NRAO Array Operations Center Requirements on VSOP Calibration Data
Version 1.0

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Contents

1 Introduction

1.1 Purpose

This document contains a specification of the VLBA requirements on calibration data related to the VSOP mission.[1] It is intended to apply to data both from ground radio telescopes and from the space radio telescope; the latter consists of the combination of the VSOP spacecraft and a tracking station. It includes the requirements of the VLBA correlator as well as the AIPS software, which are combined here as global requirements of the NRAO Array Operations Center (AOC). Three types of calibration data are included: (1) Gain (amplitude) calibration data; (2) Phase calibration data; and (3) Flag information. Each type of data is dealt with in separate sections.

In general, data from ground radio telescopes should be complete and can be supplied directly to the AOC by an agreed-upon method. Data from tracking stations alone cannot, in general, be complete, since the calibration files must also contain information regarding the spacecraft (*e.g.,* oscillator settings and conversions from measured voltage to flux units). Therefore, the calibration files for the orbiting VLBI satellite must be supplied from the VSOP Science Operations Group (VSOG).

This specification assumes the normal VSOP international observing mode throughout, having two 16-MHz channels with 2-bit sampling. Other possible VSOP modes cannot be processed by the VLBA correlator or observed using VLBA Data Acquisition Systems, so they are not covered here.

1.2 Provision of Calibration Data to AOC and to Investigators

The three types of calibration data are to be supplied to the AOC as ASCII-format tables. Currently, these tables are stored on /aspen2/vlbiobs in the subdirectory for the month of observation (*e.g.,* nov95), and made available to the investigator who analyzes a particular experiment. That user runs the appropriate AIPS tasks to generate the binary FITS tables which are attached to the correlator output data and carried throughout subsequent processing. The description of these tasks may be found in Chapter 9 of the AIPS Cookbook [1], and is not repeated in detail here; references to this chapter below correspond to the 15-Jul-95 version of Chapter 9.

The required information to construct the ASCII calibration tables may be available from stations running Version 9 of the Mark IV Field System, in the FS9 logs. If so, it can be extracted using de-logging programs **LOG2ANC** and **LOG2ANT** written by Fredrik Rantakyrö. These programs are available from Bologna on the computer astbo1.bo.cnr.it, in the ANCAL/ANTAB directory under EVN user or in the VLBINFO user[2]

It is ultimately intended that the function of generating the FITS binary tables and attaching them to the correlator output will be part of the processing by NRAO at the VLBA correlator. However, this change will not change the specification for the file format that must be supplied to the AOC, but will merely change the method of processing the calibration files *after* they are received at the AOC. The timescale for this development is not currently known.

[1] In general, this specification also will be applicable to the RadioAstron mission, with appropriate substitution of RadioAstron observing modes.

[2] Note that access may require a password–I cannot get to these directories using anonymous ftp (- jsu -)

2 Amplitude (Gain) Calibration

2.1 Purpose

The ASCII amplitude calibration table (hereafter AMPCAL table) can contain a variety of different information used for amplitude calibration. These entries may include baseline-dependent gain factors, gain curve entries, system temperature entries, and antenna temperature entries. Normally, an individual station will supply no baseline-dependent factors, so those factors are not included in the present specification. It is also expected that system temperature entries will be made rather than antenna temperature entries for all space VLBI observations.

Ultimately, the desired quantity for amplitude calibration is the system temperature *in Janksy* as a function of time during the observation. This will normally be derived through a combination of system temperature measurements in Kelvin and antenna gain measurements (in K/Jy), but may be supplied in more than one way, as described below. Further details may be found in the AIPS help file for **ANTAB**, written by Athol Kemball, from which the information in the following subsection has been extracted.

2.2 Specification of ASCII Table

The table specification here is a subset of the input file for the AIPS task **ANTAB**. It can contain as many as five different groups of entries, although not all groups are required. Two groups are required, either the TSYS or TANT Group and the Gain Group. A Control Group is usually included as well. The Baseline Group is generally not included for an AMPCAL table from a single antenna, and is not described below.

All types of lines in the AMPCAL Table have a free-format structure, consisting of fields of contiguous characters separated by one or more blanks. An entry may extend over multiple lines, but has a maximum of 200 characters. Character strings must be enclosed between single quote (') delimiters. Arithmetic expressions within parentheses will be evaluated, with allowed operators (+,-,*,/) [*e.g.,* DPFU = (0.25*1.9)]. Any characters following "!" are treated as comments. Each entry must be terminated by a backslash (/), and there must be at least one blank space before the entry is terminated. The AMPCAL table should cover a subset (at least) of the time covered by a correlator log input file (see [2] and [3]).

2.2.1 Control Group

If it appears, the Control Group must be the first group in the text file, and specifies the default input format for the TSYS or TANT entries which follow. It uses the two keywords **INDEX** and **INDEX2** to specify the mapping of the entries in the TSYS and TANT Groups and is used for all such groups that do not have **INDEX** entries specified. For VSOP, which has only two IFs (or a maximum of 4 IFs for ground telescopes observing in dual polarization), we expect that **INDEX2** will not normally be used.

Header Line

`CONTROL INDEX = <assignments> INDEX2 = <assignments> /`

`<assignments>`	This entry gives the default assignments of the individual entries that will follow in the TSYS or TANT Group. The assignments consist of one or more character strings, each limited to no more than 8 characters. There must be a separate string for each column in the TSYS or TANT Groups. If these assignments are given in each TSYS or TANT Group, or if the assignments in this groups exactly correspond to the individual IFs in the final (u,v data set, no Control Group is necessary.
Comment:	Examples of the interpretation of the **INDEX** assignments are given in the description of the TSYS and TANT Groups.

End Delimiter Line

`/`

`/`	This character is required to terminate the group.

VSOP Example

`CONTROL INDEX = 'L1', 'L2' /`

2.2.2 Gain Group

This group is used to specify antenna-based gain curves, and is required. Several formats are allowed. Each has three required keywords, <station>, <sensitivity>, and <type>, which suffice to define gain curves that are flat with respect to zenith angle. Additional keywords may be supplied to indicate the functional dependences of the gain curves. Note that there is currently no definition of gain curves with respect to Sun angle, which may ultimately be necessary for the VSOP spacecraft. Some keywords permitted by **ANTAB**, represented by <options> below, are not discussed here, since they are unlikely to be necessary for VSOP. The reader is referred to the **ANTAB** help file for a complete definition of all possible options.

Data Line

`GAIN <station> <sensitivity> <type> <table> <poly> <freq> <options> /`

`<station>` The station entry should be the two-character antenna code that will be used in the AN table. Examples are **MK** for Mauna Kea, or **TZ** for VSOP when tracked by the Tidbinbilla station. For a complete list of codes, including the different codes corresponding to the possible combinations of (VSOP + tracking station), see [4].

`<sensitivity>` Allowed entries for this parameter are **DPFU = X** or **DPFU = X,Y**. The first case is for a single polarization (*e.g.,* the VSOP spacecraft), or for the case when the value is independent of polarization. The second case is for dual circular polarizations (RCP followed by LCP), which may be used for ground telescopes in some polarization experiments. The values for sensitivity (*i.e.,* **X** and **Y**) must be given in K/Jy at zenith. For VSOP, the **DPFU** often will be defined to be **1**, with the system temperature in Jy given in the TSYS group.

`<type>` This keyword specifies the type of gain curve that will be described. Allowed values are **EQUAT** (function of Hour Angle in degrees), **ALTAZ** (function of Zenith Angle in degrees), **ELEV** (function of elevation in degrees), and **GCNRAO** (2-dimensional spherical harmonic expansion in Hour Angle and ($90° - \delta$), as used for the 140-ft telescope in Green Bank). The **GCNRAO** keyword is not described here; see the **ANTAB** help file for a definition.

`<table>` For **EQUAT**, **ALTAZ**, or **ELEV** gain curves, a detailed gain curve may be provided as a lookup table. If the optional keyword **TABLE** is included, the gain values must be tabulated immediately after the Gain Group in a two-column format. The first column is the gain ordinate (of type corresponding to the gain curve type; *e.g.,* Zenith Angle for **ALTAZ**) and the second column is the relative gain value.

`<poly>` For **EQUAT**, **ALTAZ**, or **ELEV**, the detailed gain curve also may be provided as a polynomial in the gain ordinate, if the optional keyword **POLY** is included. (Obviously, it is forbidden to include *both* **POLY** and **TABLE.** The coefficients of the polynomial fit, in increasing order, are included in the header line rather than in a separate data entry as is done for the lookup table.

`<freq>` The optional keyword **FREQ** may be used to indicate the frequency range of a given gain entry. This will be useful if a particular telescope is changing frequencies, so that there is more than one frequency included in a given file. **FREQ = X,Y** is the format of the entry for the frequency range from **X** to **Y** (in **MEGAHERTZ**, not gigahertz).

End Delimiter Line

```
/
```

/	This character is required to terminate the group.

Example of gain lookup table

```
GAIN SC DPFU=0.1 ALTAZ TABLE /
   10.4  0.98
   20.5  0.97
   50.7  0.67
   78.9  0.44 /
```

Example of polynomial gain curve

```
GAIN SC DPFU=0.1 ALTAZ POLY = 1.0, -0.002, -0.00001 /
```

Comment: In the above example, the relative gain is $(1.0 - 0.002 \times \mathrm{ZA} - 0.00001 \times \mathrm{ZA}^2)$, where ZA is the zenith angle in degrees.

Example of flat gain curve

```
GAIN SC DPFU=0.1 ALTAZ POLY = 1.0 /
```

Comment: In the above example, the POLY keyword is not required, since the default of a flat gain curve would be assumed without it.

Example for all frequencies between 4 and 6 GHz

```
GAIN SC DPFU=0.1 ALTAZ FREQ = 4000,6000 /
```

Example for VSOP

```
GAIN GZ DPFU=1.0 EQUAT POLY=1.0 FREQ=4000,6000 /
```

2.2.3 TSYS or TANT Group

These groups are used to identify a station with a series of one or more data lines, reporting system temperature or antenna temperature values that follow. The station name is required, and several additional keywords are permitted. The TSYS and TANT Groups have identical structures except for the group keyword. Negative values for temperatures, or values of 999.9, are assumed to be unknown. The temperature values correspond to the IFs assigned using the **INDEX** and **INDEX2** keywords that may be defined either in the Control Group or in the TSYS or TANT group.

Group Header

`TSYS <FT> <TIMEOFF> <SRC/SYS> <RANGE> <INDEX> <INDEX2> /`

`TSYS`	The **TSYS** entry defines this table as a **TSYS** table.
`<FT>`	This keyword provides a factor by which all values should be multiplied, and defaults to 1.0. Note that it is possible to use this keyword to eliminate the Gain Group if a flat gain curve is desired. Then an entry of **FT=X**, where **X = 1/DPFU**, would suffice to convert measured system temperatures from Kelvins to Janskys.
`<TIMEOFF>`	This keyword can be used to add a time offset (in seconds) to all the entries in the data line described below. It defaults to 0.0.
`<SRC/SYS>`	If this keyword is included, the data entries are actually in units of antenna temperature divided by system temperature, as is done for the VLA.
`<RANGE>`	This keyword supplies a range for permitted values, in the format **RANGE=X,Y**.
`<INDEX>`	This keyword identifies the IFs to be associated with each column in the data line, as described previously. It is not necessary if it has been defined in the Control Group, and the definition is unchanged.
`<INDEX2>`	This keyword supplements **INDEX**. For VSOP observations, we expect that it will not be necessary. As with **INDEX**, it also may be defined in the Control Group.

End Delimiter Line

`/`

`/`	This character is required to terminate the group.

Example of TSYS Group

```
TSYS GO FT = 1.02 RANGE = 20.0, 200.0 INDEX = 'L1', 'L2' /
```

Comment: The above example specifies that system temperatures are being reported for the Goldstone 70-m telescope. All values are to be multiplied by 1.02 to derive the correct system temperature, and only values between 20 and 200 K should be considered real. Each data line will contain two system temperature entries, the first for LCP IF1, and the second for LCP IF2.

Interpretation of INDEX Entries

(a) 'R3'	Assign the column to IF 3, RCP polarization.
(b) 'L1'	Assign the column to IF 1, LCP polarization.
(c) 'R4|L4'	Assign the column to both IF 4 RCP and IF 4 LCP.
(d) 'R1:8'	Assign the column to all IF's 1–8 RCP.
(e) 'L10:16:2'	Assign the column to all even IF's 10–16 LCP.
(f) 'X'	Do not assign the column to any IF or polarization.
(g) ' '	As for (f).

Data Line

`<ddd> <hh:mm.mm> <T1> <T2> ... <Tn>`

`<ddd>`	This indicates the day of year for the system temperature entry.
`<hh:mm.mm>`	This indicates the time of day (UTC) for the entry. Note that this time is traditionally given in hours, minutes, and fractions of a minute, rather than hours, minutes, and seconds. However, entries in the form <hh:mm:ss> also are allowed.
`<Tn>`	The system temperature entries follow, corresponding to the IFs defined by **INDEX** or **INDEX2**. There should be one entry for each character string in the **INDEX** definition. Depending on **INDEX**, a single entry may correspond to more than one IF.

End Delimiter Line

/

/	This character is required to terminate the group, after (possibly) many temperature entries.

Example of system temperature measurements for VSOP

```
TSYS TZ FT = 1.0 INDEX = 'L1', 'L2' /
   184 20:30.43 12200.1 12100.0
   184 20:32.57 12301.4 12275.7
   184 20:34.27 12347.6 12327.6
   184 20:36.10 12295.7 12300.8 /
```

Comment: The above example gives the measured system temperatures in Janskys, as will be done for the VSOP spacecraft. This requires that the **DPFU** in the Gain Group be equal to **1.0**. If a Gain Group with the true value of **DPFU**, such as **DPFU=0.009**, is also included, this would result in the conversion from Kelvin to Jansky erroneously being applied again.

Example of system temperature measurements for Goldstone 70-m

```
TSYS GO FT = 1.0 INDEX = 'L1', 'L2' /
   184 20:30.43 22.1 21.0
   184 20:32.57 23.4 22.7
   184 20:34.27 23.6 22.6
   184 20:36.10 22.7 23.8 /
```

2.3 AIPS Processing of Amplitude Calibration Data

The AIPS tasks **ANTAB** and **APCAL** are the recommended path for attaching the ASCII gain calibration table to the correlator output data, as specified in Section 9.4.2.2 of the AIPS Cookbook. An amplitude calibration (SN) table is generated from these tasks; that table is actually applied to the data using the task **CLCAL**. At some time in the future, this step will be taken at the correlator.

Note that additional gain corrections also must be generated by the user in the current system. The correlator *b*-factor is typically applied to the data when running **FITLD** to put the data on disk, using the parameter DIGICOR (see Section 9.1.2 of the AIPS Cookbook). In addition, there is a correction for a digital sampler bias caused by the necessarily imperfect settings of the voltage threshold levels of the samplers. This correction is normally important only for 2-bit-sampled data. It is applied using **ACCOR**, and is described in Section 9.4.1 of the AIPS Cookbook.

3 Phase Calibration Data

3.1 Contents

This section contains a specification for the phase-calibration table, hereafter referred to as a PCAL table, that must be supplied for data processed by the VLBA correlator. The PCAL table contains the information required for calibration of the phase within observing channels and the calibration of the relative phase between observing channels. This information consists of the frequency, amplitude, and phase that are measured for the phase-calibration tones.

3.2 Tone Extraction

For the space radio telescope, the PCAL tones are injected aboard the spacecraft and extracted by the tracking station. At a ground radio telescope, the tones are injected into (or as near as possible to) the feeds at the front end, then extracted by the VLBA formatter at the back end.

3.3 Format Specification

The table format given here is defined as a simplified subset of the input file for AIPS task **PCLOD**, so that it may be loaded in AIPS using that task. The table consists of two "groups". Each in turn has a unique header line identifying the group and the "station," followed by one or more data lines, and terminated by a unique end delimiter line. (The station may be either a ground radio telescope or the Space VLBI spacecraft.) All types of line have a free-format structure, consisting of fields of contiguous characters separated by one or more blanks. Character strings in the data lines of these tables must be enclosed between single quote (') delimiters.

A separate table, containing both a Frequency Group and a Pulse-Cal Group, must be present for each contiguous block of time in which a distinct configuration of tones is used. The PCAL table should cover a subset (at least) of the time covered by a correlator log input file (see [2] and [3]).

3.3.1 Frequency Group

The Frequency group specifies the frequency structure of the Pulse-Cal group to follow. It requires a number of parameters which duplicate information included in some of the log entries described in [2] and [3]. Much of this information is used only to match the tabulated PCAL values in the AIPS data set with the proper baseband channel ("IF" in AIPS parlance) and tone frequency.

Header Line

`FREQUENCY <station> /`

`<station>`	The identification code of the station whose observations are being logged. The normal two-character station codes should be used. For the VSOP spacecraft, there are five such codes defined, one for each tracking station (see [4]).
`/`	This character is required to terminate the header line.

Data Line

`<tone> <channel> <net-sideband> <polarization> <tone-rf-freq> <bits> <chnl-lo> <bw>`

<tone> — Alphanumeric string, effectively defined by the remaining parameters on the line, which is then referenced in the data lines of the Pulse-Cal group. For VSOP, this string shall be defined as 'm_n', where 'm' is the channel number and 'n' is the frequency of the tone relative to the channel local-oscillator frequency. For example, the tone extracted at 7 MHz in channel 1 would be designated as '1_7', while the tone extracted at 13 MHz in channel 2 would be designated as '2_13'. (Note that this definition is redundant with the definitions of channel number and frequencies given below, but is included for simplicity of understanding and for consistency with **PCLOD**.) For a ground radio telescope, tones normally will be identified as 'Tnn', where 'nn' is a number from 1 through 16.

<channel> — Consecutive channel number (*i.e.*, 1, 2, ...) in the same channel sequence used in the gain calibration table(s): RCP, then LCP, whichever are present, for each channel frequency, in order of increasing frequency. For VSOP, the channels should be numbered as in the SRT Schedule File (see [5]), and there will be two channels for the normal international observing mode.

<net-sideband> — Sign of the overall frequency conversion for signals in this baseband channel. 'U' indicates that increasing frequency in the channel corresponds to increasing RF frequency; 'L' indicates a net inversion. For VSOP, the entry will normally be 'U'.

<polarization> — State of polarization of the RF signal processed through this channel, either 'LCP' or 'RCP'. Similar to the <polarization> parameter of the BBC log entry. For VSOP, the entry should be 'LCP'. Ground radio telescopes may use both polarizations in some experiments.

<tone-rf-freq> — RF frequency, in MHz, of the phase cal tone defined by this line. This information must be supplied by the VSOG for the spacecraft.

<bits> — Number of bits per sample, either 1 or 2. In the common international observing mode for VSOP (two 16-MHz channels with 2-bit sampling), the value of <bits> will be '2'. It is possible that the value '1' may be used by ground radio telescopes during some polarization experiments.

<chnl-lo> — Total ("signed sum") local oscillator frequency, in MHz, of all frequency conversions between RF and the final baseband signal sampled in this channel. Identical to the <frequency> parameter of the BBC log entry in [2] and [3]. This information must be supplied by the VSOG for the space radio telescope.

<bw> — Filter bandwidth, in kHz, applied to this channel. Similar to the <usb-bw> and <lsb-bw> parameters of the BBC log entry. *Note the difference in units,* however. This entry will normally be 16000 for both the spacecraft and the ground radio telescopes.

End Delimiter Line

/

/ — This character is required to terminate the group.

Example of data line for VSOP

'1_7' 1 'U' 'LCP' 4878.0 2 4871.0 16000.0 /

3.3.2 Pulse-Cal Group

The Pulse-Cal group tabulates the actual phase-cal measurements.

Header Line

PULSE-CAL <station> /

<station> — The identification code of the station whose observations are being logged. For the VSOP spacecraft, this is the two-character code for the appropriate tracking station. For a ground radio telescope, it is the normal two-character station code (*e.g.,* 'KP' for Kitt Peak).

/ — This character is required to terminate the header line.

Data Line

<ddd> <hh:mm:ss> <tone> <amplitude> <phase>

<ddd> — Day-of-year.

<hh:mm:ss> — Time of day, in UT.

Comment: — The *values* of the preceding two fields are identical to those in the **yydddhhmmssxx** in the main log entry specification (see [2] and [3]); only the format differs.

<tone> — Alphanumeric string, identically matching that defined in the appropriate line in the Frequency group.

<amplitude> — Measured amplitude, in arbitrary units, of the phase-cal tone.

<phase> — Measured phase, in degrees, of the phase-cal tone.

Comment: — One such line is tabulated for each measurement. Measurements occur either as individual events or periodically.

End Delimiter Line

`/`

`/`	This character is required to terminate the group.

3.4 AIPS Processing of PCAL Data

In the current system, the ASCII table supplied to the AOC may be attached to the correlator output data by running the AIPS task **PCLOD**, which will generate a PC table. The task **PCCOR** then can be used to generate the SN table, which is actually applied to the data by using **CLCAL** to modify the CL table. This is illustrated in the diagram below (see Section 9.5 of the AIPS Cookbook for further details):[3]

$$\text{ASCII PCAL Table} \xrightarrow{(\textbf{PCLOD})} \text{PC Table} \xrightarrow{(\textbf{PCCOR})} \text{SN Table} \xrightarrow{(\textbf{CLCAL})} \text{CL Table}$$

4 Flag Table Definition

4.1 Purpose

Flag information will be used by the principal investigator during the data-analysis process, and may also be used by correlators and mission engineers. It can be used to indicate periods when data are definitely bad, as well as periods of questionable data that the investigator may wish to scrutinize more closely.

4.2 Format Definition

The overall format is free format with a maximum of 200 characters per line. A "!" denotes that the rest of the line is a comment, and a "/" denotes the end of the entry. The "=" sign is optional and all expressions must be enclosed by single quotation marks "(' and ')". Elements of an array *must* be separated by commas. Only one entry should be made on a given line of the FLAG table although a given entry may span several lines. Note that the entries need not be in time order, since each TIMERANG is considered independently.

The adverbs which may be entered in this table are: SOURCES, SUBARRAY, TIMERANG, BCHAN, ECHAN, BIF, EIF, ANT_NAME, BAS_NAME, STOKES, REASON, OPCODE, FREQID, TIMEOFF, and DTIMRANG. Of these adverbs the only ones that are probably of use to VSOP are TIMERANG, BIF, EIF, ANT_NAME, REASON and DTIMRNG. However, complete definitions of all the adverbs are given below:

`SOURCES`	The name of the source ($\leq$ 8 characters) to be flagged. The default is to flag any source fulfilling the other parameters.
`SUBARRAY`	The subarray number to be flagged. The default is 0, corresponding to any subarray.

[3] Note that the application of PCAL tones to VLBA data has not yet been completely debugged, and may occasionally yield strange results.

`TIMERANGE`	The timerange (start and stop times) of the data to be flagged. Times are given in UTC. The format is ddd,hh,mm,ss, ddd,hh,mm,ss ("ddd" is the day of year, with allowed values from 1 through 366). The default is to flag all times.
`BCHAN`	The first spectral channel to be flagged. Default is channel 1.
`ECHAN`	The final spectral channel to be flagged. Default is the highest channel.
`BIF`	The first IF to be flagged. The default is IF 1.
`EIF`	The final IF to be flagged. The default is the highest IF.
`ANT_NAME`	The name of the antenna ($\leq$ 8 characters) to be flagged. Normally, this will be a standard two-character code. For definitions of codes for all participating ground radio telescopes, and for the various combinations of spacecraft and tracking station, see [4]. The default value is for all antennas to be flagged.
`BAS_NAME`	The name of the antenna ($\leq$ 8 characters) to be flagged when forming a baseline with the antenna designated by **ANT_NAME**. The same two-character codes are defined here as for **ANT_NAME**. The default is for all antennas forming baselines with **ANT_NAME** to be flagged.
`STOKES`	The Stokes type of the data to be flagged. This can be specified as one of the following: 'I', 'Q', 'U', 'V', 'IQU', 'IQUV', 'IV', 'RR', 'LL', 'LR', 'RL', 'HALF'(=RR,LL) and 'FULL' (=RR,LL,RL,LR). For the values 'LR' and 'RL', the first character corresponds to **ANT_NAME**, while the second corresponds to **BAS_NAME**. The default is for all Stokes types to be flagged.
`REASON`	A reason string ($\leq$ 24 characters) can accompany an entry in a flag table. For VSOP, this string should include the severity code and condition code, as defined in the most recent version of [6]. Therefore the total entry would be **REASON='nnn m xxxxxxxxxxxxxxxxxx'**, where '**nnn**' is the three-digit condition code (from 001 through 999), '**m**' is the one-digit severity code (**1** or **2**), and '**xxxxxxxxxxxxxxxxxx**' corresponds to the remaining 18 characters permitted to fill out the field. These 18 characters may be entered by hand or may be generic for a given condition code, relating to the definition given in [6]. For ground radio telescopes, the condition codes and severity codes are not used, so there is freedom to use all 24 characters to specify **REASON**.
`OPCODE`	**OPCODE** is used to either flag ('FLAG') or unflag ('UFLG') the data using the flag table. The default is 'FLAG'.
`FREQID`	If the **FREQID** is known in advance (not likely with the VLBA correlator) then it can be specified. The default is for every **FREQID** to be flagged.

`TIMEOFF` — If necessary a time offset (seconds) can be added to the times specified in the flag file. This can be used to convert from UTC to IAT, for instance. For data coming to the VLBA correlator this is not necessary. The default value of **TIMEOFF** is 0.0.

`DTIMRNG` — **DTIMRANG** (seconds) can be specified. It is the number of seconds by which **TIMERANG** can be widened (*i.e.,* subtract **DTIMRNG** from the start time given in **TIMERANG**, and add **DTIMRANG** to the stop time given in **TIMERANG**). The default is **DTIMRNG**=0.0.

End Delimiter Line

/

/ — This character is required to terminate each entry.

4.2.1 Example for VLBA Telescopes

opcode 'FLAG'
timeoff=0
dtimrng = 2.0 ! add and subtract 2 seconds to the start/stop times.
ant_name='SC' timerang=254,01,02,01,254,01,16,01 reason='source change' /
ant_name='NL' timerang=254,01,36,17,254,01,36,19 reason='recorder 2 not recording' /
ant_name='HN' timerang=254,12,01,41,254,12,01,43 reason='ch. 1 bbc synth. out-of-lock' /

4.2.2 Example for VSOP Spacecraft

opcode 'FLAG'
timeoff=0
dtimrng = 2.0 ! add and subtract 2 seconds to the start/stop times.
ant_name='TZ' timerang=254,01,02,01,254,01,16,01 reason='005 2 off source' /
ant_name='TZ' timerang=254,01,00,17,254,03,50,19 reason='014 1 poor orbit' /
ant_name='TZ' timerang=254,02,01,41,254,02,05,27 reason='109 1 poor recording' /
ant_name='TZ' timerang=254,03,00,01,254,03,03,01 bif=1 eif=1 reason='004 2 if 1 non-functional' /
bif=0 eif=0 ! back to default of both ifs
ant_name='TZ' timerang=254,03,30,01,254,03,35,01 reason='109 1 poor recording' /

4.3 AIPS Processing of Flag Data

The ASCII file specified above can be used as an input text file for the AIPS task **UVFLG** in order to make flag entries in the FG table. See Section 9.2 of the AIPS Cookbook. Also, note that AIPS currently has no capability of distinguishing among condition codes and severity codes, so data of any severity code for the spacecraft will be flagged according to the **OPCODE** entry. The capability for distinguishing among these codes is expected to be added before VSOP launch.

References

[1] NRAO. Aips cookbook, January 15, 1996.

[2] J. D. Romney. Alternative log input file to the vlba correlator for space vlbi observations, July 1, 1996.

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