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IDB Database Tables

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ABSTRACT

The International Database of Reference Gamma-Ray Spectra of Various Nuclear Matter is designed to hold curated gamma spectral data is hosted by the International Atomic Energy Agency on its public facing web site. The database used to hold the spectral data was designed by Sandia National Labs under the auspices of the State Department's Support Program. This document describes the tables and entity relationships that make up the database.

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ACRONYMS AND TERMS

Acronym/Term	Definition
ERD	Entity Relationship Diagram
IDB	International Database of Gamma
MOX	Mixed oxide
PU	Plutonium
U	Uranium

1. INTRODUCTION

This document describes the tables and relationships that make up the international database (IDB) of gamma-ray spectra.[1] The IDB is designed to hold curated gamma-ray spectral data that has been formatted in the manner described in a companion document, Preparation of the IDB Spectra, v.3. The relationships and data naming conventions described in the companion document are broadly maintained in the database and are not, therefore, repeated in this document. Instead, this document describes how the table relationships in the IDB match the relationships described in the companion document. It also describes some helper tables added to the database which are identified and described in the alphabetical listing of tables given in the final section.

This document uses entity relationship diagrams (ERD) to show how the main tables in the IDB are related to one another. Each main table is the progenitor of a family of related tables; later sections of this document show how tables within each family are related to each other.

Finally, an alphabetical listing of the IDB tables is provided. The listing also includes a brief description of the data each table holds, and highlights any foreign key relationships the table has with other tables in the IDB.

The remainder of this introductory section explains conventions used in the IDB and describes how the database tables can be grouped into families of tables. Each family of tables corresponds to one of the data files from which the data is imported into the IDB.[2]

1.1. IDB Conventions

This subsection describes the conventions used in the IDB; they are:

1. All table names end with the string _table.
2. All tables have a technical key whose column name is the same as the table name except that the ending _table in the table name is replaced with the string _id in the column name. For example, the detector_table has a technical key column named detector_id.
3. All technical keys are autogenerated by the database system.
4. All foreign key constraints are made on the technical key of the table
5. All foreign key constraints are named fk_<table with the constraint>_column relating the tables. For example, fk_measurement_table_configuration is the name of the constraint on the measurement table that requires that any value entered in the measurement table's configuration column be a valid configuration_id in the configuration table.
6. All unique constraints are named uq_<table with the constraint>_<column that must be unique>. For example, uq_configuration_table_detector_distance requires that the combination of values in the detector_id and distance columns in the configuration table be unique.

1.2. Families of Tables

Each batch of spectral data that is to be loaded in the database is contained in five files. Three of the five files contain various parts of the actual spectral data, one of the files contains information about the sources (or certificates) used when the spectral data was measured, and the fifth file contains

[1] International Database of Reference Gamma-Ray Spectra of Various Nuclear Matter

[2] A complete set of loadable data contains five csv files; however, three csv files (spectrum_metadata, spectrum_checksum_metadata, spectrum_counts_metadata) are treated as one family of data when the data is imported.

information about how the measurement was made (e.g., detector, sample). Each of the three parts of the data (spectra, source or certificate, measurement) define one family of tables in the IDB. The data contained in the *source_metadata* file is loaded into tables in the certificate family of tables; the data in the *measurement_metadata* file is loaded into tables in the measurement family of tables, and the data in the *spectrum_metadata***,** *spectrum_counts_metadata***,** and *spectrum_checksum_metadata* files are loaded into the spectrum family of tables.

The data is loaded into families of tables to minimize duplication of data in the IDB. For example, the current IDB has more than 200 measurement entries, but there are only three different entries for the form of the material (powder, pellet, or empty string).

2. ENTITY RELATIONSHIP DIAGRAMS

ERDs are used to show how tables in the IDB are related to each other. The main tables' ERD shows how the main tables (source or certificate, measurement, spectrum) are related, and the three following diagrams show how those three main tables are each connected to its own family of tables.

2.1. Main Tables ERD

Figure 1 shows the relationships between the main tables of the IDB. The certificate_table is the main table in the certificate family of tables which contains data from the *source_metadata* file. The measurement_table is the main table in the measurement family of tables which contains data from the *measurement_metadata* data file. If a measurement has certificate (source) information, then there will be a non-null entry in the certificate_id column of the measurement table. The relation between the measurement table and the spectral data is slightly more complicated because multiple spectra may have been generated from one measurement setup, either with the same or with different detector settings. The spectrum_measurement_table allows one measurement not only to be associated with multiple spectra, but also to be associated with spectra for which most measurement variables are constant, but some detector settings may have changed (see Figure 6). Figure 1 also shows that the measurement family of tables includes two sub-families; one sub-family describes the sample used in the measurement, and the other sub-family describes the measurement configuration (e.g., what detector and what geometry).

Generally, joins between tables in two different families must be done using a join on the main tables in both families before doing additional joins within the family of tables to include non-main tables. For example, to find all spectra whose sample was in powder form, one would join the sample_material_form_table row, whose entry is 'powder', with the sample_table and then with the measurement_table, which can be joined to the spectrum_measurement_table, and finally, to the spectrum_acquisition_table to identify the spectra. If the actual count data is needed, then a further join to the spectrum_counts_table could retrieve that information.

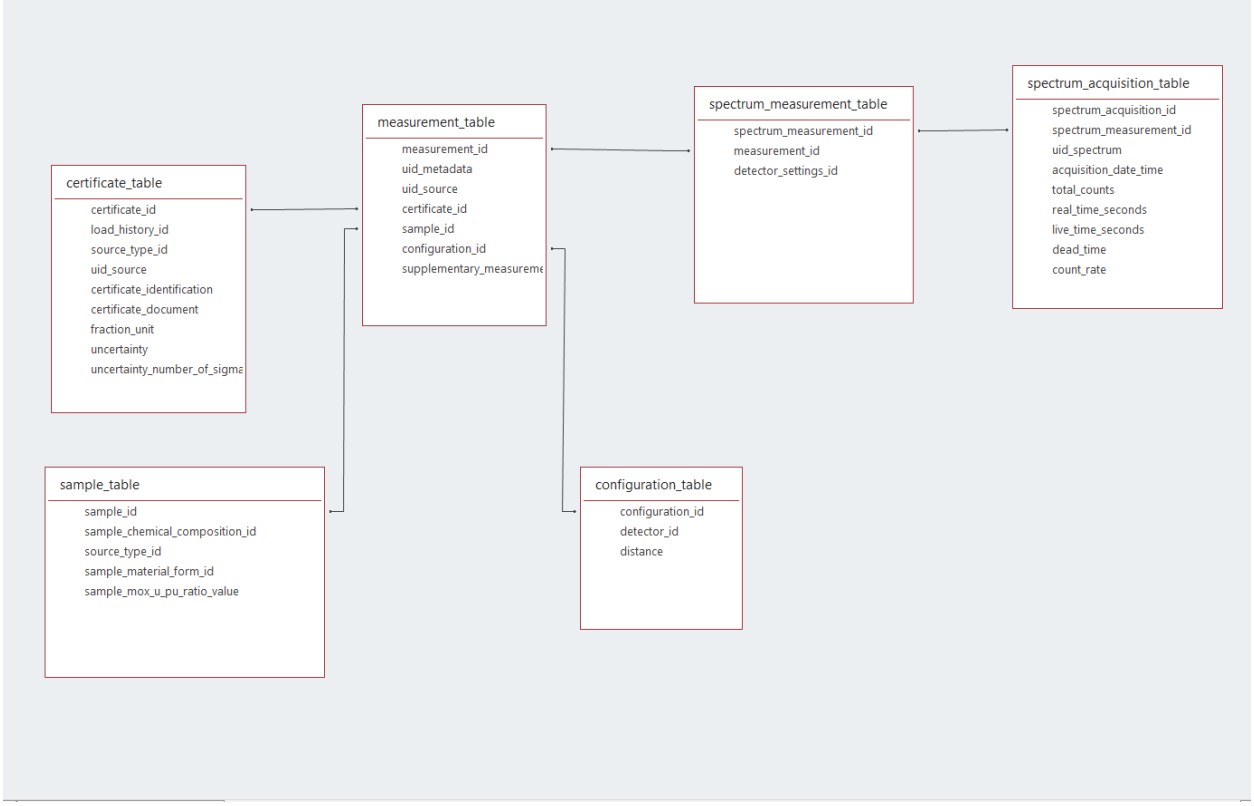

Figure 1 Main Tables Entity Relationship Diagram

2.2. Source (Certificate) Tables ERD

Figure 2 shows the ERD for the source family of tables. The certificate_table is the main table in the source family of tables and contains information that is common to all types of source. The main child tables of the certificate_table have a one-to-one relationship with the certificate table via the certificate_id column and contain details of the source being described. Information used to describe the source (e.g., which isotopes are measured) is varied and will have detailed information in multiple tables. There are separate tables for each of the three current source types: plutonium (PU), uranium (U), and mixed oxide (MOX).

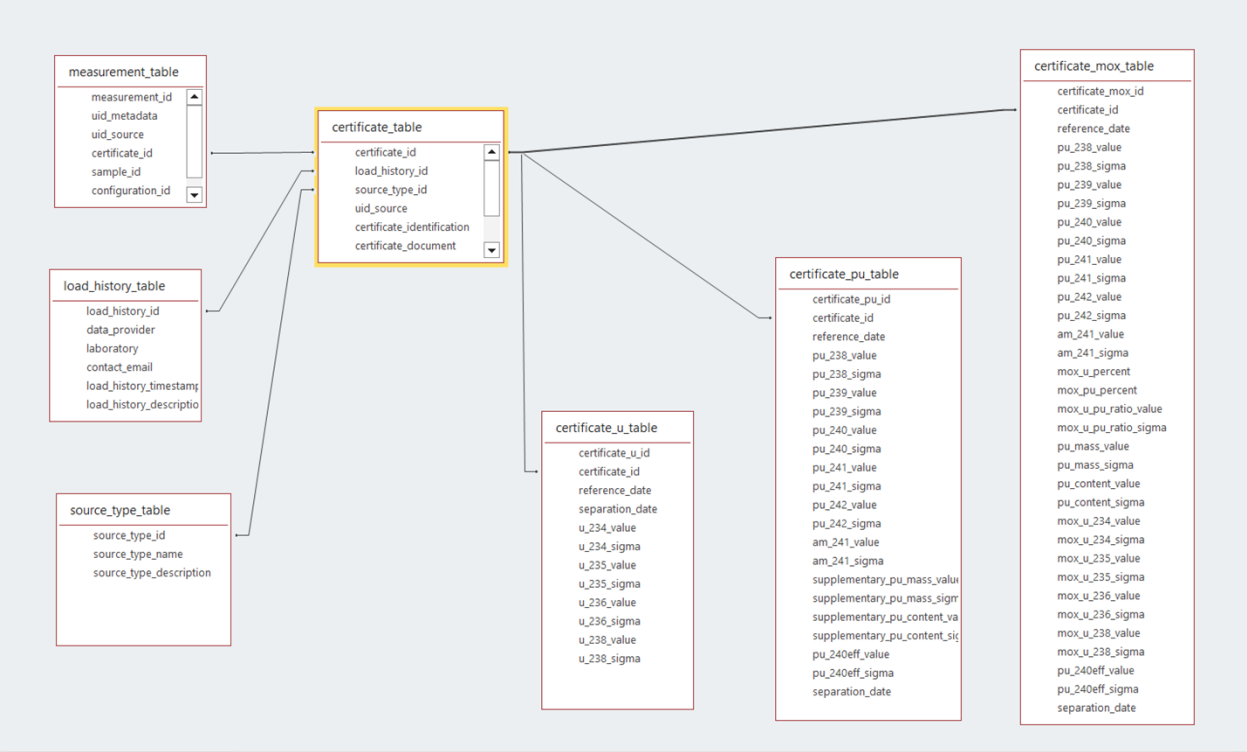

Figure 2 Source Tables Entity Relationship Diagram

Apart from its many-to-one relation with the measurement_table, the certificate_table also has a many-to-one relationship with the load_history_table and a one-to-many relation with the sample_table. The load_history_table contains a history of all sets of data that have been added to the database and currently has the entries shown in Figure 3.

load_history_id	data_provider	laboratory	contact_email	load_history_timestamp	load_history_description
1	United States Support Program	(NULL)	(NULL)	2023-11-16 19:54:00	Initial load, PU LLNL data from 29 August 2023
2	United States Support Program	(NULL)	(NULL)	2023-11-16 19:54:32	Initial load, U LLNL data from 29 August 2023
3	United States Support Program	(NULL)	(NULL)	2023-11-16 19:55:27	Initial load, U LANL data from 29 August 2023
4	United States Support Program	(NULL)	(NULL)	2023-11-16 19:56:20	Initial load, PU LANL data from 29 August 2023
5	United States Support Program	(NULL)	(NULL)	2023-11-16 19:57:18	Initial load, MOX LANL data from 29 August 2023

Figure 3 Load History

The source_type_table lists the type of source the certificate is describing. The current source types are shown in Figure 4l

source_type_id	source_type_name	source_type_description
7	PU	Plutonium
8	MOX	Mixed Oxide
9	U	Uranium

Figure 4 Source Types

2.3. Measurement Tables ERD

Figure 5 shows the ERD for the measurement family of tables. The ERD in Figure 5 includes all the tables in the sample subfamily of tables, but only the configuration_table and detector_table from the detector sub-family of tables is shown in Figure 5. The full detector sub-family of tables is shown in Figure 6.

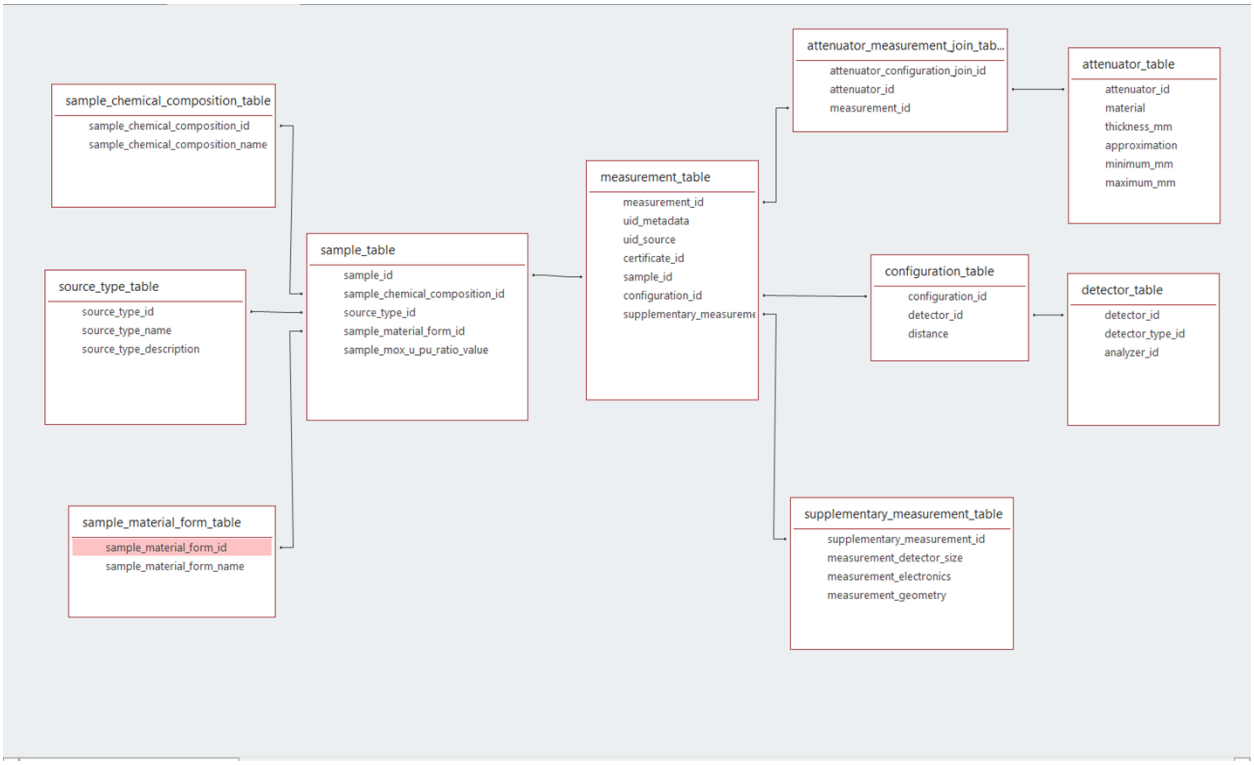

Figure 5 Measurement Entity Relationship Diagram

There is a many-to-one relation between a measurement and a sample, as one sample is often used for many measurements. The attenuator data includes thickness and material type and has a many-to-many relationship with the measurement because one measurement can use multiple types of attenuators. The attenuator data is not ordered; it is not possible to say, therefore, which material type was closest to the sample in cases when a measurement includes multiple attenuators. The measurement_table does not have a direct relation with the detector_table because measurements can be made using the same detector, but with a different distance from the detector to the sample.

Figure 6 shows the detector subfamily of tables and also the relation between the measurement_table and the spectrum family of tables that is made via the spectrum_measurement_table. The configuration_table relates one measurement to one detector (i.e., the type of detector and analyzer used to make the measurement), while the detector settings table contains what detector settings were used when one spectrum was measured.

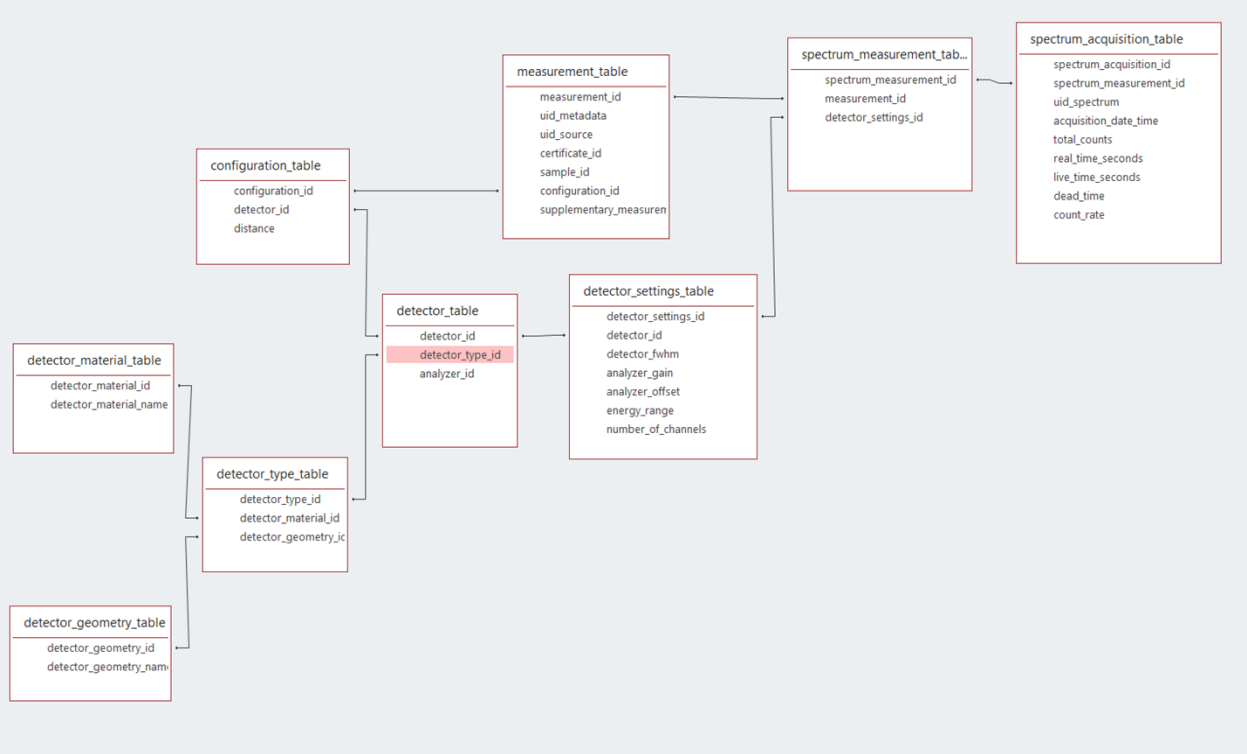

Figure 6 Measurement Detector Entity Relationship Diagram

2.4. Spectrum Tables ERD

Figure 7 shows the ERD for the spectrum family of tables. The main table is the spectrum_acquisition_table, which describes the settings used to take the counts for one spectrum. As a convenience, the actual count data is saved in a second table named spectrum_counts_table, which contains one column that holds a json array with the counts and has a one-to-one relation with the spectrum_acquisition_table.

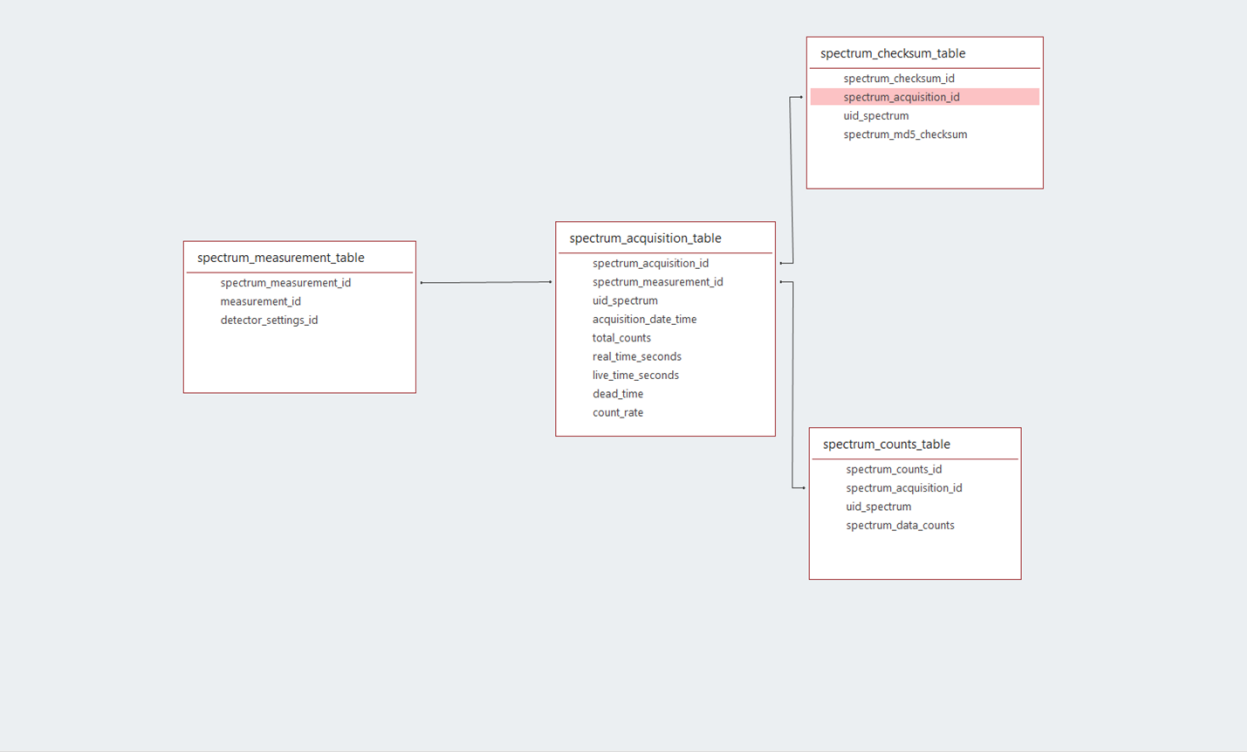

Figure 7 Spectrum Entity Relationship Diagram

3. IDB TABLES

Table 1 contains an alphabetical list of the tables in the IDB. In addition to the table's name, Table 1 lists which family (i.e., measurement, spectra, or certificate data) the table belongs to, provides a brief description of the data in the table, and finally, the relationships the named table has with other IDB tables.

Table 1 IDB Tables

NAME	FAMILY	DESCRIPTION	RELATIONSHIPS
analyzer_table	Measurement	Name of analyzer used to take measurement	One-to-Many with detector_table
attenuator_measurement_join_table	Measurement	Join table connecting attenuator data to measurement data.	Many-to-many to attenuator_table Many-to-many to measurement_table
attenuator_table	Measurement	Material type and thickness used as attenuator	Many-to-many with measurement via the join table
certificate_mox_table	Certificate	Isotopic values for certificates describing MOX sources.	One-to-one with certificate_table
certificate_pu_table	Certificate	Isotopic values for certificates describing PU sources.	One-to-one with certificate table
certificate_table	Certificate	Values common for source certificates regardless of source material type.	One-to-one with the certificate_mox_table One-to-one with the certificate_pu_table One-to-one with certificate_u_table Many-to-one with load_history_table Many-to-one with source_type_table
certificate_u_table	Certificate	Isotopic values for certificates describing U sources.	One-to-one with certificate_table
configuration_table	Measurement	Connects measurement_table to detector_table. The measurement and detector tables do not have a direct relation because multiple measurements may be taken with the same detector but at a different distance.	Many-to-one with detector_table One-to-many with measurement_table
detector_geometry_table	Measurement	The geometry of the detector	One-to-many with detector_table
detector_material_table	Measurement	The material type of the detector	One-to-many with detector_table
detector_settings_table	Measurement	Detector settings used in measurement	One-to-many with detector_table One-to-many with spectrum_measurement_table

NAME	FAMILY	DESCRIPTION	RELATIONSHIPS
detector_table	Measurement	Main table of the detector subfamily of tables	Many-to-one with detector_type_table Many-to-one with analyzer_table
detector_type_table	Measurement	The type of detector which is defined as a combination of detector material and detector geometry.	One-to-many with detector_geometry_table One-to-many with detector_material_table
element_table	Helper	Chemical elements (e.g., Am, Pu)	One-to-many with isotope table
isotope_table	Helper	Chemical isotope	Many to one with element_table One-to-many with sample_chemical_composition_table
load_history_table	Helper	History of data loads where one data load i loading the data in one set of csv data files.	One-to-many with certificate_table
measurement_table	Measurement	Main table of measurement family of tables. Relates sample and detector used in measurement.	Many-to-one to configuration_table Many-to-one to sample_table One-to-many to spectrum_measurement_table
sample_chemical_composition_table	Measurement	Chemical composition of the sample (e.g., PuO2)	One-to-many to sample table
sample_mass_fraction_table	Measurement	Set of isotope mass fractions in each sample	One-to-many to sample_table Many-to-one to isotope_table
sample_material_form_table	Measurement	The material form of the sample (e.g., Powder)	One-to-many to sample_table
sample_table	Measurement	Main table of the sample subfamily. Relates form, composition, and mass fractions of one sample.	Many-to-one to sample_chemical_composition_table Many-to-one to sample_material_form_table One-to-many to sample_mass_fraction_table
source_type_table	Certificate	The type of source described in the certificate (e.g., PU)	One-to-many to certificate_table
spectrum_acquisition_table	Spectrum	Information that describes when and with what detector settings one spectrum was measured.	One-to-one with spectrum_counts_table One-to-one with spectrum_checksum_table Many-to-one with spectrum_measurement_table
spectrum_checksum_table	Spectrum	A checksum to provide a unique id for one spectrum	One-to-one with spectrum_acquisition_table
spectrum_counts_table	Spectrum	The count data defining a measurement	One-to-one with spectrum_acquisition_table
spectrum_measurement_table	Spectrum	Relates one spectrum to the detector setting and measurement parameters used to measure the spectrum	One-to-many to spectrum_acquisition_table Many-to-one with detector_settings_table

NAME	FAMILY	DESCRIPTION	RELATIONSHIPS
supplementary_measurement_table	Measurement	Additional information about a measurement	Many-to-one with measurement_table

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