LOTAR

LONG TERM ARCHIVING AND RETRIEVAL

# TECHNICAL SPECIFICATION

## Part 230 - "As Built"

***Release 0.1***

**2018-01-08**

Status: Draft


| **LOTAR** | |
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## Document History

**Table 1 - Document History**

| Revision | Date | Change |
|---|---|---|
| 1.0 | 2018-01-08 | Initial Release as Technical Specification |
| | | |
| | | |

# As Built – Technical Specification

## 1 Scope

### 1.1 Introduction

The Part 230 scope is the “as built” data used for demonstrating completion of the build process and conformity of the product to type design. The scenarios and use cases used to support Part 230 include:

- S1 – Evidence of the baseline for verification, certification, or product liability
  - UC2 – Long term archiving of Type Certificate Configuration.
  - UC4 – Acquisition/divestiture resulting in transfer of Product Definition Data and Type Design Data.
- S2 – Reuse of design data as a starting baseline for design changes
  - UC5 – Changes to Product Definition Data resulting in a major or minor change to the Type Design Data.

This document does not attempt to describe how to create an OAIS/LOTAR information package. Nor does it address common issues in the archive domain, such as snapshot vs. incremental archival methods, or package-to-package linkages, or how to identify proper metadata for an archival package.

### 1.2 In Scope

The Part 230 TS serves as the as-built baseline. In some cases, the as-planned baseline is derived from the resolved design product structure. In other cases, the as-planned baseline equals the engineering baseline, and changes to the build sequence are incorporated in engineering.

This TS describes the expansion of the 210 TS on the as-designed baseline to include as-built records which are the results of completing the work defined in an as-planned baseline, including variances; and reflect the build configuration of individual units.

Visually, these areas may be depicted as follows:

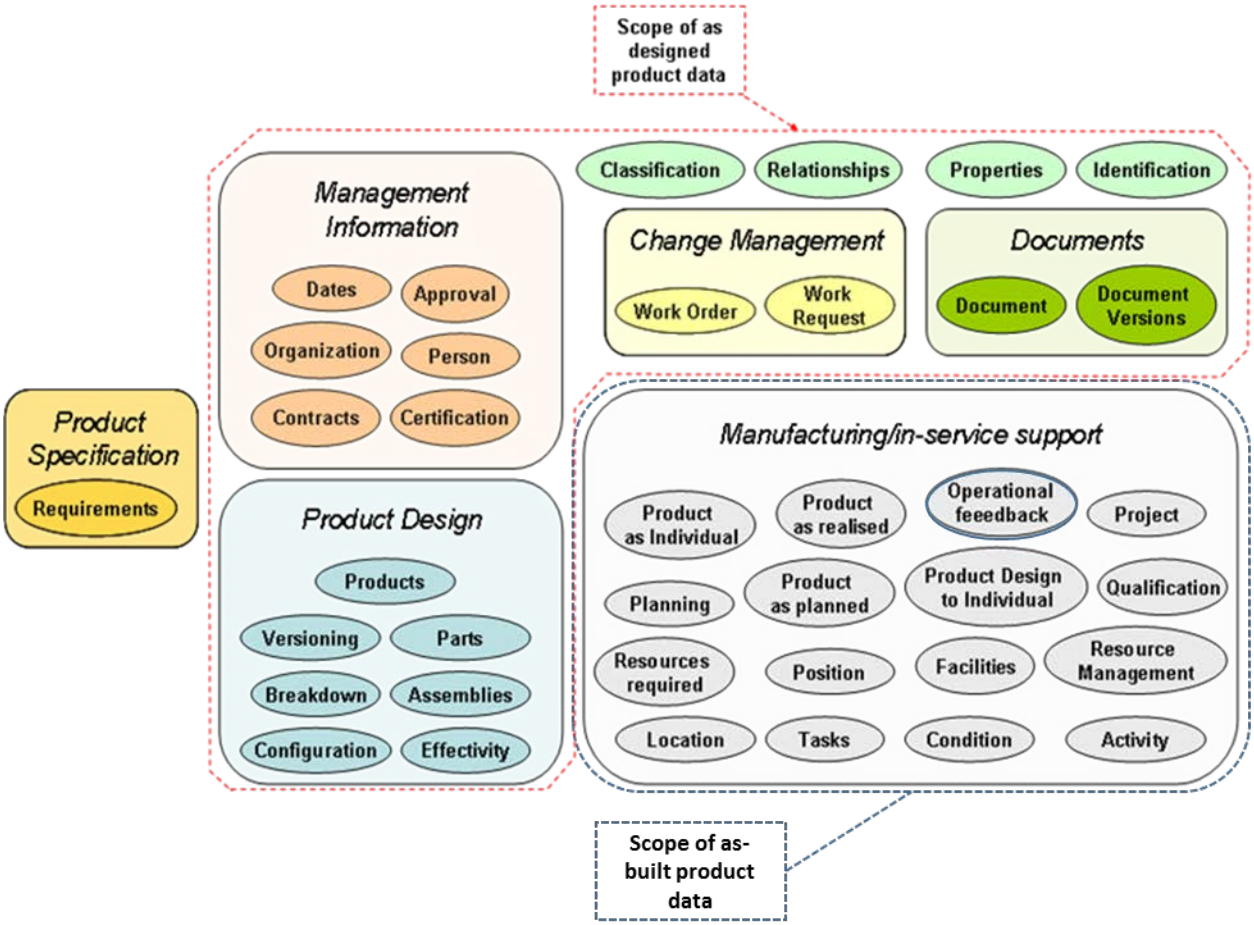



**Figure 1. Scope of Part 230 As Designed and As Built data.**

The planned work scope for LOTAR PDM is found in the Part 200 “Fundamentals and Concepts” document and is reproduced here:

**Table 2 - 9300 Part 200 series**

| *Data domain specific part* | *Document Number* |
|---|---|
| *Product Management Data in an as designed view* | *TS 9300-210 (Released)* |
| *Product Management Data in an as built / as delivered / maintained view)* | *TS 9300-230* |
| *Product Management Data In-development (including prelim design review, critical design review, FAI, etc.)* | *EN 9300-240* |
| *Change documentation* | *EN 9300-250* |

# 2 Explanation of the diagrams

## 2.1 Reason for diagrams

There is a diversity of Product Lifecycle Management (PLM) systems among LOTAR members. This diversity reflects the differences in terms and processes used to manage our products. While our members are Subject Matter Experts (SME) in our use of PLM systems, none of us are conversant with formal modeling methods as used by the STEP community. Thus, our team has developed a simple diagramming technique to supplement the textual content that is easy to understand and can be created with presentation or drawing tools. The diagrams are based on graph theory and employ only two constructs: nodes and edges. In our usage, we typically will use the terms items and connections for edges and nodes, respectively. Edges (connections) are directional; generally representing the connection in natural language. This graph form is known as a “directed property graph”. For example: “has part”. Thus, a connection has “subject” side, which we call the “from” side, and an “object” side, which we call the “to” side. Lastly, the diagrams omit cardinality information in the interest of simplicity. We believe that cardinality can easily be added once formal STEP models are developed.

NOTE: in order to keep the diagrams concise, we use a variant of graph theory called hypergraph theory where edges are permitted to connect to other edges (but not multiple nodes to multiple nodes).

## 2.2 Attributes

All nodes and edges (items and connections) have attributes. PLM systems are designed to be customized. Therefore, our team mostly focuses on the minimum attribution.

The minimum attribution for an item is generally:

- Type: the kind of thing the item represents. For example, a person, a part, a product, a document
- Name: the name used for human readable consumption
- Revision: the revision of the item as it undergoes changes
- ID: the internal identity of the item that is unique

NOTE: typically, the triplet (type, name, revision) is also unique in a PLM system.

- Timestamps: creation and modification
- References to persons or systems acting as creator, modifier, and “owner”
- Status of item: especially whether it is (was) approved
- Description: an item often has a description, such as a title for a drawing item, or nomenclature for a part item.

The minimum attribution for a connection is:

- The ID of the connection itself
- The type of the connection itself
- The ID of the FROM item
- The ID of the TO item
- The change management effectivity timestamps:
    - Start: the date the connection was approved for use
    - Stop: the date the connection was deprecated for use
- The change management effectivity authorizations:
    - Start Authority: reference to the change document approving this connection
    - Stop Authority: reference to the change document deprecating this connection
- Timestamps: creation and modification
- References to persons or systems acting as creator, modifier, and “owner”

## 2.3 Property Sheet Concept

Since these minimum attributes are not sufficient, we use the notion of a “property sheet” which is a container for the custom or PLM system-specific data that is needed. The name “property sheet” is intended to convey a simple enumeration of attribute names, values, datatypes (string, Boolean, number, date, etc.), and unit of measure. Such a set of properties could be modeled in our diagrams as a node with an edge named “has property” connecting it to the item or connection having the properties. But that needlessly complicates the diagrams, since virtually any item or connection will have custom properties. The Property Sheet concept can also be used to achieve other goals of a PLM system:

- Ad hoc properties: In this case, an item or connection might have multiple sets of properties. The extra properties might provide attributes for a part that are unique to its part family. For example,

a bolt might additional attributes of head type, length, etc.; whereas a nut may have inner and outer diameter, lock nut indicator, etc.

- Restricted properties: In this case, properties might be segregated when the values may be export controlled or are proprietary information.
- Value added properties: during the lifecycle of the part, extra attributes, such as supplier, cost, plant, etc. might be added by downstream business functions.

Here is a visual depiction of the property sheet concept:

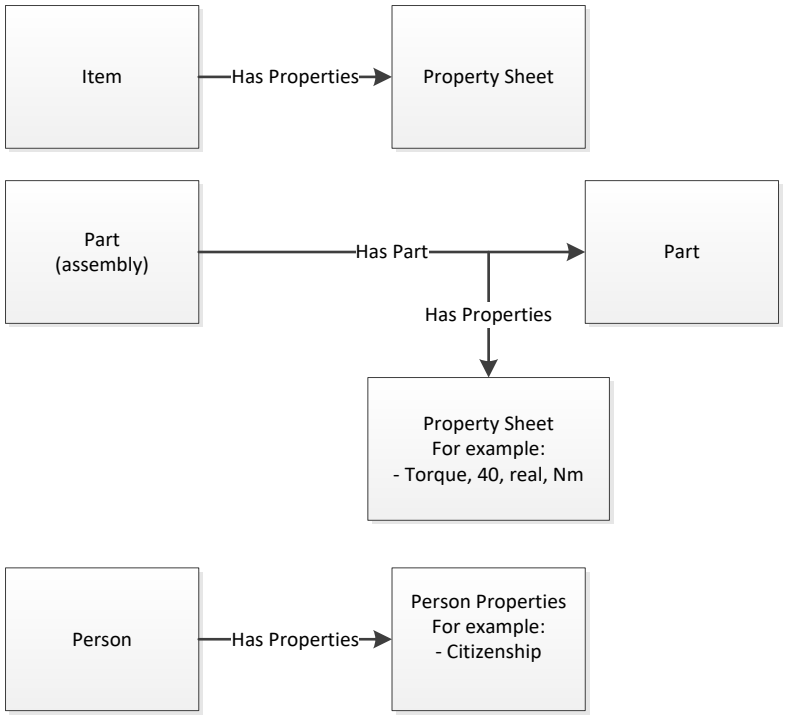



**Figure 2 - Property sheet concept**

A property sheet can be viewed a special kind of item with a type indicating the sort of properties it contains. Since most systems do not actually model properties this way, the revisions of its base item type and the properties may be synced, along with connections to change items.

## 2.4 Attachments

Since an item or connection may have one or more associated files, this aspect is not repeated in the diagrams. An attachment item will generally need other attributes to represent the file(s). These include:

- Filename
- Digital signature (such as a SHA-512 hash result)
- A reference to its actual location (in a file system, database, or external repository)

## 2.5 A Word on Change

In general, PLM systems may be concisely characterized by having “lossless change methods”. This term captures the following concepts:

- Nothing is ever deleted.
- Every change is auditable (why, who, what, and when)
- Ideally, you should be able to query the state of the PLM system at any time in the past and see:
    - What was current and approved at that time
    - What was proposed or pending at that time
    - What was historical at that time

In the following sections, the reader will see statements to the effect that these objects are subject to change control. But the above bullets points hint that change is a fundamental aspect to PLM and must permeate all aspects of product data. See section 6, Change Management.

# 3 Management Information

Here are the diagrams for management information:

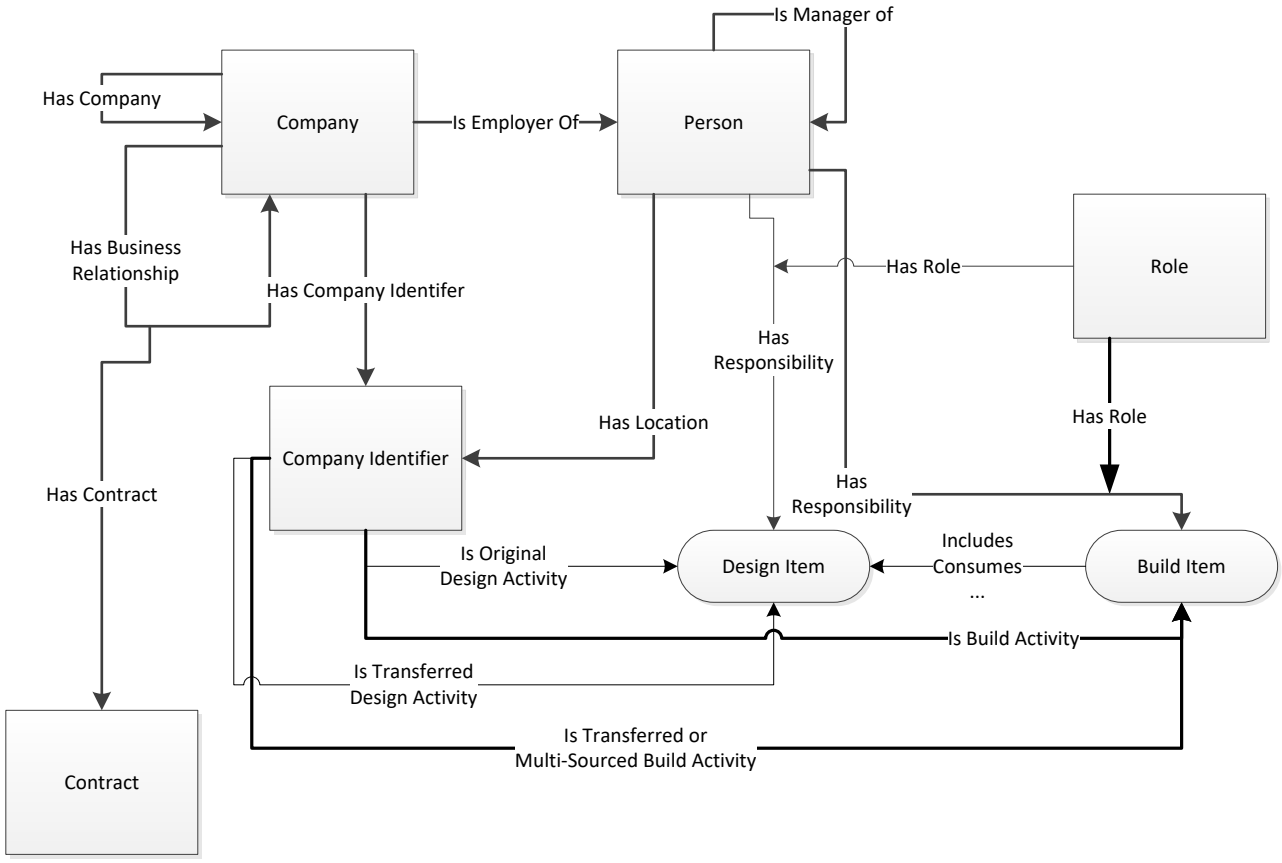



**Figure 3 - Management information diagram**

## 3.1 Items

| Name | Description | Notes |
|---|---|---|
| **Company** | The legal entity of the company. | Generally, the nationality or country of incorporation is key information for access security. |
| **Person** | Represents a person who has approved, performed work, etc. requiring certain information about the person to be retained. | In some countries the place of birth is required for access security. All require the citizenship for access security (for national export control regulations) |
| **Company Identifier** | The identifier of the legal entity where work was performed. | This is generally represented by a DUNS, CAGE code, etc. and includes street address and other contact information. Sometimes a DUNS number is also used. |
| **Role** | Represents the role of the person having responsibility of a design or build item. | For example: author, engineer, checker, etc. |
| ***Design Item*** | This represents something in the Type Design that can be owned and changed. | This could be either an item that represents a thing (like a drawing) or a connection (like “has part”) |
| ***Build Item*** | This represents an item that is built to conform to all or a portion of a design item configuration. | This represents a thing - a (physical or software) part, assembly, or installation. |
| ***Build Plan / Operation*** | This represents a manufacturing step which uses all or part of engineering definition to define the work for a detail, assembly, or installation build task. | |
| ***Nonconformance*** | The condition of a detail, assembly, or installation which does not conform to the engineering or manufacturing (partial engineering) definition. | |
| ***Nonconformance record*** | The record of a nonconformance. When complete, the record includes the disposition. | |

| Name | Description | Notes |
|---|---|---|
| ***Serial Number / Lot Number / Batch Number*** | This represents the unique identifier for an individual detail, assembly, or installation usually assigned during manufacturing. | Serial numbers are assigned to individual parts. Lot numbers are assigned to a group of parts produced as a set during manufacturing. Batch numbers generally are used to identify a quantity of raw material produced as the output of particular manufacturing sequence. |

## 3.2 Connections

| Name | Description | Notes |
|---|---|---|
| **Has Company** | • From: Company<br>• To: Company<br><br>Indicates a legal subsidiary relationship. | Laws governing this relationship vary from country to country. |
| **Has Business Relationship** | • From: Company<br>• To: Company<br><br>Indicates a partnership, supplier, etc. relationship between two legal entities. | Such relationships always have non-disclosure or proprietary information agreements which may be used in access security. In some cases, there are contracts between the companies. |
| **Has Company Identifier** | • From: Company<br>• To: Company Identifier<br><br>Indicates the locations of a company or legal entity. | |
| **Is Employer Of** | • From: Company<br>• To: Person<br><br>Indicates employer/employee relationship | The nationality of the company may be used in access security; perhaps overriding nationality of the person. |
| **Is Manager Of** | • From: Person<br>• To: Person<br><br>Indicates supervisory relationship. | This may be used to certain approvals where one-over-one signoffs are required. |

| Name | Description | Notes |
|---|---|---|
| **Has Responsibility** | • From: Person<br>• To: a design item<br><br>Indicates responsible persons in a design activity. | |
| **Has Role** | • From: Role<br>• To: “Has Responsibility”<br><br>Indicate the role of the person in the design activity. | |
| **Has Location** | • From: Person<br>• To: Location<br><br>Indicates the physical work location of the person (employee) | |
| **Is Original Design Activity** | • From: Location<br>• To: a design item<br><br>Indicates who created the design item originally. | This value is never altered, even when the ownership of the design item is sold or transferred. |
| **Is Transferred Design Activity** | • From: Location<br>• To: a design item<br><br>Indicates the current owner of a design item if it has been sold or transferred. | |
| **Has Contract** | • From: “has business relationship”<br>• To: Contract<br><br>Indicates the governing documentation between two companies | |

Here is the diagram for “organization”:

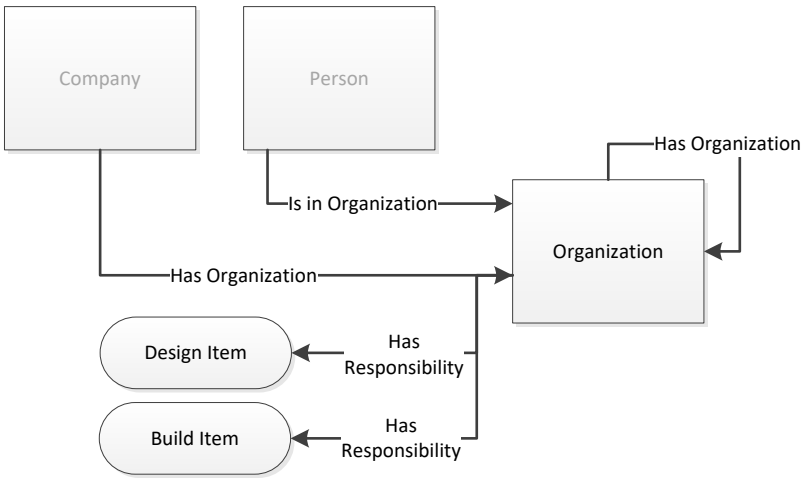



**Figure 4 - Organization**

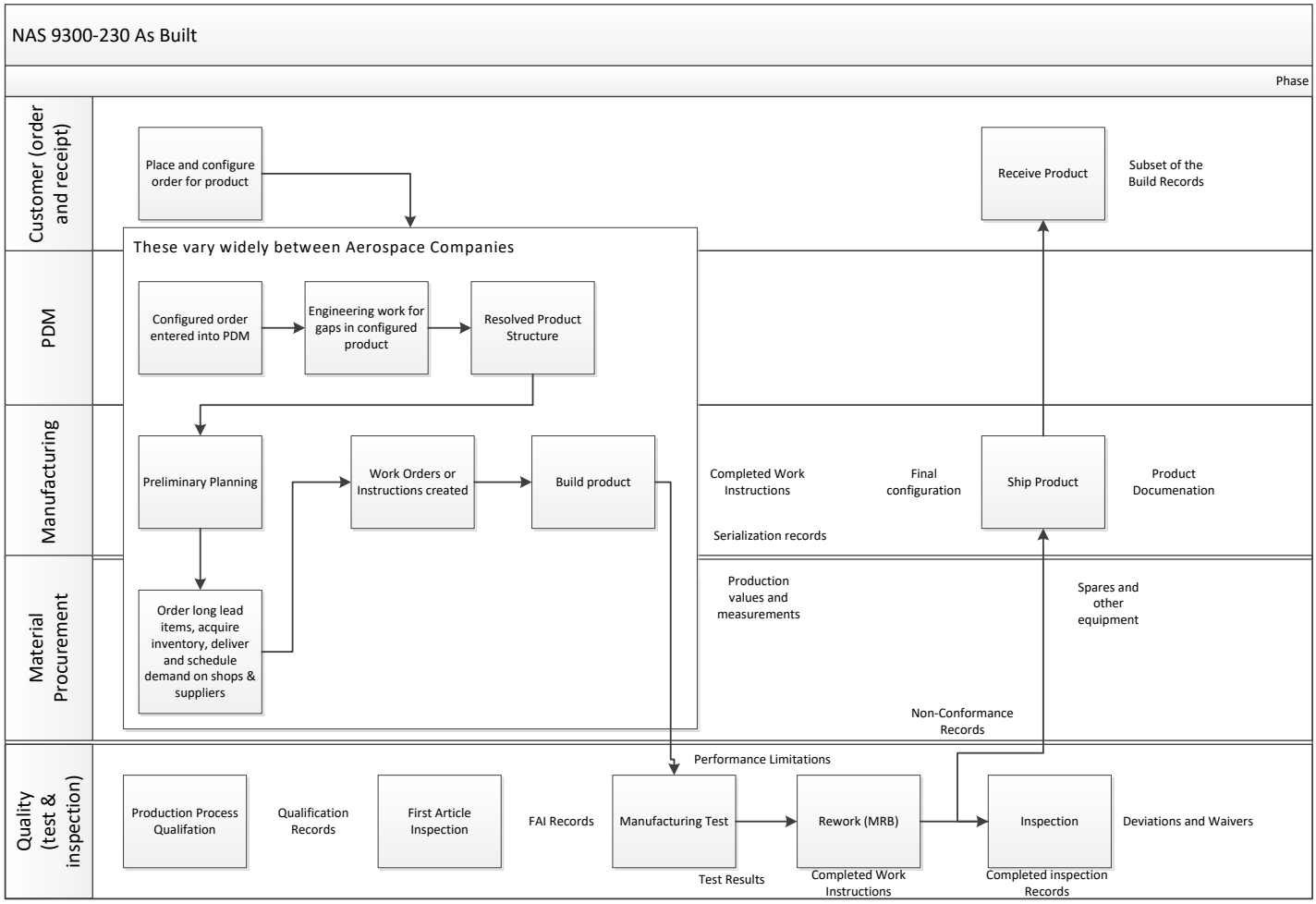
## 3.3 Items

| Name | Description | Notes |
|---|---|---|
| **Organization** | The name of an organization within a company | May also include the functional responsibility of the organization. |

## 3.4 Connections

| Name | Description | Notes |
|---|---|---|
| **Has Organization** | • From: Company<br>• To: Organization<br><br>Indicates which company has the named organization | |
| **Is in Organization** | • From: Person<br>• To: Organization<br><br>Indicates in which organization a person works | |
| **Has Responsibility** | • From: Organization<br>• To: a design item<br><br>Indicates which organization owns or created a design item | |

# 4 Product Build




The as-built baseline represents the data unique to completed build and test activity, as well as baseline engineering data applicable to individual units, and interim manufacturing configurations derived from engineering.

# 5 As-Built additions to Product Design

The diagrams for Product Design are as follows.

First is the focus on product:

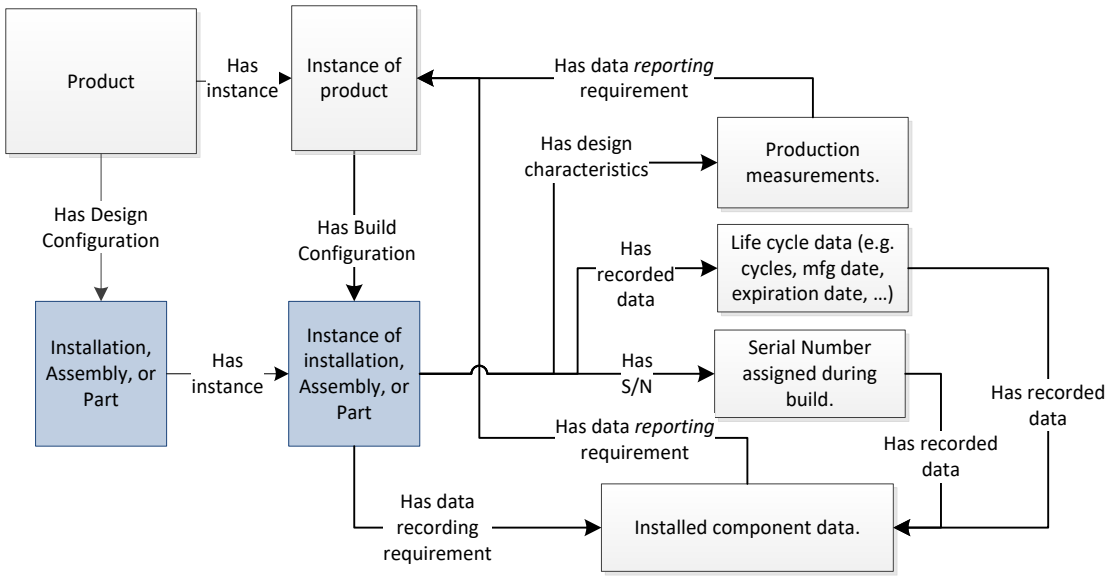



**Figure 5 – As-built data recording and reporting**

| Name | Description | Notes |
|---|---|---|
| **Product** | Indicates the design configuration, which includes design applicable to all units produced to the design. | Includes optional or alternate configurations driven by specifications. |
| **Instance of Product** | Indicates the design configuration applicable to an individual unit. | Selected options provide resolved configuration for an individual unit. |
| **Installation, Assembly, Part** | Indicates a design item (Represents deisgn configiurations of a physical installation, assembly, or part) | These are nodes in the product structure below the end item product. |
| **Instance of Installation, Assembly, Part** | Indicates a design item applicable to a particular unit (serial number, tail number, etc.) | Physical item which conforms to design item. Sum of completed work records and inspection records constitutes conformity of physical item to design. |
| **Breakdown** | Indicates an alternative breakdown of the product structure such as an interim manufacturing configuration. | Alternative views of the structure are common. Examples include: kitting, MBOM structures, etc. |
| **Completed Record** | A record of completion of work instructions defined in the as-planned baseline. | |

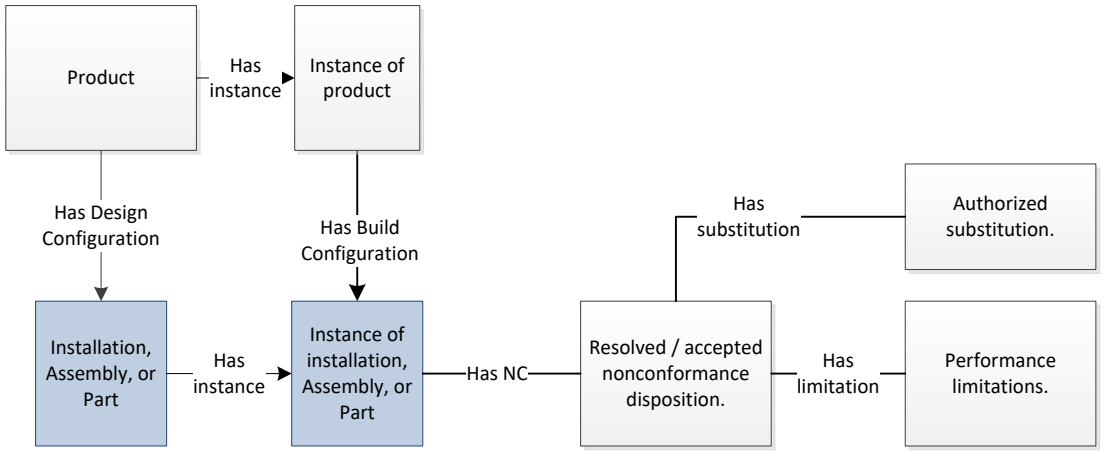



**Figure 6 – As-built non-conformance record**

This diagram depicts alternative breakdowns of the product, which may be full or partial.

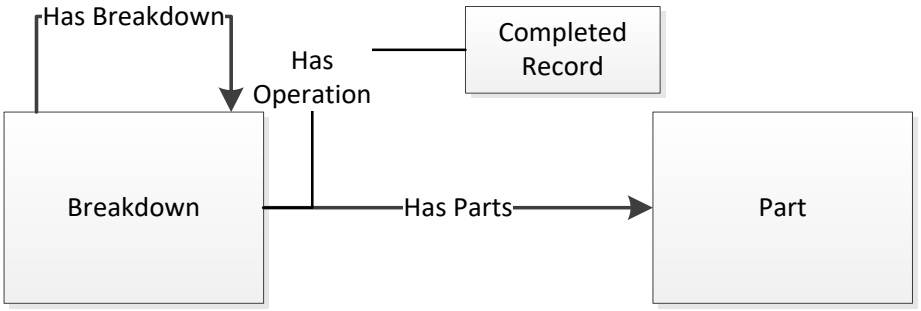



**Figure 6 - Breakdowns**

### 5.1.1 Items

| Name | Description | Notes |
|---|---|---|
| **Part** | Indicates a design item (not a physical part) | A physical part and its connections are detailed in Part 230 |
| **Breakdown** | Indicates an alternative breakdown of the product structure such as an interim manufacturing configuration. | Alternative views of the structure are common. Examples include: kitting, MBOM structures, etc. |

| Name | Description | Notes |
|---|---|---|
| **Completed Record** | A record of completion of work instructions defined in the as-planned baseline. | |

## 5.2 Connections

| Name | Description | Notes |
|---|---|---|
| **Has Specification** | • From: System or Part<br>• To: Document<br><br>Associates the system or part with its specification | |
| **Has Compliance Results** | • From: System or Part<br>• To: Document<br><br>Associates the system or part with its compliance results to its specifications | |
| **Has Breakdown** | • From: Breakdown<br>• To: Breakdown<br><br>Facilitates multiple layers of structure in the breakdown. | |
| **Has System** | • From: System<br>• To: System<br><br>Facilitates multiple layers of structure in the system. A system is a formally tested part of the product. | |
| **Has Contract** | • From: Product or Part<br>• To: Contract<br><br>Indicates governing documentation and funding source for product (project) and components (parts). | |

# 6 Change Management

The diagrams for change management are as follows.

First, the focus on changes to items:

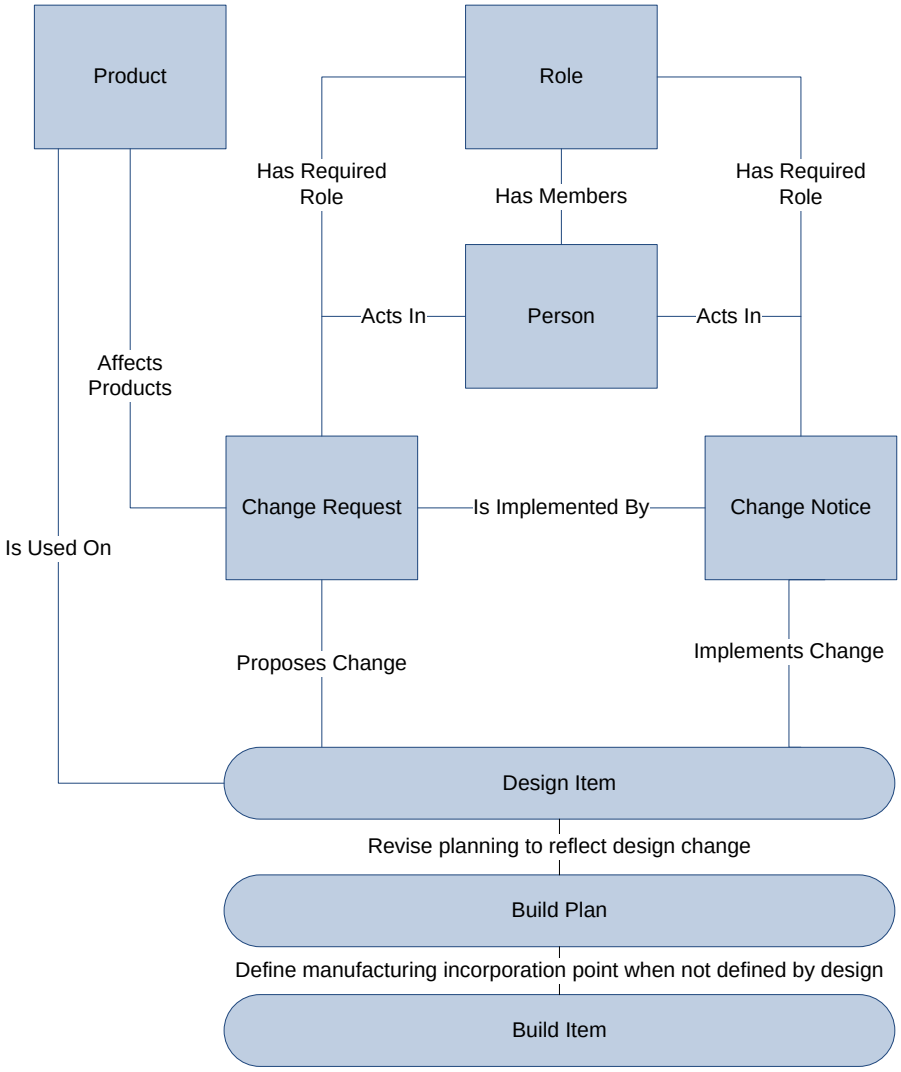



**Figure 7 - Change Management: Items**

Second, the focus is on changes to connections. In this diagram, the change results in a new connection being made. Presumably, the former connection would have a “stop effectivity” applied so that it re-mains in the historical data, but is no longer approved. Another variation, not shown, would be to simply

update the connection in place; this approach means it is very difficult to view the data at an arbitrary point in the past. However, the change records capture what happened.

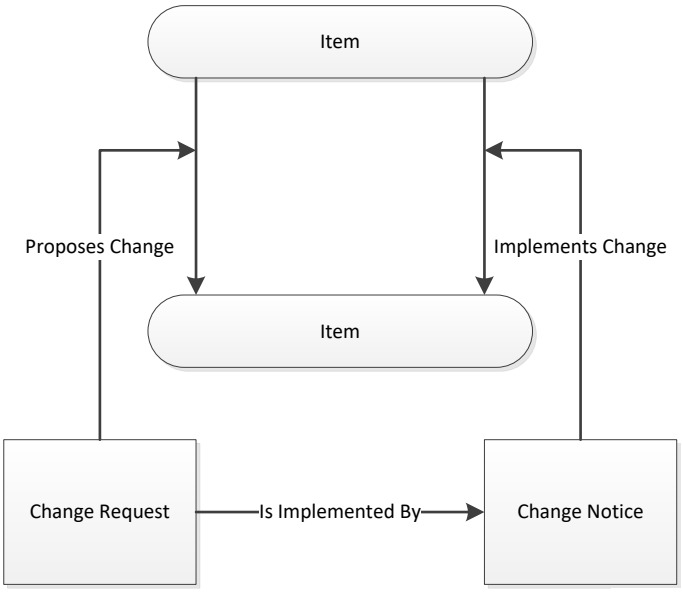



**Figure 8 - Change Management: Connections**

## 6.1 Items

| Name | Description | Notes |
|---|---|---|
| **Change Request** | This item that captures a proposed change. | |
| **Change Notice** | This item captures the data for the implementation of an approved change | |
| **Role** | The role of a person participating in a change | |

## 6.2 Connections

| Name | Description | Notes |
|---|---|---|
| **Proposes Change** | • From: Change Request<br>• To: a design item<br><br>Indicates which design item(s) are the target of the proposed change | |

| Name | Description | Notes |
|---|---|---|
| **Implements Change** | • From: Change Notice<br>• To: a design item<br><br>Indicates which design item is the result of incorporating an approved change. | This is often called a “change order” in many PLM systems. |
| **Is Implemented By** | • From: Change Request<br>• To: Change Notice<br><br>Indicates which Change Notice(s) are generated to implement the approved proposed change. | |
| **Has Required Role** | • From: Role<br>• To: Change Request & Notice<br><br>Indicates the required roles needed to participate in a change. | Different part families, cost thresholds, ownership, product control boards, etc. will drive differences in the required participants in a change. |
| **Has Members** | • From: Role<br>• To: Person<br><br>Indicates to which roles a person may be assigned | |
| **Acts In** | • From: Person<br>• To: “has required role”<br><br>Indicates the assigned role(s) of a person participating in a change. | |
| **Affects Products** | • From: Change Request<br>• To: Product<br><br>Indicates which products are impacted by a proposed change. | |

# 7 Documents

The diagram for documents is as follows.

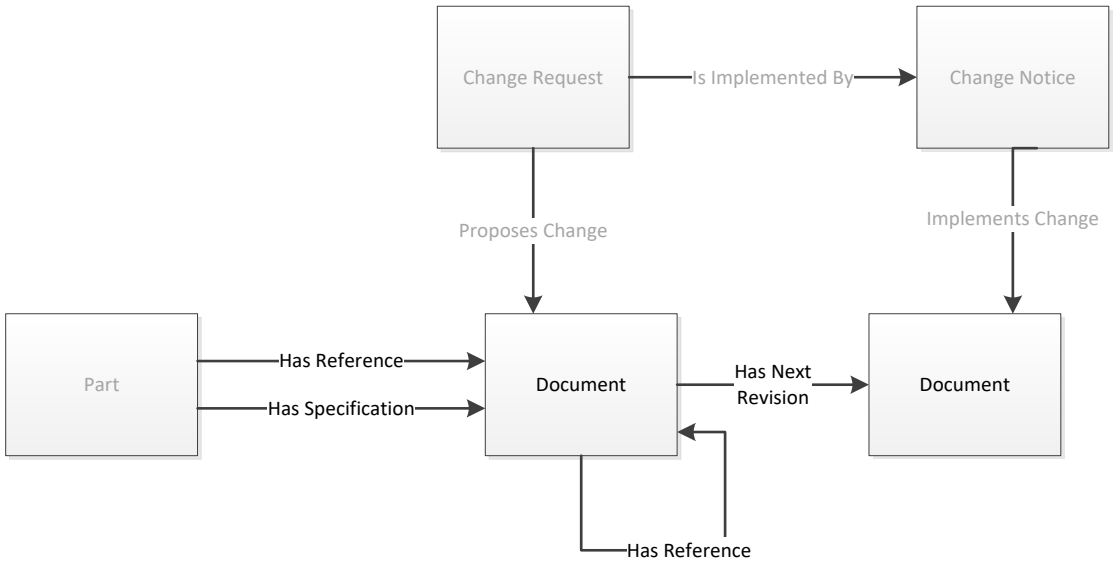



**Figure 9 - Documents**

## 7.1 Items

| Name | Description | Notes |
|---|---|---|
| **Document** | A document that captures reusable or unique design content. This item generally captures the attribute data stored in the PLM system for the actual files that are the real document. | Generally created using office formats, the published form is PDF. This object is generally a proxy for the actual file, which is associated by an attachment object and connection. |

## 7.2 Connections

| Name | Description | Notes |
|---|---|---|
| **Has Reference** | • From: Part<br>• To: Document<br><br>Associates a document to a part | This may capture compliance results or other data requiring retention. |
| **Has Specification** | • From: Part<br>• To: Document<br><br>Documents the requirements for a part | |

| Name | Description | Notes |
|---|---|---|
| **Has Next Revision** | • From: Document (or Part)<br>• To: Document (or Part)<br><br>Indicates that a document has been superseded by a newer revision | |

# 8 Access Security

This diagram shows the data needed to indicate whether an item, often an attachment item, has restrictions and how to calculate access restrictions.

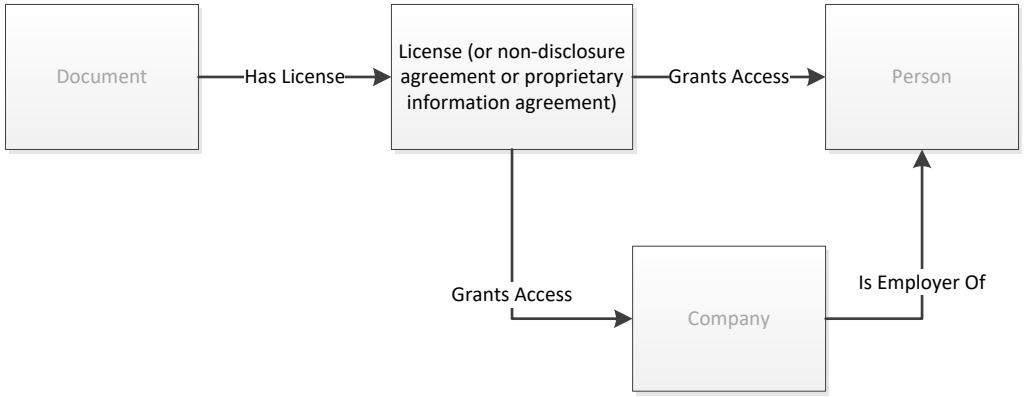



**Figure 10 - Access Security**

## 8.1 Items

| Name | Description | Notes |
|---|---|---|
| **License** | The item capturing the restrictions to be applied to design or build items | |

## 8.2 Connections

| Name | Description | Notes |
|---|---|---|
| **Has License** | • From: a design item<br>• To: License<br><br>Associates access restrictions to a design or build item | |

| Name | Description | Notes |
|---|---|---|
| **Grants Access** | • From: License<br>• To: Person or Company<br><br>Identifies the which persons or persons in companies have access | |

# 9 Options

## 9.1 Introduction

Options are elements of a product structure that are selected by the customer. Options have the following business characteristics:

- Options are associated to a product, therefore, each product can have different options.
- A product structure with options is sometimes called a “150% BOM” because it has more parts than actually needed to build the product due to available optional configurations.
- The final build configuration conforms to the design configuration which is resolved to that configuration by the options which are selected by the customer.

Options have the following technical characteristics:

- A product structure (or “BOM”) can be filtered or “configured” to reflect choices of options.
- Once options and any applicable effectivity are chosen, then the resulting BOM is a buildable and valid configuration.
- The options selected may have secondary effects. For example, the option “heated seats” may require a higher amperage battery.
- Options are essentially Boolean conditions applied to appropriate part instances.
- Since applicable options derive from a product, the product must be chosen prior to choosing options. The product provides the context for available options.

## 9.2 Definitions

These observations lead to the following definitions of:

An option is a product feature offered by the manufacturer which is chosen by the customer.

- In the PLM system, the option is a Boolean attribute which set to TRUE when selected by the customer.
- If an option excludes other options, then option rules must disambiguate (see next definition).

An option rule is a Boolean condition used to determine whether to include a particular part in a product structure.

A Boolean condition is a logic test consisting of:

- With AND/OR logical conjunctions

- With NOT negation operator
- With ONE OF operators
- With nested or ordered conditions

An Option Context is the Product or Products to which the options or option packages apply. In the PLM system, this is a “has option” connection between a Product and its parts (see diagram below).

## 9.3 Managing Change

All aspects of options are subject to change control:

- Products
- Options
- Option Rules

The applicability of a rule to a part instance is also subject to change control.

Note: being subject to change control implies the following:

- Relationships to Change Request & Change Notice
- All of the above are revisable
- All of the above have a status

## 9.4 Diagram

The diagram for options is below:

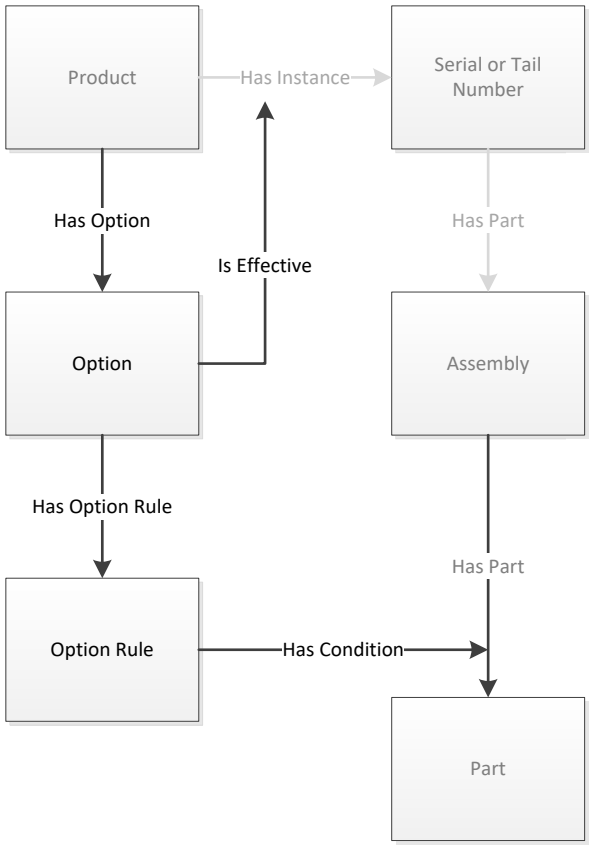



**Figure 11 - Options**

## 9.5 Items

| Name | Description | Notes |
|---|---|---|
| **Option** | The item capturing the customer selectable option name. | |
| **Option Rule** | The item containing the Boolean condition that must be applied. | |
| **Serial or Tail Number** | The identifier that represents an instance of a product. | |

## 9.6 Connections

| Name | Description | Notes |
|---|---|---|
| **Has Option** | • From: Product<br>• To: Option<br><br>Associates a product to its customer selectable options, both direct and indirect. | |
| **Has Option Rule** | • From: Option<br>• To: Option Rule<br><br>Associates the Boolean expression to the option. | |
| **Has Condition** | • From: Option Rule<br>• To: “has part” or “part (assembly)”<br><br>Connects the Boolean expression to the part instance (i.e., the “has part” connection) that must be evaluated for inclusion. Alternatively, the choice can be against which assembly to include. | |
| **Has Instance** | • From: Product<br>• To: Serial or Tail Number<br><br>Connects a Product to an actual build of the product. | |
| **Is Effective** | • From: Option<br>• To: “has instance”<br>Connects the options chosen by the customer to the product and serial/tail number. | |

# 10 Effectivity

When a change is made to a product structure, the change may come with explicit directions on when to incorporate the change into the product. The directions may be specified as date, lot, or unit. The specification may be a range, being a start and stop pair:

- From this date to that date
- From this unit to that unit

- From this lot to that lot

The specification may be a list:

- For these units…
- For these lots…
- Probably not used for dates

ERP systems and personnel often use the terms “cut-in” and “cut-off” (or “cut-out”) to refer to the effective points. PLM and ERP systems support multiple effectivities:

- An engineering effectivity may simply be the “best so far” or “latest and greatest”
- Different plants may cut-in the change on different dates (plants will not differ if specification is unit or lot)

When no effectivity is specified for a change, then the cut in will be determined later or it may be defined on a higher level item.

Effectivity has the following technical characteristics:

- To resolve a product structure will require application of effectivity
- A PLM system may have a default configuration. For example, a designer may have a rule to show the “latest working”. Or a buyer may have a rule to view the “latest released”
- An unresolved product structure may show for a given location all parts ever used at that location
- A resolved product structure for the purposes of production or support shows the configuration applicable to a specific unit or series of units.

To resolve a product structure requires several inputs:

- It requires a context, which is the Product and/or Plant
- It requires a date, unit, or lot
- It requires selection of applicable options

Once resolved, then the result is a buildable and valid configuration. For some companies, the type design may be the “150% BOM” with the option rules and demonstration that combinations of options result in a valid configuration.

Finally, until the product build or support activity is complete, all aspects of effectivity are subject to change control, including:

- Products
- Plants
- The Effectivity specification itself (date, serial/tail number, lot, list of serial/tail numbers, etc.)

The diagram for effectivity is similar to options, both being used to filter a product structure. Options filters per customer order; effectivity filters when (by date) or what (by product serial number or tail number).

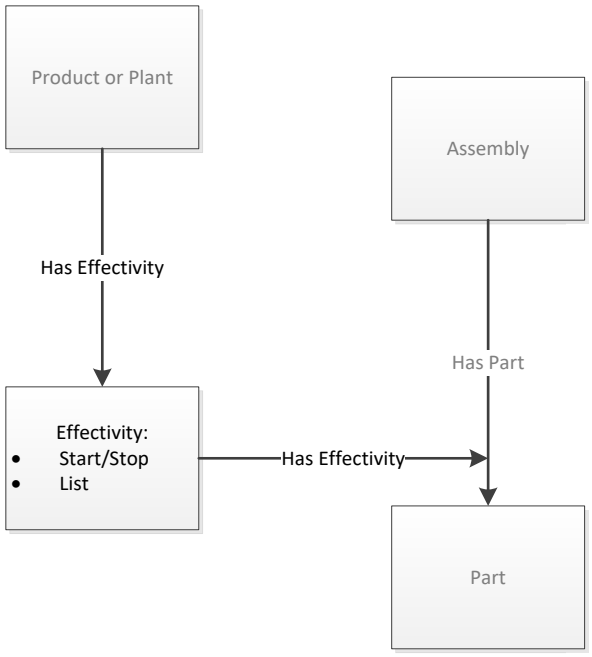



**Figure 12 - Effectivity**