Requirement Specifications For Level-2 Parameters Required Stored or Derived by The Near Earth Asteroid Rendezvous (NEAR) Gamma-Ray Spectrometer (GRS) Ground System

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Revision 1.5: May 25, 2001

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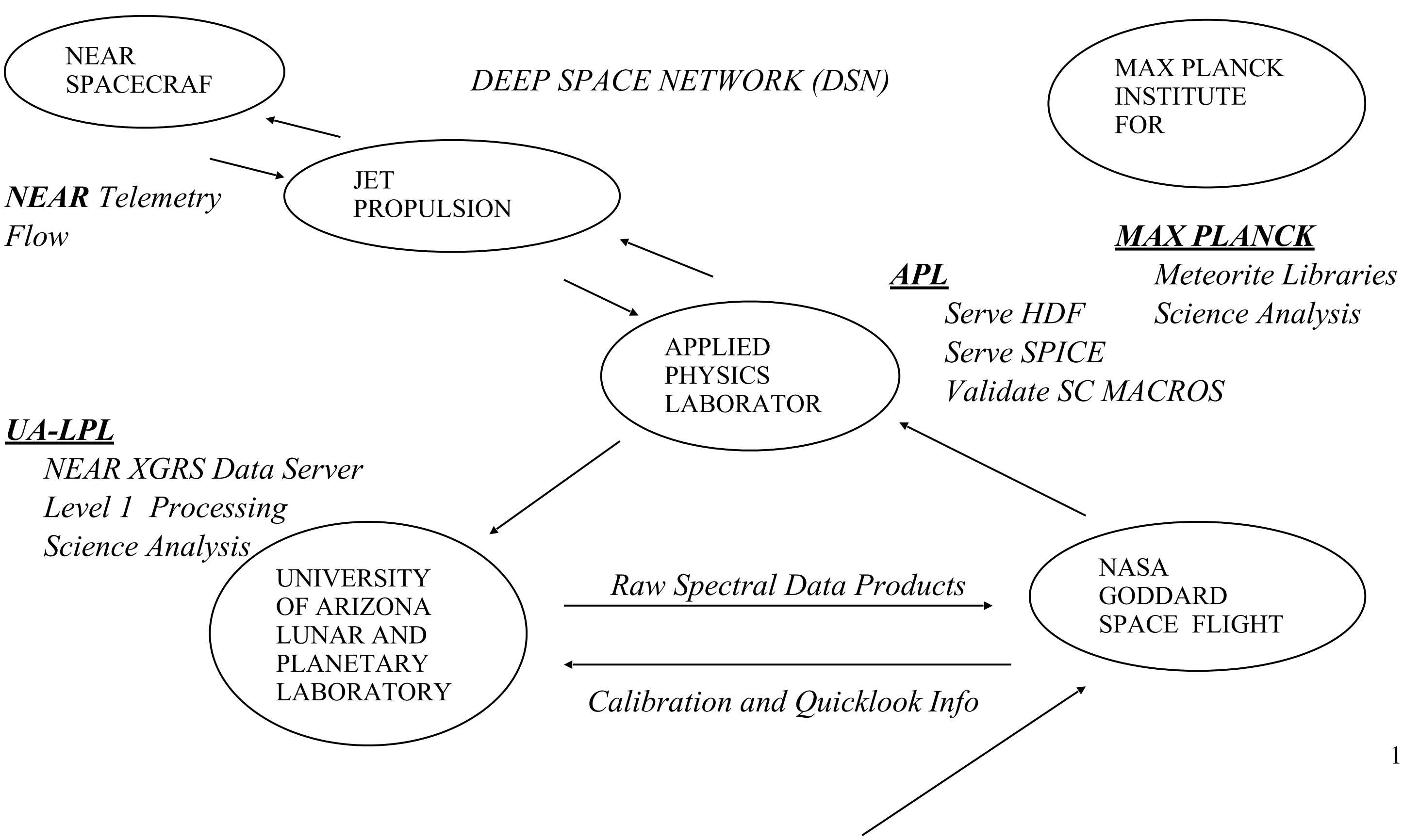
A. Introduction and Purpose

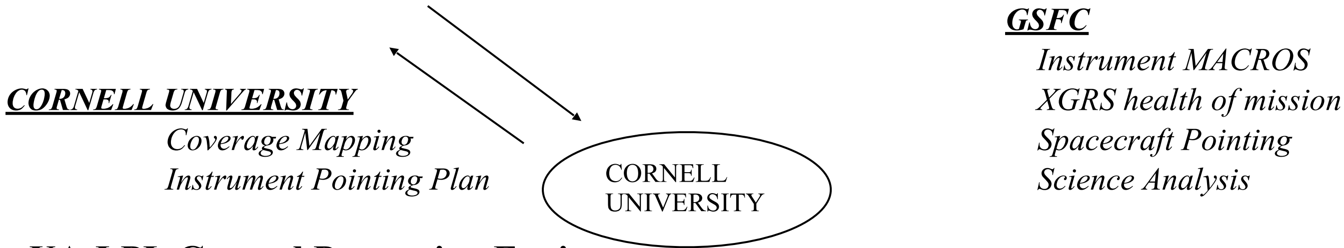
The following document will act as one part of a two part requirement specification for all Level-2 parameters required to be stored or derived by the Near Earth Asteroid Rendezvous (NEAR) X-ray and Gamma-Ray spectrometer ground system (XGRS). It will relate specifically to the Gamma-Ray spectrometer (GRS) requirements. The document will act as a primary common reference for both NEAR X-ray and Gamma-ray spectrometer (XGRS) science team members, systems development staff and future users of these data. The goal is to assist in the development and understanding of parameters defined as key to the NEAR XGRS Science objectives.

A primary data server residing at the University of Arizona, Lunar and Planetary Laboratory (UA-LPL) is designated with the function of deriving and serving mission critical parameters during cruise and encounter phases of the NEAR mission scheduled from February 1996 through February 2001. The intent of the first level product is to include all NEAR XGRS mission critical information needed for asteroid mapping, health of instrument, control, and science analysis systems.

Level -1 products will include integral spectral data in either raw or instrument calibrated format. Bundled with the spectral data products will be scientific housekeeping and engineering housekeeping data sampled by the XGRS instrumentation at the same time as the integral spectra onboard the spacecraft. This information is then telemetered through NASA's Deep Network (DSN) managed by the Jet Propulsion Laboratory in Pasadena, California, and NEAR related telemetry is forwarded to the Applied Physics Laboratory (APL). The Level-0 XGRS raw spectral and engineering data is then broken out of the NEAR mission specific data stream and stored online at the APL Science Data Center (SDC). These data are stored in the Hierarchical Data Format (HDF) file standard. These files are then picked up by the automated (UA-LPL) data processing ingest system.

Figure 1.0 **NEAR XGRS OPERATIONAL FLOW OF INFORMATION**

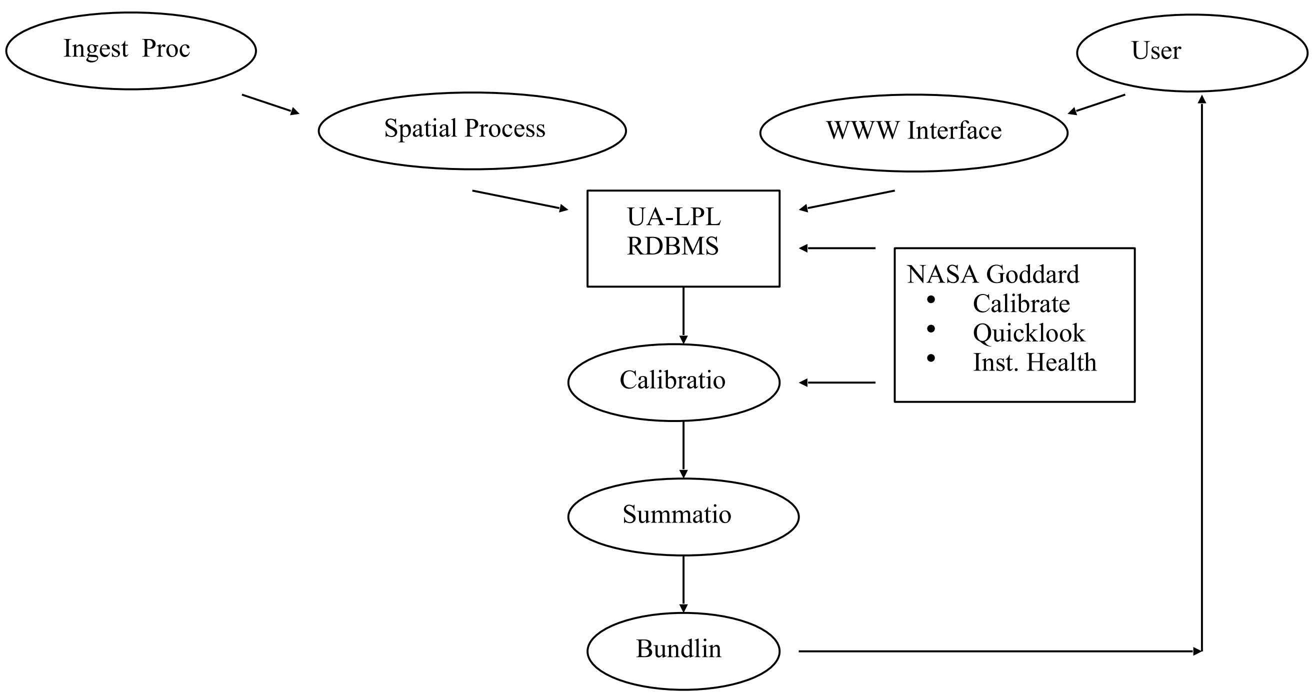




B. The UA-LPL Ground Processing Environment

The core of the UA-LPL data processing system (*Figure 2.0)* consists of a Sybase Relational Database (UA-RDBMS) that stores tables of NEAR XGRS raw spectral, science housekeeping, engineering housekeeping, derived engineering and spatial data products. XRS and GRS data processing systems are logically partitioned into separate processing environments on the UA-LPL server. A scientific data processing system has been developed around the UA-RDBMS to provide automated data ingest and science team interaction. Critical spatial and derived engineering data products are generated either at ingest time or query time. Core query time processing options include calibration and summation processing, compression and bundling of query results for return to the scientific user community over the Internet file transfer protocol (FTP).

Figure 2.0 **NEAR XGRS Ground Processing System at the UA-LPL**



UA-LPL database ingest systems automatically monitor the APL SDC for new and updated postings of XGRS data sets. These file sets are recovered via the file transfer protocol (FTP) to the UA-LPL data system. Raw spectral and engineering data products are then loaded into XGRS RDBMS tables with Mission Elapsed Time (MET) acting as the primary key for database access. Mission Elapsed Time is used with spacecraft ephemeris data SPICE system, APL Science Data Center and JPL/NASA Ancillary Information Facility) to derive spatial data products. Spacecraft navigation and pointing information is converted to SPICE data for the NEAR XGRS ground system and will be generated by participating scientists at APL/SDC. These products will then be maintained within the UA-RDBMS database system.

At Goddard Space Flight Center participating scientists will be charged with monitoring instrument health, calibration, and bad data flagging systems. These data are then forwarded to on-line ingest processes at the UA-RDBMS. The calibration system will be used to convert spectral data products to a common energy standard specified at query time. Calibration processing is optionally selected at query time. Bad flagging information is generated during instrument health checks as a function of identification of problem (MET) record sets. These (MET)'s are forwarded to the UA-LPL RDBMS for tagging.

Query time summation processes will be used to sum multiple integral record sets into a single output record. This record will include one spectrum per spectral classification and selected engineering products. Summed output will generally be specific to regional coverage and science analysis. The primary motivation for summation processing is to limit large volume network transfers incurred in this distributed processing environment. Results are then accumulated in the Xternal Data Representation (XDR) binary file standard (Sun Microsystems) then compressed, bundled and forwarded to the query initiator.

C. Description of NEAR GRS Data File Standards

In the NEAR GRS data processing system there are 3 data file standards possible for output. These different file standards reflect the different UA-LPL ground processes selectable at query time. Output format type is selected at query time through the UA-LPL WWW query interface. Integral raw GRS products will be used primarily in the calibration, instrument health and mission planning activities. Calibrated data will be used primarily in the science analysis activity. Formats for the three record standards are as follows.

Figure 3.0

FORMAT 1: GRS Integral Raw:

NAI	BGO	ANTICO	NAI1ESC	BGO1ESC	NAI2ESC	BGO2ESC	SCI HK	ENG HK	DER ENG	SPATIAL	SPARE

Description:

• NAI	1024 R*4	Sodium Iodide (NaI) raw spectrum	E.1., H.1.
• BGO	1024 R*4	Bismuth Germanate (BGO) raw spectrum	E.2., H.2.
• ANTICO	1024 R*4	AntiCoincidence raw spectrum	E.3., H.3.
• NAI1ESC	1024 R*4	NaI single escape raw spectrum	E.4., H.4.
• BGO1ESC	21 R*4	BGO single escape raw spectrum	E.5., H.5.
• NAI2ESC	1024 R*4	NaI double escape raw spectrum	E.6., H.6.
• BGO2ESC	21 R*4	BGO double escape raw spectrum	E.7., H.7
• SCI HK	31 I*4	Science Housekeeping sampled at integration time	E.8., H.8.
• ENG HK	152 R*4	Engineering Housekeeping sampled at integration time	E.9., H.9.
• DER ENG	17 R*4	Derived Engineering: only live times, galactic cosmic ray (GCR) flux, real gain zero** estimates and position of escape windows are valid ELSE Default value	E.10., H.10.
	5 I*4	1 longword for BadFlag and 4 longwords for QueryID	
• SPATIAL	1 I*4	Mission Elapsed Time (MET)	E.11., H.11.
	32 R*4	Spatial derivations, positional and pointing information	
• SPARE	25 R*4	To Be Decided (TBD)	

FORMAT 2: GRS Integral Calibrated:

NAI	BGO	ANTICO	NAI1ESC	BGO1ESC	NAI2ESC	BGO2ESC	SCI HK	ENG HK	DER ENG	SPATIAL	SPARE

Description:

•	NAI	1024 R*4	Sodium Iodide (NaI) calibrated spectrum	E.1., H.1.
•	BGO	1024 R*4	Bismuth Germanate (BGO) calibrated spectrum	E.2., H.2.
•	ANTICO	1024 R*4	AntiCoincidence calibrated spectrum	E.3., H.3.
•	NAI1ESC	1024 R*4	NaI single escape calibrated spectrum	E.4., H.4.
•	BGO1ESC	21 R*4	BGO single escape raw spectrum	E.5., H.5.
•	NAI2ESC	1024 R*4	NaI double escape calibrated spectrum	E.6., H.6.
•	BGO2ESC	21 R*4	BGO double escape raw spectrum	E.7., H.7.
•	SCI HK	31 I*4	Science Housekeeping sampled at integration time	E.8., H.8.
•	ENG HK	152 R*4	Engineering Housekeeping sampled at integration time	E.9., H.9.
•	DER ENG	17 R*4	Derived Engineering: All information is valid	E.10., H.10.
		5 I*4	1 longword for BadFlag and 4 longwords for QueryID	
•	SPATIAL	1 I*4	Mission Elapsed Time (MET)	E.11., H.11.
		32 R*4	Spatial derivations, positional and pointing information	
•	SPARE	25 R*4	To Be Decided (TBD)	

N

g(yyyy)(ddd)(hh)(mm)(ss).xdr Example: g1998234010159.xdr

NEAR GRS Summation Processing: (Format 3)

The NEAR XGRS data processing ground system is a distributed system that currently spans institutions in the United States and Europe. The summation processing system has been specified to render the possibly very large volumes of data (> Gbytes) returned from a single query down to a single summary record. The intention of summation processing will be to minimize the per query network data transfer size (bytes), by rendering a single summed spectrum from a relationally defined set. Correlated parameters will be bundled with this summed set. The summation ground processing step will be supported only on calibrated spectral data products.

FORMAT 3: GRS Summed:

NAI	BGO	ANTICO	NAI1ESC	BGO1ESC	NAI2ESC	BGO2ESC	ENG	SPATIAL

Description:

•	NAI	1024 R*4	Sodium Iodide (NaI) calibrated summed spectrum	F.1., I.1.
•	BGO	1024 R*4	Bismuth Germanate (BGO) calibrated summed spectrum	F.2., I.2.
•	ANTICO	1024 R*4	AntiCoincidence calibrated summed spectrum	F.3., I.3.
•	NAI1ESC	1024 R*4	NaI single escape calibrated summed spectrum	F.4., I.4.
•	BGO1ESC	21 R*4	BGO single escape raw summed spectrum	F.5., I.5.
•	NAI2ESC	1024 R*4	NaI double escape calibrated summed spectrum	F.6., I.6.
•	BGO2ESC	21 R*4	BGO double escape raw summed spectrum	F.7., I.7
•	ENG	13 R*4	Engineering and Derived Eng	F.8., I.8.
•	SPATIAL	13 R*4	Averaged Spatial parameters	F.9., I.9.

Nomenclature for GRS integral data products: FORMATS 3 (Summed)

h(yyyy)(ddd)(hh)(mm)(ss).xdr Example: h1998234010159.xdr

Summation processing will be query specific and all derived engineering tracking is done internal to each query process. All (XDR) file sets returned from the query will be run through the summation processing system. Integral calibrated spectra will be summed into single GRS specific output sets. Selected engineering and spatial parameters are also averaged into values representative of the parameter over the range of output (MET) records and specific to each query. Parameter rendering algorithms are listed in the numerical specifications (Section I).

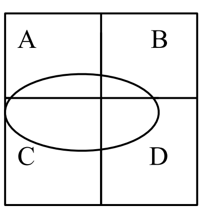
D. <u>Fractional Footprint Accounting</u>

The 433Eros asteroid is highly irregular in shape and deviates significantly from a spherical geometryA system was developed by NEAR XGRS staff to partition a virtual representation of the 433Eros asteroid into surface regions (bins) of roughly equal surface area, not based on spherical geometry. The bin system is internal to the UA-RDBMS ground processing system.

Individual spectral accumulations will most likely span multiple asteroid surface bins. This system will be used to discriminate and identify the applicability of integral footprints, based on their fractional coverage of the asteroid surface bin being queried. During UA-RDBMS ingest processing each integral footprint will be broken down into a set of records, one bin record for each bin subtended by the footprint. The current plan does not include the possibility of using the fractional footprint as a weighting function when automatically summing spectral data at query time. The fractional footprint accounting will be used as a query time threshold criteria for inclusion of the integral MET to summation processing.

Figure 3.0

⬭ FOOTPRINT ▭ BIN MET = Single Integration Mission Elapsed Time (MET)



Fractional Footprint Accounting (MET in Spatial Bins)

BIN A	BIN B	BIN C	BIN D
MET 0.2	**MET 0.1**	**MET 0.4**	**MET 0.3**

1 Integral Footprint at MET
Fraction totals = 1.0
4 total records generated Asteroid Spatial Bins A,B,C,D

A query time specification requesting all integrations (MET records) from Bin C with a fractional footprint area >= 0.4 would return the example integration and others whose fractional coverage are at least 0.4. Information related to the bin processing is included in sections G and J.

E. <u>Listings of Parameters for GRS level–2 Integral Records</u>

FORMATS 1,2 - List of RDBMS parameters for Single Raw and Calibrated GRS Level-2 record (output)

E.1. – E.7. NEAR GRS Spectra: 4 spectra*1024 channels*(Real*4), 1 spectrum*21 channels(Real*4), 1 spectrum*1024 channels*(Real*4), 1 spectrum*21 channels(Real*4)

0 – 1023 Sodium Iodide (NAI) spectrum
0 – 1023 Bismuth Germanate (BGO) spectrum
0 – 1023 Anti-Coincidence (ANTICO) spectrum
0 – 1023 Sodium Iodide (NAI1ESC) single escape spectrum
0 – 20 Bismuth Germanate (BGO1ESC) single escape spectrum
0 – 1023 Sodium Iodide (NAI2ESC) double escape spectrum
0 – 20 Bismuth Germanate (BGO2ESC) double escape spectrum

E.8. NEAR GRS Science Housekeeping (SCI HK) Parameters: 31*(Integer*4)

The following parameters are described in detail in the NEAR XGRS DPU Software Requirements Specification JHU/APL Version 7 7358-9002. Version 7 of the software was uploaded in May 1999.

1. MET
2. UTC
3. DQI * Data Quality Index
4. TIME_TAG
5. INTEGRATION_TIME
6. BGO_PROTON_FLARE_FLG
7. BGO_LEVEL_1_SAFE_FLG Version 7
8. BGO_LEVEL_2_SAFE_FLG
9. NAI_LEVEL_1_SAFE_FLG
10. NAI_LEVEL_2_SAFE_FLG
11. NAI_INT_OVERFLOW_FLG
12. BGO_INT_OVERFLOW_FLG
13. NAI_ANTICOINCID_OVFL_FLG
14. NAI_SINGLE_ESCP_OVFL_FLG
15. NAI_DOUBLE_ESCP_OVFL_FLG
16. BGO_SINGLE_ESCP_OVFL_FLG
17. BGO_DOUBLE_ESCP_OVFL_FLG
18. NAI_RAW_EVENT_RATE
19. BGO_RAW_EVENT_RATE
20. COINCIDENCE_COUNTER Version 7
21. COMMAND_COUNTER Version 7
22. PROBLEM_COUNTER Version 7
23. PROBLEM_CODE Version 7
24. NUM_NAI_ANTICOINCID_EVENTS
25. NUM_NAI_VALID_EVENTS
26. NUM_BGO_VALID_EVENTS
27. NAI_DC_OFFSET Downlinked value. No conversion to energy bins is performed. (no devision by 2 as required by NEAR XFRS DPU Software

	Requirements Specifications JHU/APL 7358-9002 Version 7)
28. BGO_DC_OFFSET	- " -
29. NAI_STAND_DEV	- " -
30. BGO_STAND_DEV	- " -
30 GRAY_DATA_QUALITY_BIT	Version 7

E.9. NEAR GRS Engineering Housekeeping (ENG HK) Parameters: 152*(REAL*4)

The following parameters are described in detail in the NEAR XGRS DPU Software Requirements Specification JHU/APL Version 7 7358-9002. Version 7 of the software was uploaded in May 1999. ENG_HK Parameters 0:137 are common to XRS and GRS. Parameters are sampled at XRS and GRS Resolutions.

1. DETECTOR_ELECTR_CURR
2. XRAY_PIN_DIODE_FET_BIAS
3. HVCE_TEMPERATURE
4. UNF_XRAY_HVPS_VOLT
5. MG_XRAY_HVPS_VOLT
6. AL_XRAY_HVPS_VOLT
7. XRAY_GAS_HVPS_VOLT
8. XRAY_PIN_HVPS_VOLT
9. NAI_HVPS_VOLT
10. BGO_HVPS_VOLT
11. DPU_DC_DC_TEMP
12. XGRS_DC_DC_TEMP
13. UNF_XRAY_HVPS_TEMP
14. MG_XRAY_HVPS_TEMP
15. AL_XRAY_HVPS_TEMP
16. XRAY_GAS_HVPS_TEMP
17. XRAY_PIN_HVPS_TEMP
18. NAI_HVPS_TEMP
19. BGO_HVPS_TEMP
20. TEC_CURRENT
21. NAI_HVPS_VOLT_CMD
22. BGO_HVPS_VOLT_CMD
23. UNF_HVPS_VOLT_CMD
24. MG_HVPS_VOLT_CMD
25. AL_HVPS_VOLT_CMD
26. HVPS_POWER_ON_OFF
27. XRAY_CALIB_HOME_FLG
28. XRAY_CALIB_MOTOR_ON_OFF
29. XRAY_CALIB_MOTOR_ENABLE
30. GAS_HVPS_VOLT_CMD

31. PIN_HVPS_VOLT_CMD
32. GAMMA_RAY_HEATER_CURR
33. spare0
34. XRAY_CALIB_MOTOR_DIR
35. XRAY_CALIB_MOTOR_CURR
36. XRAY_CALIB_MOTOR_GOAL
37. XRAY_CALIB_MOTOR_POS
38. XRAY_CALIB_MOTOR_FID_SENS
39. XRAY_CALIB_MOTOR_FID_BRIT
40. XRAY_MOTOR_IN_CALIB_POSITION
41. XRAY_MOTOR_IN_NORM_POSITION
42. ACTIVE_SOLAR_TOGGLE_MODE
43. XRAY_CALIB_MAX_STEPS
44. Spare
45. TEC_ENABLE
46. XRAY_CALIB_CUM_MOTOR_STPS
47. GRAY_BURST_THRESH_VAL
48. XRAY_SAFING_THRESH
49. XRAY_CALIB_MOTOR_DIAG
50. TEC_POWER_ON_OFF
51. TEC_MODE
52. TEC_COOL_HEAT_FLG
53. TEC_TEMPERATURE
54. TEC_COOL_MODE_TEMP_UP_LMT
55. TEC_COOL_MODE_TEMP_LOW_LMT
56. TEC_HEAT_MODE_TEMP_UP_LMT
57. TEC_HEAT_MODE_TEMP_LOW_LMT
58. GAMMA_RAY_TEMP_HYSTERESIS
59. GAMMA_RAY_HEAT_TEMP_LOW_LMT
60. FULL_GAMMA_RAY_SCIENCE_MODE
61. FULL_XRAY_SCIENCE_MODE
62. SUMM_GRAY_XRAY_SCIENCE_MODE
63. GRAY_BURST_SCI_REC_MODE
64. HVCE_TEMP_SET_POINT
65. CMDED_END_XRAY_INTEG_PER
66. CMDED_GAMMA_RAY_INTEG_PER
67. BGO_PROTON_FLARE_FLG
68. GAMMA_RAY_BIN_OVER_FLG_CMD
69. UNF_XRAY_BIN_OVER_FLG_CMD
70. MG_BIN_OVER_FLG_CMD
71. AL_BIN_OVER_FLG_CMD
72. ACT_BIN_OVER_FLG_CMD
73. NAI_BIN_OVERFLOW_FLG
74. BGO_BIN_OVERFLOW_FLG
75. NAI_ANTICOIN_OVERFLOW_FLG

76. NAI_SING_ESC_OVERFLOW_FLG	
77. NAI_DOUB_ESC_OVERFLOW_FLG	
78. BGO_SING_ESC_OVERFLOW_FLG	
79. BGO_DOUB_ESC_OVERFLOW_FLG	
80. UNF_XRAY_BIN_OVERFLOW_FLG	
81. MG_BIN_OVERFLOW_FLG	
82. AL_BIN_OVERFLOW_FLG	
83. ACT_BIN_OVERFLOW_FLG	
84. GAMMA_RAY_HEAT_ON_OFF	
85. GAMMA_RAY_HEAT_MODE	
86. BGO_LEVEL_1_SAFING_FLG	
87. BGO_LEVEL_2_SAFING_FLG	
88. Spare	
89. XRAY_INTEGR_TIME	
90. HVPS_ON_OFF	
91. PIN_SENSOR_MASK_FLG	
92. GAS_SENSOR_MASK_FLG	
93. AL_SENSOR_MASK_FLG	
94. MG_SENSOR_MASK_FLG	
95. UNF_SENSOR_MASK_FLG	
96. BGO_SENSOR_MASK_FLG	
97. NAI_SENSOR_MASK_FLG	
98. UNF_XRAY_RISE_TIME_THRESH	
99. MG_RISE_TIME_THRESH	
100. AL_RISE_TIME_THRESH	
101. GAS_RISE_TIME_THRESH	
102. UNF_RISE_TIME_VALID_THRESH	Downlinked value. No ground conversion specified in NEAR XFRS DPU Software Requirements Specifications JHU/APL 7358-9002 Version 7 is performed.
103. MG_RISE_TIME_VALID_THRESH	- " -
104. AL_RISE_TIME_VALID_THRESH	- " -
105. GAS_RISE_TIME_VALID_THRESH	- " -
106. GAMMA_RAY_INTEGR_TIME	
107. GAMMA_SING_ESC_WIND_CENTER	- " -
108. GAMMA_SING_ESC_WIND_WIDTH	
109. GAMMA_DOUB_ESC_WIND_CENTER	- " -
110. GAMMA_DOUB_ESC_WIND_WIDTH	
111. NAI_LOW_LEVEL_AMPL_THRESH	Ground conversion is: (downlinked value * 3.413 + 3.0), which is different from specified in NEAR XFRS DPU Software Requirements Specifications JHU/APL 7358-9002 Version 7
112. BGO_LOW_LEVEL_AMPL_THRESH	- " -
113. UNF_LOW_LEVEL_AMPL_THRESH	
114. MG_LOW_LEVEL_AMPL_THRESH	

115. AL_LOW_LEVEL_AMPL_THRESH
116. GAS_LOW_LEVEL_AMPL_THRESH
117. PIN_LOW_LEVEL_AMPL_THRESH
118. GAMMA_RAY_SENSOR_TEMP
119. NAI_LEVEL_1_SAFING_FLG
120. UNF_LEVEL_1_SAFING_FLG
121. MG_LEVEL_1_SAFING_FLG
122. AL_LEVEL_1_SAFING_FLG
123. GAS_LEVEL_1_SAFING_FLG
124. PIN_LEVEL_1_SAFING_FLG
125. NAI_LEVEL_2_SAFING_FLG
126. UNF_LEVEL_2_SAFING_FLG
127. MG_LEVEL_2_SAFING_FLG
128. AL_LEVEL_2_SAFING_FLG
129. GAS_LEVEL_2_SAFING_FLG
130. PIN_LEVEL_2_SAFING_FLG
131. XRAY_SENS_SAFING_REST_LEVEL
132. GAMMA_SENS_SAFING_REST_LEVEL
133. XRAY_SAFING_REST_MAX_RETRY
134. GAMMA_SAFING_REST_MAX_RETRY
135. GAMMA_HEATER_DUTY_CYCLE
136. GAMMA_SENS_SAFING_THRESH
137. HVPS_CURRENT
138. BGO_PROTON_FLARE_THRESH
139. VERSION_NUMBER Version 7
140. NAI_SPECTRUM_0 Version 7
141. HW_NAI_RAW Version 7
142. NAI_HIGH_ENERGY Version 7
143. BGO_SPECTRUM_0 Version 7
144. HW_BG Version 7
145. BGO_HIGH_ENERGY Version 7
146. NAI_ANTICOIN_SPECTRUM_0 Version 7
147. HW_NAI_ANTICOIN Version 7
148. NAI_ANTICOIN_HIGH_ENERGY Version 7
149. SINGLE_ESC_SPECTRUM_0 Version 7
150. SINGLE_ESC_HIGH_ENERGY Version 7
151. DOUBLE_ESC_SPECTRUM_0 Version 7
152. DOUBLE_ESC_HIGH_ENERGY Version 7

E.10. NEAR GRS Derived Engineering (DER ENG) Parameters: 17*(Real*4), 1*(Integer*4), 1*(4*Integer*4)

These parameters are not stored in the University of Arizona RDBMS but derived at a query time.

“Not valid” – is designated as = -1

0 GAIN_STANDARD_BGO
1 GAIN_STANDARD_NAI
2 ZERO_STANDARD_BGO
3 ZERO_STANDARD_NAI
4 REAL_GAIN_BGO
5 REAL_GAIN_NAI
6 REAL_ZERO_BGO
7 REAL_ZERO_NAI
8 LIVE_TIME_BGO
9 LIVE_TIME_NAI
10 BGO_VALID_CHANNEL_HI
11 NAI_VALID_CHANNEL_HI
12 BGO_VALID_CHANNEL_LOW
13 NAI_VALID_CHANNEL_LOW
14 Pos_ESC_1
15 Pos_ESC_2
16 GCR_FLUX
17 Bad_Flag
18 Query_ID

E.11. NEAR GRS Spatial (SPATIAL) Parameters: 1*(Integer*4), 32*(Real*4)

These parameters are derived in the University of Arizona at the ingest phase.
“Not valid” – is designated as = -1

1. MET	
2. PLATEID_BORESITE_INTERSECT	NOT VALID IF FOV_STATUS=0
3. BINID_BORESIGHT_INTERSECT	NOT VALID IF FOV_STATUS=0
4. SC_POSITION, X	
5. SC_POSITION, Y	
6. SC_POSITION, Z	
7. BS_VECTOR, X	
8. BS_VECTOR, Y	
9. BS_VECTOR, Z	
10. FOV_STATUS	
11. DOWNLINK_STATUS	
12. AVERAGE_SC_DISTANCE	NOT VALID IF FOV_STATUS=0
13. AVERAGE_EMISSION_ANGLE	NOT VALID IF FOV_STATUS=0
14. TOTAL_EFF_SOLID_ANGLE	=0 IF FOV_STATUS=0
15. TOTAL_AREA_FOOTPRINT	NOT VALID
16. TOTAL_VISIBLE_AREA	=0 IF FOV_STATUS=0

17. NC_WEIGHT_0.3MEV =0 IF FOV_STATUS=0
18. NR_WEIGHT_0.6MEV =0 IF FOV_STATUS=0
19. NC_WEIGHT_0.6MEV =0 IF FOV_STATUS=0
20. NR_WEIGHT_1.0MEV =0 IF FOV_STATUS=0
21. NC_WEIGHT_1.0MEV =0 IF FOV_STATUS=0
22. NR_WEIGHT_3.0MEV =0 IF FOV_STATUS=0
23. NC_WEIGHT_3.0MEV =0 IF FOV_STATUS=0
24. NC_WEIGHT_6.0MEV =0 IF FOV_STATUS=0
25. BORESIGHT_INTERSECT_LAT NOT VALID IF FOV STATUS = 0
26. BORESIGHT_INTERSECT_LON NOT VALID IF FOV STATUS = 0
27. BORESIGHT_INTERSECT_R NOT VALID IF FOV STATUS = 0
28. SPICE_KERNEL_ID
29. PLATE_MODEL_ID
30. PROCESSING_SOFTWARE_ID
31. DATABASE_VERSION_ID

F. Listings of Parameters for GRS Level–2 Summary Record

FORMAT 3 - List of RDBMS parameters for Summarized GRS Level-2 record (output)

F.1. – F.7. NEAR GRS Summarized Spectra: 4 spectra*1024 channels*(Real*4), 1 spectrum*21 channels(Real*4), 1 spectrum*1024 channels*(Real*4), 1 spectrum*21 channels(Real*4)

0 – 1023 Sodium Iodide (NAI) spectrum
0 – 1023 Bismuth Germanate (BGO) spectrum
0 – 1023 Anti-Coincidence (ANTICO) spectrum
0 – 1023 Sodium Iodide (NAI1ESC) single escape spectrum
0 – 20 Bismuth Germanate (BGO1ESC) single escape spectrum
0 – 1023 Sodium Iodide (NAI2ESC) double escape spectrum
0 – 20 Bismuth Germanate (BGO2ESC) double escape spectrum

F.8. NEAR GRS Summarized Engineering (ENG) Parameters: 13*(Real*4)

1. GAIN_STANDARD_BGO
2. GAIN_STANDARD_NAI
3. ZERO_STANDARD_BGO
4. ZERO_STANDARD_NAI
5. TOTAL_INTEG_TIME
6. TOTAL_LIVE_TIME_BGO
7. TOTAL_LIVE_TIME_NAI
8. BGO_VALID_CHANNEL_HI

9. NAI_VALID_CHANNEL_HI
10. BGO_VALID_CHANNEL_LOW
11. NAI_VALID_CHANNEL_LOW
12. AVG_GCR_FLUX
13. NUMBER_MET

F.9. NEAR GRS Summarized Spatial (SPATIAL) Parameters: 13*(Real*4)

"Not valid" – is designated as = -1

1.	AVG_SC_DISTANCE	NOT VALID IF FOV_STATUS=0
1.	AVG_EMI_ANGLE	NOT VALID IF FOV_STATUS=0
2.	AVG_TOTAL_EFF_SOLID_ANGLE	=0 IF FOV_STATUS=0
3.	NR_WEIGHT_0.3MEV	=0 IF FOV_STATUS=0
4.	NC_WEIGHT_0.3MEV	=0 IF FOV_STATUS=0
5.	NR_WEIGHT_0.6MEV	=0 IF FOV_STATUS=0
6.	NC_WEIGHT_0.6MEV	=0 IF FOV_STATUS=0
7.	NR_WEIGHT_1.0MEV	=0 IF FOV_STATUS=0
8.	NC_WEIGHT_1.0MEV	=0 IF FOV_STATUS=0
9.	NR_WEIGHT_3.0MEV	=0 IF FOV_STATUS=0
10.	NC_WEIGHT_3.0MEV	=0 IF FOV_STATUS=0
11	NC_WEIGHT_6.0MEV	=0 IF FOV_STATUS=0
12	ESTIMATED_COVERED_AREA	=0 IF FOV_STATUS=0

G. Listing of Parameters for GRS Fractional Footprint Accounting System

Internal to the University of Arizona RDBMS information for accounting purposes only. This information will not be output at the query time.

1.	MET	INTEGER*4	
1.	FOOTPRINT_BIN_TOTAL_AREA	REAL*4	NOT VALID
2.	FOOTPRINT_BIN_VISIBLE_AREA	REAL*4	
3.	TOTAL_EFF_SOLID_ANGLE_FRACTION	REAL*4	
4.	NR_SPECTRUM_FRACTION	REAL*4	
5.	NC_SPECTRUM_FRACTION	REAL*4	
6.	BINID	REAL*4	

H. Numerical Specifications for GRS level–2 Integral Records

FORMATS 1,2 – Numerical specifications for Single Raw and Calibrated GRS Level-2 record (output)

H.1. – H.7. NEAR GRS Spectra: 4 spectra*1024 channels*(Real*4), 1 spectrum*21 channels(Real*4), 1 spectrum*1024 channels*(Real*4), 1 spectrum*21 channels(Real*4)

The following parameters are described in detail in the NEAR XGRS DPU Software Requirements Specification JHU/APL Version 7 7358-9002. Version 7 of the software was uploaded in May 1999.

H.8. NEAR GRS Science Housekeeping (SCI HK) Parameters: 31*(Integer*4)

The following parameters are described in detail in the NEAR XGRS DPU Software Requirements Specification JHU/APL Version 7 7358-9002. Version 7 of the software was uploaded in May 1999.

H.9. NEAR GRS Engineering Housekeeping (ENG HK) Parameters: 152*(REAL*4)

The following parameters are described in detail in the NEAR XGRS DPU Software Requirements Specification JHU/APL Version 7 7358-9002. Version 7 of the software was uploaded in May 1999.

H.10. NEAR GRS Derived Engineering (DER ENG) Parameters: 17*(Real*4), 1*(Integer*4), 1*(4*Integer*4)

	PARAMETER NAME	UNITS	
0	GAIN_STANDARD_BGO	keV/channel	
1	GAIN_STANDARD_NAI	keV/channel	
2	ZERO_STANDARD_BGO	keV	
3	ZERO_STANDARD_NAI	keV	
4	REAL_GAIN_BGO	keV/channel	a1+a2*x+a3*x^2+a4*x^3+..., where x is day since launch, a1..an are derived coefficients, provided by GSFC.
5	REAL_GAIN_NAI	keV/channel	- " -
6	REAL_ZERO_BGO	keV	- " -
7	REAL_ZERO_NAI	keV	- " -

8 LIVE_TIME_BGO Unitless

LIVE_TIME_BGO =
NUM_BGO_VALID_EVENTS(SCI_HK:25)/(BGO_RAW_EVENT_RATE(SCI_HK:18) –
0.5*BGO_HIGH_ENERGY(ENG_HK:144))

9 LIVE_TIME_NAI Unitless

LIVE_TIME_NAI =

NUM_NAI_VALID_EVENTS(SCI_HK:24) / (NAI_RAW_EVENT_RATE(SCI_HK:17) - 0.2*NAI_HIGH_ENERGY(ENG_HK:141))

10	BGO_VALID_CHANNEL_HI	Channel	Highest channel of the spectrum in new (after calibration) energy scale. =N(1021), if N(1021)<=1023 =1023, if N(1021)>1023, N(1021): channel number in the new energy scale, corresponding to 1021 channel of the original spectrum.

$$N(1021)=\frac{1021\cdot REAL\_GAIN\_...+REAL\_ZERO\_...-ZERO\_STANDARD\_...}{GAIN\_STANDARD\_...}$$

11	NAI_VALID_CHANNEL_HI	Channel	- “ -
12	BGO_VALID_CHANNEL_LOW	Channel	Lowest channel of the spectrum in new (after calibration) energy scale. =N(LLD), if N(LLD)>=0 =0, if N(LLD)<0, N(LLD): channel number in the new energy scale, corresponding to low level discriminator setting of the original spectrum N(LLD_0)= BGO_LOW_LEVEL_AMPL_THRESH (Eng_HK:111) or 10, whatever is higher.
13.	NAI_VALID_CHANNEL_LOW	Channel	- “ - N(LLD_0)= NAI_LOW_LEVEL_AMPL_THRESH (Eng_HK:110)
14	Pos_ESC_1	keV	Energy, corresponding to the middle of 1-st escape window (Eng_HK:106)

$$Pos\_Esc\_1=(Eng\_HK:106)\cdot Real\_Gain\_BGO+Real\_Zero\_BGO$$

15	Pos_ESC_2	keV	Energy, corresponding to the middle of 2-nd escape window (Eng_HK:108)
16	GCR_Flux	Counts/Seconds	Parameter reflects changes in galactic cosmic ray flux. Updated after calibration

$$GCR\_FLUX = \frac{\sum_{I1}^{I2} NAI(I)}{LIVE\_TIME\_NAI \cdot INTEGRATION\_TIME},$$

$NAI(I)$ – raw (uncalibrated) spectrum
$I1 = (5000 - Real\_Zero\_NaI) / Real\_Gain\_NaI$
$I2 = (9000 - Real\_Zero\_NaI) / Real\_Gain\_NaI$

17 Bad_Flag
18 Query_ID

H.11. NEAR GRS Spatial (SPATIAL) Parameters: 1*(Integer*4), 32*(Real*4)

All spatial derivations, unless specified differently, are made for the middle of integration period.
* ET – ephemeris time corresponding to clock fixed Mission Elapsed Time in the middle of the integration period. Measuring units are seconds before January 1, 2000.

PARAMETER NAME	UNITS	
0 MET	Seconds	Mission Elapsed Time at start of integration
1 PlateID_Boresite_Intersect	Plate Index	ID of the plate that boresight intersects in the middle of integration period
2 BinID_Boresite_Intersect	Bin Index	ID of the plate that boresight intersects in the middle of integration period
3 SC_Position, X	Coord X, km	Position of spacecraft (ET*) in Eros fixed coord. system (ET*)
4 SC_Position, Y	Coord Y, km	
5 SC_Position, Z	Coord Z, km	
6 BS_Vector, X	Vector X, normal	Boresight vector of GRS (ET*) in Erosfixed coord. system (ET*)
7 BS_Vector, Y	Vector Y, normal	
8 BS_Vector, Z	Vector Z, normal	
9 FOV_Status	Status value	= 0: Field of view (FOV) is completely off the asteroid (if there are no plates in the field of view). = 1: Field of view is on the asteroid (totally or partially).
10 Downlink_Status	Status Value	= 0: No downlink = 1: Yes downlink (The angle between antenna direction and vector spacecraft(ET*) → Earth(ET*) is less than 2 degrees)

11 Average_SC_Distance | Kilometers | Average distance from the spacecraft to the surface of the asteroid in the middle of integration period.

$$Average\_SC\_Distance = \frac{\sum\limits_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} [\quad SC\_Distance \cdot Eff\_Plate\_Solid\_Angle]}{\sum\limits_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} Eff\_Plate\_Solid\_Angle};$$

$$SC\_Distance = Distance\ from\ the\ spacecraft\ to\ the\ midpoint\ of\ the\ plate$$

$$Eff\_Plate\_Solid\_Angle = Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_1.0MeV$$

$$Plate\_Solid\_Angle = |Cos(emi\_angle)| \cdot Plate\_Area / SC\_Distance^2$$

$$Instr\_Angular\_Response\_Fct\_1.0MeV:\ see\ Appendix\ 1\ for\ definition\ and\ Appendix\ 2\ for\ approximation.$$

12 Avg_Emission_Angle | Degrees | Average emission angle

$$Avg\_Emission\_Angle = \frac{\sum\limits_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\\ plates\ are\ considered)}} [\quad Emi\_Angle \cdot Eff\_Plate\_Solid\_Angle]}{\sum\limits_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} Eff\_Plate\_Solid\_Angle};$$

$$Eff\_Plate\_Solid\_Angle:\ definition\ is\ given\ in\ specifications\ for\ parameter\ 11\ of\ the\ present\ section.$$

13 Total_Eff_Solid_Angle | Steradians | Overall solid angle of all plates in the footprint weighted by the instrument angular response function for the 1 MeV radiation.

$$Total\_Eff\_Solid\_Angle = \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} Eff\_Plate\_Solid\_Angle$$

$Eff\_Plate\_Solid\_Angle$: *definition is given in specifications for parameter 11 of the present section.*

14 Total_Area_Footprint	Sq. Kilometers	NOT VALID
15 Total_Visible_Area	Sq. Kilometers	Total area of plates in the footprint visible from the spacecraft

$$\sum_{\substack{footprint,\\ visible\ plates}} Plate\_Area = \sum_{footprint} (Plate\_Area * VISAMT),$$

where VISAMT : fraction of the plate that is located within the field of view and is visible to the spacecraft.

16 Footprint_Solid_Angle	Steradians	Overall solid angle of all plates in the footprint as seen from the spacecraft.

$$Footprint\_Solid\_Angle = \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} Plate\_Solid\_Angle$$

17 NR_Geom_Weight_0.3MeV	Steradians	Normalization coefficient. It relates the gamma-ray flux at the detector and the intensity of gamma-ray radiation from the asteroid surface in the direction normal to the surface (for 0.3 MeV natural radioactivity radiation). For complete definition see Appendix 1.

$$NR\_Geom\_Weight\_0.3MeV =$$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ plates\\ are\ considered)}} \frac{Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_0.3MeV \cdot |Cos(emi\_angle)|}{|Cos(emi\_angle)|} =$$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_0.3MeV$$

$Instr\_Angular\_Response\_Fct\_0.3MeV$: *see Appendix 1 for definition and Appendix 2 for approximation.*

$Plate\_Solid\_Angle$: *definition is given in specifications for parameter 11 of the present section.*

18 NC_Geom_Weight_0.3MeV	Steradians	Normalization coefficient. It relates the gamma-ray flux at the detector and the intensity of gamma-ray radiation from the asteroid surface in the direction normal to the surface (for 0.3 MeV non-elastic scattering and thermal neutron capture radiation). For complete definition see Appendix 1.

$$NC\_Geom\_Weight\_0.3MeV =$$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} \frac{Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_0.3MeV \cdot NC\_Angular\_Fct}{|Cos(emi\_angle)|}$$

$NC\_Angular\_Fct$: *see Appendix 1 for definition and Appendix 2 for approximation*

$Instr\_Angular\_Response\_Fct\_0.3MeV$: *see Appendix 1 for definition and Appendix 2 for approximation.*

$Plate\_Solid\_Angle$: *definition is given in specifications for parameter 11 of the present section.*

19 NR_Geom_Weight_0.6MeV	Steradians	Normalization coefficient. It relates the gamma-ray flux at the detector and the intensity of gamma-ray radiation from the asteroid surface in the direction normal to

the surface (for 0.6 MeV natural radioactivity radiation).
For complete definition see Appendix 1.

$$NR\_Geom\_Weight\_0.6MeV =$$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ plates\\ are\ considered)}} \frac{Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_0.6MeV \cdot |Cos(emi\_angle)|}{|Cos(emi\_angle)|} =$$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_0.6MeV$$

Instr_Angular_Response_Fct_0.6MeV : see Appendix 1 for definition and Appendix 2 for approximation.

Plate_Solid_Angle : definition is given in specifications for parameter 11 of the present section.

20 NC_Geom_Weight_0.6MeV	Steradians	Normalization coefficient. It relates the gamma-ray flux at the detector and the intensity of gamma-ray radiation from the asteroid surface in the direction normal to the surface (for 0.6 MeV non-elastic scattering and thermal neutron capture radiation). For complete definition see Appendix 1.

$$NC\_Geom\_Weight\_0.6MeV =$$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} \frac{Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_0.6MeV \cdot NC\_Angular\_Fct}{|Cos(emi\_angle)|}$$

NC_Angular_Fct : see Appendix 1 for definition and Appendix 2 for approximation

Instr_Angular_Response_Fct_0.6MeV : see Appendix 1 for definition and Appendix 2 for approximation.

Plate_Solid_Angle : definition is given in specifications for parameter 11 of the present section.

21 NR_Geom_Weight_1.0MeV Steradians Normalization coefficient. It relates the gamma-ray flux at the detector and the intensity of gamma-ray radiation from the asteroid surface in the direction normal to the surface (for 1.0 MeV natural radioactivity radiation).
For complete definition see Appendix 1.

$$NR\_Geom\_Weight\_1.0MeV =$$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ plates\\ are\ considered)}} \frac{Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_1.0MeV \cdot |Cos(emi\_angle)|}{|Cos(emi\_angle)|} =$$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_1.0MeV$$

$Instr\_Angular\_Response\_Fct\_1.0MeV$: see Appendix 1 for definition and Appendix 2 for approximation.

$Plate\_Solid\_Angle$: definition is given in specifications for parameter 11 of the present section.

22 NC_Geom_Weight_1.0MeV Steradians Normalization coefficient. It relates the gamma-ray flux at the detector and the intensity of gamma-ray radiation from the asteroid surface in the direction normal to the surface (for 1.0 MeV non-elastic scattering and thermal neutron capture radiation).
For complete definition see Appendix 1.

$$NC\_Geom\_Weight\_1.0MeV =$$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} \frac{Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_1.0MeV \cdot NC\_Angular\_Fct}{|Cos(emi\_angle)|}$$

$NC\_Angular\_Fct$: see Appendix 1 for definition and Appendix 2 for approximation

$Instr\_Angular\_Response\_Fct\_1.0MeV$: see Appendix 1 for definition and Appendix 2 for approximation.

$Plate\_Solid\_Angle$: definition is given in specifications for parameter 11 of the present section.

23 NR_Geom_Weight_3.0MeV	Steradians	Normalization coefficient. It relates the gamma-ray flux at the detector and the intensity of gamma-ray radiation from the asteroid surface in the direction normal to the surface (for 3.0 MeV natural radioactivity radiation). For complete definition see Appendix 1.

$$NR\_Geom\_Weight\_3.0MeV =$$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ plates\\ are\ considered)}} \frac{Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_3.0MeV \cdot |Cos(emi\_angle)|}{|Cos(emi\_angle)|} =$$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_3.0MeV$$

Instr_Angular_Response_Fct_3.0MeV : see Appendix 1 for definition and Appendix 2 for approximation.

Plate_Solid_Angle : definition is given in specifications for parameter 11 of the present section.

24 NC_Geom_Weight_3.0MeV	Steradians	Normalization coefficient. It relates the gamma-ray flux at the detector and the intensity of gamma-ray radiation from the asteroid surface in the direction normal to the surface (for 3.0 MeV non-elastic scattering and thermal neutron capture radiation). For complete definition see Appendix 1.

$NC\_Geom\_Weight\_3.0MeV =$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ plates\\ are\ considered)}} \frac{Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_3.0MeV \cdot NC\_Angular\_Fct}{|Cos(emi\_angle)|}$$

NC_Angular_Fct : see Appendix 1 for definition and Appendix 2 for approximation

Instr_Angular_Response_Fct_3.0MeV : see Appendix 1 for definition and Appendix 2 for approximation.

Plate_Solid_Angle : definition is given in specifications for parameter 11 of the present section.

25 NC_Geom_Weight_6.0MeV Steradians Normalization coefficient. It relates the gamma-ray flux at the detector and the intensity of gamma-ray radiation from the asteroid surface in the direction normal to the surface (for 6.0 MeV non-elastic scattering and thermal neutron capture radiation).
For complete definition see Appendix 1.

$NC\_Geom\_Weight\_6.0MeV =$

$$= \sum_{\substack{footprint,\\ visible\ plates\\ (Fractions\ of\ the\ plates\\ are\ considered)}} \frac{Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_6.0MeV \cdot NC\_Angular\_Fct}{|Cos(emi\_angle)|}$$

NC_Angular_Fct : see Appendix 1 for definition and Appendix 2 for approximation

Instr_Angular_Response_Fct_6.0MeV : see Appendix 1 for definition and Appendix 2 for approximation.

Plate_Solid_Angle : definition is given in specifications for parameter 11 of the present section.

26 Boresight_Intersect_Lat Degrees Latitude of boresight intersection in the middle of integration period

Coordinate transformation Asteroid Body Fixed, Cartesian to Asteroid Body Fixed, Spherical. Intersection point (x,y,z) of boresight with asteroid surface converted to **Latitude**.

LAT = Degrees(ARC_SIN(Z/R)) (R solved for in eqn 28)

27	Boresight_Intersect_Lon	Degrees	Longitude of boresight intersection in the middle of integration period

Coordinate transformation Asteroid Body Fixed, Cartesian to Asteroid Body Fixed, Spherical. Intersection point (x,y,z) of boresight with asteroid surface converted to **Longitude**.

1. LON = -1.*Degrees(ARC_TAN(Y/X))
2. LON = 270 for x = 0 AND y > 0
3. LON = 90 for x = 0 AND y < 0

28	Boresight_Intersect_R	Kilometers	Radius-vector of boresight intersection in the middle of integration period

Coordinate transformation Asteroid Body Fixed, Cartesian to Asteroid Body Fixed, Spherical. Intersection point (x,y,z) of boresight with asteroid surface converted to **Radius** from center of asteroid mass.

R = SQRT(X^2 + Y^2 + Z^2) (R is needed in sol'n 26)

29	SPICE_Kernel_ID	Version Number	Specified by NAIF
30	Plate_Model_ID	Version Number	
31	Processing_Software_ID	Version Number	
32	DataBase_Version_ID	Version Number	

<u>I. Numerical Specifications for GRS Level–2 Summary Record</u>

FORMAT 3 : Numerical specifications for summarized GRS Level-2 record (output)

<u>I.1. – I.7. NEAR GRS Summarized Spectra: 4 spectra*1024 channels*(Real*4), 1 spectrum*21 channels(Real*4), 1 spectrum*1024 channels*(Real*4), 1 spectrum*21 channels(Real*4)</u>

Measuring units: Counts/Channel

Sodium Iodide summed spectrum:

$$NAI(I) = \sum_{MET} NAI(I, MET); \quad I = 0..1023 - channel$$

Bismuth Germanate summed spectrum:

$$BGO(I) = \sum_{MET} BGO(I, MET); \quad I = 0,,1023 - channel$$

Anti-Coincidence summed spectrum:

$$ANTICO(I) = \sum_{MET} ANTICO(I, MET); \quad I = 0..1023 - channel$$

Sodium Iodide single escape summed spectrum:

$$NAI1ESC(I) = \sum_{MET} NAI1ESC(I, MET); \quad I = 0..1023 \text{ - } channel$$

Bismuth Germanate single escape summed spectrum:

$$BGO1ESC(I) = \sum_{MET} BGO1ESC(I, MET);$$

I – channel, 0-20

Sodium Iodide double escape summed spectrum:

$$NAI2ESC(I) = \sum_{MET} NAI2ESC(I, MET); \quad I = 0..1023 \text{ - } channel$$

Bismuth Germanate double escape summed spectrum:

$$BGO2ESC(I) = \sum_{MET} BGO2ESC(I, MET);$$

I – channel, 0-20

I.8. NEAR GRS Summarized Engineering (ENG) Parameters: 13*(Real*4)

	PARAMETER NAME	UNITS	
0	GAIN_STANDARD_BGO	keV/Channel	User specified or default
1	GAIN_STANDARD_NAI	keV/Channel	- " -
2	ZERO_STANDARD_BGO	keV	- " -
3	ZERO_STANDARD_NAI	keV	- " -
4	TOTAL_INTEG_TIME	Seconds	$\sum_{MET} Integration\_Time(MET)$
5	TOTAL_LIVE_TIME_BGO	Seconds	

$$\sum_{MET} [LIVE\_TIME\_BGO(MET) \cdot INTEGRATION\_TIME]$$

6	TOTAL_LIVE_TIME_NAI	Seconds	

$$\sum_{MET}[LIVE\_TIME\_NAI(MET)\cdot INTEGRATION\_TIME]$$

7	BGO_VALID_CHANNEL_HI	Channel	Highest channel of summed spectrum uncorrupted by energy scale adjustments. Lowest BGO_VALID_CHANNEL_HI among all MET records in a sum.
8	NAI_VALID_CHANNEL_HI	Channel	- " – Lowest NAI_VALID_CHANNEL_HI among all MET records in a sum
9	BGO_VALID_CHANNEL_LOW	Channel	Lowest channel of summed spectrum uncorrupted by energy scale adjustments. Highest BGO_VALID_CHANNEL_LOW among all MET records in a sum.
10	NAI_VALID_CHANNEL_LOW	Channel	- " – Highest NAI_VALID_CHANNEL_LOW among all MET records in a sum.
11	Avg_GCR_FLUX	Counts/Second	Characteristics of average galactic cosmic ray flux

$$\frac{\sum_{MET} GCR\_Flux(MET)\cdot LIVE\_TIME\_NAI\cdot INTEGRATION\_TIME}{\sum_{MET} LIVE\_TIME\_NAI\cdot INTEGRATION\_TIME}$$

12	Number_MET		Number of MET records in a query

I.9. NEAR GRS Summarized Spatial (SPATIAL) Parameters: 13*(Real*4)

	PARAMETER NAME	UNITS	
0	AVG_SC_DISTANCE	Kilometers	Distance from the spacecraft to the surface of the asteroid averaged over MET records in a sum.

$$Weight(MET) = Total\_Eff\_Solid\_Angle(MET) \cdot LIVE\_TIME\_NAI(MET) \cdot$$
$$\cdot INTEGRATION\_TIME$$

$$Avg\_SC\_DISTANCE = \frac{\sum_{MET} [Avg\_SC\_Distance(MET) \cdot Weight(MET))]}{\sum_{MET} [Weight(MET)]}$$

1	AVG_EMI_ANGLE	Degrees	Emission angle averaged over MET records in a sum.

$$AVG\_EMI\_ANGLE = \frac{\sum_{MET} [Avg\_Emission\_Angle(MET) \cdot Weight(MET))]}{\sum_{MET} [Weight(MET)]}$$

Weight(MET) : definition is given in specifications for parameter 0 of the present section.

2	AVG_TOTAL_EFF_SOLID_ANGLE	Steradians	Total effective solid angle averaged over MET records in a sum.

$$\frac{\sum_{MET} [Total\_Eff\_Solid\_Angle(MET) \cdot LIVE\_TIME\_NAI(MET) \cdot INTEGRATION\_TIME]}{\sum_{MET} [LIVE\_TIME\_NAI(MET) \cdot INTEGRATION\_TIME]}$$

3	NR_Weight_0.3MeV	Steradians*Seconds	Normalization coefficient. It relates the number of counts in summed spectrum gamma-line to the intensity of gamma-ray radiation of corresponding energy from the asteroid surface in the direction normal to the surface (for natural radioactivity radiation and energy range < 0.45 MeV). For complete definition see Appendix 1.

$$\sum_{MET} [NR\_Geom\_Weight\_0.3MeV(MET) \cdot LIVE\_TIME\_NAI \cdot INTEGRATION\_TIME]$$

4	NC_Weight_0.3MeV	Steradians*Counts	Normalization coefficient. It relates the

			number of counts in summed spectrum gamma-line to the intensity of gamma-ray radiation of corresponding energy from the asteroid surface in the direction normal to the surface normalized for GCR flux = 1 proton/(s*cm^2) (for non-elastic scattering and thermal neutron capture radiation and energy range < 0.45 MeV). For complete definition see Appendix 1.

$$\sum_{MET}[NC\_Geom\_Weight\_0.3MeV(MET)\cdot LIVE\_TIME\_NAI\cdot INTEGRATION\_TIME\cdot GCR\_FLUX]$$

5	NR_Weight_0.6MeV	Steradians*Seconds	Normalization coefficient. It relates the number of counts in summed spectrum gamma-line to the intensity of gamma-ray radiation of corresponding energy from the asteroid surface in the direction normal to the surface (for natural radioactivity radiation and energy range 0.45..0.8 MeV). For complete definition see Appendix 1.

$$\sum_{MET}[NR\_Geom\_Weight\_0.6MeV(MET)\cdot LIVE\_TIME\_NAI\cdot INTEGRATION\_TIME]$$

6	NC_Weight_0.6MeV	Steradians*Counts	Normalization coefficient. It relates the number of counts in summed spectrum gamma-line to the intensity of gamma-ray radiation of corresponding energy from the asteroid surface in the direction normal to the surface normalized for GCR flux = 1 proton/(s*cm^2) (for non-elastic scattering and thermal neutron capture radiation and energy range 0.45..0.8 MeV). For complete definition see Appendix 1.

$$\sum_{MET}[NC\_Geom\_Weight\_0.6MeV(MET)\cdot LIVE\_TIME\_NAI\cdot INTEGRATION\_TIME\cdot GCR\_FLUX]$$

7	NR_Weight_1.0MeV	Steradians*Seconds	Normalization coefficient. It relates the

number of counts in summed spectrum gamma-line to the intensity of gamma-ray radiation of corresponding energy from the asteroid surface in the direction normal to the surface (for natural radioactivity radiation and energy range 0.8..2.0 MeV). For complete definition see Appendix 1.

$$\sum_{MET}[NR\_Geom\_Weight\_1.0MeV(MET)\cdot LIVE\_TIME\_NAI\cdot INTEGRATION\_TIME]$$

8	NC_Weight_1.0MeV	Steradians*Counts	Normalization coefficient. It relates the number of counts in summed spectrum gamma-line to the intensity of gamma-ray radiation of corresponding energy from the asteroid surface in the direction normal to the surface normalized for GCR flux = 1 proton/(s*cm^2) (for non-elastic scattering and thermal neutron capture radiation and energy range 0.8..2.0 MeV). For complete definition see Appendix 1.

$$\sum_{MET}[NC\_Geom\_Weight\_1.0MeV(MET)\cdot LIVE\_TIME\_NAI\cdot INTEGRATION\_TIME\cdot GCR\_FLUX]$$

9	NR_Weight_3.0MeV	Steradians*Seconds	Normalization coefficient. It relates the number of counts in summed spectrum gamma-line to the intensity of gamma-ray radiation of corresponding energy from the asteroid surface in the direction normal to the surface (for natural radioactivity radiation and energy range 2.0..4.5 MeV). For complete definition see Appendix 1.

$$\sum_{MET}[NR\_Geom\_Weight\_3.0MeV(MET)\cdot LIVE\_TIME\_NAI\cdot INTEGRATION\_TIME]$$

10	NC_Weight_3.0MeV	Steradians*Counts	Normalization coefficient. It relates the number of counts in summed spectrum gamma-line to the intensity of gamma-ray radiation of corresponding energy from the

asteroid surface in the direction normal to the surface normalized for GCR flux = 1 proton/(s*cm^2) (for non-elastic scattering and thermal neutron capture radiation and energy range 2.0..4.5 MeV).
For complete definition see Appendix 1.

$$\sum_{MET} [NC\_Geom\_Weight\_3.0MeV(MET) \cdot LIVE\_TIME\_NAI \cdot INTEGRATION\_TIME \cdot GCR\_FLUX]$$

11 NC_Weight_6.0MeV Steradians*Counts

Normalization coefficient. It relates the number of counts in summed spectrum gamma-line to the intensity of gamma-ray radiation of corresponding energy from the asteroid surface in the direction normal to the surface normalized for GCR flux = 1 proton/(s*cm^2) (for non-elastic scattering and thermal neutron capture radiation and energy range > 4.5 MeV).
For complete definition.. see Appendix 1.

$$\sum_{MET} [NC\_Geom\_Weight\_6.0MeV(MET) \cdot LIVE\_TIME\_NAI \cdot INTEGRATION\_TIME \cdot GCR\_FLUX]$$

12 ESTIMATED_COVERED_AREA Sq. Kilometers

Estimated area of the asteroid surface covered by MET records in a sum

$$\sum_{\text{Bins in a region}} Bin\_Area(MET)$$ For a spatial query

$$\sum_{\text{Different bins covered by all footprints in a sum}} Bin\_Area$$ For a temporal query

J. Numerical Specifications for GRS Fractional Footprint Accounting System

	PARAMETER NAME	UNITS	
0	MET	Seconds	Mission Elapsed Time at start of integartion.
1	Footprint_Bin_Total_Area	Sq. Kilometers	NOT VALID
2	Footprint_Bin_Visible_Area	Sq. Kilometers	Total area of all plates in the

footprint that belong to the bin, visible from the spacecraft.

$$\sum_{\substack{\text{plates of the footprint, that belong to the BIN,}\\ \text{visible from the spacecraf}\\ \text{(Fractions of the plates are considered)}}} Plate\_Area$$

Fractions are considered as in H11 param.15

3 Total_Eff_Solid_Angle_Fraction Unitless Fraction of the total effective solid angle that can be attributed to the bin.

$$Total\_Eff\_Solid\_Angle\_Fraction = \frac{\sum\limits_{\substack{\text{plates of the footprint,}\\ \text{that belong to the BIN and are}\\ \text{visible from the spacecraft}\\ \text{(Fractions of the plates are considered)t}}} Eff\_Plate\_Solid\_Angle}{\sum\limits_{\substack{\text{footprint,}\\ \text{visible plates}\\ \text{(Fractions of the plates are considered)}}} Eff\_Plate\_Solid\_Angle}$$

$$Eff\_Plate\_Solid\_Angle = Plate\_Solid\_Angle \cdot Instr\_Angular\_Response\_Fct\_1.0MeV$$

$$Plate\_Solid\_Angle = |Cos(emi\_angle)| \cdot Plate\_Area / SC\_Distance^2$$

$$SC\_Distance = \text{Distance from the spacecraft to the midpoint of the plate}$$

$$Instr\_Angular\_Response\_Fct\_1.0MeV: \text{ see Appendix 1 for definition and Appendix 2 for approximation.}$$

4 NR_Spectrum_Fraction Unitless Fraction of the spectrum that can be attributed to the bin (for natural radioactivity radiation).

$$NR\_Spectrum\_Fraction = \frac{\sum\limits_{\substack{\text{plates of the footprint,}\\ \text{that belong to the BIN}\\ \text{and visible from the spacecraft}\\ \text{(Fractions of the plates are considered)}}} (\quad Eff\_Plate\_Solid\_Angle)}{\sum\limits_{\substack{\text{footprint,}\\ \text{visible plates}\\ \text{(Fractions of the plates are considered)}}} (\quad Eff\_Plate\_Solid\_Angle)}$$

$$Eff\_Plate\_Solid\_Angle: \text{ definition is given in specifications for parameter 3 of the present section.}$$

5	NC_Spectrum_Fraction	Unitless	Fraction of the spectrum that can be attributed to the bin (for non-elastic scattering and thermal neutron capture radiation).

$$NC\_Spectrum\_Fraction = \frac{\displaystyle\sum_{\substack{\text{plates of the footprint,}\\ \text{that belong to the BIN}\\ \text{and visible from the spacecraft}\\ \text{(Fractions of the plates are considered)}}} \frac{Eff\_Plate\_Solid\_Angle \cdot NC\_Ang\_Fct}{|Cos(emi\_angle)|}}{\displaystyle\sum_{\substack{\text{footprint,}\\ \text{visible plates}\\ \text{(Fractions of the plates are considered)}}} \frac{Eff\_Plate\_Solid\_Angle \cdot NC\_Ang\_Fct}{|Cos(emi\_angle)|}}$$

NC_Angular_Fct : see Appendix 1 for definition and Appendix 2 for approximation

Eff_Plate_Solid_Angle : definition is given in specifications for parameter 3 of the present section.

6	Binid	Value	Bin identifier generated by the Bin generation system

APPENDIX 1 Definitions for:

Instr_Angular_Response_Fct_YYMeV,
where YY can be 0.3, 0.6, 1.0, 3.0 or 6.0;
NC_Angular_Fct;
NC_Geom_Weight_YYMeV;
NC_Weight_YYMeV;
NR_Geom_Weight_YYMeV;
NR_Weight_YYMeV

$$N_j^{NC}[counts] = T^{live}[s] \cdot S_{detector}[cm^2_{detector}] \cdot eff^{\gamma}[counts/photons] \cdot Gamma\_Flux_j[photons/(s \cdot cm^2_{detector})]$$

$$Gamma\_Flux_j[\frac{photons}{s \cdot cm^2_{detector}}] = I_0[\frac{GCR\_protons}{s \cdot cm^2_{surface}}] \cdot \int_{footprint}(\frac{F_j^{NC}(\beta)}{4\pi}[\frac{photons}{sr \cdot GCR\_proton}] \cdot \frac{f(YY)}{Cos\beta} d\Omega[\frac{sr \cdot cm^2_{surface}}{cm^2_{detector}}]),$$

where N_j^{NC} - number of counts at the NaI detector in j energy line (nonelastic scattering or thermal neutron capture)

Ω - solid angle of an area on the asteroid surface as seen from the spacecraft

f(YY) - angular response function of NaI detector (response, normalised to 1 at normal direction) for YY MeV photons, where YY = 0.3, 0.6, 1.0, 3.0 or 6.0.

β - emission angle

T^{live} - live time

$S_{detector}$ - area of the detector

eff^{γ} - intrisic gamma - ray efficiency of the detector

$$\frac{F_j^{NC}(\beta)}{4\pi} = \frac{1}{I_0} \cdot \frac{1}{4\pi} \cdot \int_0^{\infty} S_j^{NC}(x) exp(-\propto_j \frac{x}{Cos\beta})dx \quad [\frac{photons}{sr \cdot (GCR\_protons\ in\ a..b\ energy\ range)}]$$ - intensity of gamma - ray radiation, normalized to galactic - cosmic - ray flux = $1 \frac{GCR\_protons\ in\ a..b\ energy\ range}{s \cdot cm^2}$

$\propto_j$ - linear attenuation coefficient for j gamma line

$S_j^{NC}(x)$ - source function for galactic - cosmic - ray - produced j line photons $[\frac{photons}{s \cdot cm^3}]$ at the depth x cm

$$I_0 = \int_a^b (dN_{GCR}/dE)dE = \frac{GCR\_Flux[counts/s]}{S_{detector} \cdot eff^{p}[counts/protons]};$$

a..b - energy range responsible for counts in 5MeV..9MeV energy window of the detector

eff^{p} - intrisic efficiency of the detector for protons in a..b energy range

.

As galactic - cosmic - ray flux is isotropic $I_0 = [\frac{GCR\_protons(a..b)}{s \cdot cm^2_{det}}] = [\frac{GCR\_protons(a..b)}{s \cdot cm^2_{surf}}]$

$$Gamma\_Flux_j = I_0 \cdot F_j^{NC}(0) \cdot \frac{1}{4\pi} \cdot \int_{footprint} \left(\frac{F_j^{NC}(\beta)}{F_j^{NC}(0)} \cdot \frac{f(YY)}{Cos\beta} d\Omega \right) = \left(I_0 \cdot \frac{F_j^{NC}(0)}{4\pi} \right) \left[\frac{photons}{sr \cdot s \cdot cm^2_{surface}} \right] \cdot$$

$$\cdot NC\_Geom\_Weight\_YYMeV,$$

$$where \quad NC\_Geom\_Weight\_YYMeV = \int_{footprint} \left(\frac{F_j^{NC}(\beta)}{F_j^{NC}(0)} \cdot \frac{f(YY)}{Cos\beta} \right) d\Omega \quad \left[\frac{sr \cdot cm^2_{surface}}{cm^2_{detector}} \right],$$

$$Instr\_Angular\_Response\_Fct\_YYMeV = f(YY),$$

$$NC\_Angular\_Fct = \frac{F_j^{NC}(\beta)}{F_j^{NC}(0)} \text{ , which is a weak function of energy } j.$$

$$\sum_{MET} N_j^{NC} = S_{detector}[cm^2_{detector}] \cdot eff^{\gamma}[counts/photons] \cdot \frac{F_j^{NC}(0)}{4\pi} \left[\frac{photons}{sr \cdot GCR\_proton} \right] \cdot$$

$$\cdot \sum_{MET} \left\{ T^{live}[s] \cdot I_0 \left[\frac{GCR\_protons \text{ in a..b energy range}}{s \cdot cm^2_{surface}} \right] \cdot NC\_Geom\_Weight\_YYMeV \left[\frac{sr \cdot cm^2_{surface}}{cm^2_{detector}} \right] \right\} =$$

$$= \frac{eff^{\gamma}}{eff^{p}} \cdot \frac{F_j^{NC}(0)}{4\pi} \cdot NC\_Weight\_YYMeV,$$

$$where \; NC\_Weight\_YYMeV = \sum_{MET} \{ T^{live} \cdot GCR\_Flux \cdot NC\_Geom\_Weight\_YYMeV \}$$

$$N_j^{NR}[counts] = T^{live}[s] \cdot S_{detector}[cm^2_{detector}] \cdot eff^{\gamma}[counts/photons] \cdot Gamma\_Flux_j[photons/(s \cdot cm^2_{detector})]$$

$$Gamma\_Flux_j \left[\frac{photons}{s \cdot cm^2_{detector}} \right] = \int_{footprint} \left(\frac{F_j^{NR}(\beta)}{4\pi} \left[\frac{photons}{sr \cdot s \cdot cm^2_{surface}} \right] \cdot \frac{f(YY)}{Cos\beta} d\Omega \left[\frac{sr \cdot cm^2_{surface}}{cm^2_{detector}} \right] \right),$$

where N_j^{NR} - number of counts at the NaI detector in j energy line (natural radioactivity)
Ω; $f(YY)$; β; T^{live}; $S_{detector}$; eff^{γ} - same as above

$$\frac{F_j^{NR}(\beta)}{4\pi} = \frac{1}{4\pi} \cdot \int_0^{\infty} S_j^{NR}(x) \exp\left(-\propto_j \frac{x}{Cos\beta}\right) dx \approx \frac{1}{4\pi} \cdot S_j^{NR} \cdot \int_0^{\infty} \exp\left(-\propto_j \frac{x}{Cos\beta}\right) dx = \frac{S_j^{NR} \cdot Cos\beta}{4\pi \cdot \propto_j}$$

(assume $S_j^{NR} = Const(x)$)

$S_j^{NR}(x)$ - source function for natural radioactivity photons $\left[\frac{photons}{s \cdot cm^3} \right]$ at the depth x cm

$$Gamma\_Flux_j = F_j^{NR}(0) \cdot \frac{1}{4\pi} \cdot \int_{footprint} \left(\frac{F_j^{NR}(\beta)}{F_j^{NR}(0)} \cdot \frac{f(YY)}{Cos\beta} d\Omega \right) = \frac{F_j^{NR}(0)}{4\pi} \left[\frac{photons}{sr \cdot s \cdot cm^2_{surface}} \right] \cdot$$

$$\cdot NR\_Geom\_Weight\_YYMeV,$$

$$where \quad NR\_Geom\_Weight\_YYMeV = \int_{footprint} \left(Cos\beta \cdot \frac{f(YY)}{Cos\beta} d\Omega \right) = \int_{footprint} f(YY) d\Omega \quad \left[\frac{sr \cdot cm^2_{surface}}{cm^2_{detector}} \right],$$

$$Instr\_Angular\_Response\_Fct\_YYMeV = f(YY)$$

$$\sum_{MET} N_j^{NR} = S_{detector}[cm^2_{detector}] \cdot eff^{\gamma}[counts / photons] \cdot \frac{F_j^{NR}(0)}{4\pi} \left[\frac{photons}{sr \cdot s \cdot cm^2_{surface}} \right] \cdot$$

$$\cdot \sum_{MET} \{ T^{live}[s] \cdot NR\_Geom\_Weight\_YYMeV \left[\frac{sr \cdot cm^2_{surface}}{cm^2_{detector}} \right] \} = S_{detector} \cdot eff^{\gamma} \cdot \frac{F_j^{NR}(0)}{4\pi} \cdot NR\_Weight\_YYMeV,$$

$$where \quad NR\_Weight\_YYMeV = \sum_{MET} \{ T^{live} \cdot NR\_Geom\_Weight\_YYMeV \}$$

APPENDIX 2 Approximations for:

Instr_Angular_Response_Fct_YYMeV,

where YY can be 0.3, 0.6, 1.0, 3.0 or 6.0;

NC_Angular_Fct

$Instr\_Angular\_Response\_Fct\_0.3MeV:$

$$= 3.905641 \cdot 10^{-6} \cdot \varphi^5 - 2.474219 \cdot 10^{-4} \cdot \varphi^4 + 5.405967 \cdot 10^{-3} \cdot \varphi^3 - 5.037063 \cdot 10^{-2} \cdot \varphi^2 + 1.953235 \cdot 10^{-1} \cdot \varphi + 1.003473, \quad when \quad 0 <= \varphi <= 20$$

$$= -9.74584 \cdot 10^{-6} \cdot \varphi^4 + 1.21503 \cdot 10^{-3} \cdot \varphi^3 - 5.52397 \cdot 10^{-2} \cdot \varphi^2 + 1.04087 \cdot \varphi - 5.96365, \quad when \quad 20 < \varphi <= 40$$

$$= 0.1, \quad when \quad \varphi > 40$$

$Instr\_Angular\_Response\_Fct\_0.6MeV:$

$$= -1.94686 \cdot 10^{-7} \cdot \varphi^6 + 1.38911 \cdot 10^{-5} \cdot \varphi^5 - 3.70203 \cdot 10^{-4} \cdot \varphi^4 + 4.43077 \cdot 10^{-3} \cdot \varphi^3 - 2.32768 \cdot 10^{-2} \cdot \varphi^2 + 5.08814 \cdot 10^{-2} \cdot \varphi + 1.00741, \quad when \quad 0 <= \varphi <= 20$$

$$= 1.11855 \cdot 10^{-3} \cdot \varphi^2 - 9.48114 \cdot 10^{-2} \cdot \varphi + 2.36814, \quad when \quad 20 < \varphi <= 40$$

$$= 0.365, \quad when \quad \varphi > 40$$

$Instr\_Angular\_Response\_Fct\_1.0MeV:$

$$= 5.94557 \cdot 10^{-6} \cdot \varphi^5 - 2.79531 \cdot 10^{-4} \cdot \varphi^4 + 4.37304 \cdot 10^{-3} \cdot \varphi^3 - 2.60801 \cdot 10^{-2} \cdot \varphi^2 + 5.28193 \cdot 10^{-2} \cdot \varphi + 1.00055, \quad when \quad 0 <= \varphi <= 15$$

$$= -1.44762 \cdot 10^{-6} \cdot \varphi^4 + 1.89333 \cdot 10^{-4} \cdot \varphi^3 - 8.0781 \cdot 10^{-3} \cdot \varphi^2 + 1.11267 \cdot 10^{-1} \cdot \varphi + 0.632857, \quad when \quad 15 < \varphi <= 50$$

$$= 0.62, \quad when \quad \varphi > 50$$

$Instr\_Angular\_Response\_Fct\_3.0MeV:$

$$= -8.333 \cdot 10^{-7} \cdot \varphi^3 - 8.65 \cdot 10^{-4} \cdot \varphi^2 + 1.2333 \cdot 10^{-2} \cdot \varphi + 1.0000, \quad when \quad 0 <= \varphi <= 20$$

$$= 7.4 \cdot 10^{-4} \cdot \varphi^2 - 6.95 \cdot 10^{-2} \cdot \varphi + 1.988, \quad when \quad 20 < \varphi <= 40$$

$$= 0.392, \quad when \quad \varphi > 40$$

$Instr\_Angular\_Response\_Fct\_6.0MeV:$

$$= -1.36667 \cdot 10^{-5} \cdot \varphi^3 - 3.7 \cdot 10^{-4} \cdot \varphi^2 + 8.3666 \cdot 10^{-3} \cdot \varphi + 1.0000, \quad when \quad 0 <= \varphi <= 20$$

$$= 9.85 \cdot 10^{-4} \cdot \varphi^2 - 8.535 \cdot 10^{-2} \cdot \varphi + 2.223, \quad when \quad 20 < \varphi <= 40$$

$$= 0.385, \quad when \quad \varphi > 40$$

where φ*[Degrees] - angle between the boresight and the direction from the spacecraft to the midpoint of the plate*

$$NC\_Angular\_Fct = 2.1568 \cdot 10^{-8} \cdot \beta^4 - 1.4891 \cdot 10^{-6} \cdot \beta^3 - 1.5412 \cdot 10^{-4} \cdot \beta^2 - 1.0227 \cdot 10^{-3} \cdot \beta + 1.0031, \quad 0 <= \beta <= 87$$

$$= 0, \quad \beta > 87$$

where β*[Degrees] - emission angle*

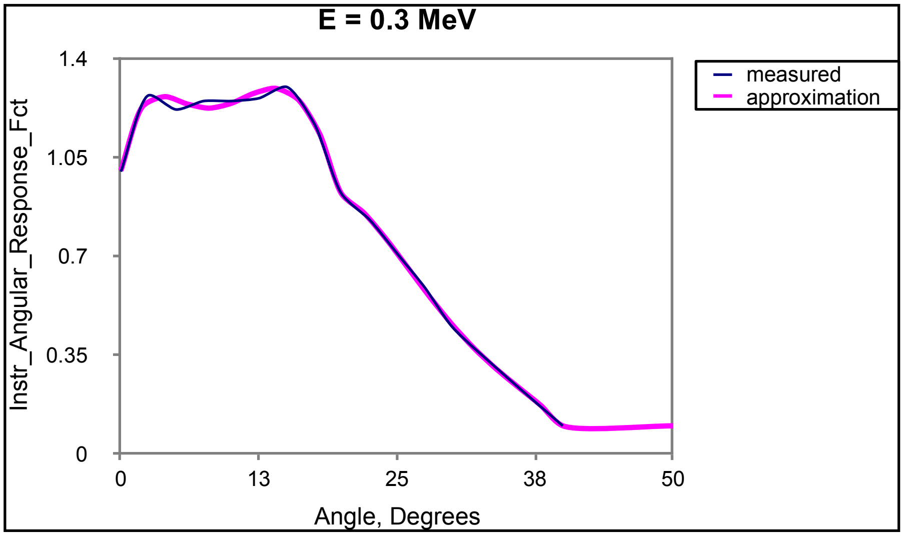


Figure 1. GRS angular response function for radiation 0.3 MeV

Figure 2. GRS angular response function for radiation 0.6 MeV

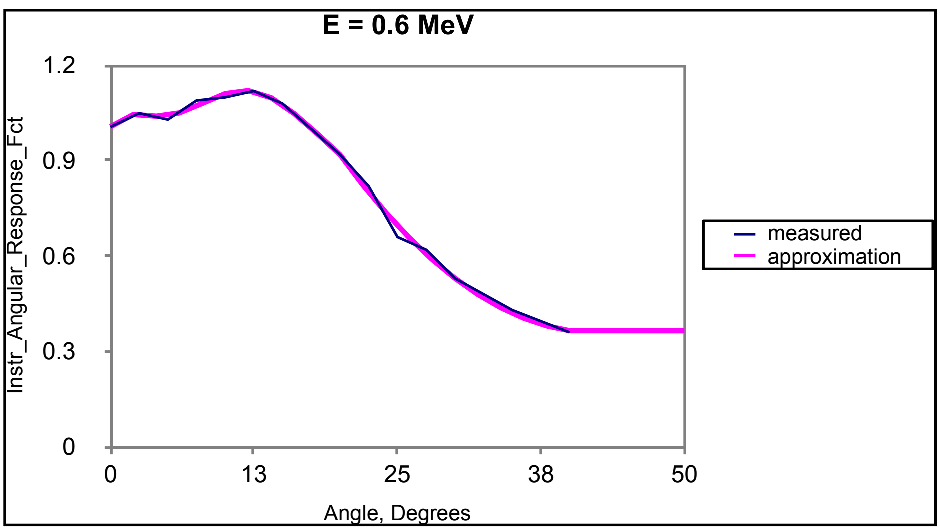
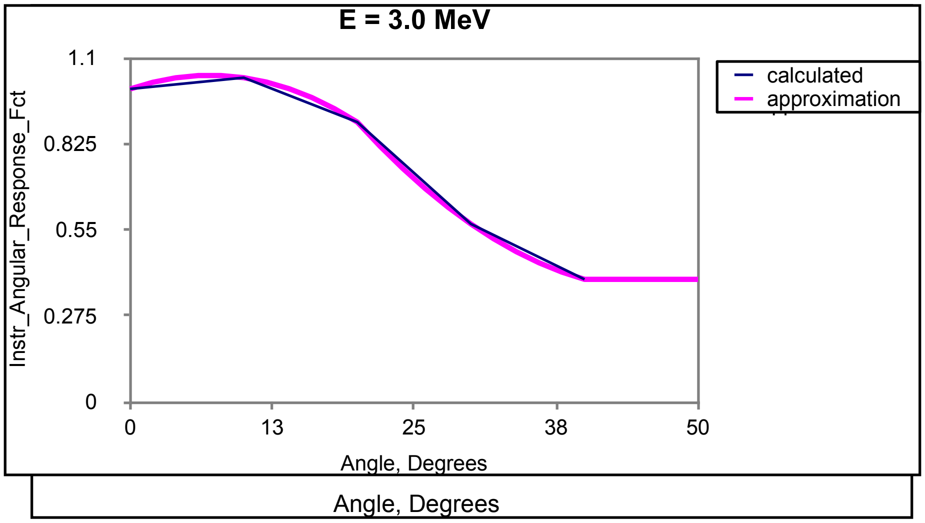


Figure 3. GRS angular response function for radiation 1.0 MeV

Figure 4. GRS angular response function for radiation 3.0 MeV



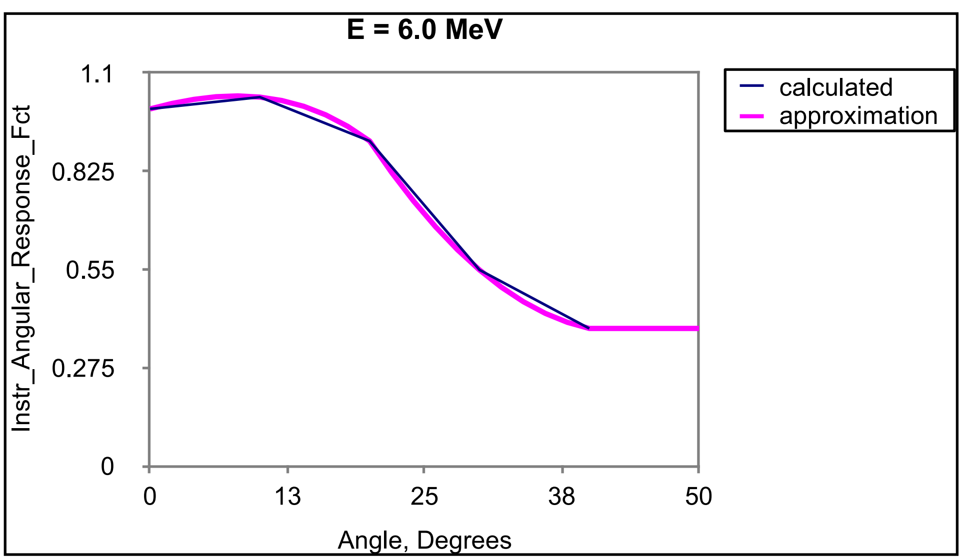
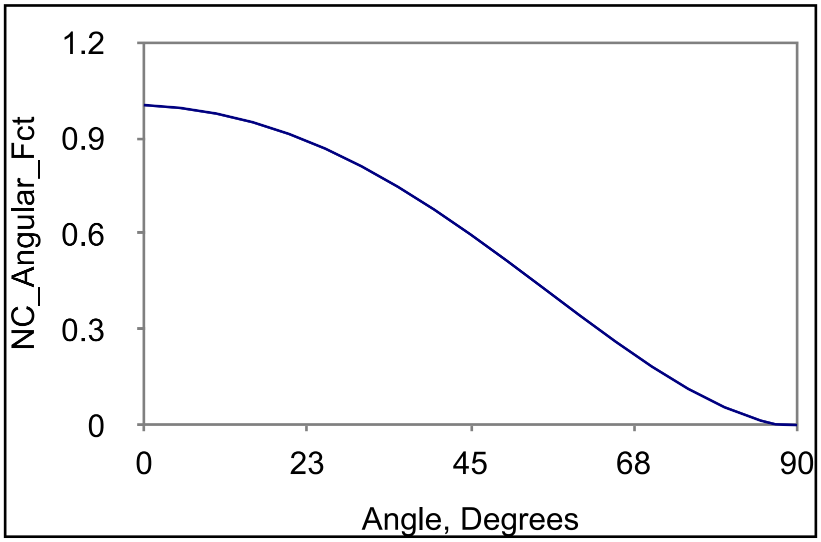


Figure 5. GRS angular response function for radiation 6.0 MeV

Figure 6. Angular dependence of non-elastic scattering and thermal neutron capture



gamma-ray emission from the surface (approximation).

APPENDIX 3 Location of GRS Level-2 Parameters in the U of A Database

E.8. NEAR GRS Science Housekeeping (SCI HK) Parameters: 31*(Integer*4)

No	PARAMETER NAME IN "Requirements Specifications For Level-2 Parameters Required Stored or Derived by The Near Earth Redezvous (NEAR) Gamma-Ray Spectrometer (GRS) Ground System"	PARAMETER NAME IN UA DATABASE	TABLE NAME	DATABASE NAME
0	MET	ACQ_MET_TIME	All tables	All databases
1	UTC	ACQ_UTC_TIME	g_nai_spec_tab, g_bgo_spec_tab, g_anti_coin_spec_tab, g_sgl_esc_sft_nai_spec_tab, g_dbl_esc_sft_nai_spec_tab, g_sgl_esc_pk_bgo_spec_tab, g_dbl_esc_pk_bgo_spec_tab	near_grs_db
			grs_hk_tab	near_hk_db

2	DQI	DQI	index_tab	near_grs_db
3	TIME_TAG	ACQ_MET_TIME	All tables	All databases
4	INTEGRATION_TIME	INT_TIME	g_nai_spec_tab, g_bgo_spec_tab, g_anti_coin_spec_tab, g_sgl_esc_sft_nai_spec_tab, g_dbl_esc_sft_nai_spec_tab, g_sgl_esc_pk_bgo_spec_tab, g_dbl_esc_pk_bgo_spec_tab	near_grs_db
5	BGO_PROTON_FLARE_FLG	BGO_PROTON_FLARE_FLG	grs_hk_tab	near_hk_db
6	BGO_LEVEL_1_SAFE_FLG	LVL1_SENSOR_SAFING_FLAG	g_bgo_spec_tab	near_grs_db
7	BGO_LEVEL_2_SAFE_FLG	LVL2_SENSOR_SAFING_FLAG	g_bgo_spec_tab	near_grs_db
8	NAI_LEVEL_1_SAFE_FLG	LVL1_SENSOR_SAFING_FLAG	g_nai_spec_tab	near_grs_db
9	NAI_LEVEL_2_SAFE_FLG	LVL2_SENSOR_SAFING_FLAG	g_nai_spec_tab	near_grs_db
10	NAI_INT_OVERFLOW_FLG	SPEC_BOF	g_nai_spec_tab	near_grs_db
11	BGO_INT_OVERFLOW_FLG	SPEC_BOF	g_bgo_spec_tab	near_grs_db
12	NAI_ANTICOINCID_OVFL_FLG	SPEC_BOF	g_anti_coin_spec_tab	near_grs_db
13	NAI_SINGLE_ESCP_OVFL_FLG	SPEC_BOF	g_sgl_esc_sft_nai_spec_tab	near_grs_db
14	NAI_DOUBLE_ESCP_OVFL_FLG	SPEC_BOF	g_dbl_esc_sft_nai_spec_tab	near_grs_db
15	BGO_SINGLE_ESCP_OVFL_FLG	SPEC_BOF	g_sgl_esc_pk_bgo_spec_tab	near_grs_db
16	BGO_DOUBLE_ESCP_OVFL_FLG	SPEC_BOF	g_dbl_esc_pk_bgo_spec_tab	near_grs_db
17	NAI_RAW_EVENT_RATE	TOTAL_RAW_EVENT_RATE	g_nai_spec_tab	near_grs_db
18	BGO_RAW_EVENT_RATE	TOTAL_RAW_EVENT_RATE	g_bgo_spec_tab	near_grs_db
19	COINCIDENCE_COUNTER	COIN_COUNTER	g_nai_spec_tab	near_grs_db
20	COMMAND_COUNTER	COMMAND_COUNTER	g_bgo_spec_tab	near_grs_db
21	PROBLEM_COUNTER	PROBLEM_COUNTER	g_bgo_spec_tab	near_grs_db
22	PROBLEM_CODE	PROBLEM_CODE	g_bgo_spec_tab	near_grs_db
23	NUM_NAI_ANTICOINCID_EVENTS	NUM_NAI_EVENTS_WITH_ANTI_COIN	g_nai_spec_tab, g_bgo_spec_tab	near_grs_db
24	NUM_NAI_VALID_EVENTS	NUM_VALID_EVENTS_PROCESSED	g_nai_spec_tab	near_grs_db
25	NUM_BGO_VALID_EVENTS	NUM_VALID_EVENTS_PROCESSED	g_bgo_spec_tab	near_grs_db
26	NAI_DC_OFFSET	DC_OFFSET_EST	g_nai_spec_tab	near_grs_db

27	BGO_DC_OFFSET	DC_OFFSET_EST	g_bgo_spec_tab	near_grs_db
28	NAI_STAND_DEV	STD_DEV	g_nai_spec_tab	near_grs_db
29	BGO_STAND_DEV	STD_DEV	g_bgo_spec_tab	near_grs_db
30	GRAY_DATA_QUALITY_BIT	GRAY_DQI	g_nai_spec_tab	near_grs_db

<u>E.9. NEAR GRS Engineering Housekeeping (ENG HK) Parameters: 152*(REAL*4)</u>

No	PARAMETER NAME IN "Requirements Specifications For Level-2 Parameters Required Stored or Derived by The Near Earth Redezvous (NEAR) Gamma-Ray Spectrometer (GRS) Ground System"	PARAMETER NAME IN UA DATABASE	TABLE NAME	DATABASE NAME
0	DETECTOR_ELECTR_CURR	DETECTOR_ELECTR_CURR	grs_hk_tab	near_hk_db
1	XRAY_PIN_DIODE_FET_BIAS	XRAY_PIN_DIODE_FET_BIAS	grs_hk_tab	near_hk_db
2	HVCE_TEMPERATURE	HVCE_TEMPERATURE	grs_hk_tab	near_hk_db
3	UNF_XRAY_HVPS_VOLT	UNF_XRAY_HVPS_VOLT	grs_hk_tab	near_hk_db
4	MG_XRAY_HVPS_VOLT	MG_XRAY_HVPS_VOLT	grs_hk_tab	near_hk_db
5	AL_XRAY_HVPS_VOLT	AL_XRAY_HVPS_VOLT	grs_hk_tab	near_hk_db
6	XRAY_GAS_HVPS_VOLT	XRAY_GAS_HVPS_VOLT	grs_hk_tab	near_hk_db
7	XRAY_PIN_HVPS_VOLT	XRAY_PIN_HVPS_VOLT	grs_hk_tab	near_hk_db
8	NAI_HVPS_VOLT	NAI_HVPS_VOLT	grs_hk_tab	near_hk_db
9	BGO_HVPS_VOLT	BGO_HVPS_VOLT	grs_hk_tab	near_hk_db
10	DPU_DC_DC_TEMP	DPU_DC_DC_TEMP	grs_hk_tab	near_hk_db
11	XGRS_DC_DC_TEMP	XGRS_DC_DC_TEMP	grs_hk_tab	near_hk_db
12	UNF_XRAY_HVPS_TEMP	UNF_XRAY_HVPS_TEMP	grs_hk_tab	near_hk_db
13	MG_XRAY_HVPS_TEMP	MG_XRAY_HVPS_TEMP	grs_hk_tab	near_hk_db

14	AL_XRAY_HVPS_TEMP	AL_XRAY_HVPS_TEMP	grs_hk_tab	near_hk_db
15	XRAY_GAS_HVPS_TEMP	XRAY_GAS_HVPS_TEMP	grs_hk_tab	near_hk_db
16	XRAY_PIN_HVPS_TEMP	XRAY_PIN_HVPS_TEMP	grs_hk_tab	near_hk_db
17	NAI_HVPS_TEMP	NAI_HVPS_TEMP	grs_hk_tab	near_hk_db
18	BGO_HVPS_TEMP	BGO_HVPS_TEMP	grs_hk_tab	near_hk_db
19	TEC_CURRENT	TEC_CURRENT	grs_hk_tab	near_hk_db
20	NAI_HVPS_VOLT_CMD	NAI_HVPS_VOLT_CMD	grs_hk_tab	near_hk_db
21	BGO_HVPS_VOLT_CMD	BGO_HVPS_VOLT_CMD	grs_hk_tab	near_hk_db
22	UNF_HVPS_VOLT_CMD	UNF_HVPS_VOLT_CMD	grs_hk_tab	near_hk_db
23	MG_HVPS_VOLT_CMD	MG_HVPS_VOLT_CMD	grs_hk_tab	near_hk_db
24	AL_HVPS_VOLT_CMD	AL_HVPS_VOLT_CMD	grs_hk_tab	near_hk_db
25	HVPS_POWER_ON_OFF	HVPS_POWER_ON_OFF	grs_hk_tab	near_hk_db
26	XRAY_CALIB_HOME_FLG	XRAY_CALIB_HOME_FLG	grs_hk_tab	near_hk_db
27	XRAY_CALIB_MOTOR_ON_OFF	XRAY_CALIB_MOTOR_ON_OFF	grs_hk_tab	near_hk_db
28	XRAY_CALIB_MOTOR_ENABLE	XRAY_CALIB_MOTOR_ENABLE	grs_hk_tab	near_hk_db
29	GAS_HVPS_VOLT_CMD	GAS_HVPS_VOLT_CMD	grs_hk_tab	near_hk_db
30	PIN_HVPS_VOLT_CMD	PIN_HVPS_VOLT_CMD	grs_hk_tab	near_hk_db
31	GAMMA_RAY_HEATER_CURR	GAMMA_RAY_HEATER_CURR	grs_hk_tab	near_hk_db
32	spare	spare	grs_hk_tab	near_hk_db
33	XRAY_CALIB_MOTOR_DIR	XRAY_CALIB_MOTOR_DIR	grs_hk_tab	near_hk_db
34	XRAY_CALIB_MOTOR_CURR	XRAY_CALIB_MOTOR_CURR	grs_hk_tab	near_hk_db
35	XRAY_CALIB_MOTOR_GOAL	XRAY_CALIB_MOTOR_GOAL	grs_hk_tab	near_hk_db
36	XRAY_CALIB_MOTOR_POS	XRAY_CALIB_MOTOR_POS	grs_hk_tab	near_hk_db
37	XRAY_CALIB_MOTOR_FID_SENS	XRAY_CALIB_MOTOR_FID_SENS	grs_hk_tab	near_hk_db
38	XRAY_CALIB_MOTOR_FID_BRIT	XRAY_CALIB_MOTOR_FID_BRIT	grs_hk_tab	near_hk_db
39	XRAY_MOTOR_IN_CALIB_POSITION	XRAY_MOTOR_IN_CALIB_POSITION	grs_hk_tab	near_hk_db
40	XRAY_MOTOR_IN_NORM_POSITION	XRAY_MOTOR_IN_NORM_POSITION	grs_hk_tab	near_hk_db
41	ACTIVE_SOLAR_TOGGLE_MODE	ACTIVE_SOLAR_TOGGLE_MODE	grs_hk_tab	near_hk_db
42	XRAY_CALIB_MAX_STEPS	XRAY_CALIB_MAX_STEPS	grs_hk_tab	near_hk_db

43	spare	spare	grs_hk_tab	near_hk_db
44	TEC_ENABLE	TEC_ENABLE	grs_hk_tab	near_hk_db
45	XRAY_CALIB_CUM_MOTOR_STPS	XRAY_CALIB_CUM_MOTOR_STPS	grs_hk_tab	near_hk_db
46	GRAY_BURST_THRESH_VAL	GRAY_BURST_THRESH_VAL	grs_hk_tab	near_hk_db
47	XRAY_SAFING_THRESH	XRAY_SAFING_THRESH	grs_hk_tab	near_hk_db
48	XRAY_CALIB_MOTOR_DIAG	XRAY_CALIB_MOTOR_DIAG	grs_hk_tab	near_hk_db
49	TEC_POWER_ON_OFF	TEC_POWER_ON_OFF	grs_hk_tab	near_hk_db
50	TEC_MODE	TEC_MODE	grs_hk_tab	near_hk_db
51	TEC_COOL_HEAT_FLG	TEC_COOL_HEAT_FLG	grs_hk_tab	near_hk_db
52	TEC_TEMPERATURE	TEC_TEMPERATURE	grs_hk_tab	near_hk_db
53	TEC_COOL_MODE_TEMP_UP_LMT	TEC_COOL_MODE_TEMP_UP_LMT	grs_hk_tab	near_hk_db
54	TEC_COOL_MODE_TEMP_LOW_LMT	TEC_COOL_MODE_TEMP_LOW_LMT	grs_hk_tab	near_hk_db
55	TEC_HEAT_MODE_TEMP_UP_LMT	TEC_HEAT_MODE_TEMP_UP_LMT	grs_hk_tab	near_hk_db
56	TEC_HEAT_MODE_TEMP_LOW_LMT	TEC_HEAT_MODE_TEMP_LOW_LMT	grs_hk_tab	near_hk_db
57	GAMMA_RAY_TEMP_HYSTERESIS	GAMMA_RAY_TEMP_HYSTERESIS	grs_hk_tab	near_hk_db
58	GAMMA_RAY_HEAT_TEMP_LOW_LMT	GAMMA_RAY_HEAT_TEMP_LOW_LMT	grs_hk_tab	near_hk_db
59	FULL_GAMMA_RAY_SCIENCE_MODE	FULL_GAMMA_RAY_SCIENCE_MODE	grs_hk_tab	near_hk_db
60	FULL_XRAY_SCIENCE_MODE	FULL_XRAY_SCIENCE_MODE	grs_hk_tab	near_hk_db
61	SUMM_GRAY_XRAY_SCIENCE_MODE	SUMM_GRAY_XRAY_SCIENCE_MODE	grs_hk_tab	near_hk_db
62	GRAY_BURST_SCI_REC_MODE	GRAY_BURST_SCI_REC_MODE	grs_hk_tab	near_hk_db
63	HVCE_TEMP_SET_POINT	HVCE_TEMP_SET_POINT	grs_hk_tab	near_hk_db
64	CMDED_END_XRAY_INTEG_PER	CMDED_END_XRAY_INTEG_PER	grs_hk_tab	near_hk_db
65	CMDED_GAMMA_RAY_INTEG_PER	CMDED_GAMMA_RAY_INTEG_PER	grs_hk_tab	near_hk_db
66	BGO_PROTON_FLARE_FLG	BGO_PROTON_FLARE_FLG	grs_hk_tab	near_hk_db
67	GAMMA_RAY_BIN_OVER_FLG_CMD	GAMMA_RAY_BIN_OVER_FLG_CMD	grs_hk_tab	near_hk_db
68	UNF_XRAY_BIN_OVER_FLG_CMD	UNF_XRAY_BIN_OVER_FLG_CMD	grs_hk_tab	near_hk_db
69	MG_BIN_OVER_FLG_CMD	MG_BIN_OVER_FLG_CMD	grs_hk_tab	near_hk_db
70	AL_BIN_OVER_FLG_CMD	AL_BIN_OVER_FLG_CMD	grs_hk_tab	near_hk_db
71	ACT_BIN_OVER_FLG_CMD	ACT_BIN_OVER_FLG_CMD	grs_hk_tab	near_hk_db

72	NAI_BIN_OVERFLOW_FLG	NAI_BIN_OVERFLOW_FLG	grs_hk_tab	near_hk_db
73	BGO_BIN_OVERFLOW_FLG	BGO_BIN_OVERFLOW_FLG	grs_hk_tab	near_hk_db
74	NAI_ANTICOIN_OVERFLOW_FLG	NAI_ANTICOIN_OVERFLOW_FLG	grs_hk_tab	near_hk_db
75	NAI_SING_ESC_OVERFLOW_FLG	NAI_SING_ESC_OVERFLOW_FLG	grs_hk_tab	near_hk_db
76	NAI_DOUB_ESC_OVERFLOW_FLG	NAI_DOUB_ESC_OVERFLOW_FLG	grs_hk_tab	near_hk_db
77	BGO_SING_ESC_OVERFLOW_FLG	BGO_SING_ESC_OVERFLOW_FLG	grs_hk_tab	near_hk_db
78	BGO_DOUB_ESC_OVERFLOW_FLG	BGO_DOUB_ESC_OVERFLOW_FLG	grs_hk_tab	near_hk_db
79	UNF_XRAY_BIN_OVERFLOW_FLG	UNF_XRAY_BIN_OVERFLOW_FLG	grs_hk_tab	near_hk_db
80	MG_BIN_OVERFLOW_FLG	MG_BIN_OVERFLOW_FLG	grs_hk_tab	near_hk_db
81	AL_BIN_OVERFLOW_FLG	AL_BIN_OVERFLOW_FLG	grs_hk_tab	near_hk_db
82	ACT_BIN_OVERFLOW_FLG	ACT_BIN_OVERFLOW_FLG	grs_hk_tab	near_hk_db
83	GAMMA_RAY_HEAT_ON_OFF	GAMMA_RAY_HEAT_ON_OFF	grs_hk_tab	near_hk_db
84	GAMMA_RAY_HEAT_MODE	GAMMA_RAY_HEAT_MODE	grs_hk_tab	near_hk_db
85	BGO_LEVEL_1_SAFING_FLG	BGO_LEVEL_1_SAFING_FLG	grs_hk_tab	near_hk_db
86	BGO_LEVEL_2_SAFING_FLG	BGO_LEVEL_2_SAFING_FLG	grs_hk_tab	near_hk_db
87	spare	spare	grs_hk_tab	near_hk_db
88	XRAY_INTEGR_TIME	XRAY_INTEGR_TIME	grs_hk_tab	near_hk_db
89	HVPS_ON_OFF	HVPS_ON_OFF	grs_hk_tab	near_hk_db
90	PIN_SENSOR_MASK_FLG	PIN_SENSOR_MASK_FLG	grs_hk_tab	near_hk_db
91	GAS_SENSOR_MASK_FLG	GAS_SENSOR_MASK_FLG	grs_hk_tab	near_hk_db
92	AL_SENSOR_MASK_FLG	AL_SENSOR_MASK_FLG	grs_hk_tab	near_hk_db
93	MG_SENSOR_MASK_FLG	MG_SENSOR_MASK_FLG	grs_hk_tab	near_hk_db
94	UNF_SENSOR_MASK_FLG	UNF_SENSOR_MASK_FLG	grs_hk_tab	near_hk_db
95	BGO_SENSOR_MASK_FLG	BGO_SENSOR_MASK_FLG	grs_hk_tab	near_hk_db
96	NAI_SENSOR_MASK_FLG	NAI_SENSOR_MASK_FLG	grs_hk_tab	near_hk_db
97	UNF_XRAY_RISE_TIME_THRESH	UNF_XRAY_RISE_TIME_THRESH	grs_hk_tab	near_hk_db
98	MG_RISE_TIME_THRESH	MG_RISE_TIME_THRESH	grs_hk_tab	near_hk_db
99	AL_RISE_TIME_THRESH	AL_RISE_TIME_THRESH	grs_hk_tab	near_hk_db
100	GAS_RISE_TIME_THRESH	GAS_RISE_TIME_THRESH	grs_hk_tab	near_hk_db

101	UNF_RISE_TIME_VALID_THRESH	UNF_RISE_TIME_VALID_THRESH	grs_hk_tab	near_hk_db
102	MG_RISE_TIME_VALID_THRESH	MG_RISE_TIME_VALID_THRESH	grs_hk_tab	near_hk_db
103	AL_RISE_TIME_VALID_THRESH	AL_RISE_TIME_VALID_THRESH	grs_hk_tab	near_hk_db
104	GAS_RISE_TIME_VALID_THRESH	GAS_RISE_TIME_VALID_THRESH	grs_hk_tab	near_hk_db
105	GAMMA_RAY_INTEGR_TIME	GAMMA_RAY_INTEGR_TIME	grs_hk_tab	near_hk_db
106	GAMMA_SING_ESC_WIND_CENTER	GAMMA_SING_ESC_WIND_CENTER	grs_hk_tab	near_hk_db
017	GAMMA_SING_ESC_WIND_WIDTH	GAMMA_SING_ESC_WIND_WIDTH	grs_hk_tab	near_hk_db
108	GAMMA_DOUB_ESC_WIND_CENTER	GAMMA_DOUB_ESC_WIND_CENTER	grs_hk_tab	near_hk_db
109	GAMMA_DOUB_ESC_WIND_WIDTH	GAMMA_DOUB_ESC_WIND_WIDTH	grs_hk_tab	near_hk_db
110	NAI_LOW_LEVEL_AMPL_THRESH	NAI_LOW_LEVEL_AMPL_THRESH	grs_hk_tab	near_hk_db
111	BGO_LOW_LEVEL_AMPL_THRESH	BGO_LOW_LEVEL_AMPL_THRESH	grs_hk_tab	near_hk_db
112	UNF_LOW_LEVEL_AMPL_THRESH	UNF_LOW_LEVEL_AMPL_THRESH	grs_hk_tab	near_hk_db
113	MG_LOW_LEVEL_AMPL_THRESH	MG_LOW_LEVEL_AMPL_THRESH	grs_hk_tab	near_hk_db
114	AL_LOW_LEVEL_AMPL_THRESH	AL_LOW_LEVEL_AMPL_THRESH	grs_hk_tab	near_hk_db
115	GAS_LOW_LEVEL_AMPL_THRESH	GAS_LOW_LEVEL_AMPL_THRESH	grs_hk_tab	near_hk_db
116	PIN_LOW_LEVEL_AMPL_THRESH	PIN_LOW_LEVEL_AMPL_THRESH	grs_hk_tab	near_hk_db
117	GAMMA_RAY_SENSOR_TEMP	GAMMA_RAY_SENSOR_TEMP	grs_hk_tab	near_hk_db
118	NAI_LEVEL_1_SAFING_FLG	NAI_LEVEL_1_SAFING_FLG	grs_hk_tab	near_hk_db
119	UNF_LEVEL_1_SAFING_FLG	UNF_LEVEL_1_SAFING_FLG	grs_hk_tab	near_hk_db
120	MG_LEVEL_1_SAFING_FLG	MG_LEVEL_1_SAFING_FLG	grs_hk_tab	near_hk_db
121	AL_LEVEL_1_SAFING_FLG	AL_LEVEL_1_SAFING_FLG	grs_hk_tab	near_hk_db
122	GAS_LEVEL_1_SAFING_FLG	GAS_LEVEL_1_SAFING_FLG	grs_hk_tab	near_hk_db
123	PIN_LEVEL_1_SAFING_FLG	PIN_LEVEL_1_SAFING_FLG	grs_hk_tab	near_hk_db
124	NAI_LEVEL_2_SAFING_FLG	NAI_LEVEL_2_SAFING_FLG	grs_hk_tab	near_hk_db
125	UNF_LEVEL_2_SAFING_FLG	UNF_LEVEL_2_SAFING_FLG	grs_hk_tab	near_hk_db
126	MG_LEVEL_2_SAFING_FLG	MG_LEVEL_2_SAFING_FLG	grs_hk_tab	near_hk_db
127	AL_LEVEL_2_SAFING_FLG	AL_LEVEL_2_SAFING_FLG	grs_hk_tab	near_hk_db
128	GAS_LEVEL_2_SAFING_FLG	GAS_LEVEL_2_SAFING_FLG	grs_hk_tab	near_hk_db
129	PIN_LEVEL_2_SAFING_FLG	PIN_LEVEL_2_SAFING_FLG	grs_hk_tab	near_hk_db

130	XRAY_SENS_SAFING_REST_LEVEL	XRAY_SENS_SAFING_REST_LEVEL	grs_hk_tab	near_hk_db
131	GAMMA_SENS_SAFING_REST_LEVEL	GAMMA_SENS_SAFING_REST_LEVEL	grs_hk_tab	near_hk_db
132	XRAY_SAFING_REST_MAX_RETRY	XRAY_SAFING_REST_MAX_RETRY	grs_hk_tab	near_hk_db
133	GAMMA_SAFING_REST_MAX_RETRY	GAMMA_SAFING_REST_MAX_RETRY	grs_hk_tab	near_hk_db
134	GAMMA_HEATER_DUTY_CYCLE	GAMMA_HEATER_DUTY_CYCLE	grs_hk_tab	near_hk_db
135	GAMMA_SENS_SAFING_THRESH	GAMMA_SENS_SAFING_THRESH	grs_hk_tab	near_hk_db
136	HVPS_CURRENT	HVPS_CURRENT	grs_hk_tab	near_hk_db
137	BGO_PROTON_FLARE_THRESH	BGO_PROTON_FLARE_THRESH	grs_hk_tab	near_hk_db
138	VERSION_NUMBER	VERSION_NUMBER	grs_hk_tab	near_hk_db
139	NAI_SPECTRUM_0	SPECTRUM_0	g_nai_spec_tab	near_grs_db
140	HW_NAI_RAW	HW_RAW	g_nai_spec_tab	near_grs_db
141	NAI_HIGH_ENERGY	HIGH_ENERGY	g_nai_spec_tab	near_grs_db
142	BGO_SPECTRUM_0	SPECTRUM_0	g_bgo_spec_tab	near_grs_db
143	HW_BG	HW_RAW	g_bgo_spec_tab	near_grs_db
144	BGO_HIGH_ENERGY	HIGH_ENERGY	g_bgo_spec_tab	near_grs_db
145	NAI_ANTICOIN_SPECTRUM_0	SPECTRUM_0	g_anti_coin_spec_tab	near_grs_db
146	HW_NAI_ANTICOIN	HW_RAW	g_anti_coin_spec_tab	near_grs_db
147	NAI_ANTICOIN_HIGH_ENERGY	HIGH_ENERGY	g_anti_coin_spec_tab	near_grs_db
148	SINGLE_ESC_SPECTRUM_0	SPECTRUM_0	g_sgl_esc_sft_nai_spec_tab	near_grs_db
149	SINGLE_ESC_HIGH_ENERGY	HIGH_ENERGY	g_sgl_esc_sft_nai_spec_tab	near_grs_db
150	DOUBLE_ESC_SPECTRUM_0	SPECTRUM_0	g_dbl_esc_sft_nai_spec_tab	near_grs_db
151	DOUBLE_ESC_HIGH_ENERGY	HIGH_ENERGY	g_dbl_esc_sft_nai_spec_tab	near_grs_db

E.10. NEAR GRS Derived Engineering (DER ENG) Parameters: 17*(Real*4), 1*(Integer*4), 1*(4*Integer*4)

No	PARAMETER NAME IN "Requirements Specifications For Level-2 Parameters Required Stored or Derived by The Near Earth Redezvous (NEAR) Gamma-Ray Spectrometer (GRS) Ground System"	PARAMETER NAME IN UA DATABASE	TABLE NAME	DATABASE NAME
4	REAL_GAIN_BGO	BGO_GAIN	grs_calib_tab	near_grs_db
5	REAL_GAIN_NAI	NAI_GAIN	grs_calib_tab	near_grs_db
6	REAL_ZERO_BGO	BGO_ZERO	grs_calib_tab	near_grs_db
7	REAL_ZERO_NAI	NAI_ZERO	grs_calib_tab	near_grs_db
17	BAD_FLAG	BAD_CODE	grs_calib_tab	near_grs_db

E.11. NEAR GRS Spatial (SPATIAL) Parameters: 1*(Integer*4), 32*(Real*4)

No	PARAMETER NAME IN "Requirements Specifications For Level-2 Parameters Required Stored or Derived by The Near Earth Redezvous (NEAR) Gamma-Ray Spectrometer (GRS) Ground System"	PARAMETER NAME IN UA DATABASE	TABLE NAME	DATABASE NAME
0	MET	ACQ_MET_TIME	s_grs_spatial_tab	near_spatial_db
1	PLATEID_BORESITE_INTERSECT	BSIGHT_PLATE_ID	s_grs_spatial_tab	near_spatial_db
2	BINID_BORESIGHT_INTERSECT	BSIGHT_BIN_ID	s_grs_spatial_tab	near_spatial_db
3	SC_POSITION, X	SC_POS_X	s_grs_spatial_tab	near_spatial_db
4	SC_POSITION, Y	SC_POS_Y	s_grs_spatial_tab	near_spatial_db
5	SC_POSITION, Z	SC_POS_Z	s_grs_spatial_tab	near_spatial_db
6	BS_VECTOR, X	BSIGHT_X	s_grs_spatial_tab	near_spatial_db
7	BS_VECTOR, Y	BSIGHT_Y	s_grs_spatial_tab	near_spatial_db
8	BS_VECTOR, Z	BSIGHT_Z	s_grs_spatial_tab	near_spatial_db
9	FOV_STATUS	FOV_STATUS	s_grs_spatial_tab	near_spatial_db
10	DOWNLINK_STATUS	DOWNLINK_FLAG	s_grs_spatial_tab	near_spatial_db
11	AVERAGE_SC_DISTANCE	AVG_SC_DISTANCE	s_grs_spatial_tab	near_spatial_db
12	AVERAGE_EMISSION_ANGLE	AVG_EMI_ANGLE	s_grs_spatial_tab	near_spatial_db
13	TOTAL_EFF_SOLID_ANGLE	TOT_EFF_SOLID_ANGLE	s_grs_spatial_tab	near_spatial_db

14	TOTAL_AREA_FOOTPRINT	TOT_AREA	s_grs_spatial_tab	near_spatial_db
15	TOTAL_VISIBLE_AREA	TOT_VIS_AREA	s_grs_spatial_tab	near_spatial_db
16	FOOTPRINT_SOLID_ANGLE	TOT_SOLID_ANGLE	s_grs_spatial_tab	near_spatial_db
17	NR_WEIGHT_0.3MEV	NR_WEIGHT_03	s_grs_spatial_tab	near_spatial_db
18	NC_WEIGHT_0.3MEV	NC_WEIGHT_03	s_grs_spatial_tab	near_spatial_db
19	NR_WEIGHT_0.6MEV	NR_WEIGHT_06	s_grs_spatial_tab	near_spatial_db
20	NC_WEIGHT_0.6MEV	NC_WEIGHT_06	s_grs_spatial_tab	near_spatial_db
21	NR_WEIGHT_1.0MEV	NR_WEIGHT_10	s_grs_spatial_tab	near_spatial_db
22	NC_WEIGHT_1.0MEV	NC_WEIGHT_10	s_grs_spatial_tab	near_spatial_db
23	NR_WEIGHT_3.0MEV	NR_WEIGHT_30	s_grs_spatial_tab	near_spatial_db
24	NC_WEIGHT_3.0MEV	NC_WEIGHT_30	s_grs_spatial_tab	near_spatial_db
25	NC_WEIGHT_6.0MEV	NC_WEIGHT_60	s_grs_spatial_tab	near_spatial_db
26	BORESIGHT_INTERSECT_LAT	BSIGHT_INTSECT_LAT	s_grs_spatial_tab	near_spatial_db
27	BORESIGHT_INTERSECT_LON	BSIGHT_INTSECT_LON	s_grs_spatial_tab	near_spatial_db
28	BORESIGHT_INTERSECT_R	BSIGHT_INTSECT_R	s_grs_spatial_tab	near_spatial_db
29	SPICE_KERNEL_ID	SPICE_ID	s_grs_spatial_tab	near_spatial_db
30	PLATE_MODEL_ID	PLATE_MODEL_ID	s_grs_spatial_tab	near_spatial_db
31	PROCESSING_SOFTWARE_ID	SPATIAL_SOFTWARE_ID	s_grs_spatial_tab	near_spatial_db
32	DATABASE_VERSION_ID	DB_VERSION	s_grs_spatial_tab	near_spatial_db

G. Listing of Parameters for GRS Fractional Footprint Accounting System

No	PARAMETER NAME IN "Requirements Specifications For Level-2 Parameters Required Stored or Derived by The Near Earth Redezvous (NEAR) Gamma-Ray Spectrometer (GRS) Ground System"	PARAMETER NAME IN UA DATABASE	TABLE NAME	DATABASE NAME
0	MET	ACQ_MET_TIME	s_grs_overlap_tab	near_spatial_db
1	FOOTPRINT_BIN_TOTAL_AREA	TOT_AREA	s_grs_overlap_tab	near_spatial_db

2	FOOTPRINT_BIN_VISIBLE_AREA	TOT_VIS_AREA	s_grs_overlap_tab	near_spatial_db
3	TOTAL_EFF_SOLID_ANGLE_FRACTION	TOT_EFF_SOLID_ANGLE_FRACTION	s_grs_overlap_tab	near_spatial_db
4	NR_SPECTRUM_FRACTION	NR_SPECTRUM_FRACTION	s_grs_overlap_tab	near_spatial_db
5	NC_SPECTRUM_FRACTION	NC_SPECTRUM_FRACTION	s_grs_overlap_tab	near_spatial_db
6	BINID	BIN_ID	s_grs_overlap_tab	near_spatial_db

NEAR GRS Requirements Specs Revision Notes

NEAR XGRS Team Meeting, September 15, 1999, (Version 7 Upgrades)

1.	Pg.3	Removed 2 Eng_hk redundant parameters from record: Formats 1 and 2: Eng_HK changed from 154 to 152 total parameters. Two parameters: gray_burst_thresh_val: Partition Offset (46,139) kept at 46 gray_burst_sci_rec_mode: positions (62,140) kept at 62 Related: Forced changes in E.9 title (pg.6) and list (Pg.9), H.9 (title) pg.13 Modified SCIHK for new V7 totals
2.	Pg.6	Added 6 SCI_HK parameters E.8 and labeled for version 7 sofware upgrade.
3.	Pg.9	Added 14 ENG_HK parameters E.9 and labeled for version 7 software upgrade.
4.	Pg.9	E.10 BADID and QUERYID is a total 5*(I*4) field in Title
5.	Pg.12	Added elaboration of 6 BINID to section G. (Fractional Footprint Accounting System)
6.	Pg.13	Modified Live Time Eqns for NAI, BGO
7.	Pg.21	Corrected Boresite intersection point for Lat-lon-R eqns Spatial Partition Offsets (32,33,34) Resp. -1. designates 180 degree rotation in longitude to match Cornell from test data
8.	Pg.15	Changed Bsite km to normal
9.	Pg.29	Added elaboration of 6 BINID to section J. See item 5. (Fractional Footprint Accounting System)
10.	Pg.32	* Need to make eqn mods for Instrument_Angular_Response_Fct_0.3Mev, 20<phi<=40. Modification is not made. (Appendix 2)
11.		Modified all occurences of NAL_ to NAI_

October 18, 1999 Following revision is suggested.

1.	Pg.3		FORMAT 1: Position of escape windows is added to the description of valid Derived Eng. Record parameters.
2.	Pg.4		FORMAT 3: “summed” is added to the description of spectra.
3.	Pg.10	E.10.:	Param.14-15: “NOT VALID IF NOT CALIBRATED” note is removed.
4.	Pg.13	H.9,title:	Number of parameters in Eng.HK is changed from 154 to 152
5.	Pg.13	H.10.:	In description of param.8-9 eng.param.names are adjusted.
6.	Pg.13-14	H.10.:	Param.10-13 definition is modified in accordance with new spectrum limits. Derivation algorithm is added.
7.	Pg.14	H.10.:	Param.14-15 (Pos_Esc_1,Pos_Esc_2): units are changed to keV Derivation algorithm is added.
8.	Pg.14	H.10.:	Param.16: “NAI_INTEGRAL(I)” is replaced by “NAI(I)”
9.	Pg.15	H.11.:	In param.3-8 description light time correction NEAR-Eros is removed.
10.	Pg.15	H.11:	Param.9: Derivation algorithm is added.
11.	Pg.15-21	H.11.:	Param.11-13,15-25: Added comment “Fractions of the plates are considered”.
12.	Pg.21	H.11.:	Param.27: specifications for Boresight_Intersection_Lon are changed.
13.	Pg.23	I.8.:	Insignificant changes in description of param.7-10.
14.	Pg.28-29	J.:	Param.2-5: Added comment “Fractions of the plates are considered”.
15.	Pg.32	App.2:	Instrument_Angular_Response_Fct_0.3Mev, 20<phi<=40: 1.04087*10^(-1) is changed to 1.04087 (in accordance with revision note 10 of September 15, 1999)
16.	Pg.36		Revision notes are added

17. Pg.37 Pending issues are added
18. Pg.i Table of contents is added

January 25, 2000. Following revision is suggested.

1. H10, param.12: (Eng_HK:111)*3.4+3 is replaced with (Eng_HK:111)
   Param.13: (Eng_HK:110)*3.4+3 is replaced with (Eng_HK:110)
2. H10, param.16: integration is changed to energy range instead of channel range
3. H11, param.14-15: discription of fractions added
4. H11, param.26-27: "degrees" added
5. J, param.1-2: description of fractions added
6. Appendix 1.: some symbols definitions are added

April 6-7, 2000. Following revision is suggested.

1. E8, param.26-29: description is clarified
2. E9, param.101-104,106,108,110,111: description is clarified.
3. E11, H11, param.14: set to –1 all the time.
4. G, J, param.1: set to –1 all the time.
5. H10, param.16: description is clarified.
7. Appendix 3 is added

May 25, 2001 Revisions

1. Renamed all Level-1 references to Level-2.

NEAR GRS Glossary and Acronym List

AL	X-ray Spectrometer: Aluminum Detector
ANTICO	Gamma-ray Spectrometer: Anti-Coincidence
APL	Applied Physics Laboratory
AVG	Average
BGO	Bismuth Germanate
CH	Channel
CMD	Command
CTP	Command and Telemetry Processing
DER	Derived Engineering
DPU	Data Processing Unit
DSN	Deep Space Network
DQI	Data Quality Index
ENG	Engineering
ESC	Escape
ET	Ephemeris Time
FCT	Function
FLG	Flag
FOV	Field of View
FTP	File Transfer Protocol
GCR	Galactic Cosmic Rays
GAS PC	Gas Proportional Counter Detector
GRS	Gamma Ray Spectrometer
GSFC	Goddard Space Flight Center
LT	Light Time
HDF	Hierarchical Data Format
HK	Space Craft or Instrument **H**ouse **K**eeping Parameters
HVPS	High Voltage Power Supply
I*4	Signed Integer 4 byte parameter = 32 bits
JPL	Jet Propulsion Laboratory
keV	Kilo Electron Volts
LLD	Lower Level Discriminator
MET	Mission Elapsed Time
MeV	Mega Electron Volts
MG	X ray Spectrometer: Magnesium Detector
NAI	Sodium Iodide
NAIF	Nasa Ancillary Information Facility
NASA	National Aeronautics and Space Administration
NC	Neutron Capture Radiation
NR	Natural Radioactivity Radiation
NEAR	Near Earth Asteroid Rendezvous
POS	Position
PIN	X-ray Spectrometer: Silicon PIN Detector
QueryID	**Q**uery **ID**entifier file served by Relational Database Management System

R*4	Floating Point 4 byte Parameter = 32 bits
RDBMS	Relational Database Management System
RT	Rise Time
SC	Space Craft
SCI	Science

GRS Glossary and NEAR Acronym List Cont.

SDC	Applied Physics Laboratory Science Data Center
SPICE	**S**pacecraft – **P**lanetary – **I**nstrument – **C**-matrix – **E**phemerides
TBD	To Be Decided
UA	University of Arizona
UA-LPL	University of Arizona – Lunar and Planetary Laboratory
UA-RDBMS	University of Arizona – Relational Database Management System
UNF	X-ray Spectrometer: Unfiltered Detector
WWW	World Wide Web
XDR	e**X**ternal **D**ata **R**epresentation
XGRS	X-ray and Gamma-ray Spectrometer
XRS	X-ray Spectrometer