Public Petroleum Data Model Association

PPDM Association

Wells Reference Guide

Last updated for PPDM 3.5

Prepared for The Public Petroleum Data Model Association by

David Fisher, Consultant

L. A. McCulloch-Smith, Geowrite Inc.

Trudy Curtis, TruBear Custom Design Inc.

Table Of Contents

About This Document

This reference guide has been prepared to help managers, analysts, DBAs, programmers, data managers, and users understand how the Data Model is intended to be used. Readers at many levels, from managerial to technical implementers will benefit from reading 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.

- **Introduction**
  Provides an executive overview of the PPDM Model as it pertains to Wells.
- **Business Process Overview**
  Summarizes Wells and provides examples of related business processes.
- **Integration**
  Discusses how this module is integrated with the other PPDM Business Modules and provides information about related references guides.
- **Model Overview**
  Includes the entity relationship diagram and discusses the use of Well Module tables in the PPDM Data Model.
- **Tables and Columns – Wells**
  Identifies the data model tables for the Well Module, how they should be used, what they contain, and recommends how they should be used. This section is intended to 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 Well Module.
- **Appendix A – Sample Queries**
  Provides example queries with the appropriate SQL scripts that illustrate uses of the model based on the Business Requirements Document.
- **Appendix B – Versioning**
  Identifies the changes in the Well Module from the latest version to the newest release version of the PPDM model.

Appendix C– Capturing DST Data in PPDM v. 3.5b

Helps you decide where DST data should be captured in tables of this module.

Introduction

A vast quantity of data is associated with the life of a well, and we summarize the various stages and related data in the following list:

- Once a well location is selected, planning such details as preparing the surface lease, selecting drilling contractors, and estimating well prognosis depths begins.
- Drilling the well involves recording operational data, including the rig on location date, spud date, rig release date, bit types, numbers of bits used, etc.
- Once the target formation is reached, it is evaluated by coring, logging, and testing. The results are analyzed and recorded.
- If the well encounters hydrocarbons in economic quantities, the well must be put on production by installing completion strings, perforating, etc.
- Once the well is put on production, fluid volumes, allocation, and composition must be recorded, along with the results of periodic testing.
- Alternatively, the well may be a suitable injection well, and fluid injection will need to be monitored, and the results recorded.
- With time, production from the well may no longer be economical, and the well interests may be sold to another company.
- Alternatively, the well may be abandoned.

The Well Module captures all data related to the life of the well, with the exception of production data. That data is captured in the Production Module of PPDM.

Business Process Overview

Purpose

The Well Module provides a means of describing and managing well information.

Description

The life of a well starts with planning and proceeds to drilling, evaluating, sampling, completing, producing or injecting, and possibly selling, and finally ends with abandonment. Data from these various stages must be recorded and tracked.

Key Business Processes

Planning

Once a team of geoscientists has conceived a hydrocarbon prospect and proposed a well location, planning the well begins.

During this stage, geoscientists on the team will evaluate seismic and geological data and contribute a well prognosis, which spells out the anticipated stratigraphic units and their estimated depths. The engineer will be responsible for design of the well, from selecting the number and type of drill bits to installing completion strings to produce the formation fluids. As well, the land department will assess the land rights and regulations involved and determine who the stakeholders are.

Drilling

The drilling stage involves many operations, including (but not limited to) surveying the site; selecting a rig contractor and rig; spudding the well and recording spud date; filling out drilling reports; and coring, testing, and logging.

Evaluating

Once the target formation is reached, the team of oil and gas specialists begins evaluating logs, examining cores, and analyzing tests.

Sampling

It is also useful to track where fluid and rock samples come from in the wellbore, the methods used for collecting and analyzing the samples, the results of analysis, and sample storage.

Completing

A well that encounters a viable source of hydrocarbons must then be completed and put on production. This process involves opening the producing interval to the wellbore and isolating the reservoir from contamination by water-producing intervals, etc.

Producing or Injecting

You may find that the successful well has encountered a new pool in an existing field. You will likely need to report this information to your regulatory agency. In addition, during this stage of the life of the well, you will conduct periodic tests and determine volumes of produced fluids, composition, and allocation.

Alternatively, you may be using this well to inject water and improve production from surrounding wells.

Selling

At some point, as production declines with time, you may decide that producing the well is no longer profitable or that you want to sell your interests in the well and funnel money into a higher priority project. In any case, you contemplate farming out your interest in the well.

In determining its worth, you will have assessed remaining reserves, contacted other stakeholders, completed the legal agreements governing its sale, etc.

Abandoning

Eventually, your new well may begin producing at such high water-oil ratios that you want to abandon it. Operations associated with abandonment include obtaining the appropriate permits for abandoning the well, contracting a rig to perform the operation, plugging the well, recovering the wellhead and other equipment, and reclaiming the well site and disposing of it.

Integration

Integration is the key to managing the Well Module and its components properly. This module is integrated with a number of other modules in the PPDM data model, including:

Land Mineral Rights and land sales

Stratigraphy

Contracts

Facilities

Production

Fields and pools

Geographic areas, such as organizational boundaries or project areas

Jurisdictional agencies

Well, seismic, and field station interpretations

Interest sets

Records management

Obligations

- Lithology.

Contact PPDM to inquire about the status and availability of reference guides for these modules.

Model Overview

Entity Relationship Diagram

The diagram on the next page uses the following color conventions for entities and table projections. Note that some colors may not apply to this diagram:

- **White boxes:** This entity represents a table that existed in a previous version of PPDM. Changes or additions may have been made to the table definitions. White boxes that contain yellow boxes or that are contained by yellow boxes are not projected as tables in PPDM version 3.5.
- **Green boxes:** This entity represents a table that is new for PPDM version 3.5.
- **Yellow boxes:** This entity represents a table in a super_sub type set that is projected. The white box that is either within a yellow box, or that contains a yellow box is not projected as a table in PPDM version 3.5.
- **Red boxes:** These represent tables from a previous version of PPDM that were deleted in version 3.5.
- **Pink boxes:** These represent tables that are under discussion by the work groups and may change significantly or disappear.

Well

A well is a set of holes drilled in the ground for the purpose of exploring for, or obtaining production of, hydrocarbons. The hole is drilled by a rock bit. Most wells have only one hole (wellbore), although some are a complex set of branching holes with a common surface point.

In the Well Module, all the information is referenced to a particular well. The primary key is the Unique Well Identifier. The UWI is therefore part of the primary key in every related table throughout this module. WELL_VERSION is an almost identical table, with the addition of SOURCE to the primary key. This allows for storage of multiple versions of the same information about a well, and the promotion of one set of information to the WELL table for routine use.

The WELL table contains several types of information:

- general: name, class, type, depth, operator, regulator, elevations, general location
- summary indicators (flags): discovery, faulted
- information copied from other parts of the Well Module: location, status, dates, etc.
- connections to other tables in the Well Module: node, source (for WELL_VERSION)
- connections to other parts of the Model: lease, tax code

The WELL table was the first table designed in PPDM, about 1989. It has undergone changes over time, but still retains some of the original requirements. These may be important to support older implementations, even if there is now a better way. For example, as database systems have evolved, the need to denormalize for query performance has diminished, and so some columns in this table are best left unpopulated if the data can be efficiently retrieved from the primary table. Any attempt to store the same information in more than one table is an invitation to quality problems and complicates data loading procedures.

Directional Surveys

The position of the wellbore may be surveyed by a downhole device, mounted in the drill string or operated on a wireline. The data may be recorded and held within the device, or transmitted in real time to the surface. The simplest survey device records only the inclination of the wellbore at selected depths. More advanced devices allow for accurate three-dimensional mapping of the entire well.

Directional survey information is captured in the PPDM in three related tables:

- general information: type of tool, dates and depth range, computation method, coordinate system
- survey stations: measured and recalculated X, Y, Z position, and related data.
- geometry: a table specifically for spatially enabling the PPDM.

Logs

A log is an organized record of measurements. In the Well Module, the log data is ordered by depth. The measurements deal with the rocks and fluids, the materials placed in the wellbore, and the drilling processes. The data may be raw or observed properties, but are more usually computed, adjusted, or interpreted.

Most well logs are obtained by a device suspended in the wellbore on a wire line. These wireline (or "mechanical") logs are captured in the PPDM model, in various related tables:

- general information: contractor, dates, data about the well at the time of logging
- run (trip): dates, depths, tool, related mud samples, formation interval logged
- curves: properties measured, curve scales, digital sampling interval
- mud (drilling fluid): sampling times, density, resistivity, temperature, fluid loss

Properties such as the composition of gases entrained in the drilling fluid are measured by devices placed in the stream of the circulating fluid when it reaches the surface. The data is recorded with computed depth values, so that the values represent events at the drill bit. The Log Module was not designed for this type of "mud log" information. However, the data can be captured in the table WELL_LOG_CURVE. For example, C1, C2, etc. can be defined as curve types.

Lithology logs describe the observed or interpreted geological features of the rock intersected by the well. This type of log is captured in the Lithology module of PPDM.

Some of the common log-related terms used in the model are job, run, pass, tool string, tool, bottom and top depths, and curve. These terms are defined in a separate Glossary, available from PPDM.

Cores

A core is a cylinder of rock obtained by a hollow drill bit. It is the only undisturbed sample of the subsurface that is available for direct examination. Cores are obtained only for intervals of special interest in the well, because of the high cost.

Sidewall cores are a special category. They are small cylinders of rock obtained at selected depths from the side of the open wellbore, usually after the well has been logged. The coring device uses a small drill or explosive projectile to cut the core. Sidewall cores are not necessarily collected in depth order.

Information is obtained from the cores by direct examination (description and geological interpretation), by laboratory analysis, and by mechanical measurement (e.g., spectrometry).

Core information is captured in the PPDM model in various related tables:

- general information: contractor, dates, data about the well at the time of coring
- coring operation: dates, depths, diameter, length, recovery, formations cored
- descriptions: textual remarks on the entire core, and about samples taken for analysis
- analysis procedures: laboratory company, dates, methods, sample type, and size
- analysis results: porosity, permeability, density, etc.
- core shift: adjustments to match coring depths to logging depths

Lithology logs are textual and graphic descriptions of the observed or interpreted geological features of the core. This type of log is captured in the Lithology module of PPDM.

Well Tests

A well test is a set of procedures, performed under specified conditions, to measure the factors affecting the capability of a well for production or injection of fluids.

The well test portion of PPDM is large and complicated. It has a long history in PPDM; was included in the early versions of the model; and is used, with modifications, in many implementations. Some of the complexities are:

- There are several types of tests, each creating special kinds of data.
- Some tests are not assigned a unique number in the field, so the numbers required in the primary key must be created prior to loading the data for these tests.
- Some column names, inherited from earlier versions, do not conform to current naming principles. Because of numerous implementations, the destructive impact was deemed too great to change these names without a strong business purpose.

- Some tables, especially the parent table WELL_TEST, have many columns of denormalized values. These were created for the convenience and efficiency of queries, but are not mandatory. We recommend that they not be used without a special purpose.

- Many columns have a foreign key to a reference table, to another table in the well test subject, or to another table in a different part of the model. This integration is powerful within the database, but requires extra attention to data loading.

The five-part primary key in the WELL_TEST parent table is carried through all the child tables. This key consists of:

- UWI: identifies the well and wellbore in which the test was performed

- SOURCE: identifies the source of the data

- TEST_TYPE: describes the general type of test, such as drill stem or initial productivity. Allowable values are in R_WELL_TEST_TYPE.

- RUN_NUM: identifies the run (trip) into the well for the purpose of testing. With DSTs and WLTs, it is possible to conduct several tests during a single run.

- TEST_NUM: identifies the individual test generating a set of data such as depth, time interval, pressures, and recoveries

Because SOURCE is part of the primary key, the model does not allow for some of the test data to be supplied from a different source. For example, you might purchase most of the test data from your primary data supplier, VENDOR A. But you buy test pressure data from VENDOR B, who offers higher quality or more comprehensive coverage for this data type. In the model, you must keep VENDOR A as the source throughout the well test tables. Data from VENDOR B could be identified in the remarks column, or by extending the model by adding your own column such as XTND_SOURCE.

See Appendix A: Sample Queries for an illustration of the primary key for the test tables.

Completions and Related Operations

A completion is a set of operations to prepare a well for the production or injection of fluids.

Several other tables are closely related to completions. They provide information about:

- **Perforation** is the operation of making holes in the casing to allow fluid exchange between the formation and the well.

- **Tests** are the operations and measurements to determine fluids and pressures in a reservoir. A completion is not essential for some kinds of well tests (e.g., drill stem test, formation pressure test).

- **Treatment** is the operation and materials applied to "stimulate" the reservoir to enhance productivity (e.g., acid wash).

- **Tubular** is the casing and production tubing placed in the well during drilling and completion.

- **Cement** is the operation and materials used to secure the casing in the wellbore and to prevent the flow of fluids in the annulus (space between casing and rock).

- **Production String** is the conduit within a producing well for fluid exchange between the formation and the surface.

- **Production String Formation** is the name of the rock unit connected to the production string.

Analysis of Reservoir Fluids

Gas, oil, and water obtained from a subsurface reservoir may be analyzed for compositional and physical properties. The information is often important for evaluating the potential of a reservoir, for determining the components of production and their commercial value, and for modeling the performance of the reservoir.

Fluid analysis is captured in the PPDM in the following pair of tables for each of gas, oil, and water:

- sample: where, when, and how the analyzed sample was obtained from the well, plus some analyzed properties

- analysis results: property (e.g., C3, H2S), measured or computed value, and units.

The WELL_TEST_ANALYSIS table is less comprehensive than the fluid analysis tables, but is intended to record information commonly reported for a well test (e.g., GOR, H2S, oil gravity). The source of this information may be the test report, whereas data in the fluid analysis tables is usually derived from the laboratory reports.

Well Positions

The three-dimensional path of the wellbore is valuable information in exploration, drilling operations, production planning, and lease administration. This path must be expressed in numeric values that allow for accurate mapping. If the well is not positioned correctly, significant errors are likely in relation to seismic lines, pipelines, surface facilities, lease boundaries, cultural and topographic features, other wells, and subsurface targets.

Survey information is captured in the PPDM in numerous tables, many of which are shared by other subject modules. These general tables can be considered as several types:

- reference values for coordinate systems, computation methods, etc.
- coordinate system and parameters
- survey methods
- survey points: X Y, Z field data, and computed values
- methods of expressing the position for mapping purposes: geodetic or relative

In the Well Module, the most important positional information is stored as latitude and longitude sets for the surface location and certain key subsurface points, such as the bottom of the hole, kickoff points, and target intersections. Some of these values may be denormalized to the WELL table for more efficient retrieval. The entire path of a wellbore may be described or plotted using computed survey data in the directional survey tables.

Any set of coordinates is potentially confusing or useless without the related information about the coordinate system and reference points. An organization could declare that only one coordinate system is used for all its spatial information, and then not bother to populate some of these tables in the PPDM. This is probably a short-sighted decision, degrading the quality and integrity of the database.

Tables and Columns: Wells

WELL

The following columns are intended for information that is (or should be) captured elsewhere in the Well Module. A copy can be made into the Well table, if required by your circumstances, such as for database or application performance. However, in many cases where well data is purchased from a data supplier, the value will be provided directly for the WELL table. This is especially convenient where the procedure for copying the appropriate value involves manual interpretation. The data administrator should decide how to achieve acceptable data quality if the same information is stored in two places. This could be done, for example, by quality checks on loading or by using database triggers to populate one column from the other.

- The source for the BOTTOM_HOLE_LATITUDE column is WELL_NODE.LATITUDE (foreign key BASE_NODE_ID). Coordinates in the WELL table may substantially improve the performance of many applications.

- The source for COMPLETION_DATE is WELL_COMPLETION.COMPLETION_DATE.

- The source for CURRENT_STATUS is WELL_STATUS.STATUS (for latest STATUS_DATE).

- The source for DEEPEST_DEPTH is WELL_DRILL_STATUS.STATUS_DEPTH (for ACTIVITY_TYPE describing the deepest or final drilled depth). This is probably never used as the source of data for the WELL table.

- The source for FINAL_DRILL_DATE is WELL_DRILL_STATUS.STATUS_DATE. See the note for DEEPEST_DEPTH.

- The source for FINAL_TD is WELL_DRILL_STATUS.STATUS_DEPTH. See the note for DEEPEST_DEPTH.

- The source for LOG_TD is WELL_LOG_TRIP.BASE_DEPTH. This is difficult to populate programmatically because each log trip may have a different depth.

- The source for MAX_TVD is WELL_DIR_SRVY_STATION.STATION_TVD. This is difficult to populate programmatically because there may be multiple surveys, and none may have reached total depth.

- The source for NET_PAY is WELL_PAYZONE.NET_PAY. This is difficult to populate programmatically because there may be multiple pay zones in the well.

- The source for OLDEST_STRAT_UNIT is STRAT_WELL_SECTION.STRAT_UNIT_ID, where CERTIFIED_IND = Y and the oldest unit is determined from STRAT_UNIT_AGE. You must also specify STRAT_NAME_SET_NAME.

- The source for PLUGBACK_DEPTH is WELL_PLUGBACK.TOP_DEPTH (for latest PLUGBACK_DATE and/or selected PLUG_TYPE).

- The source for RIG_ON_SITE_DATE is WELL_DRILL_STATUS.STATUS_DATE (for ACTIVITY_TYPE describing the arrival of the rig at the well site).

- The source for RIG_RELEASE_DATE is WELL_DRILL_STATUS.STATUS_DATE (for ACTIVITY_TYPE of "rig release"). This is probably never used as the source of data for the WELL table.

- The source for SPUD_DATE is WELL_DRILL_STATUS.STATUS_DATE (for ACTIVITY_TYPE of "spud"). This is probably never used as the source of data for the WELL table.

- The source for SURFACE_LATITUDE is WELL_NODE.LATITUDE (foreign key SURFACE_NODE_ID). Coordinates in the WELL table may substantially improve the performance of many applications.

- The source for TD_STRAT_UNIT is STRAT_WELL_SECTION.STRAT_UNIT_ID, where CERTIFIED_IND = Y and maximum depth. You must also specify STRAT_NAME_SET_NAME.

- The source for WHIPSTOCK_DEPTH is WELL_DRILL_STATUS.STATUS_DEPTH (for ACTIVITY_TYPE of whipstock).

The WELL table has several foreign key constraints. Before adding data, the following tables—as a minimum set—should first be populated with appropriate values (unless the constraints are turned off by the database administrator).

R_COUNTRY

R_PROVINCE_STATE
R_WELL_CLASS

R_WELL_STATUS

R_WELL_DATUM_TYPE

R_GEOLOGIC_AGE

R_WELL_RELATIONSHIP

R_SOURCE

R_WELL_PROFILE_TYPE

R_WATER_DATUM

BUSINESS_ASSOCIATE

STRAT_UNIT

WELL_NODE

The DEPTH_DATUM column describes the type of reference for depths reported in the well. It is often the kelly bushing or derrick floor, which is the level having a measured depth of zero. Elsewhere in the Well Module (e.g., WELL_LOG_TRIP), it is possible that a different datum is used for the depths. This is an issue for investigation of data quality, not enforced in the PPDM.

DEPTH_DATUM_ELEV is the elevation (e.g., height above mean sea level) of the depth datum. Subsurface elevations may then be computed as DEPTH_DATUM_ELEV—MEASURED_DEPTH, provided the measured depth is "true vertical".

DRILL_TD is the total depth reported by the driller (or operator). It is the length from the datum (at surface) to the bottom of the hole, measured along the wellbore. This total depth may vary somewhat from the total depth measured by logging tools or other means, especially in a very deep well.

FINAL_TD may be redundant with DRILL_TD, but this column can also be used to capture the preferred value for total depth, which may disagree with the driller's depth.

GROUND_ELEV_TYPE describes the type of datum for the ground elevation. Allowable values are in R_WELL_DATUM_TYPE.

INITIAL_CLASS is the assigned "class" of the well, such as New Pool Wildcat. The designation may change in the life of the well, but the explorationist's interest is chiefly in the initial assignment as an indicator of why the well was drilled.

LEASE_NAME and LEASE_NUM provide basic connections to the PPDM Land Module, although no foreign key is assigned in this version of the Model. A well is usually part of a lease or other type of permit to drill and operate.

LOG_TD is the maximum depth achieved by the wireline logging tools. It provides another estimate of the total depth of the well, separate from the calculation made by the driller. In some wells, the logs were never run to the

bottom (e.g., hole collapse), so LOG_TD might be a much smaller value than DRILL_TD.

MAX_TVD is the total depth of the well as measured vertically from the datum. It should be computed from directional surveys, if available. Otherwise, it should be left null.

NET_PAY is the cumulative thickness of productive reservoir in the well. Normally, this value refers to only the producing zone in the well, although it is possible to have multiple pay zones. Detailed information is captured in WELL_PAYZONE, as the WELL table provides only a summary.

OLDEST_STRAT_UNIT is the oldest unit ("formation") encountered in the well. In faulted or overturned strata, the oldest unit is not necessarily found at the bottom of the well.

OPERATOR is the name of the business associate holding the permit to drill and responsible for reporting the drilling activity to the regulatory agency. The operator may be acting on behalf of other partners in the well. The present operator is not necessarily the one at the time the well was drilled.

PARENT_RELATIONSHIP_TYPE describes how one wellbore is related to another in the same well (e.g., sidetrack). This information is necessary to reconstruct the geometry of a well with multiple holes.

PRIMARY_SOURCE is the link to the source of the data in WELL_VERSION.

PROFILE_TYPE is a general description of the well, such as vertical or deviated.

SOURCE_DOCUMENT describes the original data source, if known. In contrast, WELL.SOURCE describes the supplier of the data as loaded. For example, the source document might be a well report submitted to the government, and the source is the data vendor who collected and delivered the data to a client.

STRAT_NAME_SET_NAME is required to ensure uniqueness of any STRAT_UNIT referred to in the WELL table (e.g., TD_STRAT_UNIT).

SURFACE_LATITUDE and SURFACE_LONGITUDE hold a copy of the surface coordinates of the well, derived from WELL_NODE using the foreign key WELL.SURFACE_NODE_ID. To ensure data quality, it is essential to maintain the links between these tables.

TD_STRAT_UNIT is the deepest formation encountered in the well.

WELL_GOVERNMENT_ID may be any string describing the well, as assigned by the regulatory agency. It is not used in the primary key for this table, although it may be identical to WELL.UWI in some jurisdictions.

WELL_NUM may be any string describing the well, as assigned by the operator or by the owner of the database. It is not used in the primary key for this table,

but may be useful to simplify or shorten the well designations on maps and printed lists.

WELL_NUMERIC_ID is a unique number for use in spatial queries. Note that it is not the same data type as WELL.UWI.

General Information

WELL_ALIAS

This table contains names and identifiers that a well may otherwise be known as. This would include previous or alternate well identifiers assigned to the well by a regulatory agency.

WELL_FACILITY

FINISH THIS

WELL_STATUS

This table contains a historical account of the operating status of the wellbore. The actual status of the wellbore on a specific date is described here. The information may include the dates when the well was completed, produced oil/gas, injected, plugged, or abandoned.

WELL_VERSION

This table is a duplicate of the WELL table, with the addition of SOURCE as part of the primary key to accommodate versioning. A well may consist of many wellbores. The WELL table contains “header type” information pertaining to a specific well or wellbore. The parent UWI and the parent relationship columns are used to identify a well that may have many wellbores. Important dates, depths, and elevations are included as part of the WELL table.

The term well can be used in the column comments to represent a well or wellbore.

WELL_PLATFORM

FINISH THIS

WELL_REMARK

This table contains additional information pertaining to a specific event within the wellbore. Remarks contained in this table may also refer to information regarding formation and stratigraphic interval.

WELL_MISC_DATA

This table contains miscellaneous data about the wellbore and serves as a note pad for recording general well data.

Well Spatial: Location

LEGAL_CARTER_LOC

This table represents a supertype that groups different methods of describing the location of a cartographic object in reference to various systems of local reference. The table describes the location of a cartographic object in reference to the Carter Grid Survey System, which is a township, range, and section system using latitude and longitude lines for subdivision boundaries. This land survey system is primarily used in the United States for the states of Kentucky and Tennessee.

LEGAL _CONGRESS_LOC

This table represents a supertype that groups different methods of describing the location of a cartographic object in reference to various systems of local reference. The table describes the location of an object in reference to the Congressional Land Survey System, which forms a grid system of townships, ranges, and sections. This rectilinear system is also known as Congressional, Jeffersonian, Civil, or Dominion Surveys. It is the basic survey system used in the U.S. for surveying civil boundaries below the county level.

LEGAL_DLS_LOC

This table represents a supertype that groups different methods of describing the location of a cartographic object in reference to various systems of local reference. The table describes the location of an object based on the Canadian Dominion Land Survey (DLS). This survey system is used in the Canadian provinces of Manitoba, Saskatchewan, Alberta, and in the Peace River Block of British Columbia.

LEGAL_FPS_LOC

This table represents a supertype that groups different methods of describing the location of a cartographic object in reference to various systems of local reference. The description of locations in the Federal Permit System (FPS) used in Canada. This system is used in all Canadian Federal Lands in both the offshore and northern territories.

LEGAL_GEODETIC_LOC

This table is a supertype that groups different methods of describing the location of a cartographic object in reference to various systems of local reference. The table describes a location in the Geodetic System used in Canada. This system is used in Quebec, Ontario, and the Maritime Provinces.

LEGAL_LOC_REMARK

This table contains information about the narrative description of the location. Typically, this data can be used for miscellaneous comments about the location that do not fit into other fields.

LEGAL_NE_LOC

This table is a supertype that groups different methods of describing the location of a cartographic object in reference to various systems of local reference. The North East Location table contains location information pertaining to states located in the northeast region of the United States.

LEGAL_NORTH_SEA_LOC

This table is a supertype that groups different methods of describing the location of a cartographic object in reference to various systems of local reference. The table describes the European locations and is primarily used to store the coordinates of an object surveyed within the North Sea system of offshore areas, blocks, and block subdivisions.

LEGAL_NTS_LOC

This table is a supertype that groups different methods of describing the location of a cartographic object in reference to various systems of local reference. The table describes a location in reference to the National Topographic Series survey system used in British Columbia, Canada.

LEGAL_OFFSHORE_LOC

This table is a supertype that groups different methods of describing the location of a cartographic object in reference to various systems of local reference. The table locates an object within a grid of blocks covering U.S. Federal and State waters. The offshore location table includes the Gulf states and Outer Continental Shelf area.

LEGAL_OHIO_LOC

This table is a supertype that groups different methods of describing the location of a cartographic object in reference to various systems of local reference. The table describes the location of an object within the state of Ohio. This land survey scheme is patterned for identifying Ohio wellbore locations.

LEGAL_TEXAS_LOC

This table is a supertype that groups different methods of describing the location of a cartographic object in reference to various systems of local reference. The table describes the location of an object in reference to a Texas land survey.

Well Planning

WELL_INTEREST

This table contains information pertaining to the ownership of a specific well and identifies individual participants, along with their percentages of participation in the well. General comments about the well ownership are also contained within this table.

This table will be removed from future versions and should not be populated by new implementations. Existing implementations should develop a migration path to the new module.

WELL_LICENSE

This table contains well license information identifying the licensee and drilling contractor authorized to explore and drill for petroleum on the tract of land covered by the license during the term of the license. Location and formation information are also stored in this table. In addition, the table contains data pertaining to the drilling rig and other drilling tools used.

WELL_RIGHT

This table contains information pertaining to well mineral rights and identifies those who have the legal right to search for, drill, and produce oil and gas from land. The mineral rights in a parcel of land is conveyed by deed and can be transferred by a lease. This table is under review as part of the land and contracts model.

WELL_GEOMETRY

FINISH THIS

Drilling Operations

WELL_EQUIPMENT

This table enumerates the equipment installed at the well.

WELL_EVENT

This table describes the type, date, depth, and comments of a particular event in a wellbore.

WELL_AIR_DRILL

This table contains information pertaining to the contractor and compressor sources used to perform an air drilling operation.

WELL_AIR_DRILL_INTERVAL

This table contains depth interval and air volume information, where air drilling was used in a wellbore.

WELL_DRILL_BIT

This table describes the physical characteristics of the drill bit and the operating conditions while using the bit during a drilling operation.

WELL_DRILL_MEDIA_INTRVL

This table contains information on the type of drilling media used during rotary drilling. Drilling media is used to cool and lubricate the bit, control subsurface fluids, or build a filter cake along the well walls.

WELL_DRILL_MEDIA_WEIGHT

This table contains information pertaining to the density of drilling media, which is most commonly mud weight. It is measured in the field with a mud balance. Fresh water weight is 8.3 ppg, normal drilling mud weight is 9 to10, and heavy drilling mud is 15 to 20. The heavier the mud weight, the greater the pressure it exerts on the bottom of the well.

WELL_DRILL_STATUS

This table contains information about the current drilling status on an active well. Included are the drilling status (e.g., coring or waiting on cement), the depth at which the status was observed, and the status date.

WELL_SIEVE_ANALYSIS

This table contains information identifying a specific location in a wellbore where samples for a sieve analysis were obtained. A sieve analysis determines the particle-size distribution in soil, sediment, or rock by measuring the percentage of the particles that pass through standard sieves of various sizes.

WELL_SIEVE_SCREEN

This table contains information relating to the sieve screen mesh size. This apparatus is used to separate soil or sedimentary material, according to the size of its particles. It is usually made of brass with a wire-mesh cloth, having regularly spaced square holes of uniform diameters, spread across the base.

WELL_MUD_RESISTIVITY

This table contains information pertaining to the resistivity found in mud, mud cake, or filtrate. It is used to determine the nature of the strata penetrated (i.e., the content of gas, oil, or water enclosed in rock pores). Formations containing salt water have low resistivity; those containing freshwater or oil have higher resistivities.

WELL_MUD_SAMPLE

This table contains information on the physical, chemical, and electrical properties of the drilling fluid that is associated with a set of wireline logs from the same wireline logging job. The mud sample is a sample of the fluid that is circulated through the wellbore during the drilling operation. It is the physical properties of the mud that have a direct effect on the measurements taken during a logging operation.

WELL_CEMENT

This table describes the cementing operation being performed on the well, such as primary cementing of casing strings.

WELL_TOUR_OCCURRENCE

This table contains information about any noteworthy event taking place during the drilling tour. The table can also describe problems encountered during the drilling operation. Examples of drilling problems include lost circulation, blowout, casing failure, and fishing operations. Each drilling occurrence is uniquely identified by the observation number and occurrence type.

Directional Surveys

WELL_DIR_SRVY

This table captures general information and other data that apply to all points in the wellbore survey. Numerous foreign keys allow for definition of various parameters necessary to convert the raw survey data into correct positional information.

The SURVEY_ID column is part of the primary key in this table. It identifies a specific run in the wellbore by the survey device. When a wellbore is surveyed by a wireline device, several successive surveys may be required for the complete path. In some cases, a well is resurveyed with a similar or different type of device. This can result in more than one survey for the same depth interval.

The DIR_SURVEY_CLASS column describes a general classification based on the type of survey data collected. The common classes, defined in a reference table, yield inclination data only or inclination and azimuth data.

The SURVEY_TYPE column is a classification of the survey based on the method and device. These types, defined in a reference table, include wireline gyroscope, multi-shot, and MWD (measure while drilling).

The SOURCE_DOCUMENT column captures the type of document that the survey data were obtained from. This information may be helpful in assessing the quality of the data. Use this in conjunction with the WELL_DIR_SRVY.SOURCE column.

The COORD_SYSTEM_ID column is one of several columns used to capture information on the positional framework of the survey, essential for computing the correct X and Y values.

TOP_DEPTH and BASE_DEPTH define the surveyed interval. If more than one survey exists, there may be gaps or overlaps in coverage of the wellbore. Choices and decisions are left to the users of the survey data.

WELL_DIR_SRVY_STATION

This table captures the measured and computed survey values by depth in the wellbore. For each survey (SURVEY_ID primary key), there is one row of data for each measured depth point (station). The measured values are STATION_MD, INCLINATION, and (except for a simple survey type) AZIMUTH. Most other columns in this table are for parameters (e.g., VERTICAL_SECTION) and computed results (e.g., LATITUDE, X_OFFSET).

STATION_ID is not part of the primary key for this table. But it may be provided by the survey operator or data supplier. It may also be used if necessary to enforce uniqueness when two rows have the same STATION_MD within the same survey (a rare situation, but possible in some types of surveys).

LATITUDE and LONGITUDE are computed values. To be meaningful, every station must of course be computed the same way, with reference to a single coordinate system. Therefore, the WELL_DIR_SRVY.COORD_SYSTEM_ID column must be populated if latitude and longitude are captured. The model does not enforce this (the column is not designated NOT NULL), because some business requirements (e.g., for an inclination-only survey) do not include coordinate position.

WELL_DIR_SURVEY_GEOMETRY

FINISH THIS

Horizontal Drilling

WELL_HORIZ_DRILL

This table contains information about a horizontally drilled well, which is a new well drilled from the surface with lengths varying from 100 to 3,000 feet or more. This table stores the type of horizontal well (Ultra Short, Short, Medium and Long radius).

WELL_HORIZ_DRILL_KOP

This table contains information related to kickoff points.

WELL_HORIZ_DRILL_POE

This table contains information related to point of entry.

WELL_HORIZ_DRILL_SPOKE

This table contains information related to a spoke terminus.

Logs

WELL_LOG_JOB

This table captures information that is common to a set of logging operations. The “job” is usually conducted by a contractor at the wellsite when drilling has been halted at a strategic depth and the drill string removed from the wellbore. The start and end dates of the job, the total depth of the wellbore, and the depth of deepest casing can be recorded here.

WELL_LOG_TRIP

This table contains information about the tool used in one operating cycle down the well, from the time it is lowered to the time it is retrieved. The primary key includes JOB_ID and LOG_RUN (number). The logged interval is defined by the bottom and top depths. A single trip may have more than one pass of the interval; these are captured in the table WELL_LOG_PASS.

There can be only one tool string for a trip, because the configuration cannot be changed down the hole. The tool string may contain several sensing devices (tools), each measuring several properties (recorded as curves).

The LOG_RUN column has not been renamed to conform to the current architectural principles. It is analogous to RUN_NUM, as used in WELL_TEST and other tables.

The CURVE_TYPE column identifies the type or category of the measured property, such as acoustic velocity or resistivity. The specific property, such as deep induction resistivity, is captured in table WELL_LOG_CURVE. The CURVE_TYPE, therefore, is related to the tool used for the trip and should be defined in the reference table R_LOG_TOOL_TYPE. The WELL_LOG_TRIP table only tells what curves are possible for this trip; the actual recorded properties and the logged intervals must be entered in other tables.

Samples of the drilling fluid may be taken and analyzed for properties needed for calibration and interpretation of the log curves. The MUD_SAMPLE_ID, type, and source are foreign keys to the WELL_MUD_SAMPLE table.

WELL_LOG_TRIP_REMARK

The table captures narrative remarks about the well log trip. These comments may be made by the field crew, processing house, or interpretation specialists at any time, and could comment on the quality of the logs, field conditions, or problems.

WELL_LOG_CURVE

This table contains information about the properties that the tool string is capable of measuring during a trip. The table WELL_LOG_TRIP identifies the tool; this table identifies what curves may be recorded by the tool. For example, the acoustic velocity (sonic) tool may record curves for two-way travel time, hole

diameter (caliper), and gamma ray. The primary key for this table is CURVE_ID. For convenience, a curve name may also be included.

WELL_LOG_CURVE_INTRVL

This table captures the depth range for every curve recorded during a trip. Each curve may have a different depth range, even though they were all recorded by the same tool during the same trip. For example, the operator may choose to record a certain property only across the reservoir interval because it would be too expensive to record for the entire logged interval on this trip. Alternatively, one device may have failed part way through the logging pass.

The model does *not* store the actual digital data defining the curves. It only reports the existence and characteristics of these curves.

WELL_LOG_CURVE_SCALE

This table captures the vertical and horizontal scales and related parameters used in analog recording. This information may be valuable in assessing the precision of the measurements.

WELL_LOG_DIGIT_CURVE

This table is used to describe well logs that were recorded in digital format, or logs that were digitized from analog format. DEPTH_INCREMENT is the sampling interval used for analog-to-digital conversion.

Geological Interpretation

WELL_PAYZONE

This table contains information on the pay of producing zones in the well, such as the thickness of net pay and gross pay zones within an interval of the wellbore. The top and bottom depth define the position of the pay interval within the wellbore.

WELL_POROUS_INTERVAL

This table describes information about the type, thickness, depth range, and stratigraphic formation of rock porosity in an interval. Because rock porosity can be identified over many intervals in a wellbore, the primary key is POROUS_INTRVL_ID.

ZONE

This table contains the name of a zone described within a wellbore. A zone may be a regular or irregular belt, layer, band, or strip of earth materials disposed horizontally, vertically, concentrically or otherwise, and characterized as distinct from surrounding parts by some particular property or content.

WELL_ZONE_INTERVAL

This table contains information within a wellbore pertaining to a belt, layer, band, or strip of earth materials (e.g., rock or soil), disposed horizontally, vertically, concentrically, or otherwise, and characterized as distinct from surrounding parts by some particular property or content (e.g., part of the Earth's crust such as a zone of saturation, zone of fracture, or a structural zone characterized by folding of different styles and periods).

WELL_ZONE_INTRVL_VALUE

This table contains the actual data values resulting from an interpretation of a wellbore zone interval.

Cores

WELL_CORE

This table captures general information about a coring operation. Each trip into the hole with a core barrel or a sidewall coring device is a separate data row in this table. Dates, depths, core dimensions, and recovery are recorded here. Flags allow for easy indication of related data such as gamma ray correlation or core orientation. With foreign keys to reference tables, you may describe other features, such as core handling and the type of hydrocarbon "show" observed in the core.

The RUN_NUM column is not part of the primary key in this table. Do not be confused by the use of the same column name in some other parts of the model (e.g., well_test). Here, RUN_NUM refers to a set of downhole operations by a sidewall coring tool. You may leave this column set to NULL for conventional cores.

The PRIMARY_CORE_STRAT_UNIT column allows quick identification of the formation (stratigraphic unit) of primary interest in the core. For example, you may want to see a list of all cores taken from the Wilcox Formation (a producing zone in Texas). More than one formation may be present in the core. The "primary" one is not necessarily the longest section of the core, just the one considered to be of particular interest. In some cases, the "coring objective" may be designated on the coring report. But often, the primary unit data is not available. Information about all formations in the core is captured in STRAT_WELL_SECTION table.

WELL_CORE_ANALYSIS

This table describes the type of analytical sample collected. Information contained in this table includes sample shape, sample length, sample diameter, and analyst performing the analysis, etc.

WELL_CORE_ANAL_METHOD

This table contains information pertaining to the methods used during a core analysis. For example, SOLVENT stores a code representing the type of solvent (such as toluene) used for distillation extraction. DRYING records how the core was dried after the extraction process has been completed. The core might be dried in a high temperature oven, for example.

WELL_CORE_ANAL_REMARK

This table contains additional narrative remarks pertaining to the type of techniques used for core analysis.

WELL_CORE_DESCRIPTION

This table is to capture a textual description of the core as a whole. The information may be obtained from sources such as a well site report, laboratory report, or geologist's notes. Use table WELL_CORE_SAMPLE_DESC to describe a sample taken for analysis or reference.

The DESCRIPTION_OBS_NO is part of the primary key and allows you to capture more than one row of information about the same interval. If the numbers are assigned in numeric sequence, the descriptions can be placed in order.

TOP_DEPTH and BASE_DEPTH define the core interval being described in the data row. They are not necessarily equal to the like-named columns in table WELL_CORE.

The INTERVAL_THICKNESS column may be used to report the thickness of the bed or interval being described. The model does not enforce a particular business use of this column, but it is probably best to reserve it for a true thickness that is interpreted from all selected information (outside the database). The *apparent* true thickness may be easily computed as [(BASE_DEPTH - TOP_DEPTH) * sin dip_angle]. However, this algorithm does not take into account that the *observed* dip angle may be a very local geometry, not representative of the unit on a broader scale.

The LITHOLOGY_DESC column is for a brief textual description of the interval. It may include terms such as "sandstone," "cross-bedded," "micro-fractured," "moderately burrowed," and "abundant *Halysites*."

Use the POROSITY_LENGTH column to summarize the length of a specified type of porosity in the interval being described. This value must be less than or equal to (BASE_DEPTH - TOP_DEPTH). For a particular core, the aggregate length of all porous intervals may be computed as the sum of all rows of this data.

The POROSITY_TYPE column is the kind of porosity being described. Types in the reference table may include vuggy, microporosity, etc.

Use SHOW_LENGTH and SHOW_TYPE in the same way as porosity_length, etc.

WELL_CORE_REMARK

This table contains any remarks pertaining to a core. Comments could include a narrative describing the conventional and/or sidewall coring operations.

WELL_CORE_SAMPLE_DESC

This table describes any sample that was analyzed in a lab. The sample is normally obtained by cutting a piece from the whole core. The description is usually obtained from the laboratory report. Many of the columns in this table are analogous to those in table WELL_CORE_DESCRIPTION, describing the whole core.

WELL_CORE_SAMPLE_ANALYSIS

This table captures the results of laboratory analysis on individual core samples. The model does not presently allow for specialized analysis data such as capillary pressure curves, but some PPDM members have developed model extensions for this information.

WELL_CORE_SAMPLE_RMK

This table contains narrative comments about the sample of analyzed core.

WELL_CORE_SHIFT

This table captures an interpretation of the cored depth normalized to the depths used in the wireline logs. When the "shifted" depths are used, the position of a described or analyzed length of core can be referenced directly to the logs. Because of lost core and other factors, the core shifts involve judgements and interpretations. The same shift factor is not necessarily relevant to the entire core.

The TOP_DEPTH column is the measured depth to the top of any identified interval in the core, referenced to the depths reported from the coring operation. This value must be equal to or greater than well_core.top_depth, and less than well_core.base_depth.

The TOP_SHIFT_DEPTH column is the interpreted adjusted depth for the specified interval in the core.

WELL_CORE_STRAT_UNIT

This table captures the geological units (formations, etc.) identified in the core. The interpretation is part of the core description, so the primary key for this table includes foreign keys to table WELL_CORE_DESCRIPTION.

The CORE_STRAT_UNIT_MD column is the measured depth to the top of the unit. The table does not provide for a base depth.

Formations identified in the core by geological interpretation do not necessarily agree with the stratigraphy captured in STRAT_WELL_SECTION. Multiple and conflicting interpretations are possible and are allowed by the Model. For example, a query for Wilcox Formation cores could use WELL_CORE_STRAT_UNIT, or instead could find the Wilcox depth interval in STRAT_WELL_SECTION, as picked by INTERPRETER = JOE, and apply that to WELL_CORE.TOP_DEPTH and WELL_CORE.BASE_DEPTH.

Drilling Results

WELL_SHOW

This table contains information about the appearance of oil and/or gas obtained from a sample type (e.g., cuttings, pit, bailer, etc.). Description of the lithology associated with the hydrocarbon show is also stored in this table.

Tests

WELL_TEST

This table is the parent for all the data about well tests. Before you implement this section, we recommend that you read the Constraints Reference Guide first.

Tip: On Data Loading

First, identify and populate the required reference tables (e.g., R_WELL_TEST_TYPE) and other related tables (e.g., WELL_COMPLETION). Then, load the data into WELL_TEST.

The following tables are the minimum recommended set prior to loading WELL_TEST:

- WELL: must contain the UWI for the test
- R_SOURCE: must contain the value for SOURCE (part of the primary key in WELL_TEST)
- R_WELL_TEST_TYPE: must contain the value for the type of test (e.g., DST)
- STRAT_UNIT: must contain STRAT_UNIT_ID for any formations reported for this test (e.g., TOP_STRAT_UNIT)
- STRAT_NAME_SET_NAME: part of the primary key for STRAT_UNIT

- WELL_COMPLETION: must describe the completion interval. This is not required for most open hole tests.

- R_PRODUCTION_METHOD: required if the test is performed on a producing zone

- PROD_STRING: required if the test is performed on a producing zone

- PROD_STRING_FORMATION: required if the test is performed on a producing zone

- STRING_SOURCE: required if the test is performed on a producing zone

- BUSINESS_ASSOCIATE: required if the test data includes the name of the testing company

- R_TEST_RESULT: required to describe the general result of the test

- R_TEST_SUBTYPE: required if the test data includes the subtype (e.g., closed chamber test)

TEST_TYPE specifies the general type of test. It is useful primarily to distinguish among drill stem tests, wireline tests, and productivity (well completion) tests.

RUN_NUM identifies the run (trip) into the well for the purpose of conducting a test. In the case of a drill stem test or wireline test, the operator or testing contractor usually assigns the number in the field. However, data available for a test conducted on a completed interval may not include a suitable number. To load the data, a number must be created. Where there is more than one run in a well, the model does not require the number to be in any meaningful sequence, although there may be some added business value to placing the runs in chronological order. However, time order can also be determined using the TEST_DATE and START_TIME columns. Note that the data type is VARCHAR2, not a number, so values such as 3, B2, or RUN3 are all acceptable.

TEST_NUM identifies the individual test conducted during a single run (trip). For a wireline tester, multiple tests are common in a single run. Several drill stem tests may be conducted in a single run, particularly if there are several misruns (e.g., packer failure). For a test of a well completion, TEST_NUM is probably not available in the source data, and must be generated in order to load into the database (a value of 1 is suggested). If the number is available from the source, it may also be captured in REPORT_TEST_NUM, even if this number is not suitable for use as TEST_NUM.

Although optional, AGE_CODE may be used to identify the general chronostratigraphic interval being tested. For example, this may be useful if you have a requirement to quickly identify all Silurian tests in a region. Allowable ages are in R_GEOLOGIC_AGE.

The BASE_STRAT_UNIT and TOP_STRAT_UNIT columns are intended to capture the formations as reported on the source document. They must be defined with the same STRAT_NAME_SET_NAME. If the values are not available from the source of this row, we recommend these columns be left null. Do not copy values from STRAT_WELL_SECTION, as this would be too difficult to maintain. Note that a drill stem test interval may span several formations, and the objective formation may therefore not be at either the top or the base. For this purpose, see WELL_TEST.REPORTED_STRAT_UNIT.

BHP_Z captures a derived value relating bottom hole pressure and gas compressibility. See also WELL_TEST.Z_FACTOR.

CASED_HOLE_IND is a simple flag to identify a test performed through perforated casing. The test type may be DST or production.

COMPLETION_OBS_NO relates the test to a specific well completion. If the test is a wireline test or an open-hole DST, this column should be NULL.

COMPLETION_SOURCE is used in conjunction with COMPLETION_OBS_NO. The data source for the completion information need not be the same as the source for the well test information. This column is necessary to uniquely identify the data row where different sources each use the same value for COMPLETION_OBS_NO.

For more information about CONDENSATE_**, see the discussion on the GAS_*** columns.

DAMAGE_QUALITY is a value from the reference table, intended to capture a brief statement of the interpretation of formation damage related to the test (e.g, FAIR or SEVERE). A numerical value may be captured in WELL_TEST_COMPUT_ANAL.EST_DAMAGE_RATIO.

FLOW_PRESSURE is a summary value of various pressures recorded during a test. It is the maximum pressure recorded at the surface during a flow period. The value must be entered in the default units of measure.

FLOW_TEMPERATURE is a summary value of various temperatures recorded during a test. It is the maximum temperature recorded at the surface during a flow period. NEED TO CLARIFY the meaning – the column comments say it is the temperature of the “drilling fluid”, but it should probably be defined as the temperature of the produced fluid.

The GAS_FLOW_AMOUNT value may be copied into this column from WELL_TEST_FLOW_MEAS.MEASUREMENT_VOLUME (for FLUID_TYPE = GAS).

The GAS_FLOW_AMOUNT_UOM value must be related to the value in gas.flow_amount. If that value was copied from WELL_TEST_FLOW_MEAS, this column should be populated from well_test_flow_meas.measurement_volume_uom (for FLUID_TYPE = GAS).

The GAS_GRAVITY column should not be populated directly from the source. Rather, this value should be entered into well_test_analysis.gas_gravity and copied to the WELL_TEST table only if necessary.

The GOR column should not be populated directly from the source. Rather, this value should be entered into well_test_analysis.gor and copied to the WELL_TEST table only if necessary.

The H2S_PERCENT column should not be populated directly from the source. Rather, this value should be entered into well_test_analysis.H2S_percent and copied to the WELL_TEST table only if necessary. Alternatively, use this column only for the reported H2S %; i.e., the percent recorded on the source document. Be aware that subsequent analysis of samples from the test may yield a different H2S value in WELL_TEST_ANALYSIS.

The MAX_GAS_FLOW_RATE value may be copied into this column from well_test_flow.max_fluid_rate (for fluid_type = GAS).

MAX_HYDROSTATIC_PRESSURE captures the value for the highest hydrostatic pressure recorded at the test interval during the test. This value is not captured elsewhere in the model.

The MAX_OIL_FLOW_RATE value may be copied into this column from well_test_flow.max_fluid_rate (for fluid_type = OIL).

The MAX_WATER_FLOW_RATE value may be copied into this column from well_test_flow.max_fluid_rate (for fluid_type = WATER).

OIL_AMOUNT_PERCENT captures a computed value derived from the total volume of oil recovered, divided by the total liquid volume recovered. It may be copied from well_test_recovery.recovery_amount_percent for recovery_type= OIL. The column should not be populated in the WELL_TEST table unless necessary for a special reason such as query performance.

The OIL_FLOW_AMOUNT value may be supplied directly by the source or may be copied into this column from well_test_flow_meas.measurement_volume (for fluid_type = OIL).

The OIL_FLOW_AMOUNT_UOM value must be related to the value in oil.flow_amount. If that value was copied from WELL_TEST_FLOW_MEAS, this column should be populated from well_test_flow_meas.measurement_volume_uom (for fluid_type = OIL).

OIL_GRAVITY reports the “API gravity” of the oil. The value may be supplied directly by the source as part of a summary of the test (compare WELL_TEST.REPORTED_STRAT_UNIT). If not, this value should be entered into well_test_analysis.oil_gravity and copied to WELL_TEST only if necessary. The API gravity may be calculated using the data in well_test_analysis.oil_density.

PERMEABILITY_QUALITY is an interpretation specified as a word (not a numerical value). It may be supplied directly by the source, or derived as a qualitative summary of the values in well_test_comput_anal.computed_permeability.

PRIMARY_FLUID_RECOVERED captures an interpreted value. For some tests, only one fluid is recovered, and the appropriate value for this column is obvious. In others, large amounts of gas, oil, and water may be recovered. The interpreter makes a decision on which is most important to record as the "primary" fluid. This column may be useful for reconnaissance queries of a large database. Information about all the recovered fluids should be captured in WELL_TEST_RECOVERY.

PRODUCTION_METHOD captures a code representing a procedure by which fluids were obtained during the test (e.g., swab, pump, or flow). A fuller summary of the test methods can be obtained using the TEST_TYPE, TEST_SUBTYPE, and PRODUCTION_METHOD columns.

PROD_STRING_ID, PROD_STRING_OBS_NO, and STRING_SOURCE should be recorded in this table for a test of a completed and producing well, where the fluids are recovered through tubing in the well.

RAT_HOLE_DIAMETER refers to the size of a smaller gauge hole drilled from the bottom of the wellbore, for the purpose of accommodating the tools for a drill stem test. RAT_HOLE_LENGTH is the length of a smaller gauge hole drilled from the bottom of the wellbore, for the purpose of accommodating the tools for a drill stem test.

REPORTED_STRAT_UNIT captures the reported formation or zone name, usually as contained in the test report. It indicates the objective formation as supplied to the testing company by the well operator. The actual formations tested may be a matter of various subsequent interpretations. These are captured in STRAT_WELL_SECTION and may be referenced to the test interval using well_test.top_depth and well_test.base_depth. When this column was added to an earlier version of the model, the column comments said it was used only in the Permian Basin (West Texas area). The business requirements are unclear.

REPORT_TEMPERATURE is the temperature at the test interval, as reported on the source document.

REPORT_TEST_NUM is used to capture the number assigned by the testing company or well operator. It can be valuable to explicitly relate the test data to the source document. It may or may not be the same as well_test.test_num.

START_TIME captures the time of day of the start of the test. The data type is varchar2, allowing a free format for time, such as "2:30 PM" or "1430" or "Tuesday night". If two tests are started on the same TEST_DATE, this time allows you to place them in the correct time order. However, the combination of RUN_NUM and TEST_NUM (in the primary key) should also give the right time sequence for all the tests in the well.

STATIC_PRESSURE may be used to record the maximum buildup pressure at the end of the shut-in period. We recommend that the value be copied, only if necessary, from the interpreted (extrapolated) reservoir pressure in well_test_comput_anal.final_pressure. But be sure of your business requirements and the exact definition of the pressure values supplied.

For more information about STRAT_NAME_SET_NAME, see the previous description of BASE_STRAT_UNIT.

For more information about STRING_SOURCE, see the previous description of PROD_STRING_ID.

TD is for the total depth of the wellbore at the time of the test. The bottom of the wellbore may be far below the base of the test interval. Also, see the previous description of RAT_HOLE_LENGTH.

The definition for TEMPERATURE_CORRECTION needs clarification. DO WE WANT TO LEAVE AS IS?

The TEST_COMPANY column captures the name of the service company that conducted the test. The value is BUSINESS_ASSOCIATE.BUSINESS_ASSOCIATE. This is a code, not the actual name of the company.

TEST_DATE is the date of the test, usually as reported on the source document.

TEST_DURATION is the period of time of the test. All values entered in this column must be in the units defined for this column in PPDM_UNITS_OF_MEASURE. The data type allows for two decimal positions (e.g., 18.42 hours).

TEST_DURATION_UOM allows you to record the original unit of measure for the duration of the test, if available or required. For example, a drill stem test may be timed in minutes, whereas a deliverability test may be timed in hours. All values in the TEST_DURATION column must be in the same units.

TEST_RESULT_CODE is a value used to summarize the result of the test. Allowable values are in R_TEST_RESULT (e.g., good or misrun).

TEST_SUBTYPE describes the category or technique used for the test. Allowable values are in R_TEST_SUBTYPE. For example, test type may be “drill stem test”, and test subtype is “closed chamber test”.

TOOL_OPEN_TIME is used for a drill stem test to report the time of day when the tool was “opened”, to allow fluids from the test interval to enter the tool chamber. Note that this is not a duration; it is a text string for the clock time (e.g., “2:30 PM” or “1430”).

TOP_CHOKE_DESC captures the diameter of the top choke used in the test. The data type is varchar2 rather than a number, because the diameter is often reported as a fraction (e.g., 1 ½ inch), rather than as a decimal number. The unit should be

included in the text string. There is no “units of measure” column associated with this column.

WATER_AMOUNT_PERCENT captures a computed value derived from the total volume of water recovered, divided by the total liquid volume recovered. It may be copied from well_test_recovery.recovery_amount_percent for recovery_type = WATER. The column should not be populated in the WELL_TEST table unless necessary for a special reason such as query performance.

The definition of WATER_CUT_PERCENT needs clarification, specifically to distinguish how it is different from WATER_AMOUNT_PERCENT.

The WATER_FLOW_AMOUNT value may be copied into this column from well_test_flow_meas.measurement_volume (for fluid_type = WATER).

WELLBORE_COMPLETION_TYPE may be used where information is lacking to populate the WELL_COMPLETION table. This column may then describe the completion type, such as single, dual, or commingled, as defined in R_WELLBORE_COMPLETION_TYPE. However, the reference table R_COMPLETION_TYPE makes this “wellbore” table redundant and therefore likely to be deleted from the next version of PPDM.

Z_FACTOR captures a computed value for the gas compressibility factor, Z. The value may be computed from the gas analysis, but is more commonly captured from the test report.

WELL_TEST_COMPUT_ANAL

This table contains computed analysis information obtained from testing laboratories (e.g., measurement of permeability of the formation tested, the production index (flow rate a well can produce), estimated damage ratio, and maximum reservoir pressure computed from plotted gauge information.

WELL_TEST_CONTAMINANT

This table contains information pertaining to the type of contaminant encountered during a well test, such as corrosive gases.

WELL_TEST_CUSHION

This table records descriptive information about the type and amount of cushion used during a drill stem test to buffer the formation being tested from the effects of radical pressure change.

WELL_TEST_EQUIPMENT

This table contains descriptive information about the specific tools used to perform a well test. Included are the type of tool used (EQPT_TYPE) and the specific feature of that tool (e.g., length, weight, and diameter).

WELL_TEST_FLOW

This table provides information about the flow of material recovered at the surface. It also describes pressure associated with surface recoveries during each well test period.

WELL_TEST_FLOW_MEAS

This table provides information unique to each flow rate conducted for a well test, such as surface choke diameter, flow rate pressure, and time.

WELL_TEST_MUD

This table contains information on the physical, chemical, and electrical properties of the drilling fluid associated with a well test.

WELL_TEST_PERIOD

This table contains information about the individual, discrete events or periods during a well test. Most of these periods occur after the packer or packers are set to isolate the zone from the drilling fluid column.

WELL_TEST_RECOVERY

This table contains information about the fluids recovered from the drill pipe as a result of running a well test.

WELL_TEST_REMARK

This table consists of additional descriptive comments about the well test, including comments regarding any problem affecting the results, such as a misrun due to packer failure, or a leaking shut-in valve.

WELL_TEST_SHUTOFF

This table contains information describing the type of shutoff method used to shut off perforated or open hole intervals. This data should reflect those intervals that are shut off at the time the well is completed.

WELL_TEST_STRAT_UNIT

This table describes the formations overlapped by the well test.

Completions and Related Operations

WELL_COMPLETION

This table defines the completion depth interval, the stratigraphic (formation or zone) name, and some basic information about the operation.

COMPLETION_OBS_NO is part of the primary key. One well (UWI) may have many completions. Completions may be at different depth intervals, overlapping intervals, or even the same interval at a different time.

The COMPLETION_TYPE column gives a general term for the category of the completion, using a value from R_COMPLETION_TYPE. There is not yet an agreed standard set of reference values, but we recommend a set of completion types including single, dual, and commingled. Terms such as flowing, quasi-flowing (e.g., gas lift), and pumping, are intended for PDEN.PRODUCTION_METHOD. If you are not implementing the Production Module of PPDM, you could add a column WELL_COMPLETION.PRODUCTION_METHOD, with a foreign key to R_PRODUCTION_METHOD.

The COMPLETION_METHOD column refers to the design or operation to permit the exchange of fluid between the reservoir and the well, such as perforation, gravel pack, or open hole. These values should be in R_COMPLETION_METHOD.

The TOP_STRAT_UNIT and BASE_STRAT_UNIT columns are intended to capture the formations as reported on the source document. They must be defined with the same STRAT_NAME_SET_NAME. If the values are not available from the source, we recommend these columns be left null. Do not copy values from STRAT_WELL_SECTION, as this would be too difficult to maintain. For most completions, only the COMPLETION_STRAT_UNIT is necessary, but the others may be useful in handling information on commingled production.

This table does *not* have a column for the status of the completion. This information is in WELL_PERFORATION.COMPLETION_STATUS and PDEN.PDEN_STATUS.

This table does not describe the completion fluid(s). This may be a deficiency in capturing business requirements, but some information may be placed in WELL_TREATMENT.TREATMENT_FLUID_TYPE.

WELL_PERFORATION

A perforation is a deliberate hole in the casing or tubing to permit the exchange of fluid with the reservoir or annulus. A well may have one or many perforated intervals, separate, overlapping or identical. Each is assigned a PERFORATION_OBS_NO. This table defines the perforated depth interval, the stratigraphic (formation or zone) name, and some basic information about the operation.

A set of perforations is usually created in a regular pattern. Each component of the pattern is captured in a column: angle (for directional perforation, relative to north), phase (the horizontal angle between successive perforations), density (the number of perforations per unit of depth), and diameter (of the hole in the casing).

The important information about the perforating operation is captured in a set of columns: the contractor (business associate), date, type, and method.

The TOP_STRAT_UNIT and BASE_STRAT_UNIT columns are intended to capture the formations as reported on the source document. They must be defined with the same STRAT_NAME_SET_NAME. If the values are not available from the source, we recommend these columns be left null. Do not copy values from STRAT_WELL_SECTION, as this would be too difficult to maintain.

Several columns also capture the relationship to a well completion. The foreign key to WELL_COMPLETION requires three components: UWI, COMPLETION_OBS_NO and COMPLETION_SOURCE (the SOURCE column in the other table).

The COMPLETION_STATUS and CURRENT_STATUS_DATE columns allow you to indicate whether or not the perforated interval is presently producing.

WELL_TREATMENT

A treatment is a process performed on the reservoir near the well, or on the well itself, for the purpose of enhancing productivity. A well may have one or many treatments, at different depths or times. Each is assigned a TREATMENT_OBS_NO. This table defines the interval, the stratigraphic (formation or zone) name, and some basic information about the operation.

A treatment consists of the application, under pressure, of a fluid and/or solid (proppant). This table has columns to record the types and quantities of these materials. Information about the treatment operation is also captured: the contractor (business associate), date, type of treatment operation, pressures, and injection rate.

A particular type of treatment (a “frac”) involves the application of sufficient pressure to fracture the reservoir rock. This operation is usually done in stages of increasing pressure, and the STAGE_NO column allows information to be recorded in the order of operation.

The TOP_STRAT_UNIT and BASE_STRAT_UNIT columns are intended to capture the formations as reported on the source document. They must be defined with the same STRAT_NAME_SET_NAME. If the values are not available from the source, we recommend these columns be left null. Do not copy values from STRAT_WELL_SECTION, as this would be too difficult to maintain.

Several columns also capture the relationship to a well completion. The foreign key to WELL_COMPLETION requires three components: UWI, COMPLETION_OBS_NO, and COMPLETION_SOURCE (SOURCE column in the other table).

The treatment is sometimes part of the preparation for a well test. To capture this relationship in the database, the foreign key to WELL_TEST has five components: UWI, WELL_TEST_SOURCE, TEST_TYPE, RUN_NUM, and TEST_NUM.

The COMPLETION_STATUS and CURRENT_STATUS_DATE columns allow you to indicate whether or not the treatment interval is presently producing.

Several columns describe the treatment using terms defined in reference tables. There is not yet an agreed standard set of reference values, but the following values illustrate the intended meanings:

- TREATMENT_TYPE: acidize, fracture
- TREATMENT_FLUID_TYPE (foreign key to R_TREATMENT_FLUID): crude oil, diesel, formation water, brine, nitrogen foam
- ADDITIVE_TYPE: inhibitor, perforating, viscosifier
- PROPPANT_TYPE: sand, sintered bauxite

WELL_TUBULAR

Tubular goods is a general term for any kind of oilfield pipe. Casing is steel pipe installed during drilling to prevent collapse of the wellbore and to prevent fluid exchange between the rock and the well. Liner is casing that does not extend to surface. Tubing is a removable pipe connecting the well completion to the surface for the purpose of carrying produced fluids. Drill pipe is used only during drilling operations, to convey and power a drilling assembly (bit, core barrel, etc.) and to circulate drilling fluids. A well may have one or several tubular strings of different types, diameters, properties, and purposes. Each is assigned a TUBING_OBS_NO.

This table defines the length and depth of the pipe string, pipe specifications (diameters, steel grade, weight, density, strength), and some other information about the operations of installing and pulling the pipe.

The TOP_STRAT_UNIT and BASE_STRAT_UNIT columns are intended to capture the formations as reported on the source document. They must be defined with the same STRAT_NAME_SET_NAME. If the values are not available from the source, we recommend these columns be left null. Do not copy values from STRAT_WELL_SECTION, as this would be too difficult to maintain.

Several columns use terms defined in reference tables. There is not yet an agreed standard set of reference values, but the following values illustrate the intended meanings:

- TUBING_TYPE: general categories; e.g., casing, liner, production tubing
- COLLAR_TYPE: a coupling to join two pipes, e.g., drill collar, combination collar
- LINER_TYPE: drilling, slotted, gravel pack

WELL_PLUGBACK

This table contains information pertaining to a well plugback (e.g., depth, date, quantity of cement, plugback type, etc.).

Fluid Analysis

The fluid analysis tables are inherited from PPDM version 2, with few modifications or enhancements. Consequently, business requirements are not fully addressed in the current version. However, the tables are designed to capture most of the information on a typical laboratory report.

Fluid samples are often, though not always, taken from the well during a test. So the tables have foreign keys to the test type, run number, test number and source (see the SOURCE column description later in this section).

The model also has a table WELL_TEST_ANALYSIS. It is not as comprehensive as the fluid analysis tables, but is intended to capture information commonly reported for a well test (e.g., GOR, H2S, oil gravity). The source document may be the test report, whereas data in the fluid analysis tables is usually derived from the laboratory reports.

For gas and water, the vertical table design of WELL_GAS_ANAL_DETAIL and WELL_WATER_ANAL_DETL allows for the reporting of any measured property, defined by ANALYSIS_PROPERTY.

For oil analysis, some values are captured in the parent table and others in WELL_OIL_VISCOSITY. In WELL_OIL_ANALYSIS, multiple analyses on the same sample can be recorded simply by using a different ANALYSIS_OBS_NO for each analysis.

There are some inconsistencies in the design of the fluid tables, when comparing WELL_GAS_ANALYSIS, WELL_OIL_ANALYSIS, and WELL_WATER_ANALYSIS. For example, only the table WELL_WATER_ANALYSIS has columns for laboratory name and analysis file reference.

SOURCE is used for two purposes: to identify the source of the data in the analysis table, and as part of the foreign key to WELL_TEST.SOURCE. If the source of data in WELL_TEST is not the same as the source for data in WELL_“fluid type”_ANALYSIS, the relationship cannot be established. To support this business requirement, add a column (compare well_treatment.well_test_source) and submit a change request to PPDM Association.

FLUID_TYPE column is only in the WELL_GAS_ANALYSIS table. It is part of the primary key, so it should be populated as gas or condensate. A similar column, well_water_anal.water_type, should have values such as water, salt water, formation water, load water, etc.

SAMPLE_LOCATION is the position in the well where the sample was taken (downhole or at surface). Reference values should be defined in R_SAMPLE_LOCATION.

REPORTED_TVD captures the true vertical depth, if included in the laboratory report. This depth may not be as accurate as what is derived from a directional survey (see WELL_DIR_SRVY), perhaps because the laboratory was provided with a preliminary number or because of a typographical error on the report. But if the source of an analysis is uncertain, this reported depth may help to resolve the confusion.

The TOP_STRAT_UNIT and BASE_STRAT_UNIT columns are intended to capture the formations as reported on the source document. They must be defined with the same STRAT_NAME_SET_NAME. If the values are not available from the source, we recommend these columns be left null. Do not copy values from STRAT_WELL_SECTION, as this would be too difficult to maintain.

LABORATORY_REFERENCE_NUM is the number or code on the source document. Note that this column is not part of the Primary Key (use ANALYSIS_OBS_NO instead, usually assigned by the data vendor or your system). It is used the same way as well_water_analysis.file_num.

STRING_ID in WELL_OIL_ANALYSIS is used to identify the source of the sample when taken from a production string in the well. The value should be a reference to prod_string.string_id.

Well Positions

WELL

This table provides for the direct capture of information on the elevation of the well. The elevations pertain to ground level, rotary table, etc., and also define which point is used as a reference (DEPTH_DATUM; e.g., Mean Sea Level) for these elevations.

For convenience and performance requirements, this table also allows for denormalized positional information from other parts of the Model. This includes computed latitude and longitude coordinates of the surface (surface node) and bottom hole (base node) locations, copied from WELL_NODE. To maintain database integrity and quality, careful rules should be established and maintained for populating these columns.

WELL_DIR_SRVY

See the discussion of this table later in the Directional Surveys subsection of this document.

WELL_NODE

This table is designed to capture the coordinate position of any point in the well. This may be the surface location of the well, the bottom of the hole, a kickoff point, the top of the producing interval in the well, or any other point defined by NODE_POSITION.

WELL_NODE_GEOMETRY

This is an intersection table provided for spatially enabling the Model.

WELL_NODE_M_B

This table is designed to capture the relative surface position of the well, measured by lengths and bearings from another defined point, such as a monument or township corner.

WELL_NODE_VERSION

This table stores all the different coordinate values associated with a well point projected to the surface of the Earth. NODE VERSION is a version of a location for a position that must be kept permanently.

Pressures

WELL_PRESSURE

This table is used to capture the pressures and related data obtained by a well pressure survey or test. The main measured values are the pressures on the casing and tubing during flowing and shut-in conditions. The pressure difference ("drawdown") is used to compute various deliverability indicators, such as productivity index. The pressure may also be related to a defined field or pool.

The TOP_STRAT_UNIT and BASE_STRAT_UNIT columns are intended to capture the formations at TOP_DEPTH and BASE_DEPTH respectively, as reported on the source document. They must be defined with the same STRAT_NAME_SET_NAME. If the values are not available from the source of this row, we recommend these columns be left null. Do not copy values from STRAT_WELL_SECTION, as this would be too difficult to maintain.

POOL_DATUM is the reference point for all pressures reported in the hydrocarbon pool named in WELL_PRESSURE.POOL.

POOL_DATUM_DEPTH is the depth of the POOL_DATUM, expressed in downhole depth (same point of reference as TOP_DEPTH, etc.). There is a change request to rename this column POOL_DATUM_ELEV and redefine it as the elevation of the pool datum expressed relative to the common datum for the well, WELL.DEPTH_DATUM. <-DO WE WANT TO KEEP THIS?

WELL_DATUM_DEPTH is probably intended to be the elevation of WELL.DEPTH_DATUM. This value is already captured in

WELL.DEPTH_DATUM_ELEV but may be copied here if required for performance or other reasons. There is a change request to rename this column WELL_DATUM_ELEV and redefine it as the elevation of the well datum. <-DO WE WANT TO KEEP THIS?

WELL_PRESSURE_BH

This table captures bottom pressure measurements, related parameters of the pressure survey, and various computed results.

To create the data for this table, a series of pressure measurements were taken by a recorder (gauge) placed in the wellbore at the RUN_DEPTH. Each measurement is a row in the table, identified by BHP_OBS_NO. Several types and methods are possible, and these should be defined using values from the reference tables R_PRESS_TEST_TYPE (static gradient, buildup, etc.) and R_BH_METHOD (measured or calculated pressures).

The bottom hole pressure should be adjusted to a common datum; the value belongs in the column DATUM_PRESSURE. The calculation is based on data in other columns of this table (SEA_LEVEL_DATUM, RUN_DEPTH_TEMPERATURE, etc.), and must use the true vertical depth (not RUN_DEPTH in a deviated well). The TVD should be calculated first, using data in the table WELL_DIR_SRVY. REPORTED_RUN_TVD captures the value used (i.e., reported) in the well pressure survey report.

The table allows for a relationship between the pressure measurements and a well test, although this is not mandatory. Thus, WELL_TEST_TYPE, WELL_TEST_NUM, etc., are not part of the primary key in this table.

WELL_PRESSURE_AOF

This table contains the parameters and calculated results for the “absolute open flow potential” of a gas well. This is the theoretical flow rate, assuming zero bottom hole pressure. The AOF rate may be calculated in several ways, using reference values in R_AOF_ANALYSIS_TYPE and R_AOF_CALC_METHOD. The AOF result may be captured in AOF_POTENTIAL, CAOF_RATE and/or FOUR_POINT_CAOF_RATE (for a standardized “4-point test”). The table also provides columns for parameters used in the calculation (choke size, measured flow rate, AOF slope, etc.)

To get other details of the AOF test, such as TEST_NUM and TOP_DEPTH, connect this table to the WELL_PRESSURE table. To get the values of the individual stabilized flow measurements, connect to the WELL_PRESSURE_AOF_4PT table.

WELL_PRESSURE_AOF_4PT

This table contains values for the computed points used to calculate the AOF slope. Each POINT_OBS_NO corresponds to a different choke size in the test. A set of these points constitutes one AOF_OBS_NO in the parent table.

WELL_TEST_PRESSURE

This table captures pressure data, and related information, obtained during a well test. In practice, it seems that most implementations of PPDM use this table for DST and WLT tests only; pressures from deliverability tests and pressure surveys are captured in WELL_PRESSURE. For each test period (flow or shut-in), columns are provided for the pressure at the start and end of the test period. This table is essentially a synthesis or selection of all the pressure measurements captured in WELL_TEST_PRESS_MEAS.

WELL_TEST_PRESS_MEAS

This table captures the pressure recorded at each time increment during a well test. For each MEASUREMENT_OBS_NO, data may be entered for the depth, pressure, time, and temperature. Through the primary and foreign keys, these observations may be related to other tables with information about the test period and pressures. See Figures 2 and 3 in *PPDM Version 3.4 User Guide - Constraints (Oct. 1997)*, for illustrations and discussion of the complex foreign key constraints in this table.

WELL_TEST_RECORDER

All pressures and temperatures are obtained with recording devices (pressure gauges) in the well or at the surface. This table captures the specifications (not the recorded data) for each recorder. It also contains the details of where each recorder was used in a specific test: UWI, TEST_NUM, RECORDER_DEPTH, etc. The actual recorded data (pressure, time, temperature) are captured in WELL_TEST_PRESS_MEAS. The position of the gauge is defined by reference to R_RECORDER_POSITION, such as bottom chamber gauge above test valve, conventional gauge below test valve, or surface. In addition, the RECORDER_INSIDE_IND column requires Y or N to indicate whether or not the gauge was placed inside the pipe. Inside and outside recorders at the same depth may show different pressures if the test tool is partly or completely plugged.

WELL_PRESSURE_BH

This table is intended to capture pressure measurements taken by a downhole gauge(s) during a pressure test. The test type is defined by R_BH_PRESS_TEST_TYPE, such as a bottom hole static gradient test, or a bottom hole buildup test. Note that this table is not designed for pressures measured during a drill stem test or productivity test, as there are no foreign keys to TEST_TYPE, TEST_NUM, RUN_NUM. For this purpose, use WELL_TEST_PRESS_MEAS.

Checkshot and Velocity Surveys

WELL_CHECKSHOT_DETAIL

This table defines checkshots with data only at isolated points in the well such as measured depth, true vertical depth, or shot number, etc. At each recording

position in the well, the seismic time to that depth is measured, and the velocity is calculated.

WELL_CHECKSHOT_SURVEY

This table contains well checkshot survey information.

WELL_VELOCITY

This table contains information about the method used to determine the average velocity as a function of depth. Velocities are obtained from the sonic log, calibration of the velocities from checkshots, and densities from a density log.

Implementation Considerations

Constraints in PPDM

It is essential that anyone who is considering using PPDM version 3.5 review the Constraints Reference Guide first. Improper use or population of constrained columns in PPDM can compromise the quality of your data and the reliability of your queries. This document may be obtained from the PPDM Association.

Check Constraints

PPDM Version 3.5 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 3.5.

- 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 PDEN and LAND_RIGHT.

  Let's use LAND_RIGHT as an example. This structure consists of a parent table (LAND_RIGHT) and seven sub-type tables (LAND_TITLE, LAND_LEASE, LAND_GRANTED_RIGHT, LAND_AGREEMENT, LAND_AGREE_PART, LAND_UNIT and LAND_UNIT_TRACT). Each of the eight tables has a two-part primary key: LAND_RIGHT_ID and LAND_RIGHT_TYPE.

  LAND_RIGHT_ID is assigned by the user and can have any value as long as it is unique for that LAND_RIGHT_TYPE. LAND_RIGHT_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 seven valid sub-types. In LAND_RIGHT, the LAND_RIGHT_TYPE can have any of the seven 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

Costs in PPDM may originate in any valid Unit of Measure (UOM), such as USD, $CDN, YEN, etc. However, to ensure that queries for retrieval and reporting are efficient, it is desirable to convert all original currencies to a standard unit of measure for storage in the database. PPDM supports the requirement to restore the original value in the following way:

- Convert all stored currencies to a single currency type, such as US dollars.

- CURRENCY_OUOM stores the currency in which the funds were initially received. When the stored currency is multiplied by the CURRENCY_CONVERSION, the value of the transaction in the original currency is obtained.

- CURRENCY_CONVERSION stores the rate applied to convert the currency to its original monetary UOM from the stored UOM. This value is valid for this row in this table at the time of conversion only. 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. For the SOURCE column, specify where you obtained the data from. 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.

ACTIVE_IND

Most tables in the Land, Contracts, Interest Sets, Restrictions and Obligations modules contain a column called ACTIVE_IND. The values for this column may be one of Y, N, or null. 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.

When more than one row has been created for a business object, use the ACTIVE_IND to indicate the row that is currently active. 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.

Frequently Asked Questions (FAQ)

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.

- **Spatial or GIS queries:** Spatial queries are not thoroughly addressed in this section of the reference guide; how you deal with these queries depends on the spatial engine you are using. In many cases, we have avoided using spatial queries because the number of query lines needed obscures the rest of the query and makes it more difficult to read. Sometimes, we have provided a connection to a NAMED AREA, rather than a lat/long box.

- **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.

The following sample query illustrates the primary key for the test tables:

```
select      UWI, SOURCE, RUN_NUM, TEST_NUM, TEST_TYPE,
            TEST_SUBTYPE, TEST_DATE, TEST_RESULT_CODE, TOP_DEPTH,
            BASE_DEPTH
from        WELL_TEST
where       UWI = '……' and SOURCE = '…..…'
            ORDER BY UWI, RUN_NUM, TEST_NUM;
```

```
select

  from

 where
   and
   and
```

```
and
and
```

Appendix B: Versioning

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.

Changes Between Versions 3.4 and 3.5

The WELL_INTEREST table has been replaced by the BA INTEREST SET module. New implementations should not use the WELL_INTEREST table. Refer to the BA Interest Set Reference Guide for information about this module.

The WELL_FORMATION and WELL_FAULT tables have been subsumed into STRAT WELL SECTION. Refer to the Stratigraphy Reference Guide for more details.

Minor changes requested by members have been made as well. Refer to the model mapping document for details about these changes.

Appendix C: Capturing DST Data in PPDM v. 3.5b

This table is intended to help you decide where DST data should be captured in tables of this module.

INFORMATION	PPDM 3.5 TABLE.COLUMN
Planning:	well_test.test_type = DST
• depth interval	well_test.top_depth - well_test.base_depth
• expected reservoir P, T	interpretation input value, not part of the captured data
• depth to top packer	well_test_equipment.top_depth where equip_type = top packer
• length of tools between packer and SI valve	well_test_equipment.top_depth for equip_type = packer and SI valve
• length, ID of drill collars and drill pipe	well_test_equipment.equip_length, inside_diameter order by top_depth
• amount of cushion	well_test_cushion.cushion_volume
• choke size	well_test.bottom_choke_desc
• Z-factor	well_test.z_factor
Measured:	
• pre-flow time	well_test_period.period_duration for period_type=flow (ordered by period_obs_no)
• initial shut-in time	well_test_period.period_duration for period_type=SI (ordered by period_obs_no)
• main flow time	well_test_period.period_duration for period_type=flow (ordered by period_obs_no)
• gas to surface (GTS) time	well_test_flow.tts_elapsed_time for fluid_type=gas
• initial shut-in pressure	well_test_pressure.end_pressure for period_type=SI and period_obs_no FK to well_test_period
• surface pressure change dp/dt (for closed chamber DST)	well_test_press_meas.measurement_pressure, measurement_time, for recorder_id used at surface
• chamber temperature	well_test.report.temperature
• atmospheric pressure at well site	interpretation input value, not part of the captured data
• pressures at start and end of Flow	well_test_pressure.start_pressure, end_pressure

	for period_type = flow
• recovery	well_test_recovery.recovery_amount, recovery_type
• liquid volume produced (may be reported for each elapsed time)	well_test_flow_meas.measurement_volume for each fluid_type and period_type OR well_test.oil_flow_amount, water_flow_amount
Calculated:	
• average flow rate on test	not captured directly, but can compute from well_test_flow_meas.measurement_volume / measurement_time for fluid_type and period_obs_no
• max flow rate on test	well_test.max_gas_flow_rate, max_oil_flow_rate, etc.
• static reservoir pressure	well_test_comput_anal.final_reservoir_pressure
• damage ratio (skin effect)	well_test_comput_anal.est_damage_ratio
• permeability	well_test_comput_anal.computed_permeability