PPDM Association

Production Data Model

Reference Guide

Revised for PPDM 3.7

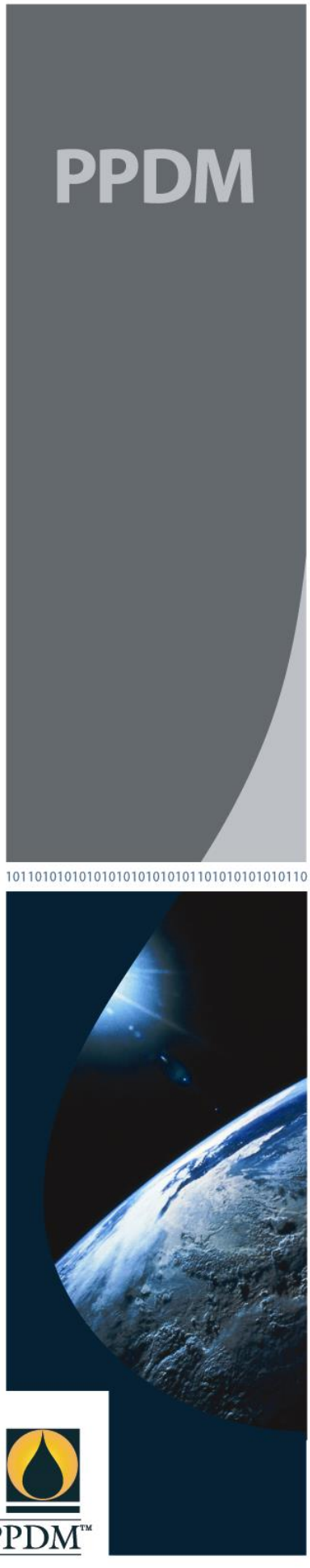

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Table of Contents

About This Document 5
Introduction 7
Business Process Overview 12
Purpose *12*
Description *12*
Key Business Processes *12*
Integration 21
Data Diagrams *24*
Model Overview 25
Key Data Concepts Overview ***Error! Bookmark not defined.***
Key Data Concepts ***Error! Bookmark not defined.***
Tables and Columns: Production 35
Production Entities: Types of PDENs *36*
PDEN Relationships *40*
Production Reserves Forecasts *41*
PDEN Fluid Analysis *45*
PDEN Historical Data *46*
Production Volume Regime *47*
PDEN Volume Data *48*
PLATFORM *50*
Production from a Facility *50*
Production from a Field *52*
Production from a Pool *53*
Production from a Lease Unit *54*
Production from a String *55*
Implementation Considerations 57
Constraints in PPDM *57*
Check Constraints *57*
Currencies in PPDM *57*
Units of Measure *58*
Audit Columns *59*
Identifying Rows Of Data That Are Active *60*
Modifying the Reserves Module *60*

Frequently Asked Questions (FAQ) _____ 62
Appendix A: Sample Queries _____ 65
Appendix B: Changes to the Model _____ 66
Changes Between Versions 3.4 and 3.5 _____ *66*
Changes Between Versions 3.5 and 3.6 _____ *66*
Changes Between Version 3.6 and 3.7 _____ *66*

Acknowledgements

PPDM wishes to thank John Gillespie for his contributions to this document, both for textual content and many diagrams created by him.

About This Document

This reference guide has been prepared to help managers, analysts, database administrators, programmers, data managers, and users understand how to use the Production Data Module in PPDM 3.7. Readers at many levels, from managerial to technical implementers will benefit from reading various sections of this document. General, high-level business information is contained at the beginning of the document, with each section becoming progressively more technical and detailed.

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

This reference guide contains the following sections:

- Introduction

  Provides an executive overview of the PPDM Model as it pertains to Production reporting.

- Business Process Overview

  Summarizes business processes and provides examples of related business processes.

- Integration

  Discusses how biostratigraphy 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 Production reporting module tables in the Data Model.

- Tables and Columns

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

- Implementation Considerations

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

- Frequently Asked Questions

  Addresses technical and business questions about the Production reporting 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 – Changes to the Model

  Identifies the changes in the Modules from the latest version to the newest release version of the PPDM model.

Introduction

This Reference Guide is intended to assist data managers in implementing the Production Entities subject of the PPDM Model 3.9. The goal is that every implementation of the Model conforms to the best practice. Consistent compliance reduces the risks of data exchange errors and simplifies the adoption of products that use the PPDM database.

The Guide starts with an overview of production in the upstream oil and gas industry, and how the business deals with the information. Then it explains how the information should be captured in the PPDM Model 3.9.

In the life of a well (or group of wells) the producing phase is the longest unless the original intention failed and the well was abandoned. The huge amount of information from the producing phase can be regarded in several categories or modules in the data model: production volumes, operations, well tests, reserves and financial. This Reference Guide deals mainly with production volumes.

Oil and gas production first starts with the drilling of a well to test models for hydrocarbon accumulations envisioned by geologists and geophysicists. Once the well is drilled and it encounters a hydrocarbon reservoir, various other specialists become involved.

For example, responsibility for production falls to petroleum engineers, who are charged with installing and maintaining equipment such as casing to produce the formation fluids, which may include gas, oil, and water, in quantities that vary with time.

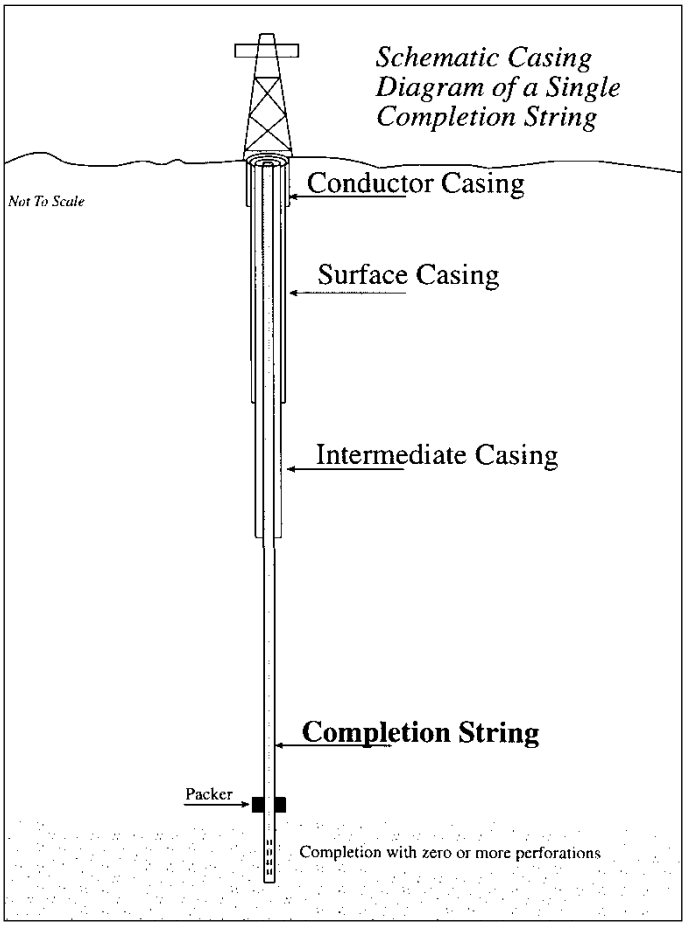


Figure 1: Well casing schematic, showing a single completion string

If the well encounters two or more producing reservoirs, equipment known as completion strings can be installed to allow production from each to remain separate, as shown in the following figure.

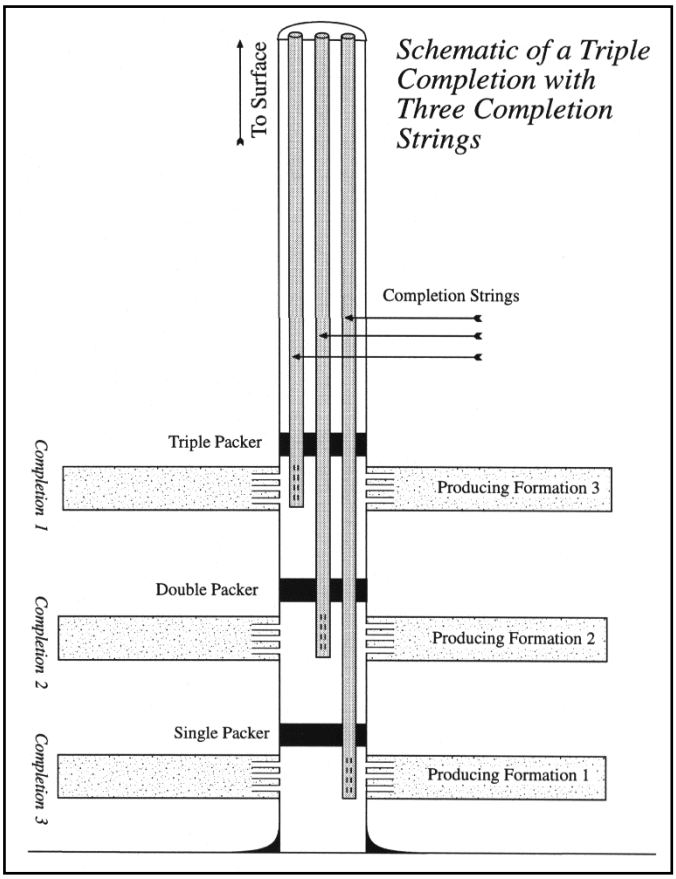


Figure 2: Well casing schematic, showing a triple completion string.

Alternatively, if the well encounters two or more producing reservoirs, completion strings can be installed to allow production from each to be combined (commingled).

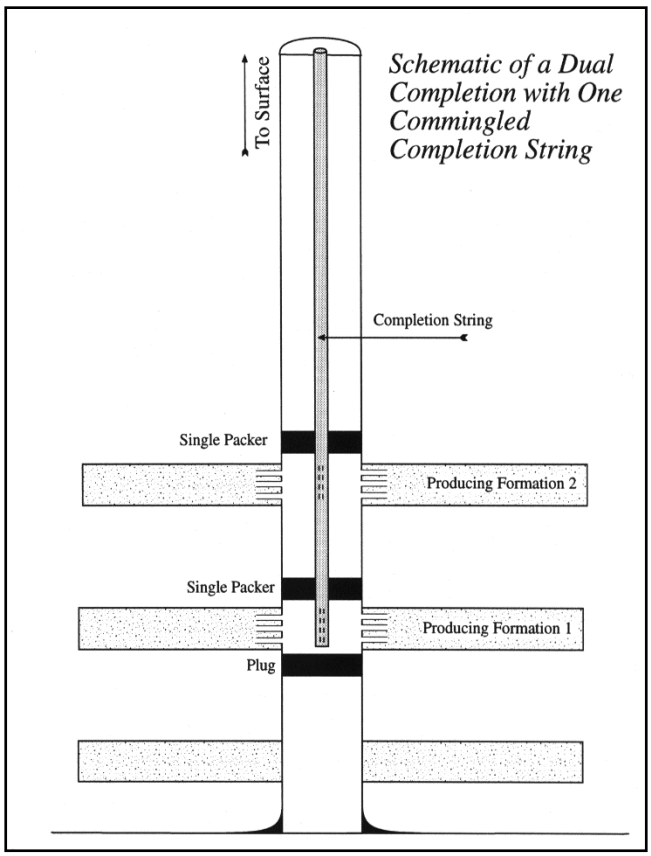


Figure 3: A dual completion with one commingled completion string

These engineers manage fluid flow from the reservoir and monitor flow rate by observing the quantity of fluids collected in surface storage facilities each day. As well, engineers try to forecast the future production rate for each producing interval.

It is the job of production accountants to track the fluids through various delivery systems, including tanks, batteries, facilities, pipelines, and tankers. Regulatory agencies may require reporting of types and quantities of produced fluids grouped or measured at different points of this delivery system. Many commercial sources of production information only have the information available at these aggregate levels.

Once several wells are drilled, production reporting becomes more complicated, and the number of production entities increases.

For example, production from several wells and all their production strings may have their fluids commingled into a single storage facility, and the aggregate volume may be recorded on several levels, including production platforms, gas leases, reservoirs, production units, etc. In addition, production may be controlled by a lease that only allows production from a deep zone (called deep rights). Alternatively, wells may be grouped as a unit, which may be set up to maximize

production. The governing regulatory body may allow production to be reported as a unit. Finally, production may be reported for a field, which can have numerous reservoirs, wells, leases, pools, and units.

As well, versions of production data from different sources may exist and may vary over time.

These complexities of production reporting and the various types of production entities can all be tracked in the Production Module of PPDM.

Business Process Overview

Purpose

The Production Module provides a means of describing and managing information from oil and gas production.

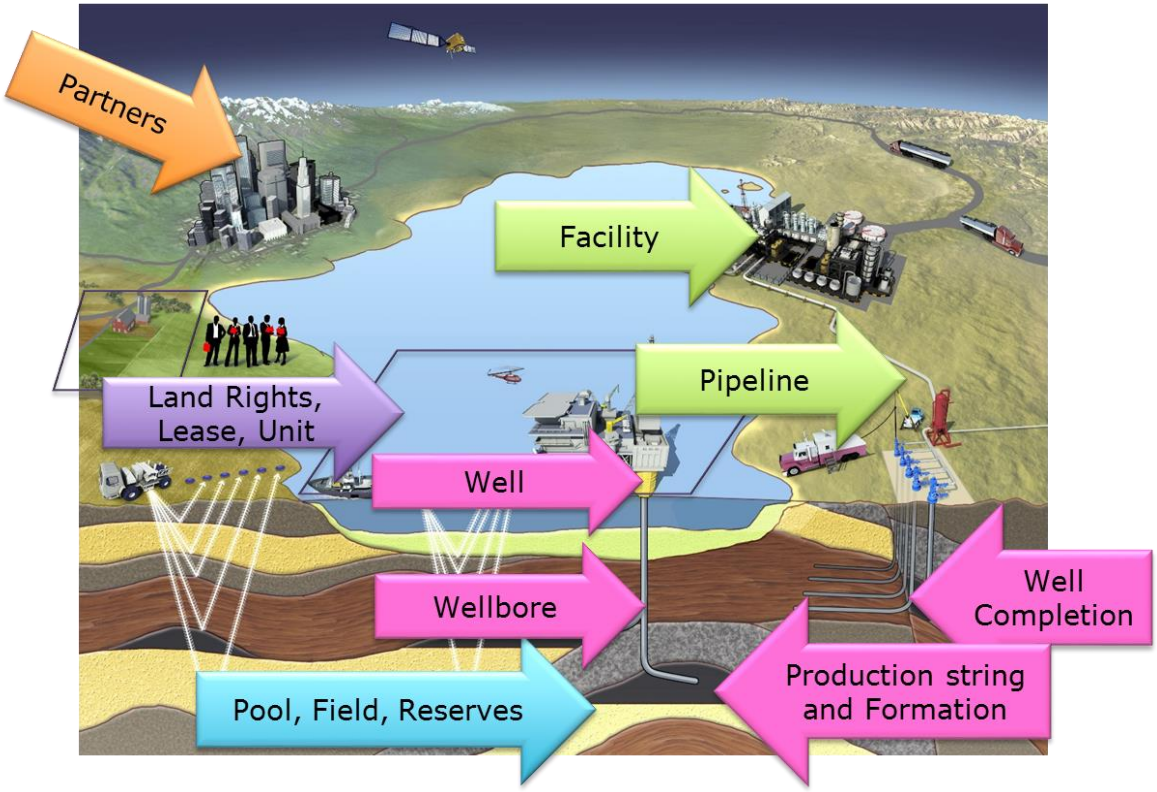
Description

Once a well is drilled and completed, fluid production from the well is delivered through various systems, allocated to various production entities, reported to the company and to regulatory agencies, and measured and forecasted. Injected or produced fluids and all data associated with production must be tracked.

Key Business Processes

Finding hydrocarbons

Oil and gas production starts with the drilling of a well. If hydrocarbons are found in sufficient quantity, the well is prepared ("completed") for production by installing equipment to isolate the gas and/or oil and related fluids and to bring them to the surface for processing, distribution and sale.



Hydrocarbons occur in certain rock units. Geologists classify these units as "formations" based on similarities of age, rock type (sandstone, limestone, shale, etc.) and other properties. A reservoir is a part of a formation that contains hydrocarbons in sufficient quantity to be extracted. A single reservoir may be a few feet/metres thick or a few hundred feet/metres thick; it may extend for several miles and may have a complex shape involving faults and folds. Wells are drilled to penetrate the reservoir at intervals determined by economics, ownership and government regulation. One well may intersect several reservoirs at different depths. One well may have several wellbores sharing the same surface location, like a tree with roots. A wellbore may intersect more than one reservoir.

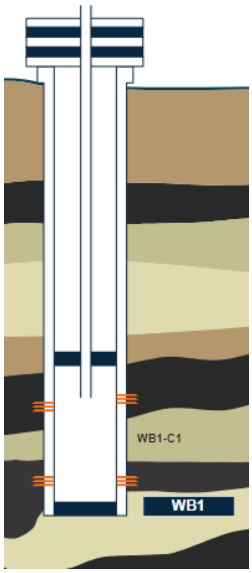
Reservoirs

A reservoir, or a group of related reservoirs, is usually designated as a pool. A geographic area of wells in one or many pools may be designated as a field. The pool and field criteria are variable around the world. When a field or pool has multiple ownerships, the owners may form a production unit to enable efficient operations. Expected production volumes, called reserves, are usually assigned to a reservoir or to group of reservoirs and/or to a field.

Production strings

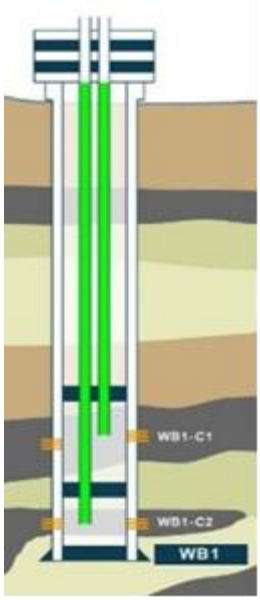
A well is completed by installing equipment to bring the fluids to the surface, or to inject fluids into the rock, in a controlled manner. This usually consists of steel tubing inside the production casing. In PPDM, this fluid conveyance is called a Production String.

If two or more reservoirs are accessed by the same well, there are two typical methods of conveyance. A dual completion has two production strings. Alternatively, the fluids may be commingled in a single string within the well or in a pipeline at the surface. Commingling is usually subject to special regulations to manage the resource and to prevent cross-contamination of the reservoirs.



Top illustration: The same two reservoirs commingled in one production string.

Lower illustration: A dual completion. This well has two production strings. The fluids from each reservoir are brought separately to the surface.



The production string is a component of the completion of a well. In this context, a completion is what makes a well capable of production. The term also has other meanings; see PPDM's What Is A Completion for details. The relationships between production strings and completions may be complex. A production string formation may have more than one completion associated with it, such as in the case of commingled production from multiple reservoirs. The fluid types and flow rates may change suddenly when a completion is changed mechanically in response to economic conditions or changes within the reservoir.

Well production

Information about production is not just the volumes of oil, gas, water or other fluids obtained over time (day, month, year.) It includes periodic measurement of pressures and fluid composition. Where a well or producing area has multiple leases and owners, various fractional interests are applied to the gross volumes.

For simplicity, this discussion refers to hydrocarbons produced from a well or other entity. However, many wells also yield significant volumes of water and other non-hydrocarbon liquids and gases. Also, production operations include the injection of water or other fluid into a reservoir for pressure support or for disposal. As with production, these injected and disposed volumes are captured and reported.

The government regulator may assign a maximum allowable production rate or monthly volume to a well or production string. This "allowable" volume is calculated to prevent damage to the reservoir and/or to ensure fair treatment of all well owners in a pool or field.

The regulator may assign a production spacing unit to each planned well. This is done to manage the maximum ultimate recovery and to ensure that the owners of adjacent wells can obtain their share of the resource. Production spacing units are larger for conventional gas than for oil, because a well's drainage area is greater for gas (it flows more easily through the rock.)

Business roles

Petroleum engineers design and manage fluid flow from the reservoir and its handling at the surface. Information is collected periodically or continuously by field operators or automated systems. Engineers specify and analyze the required periodic tests for flow rate, pressure and composition.

Reservoir engineers, with input from geoscientists, calculate reserves and use models to forecast future production rates and volumes. The models, updated throughout the life of the pool or field, are the basis for economic analysis and for designing the production facilities. Actual production is tracked against forecasts for specific classes of reserves (proven, probable, etc.)

Production accountants track the fluids through various delivery systems, including tanks, batteries, facilities, pipelines, and tankers. They calculate volumes and prepare the necessary reports, partner payments and royalties. In some cases, they "back allocate" the commingled volumes to the relevant reservoirs or wells. Regulatory agencies may require reporting of production grouped or allocated at different points of the delivery system. Many commercial sources (data vendors) of production information only have access to these aggregate levels. Versions of production data from different sources may exist and vary over time.

Government regulators authorize and monitor the production operations. They ensure compliance to regulations and leases, effective management of the resource, and payment of taxes and royalties.

Data managers and analysts receive, validate, store and distribute data about wells.

Various non-technical roles are also involved in well production. They manage the land titles, leases, mineral rights, partnerships and contracts; they prepare business models and financial reports; they negotiate the purchase and sale of wells.

Monitoring production

A producing well must be operated and monitored. As more wells are drilled in a field, the number of production entities increases, and production reporting becomes more complicated.

Volumes and related data (composition, heat content, etc.) are based on volumes and flow rates measured at the wellhead or tank; downhole measurements are used in special cases.

Leases and units

The right to develop and operate a hydrocarbon resource is usually granted by a government, although in some countries the resource is owned ("freehold") by a person or corporation. This is usually called a land right because the right is restricted to a geographic area, onshore or offshore. This kind of right confers rights for specific activities but does not confer ownership of the land. is usually conveyed in the form of a lease (also contract, concession or similar term) specifying the location boundaries, obligations incurred (such as payments), and

duration of the rights. The lease has other conditions and may be limited by formation, depth or substance (e.g. oil only.)

Where a reservoir is covered by two or more leases with different ownerships, the parties may form a partnership to develop the reservoir in an efficient way. In some cases, the government may insist on this kind of relationship, called a production unit or unitization. Each party has a working interest in the unit; costs and benefits are shared proportionately.

Reserves

A reserve is something that is held for future use. In our industry, reserves are the hydrocarbons that have not yet been produced but could be exploited over a period of time. Reserves are classified by type (proven, probable, possible, etc.) depending on the confidence level and predictions about the economics and technologies. The Society of Production Engineers (SPE) produced a classification system (Petroleum Resources Management System) that is publicly available and used by many companies, particularly for financial or regulatory reporting. In PPDM, a Reserve Entity is an object with an assigned reserve; it may be real (e.g. a reservoir rock unit) or virtual (e.g. a production forecast model).

The quantity of oil and/or gas in a reservoir is estimated from direct evidence (e.g. flow rate, pressure) and indirect evidence (e.g. seismic mapping). It is impossible to recover all the oil and gas. The recovery factor is the ratio of the estimated lifetime production to the estimated original oil (or gas) in place. Typical recovery factors are 10% to 40%, depending largely on the rock and fluid properties, the methods of production and prices.

INFORMATION PROCESS OVERVIEW

The fluids that are produced from and injected into a well are generally reported by volume, either measured or calculated. The volume numbers are used for well and facility operations, product marketing and disposition, reservoir management, financial reporting and analysis, and regulatory compliance.

As production from the well moves through various facilities and systems, the measurements and calculations must be recorded and assigned to the appropriate object (entity.) The PPDM Data Model provides the means to describe and manage all this information.

A Production Entity (PDEN), in the PPDM Model, is a real or virtual object that measures, contains or processes fluids related to petroleum production. A simple way to understand the PDEN is to imagine a meter placed wherever you need to record a volume, rate, fluid analysis or ownership. A PDEN can therefore be a:

- Business associate (partner's share, customer, etc.)
- Area (county, production sharing agreement area, etc.)
- Field

- Pool
- Land Right (mineral lease or production permit)
- Lease or Production Unit
- Production String (tubing)
- Production String Formation (the reservoir)
- Reserve entity (a calculated future volume, usually assigned at the level of pool, field, or unit)
- Well or Wellbore
- Facility (battery, separator, pipeline, plant, etc.)
- Other object.

For the purpose of recording production data, a PDEN takes on the identity of an object whose full description is stored elsewhere in the Model. Imagine an object, such as a well or a pool, with properties such as location, size, status and ownership. It would be cumbersome and inflexible to attach all the production data directly to this object; it already has many attributes. Therefore, a PDEN is created to hold the production data. The Model is designed to link the PDEN to the object. You can then query the database for information about the object and about the volumes associated with it.

In terms of information flow, the description of the object is stored in the appropriate table in the Model; each table is a unique design suited to the object. For example, the columns of the WELL table are different from the columns of the POOL table. The information specific to production volumes is stored in the PDEN and related tables, all with the same data types (columns).

Where the words *lease* and *unit* are treated synonymously, a data manager may be unable to distinguish between them when handling data from third-party production reports. A lease is the right to develop and produce hydrocarbons; it is typically described by surface boundaries and subsurface intervals. A unit is a combination of leases in a joint operating agreement among various leaseholders.

Relationships between production entities

Production may be disposed (e.g. sold, consumed), allocated or transferred from one production entity to another. For example, fluids reported for each of several wells may be combined at a storage tank. Or, a well may be switched from one facility to another. During maintenance, the production may be temporarily trucked to a different facility.

When production is reported for an entity, it is tied to an identifier for that entity. This identifier may be the same as the identifier for the business entity that the production references, such as the well name or facility code. However, different names, codes, or identifiers may also be found in a production report obtained from a well operator, regulator, data vendor, or another party. All these identifiers and aliases can be managed in the Production Module.

Volume measurements

The starting point for most volume records is a field measurement at the well and/or on a pipeline. Flow rate and/or volume, temperature and pressure are recorded with the time and duration of the measurement. Downhole devices are sometimes used near the reservoir.

The raw data are rarely used directly as volumes for reporting; they are inputs for calculations.

Calculating production data

Most volumes used for analysis and reporting are obtained by calculation. The raw numbers are processed to obtain volumes for separate fluids (oil, gas, water) and to convert to standard temperature and pressure. Some volume calculations are based on flow rates, pressures and samples obtained during periodic well tests; some are based on the change in volume at a storage facility. After adjusting for composition, temperature, etc., the volume of each fluid for a period (usually a day or month) is reported. A program of periodic well testing collects information on the pressure-volume-temperature regime so that the necessary volumes can be calculated for the period between tests.

A reported volume may be recalculated based on newer data. These volume amendments must be captured without destroying the original records.

Using production data

In general, production data includes volumes, volume dispositions, allowable levels, fluid analysis, forecasts, entitlements, allocations, amendments and operating status. All the historical data must be retained; users should never overwrite or delete previously reported production volumes. All changes are recorded as amendments, with associated date and descriptive information.

Production data is useful in various business units and at any time, even beyond the life of the well. Geologists, reservoir engineers, financial analysts, lease administrators and others may need this information. It is especially important for forecasting future production, cash flow and asset value. Therefore, the data must be preserved in a way that allows accurate retrieval by all these stakeholders.

The produced (or injected) fluids are processed, consumed on site (fuel gas, testing), sold, disposed or distributed. A volume disposition report shows the inventory changes for fluids and volumes in a month or other period.

Allocation

Some jurisdictions (e.g. Texas) do not require volume reporting for each well or completion interval, if there are multiple wells in a lease. The production from several wells is measured and reported at the entry into a battery, storage facility or pipeline (surface commingling) without measurement of the separate streams. The aggregate volume may be reported on several levels, such as a production platform, lease, unit or field.

Where volumes are only available as aggregates, allocation is a process to estimate and assign appropriate values to each contributing entity. For example,

monthly volumes may be reported only at the lease level but you may want to attribute a volume to each producing well or reservoir. Or, production may be commingled in a well but split into a volume for each reservoir.

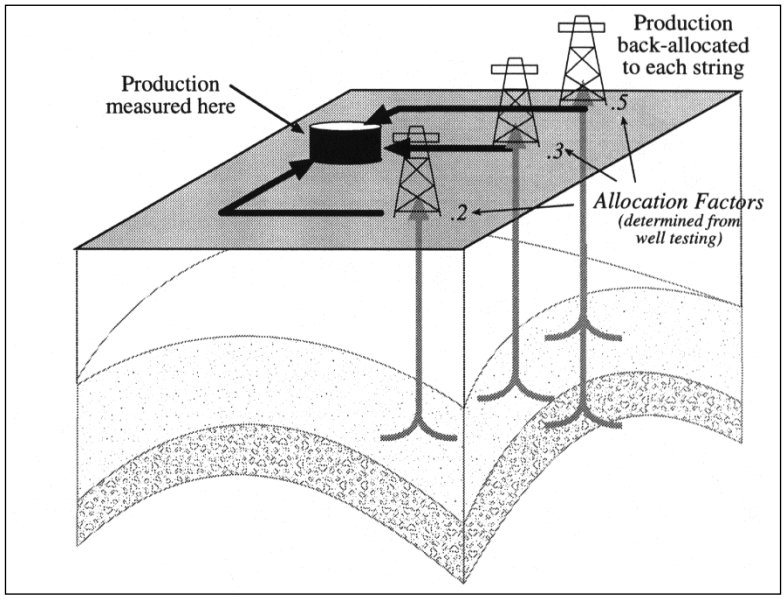


Figure 4: Back allocation step 1: Measurement point to string

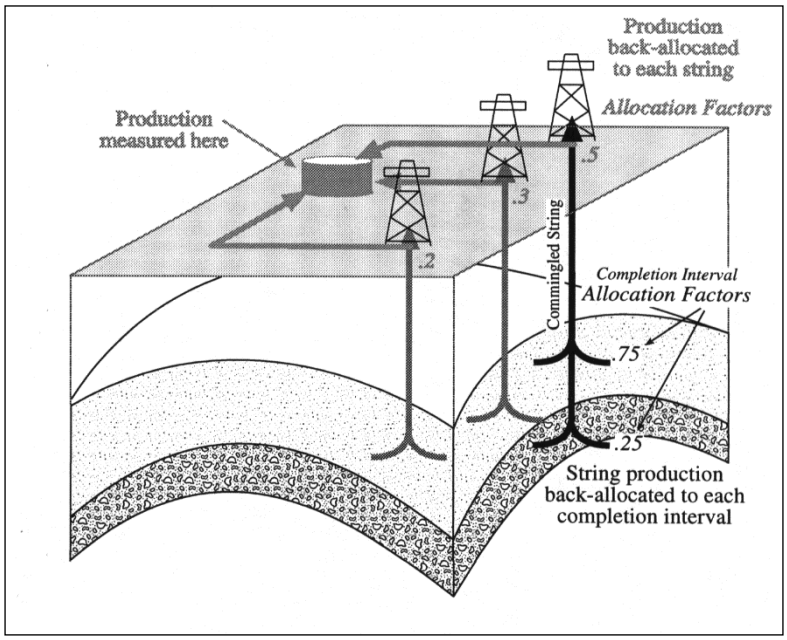


Figure 5: Back allocation step 2: String to completion interval

Allocation can be done by a variety of methods. The simplest approach for a lease-level volume is to divide the volume by the number of wells and allocate an equal amount to each. If well test data are available, a more accurate allocation factor can be determined for each well.

Versions and sources of data

More than one version of the same production data may be available for a production entity. Authorized information is data that is known or assumed to be correct. Other reports may contain inaccuracies or the quality assurance process may be unknown. Nevertheless, companies and jurisdictional bodies must retain data values as reported, even when the values are known to be incorrect.

Production data can be purchased from commercial sources that obtain information from regulatory agencies. This data may be reported by lease, well, or reservoir. Where data are purchased from more than one vendor, there is more than one version of the "same" data.

Integration

Integration is the key to managing the Production Module and its components properly. Information critical to managing data throughout its life cycle is managed in many support and business modules in PPDM version 3.7:

Support Modules

Business Associate Licenses And Authorizations: This module is used when it is necessary to ensure that proper authorization has been obtained for field work. Information about the application, the license or permission and any associated conditions or obligations can be tracked.

Business Associates: track detailed information about partners, service providers and other people, companies and regulatory agencies that you do business with.

Coordinate Systems: use this module to reference any positional information to geodetic or cartographic information.

Entitlements: information about the rights that you have to any type of data and what you are able to do with it.

Financial Summaries: Capture information about the cost centers or AFE's used through the life cycle.

Instruments: Reference caveats or liens registered against land ownerships.

Interest Sets And Division Of Interests: Describe partnership information for the ownership of any type of business object or information.

Named Areas: Use this module to describe any area of land, such as a field operations area, project area, area of interest, jurisdictional area etc.

Notifications: Tracks notifications sent to operators, regulatory agencies, partners etc regarding operations and decision making processes.

PPDM Meta Model: A model of the PPDM model. Use these tables to track extensions to PPDM, to group tables or columns by business function, to generate new DDL etc.

PPDM Unit Of Measure: Capture the default stored unit of measure for any measured value in the database. Can also be used to track conversions between units of measure.

PPDM Volume Regimes: Capture details about converting between volume measurements using regimes specific to areas, such as the state of Texas or the province of Alberta

Products: Describe products related to hydrocarbon production, at any level of granularity desired. Composition of various products may be captured.

Projects: Use this set of tables when you want to define a set of tasks to be completed and track their status or progress.

Rate Schedules: Defines rate schedules for application fees, road access, processing, services and so on.

Source Documents And Bibliographies: Tracks bibliographic references to literature.

Spatial Descriptions: This set of tables can be used to provide spatial descriptions for any business object, either as points, lines, polygons, textual descriptions or references to survey systems. Optional details about depth and stratigraphic or substance coverage is also included.

Work Orders And Requests: Requests for work to be completed with some summary information about what was done and the data affected by the work order.

Business Modules

Applications: Tracks applications to partners or regulatory agencies, usually to obtain permission for something. Details about the application, who it was sent by and to are tracked.

Consents: Details about consents obtained to conduct various types of operations are tracked.

Consultations And Negotiations: Information about discussions that are held and issues raised and resolved in order to obtain a license, consent, permit or authorization.

Contests And Disputes: Summary information about legal issues that are related to business objects in PPDM.

Contracts And Legal Agreements: Track details about legal contracts. Although much of the focus was on land related contracts, the model can be used to support general service or other types of contract as well.

Ecozones And Environments: Used for paleontology at present, tracks classification systems for defining ecozones.

Facility Licenses And Authorizations: Tracks permissions, authorizations and licenses to build and operate production facilities.

Fields: Tracks information about production fields.

Fossils: Describes fossils that are used in biostratigraphic research.

Lithologic Samples: Describes samples taken from well bores, ditches and other locations for use in various types of analysis.

Lithology: Describes the results of core lithologic analysis in summary.

Obligations: Captures information about financial and work related obligations, either as a one time requirement or a repeating requirement.

Paleontology: Information about Paleontological study results.

Pools: Information about production pools.

Production Entities: Information about any object for which production may be reported, including volumes and dispositions.

Production Related Facilities: Describes facilities related to the production, processing or transportation of hydrocarbons. Includes pipelines, batteries, meters etc.

Production Strings: The production string inserted into a well bore for the purpose of extracting hydrocarbons from the subsurface.

Records, Product And Information Management: Information related to the indexing, cataloguing, storage, circulation and retention of information or products.

Reserve Entities And Classifications: Captures the results of reserves forecasting and analysis.

Restrictions: Describes restricted areas such as nesting grounds, migration routes and protected areas.

Seismic: Describes seismic data from planning through acquisition, processing, interpretation and archival.

Seismic Licenses: Describes the authorizations and permissions obtained to conduct seismic or geophysical operations.

Stratigraphy: Detailed information about stratigraphic structures, whether chrono-stratigraphic, litho-stratigraphic, bios-stratigraphic etc.

Support Facilities: Summary information about supporting facilities that are tracked as part of the E&P process. Includes roads, transmission towers, docks, bridges etc.

Surface And Mineral Lands: Describes the rights held in land, regardless how they were obtained or are held.

Well Licenses And Authorizations: Describes the authorizations and permissions obtained to drill, complete and produce a well.

Wells: Describes well information in detail, including logs, cores, analysis, tests and so on.

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

Data Diagrams

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

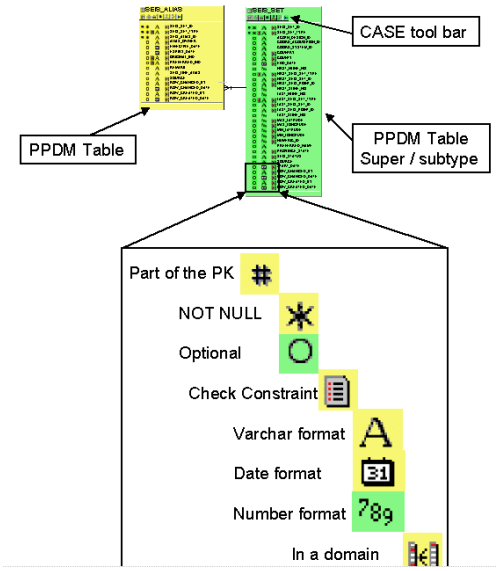


Figure 6: *This illustration shows the functions of each icon used in the data diagrams provided with PPDM version 3.7.*

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

Model Overview

The petroleum industry is based on the production of oil and gas from wells. The ability to store and access all the data about production is therefore essential for any comprehensive data model. The Production Module of the PPDM Data Model 3.9 is designed to meet this need.

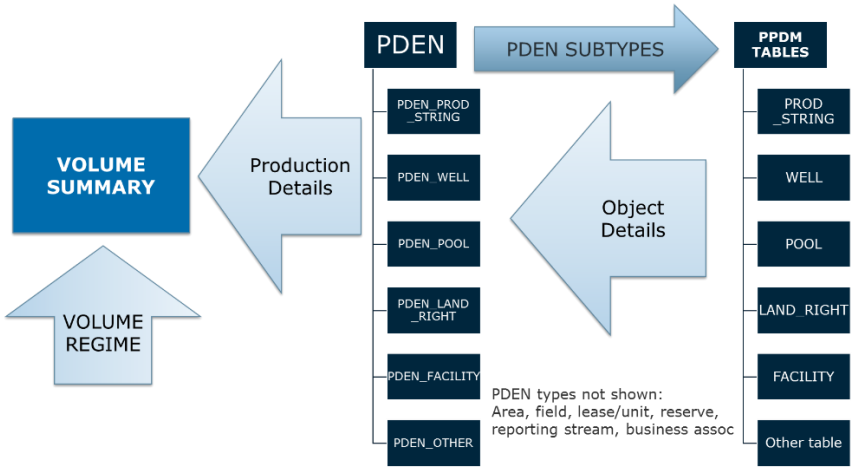
The Production Module is comprehensive and flexible to accommodate all the data types and business requirements. This Reference Guide helps to navigate the Model although it is not a handbook for implementation. The greatest benefit to the industry is achieved when the Model is used consistently. The PPDM Association provides training, networking and other resources for this purpose.

Key data concepts

The Production Module design includes these features:

- A PDEN (production entity) takes on the identity of any object described in PPDM 3.9: physical object, working interest, lease, etc.
- A PDEN is one of several subtypes. The supertype-subtype relationship is enforced by constraints in the Model.
- The Volume Summary table is designed for efficient database performance; a vertical table is possible for unusual products or for small datasets.
- Relationships with other entities are set with foreign keys and enforced with constraints.
- Reference tables are required but in most cases PPDM does not provide the content.

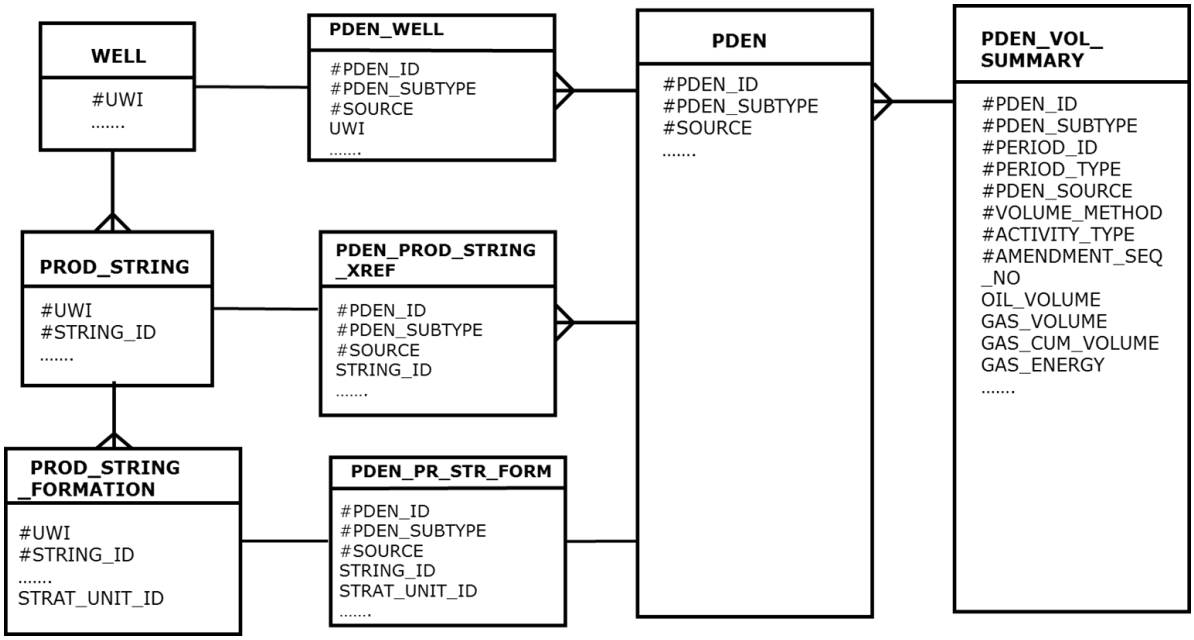
The essential design concept is to capture the production entity in one place and the associated volumes in another. In Figure ___, the volumes are on the left; on the right is the object to which the volumes are assigned. The appropriate PDEN_* table is a bridge between the object details and the volume records.



Production entity

The production entity (PDEN) is the cornerstone of the Production Module. It is an alias for any entity to which production volumes must be associated. The required entities are determined by the organization or business unit, including partners and regulatory agencies.

Each PDEN takes on the identity of an object described elsewhere in PPDM. These objects are described in the Business Overview section and illustrated in Figure __. The PDEN_SUBTYPE may be a well, facility, geographic area, rock formation, etc.; it is referenced in a table PDEN_* . Slide 47. Information about these things is stored in the appropriate tables elsewhere in the PPDM Model and is referenced with foreign keys. In a few cases, the information is denormalized in the Production Module.

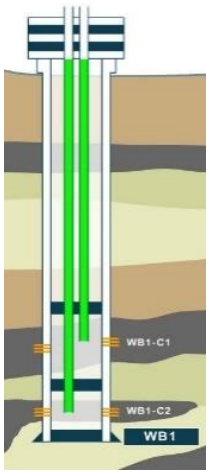


Many organizations have their own identification scheme for a production entity. Data vendors create their own identifiers to manage production data from different sources, especially public data from governments. A vendor may have to transpose these identifiers to suit each customer's identification scheme. The Production Module can handle these various kinds of identifiers by using ALIAS tables. We caution implementation teams to be wary of natural identifiers, particularly those assigned by operators or regulators; these identifiers are often subject to change over time and may pose significant challenges over time.

The Production Module makes provisions for different versions of a PDEN by source of data or by level of confidence. The approach is consistent with how versioning is handled for well data.

Production string

A production string is a PDEN subtype. It is the conduit in the well through which a fluid moves (either way) between the reservoir and the surface. The production string is the most location-specific entity related to production volumes in PPDM.



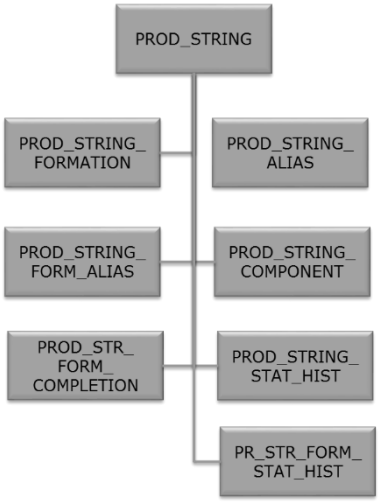
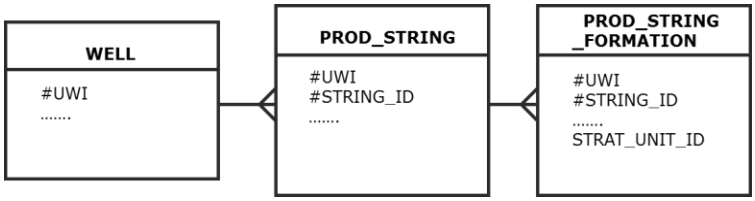


Figure __ (slide 42) shows two production strings in one well. Each string has production from a completion in a different reservoir. Figure __ (slide 41) shows how the relationships between a production string, completion and reservoir (formation) are modeled. This includes the ability to track changes to the production string, completion and formation over time.

A completion is the construction that makes a well capable of producing from a reservoir. The production string connects the completion to the surface. Therefore, PDEN_PROD_STRING or PDEN_PR_STR_FORM may be used as appropriate to associate production volumes with a completion. Details about the completion are described in the well subject area.

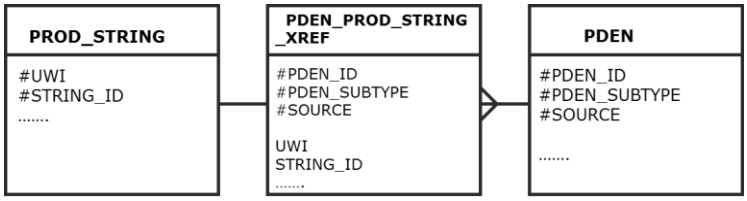
The details about the production string, and its relationship to the completion and the well, are captured in the PROD_STRING and related tables. Within the Production Module, the focus is on the production string's role as a PDEN; other properties and roles are handled elsewhere in Model 3.9.

Production is obtained from (or fluid injected into) a reservoir. The reservoir geology is described by a *formation* name (STRAT_UNIT_ID) and its rock properties. A *commingled completion* involves two or more formations connected to one production string. This many-to-one relationship is essential for some production reports and is captured by using the PROD_STRING_FORMATION table. Slide 43



A Production String Formation may have more than one completion (or Wellbore Contact Interval), especially if there are multiple reservoirs in a thick formation or when the well is reworked after years of operation. Foreign keys link to details in the WELL_COMPLETION and related tables. Using FORM_COMPLETION_OBS_NO, you can keep versions of the data over time as a completion is activated and deactivated (status change) or the reservoir is treated to improve the flow rate.

A production string may have different names for internal use and as assigned by the regulator or data vendor; these may change over time. The PROD_STRING_ALIAS table is used to track these changes. The production string can also be cross-referenced to other objects using PDEN_PROD_STRING_XREF to report production to the appropriate level. For example, Texas oil is reported to the government at the lease level but gas is reported at the string level. Slide 44



A regulator may restrict a well or other type of PDEN to an "allowable" volume, the maximum amount that can be produced during the reporting period. The table PDEN_PR_STR_ALLOWABLE captures these allowable volumes. It also manages the relationships between production strings.

Entities that can report production

A production entity refers to anything, real or imagined, to which production is attributed. This entity may be a physical installation, such as a well completion, a surface facility or a pipeline. It may be a spatial construct such as lease or reservoir. It may be an organizational concept, such as a business unit. It may be an analysis concept such as a reserve entity or working interest.

Each kind of production entity is modeled as an explicit subtype of the table PDEN, as shown in Figure ... above. Several subtypes are defined in the Model (PDEN_WELL, PDEN_POOL, etc.), including a generic PDEN_OTHER. No other value for PDEN_SUBTYPE is allowed; the Model enforces this by a check constraint. Implementation teams are not permitted to alter this value list.

Some of the relevant information about the production entity, such as operator, primary product, key dates and status, is stored in the PDEN table. However, some of these values are denormalized; they should always be derived procedurally and only stored here if necessary.

The PDEN table's Primary Key is the link to the PDEN_VOL_SUMMARY table that captures the volume details. The table PDEN_VOL_SUMM_OTHER is also possible for special circumstances.

The PDEN table has a foreign key, PDEN_ID, to information about the specific subtype (PDEN_SUBTYPE). The following subtypes are allowed:

- Well. It may have more than one wellbore (a drilled hole with a unique bottom point.) In the PPDM Model, specify WELL_LEVEL_TYPE as well, wellbore, etc. See PPDM's What Is A Well for the baseline definitions of these terms.
- Production String. This tubing connects the reservoir with the well's surface facilities. The production string is the most location-specific entity related to production volumes in PPDM. Volumes for production strings are captured in the PDEN subtype PDEN_PROD_STRING. Note that each occurrence is associated with a single production string. If production volumes are reported to multiple entities, the table PDEN_WELL_REPORT_STREAM should be used.
- Production String Formation. This is reservoir connected to the production string and

the well. There may be more than one formation contributing to the same string. This PDEN subtype relationship is handled in the PDEN_PR_STR_FORM table. If production volumes are reported to multiple entities, the table PDEN_WELL_REPORT_STREAM should be used.

- Well Reporting Stream. Use this to create a set of components, such as two production strings within one well. This PDEN behaves much like a subtype, and uses the PDEN_SUBTYPE = WELL. The Primary key is supplemented with the ability to connect the PDEN with as many well components as needed. The well components can be the entire well, Wellbore, Wellbore Segment, Wellbore Contact Interval, Wellbore Completion, Well Origin etc.) The contribution of each component to the whole may be recorded.
- Lease or production unit. Volumes are usually assigned to one of these area-based entities, even if also recorded at a more detailed level. There are two ways to handle lease/unit data in Model 3.9. The first way is recommended, the second way is a legacy from Model version 3.3.
    - Recommended: The PDEN_LAND_RIGHT (Production Entity as a Land Right) table provides the links to tables in the Land Rights Module that have all the details about locations, leases, agreements, obligations, etc. In this module, a Unit is a type of land right.
    - Legacy: The PDEN_LEASE_UNIT (Production Entity as a Lease or Unit) table captures volumes for a mineral lease or a unitization agreement (unit) and has links to LAND_RIGHT and associated tables for details about locations, leases, agreements, obligations, etc.
- Pool. This term is often used to define the extent of a reservoir using geologic criteria. The definition may be revised as more information is available over time. The pool name and definition may be assigned by a regulatory agency.
- Field. This term is often used to define a set of one or more pools within a geographic area. However, there is no worldwide consensus on the use of the term. The definition may be revised as more information is available over time. The field name and definition may be assigned by a regulatory agency.
- Area. This could be a production permit, a group of leases, an operating region, etc.
- Facility. This is a surface installation for collecting, processing and delivering the fluids produced by or injected into a well. Examples include separator, battery, platform, pipeline. The PPDM Model captures only basic properties for a facility. Other data models deal with the complexities of a facility's components and transactions.
- Reserve Entity. A calculation of hydrocarbon reserves, including volumes, is usually assigned to a well, a group of wells, an area, or a facility. The composition (well components that contribute to the volumes) of the Reserves Entity is described in the RESENT subject area.
- Business Associate. The subtype PDEN_BUSINESS_ASSOCIATE includes partners or other stakeholders who have interests in the production volumes. This table can be used to allocated volumes between participants in a unitization agreement, for example.

- Area: The subtype PDEN_AREA allows a defined area, such as a county or parish, to have volumes allocated to it. This table allows the PDEN entity to take on the identify of an area. Spacing units may be included in this subtype. *(Note that a similarly named table, PDEN_IN_AREA, allows you to associate any PDEN with the areas in which is may be contained. PDEN_IN_AREA is provided for reporting and aggregation purposes).*
- Other. This is a generic PDEN table.

Flow measurement

Routine field data on flow rates and volumes are obtained at the well or pipeline, or (rarely) by a device installed in the wellbore near the reservoir interface. The PDEN_FLOW_MEASUREMENT table captures these measured values.

Most wells undergo periodic testing for rates, pressures and sample analysis. The data are recorded in WELL_TEST_FLOW_MEAS with links to more information about the tests (procedures, dates, etc.) in the Well Module.

There are many types of volume information for production. It is of course not just the volume numbers but also many other supporting details (slide 50):

- Product: gas, oil (light, heavy, etc.), water (brine, steam, etc.), etc.
- Activity: produce, inject, consume (fuel gas), sell, etc.
- Method: measure, calculate, estimate, forecast, etc.
- Time: day, month, year, etc.
- Source: data about the same event may come from multiple sources, e.g. partner, data vendor.

The best practice in most cases is to use the PDEN_VOL_SUMMARY table. It stores volumes (current, YTD and cumulative) for the common products: oil, gas, NGL, water, CO2, nitrogen, sulphur. The table also captures information related to these volumes:

- Period type: day, month, year
- Volume method: how the volume was measured or calculated
- Activity: how the volume was obtained or used, e.g. produced, injected, sold
- Inventory: opening and closing balances
- Well count: number of wells (or well components) contributing the volume
- Volume period: the time duration for this report, e.g. 30 days
- Period on production/injection: the time period of activity during the volume period, e.g. the well was producing for 22 days in the month.
- Allowable: the maximum volume allowed for the primary product during the reporting period
- Dates: reporting date, posting date, etc.

- Injection details: support for multiple injection cycles during the same period
- Original units of measure: the stored units for each product are defined in the PPDM model but it is often important to also record the original units and the conversion factors.

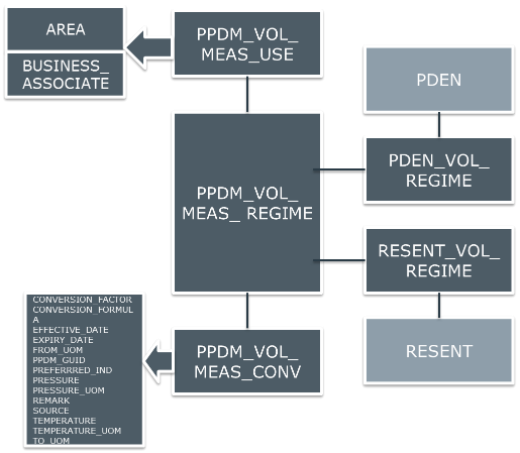
A sequence number is part of the primary key in PDEN_VOL_SUMMARY to ensure that amended volumes are captured as new data and do not overwrite the existing data. An AMEND_REASON value and POSTED_DATE explain why and when a volume was amended. The reasons (e.g. calibration, volume balancing, calculation error) are entered in a reference table. Even if the amendment fixes a data entry error, you must create a new row of data; never overwrite a volume!

Other production volumes can be stored in a vertical table, PDEN_VOL_SUMM_OTHER. Here the data can be arranged by product, time, calculation method (e.g. pro-rated), or activity (e.g. injected, flared). In theory, this normalized table could be used for all production volumes. However, there are performance and management challenges. The number of rows could be huge, queries are complex, and units of measure are a problem.

Volume conversions

To compare volumes of the same product, the volumes must be expressed in the same unit of measure and must be adjusted to the same "standard pressure and temperature." A Volume Regime specifies the measurement units and P/T conditions for a particular PDEN; it is defined in PDEN_VOL_REGIME. For reports, it may be necessary to convert the volumes according to the parameters and units of measure that are necessary for a report or regulator.

The table PPDM_VOL_MEAS_REGIME defines sets of volume units and standard conditions. The table PPDM_VOL_MEAS_USE captures the reporting requirements for any business entity such as the regulator. The table PPDM_VOL_MEAS_CONV has the unit conversion factors. Slide 58



Serious errors are likely if you do not account for the measurement regime of each source. For example, an aggregate volume for a field may require the sum of monthly volumes from dozens of wells in several pools and with different ownerships. Before aggregating, the data manager or production accountant must ensure that all the well volumes are expressed in the same units and at standard conditions.

Allocation and Disposition factors

The allocation process is based on volume measurements, well tests, fluid sample analysis and ownership share (interest set.) The factors are recorded in the PDEN_ALLOC_FACTOR table, showing each “from” PDEN and “to” PDEN and the allocation factor used in each calculation. Allocation factors can be versioned over time.

The volumes allocated to each formation are in the PROD_STRING_FORMATION table.

The PDEN_VOL_DISPOSITION table tracks the movement of product from one PDEN to another. It can be used to keep track of how volumes are moving through a processing facility and ultimately sold.

Production Networks

A business may need to link a PDEN to one or more facilities, particularly for the purpose of tracking volume transfers (dispositions) from one location to another.

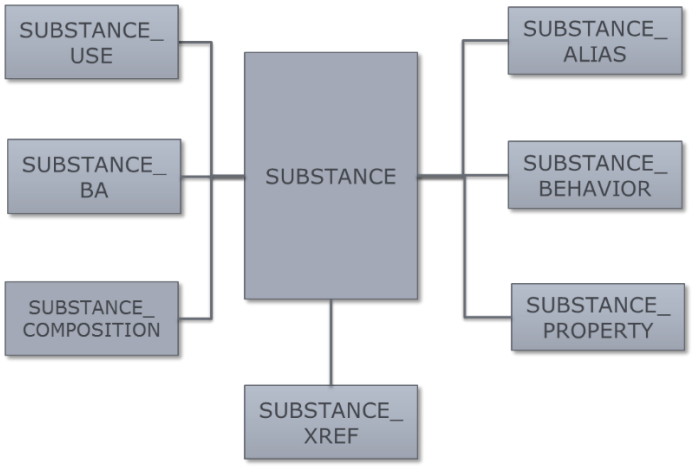
This can be done in the tables PDEN_XREF and FACILITY_XREF. FACILITY_XREF captures physical relationships between facilities in a network (i.e. the nodes). PDEN_XREF describes which of those connections are active during a particular reporting period. As a rule, every active connection in PDEN_XREF should also exist as a physical connection in FACILITY_XREF.

Substances

Any process material or product can be fully described in the SUBSTANCE tables. For example, you can record the range of API Gravity values for the oil, the chemical formula of butane, and some conversion factors.

Regulatory and operator definitions for substances can be highly variable, and care should be taken when aggregating volume reports for substances with the same name, but from different sources. For example, at least one US state includes NGL with both oil and gas volume reporting. This exception can cause confusion when volumes are analyzed.

The Substance tables are also used for purposes outside the Production Module and are therefore not discussed further here.



Other Related information

Information recorded for a Production Entity is often relevant to other parts of the business and is not all stored within the Production Module. This includes pressures, well tests, fluid analysis, interest sets, and completion depth intervals. Refer to the Model documentation and other Reference Guides.

Associating corporate data with PDEN

Sometimes, the data received on a production report may not match the master data on record for a well or other producing object. For example, dates or well location may be different, or a well identifier (API, UWI) may have been amended.

In some regions, the regulatory well identifier may change over time, creating challenges with integrating production volumes from the same well object. Tracking changes to the identity of these producing objects is important. The PDEN tables allow you to capture "as reported" information if you wish. Generally, the trusted master record of identify or location will be found in the underlying subject area in PPDM.

Sometimes, volumes may be aggregated (or reported) to a single Wellbore, even though they may have physically come from multiple Wellbores, Well Completions, or Wellbore Contact Intervals. Data that comes from regulatory agencies should be reviewed to identify these potentially misleading results. Where this happens, allocation practices may be used to allocate volumes to the correct well objects.

It is good data management practice to keep reported data intact while preventing these errors from compromising the quality of trusted or authorized data. In PPDM, authorized well information is stored in the Well Module and the "as reported" data may be stored in the Production Module. The relationship between each production entity and its authorized data is managed by the PDEN sub-type tables.

Relating Production to Reserves

Production operations are designed and conducted to exploit a reserve of hydrocarbons. As volumes are produced, the reserve volume is depleted. The Production Module is designed to relate the produced volumes to the remaining reserves in the ground. A separate Reference Guide deals with the ways in which reserves are calculated and with the information that must be captured.

The Reserve Entity Volume Summary table, RESENT_VOL_SUMMARY, tracks the reserves. It includes the information on how the volumes were calculated and the various ownership shares (interest sets.) Production volumes are related to the reserves through the PDEN_RESENT table. This allows updates to the reserves as volumes are removed from the reservoir.

Hierarchies

In some business contexts, production volume reporting involves consolidating into increasingly large entities, such as a field, state or business unit. The Model allows for templates of various types of hierarchies, and the application of a template to a specific requirement. Use the table REPORT_HIER and associated tables.

Implementing the database

The PPDM Model 3.9 can be used to create a relational database that includes well production information. Inserting and managing the data values are responsibilities of the data manager. Production accounting procedures are beyond the scope of this Reference Guide. However, a few things deserve special attention. The PPDM Association offers training courses to support the best practices for the Model.

Referential integrity is essential to ensure accurate data, especially in the processes of exchanging data between parties and systems. The Model includes constraints and other database system devices to support these processes. These should not be ignored or circumvented.

The Model is designed with many reference tables. The values must be populated before the data loading process begins. Generally, PPDM does not supply the reference values but can facilitate the sharing of values through the PPDM community.

Some of the information, especially in PDEN tables, may be replicated (denormalized). This data should never be entered directly but always by stored procedures and triggers.

Tables and Columns: Production

FACILITY
FACILITY_ALIAS
FACILITY_BA_SERVICE
FACILITY_FIELD
FACILITY_SUBSTANCE
FACILITY_VERSION
FACILITY_XREF
FIELD
FIELD_ALIAS
FIELD_IN_COUNTY
FIELD_INSTRUMENT
FIELD_VERSION
PDEN
PDEN_AREA
PDEN_ALLOC_FACTOR
PDEN_BUSINESS_ASSOC
PDEN_FACILITY
PDEN_FIELD
PDEN_FLOW_MEASUREMENT
PDEN_FORECAST
PDEN_GAS_ANAL_DETAIL
PDEN_GAS_ANALYSIS
PDEN_IN_AREA
PDEN_LAND_RIGHT
PDEN_LEASE_UNIT
PDEN_OIL_ANALYSIS
PDEN_OIL_VISCOSITY
PDEN_OPER_HIST
PDEN_OTHER
PDEN_POOL
PDEN_PR_STR_ALLOWABLE
PDEN_PR_STR_FORM
PDEN_PROD_STRING
PDEN_PROD_STRING_XREF
PDEN_RESENT
PDEN_RESENT_CLASS
PDEN_STATUS_HIST
PDEN_VOL_BY_DAY
PDEN_VOL_BY_MONTH
PDEN_VOL_DISPOSITION
PDEN_VOL_REGIME
PDEN_VOL_SUMM_OTHER
PDEN_VOL_SUMMARY
PDEN_WATER_ANAL_DTL
PDEN_WATER_ANALYSIS
PDEN_WELL
PDEN_XREF
POOL
POOL_ALIAS
POOL_IN_COUNTY
POOL_INSTRUMENT
POOL_VERSION
PPDM_VOL_MEAS_REGIME
PPDM_VOL_MEAS_USE
PPDM_VOL_MEAS_CONV
PR_LSE_UNIT_IN_COUNTY
PR_LSE_UNIT_STR_HIST
PR_STR_FORM_STAT_HIST
PROD_LEASE_UNIT
PROD_LEASE_UNIT_ALIAS
PROD_LEASE_UNIT_VERSION
PROD_STR_STAT_HIST

PROD_STRING RESENT_VOL_REGIME
PROD_STRING_FORMATION

Production Entities: Types of PDENs

A production entity refers to any entity that reports production. This entity may represent physical installations, such as a production well string; a spatial construct, such as lease or reservoir; or an organizational concept, such as a business unit.

PDEN

This parent table tracks any entity that reports production.

PDEN_TYPE identifies the type of production entity for the reported data. Its value may only be equal to one of the table names of the PDEN subtype tables, such as PDEN_WELL, PDEN_COUNTY, or PDEN_FIELD. This column is validated by check constraint. These constraints are discussed in the Implementation Considerations section of this guide.

This table also tracks the name of the production entity, name of the production string and any number that modifies it (e.g., Jones No. 1), the number assigned by a regulatory agency to identify the producing string, when the production entity was valid, stratigraphic information, when injection volumes and production were first and last reported, and when a production report was last submitted for the entity. Summary information about the production entity, such as the PRODUCT_TYPE (fluid) produced, any enhanced recovery method in use, and the current operator and its location are also captured.

If the information is not yet available to the public, set the PROPRIETARY_IND to yes (Y).

Back to the list of table names

PDEN_BUSINESS_ASSOC

PDEN_BUSINESS_ASSOC is a valid sub-type of PDEN. The column PDEN_TYPE may only be set to PDEN_BUSINESS_ASSOC; its value is controlled through a check constraint.

This table supports production reporting for partners and other business associates. It can be used to assist with the calculation of Gross Overriding Royalties that are paid to partners based on a land contract. In other cases, it may be used to help calculate royalties to be paid to regulatory authorities.

A foreign key to the BUSINESS_ASSOCIATE table provides a connection to more detailed information about the business associate in tables of the Business

Associates Module. The table also tracks the number of gas, injection, and oil wells associated with this production reporting entity and when the entity was in effect.

Back to the list of table names

PDEN_AREA

PDEN_AREA is a valid sub-type of PDEN. The PDEN_TYPE column may only be set to PDEN_AREA; its value is controlled through a check constraint. This table also contains a foreign key to the AERA business table. This provides a connection to the authorized data about the business object.

This table supports production reporting by a county or any other kind of area. This is an important regulatory reporting requirement in some countries, such as the United States. Its format is similar to that of PDEN_BUSINESS_ASSOCIATE. The table also tracks the number of gas, injection, and oil wells associated with this production reporting entity and when the entity was in effect.

Back to the list of table names

PDEN_FACILITY

PDEN_FACILITY is a valid sub-type of PDEN. The PDEN_TYPE column may only be set to PDEN_FACILITY; its value is controlled through a check constraint. This table also contains a foreign key to the FACILITY business table. This provides a connection to the authorized data about the business object.

This table supports production reporting by a facility. The table identifies the facility and specifies the number of wells associated with this production entity, but more detailed information, such as when the facility was constructed, etc., is stored in the FACILITY table.

Back to the list of table names

PDEN_FIELD

PDEN_FIELD is a valid sub-type of PDEN. The PDEN_TYPE column may only be set to PDEN_FIELD; its value is controlled through a check constraint. This table also contains a foreign key to the FIELD business table, which provides a connection to the authorized data about the business object.

This table supports production reporting by a field. The table also tracks the number of gas, injection, and oil wells associated with this production reporting entity and when the entity was in effect. Its format is similar to that of PDEN_BUSINESS_ASSOCIATE.

Back to the list of table names

PDEN_LAND_RIGHT

PDEN_LAND_RIGHT is a valid subtype of PDEN. The PDEN_TYPE column may only be set to PDEN_LAND_RIGHT; its value is controlled through a check constraint. This table also contains a foreign key to the LAND_RIGHT table, the parent table in the of the Land Rights module; this module is used to track detailed information about mineral and surface rights that are held.

This table supports production reporting by land right, whether that right be held through title, lease or contract. The table also tracks the number of gas, injection, and oil wells associated with this production reporting entity and when the entity was in effect. Its format is similar to that of PDEN_BUSINESS_ASSOCIATE.

Back to the list of table names

PDEN_LEASE_UNIT

PDEN_LEASE_UNIT is a valid sub-type of PDEN. The PDEN_TYPE column may only be set to PDEN_LEASE_UNIT; its value is controlled through a check constraint. This table also contains a foreign key to the PDEN_LEASE_UNIT business table. The table is in turn associated with the LAND_RIGHT table to provide a connection to the authorized data about the business object. Note that this table is used only for specialized reporting in the United States; we recommend that PDEN_LAND_RIGHT be used when possible.

This table supports production reporting by a lease unit. Note that lease and unit are often treated synonymously for production reporting purposes and that it is sometimes not possible to distinguish between them on the basis of production reports. For this reason, they are treated as a single entity. The entity actually represents an alias used for production reporting purposes.

The table identifies the lease or unit and provides a reference to the detailed information in the PROD_LEASE_UNIT table. Its format is similar to that of PDEN_BUSINESS_ASSOCIATE.

Back to the list of table names

PDEN_OTHER

PDEN_OTHER is a valid sub-type of PDEN. The PDEN_TYPE column may only be set to PDEN_OTHER; its value is controlled through a check constraint. This table allows you to track a production reporting entity not explicitly defined in the Production Module of the PPDM.

Users who require the ability to capture production information for a business object not defined by PPDM may either use this table (and add a foreign key to the referenced business object) or create a new extension table using this as a template. Refer to the PPDM Architectural Principles guide for details about creating extensions to PPDM.

This subordinate table tracks similar information as all other tables representing types of production reporting entities, such as PDEN_BUSINESS_ASSOC, etc. The table also tracks the number of gas, injection, and oil wells associated with this production reporting entity and when the entity was in effect.

Back to the list of table names

PDEN_POOL

PDEN_POOL is a valid sub-type of PDEN. The PDEN_TYPE column may only be set to PDEN_POOL; its value is controlled through a check constraint. This table also contains a foreign key to the POOL business table, which provides a connection to the authorized data about the business object.

This table supports production reporting by pool. The table also tracks the number of gas, injection, and oil wells associated with this production reporting entity and when the entity was in effect.

Back to the list of table names

PDEN_PROD_STRING

PDEN_PROD_STRING is a valid sub-type of PDEN. The PDEN_TYPE column may only be set to PDEN_PROD_STRING; its value is controlled through a check constraint. This table also contains a foreign key to the PROD_STRING business table, which provides a connection to the authorized data about the business object.

This table supports production reporting by a production string. The table also tracks the number of gas, injection, and oil wells associated with this production reporting entity and when the entity was in effect.

Back to the list of table names

PDEN_PR_STR_FORM

PDEN_PR_STR_FORM is a valid sub-type of PDEN. The PDEN_TYPE column may only be set to PDEN_PR_STR_FORM; its value is controlled through a check constraint. This table also contains a foreign key to the PROD_STRING_FORMATION business table. This provides a connection to the authorized data about the business object.

The table supports production reporting by a production string at a formation (completion). The table also tracks the number of gas, injection, and oil wells associated with this production reporting entity and when the entity was in effect.

Back to the list of table names

PDEN_RESENT

PDEN_RESENT is a valid sub-type of PDEN. The PDEN_TYPE column may only be set to PDEN_RESENT; its value is controlled through a check constraint.

This table also contains a foreign key to the RESERVE_ENTITY business table. This provides a connection to the authorized data about the business object.

The table supports production reporting for any reserves entity. It is used to track production reporting and analysis for a group of business objects defined for the purpose of reserves estimation and forecasting.

Back to the list of table names

PDEN_RESENT_CLASS

PDEN_RESENT_CLASS is a valid sub-type of PDEN. The PDEN_TYPE column may only be set to PDEN_RESENT_CLASS; its value is controlled through a check constraint. This table also contains a foreign key to the RESENT_CLASS business table. This provides a connection to the authorized data about the business object.

This table may be used to associate projected production figures with probability and certainty factors as are supported in the reserves module. Actual volumes are normally associated with PDEN_RESENT, while forecast volumes are associated with PDEN_RESENT_CLASS.

Back to the list of table names

PDEN_WELL

PDEN_WELL is a valid sub-type of PDEN. The PDEN_TYPE column may only be set to PDEN_WELL; its value is controlled through a check constraint. This table also contains a foreign key to the WELL business table. This provides a connection to the authorized data about the business object.

The table supports production reporting by a well. This table also tracks the number of gas, injection, and oil wells associated with this production reporting entity and when the entity was in effect. The table includes the UWI and effective date the well was on production.

Back to the list of table names

PDEN Relationships

PDEN_IN_AREA

This table identifies areas that a production reporting entity covers, in full or in part.

Back to the list of table names

PDEN_PROD_STRING_XREF

This table tracks the contribution of production from a production string to a production reporting entity. In some jurisdictions, production from a number of

strings is aggregated for the purposes of reporting and regulation. Sometimes this is done differently, depending on the product. For instance, in Texas, oil is reported on a lease basis, while gas is reported on a string basis.

In addition to the UWI and string identifier, this table also tracks when this cross-reference was valid and provides a sequence number that allows ordering of cross-references by time.

Back to the list of table names

PDEN_XREF

This table provides a means of linking production entities to support relationships not explicitly defined in the Production Module of PPDM.

Many different levels of relationships are possible between entities for the purposes of production. For instance, in a given reporting month, a well may be reconnected from one facility to another. *Corporate data* would show that the production string is now connected to the new facility. *Production reporting data* would show that the string is connected to the old facility because it is based on the previous reporting month.

Finally, while the pipeline from the string is being changed, it is possible that production from the string is being trucked to a third facility. This could show up as a volume disposition (PDEN_VOL_DISPOSITION) from the production string to the third facility. Volume disposition transactions are the most detailed and may indicate relationships that are more transient than those maintained at the production reporting or corporate levels.

In addition, this table is provided to allow other means of relating production reporting entities to each other.

Back to the list of table names

Production Reserves Forecasts

These tables hold the Decline Case and Decline Segment information associated with Decline Analysis, as well as data derived from material balance and volumetric analysis.

PDEN_DECLINE_CASE

As with any commodity being extracted from a container, the rate at which it comes out diminishes as it is being consumed (try this with ketchup for example). With oil and gas, this is usually because it is reservoir pressure which forces fluid to move from the reservoir to the wellbore, and as the fluid is produced the reservoir pressure is diminished. Decline analysis is a way of statistically analyzing production volumes which decrease with time and cumulative production under consistent operating practices, to arrive at a forecast which continues along this established trend to predict future performance. Eventually

the forecasted production rate falls below a minimum threshold, and the well is assumed to be abandoned. If you significantly change the way you operate the well, you will change the rate at which it produces oil and gas. Such changes interfere with the validity of trying to perform decline analysis along the established trend.

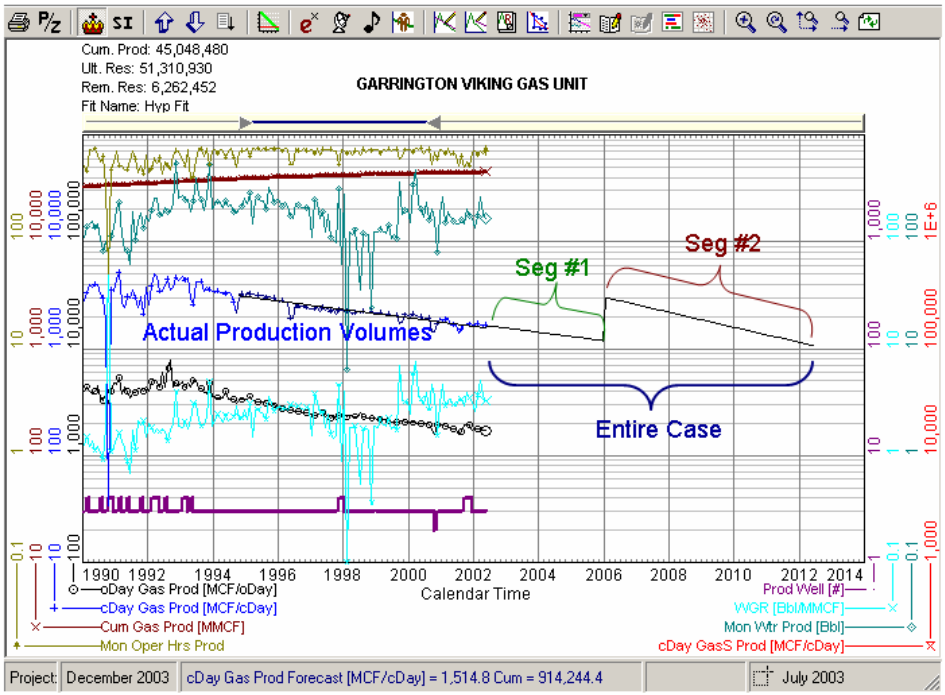
The PDEN_DECLINE_CASE table holds the case level summary information associated with an entire Decline Analysis forecast. The forecast itself may be made up of one or more segments. Generally a segment covers a portion of the decline forecast based on a single set of decline curve parameters, such as initial rate, decline rate, and exponent. Where the forecast shifts abruptly due to planned changes in operating conditions (e.g. installation of additional compression facilities) a second decline segment is used.

Back to the list of table names

PDEN_DECLINE_SEGMENT

This table holds the individual segment parameter sets, along with the summary data for each segment.

See sample Decline analysis graph below:



Back to the list of table names

PDEN_DECLINE_CONDITION

This table holds any decline data that does not fit in the Case or Segment tables. It can be used to hold non forecast related data such as well count and service factors. It can also be used to hold monthly forecast volumes associated with the production forecasts from the Segment table to make this data directly available for economic evaluation.

Back to the list of table names

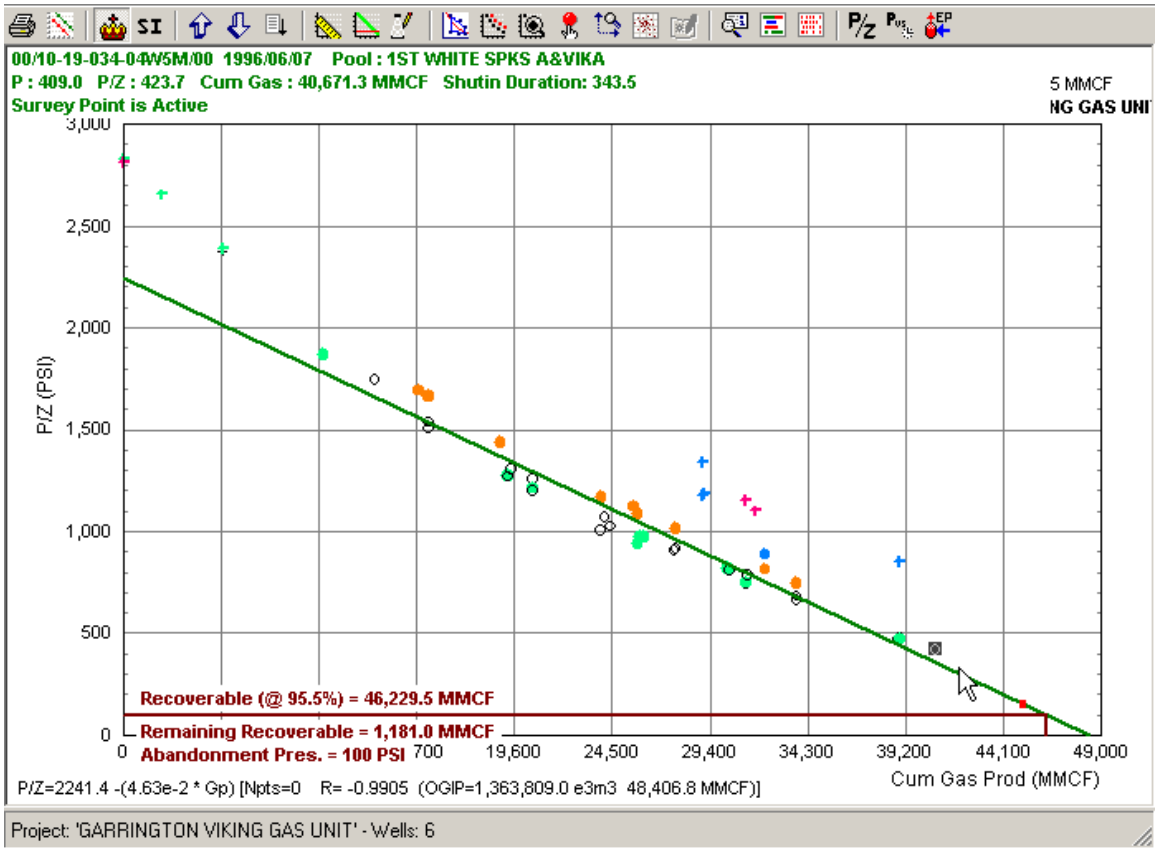
PDEN_MATERIAL BAL

The basis of gas material balance is to assume that the reservoir acts like a closed tank of inert gas under pressure. As gas is removed from the reservoir, the pressure declines in a fashion consistent with the size of the tank and the compressibility of the gas itself. The underlying assumptions do not allow for movement of any fluid into the reservoir, phase change behaviour within the reservoir, or compaction of the reservoir rock due to settling, as the reservoir pressure diminishes.

To perform the calculations, average reservoir pressures are required over the life of the reservoir. While a well is producing, the pressure immediately around the reservoir is lower than the average reservoir pressure. It is this pressure differential that causes gas to move toward the well bore. To achieve a

measurement of average reservoir pressure, the well is shut in for a period of time to allow the pressure in the reservoir to equalize. Where the reservoir permeability is low, the time required to get true equalization may be many years, and as such, the pressure measurements made in these situations are only approximations. Generally though, the longer the well was left shut in before the pressure measurement was made the more accurately the average pressure is determined. If more than one well is producing from the same reservoir, then ideally all the wells should be shut in while allowing the reservoir pressure to equalize. This loss of production is the most expensive component to acquiring accurate pressure data.

The PDEN_MATERIAL_BAL table holds the generic fluid property, cumulative production volumes and overall recovery factors that are used for Material Balance Calculations. The table also holds the summarized results from a gas material balance.



[Back to the list of table names]

PDEN_VOLUME_ANALYSIS

With volumetric analysis, the reserve volumes are calculated based on knowledge of the reservoir's physical characteristics as a container for the reserves. First the rock pore volume is determined by multiplying the aerial extent of the reservoir by its average net pay and average connected porosity. This yields the total volume available to contain moveable fluids. This is then multiplied by the fraction of the pore volume containing either gas or oil, which is usually calculated as 1 - Water Saturation and to a volume conversion factor between fluid volumes at surface conditions and fluid volumes at reservoir conditions. This yields the hydrocarbon volume originally in place. The last factor is the recovery factor, which is the percent of the total hydrocarbon in the ground that you expect to produce. This then results in the ultimate recoverable reserves volume.

The PDEN_VOLUME_ANALYSIS table holds the reservoir and fluid property data used to perform volumetric reservoir calculations, as well as the reserve volumes resulting from these calculations.

PDEN Fluid Analysis

PDEN_GAS_ANALYSIS

This table identifies the composition of a normal gas sample analyzed in a lab. The table allows you to specify when the analysis was completed, the number identifying the gas sample, and the quality and location of the sample. This table is similar to the WELL_GAS_ANALYSIS table.

Back to the list of table names

PDEN_GAS_ANAL_DETAIL

This table stores the results, such as mole percentages of CO2, He, H2S, etc., from a hydrocarbon compositional analysis of a normal gas sample. Information recorded here includes the measurement value and the property of the sample. This table is similar to the WELL_GAS_ANAL_DETAIL table.

Back to the list of table names

PDEN_OIL_ANALYSIS

This table identifies the composition and location of an oil sample obtained from a wellbore and analyzed in a lab.

In addition to the sample number, date, location and quality, the table stores the gas-oil ratio, pressure recorded during the oil density measurement, temperature of the oil when density or specific gravity was measured, oil density, and sulphur content. This table is similar to the WELL_OIL_ANALYSIS table.

Back to the list of table names

PDEN_OIL_VISCOSITY

This table stores information about the viscosity of an oil sample obtained for analysis. You can also track oil temperature and pour point temperature. This table is similar to the WELL_OIL_VISCOSITY table.

Back to the list of table names

PDEN_WATER_ANALYSIS

This table stores the analysis of a normal water sample conducted to determine salinity, resistivity, density, pH, and temperature. This table is similar to the WELL_WATER_ANALYSIS table.

Back to the list of table names

PDEN_WATER_ANAL_DTL

This table stores the composition and physical properties of an analyzed water sample. Properties may consist of dissolved solids, such as sodium (Na), calcium (Ca), or magnesium (Mg), etc. This table is similar to the WELL_WATER_ANAL_DTL table.

Back to the list of table names

PDEN Historical Data

PDEN_OPER_HIST

Use this table to record a historical account of the operators responsible for a production entity. The table references the BUSINESS_ASSOCIATE table and allows you to specify when that business associate became the operator of this particular production entity.

Back to the list of table names

PDEN_STATUS_HIST

This table tracks the operating history of the production reporting entity. The STATUS column references the WELL_STATUS table. The table also includes the date the status was recorded.

Back to the list of table names

Production Volume Regime

PPDM_VOL_MEAS_REGIME

When reserve determinations cross regulatory jurisdictions, it is often necessary to adjust the conversion factors, especially those used for gas volume conversions. Gas is by its nature compressible, and it will expand or contract as pressure and temperature change. When a cubic foot or cubic meter of gas is measured, it is necessary to know the standard pressure and temperature at which the volume was measured. From a practical perspective the effect of these changes is minor indeed, however, when large reserve volumes are being managed, even a difference of a fraction of a percent in the conversion factor can result in significant volume discrepancies.

The RESENT_VOL_REGIME table allows for a number of volume measurement regimes to be defined, each with its own standards for gas and oil measurement.

Back to the list of table names

PPDM_VOL_MEAS_USE

This table identifies the political and geographical regions for which a specific measurement regime would apply. In Canada a single measurement regime is adequate, as standard conditions have been defined federally. In the United States, multiple measurement regimes may be needed, as measurement standards have been defined at both the state and federal levels.

Back to the list of table names

PPDM_VOL_MEAS_CONV

This table identifies the actual conversion factor, and formula that may be required for converting volumes for each defined CONVERSION QUANTITY. Conversion quantities would be such measurement types as Gas Volumes, or Oil Volumes. The use of a Conversion Quantity, rather than using the product type directly, avoids the need to set up conversion equivalents for each type of gas, oil, or hydrocarbon fluid that may exist in the PRODUCT table.

The conversion factor is the multiplier to transform the data value from the FROM_UOM to the TO_UOM. The formula includes any other data that may also be used as part of this calculation. Where gas volumes are converted into a heating value equivalent the HEAT_CONTENT is used. When oil is converted into a weight equivalent the OIL_DENSITY is used. The LOSS_FACTOR is used to define the processing loss from one related product type to another, such as from RAW GAS to SALES GAS.

Back to the list of table names

RESENT_VOL_REGIME

This table explicitly defines the volume measurement regime to be used for a given Reserve Entity. Note that the regime to be used may change over time.

Back to the list of table names

PDEN_VOL_REGIME

This table explicitly defines the volume measurement regime to be used for a given PDEN Entity. Note that the regime to be used may change over time.

Back to the list of table names

PDEN Volume Data

PDEN_VOL_BY_DAY

This table stores daily volumes reported as part of a specified activity for a specific fluid type by a production reporting entity for a specific reporting year and month.

Along with the volume method, volume start and end date, year-to-date volume, activity type, and product type, this table also tracks the year, month, cumulative volume for the fluid reported, volumes for days 1 to 31, and the thermal quality for days 1 to 31.

Use of this table will be deprecated in the near future. PPDM does not recommend that this table be implemented for new installations. It is provided to support a migration path to the new production table PDEN_VOL_SUMMARY only.

Back to the list of table names

PDEN_VOL_BY_MONTH

This table tracks monthly volumes reported as part of a specified activity for a specific fluid type by a production reporting entity for a specific reporting year.

This table tracks similar information as the PDEN_VOL_BY_DAY table.

Use of this table will be deprecated in the near future; PPDM does not recommend that this table be implemented for new installations. It is provided to support a migration path to the new production table PDEN_VOL_SUMMARY only.

Back to the list of table names

PDEN_VOL_DISPOSITION

Use this table to track the reported movement of fluid between two production entities. A relationship is established between two production entities for the duration of the transaction (movement). This relationship may be different from the usual reported or operational relationships established by the two production entities.

Along with a number that identifies a reported movement of fluid between two production entities, this table allows you to specify volume method, volume of fluid movement, volume start and end date, duration of fluid movement, and the thermal quality of the fluid.

Back to the list of table names

PDEN_VOL_SUMMARY

This table records a summary of reported volumes for common fluids over a specified time period. In addition to produced volumes, this table may be used to track volumes that were injected, flared, sold, etc., through the VOLUME METHOD column.

The table stores cumulative volumes, volumes, and year-to-date volumes for CO2, gas, NGLs, nitrogen, sulphur, oil, and water. Substances not specifically supported in this table should be reported using the PDEN_VOL_SUMM_OTHER table.

Injection parameters, such as cumulative volume, cyclic injection, pressure, volume, and year-to-date volume; the opening and closing balance of the inventory product; the number of gas, injection, and oil wells; the period of injection and production; and the primary allowable (i.e., the primary production rate of oil or gas a production entity is permitted to produce under proration orders) are also supported.

Storage of allowable volumes, forecast data, estimated reserves, and other types of volumetric data should use the same PDEN volume data tables used for storing production and injection data. Differentiating the type of volumetric data stored is indicated by VOLUME_METHOD and ACTIVITY_TYPE.

For instance, to store estimated reserves, ACTIVITY_TYPE could have the value “RESERVES”, and VOLUME_METHOD could have the values “VOLUMETRIC”, “DECLINE”, or “MATERIAL BALANCE”.

Cumulative volumes should be stored as the closing volume at the end of the reported period. Opening volumes can be calculated by subtracting the closing volume and the reported volumes for that period.

Back to the list of table names

PDEN_VOL_SUMM_OTHER

This table records a summary of reported volumes for fluids not included as categories in the volume summary report (discussed in the previous section).

Back to the list of table names

PLATFORM

This table contains information pertaining to a fixed drilling location (i.e., offshore platform or onshore pad). The table tracks the number of drill slots on the platform, when the platform was installed and removed, and water depth.

Back to the list of table names

Production from a Facility

In addition to production string equipment, facilities are required to handle fluids that are either being produced from a reservoir or are being injected into the reservoir. These facilities can be everything from gas processing plants and batteries to pumps, metering station, and pipelines.

The following subsections outline the parent table and associated tables related to this type of production.

FACILITY

This parent table allows you to track general information, such as its location, when the facility was constructed, when it was active, when injection volumes and production were first and last reported, and when a production report was last submitted for the facility.

If the facility is operated by a unit operating agreement, the UNIT_OPERATED_IND must be set to Y (yes). If the facility is still active, set ACTIVE_IND to Y.

Back to the list of table names

FACILITY_ALIAS

Partners and regulatory agencies often assign differing names, codes, or other identifiers to facilities. In addition, the identification for a facility can change over time. This table allows you to track all names or aliases of the facility, along with whether the alias belongs to a partner, etc., and when the alias was valid. All names and codes used to identify the facility should be stored in this table and used for searches. Generally, the preferred name should be populated in the FACILITY table by means of a stored procedure or trigger only if required for performance.

Back to the list of table names

FACILITY_FIELD

This table provides a way of associating a facility with multiple fields; this situation is not uncommon in international exploration and development.

Back to the list of table names

FACILITY_BA_SERVICE

Facilities require maintenance, inspections, and supplies. This table allows you to track these services and when they were performed.

The contracts that govern the services and business associates who performed them are identified here. More detailed information is stored in the Contracts and Business Associates Modules.

Back to the list of table names

FACILITY_SUBSTANCE

This table tracks the substances handled by the facility and when they were handled. Related information, such as average and maximum volumes and stratigraphic information, are also recorded here.

To make query writing easier, make sure you specify whether the named substance is or is not handled by the substance. So, for example, if the named substance is not explicitly handled by the facility, set the SUBSTANCE_EXCLUDED_IND to yes (Y). If it is handled, set SUBSTANCE_INCLUDED_IND to yes (Y). The opposing column should be set to no (N) rather than left null.

Back to the list of table names

FACILITY_VERSION

This table provides information about the facility from other sources. So, for example, if information about the facility is available from more than one data vendor, this table allows you to track these various sources.

The preferred version of the data is stored in the FACILITY table. The preferred version may represent the best data combined from several sources.

Back to the list of table names

FACILITY_XREF

Use this table to track the relationships between facilities, such as which facilities are components of, adjacent to, or attached to another facility. For example, you can track which pipelines feed into a battery. You can also track when the relationships were in effect.

Back to the list of table names

Production from a Field

A field is a geographical area defined for administrative and legal purposes. The field name refers to the surface area, although it may refer to both the surface and the subsurface productive zones. In the United States a field is often an area consisting of a single reservoir or multiple reservoirs all grouped on, or related to, the same individual geological structural feature and/or stratigraphic condition. Fields are usually defined at a province/state level but possibly are done at the district level.

The following subsections outline the parent table and associated tables related to this type of production.

FIELD

This table allows you to specify general information about a field, including when it was discovered, its location, and how long it remained in effect.

Back to the list of table names

FIELD_ALIAS

This table stores all known names and codes assigned to a given field. For example, the Hugoton Gas Field may have many versions of the name assigned by a regulatory body, such as Hugoton G. Field, etc. This table allows you to track all names or aliases for the field, and state whether the alias belongs to a partner, etc., and when the alias was valid. All names and codes used to identify the field should be stored in this table and used for searches. Generally, the preferred name should also be populated in the FIELD table by means of a stored procedure or trigger only if needed for performance.

Back to the list of table names

FIELD_INSTRUMENT

This table tracks the relationship between fields and instruments. In many regulatory jurisdictions, legal instruments are created that completely describe and define the field.

Back to the list of table names

FIELD_IN_COUNTY

This table identifies counties a field covers, in full or in part.

Back to the list of table names

FIELD_VERSION

This table tracks a version of field information from a specific source. So, for example, if information about the field is available from more than agency or

company, this table allows you to track these various sources. The preferred version is added to the FIELD table. The preferred version may represent the best data combined from several sources.

Back to the list of table names

Production from a Pool

A pool represents a reservoir or a group of small tracts of land brought together for the granting of a well permit under applicable spacing rules. In Canada, pool almost exclusively refers to a reservoir, and these codes are usually unique within a province or field. In the United States, these codes are unique either to the state, or to the state, field, or district.

The following subsections outline the parent table and associated tables related to this type of production.

POOL

This table tracks location, status, discovery date, pool code and name, and stratigraphic information.

Back to the list of table names

POOL_ALIAS

This table stores all known names and codes for a pool. The table allows you to track whether the alias belongs to a partner, etc., and when the alias was valid. All names and codes used to identify the pool should be stored in this table and used for searches. Generally, the preferred name will populated in the POOL table by means of a stored procedure or trigger only if needed for performance.

Back to the list of table names

POOL_INSTRUMENT

This table tracks the relationship between pools and instruments. It is a legal document that defines and describes the pool legally. It is used to support contractual agreements, leases, production agreements, and more.

Back to the list of table names

POOL_IN_COUNTY

This table identifies counties a pool covers, in full or in part.

Back to the list of table names

POOL_VERSION

This table tracks alternate versions of pool information. So, for example, if information about the pool is available from more than one agency or company, this table allows you to track these various sources. The preferred version is stored in the POOL table. The preferred version may represent the best data combined from several sources.

Back to the list of table names

Production from a Lease Unit

Use of this module should be restricted to cases where production reporting comes from an undefined land right. When possible, we strongly recommend that the Land Right module be used to capture information about mineral rights, whether they are owned, leased or unitized. This module was created to support production reports that come from land rights that are poorly or incompletely defined.

Production can come from a mineral lease or unitization agreement (unit). Note that lease and unit are often treated synonymously for production reporting purposes and that it is sometimes not possible to distinguish between them on the basis of production reports. For this reason they are treated as a single entity.

Detailed information about the land right that a lease unit refers to can be fully described using the Land Right module in PPDM. For more information about this module, refer to the Land Right Reference Guide.

The following subsections outline the parent table and associated tables related to this type of production.

PROD_LEASE_UNIT

This table allows you to track an alias used for production reporting purposes of a lease or unit.

Here you record location, duration of the lease or unit, date of current status, lease names, and stratigraphic information. The table contains a foreign key to the LAND_RIGHT table of the Land Mineral Rights Module.

Back to the list of table names

PROD_LEASE_UNIT_ALIAS

This table allows you to track all known names and codes the lease unit is known by. The table allows you to track whether the alias belongs to a partner, etc., and when the alias was valid. All names and codes used to identify the lease unit should be stored in this table and used for searches. Generally, the preferred name will be populated in the PROD_LEASE_UNIT table by means of a stored procedure or trigger only if needed for performance.

Back to the list of table names

PROD_LEASE_UNIT_VERSION

This table stores alternate information about the lease unit from different sources. So, for example, if information about the lease unit is available from more than one agency or company, this table allows you to track these various sources. The preferred version is stored in PROD_LEASE_UNIT. The preferred version may represent the best data combined from several sources.

Back to the list of table names

PR_LSE_UNIT_IN_COUNTY

This table identifies counties a production lease or unit covers, in full or in part.

Back to the list of table names

PR_LSE_UNIT_STR_HIST

This table tracks historical relationships (assignments) of production strings to a lease or unit. You can identify when a production string was assigned to a production lease or unit.

Back to the list of table names

Production from a String

Production can come from a production string. The production string may be a physical string or an annulus string. The following subsections outline the parent table and associated tables related to this type of production.

PROD_STRING

Besides identifying the string, you can also track detailed information for the string, such as the depth of the highest and lowest packers that control fluid flow, whether the production is commingled, when the string was producing, date of the current status, date that injection or production was first reported, true vertical depth, total depth, and the number or code, such as API or CPA number, assigned by a regulatory agency or government.

Back to the list of table names

PROD_STRING_FORMATION

This table stores information about the producing formation (stratigraphic units) and can be used to prorate production from a production string back to individual formations. In addition to the UWI, string identifier, and allocation factor, you can track stratigraphic information, top and base of the producing formation, date of the current status, and when the formation was producing. The PR_STR_FORM_OBS_NO column stores a sequential observation number used

to uniquely identify each completed (perforated) formation or layer that is contributing production to a well string.

Back to the list of table names

PROD_STR_STAT_HIST

This table tracks the history of the operating status of the production string.

PROD_STRING_FORMATION has its own status and status history (PROD_STR_STAT_HIST) because there are cases (offshore) where a particular formation will have shutters on the perfed tubing so that individual formations within a single production string can independently be turned off and on.

Back to the list of table names

PR_STR_FORM_STAT_HIST

This table records the history of how a particular formation or layer was configured to contribute production to a production string.

Back to the list of table names

Implementation Considerations

Constraints in PPDM

It is essential that anyone who is considering using PPDM version 3.7 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 or downloaded from the PPDM web site at www.ppdm.org.

Check Constraints

PPDM version 3.7 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 3.7.

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

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

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

Currencies in PPDM

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.

Units of Measure

Relational databases, powerful as they are, are not good at certain types of query and retrieval. Any time a query is developed that requires the database to retrieve all the rows in a large table and perform some calculations on the data before returning results to a user is likely to perform very poorly. This assumes, of course, that the person constructing the query is aware that a calculation is necessary when writing the query. Data management strategies for such tables recommend that requirements for on-line conversions such as this be eliminated if at all possible. The PPDM strategy for handling units of measure falls into this category.

Every column in the data model that references a Unit of Measure (such as a depth, temperature, length etc.) should be stored using a single, common unit of measure. For example, in one PPDM instance, all the total well depths should be stores as meters or as feet. Storing some depths as meters and the rest as feet creates problems for the data base and adds confusion to the user (who may not be aware that the numbers in the DEPTH column are not all meters).

The original unit of measure (the unit in which the data was originally received) can be stored in the data table. For example, the WELL table captures FINAL_TD and FINAL_TD_OUOM. These columns capture the value of the final total depth of the well and the units that the depth was originally captured in.

The ***stored unit of measure*** is captured in the PPDM meta model, PPDM_COLUMN. This table captures the default unit of measure for a column and the name of the column where the original unit of measure is stored. The following illustration provides an example:

WELL

UWI	DRILL_TD	DRILL_TD_OUOM
SMITH12F	1250	FEET
JONES44	1560	METERS
12345	1400	FEET

PPDM_COLUMN

TABLE_ NAME	COLUMN_ NAME	UOM_ COLUMN	OUOM_ COLUMN	DEFAULT _ OUM_ SYMBOL
WELL	UWI			
WELL	DRILL_TD		DRILL_TD_OUOM	M
WELL	DRILL_TD_OUOM			
WELL_CEMENT	CEMENT_AMOUNT	CEMENT_AMOUNT_UOM	CEMENT_AMOUNT_OUOM	

Figure 9: *The method for storing and tracking units of measure is illustrated here..*

Note that in the example, the Drilling TD is stored in meters, but was originally received as feet. In some cases, it is not possible to ensure that all the rows in a column are stored as a single unit of measure – this is common in cases where the unit of measure is dependent on some other factor. For example, substance measurements may depend on the substance being measured; gases are stored as MCF, liquids as BBL etc. In these cases, the unit of measure is stored directly in the business table.

Audit Columns

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

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

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

Identifying Rows Of Data That Are Active

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

Many tables in PPDM version 3.7 contain a column called ACTIVE_IND. The values for this column may be one of Y, N, or null. When more than one row of data (such as a spatial description or a status) has been created for a business object, use the ACTIVE_IND to indicate which row is currently active (note that in some cases, more than one row may be active simultaneously).

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

If this column is used for queries, as recommended (such as "find me the currently active status for this land right"), you should implement procedures to ensure that this column is always populated as either Y or N and maintained appropriately. If the column is left blank (NULL), the query will not be consistent or reliable.

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

Modifying the Reserves Module

Subsetting PPDM

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

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

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

Expanding PPDM

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

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

Feedback to PPDM

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

Frequently Asked Questions (FAQ)

How should I load new data into the PDEN Tables?

1. To ensure consistent results using the Production Module, we recommend the following loading procedures. Decide what type of PDEN you are dealing with. Populate the PDEN table and the table for the sub-type of PDEN being loaded. The column PDEN_TYPE should be populated with the name of the sub-type table.

   Examples:

   a. If the PDEN is a well, you must populate PDEN and PDEN_WELL. The column PDEN_TYPE in each table must be "PDEN_WELL".

   b. If the PDEN is a business associate, you must populate PDEN and PDEN_BUSINESS_ASSOC. The PDEN_TYPE column in each table must be "PDEN_BUSINESS_ASSOC".

2. Decide how to uniquely identify PDENs.

   You may use surrogate or natural keys, as your organization prefers. If you decide to use natural keys, it may be desirable to use the natural ID of the producing object. Before this decision is made, ensure that only one PDEN will ever be created for that producing object. If an object may contribute to more than one PDEN, it will be necessary to ensure that the natural ID is modified to make it unique.

   Examples:

   a. If the PDEN is a well, the PDEN_ID may be the UWI.

   b. If the PDEN is a business associate, the PDEN_ID may be the BA_ID.

How should I use the Production Module to determine my cumulative production for a well?

The PDEN_VOL_SUMMARY table captures volume reporting for the most common substances by providing a set of reporting columns explicitly for that substance. In addition, you can capture information about the BOE summary, gas summary, and injection summary. Each of these groups allows you to capture the cumulative volume and the year-to-date volume for that PDEN.

How should I capture production volumes in PPDM 3.5?

The Production work group carried the monthly and daily reporting tables forward from the previous version of the model to allow a migration path, but these tables are to be deprecated, so should not be used for new implementations. Use the PDEN_VOL_SUMMARY and PDEN_VOL_SUMM_OTHER tables. These tables allow you to capture volumes for any fluid for any reporting period based on any activity required. They provide more flexibility than the production reporting tables PDEN_VOL_BY_MONTH and PDEN_VOL_BY_DAY.

How do I describe the movement of my produced volumes from one PDEN to another?

This function is handled in the PDEN DISPOSITION table. It allows you to indicate how your volumes move from one PDEN to another.

Although I measure my flow rates at the well head, I need to back allocate the production to each completion for reporting purposes. How do I back and forward allocation production?

The PDEN_ALLOC_FACTOR table handles this function by allowing you to capture the PDEN where volumes were measured, where they are allocated to, and the allocation factor used.

Where should I capture information about tests (oil, water, gas) I have done on produced volumes?

The PDEN_WATER_ANALYSIS and PDEN_WATER_ANAL_DTL tables capture information about water tests. Similarly, PDEN_OIL_ANALYSIS and PDEN_OIL_VISCOSITY can be used for oil tests, and PDEN_GAS_ANALYSIS and PDEN_GAS_ANAL_DETAIL for gas analysis. These tables match the corresponding well test tables in content.

Can I capture my flow measurement details anywhere in the model?

Yes, you can use the PDEN_FLOW_MEASUREMENT table to capture information about the flow rates and the conditions at the time of measurement.

How do I associate production volumes with a contract?

The CONTRACT_COMPONENT table allows you to associate PDENs and contracts.

How do I associate production volumes with a land right?

We recommend that you use the LAND_RIGHT module to describe all mineral rights that are held. These land rights may be owned, leased, contracted, unitized etc. The table PDEN_LAND_RIGHT table can be used to associate production information with the appropriate land right. See the PPDM Land Mineral Rights reference guide for more details about how this module functions.

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.

What is the cumulative NGL production for my well ABCD432?

```
select      PVS.NGL_CUM_VOLUME
  from      PDEN_VOL_SUMMARY PVS, PDEN_WELL PW
 where      PW.UWI = 'ABCD432'
   and      PW.PDEN_ID = PVS.PDEN_ID
   and      PW.PDEN_TYPE = 'PDEN_WELL'
   and      PVS.PDEN_TYPE = PW.PDEN_TYPE
   and      PVS.PDEN_SOURCE = PW.PDEN_SOURCE
```

What allocation factor did I use to back allocate from well ABCD432 to completion ABCD432a?

```
select      PAF.ALLOCATION_FACTOR
  from      PDEN_ALLOC_FACTOR PAF, PDEN_WELL PW, PDEN_PR_STR_FORM PSF
 where      PW.UWI = 'ABCD432'
   and      PSF.UWI = 'ABCD432'
   and      PSF.STRING_ID = 'ABCD432a'
   and      PAF.FROM_PDEN_ID = PW.PDEN_ID
   and      PAF.TO_PDEN_ID = PSF.PDEN_ID
   and      PW.PDEN_TYPE = 'PDEN_WELL'
   and      PSF.PDEN_TYPE = 'PDEN_PR_STR_FORM'
   and      PSF.PDEN_SOURCE = PW.PDEN_SOURCE
```

What was the monthly OIL production for well ABCD432 ?

```
select      VOLUME_DATE,OIL_CUM_VOLUME,OIL_YTD_VOLUME,OIL_VOLUME,
            OIL_VOLUME_OUOM,OIL_QUALITY,OIL_QUALITY_OUOM
  from      PDEN_VOL_SUMMARY PVS, PDEN_WELL PW
 where      PVS.VOLUME_METHOD = 'PRODUCTION'
   and      PVS.PERIOD_TYPE = 'MONTHLY'
   and      PW.UWI = 'ABCD432'
   and      PW.PDEN_ID = PVS.PDEN_ID
   and      PW.PDEN_TYPE = PVS.PDEN_TYPE
   and      PW.PDEN_SOURCE = PVS.PDEN_SOURCE
```

Appendix B: Changes to the Model

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

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

Changes Between Versions 3.4 and 3.5

PPDM version 3.4 allowed production reporting only for a well. The tables designed to do that, WELL_VOL_BY_MONTH and WELL_VOL_BY_DAY, have been replaced by the new table PDEN_VOL_SUMMARY. The previous tables were left in the model (but renamed PDEN_XXX) to give you a good migration path to the new tables. New implementations should not use the tables PDEN VOL BY MONTH or PDEN VOL BY DAY, as they will be removed in future versions of PPDM.

All business requirements supported in production reporting tables of PPDM version 3.4 are fully supported by the Production Module in version 3.5.

Changes Between Versions 3.5 and 3.6

New tables

FACILITY_FIELD

PDEN_LAND_RIGHT

Changes Between Version 3.6 and 3.7

New Sub-types

PDEN_RESENT and PDEN_RESENT_CLASS have been added as valid sub types of PDEN to support volume reporting for reserves.

New detail tables

PDEN_DECLINE_CASE – replaces PDEN__FORECAST

PDEN_DECLINE_CONDITION– replaces PDEN__FORECAST

PDEN_DECLINE_SEGMENT

PDEN_MATERIAL_BAL

PDEN_VOL_MEAS_CONV

PDEN_VOL_MEAS_REGIME

PDEN_VOL_MEAS_USE

PDEN_VOL_REGIME

PDEN_VOLUME_ANALYSIS

RESENT_VOL_REGIME