PPDM Association

Units of Measure

Reference Guide

Last updated for PPDM 3.8

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About This Document

This reference guide has been prepared to help managers, analysts, database administrators, programmers, data managers, and users understand how to use the Units of Measure (UOM) Module in PPDM 3.8. Readers at many levels, from managerial to technical implementers will benefit from reading various sections of this document. General, high-level business information is contained at the beginning of the document, with each section becoming progressively more technical and detailed.

Sometimes the terms we use in this and other PPDM documents need to be defined. We provide definitions in a separate Glossary, which you can obtain from PPDM.

This reference guide contains the following sections:

- Introduction

  Provides an executive overview of the PPDM Model as it pertains to Units of Measure.

- Business Process Overview

  Summarizes Units of Measure and provides examples of related business processes.

- Model Overview

  Includes the entity relationship diagram and discusses the use of the Units of Measure tables in the Data Model.

- Tables and Columns – Units of Measure

  Identifies the data model tables for the Units of Measure Module, how they should be used, what they contain, and recommends how they should be used. This section should be used in conjunction with the PPDM Table Report available for download from the PPDM Web Site (www.ppdm.org).

- Implementation Considerations

  Discusses issues related to implementing the PPDM model, architectural methodologies used in design, or special considerations for implementation that are not related to a specific table.

- Frequently Asked Questions

  Addresses technical and business questions about the Units of Measure Module.

- Appendix A – Sample Queries

Provides sample queries with the appropriate SQL scripts that illustrate uses of the model based on the Business Requirements Document.

- Appendix B – Changes to the Model

  Identifies the changes in the Units of Measure Module from the latest version to the newest release version of the PPDM model.

- Appendix C – Sources of UOM Data

  Identifies the organizations and source documents used in compiling the reference data.

Introduction

Identification of, and conversion between units of measure is critical to all scientific and technical work. Calculations and comparisons between values can only be made if the units are known.

Many different units can be used to describe the same concept. For example, consider volumes. In North America, some of the commonly used units to describe volumes are fluid ounces, pints, quarts, gallons, barrels, milliliters, liters, kiloliters, cubic inches, cubic feet, cubic meters. Depending upon the quantity being measured, the selection of units is somewhat narrowed -- the volume of oil produced by a well would not be measured in milliliters, nor would fluid samples used in a laboratory analysis be measured in cubic feet. However, even with consideration given to the quantity being measured, there are still many different units that could describe the same item. Therefore, a database containing measurements must clearly specify units.

Nomenclature is inconsistent, as well:

- the same word can describe more than one quantity. For example, a gallon (US) is defined to be 231 cubic inches (3.785412L) while a gallon (British Imperial) is defined to be the volume taken up by 10 pounds of water (4.54609L).

- the same word can be used to describe more than one concept. For example, degrees measure both temperature and the arc of a circle.

- a lowercase letter may represent a different unit, or unit prefix, than an upper case letter. For example: s represents seconds, S, siemens; mW represents milliwatt, MW, megawatt.

- spelling can differ even when a unit is standardized. For example: liter *versus* litre.

- plurals may or may not be used.

- the same unit can be abbreviated in many different ways. For example, feet can be abbreviated as ft, ‘, F.

- compound units can often be written in different ways. For example m/s or $m \cdot s^{-1}$.

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The PPDM Units of Measure project was initiated by PPDM in 2003 in response to member interest, with the intent to develop a single, reconciled set of units of measure that could be used as a starter set for new implementations. Reference data was gathered from the international standards bodies, to provide member

companies an inclusive set of units of measure, with conversion data for more common conversions. This data was supplemented by PPDM member companies with specific UOM needs. The reference data should not be considered absolute or permanent – many organizations have or will develop their own reference sets, tailored to their specific objectives, while PPDM plans to add additional conversion data.

Business Process Overview

Purpose and History

The purpose of the PPDM Units of Measure (UOM) project was to develop a single, reconciled set of units of measure that could be used as a starter set for new implementations. Reference data is intended to give member companies an inclusive set of defined units of measure, with data allowing for commonly performed conversions. In conducting the UOM project, the PPDM Association gathered data from international standards bodies – units were assigned unique IDs in the PPDM model, definitions of units were noted, and conversion data were gathered. The PPDM Association assigned an order of preference to the reference sources, in order to resolve conflicts (most often concerning currency of use and spelling of unit names). See Appendix C for a list of source materials, appearing in the order of preference.

The PPDM Reference Data should not be considered absolute or permanent – indeed, it has been supplemented by PPDM member companies with specific UOM needs. Many organizations have or will develop their own reference sets, tailored to their specific objectives, while the PPDM Association plans to add additional conversion data. The PPDM Association is interested in receiving information about units not already in the reference data.

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The purpose of this guide is to discuss units of measure within the context of PPDM 3.8. As units of measure affect every module in PPDM, this guide has been designed to address four general considerations.

- What are the general concepts and difficulties?
- How would I enter and retrieve measurement data (data with units of measure) within PPDM 3.8?
- What is the PPDM Reference Data, and of what is it comprised?
- How would I implement the UOM Module?

Note

Production volume calculations are not covered in this guide, as these calculations are dependent upon external conditions, including temperature and pressure. Production volume calculation information can be recorded in the PPDM_VOL_% tables.

General Concepts

Conversions

To convert from one unit to another, the following generalized conversion formula can be used [1]:

$$\text{TO} = (Pre\_Offset + \text{FROM}) \cdot \frac{Factor\_Numerator}{Factor\_Denominator} + Post\_Offset$$

where TO indicates the units we are converting to and FROM indicates the units we are converting from, the *Pre_Offset* indicates a number to be added prior to multiplying, and the *Post_Offset*, a number to be added after multiplying.

Temperature conversions, between degrees Fahrenheit and degrees Celsius, provide an example.

1. $\deg F = \deg C \cdot \frac{9}{5} + 32$

2. $\deg C = (-32 + \deg F) \cdot \frac{5}{9}$

In Equation 1 (FROM deg *C*, TO deg *F*), the *Pre_Offset* is 0 and the *Post_Offset* is 32 . In Equation 2 (FROM deg *F*, TO deg *C*), the *Pre_Offset* is -32 and the *Post_Offset* is 0.

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Where the zeroes in two measurement scales are equal (ex: 0 cm = 0 in), the *Pre_Offset* and *Post_Offset* values will both be 0, and the conversion equation simplifies to become the multiplication of the original (FROM) value by a conversion factor.

For example, if converting 8.72 inches to centimeters, where 1 inch = 2.54 cm, we get

$$\text{TO} = 8.72\,in \cdot \frac{2.54\,cm}{1in} = 22.1488\,cm$$ [2]

Where the zeroes in measurement scales are equal, conversions can easily be applied successively. For example, converting 30 knots (nautical miles per hour)

[1] By distributing and rearranging terms, equivalent formulas could also be used.

[2] Rounding to the correct number of significant figures would usually be performed at the end of the conversion process.

into meters per second (1 nautical mile = 1852 meters, 1 hour = 60 minutes, 1 minute = 60 seconds) results in:

$$\mathrm{TO} = \frac{30\,nmi}{hr} \cdot \frac{1852\,m}{1\,nmi} \cdot \frac{1\,hour}{60\,min} \cdot \frac{1\,min}{60\,s} = 15.4\bar{3}\ m/s$$

Rounding Errors

Errors occur when a calculation has been made with rounded or inexact values. These errors are magnified when successive calculations are performed on data, especially if the calculations are done in steps, with rounding after each step. In order to minimize errors in conversion calculations, exact conversion factors, when available, should be used[3] and rounding should not be performed until the final step in the procedure. Should rounding in an intermediate step be unavoidable, as many digits as possible should be kept.

Conversion Facts in PPDM 3.8

In developing the PPDM Units of Measure Reference Data, conversion facts were gathered from internationally recognized authorities (details in Appendix C). The table PPDM_UNIT_CONVERSION includes this conversion data, and will be expanded by the PPDM Association to include additional conversion facts.

The terminology used in the table corresponds to that of the general conversion formula given on page 8. The column FROM_UOM corresponds to the FROM value in the conversion formula, the column TO_UOM is the TO value in the conversion formula; the FACTOR_DENOMINATOR, FACTOR_NUMERATOR, PRE_OFFSET, and POST_OFFSET values are listed.

Nomenclature in the PPDM Units of Measure Module

Consistent nomenclature within a database is desirable: it improves query efficiency and ensures correct interpretation of measured values.

In developing nomenclature for a UOM database, the following issues are among those points that must be considered.

- ***The same word is used to describe different quantities or concepts***

[3] It is interesting to note that the IEEE/ASTM SI 10-2002 document used as PPDM's primary conversion data source, uses the rounded value 0.555 555 6 instead of the exact value 5/9 for converting between an interval in degrees Fahrenheit to an interval in degrees Kelvin or Celsius, but uses the exact value $\frac{1}{1.8} = \frac{5}{9}$ for conversion of temperature values.

In the PPDM Units of Measure Module, a unique UOM_ID must be assigned to each unit of measurement that appears in the database. In the PPDM Units of Measure Reference Data, UOM_IDs were chosen to resemble unit abbreviations or names. When the same word is used for more than one quantity, quantifiers were added to the UOM_ID. For example, the UOM_IDs for US gallons and British Imperial gallons are galUS and galBI, repectively. Angle degrees have UOM_ID deg; temperature degrees have UOM_IDs degC, degF, and degR.

- ***Abbreviations are distinguished only by case***

  Standards organizations address this problem in two ways: in most cases the context of the measured data would identify the correct unit; in cases where the correct unit cannot be identified by context, the unit should be written out in full (i.e. MEGAWATT OR MILLIWATT).

  In the PPDM Reference Data, UOM_IDs distinguished only by case (i.e. s for seconds, S for Siemens) have usually been avoided by spelling out the name of at least one of the units. However, care should be given when working with all unit abbreviations and UOM_IDs, as errors in case can potentially cause confusion.

- ***More than one abbreviation is used to represent the same concept***

- ***More than one spelling of a name exists***

- ***Units are sometimes referred to in singular, and sometimes in plural***

- ***Characters not appearing on a keyboard are used in the unit abbreviation***

  All of these issues can be solved through the selection of a single abbreviation, used as the UOM_ID, to represent a unit. This abbreviation should also be used in all PPDM tables where units must be entered. Alternate abbreviations, names, and spellings can be recorded in the UOM_ALIAS table.

  Non-Latin keyboard characters can either spelled out, or written using similar Latin-based letters. For example, in the PPDM data, the UOM_ID for ångström is angstrom; the UOM_ID for ohm (Ω) is ohm; the metric prefix "μ" is represented as "u" in UOM_IDs.

  Should you want unit names in the UOM_NAME column of the PPDM_UNIT_OF_MEASURE table be searchable, one standard should be selected. For example, in the PPDM Units of Measure Reference Data, the conventions from authorities (with IEEE/ASTM SI 10-2002 preferred) have been followed: Liter and meter are used (instead of litre and metre), and unit names are written in singular (meter per second, not meters per second).

- ***Exponents and fractional signs are used in the unit abbreviation***

In the PPDM Reference Data, UOM_IDs have exponents written in regular case, so m^3 becomes m3. The symbol / is used for division, while the underscore, _ , is used to indicate multiplication of terms

Entering and Retrieving Measurement Data in PPDM

Before Entering Data

We suggest that each organization decide on a standard set of units of measure, and convert everything to those units (for example, convert all measurements to SI). Using a standard set of is more efficient and results in fewer problems than leaving data in "legacy" units.

Advantages of converting to standardized units:

- The fewer units involved, the faster most queries involving units of measure will be. A query that requires the database to retrieve all the rows in a large table and then to perform calculations on the data before returning results to a user is likely to perform very poorly.
- The number of queries including conversion formulas will decrease, thus decreasing the time spent developing queries, and lowering the chance of making errors when converting data during queries.
- The nomenclature used in describing non-standardized units is very inconsistent. If units have been converted to standardized units, the chances of later misinterpretation should decrease.

The Model

All tables in PPDM 3.8 that record measurement data will have columns devoted to units of measurement. For illustration, we will consider the WELL_LOG_CURVE_FRAME table from the Well Log module, and within that table, the Frame spacing and Base Depth columns.

The relevant columns are shown:

Empty Row (Table: WELL_LOG_CURVE_FRAME)

UWI	*WELL LOG ID*	*BASE DEPTH*	*DEPTH_OUOM*	*FRAME SPACING*	*FRAME SPACING OUOM*	*FRAME SPACING UOM*

Values are stored in the BASE_DEPTH and FRAME_SPACING columns, while their corresponding Units of Measure (UOM) are also recorded in the model. Where measurements (such as base depth) can be standardized, the default UOM is stored in a separate table (PPDM_COLUMN) and applied to all values in the

column. Where it is not possible to ensure that all the rows in a column are stored as a single unit of measure, the UOM is stored directly in the business table; this treatment is common in cases where the unit of measure is dependent on some other factor. For example, frame spacing can be measured as either a distance or a time; volume measurements may depend on the substance being measured -- gases are often stored with units MCF, liquids with units BBL.

The OUOM columns record the original units of measure. These may be important for regulatory reporting or for comparison of datasets.

In most cases, the name preceding the %_OUOM and %_UOM is the same as that in the column where values are entered – in some cases exceptions have been made for historical reasons or if the addition of _OUOM or _UOM causes the column name to exceed its allowable length.

Vertical Tables

Vertical tables can give us a powerful tool for storing many kinds of descriptive information about an object in a database when a complete list of the descriptive types can't be captured at design time.

Take, for example, the table EQUIPMENT_SPEC. Various types of equipment will be described using different criteria. The reference table R_EQUIP_SPEC governs the behavior of the table, in that it captures the different kinds of specifications that will be captured (mass, wheel diameter, pipe diameter, color, tensile strength etc.) and their behavior in the table (see the vertical tables document for details).

Colors may be validated against a reference list of colors, wheel diameters given in inches with one decimal place of precision, pipe diameters in millimeters with 2 degrees of precision etc. The preferred unit of measure for each value in this reference list is indicated in the property set for the value.

Entering Data

In the following examples, we will assume that all data in the database is to converted to SI. We will discuss a well log with original data in feet: a bore depth of 12,967 feet (3952.3 m), and with frame spacing of 1 foot (0.3048 m).

1. When the database is set up (with the assumption that units will be standardized), the following entries would be made in the table PPDM_COLUMN:

Initial Set-Up. (Table: PPDM_COLUMN)

SYSTEM ID	*TABLE NAME*	*COLUMN NAME*	*DEFAULT UOM ID*	*OUOM COLUMN NAME*	*UOM COLUMN NAME*
PPDM38A2	WELL LOG CURVE FRAME	BASE DEPTH	m	DEPTH OUOM	

PPDM38A2	WELL LOG CURVE FRAME	FRAME SPACING		FRAME SPACING OUOM	FRAME SPACING UOM

In this table, the SYSTEM_ID, TABLE_NAME, and COLUMN_NAME columns are all primary keys; the DEFAULT_UOM_ID, OUOM_COLUMN_NAME, and UOM_COLUMN_NAME all have foreign key constraints.

2. The well log data, converted to SI units, would be entered:

Data Entry (Table: WELL_LOG_CURVE_FRAME)

UWI	*WELL LOG ID*	*BASE DEPTH*	*DEPTH_OUOM*	*FRAME SPACING*	*FRAME SPACING OUOM*	*FRAME SPACING UOM*
123	xyz	3952.3	ft	0.3048	ft	m

Notes

- As designed, PPDM 3.8 will not automatically convert the entered data to the default units – it is assumed that data has been run through a conversion program prior to its downloading or entry in PPDM 3.8. See the "Sample Queries" section in this guide for converting and loading data.
- Since the launch of PPDM 3.6, members have been able to add referential integrity constraints for units of measure. Enabling or disabling these constraints does not affect compliance measures of applications of products in PPDM 3.6, PPDM 3.7, or PPDM 3.8.

Receiving and Sending Measurement Data

When receiving and sending information, these steps outline the general process that should be followed.

Receiving

1. When you receive data, check the units – do they match the UOMs that you are using? Do the abbreviations match your UOM_IDs?
2. a. If the data's units do not match your UOMs you will have convert the measured values. You can use an external application to convert data before entering it into PPDM, or you can use the PPDM_UNIT_CONVERSION table to convert. See the "Sample Queries" section of the guide for an example.

   b. If the units match your UOMs, but the abbreviations do not match your UOM_IDs, you can use the PPDM_UOM_ALIAS table to replace the nomenclature.
3. Store data, including converted values, their UOMs (when not defined by default in PPDM_COLUMN), and OUOMs.

Sending

1. Before you send data, check to see whether the receiving organization specifies which units (and abbreviations) they require in submitted data.

2 a. If your UOMs are different from the required units, you can use the PPDM_UNIT_CONVERSION table to convert the measured values. (You could also download the data and use an external application to make the necessary conversions). See the "Sample Queries" section of the guide for an example.

b. If your UOM_IDs are different from the abbreviations required, you can use the PPDM_UOM_ALIAS table to switch to the desired nomenclature. See the "Sample Queries" section of the guide for an example.

3. Retrieve and send the information.

Implementing the PPDM Units of Measure Reference Data

Before implementing the UOM Reference Data, processes and potential problem areas should be examined.

Planning for Units of Measure Implementation

A systematic approach should be taken when planning for UOM Reference Data implementation. Some of the tasks you will likely need to go through include:

Units of Measure Survey

We suggest that you start off by surveying all of the Unit of Measure identifiers that are used by your organization. Examine your data in PPDM and also look at anything that might potentially feed into PPDM or might be reported from the database. If you have an application that is used to populate or retrieve values from PPDM, be sure to check its assumptions about UOM_IDs.

Problems with implementing UOM Reference Data will occur if you belatedly discover that you need a particular unit of measure, or find that a conversion isn't going to be handled correctly.

Build a translation table between your units and the PPDM UOM_IDs. Use this table to populate the PPDM_UOM_ALIAS table. Beware of duplication of symbols – for example, LIS uses F for feet; in the PPDM UOM Reference Data, and F is the UOM_ID for Farad. Also be careful to look at capitalizations – for example, have K and k been used interchangeably?

Choice of Units

The PPDM Association believes that consistent use of standardized units of measure throughout your system simplifies all future processes. You may decide to use base SI Units. Alternatively, you could look at typical data that will be stored in each table, and choose units appropriate to the data.

Symbols

Decide which symbol sets to use. Some specialized symbols require non-standard character sets. If you are considering a switch to UTF-8, remember that string length functions and column widths may be affected in some versions of Oracle and in other RDBMS.

Procedures/Applications/Forms etc.

Convert stored procedures, external applications, packages, forms, and anything else that might reference UOM_ID values directly.

Things to consider

- The unit conversion data in PPDM 3.8 are not complete, but will be expanded in future versions of the model. (If you add conversion data, please let the PPDM Association know, so that we can include it in the Reference Data).
- The PPDM model does not recognize metric prefixes as such, and so there are no universal conversions between metric prefixed units. In other words, to convert kg to g, a row in the PPDM_UNIT_CONVERSION table must exist; to convert between km and m, a separate row must also exist.
- Your organization is likely already using units of measure within PPDM, with primary key values (UOM_IDs) not matching the primary keys in the PPDM's Reference Data. Therefore, the symbols you are already using will have to be translated to match reference values.
- You may have UOM_IDs hard-coded into application logic – these applications will have to be modified.
- Special characters appear in some UOM_NAMEs (for example, ångström). PPDM load scripts include those characters, as long as they are in ISO 8859 (ASCII). However, because special characters could be problematic to some PPDM members, their use has been minimized, and they have not been used in database keys – in particular, no special characters are used in UOM_ID entries. In some cases, database loaders may transform accented characters to their unaccented equivalents.
- Capitalization is important in distinguishing between units of measure. Whenever possible, upper and lower cases should be preserved.

Implementation

If possible, we suggest that before implementation, **a trial run** is performed on **a copy** of your production PPDM instance, to verify that your Units of Measure implementation works correctly. We suggest that you leave referential integrity checking on during the entire process.

We recommend that the following steps be used as a starting point in your planning:

1. Backup.
   Make a copy of the database and develop a good backout plan, just in case.

Work with the copy until you are sure you have all the problems worked out and everything is ready! Have a good plan and management backing for your project.

2. Take the (test) database off-line.
   People accessing the database while conversion is taking place could cause problems, but remember to first work on a copy of the database.
3. Mark your existing PPDM_UNIT_OF_MEASURE table entries.
   These UOM data will not be deleted by inserting the PPDM Reference Data. However, after successful implementation, you will want to delete the old data, and will thus want it to be easily identifiable. One way to mark existing rows would be by changing "Y" to "N" in the ACTIVE column.
4. Insert the new PPDM_UNIT_OF_MEASURE table.
   Run the PPDM Insert scripts (in order) for:
   - R_SOURCE
   - SOURCE_DOCUMENT
   - R_PPDM_UOM_ALIAS_TYPE
   - R_PPDM_UOM_USAGE
   - R_PPDM_MEASUREMENT_SYSTEM
   - PPDM_QUANTITY
   - PPDM_UNIT_OF_MEASURE
   - PPDM_UOM_ALIAS
   - PPDM_UNIT_CONVERSION
5. Create and run UOM_ID conversion.
   Run a translation script to translate your existing UOM_ID values to their corresponding new UOM_ID values.
6. Add PPDM_UOM_ALIAS entries.
   Add all of the PPDM_UOM_ALIAS entries that you need in order to make your system work.
7. Delete old PPDM_UNIT_OF_MEASURE table entries.
   The rows that you marked in Step 3 need to be deleted. Rather than use a cascade delete, leave referential integrity turned on, so you can see if anything was missed.
8. Convert packages.
   Convert any packages, stored procedures, forms, and external applications that might reference UOM_ID values directly.
9. Test and document.
   Develop (if necessary) and then run a PPDM integrity test suite. Document everything at every stage of the program, including all of your assumptions about the data. Write the document as if someone completely new to the project will be reading it in several years' time.

Validation

After running the UOM Implementation, the following should be specifically checked on your test database:

- Character sets -- UNIT_OF_MEASURE table
  Does everything display correctly? Check the UOM_NAME "ångström". Does it display correctly? If not, do you get the non-accented characters, or do you get a mess? If you get a mess, check the UOM_NAMEs "calorie at 15°C", "calorie at 20°C", "perm(0°C)", "perm(23°C)", "perm inch(0°C)", "perm inch(23°C)" – these UOM_NAME entries also use special characters.
- Character sets -- UOM_ALIAS table
  Check symbols. In particular, check symbols that use either a raised dot (multiplication operator) or a degree symbol, and make sure that they look OK.[4]
- Character sets -- UTF-8 characters
  If UTF-8 character load script was used, check that the symbols look OK on your system.
- Alias resolution
  If a process used hard-coded UOM_ID values, and these values were retained as UOM_ALIAS values, check that the process still works. Instead of a direct link to the PPDM_UNIT_OF_MEASURE table, there should now be an indirect link from the PPDM_UOM_ALIAS table to the PPDM_UNIT_OF_MEASURE table.
- Unit Conversions
  Use the PPDM_UNIT_CONVERSION table to convert some values, and check that you get the expected results. Run a wide variety of conversions, to be certain that all necessary conversion data exist.

[4] Some versions of TOAD may prevent you from loading characters such as Ω (omega) and μ (mu).

Model Overview

Data Diagrams

The diagram on this page is the legend for the tables discussed later in this document. Note that some or all of these elements may be present in data diagrams provided by the Association. Some elements are removed from final products to reduce file size:

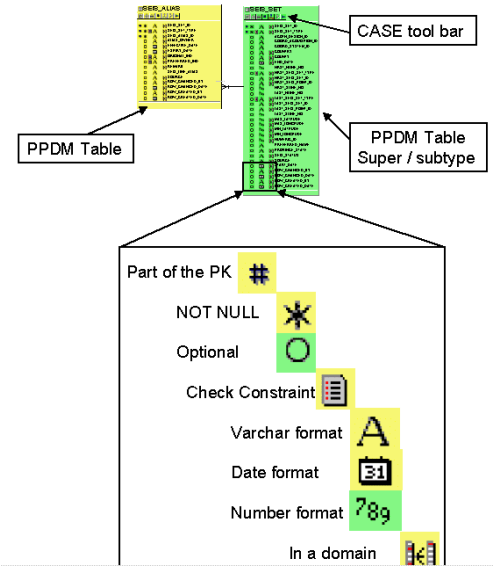

Figure 1: *This illustration shows the functions of each icon used in the data diagrams provided with PPDM version 3.8.*

The data diagrams for the Units of Measure Module are not provided in this reference guide because of their very large file size. Data diagrams can be obtained from the PPDM Association as part of the final model documentation or as a set of PowerPoint diagrams. The PowerPoint diagrams will provide the best resolution for printed quality.

Tables and Columns: Units of Measure

The following tables exist in the Units of Measure module of PPDM version 3.8. Each table is described in the following section; you can jump to a table description by clicking on the hyperlinked table name below. Note that for detailed content descriptions for each table, you should refer to the PPDM version 3.8 table documentation.

PPDM_UNIT_OF_MEASURE

Use this table to record valid units of measure (UOMs). Each unit will have assigned to it a unique UOM_ID, the primary key for the table. To simplify UOM use, the UOM_ID should be similar to the unit abbreviation. The full name of a unit (and if necessary, quantifiers, such as US or BI), is recorded in the UOM_NAME -- when necessary, further description can be included in the REMARK column.

The system of measurement (SI, British Imperial…) in which the unit is defined can be recorded in the UOM_SYSTEM_ID while the type of measurement that the unit is used for (ex. length, pressure…) can be listed in the UOM_QUANTITY_TYPE field. Should it be desirable to link a unit to more than one type of measurement (ex. the joule measures energy, but also work and quantity of heat), extra UOM_IDs can be created. For example, a row with UOM_ID "joule – heat" and row with UOM_ID "joule – work" could be added to the data.[5]

Entries in the SOURCE and SOURCE_DOCUMENT columns identify by whom, and in which document, the unit was defined, while the

[5] For PPDM 38A3, the PPDM Association did not add extra rows for these UOM_QUANTITY_TYPEs. Future work may be done to create these additional entries.

UOM_USAGE_TYPE allows the status, or currency, of a unit of measure to be indicated (ex. current, deprecated, discouraged, strongly discouraged).

Click here to return to the list of tables

Reference Data

Over 800 records appear, with data gathered from internationally recognized authorities,[6] and supplemented by PPDM member data. Conflicts in data (occurring most frequently in quantity type and usage type) were resolved by assigning a preferred order to the authorities. See Appendix C for more details. Should your organization use units not included in the UOM Reference Data, please notify the PPDM Association so that we can expand the data.

The UOM_ID is the primary key for this table. Entries in the UOM_ID column were designed to resemble the mixed-case symbol.

- Spaces and raised dots (indicating multiplication) are replaced with underscores. For example, the unit "$N \cdot m$" translates to the UOM_ID "N_m"
- A forward slash, /, is used to indicate division. For example, "m/s".
- The temperature degree symbol is not used. UOM_IDs for temperature units are degF, degC, degR, and K. When part of a compound symbol, the abbreviation "deg" is omitted. For example, "cal/(g · °C)" becomes the UOM_ID "cal/(g_C)".
- Exponents follow the unit symbol to which they apply. For example, "m^3" has the UOM_ID "m3"
- Where subscripts might normally be used to differentiate between abbreviations, they are replaced by an underscore, _, followed by the subscripted characters. For example, "in_{US}" is written as "in_us".
- US Customary and British Imperial units often have US or BI at the end of their UOM_IDs.
- Currencies are represented by their 3-letter abbreviations specified by the ISO.
- When necessary, in order to ensure unique UOM_IDs, other modifications were made.

The UOM_NAME is the full name of the unit of measure, as assigned by a standards body. When different authorities used different conventions, the PPDM Association followed the conventions of IEEE/ASTM SI 10-2002.

[6] Units of measure are dynamic, no matter what system is used. New units are defined and old units become deprecated. PPDM Reference data was gathered in 2004 – developments made since that time may not be reflected in the PPDM data. Historical units, and historical definitions of units, may also be missing.

- Unit names are written in full.
- Unit names are singular. For example, meter per second, rather than meters per second.
- The word "per" is used to indicate ratios. For example, meter per second, rather than meter/second.
- Unit names and unit symbols begin with lower case characters, unless a reference organization has specified otherwise.

The UOM_USAGE_TYPE has also been determined with reference to the authorities, in the assigned order of precedence.

The UOM_QUANTITY_TYPE is defined following IEEE/ASTM SI 10-2002, wherever possible, and otherwise, follows selected authorities in the order outlined in Appendix C. If a quantity type has not been defined by one of the authorities, it is listed as *unclassified*. (SI units differing from base units only by their metric prefix, have been assigned the same UOM_QUANTITY_TYPE as the base unit)

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PPDM_UNIT_CONVERSION

PPDM UNIT CONVERSION: This table stores numeric data used to convert between different units of measure.[7] Primary keys FROM_UOM and TO_UOM match the original and final units, respectively, of the data to be converted (for integrity, both keys are linked to the UOM_ID). Columns allow for the recording of conversion data (FACTOR_NUMERATOR, FACTOR_DENOMINATOR, PRE_OFFSET, POST_OFFSET), corresponding to the conversion formula:

$$\mathrm{TO} = (Pre\_Offset + \mathrm{FROM}) \cdot \frac{Factor\_Numerator}{Factor\_Denominator} + Post\_Offset$$

(See pages 8 and 9 of this guide for details concerning this formula, and examples of its use).

A Y/N in the EXACT_CONVERSION_IND indicates whether conversion data is exact, or rounded or experimentally derived.

The column UNIT_EXPRESSION is deprecated (since PPDM3.7), but remains in the model for companies that have converted from earlier versions.

The conversion facts in the table are linked to their SOURCE and SOURCE_DOCUMENT.

[7] Because fractions are used in converting units, data might not always appear as expected. For example, in converting from degrees Fahrenheit to degrees Celsius, 1/1.8 is used instead of the equivalent 5/9. In computer-generated conversion facts, 25400/254000 might appear instead of the reduced 1/10.

Notes

- For every pair of units being converted, two rows in the PPDM_UNIT_CONVERSION table exist – one for converting from the first unit to the second, and the other for converting in the opposite direction.
- One row per pair of units would be adequate if a second conversion formula (the reverse of the first one) were used. This formula is:

$$\text{FROM} = (\text{TO} - \textit{Post\_Offset}) \cdot \frac{\textit{Factor\_Denominator}}{\textit{Factor\_Numerator}} - \textit{Pre\_Offset}$$

  See the "Sample Queries" section of this guide for an illustration of this formula's use.

- A conversion from a unit to itself is a useful addition to the table. For any such conversion, the conversion facts

  PRE_OFFSET = POST OFFSET = 0,

  FACTOR_NUMERATOR = FACTOR_DENOMINATOR = 1

  would apply.

  See the "Sample Queries" section of this guide for an illustration of this conversion's use.

- Calculations that are non-linear (ex. logarithmic calculations used to determine decibels) are not supported by the table.
- Production volume calculations are not covered in this guide, as these calculations are dependent upon external conditions, including temperature and pressure. Production volume calculation information can be recorded in the PPDM_VOL_% tables.

Click here to return to the list of tables

Reference Data

At the time of writing this reference guide, there were over 900 rows of data in the conversion table. Precision of the conversion data (number of significant figures) matches the precision defined by the source from which the data was obtained.

While the conversion facts in this table support many conversions, the data is incomplete and will likely need to be supplemented. Additional conversion data can be generated using the conversion facts already in the database (see the Frequently Asked Questions" section of this guide for details. However, if you need supplemental data, ensure that the definitions of the units in the PPDM_UNIT_OF_MEASURE table match with the definitions of units used by your company.

Note

- Currency conversion rates are continuously changing, so unlike the conversion data for other units of measure, currency conversion data is stored in the same PPDM table as the currency values. Tables that record costs

have an associated CURRENCY_CONVERSION column where appropriate conversion information can be inserted.

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PPDM_UOM_ALIAS

This table links aliases (alternate names and abbreviations for units) to the preferred symbol used as the UOM_ID.

Primary keys for this table are UOM_ID, UOM_SYNONYM, and SOURCE.

The UOM_SYNONYM column is currently used to link the alias to its source (or, more generally, provide the explanation as to why an alias is needed).

Alternate names for the unit are stored in the UOM_ALIAS column, with their sources in the SOURCE and SOURCE_DOCUMENT columns. The PREFERRED_INDICATOR column indicates whether the alias is a preferred name or code.

Use the ALIAS_OWNER_BA_ID column to record the owner of each alias.

The UOM_ALIAS_TYPE column may record the type of alias (ex. name, alternate UOM nomenclature system, …) or a description of which symbols can be used to represent the data.

*****

Looking at an example might best explain how the column could be used.[8]

In the PPDM data, the "ampere" has UOM_ID "A", and UOM_NAME "ampere". However, in the *Unified Code for Units of Measure* its name is written "Ampère", and in LIS, can be abbreviated "AMP" or "AMPS" ("AMP" is preferred).

Using the PPDM_UOM_ALIAS table, we could have the following entries:

Ampere row entries (Table: PPDM_UOM_ALIAS)

UOM_ID	*UOM SYNONYM*	*SOURCE*	*ALIAS OWNER BA ID*	*PREFERRED IND*	*UOM ALIAS*	*UOM ALIAS TYPE*
A	MIXED CASE SYMBOL	IEEE/ASTM	IEEE/ASTM	N	A	MIXED_CASE_SYMBOL
A	SINGLE CASE SYMBOL	IEEE/ASTM	IEEE/ASTM	N	A	SINGLE_CASE_SYMBOL
A	UOM_ID	IEEE/ASTM	IEEE/ASTM	Y	A	UOM_ID
A	UOM_NAME	UCUOM	UCUOM	N	Ampère	UOM_NAME
A	LIS-AMP	LIS	LIS	Y	AMP	ALTERNATE_UOM_SYSTEM
A	LIS-AMPS	LIS	LIS	N	AMPS	ALTERNATE_UOM_SYSTEM

Note

- The PPDM Association recommends that each unit in the PPDM_UNIT_OF_MEASURE table is also represented in the ALIAS table.

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Reference Data

Currently, there are two types of entries in the PPDM_UOM_ALIAS table. Some entries result from a unit having more than one name (meter, metre) or symbol (Btu *vs* BTU) or having an equivalent EPSG code. Other entries describe which coding is best used to represent a symbol. Data in the UOM_ALIAS_TYPE column categorizes the type of alias, using the following descriptions.

UOM_NAME	Used when more than one UOM_NAME exists. For example, meter *vs.* metre.
UOM_ID	Used for entries where the UOM_ID has been copied into the PPDM_UOM_ALIAS table.
ALTERNATE_UOM_SYSTEM	Used to indicate that an alias is preferred by an organization or in an application.

[8] Thanks to Harry Schulz of Oilware for his suggestions concerning aliases in the PPDM model.

EPSG	Used when the European Petroleum Survey Group (EPSG) has an code equivalent to the UOM_ID. The EPSG uses four digit codes to represent each of the units of measure that they publish.
MIXED_CASE_SYMBOL	Designated to be the best representation for a symbol when 8-bit ASCII (ISO 8859) is available.
SINGLE_CASE_SYMBOL	Designated to be the best representation for a symbol when only the 7-bit ASCII character set is available.

Notes

- Currently, when entries in the PPDM_UOM_ALIAS table indicate the coding best used, (i.e. MIXED_CASE_SYMBOL or SINGLE_CASE_SYMBOL, the UOM_SYNONYM column duplicates the UOM_ALIAS_TYPE column.

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R_PPDM_UOM_ALIAS_TYPE

This reference table contains a standardized vocabulary for the entries in the PPDM_UOM_ALIAS table's UOM_ALIAS_TYPE column. The column provides an explanation as to why a particular alias exists.

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Reference Data

The entries in the UOM_ALIAS_TYPE column are of two types:

- UOM_NAME, UOM_ID, ALTERNATE_UOM_SYSTEM, and EPSG, all which explain the purpose of the alias
- MIXED_CASE_SYMBOL and SINGLE_CASE_SYMBOL, which explain coding that can be used to represent the symbol.

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R_PPDM_UOM_USAGE

This reference table provides a standardized vocabulary for describing the recommended usage of a unit of measure, as designated by an agency such as IEEE, by an organization, or by an application. Possible entries could be *NULL* or *CURRENT*, or *preferred*, *current*, *deprecated*, *discouraged or strongly*

discourage, and *not specified*. The valid terms defined in this table are used in the UOM_USAGE_TYPE column in the PPDM_UNIT_OF_MEASURE table.

It is important to note that recommended usage of a unit of measure may change over time -- periodic review of assigned usage types is desirable.

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Reference Data

Usage terms in the PDM3.8 table are: *preferred, current, deprecated, discouraged, strongly discouraged* and *not specified*. These designations were determined based on the reference documents used in the PPDM UOM project. (See Appendix C).

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PPDM_COLUMN

This table contains meta data regarding the columns in the PPDM schema. This information is designed to assist in the units of measure module. By using this table, each column in the PPDM model that contains measured data can be assigned a default unit (a pre-selected, standardized unit). Additionally, columns containing measurements can be linked to columns containing their units, and original units of measure.

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Implementation Considerations

Check Constraints

PPDM Version 3.8 makes use of check constraints in rare cases where the values that may be input for a column are known at design time and will not change over time. Two types of uses are observed in PPDM 3.8.

- Where the column name is %_IND, the column is an indicator field, and the values may only be Y, N, or null.
- Super-sub type implementations use check constraints to enforce the integrity of the super-sub type relationship. Currently these relationships are in use for Seismic, Business Associates, Records Management, Support Facilities, Production Entities and Land Rights.

  Let's use Seismic Sets as an example. This structure consists of a parent table (SEIS_SET) and eight sub-type tables (SEIS_3D, SEIS_ACQTN_SURVEY, SEIS_INTERP_SET, SEIS_LINE, SEIS_PROC_SET, SEIS_SEGMENT, SEIS_SET_PLAN and SEIS_WELL). Each of the tables has a two-part primary key: SEIS_SET_ID and SEIS_SET_TYPE.

  SEIS_SET_ID is assigned by the user and can have any value as long as it is unique for that type of seismic set. SEIS_SET_TYPE was designed to maintain the integrity of the super-sub type structure and can only have the values assigned to it by check constraints; these values are the table names of the eight valid sub-types. In SEIS_SET, the SEIS_SET _TYPE can have any of the table names, but in each of the sub-types, it can only have the name of the table it is owned by.

Currencies in PPDM

Currencies are a Unit of Measure – their 3-letter abbreviations, as specified by the ISO, are stored in the PPDM_UNIT_OF_MEASURE table. Currency symbols that appear on a standard keyboard (such as $) are listed as aliases in the PPDM_UOM_ALIAS table, while non-keyboard symbols (such as £, or ¥) have their hexadecimal Unicode representations entered as aliases in the PPDM_UOM_ALIAS table.

As with other units, it is desirable to convert all original currencies to a standard unit of measure for storage in the database. The standardization ensures that queries for retrieval and reporting are efficient. PPDM supports the requirement of restoring the original value in the following way:

- Convert all stored currencies to a single currency type, such as US dollars.
- Within a table in which currency information is stored, CURRENCY_OUOM stores the currency in which the funds were initially received. When the stored currency is multiplied by the conversion factor in

the CURRENCY_CONVERSION column, the value of the transaction in the original currency is obtained.

- The CURRENCY_CONVERSION column stores the rate applied to convert the currency to its original monetary UOM from the stored UOM. **This rate is valid for this row in this table at the time of conversion only, as currency rates are continuously changing.** When this value is multiplied by the stored currency value, the original value of the transaction in the original currency is restored.

Audit Columns

Each table contains five columns: SOURCE, ROW_CHANGED_BY, ROW_CHANGED_DATE, ROW_CREATED_BY, and ROW_CHANGED_DATE. These columns satisfy a data-auditing requirement to identify the user and date of database transactions.

Use the "CREATED" columns when you are inserting new data rows and the "CHANGED" columns when you are updating a data row. The ROW_CHANGED / CREATED_BY columns are usually populated using the system login id in use. ROW_CHANGED / CREATED_DATE is usually set to the system date of the insert or update operation.

To populate the SOURCE column, specify where you obtained the data. If you receive the data from Vendor A, and Vendor A received the data from Regulatory B, you should set the SOURCE to Vendor A. In some cases (such as for interpreted picks), data is created by an application. In this case, the source may be set to identify the application that created the data.

Identifying Rows Of Data That Are Active

Maintaining information about how a business object has changed over time is an important business requirement for all these modules. To support this, mechanisms for allowing versioning have been added to many tables.

Tables in PPDM version 3.8 contain a column called ACTIVE_IND. The values for this column may be one of Y, N, or null. When more than one row of data (such as a spatial description or a status) has been created for a business object, use the ACTIVE_IND to indicate which row is currently active (note that in some cases, more than one row may be active simultaneously).

This provides implementers with two benefits. First, when populating EFFECTIVE_DATE and EXPIRY_DATE it will not be necessary to populate EXPIRY_DATE with a false future date to indicate that the row of data has not expired yet. Second, queries can explicitly search only for rows that are active.

If this column is used for queries, as recommended (such as "find me the currently active status for this land right"), you should implement procedures to ensure that this column is always populated as either Y or N and maintained

appropriately. If the column is left blank (NULL), the query will not be consistent or reliable.

For example, you could default the value to N if the expiry date is filled in and has already happened. Make it Y if the expiry date is empty *or* if the expiry date contains a future date.

Modifying PPDM 3.8

Subsetting PPDM

The PPDM data model is designed to allow users to implement portions that support their business without needing to manage modules that are not required. Good data management practices are also supported; this means that data redundancy is reduced in the Model whenever possible.

All information about seismic operations will be found in the Seismic Module; information about contracts is stored in the Contracts Module, details about objects that are retained for long term use are stored in the Records Management Module and so on. Depending on your business requirements, you can implement all or some of the modules.

In general, it is usually simplest to install the entire PPDM data model and simply restrict usage to the portions that are useful to you. Additional tables can be implemented as your business requirements expand, or as your data and processes are able to support capture in a data model. Architectural guidelines for subsetting PPDM are contained in the PPDM Architectural Principles Document. This document can be obtained from the PPDM Association or downloaded from the PPDM web site at www.ppdm.org.

Expanding PPDM

As a consequence of the PPDM Design process, which actively solicits and incorporates business requirements from Industry, many users find that the model is quite complete. However, individual implementations may find that additional columns are needed, or that some denormalization will help their performance.

The Association provides documentation about how to expand the data model to accommodate your specific requirements. This document can be obtained from the PPDM Association or downloaded from the PPDM web site at www.ppdm.org.

Feedback to PPDM

Much of the growth of the PPDM model can be attributed to Industry feedback. All implementers are requested and encouraged to provide feedback to the Association about changes they have made for implementation. Feedback can be submitted to changes@ppdm.org.

Frequently Asked Questions (FAQ)

We generally prefer not to be the first to implement something new. How many PPDM members have already implemented the Units of Measure reference data?

Most new implementations are including validated units of measure.

We're using LIS as our units of measure. How do we integrate the new PPDM units of measure?

Refer to the section in this guide titled *Implementing the PPDM Units of Measure Reference Data*, and also refer to the discussion about the PPDM_UOM_ALIAS table in the *Tables and Columns: Units of Measure section.* LIS nomenclature should be added to the PPDM_UOM_ALIAS table, and UOM_ID values should be replaced with the new, standard values.

We'd like to keep our existing UOM_ID values, and just add units of measure for the units we don't already have. Is this a good idea?

This approach would likely result in more work than the implementation of the entire reference data set. All existing UOM_ID values would have to be mapped (as is necessary for full implementation, as well) to ensure the uniqueness of the UOM_IDs.

Companies can choose to continue using their old UOM data, rather than to implement the PPDM UOM Reference Data.

Why are Units of Measure in PPDM standardized wherever possible?

- The fewer units involved, the faster most queries involving units of measure will be. A query that requires the database to retrieve all the rows in a large table and then to perform calculations on the data before returning results to a user is likely to perform very poorly.

- The number of queries including conversion formulas will decrease, thus decreasing the time spent developing queries, and lowering the chance of making errors when converting data during queries.

- The nomenclature used in describing non-standardized units is very inconsistent. If units have been converted to standardized units, the chances of later misinterpretation should decrease.

Appendix A: Sample Queries

These sample queries have been developed using a subset of the requirements defined in the Business Requirements Document. Note that there are many ways to address the questions posed here, but we have tried to provide useful examples that illustrate the use of the data model. The PPDM Association does not provide any guarantee that these queries will satisfy your business requirements; they are for illustration only.

- **Volume and Currency Conversions:** These conversions are not addressed in this section of the reference guide; volume conversions vary depending on temperature and pressure conditions; currency conversions require up-to-date currency rates, and so are not included in the PPDM UOM Reference data.

- **Versioning over time:** Many aspects of the oil and gas business have a strong time component. Users require information about how a business object was configured in the past, what it looks like now, and what it is expected to look like in the future (i.e., if a project is not active now, when was it in the past). If your queries need to address the situation as it is now, use the ACTIVE_IND you will find in many versioned tables. Using this flag helps ensure that you do not return data that is out of date.

Retrieving Measurement Data from PPDM 3.8 -- Examples

How many wells, operated by XYZ, have depth more than 3000 meters? I'd like the UWI, and depth in meters <u>and</u> in OUOM.

Data was stored in standardized units (meters)

```
SELECT      W.OPERATOR, W.UWI, W.FINAL_TD, 'm', ((UOM.PRE_OFFSET +
W.FINAL_TD)*UOM.FACTOR_NUMERATOR/UOM.FACTOR_DENOMINATOR
+UOM.POST_OFFSET) Original_Units, FINAL_TD_OUOM
FROM        WELL W, PPDM_UNIT_CONVERSION UOM
WHERE       W.OPERATOR = 'XYZ'
AND         FROM_UOM_ID = 'm'
AND         TO_UOM_ID = FINAL_TD_OUOM
AND         W.FINAL_TD > 1000
```

How do I list all available logs for wells in Wheatland County, Alberta , with their top and bottom depths in meters, where the logs have a depth of at least 1500 m ?

Data was stored in standardized units (meters)

```
SELECT      W.UWI, W.COUNTY, W.PROVINCE_STATE, WL.TOP_DEPTH,'m',
            WL.BASE_DEPTH, 'm'
FROM        WELL W, WELL_LOG WL
WHERE       W.UWI=WL.UWI
  AND       W.COUNTY='WHEATLAND'
  AND       W.PROVINCE_STATE='AB'
  AND       WL.BASE_DEPTH > 1500
```

I want to insert data about well 'XYZ' into the WELL table. The final depth of the well was 5000 ft. I want to convert this to meters as I add the record to the database.

```
INSERT INTO       WELL
                  (UWI, FINAL_TD, FINAL_TD_OUOM)

SELECT                  'XYZ', ((UOM.PRE_OFFSET +
5000)*UOM.FACTOR_NUMERATOR/UOM.FACTOR_DENOMINATOR +UOM.POST_OFFSET),
'ft'
FROM              PPDM_UNIT_CONVERSION UOM
WHERE                   UOM.FROM_UOM_ID = 'ft'
AND               UOM.TO_UOM_ID = 'm';

COMMIT;
```

Normally more information than UWI and Final Depth would be inserted into a record in PPDM. This illustration focuses only on unit conversion.

Appendix B: Changes to the Model

The PPDM Association has made a concerted effort to reduce the impact of new model development on members who are using other versions of PPDM. However, any new development is accompanied by some changes. Arriving at a model that is sufficiently detailed to meet the business needs of every member and yet flexible or abstract enough to be shielded from corporate or regulatory variations is complex, but achievable. Every attempt is made to ensure the model complies with, but is relatively independent of, specific jurisdictional requirements, changes in government policy, regulations or structure that may at times invalidate portions of the model. Internal re-engineering of business processes in industry companies may affect business requirements, which drive the data model. Rapid technological changes may also affect the model structure.

This section identifies all applicable changes from the latest version to the newest release version, to help members implement the latest version of the PPDM model.

The Units of Measure Module was updated for PPDM 3.7, and has remained the same for version 3.8.

Changes between versions 3.6 and 3.7/3.8

- Reference data, to be used as a "starter set", has been created.
- In the PPDM_COLUMN table, entries were added to the OUOM_COLUMN_NAME and UOM_COLUMN_NAME.
- The reference tables R_PPDM_UOM_ALIAS_TYPE and R_PPDM_USAGE were added.
- In each table, columns were added and renamed, as listed in the following charts.

PPDM_UNIT_OF_MEASURE table

Columns added to 3.7/3.8		**Columns in 3.6**
UOM_ID	*replaces*	UNIT_SYMBOL
UOM_NAME	*replaces*	UNIT_NAME
UOM_QUANTITY	*replaces*	UNIT_QUANTITY
UOM_SYSTEM_ID	*replaces*	UNIT_SYSTEM

SOURCE_DOCUMENT	*added*
USAGE_TYPE	*added*
BASE_UNIT_INDICATOR	*added*

PPDM_UNIT_CONVERSION table

Columns added to 3.7/3.8		**Columns in 3.6**
FROM_UOM_ID	*replaces*	FROM_UNIT_SYMBOL
TO_UOM_ID	*replaces*	TO_UNIT_SYMBOL
PRE_OFFSET POST_OFFSET	*replace*	UNIT_SYMBOL
FACTOR_NUMERATOR FACTOR_DENOMINATOR	*replace*	UNIT_EXPRESSION
SOURCE_DOCUMENT	*added*	
EXACT_CONVERSION_IND	*added*	

PPDM_UOM_ALIAS table

Columns added to 3.7/3.8		**Columns in 3.6**
UOM_ID	*replaces*	UNIT_SYMBOL
UOM_ALIAS	*replaces*	UNIT_SYNONYM
ALIAS_OWNER_BA_ID	*replaces*	UNIT_QUANTITY
APPLICATION_ID	*replaces*	UNIT_SYSTEM
PREFERRED_IND	*added*	
SOURCE_DOCUMENT	*added*	
UOM_ALIAS_TYPE	*added*	

Appendix C: Sources of UOM Data

Sources of PPDM Units of Measure Reference Data. Sources are listed in the order of precedence used to resolve conflicting data. Additional information is available in the R_SOURCE and SOURCE_DOCUMENT tables.

Source	Source Document	Document Title
IEEE/ASTM	SI 10-2002	American National Standard for Use of the International System of Units (SI)
ANSI/IEEE	Std 260.1-1993	American National Standard Letter Symbols for Units of Measurement
Organisation Intergouvernementale de la Convention du Mètre	Supplement 2000	The International System of Units (SI)
POSC	Version 2.1	Epicentre
POSC/API	API RP-66	
ANSI	X3.50-1986	
Regenstrief Institute	Version 1.7	The Unified Code for Units of Measure
Wolfram Research	Version 5.0	Mathematica
NIST	Special Pub. 811	