CATALOG/PERSONNEL.CAT is missing from all data sets.

Use of NH templates for creating files such as AAREADME.TXT and DATASET.CAT is efficient for NH; but it leaves users interested in only one instrument/data set with a lot of chaff that may obscure what is important for that instrument/data set.

With the exception of INTRODOC.PDF, the writing is generally very good. Even when there are mistakes or ambiguities, it is usually easy to understand what the intent was (or might have been). Problems are not usually the result of poor grammar or sentence construction.

Per PDS *Standards Reference* v3.8 sections 8.2 and 10.1.2, directory and file names must be constructed from upper cases letter, digits, and the underscore (periods may be used in file names). Most values of keywords are also restricted to upper case. Observance of these requirements is spotty in the NH/REX data sets.

**LAUNCH L2 Data Set**

**AAREADME.TXT:**

Page numbers below are from AAREADME.TXT after the file was loaded into Microsoft Word.

The first 2-1/2 pages have been pasted directly from INTRODOC.PDF. There is no transition (the Table of Contents at the bottom of page 3 doesn’t even show the quick-start guide). The INTRODOC.PDF material needs to be integrated with the remainder of AAREADME.TXT.

At the beginning of AAREADME.TXT there should be a clear statement of what the REX instrument is and what it was doing during the post-launch period (ditto the other missions phases and their respective data sets).

Page 4: “The start and stop times of data products in this data set overlap the \*NOMINAL\* start and stop times, i.e. 2006-01-19T00:00:00 and 2007-01-01T00:00:00 UTC” I don’t find any data products that are earlier that 2006-04-01 or any later than 2006-06-30.

Page 5: The NH Jupiter Encounter Trajectory Table is Required Reading for the Launch L2 data set. Why?

Page 5: Why is DATASET.CAT not considered Required Reading?

Page 7: “NASA archive procedures do not guarantee that archive documentation will remain with archive data as archives are migrated to newer media.” I am puzzled by this statement; as I understand it, I don’t agree with it.

Page 8: “All reasonable efforts have been made to include the documents multiple formats in the document portion of this archive. Where that was not possible due to copyright restrictions …” This text is garbled. Aside from that, why do copyright restrictions control the range of formats?

Page 8: “This volume has been formatted according to the PDS Standards Reference 3.x version current as of this data set's publication date.” This should be fixed at 3.8. The current version of the Standards Reference is 1.2.0.”

Page 9: The File Formats section mentions only files encoded as text. This is a place where the INTRODOC.PDF material (which is largely about the binary formats) should be merged with the AAREADME.TXT material.

Pages 12-17: Although useful, I’m not convinced the ‘overview’ of PDS label structure belongs in AAREADME.TXT. Ordinarily I would expect this level of detail to be in a SIS.

**CATALOG/CATINFO.TXT**

“For the latest versions of these files, please consult the Planetary Data System Data Set Catalog available on the PDS web site at: <http://pds.jpl.nasa.gov/>” It is not clear what one should do after pasting the URL into a browser address window; there’s nothing at the destination page that mentions catalogs. An additional suggestion to type “data set catalog” into the “Search for” window might be helpful.

“N.B. The following Target catalog object were \*NOT\* delivered with this data set but are listed here for completeness.” Why is this more nearly “complete” if the target catalog file was *not* included? In any case, I’ve never heard of a CALIBRATION.CAT file before.

**CATALOG/DATASET.CAT**

See edited version of file (dataset.cat.docx) for detailed comments.

CONFIDENCE\_LEVEL\_NOTE should be moved to the end of the file.

A Data Coverage and Quality summary should be added under CONFIDENCE\_LEVEL\_NOTE.

Essay about difficulty in determining “target” should be removed. The targets observed by REX are very limited, and there should be no problem recalling what they were.

Boilerplate language about future versions is not helpful and should be removed.

**CATALOG/NH.CAT**

A handful of minor typos, but a very nice MISSION.CAT overall. I sometimes complain about the heavy emphasis on instruments and instrument activities in MISSION.CAT files; that’s not a problem here. The focus is very clearly on ‘mission’.

**CATALOG/NHSC.CAT**

INSTRUMENT\_HOST\_TYPE = “SPACECRAFT” isn’t entirely correct because REX has an active “ground element”. This can sometimes be mitigated by including a short, separate OBJECT = INSTRUMENT\_HOST describing the DSN. I’m going to let this go because REX data collection really is on the spacecraft.

“The New Horizons team selected instruments that not only directly measure NASA-provided items of interest ...” Should this be “The New Horizons team selected instruments that not only directly measure NASA-specified quantities of interest …”?

There are a couple problems with the second paragraph in the REX section. Bending also depends on a third parameter – the closest approach distance of the raypath. In occultation mode, REX records samples of the radio signal, not the detected radio waves; detection is done on the ground as part of sample processing much later. Suggested rewrite: ”As the spacecraft passes behind Pluto, the atmosphere bends the radio waves by an amount that depends on the average molecular weight of the gas in the atmosphere, the atmospheric temperature, and the closest approach distance of the raypath at each instant of time. REX samples the received radio signal and sends the data back to Earth for analysis.”

Communications paragraph: Suggest rewording to “… the spacecraft through the NASA Deep Space Network. The DSN consists of …

In a typical instrument host CATALOG file there are usually sections on Propulsion and the spacecraft Coordinate System, including specification of the x-y-z axes. Propulsion can be discussed briefly here and then ignored. The spacecraft coordinate system is *mentioned* in NH\_REX\_V100\_TI.TXT; I have not found a definition of the coordinate system, however.

**CATALOG/REF.CAT**

TYLERETAL2007 and TYLERETAL2008 are the same.

**CATALOG/REX.CAT**

See edited version (rex.cat.docx) for detailed comments. Note that the ASCII drawing of the Flight Element has been edited.

LABEL\_REVISION\_NOTE (and text elsewhere) stresses that only the data from one-way uplink observations and thermal emission measurements are included in the archive. But Investigation 4 (Individual Body Masses) is listed as a REX activity, and a statement later says that “ … these ranging data will NOT normally be archived with the REX data” leaving the situation ambiguous. In fact, what is in the archive is a subject for DATASET.CAT, not REX.CAT; but what is included does need to be clarified.

The statement “Other spacecraft hardware used by REX, but not strictly part of REX, include the telecommunications system electronics and the 2.1 meter high gain antenna …” may be true from a management point of view; but the capabilities and limitations of that other hardware are very important to the successful execution of the REX investigations and cannot be ignored.

The description of the DSN is taken largely from the INST.CAT file in CO-SS-RSS-1-SCC2-V1.0; but that material emphasizes the downlink capabilities and performance of the DSN and is now 1-2 decades old (for example, RMDCT ceased production of the ATDF in about 2001). The edited file attempts to streamline the file for NH, but comments have been included where replacements for some of the old information are not known. Someone more familiar with which parts of the DSN are important to REX could probably shorten the file much more.

REX.CAT contains results from a limited set of Post-Launch Phase tests and calibrations. Other calibrations were conducted (see SEQ\_REX\_LAUNCH.{LBL,TAB} for the list). There is no CALIB directory in any of these archives, and there appears to be no calibration report in the DOCUMENT directories; where can these other results be found?

Compression of REX data was suspended on 5 March 2007. Does this mean that archival data from 2006 and early 2007 are compressed? If so, what is the effect of C&DH errors on the data that reached the archive? This question should be answered in DATASET.CAT and/or ERRATA.TXT.

**DOCUMENT/DOCINFO.TXT**

The following are not listed in DOCINFO.TXT but appear in the DOCUMENT directory:

 AAREADME\_BU.TXT

 NH\_MISSION\_TRAJECTORY.{LBL,TAB}

 REX\_AGCGAIN{A,B}.{LBL,CSV}

SOC\_INST\_REX.PDF is listed in DOCINFO.TXT, but SOC\_INST\_ICD\_REX.PDF appears. No label file for either appears in DOCINFO.TXT.

The first three blocks of text after “NOTE = ‘DOCUMENT directory contents” will not add anything to the final archive and can be omitted.

**DOCUMENT/NH\_FOV.{LBL,PNG}**

More description of the figure would be helpful; I don’t understand all the information being displayed. On the other hand, this document doesn’t appear to be relevant to REX, so it could be omitted.

**DOCUMENT/NH\_MET2UTC.{LBL,TAB}**

Column 1 should have DATA\_TYPE = ASCII\_INTEGER and UNIT = “SECOND”

Should users interpolate linearly between the points listed?

Typo: “into to” should be “into the”

**DOCUMENT/NH\_MISSION\_TRAJECTORY.{LBL,TAB}**

DESCRIPTION in the label says the table contains “the velocity of a hypothetical dust particle, at the same position as the spacecraft ...” but later “The heliocentric Z-component of the dust particle ... is assumed to be zero.” How can it be both?

**DOCUMENT/NH\_REX\_V100.TXT**

(I think we agreed that this document would be removed)

After all of the disclaimers (“only provided as a convenience”, “file will not be updated”, “(file) should therefore not be used … in any scientific investigation”, “only the FOV description is relevant”, …) why include this file at all?

DESCRIPTION is not a valid keyword for OBJECT = TEXT.

CAVEATS paragraphs 1 and 2 are copied almost verbatim from DESCRIPTION paragraphs 2 and 3. Another reason for dropping DESCRIPTION (put everything into NOTE instead).

REX Description is not relevant to an IK and contains several inaccuracies and misleading statements. (1) REX shares the spacecraft radio system (including the USO and HGA) and the Earth-based DSN transmitting system; it is more than “just a small printed circuit board”. (2) There is no description of the Alice instrument. (3) Bending depends on molecular weight, atmospheric temperature, and height of the raypath closest approach. (4) Characterization of REX measurements as being taken “following the flyby” are technically correct if the “flyby” is limited to the time of closest approach. However, many will think of the “flyby” as extending over hours or days. (5) Frequency stability should be expressed as “delta-f/f” rather than “f/f”.

**DOCUMENT/REX\_AGCGAIN{A,B}.LBL**

Line 18: DOCUMENT\_NAME is not an allowed keyword in a SPREADSHEET object definition; however, NAME is allowed.

Lines 45-46: “The data have been extracted from ground-based, simulated command logs of NH flight activities.” These are not real data? Add a short statement that telemetry does not have sufficient time resolution to quantify gain changes.

Field 3: DESCRIPTION doesn’t make sense; what documentation is provided with this document? What are the units for values in this field?

Lines 56-57: Field 6 should be calendar format.

Line 59: Field 5 should be DOY format.

Field 4, DESCRIPTION: Typo “inforation”

Fields 5 and 6, DESCRIPTION: I would omit “insignificant”.

Field 6, DESCRIPTION: Typo “calendate”

**DOCUMENT/REX\_SSR.LBL**

According to the first page of the PDF, PUBLICATION\_DATE should be 2007-01-08.

**DOCUMENT/SAMPLES**

All of the examples of unpacked binary files are from a different data set.

**DOCUMENT/SEQ\_REX\_LAUNCH:**

Haven’t seen one of these before; it’s a good addition. Label seems to describe table well. A couple minor issues.

Column 3: PDS date/time data type would be better than character; omit double quotes.

Statement that “end time of each (sequence) is the start time of the next sequence” may be accurate when applied to REX alone; but it seems dubious for the mission as a whole (and mission sequences, which are presumably the only ones that matter).

**DOCUMENT/SOC\_INST\_ICD\_REX.{LBL,PDF}**

12.1, end of second paragraph: “ … which radiate an uplink signal that is detected and measured by REX on-board the spacecraft.” There is no “detection” of the uplink signal on the spacecraft; detection takes place during processing of the samples on the ground.

12.1, experiment 3, first line: “… designed to measure the hemispherically averaged surface emission …” During the radiometry observations, Pluto will subtend an angle of about 14° at the spacecraft. Since HGA beamwidth is 0.6°, the target will be easily resolved. There is certainly spatial averaging as the beam sweeps across the night side, but the measurements are not “hemispherically” averaged.

12.1, 3rd line from end of page 105 (and elsewhere): “ … one-way uplink tracking signal …” should be replaced by “ … one-way uplink signal …” The uplink signal is unmodulated; there is no “tracking”. See also second line on page 106.

12.1, page 106, end of first paragraph: Extend the final sentence as follows: “ … the lunar occultation data are described by labels and by DOCUMENT/TNFSIS.LBL.”

12.2, first line: “After receiving the command to start taking data …” CATALOG/REX.CAT states that sampling is “constant” from the time REX is powered up, implying that there is no command to start taking data. These two descriptions need to be reconciled. Likewise, the statement at the beginning of the next paragraph, implying that there is a command to stop taking data, needs to be revised.

12.2, lines 1-2: “ … start taking data on the next 1 PPS strobe … the REX FPGA starts generating a continuous stream of data …” CATALOG/REX/CAT states that data collection and storage are asynchronous with respect to the 1PPS markers. As a result, there can be partial frames at both the beginning and end of a data taking event, which lead to C&DH errors if compression is attempted. These two descriptions need to be reconciled. See additional comments in the REX.CAT section about what the data stream looks like in these error situations. How does the SOC telemetry to raw data processing respond?

12.2.1.1.2, first line: “In bit positions 6, 5 & 4 …” Need to define the bit numbering convention somewhere in the document. From Table 12-3, I infer that the convention is b7, b6, … b1, b0 right to left; so a reference to the *PDS Standards Reference* v3.8 (Appendix C) could be used. Users should not have to infer.

12.2.1.1.2, line 2: “ … all other bits are normally zero.” What does an abnormal setting indicate?

Table 12-4: Since the information in the rightmost column is never used (all descriptions in the text use 1-based counting), I recommend that it be omitted. Its presence introduces some confusion since the text assumption of 1-based counting is never stated explicitly. On the other hand, there *should be* such a statement, since the PDS default is 0-based counting (*PDS Standards Reference* v3.8, Appendix C).

12.2.1.2.3, line 3: Typo “tage”

Table 12-6: Typo, missing bracket in row 4: I[K] = IQ(ROF[15+KMOD\*4+Oj], …

12.2.4: The transition from 12.2.1 to 12.2.4 is very abrupt (12.2.2 and 12.2.3 are too short to matter). Familiarity with FITS is assumed, acronyms appear without definition (e.g., PHDU and TFORM), ApIDs appear without explanation, and proofing is incomplete (e.g., typos, awkward first sentence in 12.2.4, overstruck text not removed, meaning of “calibration” not explained). Text could use some technical editing.

Table 12-7, row 2: According to page 157, EDU numbering starts at 1; but the table shows 0 (presumably the PDU, but not explained).

12.2.4.1, first line: Typo “The the”

12.2.4.2.1, line 2: Typo “n”

12.2.4.2.2, line 3: Typo “stoed”

12.2.4.2.2: Question — Although Radiometry and Time Tag values are stored as signed 64-bit and 32-bit integers, respectively, both should always be positive, yes? If not, why not?

12.2.4.2.3: Referring to FITS headers and PDS labels is not very helpful to the reader, who has no clue what is contained in these extensions. It also means that validation depends entirely on what is in the data products themselves and not on some external specification against which the products can be compared. To compound the problem, the PDS label refers users back to *this* document.

12.2.5, line 4: Typo “tointerpret”

12.2.6: This section seems to start and end nowhere. Please flesh out.

12.3.1.1: CATALOG/REX.CAT says (in the paragraph titled Sample Calibration) “the calibration takes the raw 16-bit samples and scales the values to standard voltages using a calibrated reference voltage and an Automatic Gain Control (AGC) setting.” Where is the AGC setting in the expression for mV?

12.3.1.1: If I understand the I/Q calibration correctly, original measurements with ±0.1221 mv precision are being ‘calibrated’ to values with ±1.0 mv precision. How is losing a factor of 8 in measurement precision an improvement?

12.3.1.2 (dBm): How was the expression for dBm obtained?

12.3.1.2 (AGC): “A state table of commanded, per-Side AGC settings as a function of time …” Is there a reason this is called AGC rather than simply “gain control”. A conventional automatic gain control (AGC) operates using feedback; there doesn’t seem to be anything here that is “automatic”.

12.3.1.3: Question — the expression for Ts is sufficient for differential time measurements over short time intervals. Is there any calibration that can recover absolute time over intervals longer than the rollover time (approx 20 days) or that relates REX Time Tags to MET? To measure the chords of Pluto and Charon, absolute time will be required so that the observing geometry can be reconstructed. It would be helpful if you gave users an outline of the procedure to derive absolute time from time tags, MET2UTC, etc.

12.3.2: “in the EDU 2 BINTABLE, the radiometry values represent rates instead of accumulating values” is not correct. The radiometry values are *derived from* accumulator rates, but they are measurements of power. The current wording confuses how the measurements are obtained with what they represent.

12.3.2.3: A comment — Calibration of the I/Q pairs simply ensures that the filter output is scaled to the ADC input. There is still a lot of additional calibration needed to get from the ADC back to the antenna (physical units independent of the instrument). The EDU 2 Radiometry values appear to include this additional calibration.

12.3.2.3 (Time Tag): as noted above (12.3.1.3) the units are “seconds on the spacecraft relative to the most recent counter rollover”. It would is misleading to imply that the scientific units of Time Tag are seconds in any global sense (independent of the instrument).

12.3.2.4.1 and 12.3.2.4.2: I don’t understand why these sections are included.

12.3.6: “Calibration Files Needed: None, all calibration factors are in the source code and listed above” does not appear to be correct. According to 12.3.1.2, “A state table of commanded, per-Side AGC settings … is stored in the Uplink DataBase … and … the pipeline retrieves the appropriate values based on the observation time of the FITS file …”

**ERRATA.TXT:**

The file is not mentioned and does not exist. This is OK; but it presupposes that no errors (or comments worthy of being recorded in ERRATA.TXT) will ever exist. One such comment might be about the SSR papers that appear only in ‘submitted’ form.

**INDEX/INDEX.{LBL,TAB}**

Date/time values in INDEX.TAB should not be enclosed in quotes and should be specified as DATA\_TYPE = TIME for consistency with other PDS data sets. However, I see that the *PDS Standards Reference* v3.8 shows time columns in CHARACTER format while the on-line dictionary says STOP\_TIME (at least) should be given in TIME format. So PDS may have a problem here.

**VOLDESC.CAT**

The volume, volume set, and volume series hierarchy is puzzling. This is for NH and PDS to answer. VOLUME\_SERIES\_NAME = NEW HORIZONS” makes sense. But why drop all the way down to VOLUME\_SET\_NAME = “NEW HORIZONS REX POST\_LAUNCH CHECKOUT RAW DATA”? Wouldn’t something like VOLUME\_SET\_NAME = “REX” or “REX LAUNCH CHECKOUT” make more sense? The fact that VOLUME\_NAME is a truncated version of VOLUME\_SET\_NAME is even more puzzling (“DATA” has been dropped) and suggests this hasn’t been thought all the way through.

Everything in DESCRIPTION starting with “(Note 1)” should be removed. The fact that the volume includes mission, spacecraft, instrument, and data set documentation and that it contains index tables is not unusual. The catalog files are listed at the end of VOLDESC.CAT. Note 1 does not apply to this REX data set (see similar comment regarding page 4 in AAREADME.TXT comments).

**Comments on Selected Data Files**

Calibrated RAD values for rex\_0007754260\_0x7b0\_eng\_1.fit (raw = 492342479) are -114.08 dBm. Applying the calibration formula in soc\_inst\_icd\_rex.pdf I get -114.19 dBm. This isn’t a large difference, but I’m surprised there is any difference at all. Please confirm that the formula given in the ICD is the one being executed during the calibration step.

-114 dBm is 4 dB smaller than the -110 dBm of a 150K receiver with 4.5 MHz bandwidth.

Some early FITS files are outside the time range of REX\_AGCGAIN\*.

Time tags seem to be reinitialized to 0 for each new data run. Sometimes there are multiple 0 time tags; sometimes the next time tag is 1, sometimes it is 10. I will provide a list of examples.

I don’t see how to recover absolute time from the time tags.