|--------------------------|------------------
FQDO_Quality=5  | SREM count-rate data     | Do not use FQDO
                | dominated by background  |
                | (cosmic, detector        |
                | electronics)             |
----------------|--------------------------|------------------

(Table above is taken from SREMDC_Final_Report_V1.0.PDF,
available in the DOCUMENT directory)"
```

```
OBJECT                    = COLUMN
  NAME                    = "TIME"
  DATA_TYPE               = TIME
  START_BYTE              = 1
  BYTES                   = 23
  FORMAT                  = "A23"
  UNIT                    = "ms"
  DESCRIPTION             = "Time records of the SREM measurements,
                             corresponding to the middle of the
                             observation interval (centered)"
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  NAME                    = "FPDO"
  DATA_TYPE               = ASCII_REAL
  START_BYTE              = 34
  BYTES                   = 315
  ITEMS                   = 13
  ITEM_BYTES              = 15
  ITEM_OFFSET             = 25
  FORMAT                  = "E15.4"
  UNIT                    = "1/(cm**2 str s MeV)"
  MISSING_CONSTANT        = -1.0E31
  DESCRIPTION             = "SREM proton energy measurements per energy
                             channel (MeV). The 13 channels are centered
                             at the following energies (in MeV):
                             14.50, 17.63, 20.69, 24.62, 29.31, 36.44,
                             44.33, 56.33, 73.16, 89.00, 116.40, 146.88
                             and 194.00."
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  NAME                    = "FPDO_QUALITY"
  DATA_TYPE               = ASCII_REAL
  START_BYTE              = 359
  BYTES                   = 3
  FORMAT                  = "F3.1"
  DESCRIPTION             = "The quality of the data increases as the
                             FPDO_Quality index decrease. FPDO fluxes
                             with FPDO_Quality index above/equal to 2
                             should not be considered."
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
```

```
    NAME                        = "FEDO"
    DATA_TYPE                   = ASCII_REAL
    START_BYTE                  = 370
    BYTES                       = 222
    ITEMS                       = 10
    ITEM_BYTES                  = 15
    ITEM_OFFSET                 = 23
    FORMAT                      = "E15.4"
    UNIT                        = "1/(cm**2 str s MeV)"
    MISSING_CONSTANT            = -1.0E31
    DESCRIPTION                 = "SREM electron energy measurements per energy
                                   channel (MeV). The 10 channels are centered
                                   at the following energies (in MeV):
                                   0.65, 0.73, 0.83, 0.93, 1.06, 1.19, 1.35,
                                   1.52, 1.71, and 1.93."
  END_OBJECT                    = COLUMN

  OBJECT                        = COLUMN
    NAME                        = "FEDO_QUALITY"
    DATA_TYPE                   = ASCII_REAL
    START_BYTE                  = 602
    BYTES                       = 3
    FORMAT                      = "F3.1"
    DESCRIPTION                 = "The quality of the data increases as the
                                   FEDO_Quality index decrease. FEDO fluxes
                                   with FEDO_Quality index above/equal to 2
                                   should not be considered."
  END_OBJECT                    = COLUMN
END_OBJECT                      = SREM_DATA_TABLE

END
```