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Enterprise-Control System Integration – Part 4: Objects and Attributes for Manufacturing Operations Management Integration

Approved 24 May 2018

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Enterprise-Control System Integration – Part 4: Objects and Attributes for Manufacturing Operations Management Integration

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This standard was approved by the ISA Standards and Practices Board on 16 April 2018.

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FOREWORD

This is Part 4 of a series of standards that defines the interfaces between Level 3 manufacturing operations management activities.

The scope of this Part 4 standard is limited to defining the details of the interface content within manufacturing operations management. The scope of this Part 4 standard is limited to the definition of object models and attributes for the information defined in ISA-95 Part 3. The goal is to reduce the effort, cost, and errors associated with implementing these interfaces.

The standard may be used to reduce the effort associated with implementing new product offerings. The goal is to have enterprise systems and control systems that interoperate and easily integrate.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2. Therefore, the first three clauses present the scope of the standard, normative references, and definitions, in that order.

Clause 4 is informative. It describes the general information about the object information models for manufacturing operations management. It defines the general information model characteristics.

Clause 5 is normative. It defines the object information model, relationships, and attributes for resource relationship network model.

Clause 6 is normative. It defines the object information model, relationships, and attributes for work definition information and workflow specification information.

Clause 7 is normative. It defines the object information model, relationships, and attributes for work schedule information.

Clause 8 is normative. It defines the object information model, relationships, and attributes for work performance information.

Clause 9 is normative. It defines the object information model, relationships, and attributes for work capability information.

Clause 10 is normative. It defines the object information model, relationships, and attributes for work master capability information.

Clause 11 is normative. It defines the references for Work KPI information.

Clause 12 is normative. It defines the object information model, relationships, and attributes for work alert information.

Clause 13 is normative. It defines the object information model, relationships, and attributes for work calendar information.

Clause 14 is informative. It defines the how to exchange documents for the scheduling, execution and reporting of work.

Clause 15 is normative. It defines the object information model, relationships, and attributes for work record information.

Clause 16 is informative. It defines the inter-relationships between the object models and lists the objects defined in the standard as an aid to documenting conformance and compliance.

Clause 17 is normative. It defines completeness, conformance and compliance criteria associated with the objects and attributes.

Annex A is informative. It contains questions and answers on the use and reason for elements in the standard.

Annex B is informative. It provides details on related standards.

Annex C is informative. It illustrates how to represent a workflow specification in BPMN.

Annex D is informative. It illustrates how to represent a workflow specification in flowchart notation.

Annex E is informative. It illustrates examples of work calendars.

Annex F is informative. It illustrates an example of a work record implementation.

INTRODUCTION

This ISA-95 Part 4 standard further defines the object models and attributes involved in data exchange between activities of manufacturing operations management defined in the Part 3 standard. The models and terminology defined in ISA-95 Part 3 and this Part 4:

- emphasize good manufacturing operations management integration practices during the entire life cycle of the systems;
- can be used to improve existing integration capability of manufacturing operations management systems; and
- can be applied regardless of the degree of automation.

Specifically, ISA-95 Part 3 and Part 4 provide a standard terminology and a consistent set of concepts and models for integrating manufacturing operations management systems that will improve communications between all parties involved. Benefits produced will reduce a user's time to reach full production levels for new products because they:

- enable vendors to supply appropriate tools for implementing integration of manufacturing operations management systems;
- enable users to better identify their needs;
- reduce the cost of automating manufacturing processes;
- optimize supply chains; and
- reduce life-cycle engineering efforts.

ISA-95 Part 3 and Part 4 may be used to reduce the effort associated with implementing new product offerings. The goal is to have manufacturing operations management systems that interoperate and easily integrate.

It is not the intent of the standards to:

- suggest that there is only one way of implementing integration of manufacturing operations management systems;
- force users to abandon their current way of handling integration; or
- restrict development in the area of integration of manufacturing operations management systems.

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1 Scope

This ISA-95 Part 4 standard defines object models and attributes exchanged between Level 3 manufacturing operations management activities defined in ISA-95 Part 3.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI/ISA-95.00.01-2010, *Enterprise-control system integration – Part 1: Models and terminology* (referred to hereafter in the standard as ISA-95 Part 1 or simply “Part 1”)

ANSI/ISA-95.00.02-2010, *Enterprise-control system integration – Part 2: Objects and attributes for enterprise-control system integration* (referred to hereafter in the standard as ISA-95 Part 2 or simply “Part 2”)

ANSI/ISA-95.00.03, *Enterprise-control system integration – Part 3: Activity models of manufacturing operations management* (referred to hereafter in the standard as ISA-95 Part 3 or simply “Part 3”)

IEC 61512-1, *Batch control – Part 1: Models and terminology*

IEC 61512-4:2009, *Batch control – Part 4: Batch production records*

ISO/IEC 19501, *Information technology – Open Distributed Processing – Unified Modeling Language (UML) Version 1.4.2*

ISO/IEC 19505-1, *Information technology – Object Management Group Unified Modeling Language (OMG UML) – Part 1: Infrastructure*

ISO/IEC 19505-2, *Information technology – Object Management Group Unified Modeling Language (OMG UML) – Part 2: Superstructure*

ISO 8601, *Data elements and interchange formats – Information interchange – Representation of dates and times*

ISO 22400-1, *Automation systems and integration – Key performance indicators (KPIs) for manufacturing operations management – Part 1: Overview, concepts and terminology*

ISO 22400-2, *Automation systems and integration – Key performance indicators (KPIs) for manufacturing operations management – Part 2: Definitions and descriptions*

IEC 62682, *Management of Alarm Systems for the Process Industries*

3 Terms, definitions, abbreviations, and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISA-95 Part 1 (see Clause 2 above) apply, as do the following:

3.1.1

batch production record (BPR)

subset of the execution and business information that is retained based upon business requirements identified by the batch production record specification

NOTE 1 This note applies to the French language only.

[SOURCE: IEC 61512-4:2009, 3.2]

3.1.2

job list

collection of *job orders* for one or more work centers and/or resources for a specific time frame

3.1.3

job order

unit of scheduled work that is dispatched for execution

[SOURCE: ISA-95 Part 3]

3.1.4

job response

information on the result of execution of a *job order*

3.1.5

job response list

collection of *job responses* for one or more work centers and/or resources for a specific time frame

3.1.6

resource relationship network

one or more expressions of a relationship between two or more resources

3.1.7

work alert

notification of a Level 3 event that does not require acknowledgement

3.1.8

work calendar

collection of *work calendar* entries

3.1.9

work calendar entry

information about a specific time period

3.1.10

work capability

collection of information about the resources for work for selected future and past times

3.1.11

work definition

collection of information about resources and workflow specification associated with *job orders*

3.1.12

work directive

type of *work definition* derived from a *work master* and used to perform a specific *job order*

3.1.13

work KPI

key performance indicator related to Level 3 activities

3.1.14

work master

type of *work definition* that is a template for work to be performed for a *job order*

3.1.15

work master capability

collection of information about the resources for selected future and past times for a specific *work master*

3.1.16

work performance

collection of *work responses*

3.1.17

work record

subset of the execution and business information that is retained based upon business requirements

3.1.18

work request

collection of *job orders*

3.1.19

work response

collection of *job responses*

3.1.20

work schedule

detailed schedule of MOM activities as a collection of *work requests*

3.1.21

workflow specification

information representing work as a pattern of activities used to orchestrate the execution of procedures

EXAMPLE A repeatable sequence of procedures, enabled by an organization of resources with defined roles corresponding to flows of mass, energy or information.

3.2 Abbreviations

BPMN: Business Process Model and Notation

BPR: Batch production record

ERP: Enterprise resource planning

ID: Identifier

KPI: Key performance indicator

MES: Manufacturing execution system

MOM: Manufacturing operations management

SOP: Standard operating procedures

UML: Unified Modeling Language

UTC: Coordinated Universal Time

3.3 Conventions

3.3.1 General

Italics are used for the use cases of names of objects used in exchanged data, beyond the use defined in ISO/IEC Directives Part 2, to emphasize the ISA-95-specific meaning of terminology.

The information object models are depicted using a simplified application of the Unified Modeling Language (UML) notational methodology, as defined in ISO/IEC 19501.

3.3.2 UML notation in information object models

ISA-95 Part 2, Clause 3 defines the UML notation in information object models in this part.

3.3.3 Object color convention for object relationship between UML models

ISA-95 Part 2, Clause 3 defines the object color convention for object relationship between UML models in this part.

3.3.4 Relationship types

ISA-95 Part 2, Clause 3 defines the conventions used for relationship types in relationship table and role table for each object in an information model in this part.

3.3.5 Relationship table

ISA-95 Part 2, Clause 3 defines the conventions used in relationship tables in this part.

3.3.6 Relationship role table

ISA-95 Part 2, Clause 3 defines the conventions used in relationship role tables in this part.

3.3.7 Object attribute tables

ISA-95 Part 2, Clause 3 defines the conventions used in object attribute tables in this part.

3.3.8 Relationships between information models and resource models

ISA-95 Part 2, Clause 3 defines the convention for relationships between information models and resource models in this part.

4 Information exchange between manufacturing operations activities

4.1 Manufacturing operations management information models

4.1.1 General

The information models define structures for information exchange that can be used to define, manage, and execute work within Level 3 MOM. The work information models are built from the structures of those manufacturing operations information models defined in ISA-95 Part 2 but are defined for information exchange between Level 3 MOM activities.

4.1.2 Information models

ISA-95 Part 2, Clause 4 defines the concept of the generic MOM information model in this part.

4.1.3 Relationship of exchange information models to operations management activity categories

ISA-95 Part 2, Clause 4 defines the relationship of exchange information models to operations management activity categories in this part.

4.1.4 Cross model relationships for MOM activity context in exchanges

The Part 2 operations information models and Part 4 work information models are aligned through defined cross-model relationships to provide the context of MOM activity or workflow for schedules/requirements, definitions, and performance/response exchanges. These cross-model relationships provide a manufacturing integration framework for interactive manufacturing operations in the plant and between the plant and enterprise functions.

ISA-95 Part 2, Clause 4 shows the supported relationships between MOM objects that provide data references for schedule/request/requirement; job order/definitions; and responses/actuals.

4.1.5 Abstract UML model information

ISA-95 Part 2, Clause 4 defines the concept the abstract UML model applied the information models this part.

4.1.6 Attributes of an object in an information model

ISA-95 Part 2, Clause 4 defines the use of attributes of an object in an information model in this part in terms of

- a) minimum object attribute sets (Part 2 Subclause 4.5.2),
- b) data types of object attributes (Part 2 Subclause 4.5.3),
- c) object attribute extensibility (Part 2 Subclause 4.5.4), and
- d) common object attributes (Part 2 Subclause 4.5.5):
 - 1) object identification,
 - 2) value type and use,
 - 3) measurement uncertainty sub-attributes in value and quantity attributes, and
 - 4) unit of measure.

4.2 Information exchange network between MOM activities

A set of information models are used to represent the information exchanged between activities defined in ISA-95 Part 3. This is illustrated in Figure 1 with each information model represented as black rounded rectangles. This part defines models of information which can be exchanged between Level 3 activities (represented as ellipses in the figure) within an operational category or across operational categories. ISA-95 Part 2 defines models of information that may be exchanged between Level 4 activities and Level 3 activities and are represented as beige rounded rectangles. Other information (represented as hashed elements) shown in Figure 1 is defined in other standards, such as ISA-88 and IEC 62541.

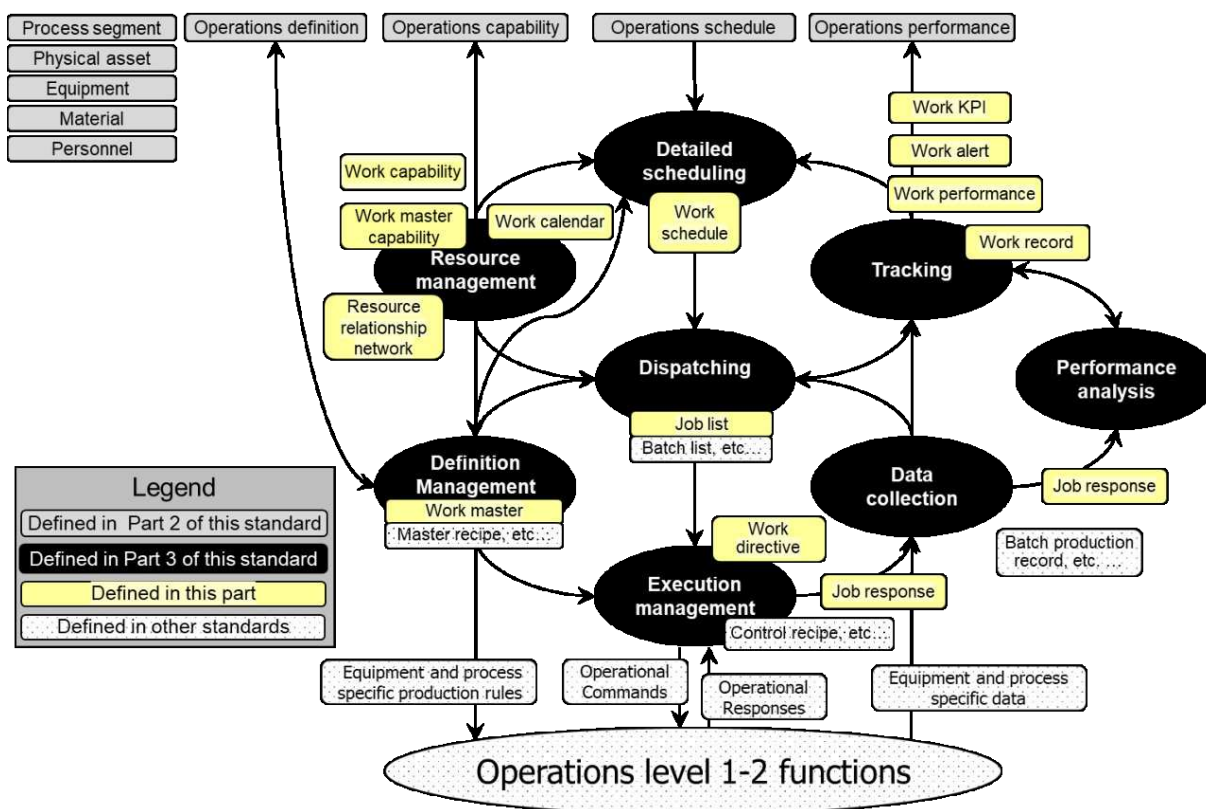


Figure 1 – Information exchange between manufacturing operations management activities

NOTE ISA-88 defines object models that relate to the lower elements of the Level 3 activities and defines the information used to create and manage master recipes, control recipes, batch lists, and batch production records. Equivalent structures, or ISA-88 structures, could be used for other types of production. This standard does not redefine these objects.

4.2.1 Process segment, operations segment, and work master information models

ISA-95 Part 2 operations information models define the business view of manufacturing as seen by Level 4 business operations planning and logistics functions. This business view of manufacturing is defined using the *process segment* and *operations segment* objects. The information models of this part define the work view of manufacturing as seen by Level 3 MOM scheduling and execution functions. This work view of the manufacturing processes is defined using in the *work master* object.

A *work master* defines the resources and workflow specification for a *job order* that is scheduled, displayed, executed, and tracked by Level 3 MOM activities.

NOTE Part 2 information models are used to exchange information from the *process segment* and *operations segment* (business) view for Level 4 planning. Models such as *operations definition* and *operations schedule* support the allocation of resources and scheduling activities to the plant. Information models in this part are used to exchange information for Level 3 execution. Models such as *work master* reference the *operations definition* exchanged with Level 4, but the *work master* has the details needed for actual execution of Level 3 activities. See Annex B for additional discussion of Part 2, and IEC 61512 model relationships.

4.2.2 Common resource definitions

The information models in this part of the standard use the personnel, equipment, physical asset, and material information defined in ISA-95 Part 2. When used with Level 3 work objects, the personnel, equipment, physical asset, and material information may include information required for Level 3 activities in addition to the information required to be shared with Level 4 activities.

EXAMPLE 1 The personnel information required for Level 3 activities can include detailed experience and qualification levels that are not shared with a Level 4 personnel or training management system.

EXAMPLE 2 The material information maintained for Level 3 activities can include subplot information which is not shared with Level 4 material management systems.

EXAMPLE 3 Delivery, usage and emission of energy units can be handled as material information.

4.2.3 Work information models

The following information models are defined in this standard:

- a) Resource relationship network: *resource relationship network* is created by tasks in resource management and definition management activities.
- b) Work definition:
 - 1) Work master: *work master* is created by an engineering activity defined in this standard and to be managed by a task in definition management activities.
 - 2) Work directive: *work directive* is created by a task in execution management activities.
- c) Work schedule: *work schedule* is created by a task in detailed scheduling activities.
- d) Job list: *job list* is created by a task in dispatching activities.

NOTE 1 In this standard, the term, job, can sometimes be used instead of *job order* when referring to an entry in a *job list*.

- e) Work performance: *work performance* is created by a task in tracking activities.
- f) Work capability: *work capability* is created by a task in resource management activities.
- g) Work master capability: *work master capability* is created by a task in resource management activities.
- h) Work alert: *work alert* may be created by any activity in the activity model.
- i) Work calendar: *work calendar* may be created by a task in resource management activities.

NOTE 2 *Work calendars* can be created by a task in a Level 4 activity.

- j) Work record: *work record* is created by a task in tracking activities.

5 Resource relationship network information

5.1 Resource relationship network model

Resource relationship networks shall be used to describe relationships between two or more resources in order to represent information that may be required for detailed scheduling activities, dispatching activities, execution activities, or other Level 3 activities.

Each *resource relationship network* is a collection of *resource network connections*, as shown in Figure 2 – Resource relationship network model.

Table 1 lists the relationships of the objects in the *resource relationship network* model. Annex A.3 provides examples for applying resource relationship network.

Each *resource network connection* shall be represented as a directed connection between a *to resource reference* and a *from resource reference*.

NOTE 1 Relationships are represented as directed multi-graphs in graph theory. Each relationship represents an “edge” with the resource references represented as vertices.

NOTE 2 The properties of the resource relationship elements are used to represent constraints in the network, such as constraints in flow, direction, set or ordering.

EXAMPLE 1 A “route” *resource network connection* between *equipment* can include properties that include the material transport time between the *equipment* and the material transfer rate between the *equipment*.

EXAMPLE 2 An “approved for use” *resource network connection* between *equipment* and *material definitions* can define which specific *equipment* has been approved for use with specific *materials*. A property of the *resource network connection* can be the date at which the approval for use is expired or revoked.

EXAMPLE 3 A “material substitution” *resource network connection* can define a primary *material* and the list of possible alternate *materials*.

Each *resource network connection* is defined by a *resource network connection type*. The *resource network connection type* may include *resource network connection type properties*, which define the allowable *resource network connection properties*.

NOTE 3 The *resource relationship network* model is conceptually similar to the MIMOSA CCOM network model. See bibliography.

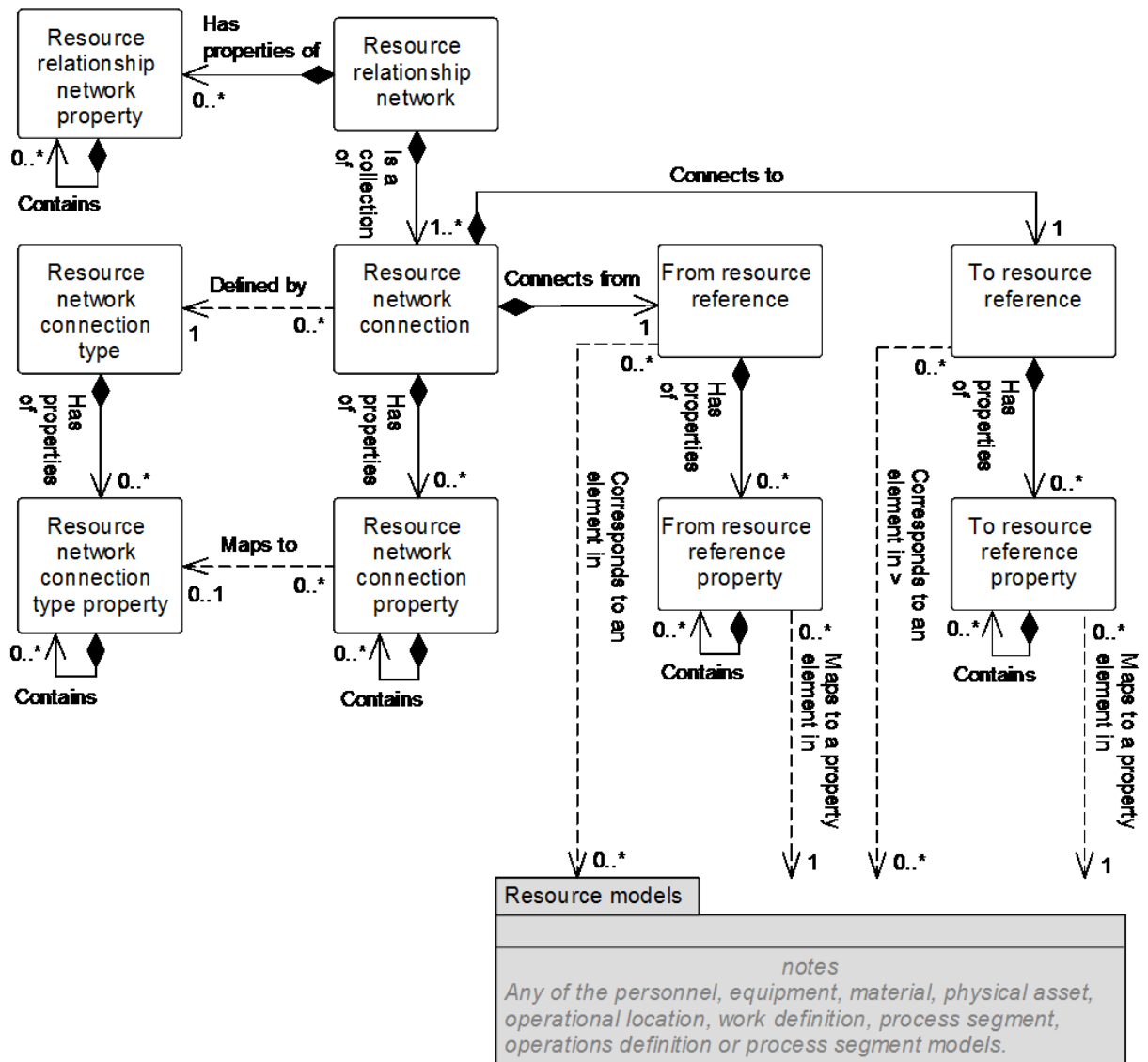


Figure 2 – Resource relationship network model

NOTE 4 The object color convention used in the ISA-95 Part 2 and Part 4 UML diagrams for information models is as shown in Clause 3.3.3.

Table 1 – Resource relationship network model relationships

From	To	Type	Relationship Name
Resource relationship network	Resource relationship network property	Composition whole	Has properties of
Resource relationship network	Resource network connection	Composition whole	Is a collection of
Resource relationship network property	Resource relationship network property	Composition hierarchy	Contains
Resource network connection	Resource network connection type	Dependency	Defined by
Resource network connection	From resource reference	Composition whole	Connects from
Resource network connection	To resource reference	Composition whole	Connects to
Resource network connection	Resource network connection property	Composition whole	Has properties of
Resource network connection type	Resource network connection type property	Composition whole	Has properties of
From resource reference	From resource reference property	Composition whole	Has properties of
To resource reference	To resource reference property	Composition whole	Has properties of
Resource network connection property	Resource network connection property	Composition hierarchy	Contains
Resource network connection type property	Resource network connection type property	Composition hierarchy	Contains
From resource reference property	From resource reference property	Composition hierarchy	Contains
To resource reference property	To resource reference property	Composition hierarchy	Contains
From resource reference	[Resource] class	Association (A)	Corresponds to
From resource reference	[Resource]	Association (C)	Corresponds to
From resource reference property	[Resource] class property	Dependency (B)	Maps to
From resource reference property	[Resource] property	Dependency (D)	Maps to
To resource reference	[Resource] class	Association (A)	Corresponds to
To resource reference	[Resource]	Association (C)	Corresponds to
To resource reference property	[Resource] class property	Dependency (B)	Maps to
To resource reference property	[Resource] property	Dependency (D)	Maps to

In Table 1, [Resource] shall apply to the similar object in the following models: *personnel, equipment, material, physical asset, operational location, work definition, process segment, operations definition or process segment*.

In Table 1, [Resource] class shall apply to objects that identify classes of resources or similar resource grouping objects (e.g. *material definition*).

5.2 Resource relationship network

A *resource relationship network* shall be a composition of one or more *resource network connections*.

Table 2 defines the relationships roles for the *resource relationship network*.

Table 3 defines the attributes for the *resource relationship network*.

Table 2 – Resource relationship network relationships roles

Related Object	Role	Multiplicity	Relationship Name	Description
Resource network connection	Resource network connection	1..*	Is a collection of	The <i>resource network connections</i> related to this <i>resource relationship network</i> as a whole.
Resource relationship network property	Resource relationship network property	0..*	Has properties of	The <i>resource relationship network property(s)</i> of this <i>resource relationship network</i> .

Table 3 – Resource relationship network attributes

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification of a <i>resource relationship network</i> . Required attribute.	BN5FP	B5EN	B5RS	BFFTR
Description	A description of the <i>resource relationship network</i> .	Building 5 flow path	Building 5 electrical network	Building 5 receive signoff	Building 5 fork truck route
Relationship type	Defines the type of the relationship. Defined types are - physical: the elements of the relationship are physically connected or in the same area; and - logical: the elements of the relationship are not necessarily physically connected or in the same area.	Physical	Physical	Logical	Logical
Relationship form	Defines the form of the relationships. Defined types are - permanent: the relationship is not intended to be split or changed during operations processes; and - transient: the relationship can be split or changed during operations processes.	Permanent	Permanent	Permanent	Transient

5.3 Resource relationship network property

A property of a *resource relationship network* shall be defined as a *resource relationship network property*.

A *resource relationship network property* may contain nested *resource relationship network property(s)*.

Table 4 defines the relationship roles for *resource relationship network property* objects.

Table 5 defines the attributes for *resource relationship network property* objects.

Table 4 – Resource relationship network property relationship roles

Related Object	Role	Multiplicity	Relationship Name	Description
Resource relationship network	NA	1	Has properties of	The <i>resource relationship network</i> to which this <i>resource relationship network property</i> belongs.
Resource relationship network property	Resource relationship network property child	0..*	Contains	The nested <i>resource relationship network properties</i> of this <i>resource relationship network property</i> .

Table 5 – Resource relationship network property attributes

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification of a <i>resource relationship network property</i> . Required attribute.	P&ID document reference	Resource relationship network type	Last updated date	Approver
Description	Additional information about the <i>resource relationship network property</i> .	Reference to the P&ID document for this resource relationship network.	The type of resource relationship network	The date of the last update to the resource relationship network.	The approver of the resource relationship network.
Value	The value, set of values, or range of the property.	http://...	Dependency model	3 March 2015	J. Smith.
Value unit of measure	The unit of measure of the associated property value.	N/A	N/A	N/A	N/A

5.4 Resource network connection

The directed relationship between two resources in a *resource relationship network* shall be defined as a *resource network connection*.

A *resource network connection* shall be composed of the following:

- a *from resource reference* relationship defining one *resource reference* (as the starting point of a directed connection or the tail of an arrow that graphically represents the relationship);
- a *to resource reference* relationship defining one *resource reference* (as the ending point of a directed connection or the head of an arrow that graphically represents the relationship);
- zero or more *resource network connection properties*;
- an associated *resource network connection type*.

Table 6 defines the relationship roles for the *resource network connection*.

Table 7 defines the attributes for the *resource network connection*.

Table 6 – Resource network connection relationship roles

Related Object	Role	Multiplicity	Relationship Name	Description
Resource relationship network	NA	1	Is a collection of	The <i>resource relationship network</i> defined in part by this <i>resource network connection</i> .
Resource network connection type	Resource network connection type	1	Defined by	The <i>resource network connection type</i> defining this <i>resource network connection</i> .
To resource reference	To resource reference	1	Connects to	The <i>to resource reference</i> to which this <i>resource network connection</i> connects.
From resource reference	From resource reference	1	Connects from	The <i>from resource reference</i> from which this <i>resource network connection</i> connects.
Resource network connection property	Resource network connection property	0..*	Has properties of	The <i>resource network connection property(s)</i> related to this <i>resource network connection</i> .

Table 7 – Resource network connection attributes

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification of a <i>resource network connection</i> . Required attribute.	7685	6383290	Hyuwq9	TT28623
Description	A description of a <i>resource network connection</i> .	Piping	Wiring	Next signer	Next stop

5.5 Resource network connection property

A property of a *resource network connection* shall be defined as a *resource network connection property*.

Resource network connection properties are used to contain property values that are associated with the specific connection.

A *resource network connection property* may contain nested *resource network connection property(s)*.

Table 8 defines the relationship roles of the *resource network connection property*.

Table 9 defines the attributes of *resource network connection property*.

Table 8 – Resource network connection property relationship roles

Related Object	Role	Multiplicity	Relationship Name	Description
Resource network connection	NA	1	Has properties of	The <i>resource network connection</i> defined in part by this <i>resource network connection property</i> .
Resource network connection type property	Resource network connection type property	0..1	Maps to	The <i>resource network connection type property(s)</i> of the <i>resource network connection type</i> defines this <i>resource network connection property(s)</i> when derived from a specific <i>resource network connection type</i> .

Related Object	Role	Multiplicity	Relationship Name	Description
Resource network connection property	Resource network connection property child	0..*	Contains	The nested <i>resource network connection</i> properties of this <i>resource network connection</i> property.

Table 9 – Resource network connection property attributes

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification of a <i>resource network connection</i> property. Required attribute.	Pipe type	Gauge	N/A	Inside
Description	Additional information about the <i>resource network connection</i> property.	Type of piping	Wire type	N/A	Location
Value	The value, set of values, or range of the property.	53	20	N/A	TRUE
Value unit of measure	The unit of measure of the associated property value.	Steel grade	AWG	N/A	Boolean

5.6 From resource reference

A “from” reference to a resource shall be defined as a *from resource reference*.

A *from resource reference* may be composed of zero or more *from resource reference* properties.

A property of a *from resource reference* shall be defined as a *from resource reference* property. A *from resource reference* property may contain nested *from resource reference* property(s).

Table 10 defines the relationship roles for the *from resource reference*.

Table 11 defines the attributes for the *from resource reference*.

Table 10 – From resource reference relationship roles

Related Object	Role	Multiplicity	Relationship Name	Description
Resource network connection	NA	1	Connects from	The <i>resource network connection</i> defined in part by this <i>from resource reference</i> .
From resource reference property	From resource reference property	0..*	Has properties of	The <i>from resource reference</i> property(s) defines in part this <i>from resource reference</i> property.
[Resource]** class	[Resource] class	0..*	Corresponds to	A cross-model association to element in the [resource] model as explained in Clause 3.3.8.
[Resource]**	[Resource]	0..*	Corresponds to	A cross-model association to element in the [resource] model as explained in Clause 3.3.8.

In Table 10, [Resource] shall apply to the similar object in the following models: *personnel*, *equipment*, *material*, *physical asset*, *operational location*, *work definition*, *process segment*, *operations definition* or *process segment*.

Table 11 – From resource reference attributes

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification of a <i>from resource reference</i> . Required attribute.	12345	12346	A123	S7728
Resource type	The type of the resource. Defined types are: • <i>personnel class</i> • <i>person</i> • <i>equipment class</i> • <i>equipment</i> • <i>physical asset class</i> • <i>physical asset</i> • <i>material class</i> • <i>material definition</i> • <i>material lot</i> • <i>material subplot</i> • <i>work master</i> • <i>process segment</i> • <i>operation definition</i> • <i>operational location</i> • <i>operations segment</i> • <i>test specification</i> • <i>test result</i>	Equipment	Physical asset	Personnel class	Equipment

5.7 From resource reference property

A property of a *from resource reference* shall be defined as a *from resource reference property*.

A *from resource reference* with one or more *from resource reference properties* shall define the subset of the *resource* that has the defined *resource property* values.

Table 12 defines the relationships for the *from resource reference property*.

Table 13 defines the attributes for the *from resource reference property*.

Table 12 – From resource reference property relationships roles

Related Object	Role	Multiplicity	Relationship Name	Description
From resource reference	NA	1	Has properties of	The <i>from resource reference</i> defined in part by this <i>from resource reference property</i> .
From resource reference property	From resource reference property child	0..*	Contains	The nested <i>from resource reference properties</i> of this <i>from resource reference property</i> .
[Resource]class property	[Resource] class property	0..*	Maps to	A cross-model dependency to element in the [Resource] model as explained in Clause 3.3.8.
[Resource] property	[Resource] property	0..*	Maps to	A cross-model dependency to element in the [Resource] model as explained in Clause 3.3.8.

In Table 12, [Resource] shall apply to the similar object in the following models: *personnel, equipment, material, physical asset, operational location, work definition, process segment, operations definition or process segment*.

Table 13 – From resource reference property attributes

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification of a <i>from resource reference property</i> . Required attribute.	A7872	CB101	HhJw78	Tye8
Value	A value of a property that is used to identify the subset of the resources that are referenced.	200	40	First	42
Value unit of measure	The unit of measure of the associated property value.	L/min	A	N/A	N/A

5.8 To resource reference

A “to” reference to a resource shall be defined as a *to resource reference*.

A *to resource reference* may be composed of zero or more *to resource reference property(s)*.

Table 14 defines the relationship roles for the *to resource reference*.

Table 15 defines the attributes for the *to resource reference*.

Table 14 – To resource reference relationships roles

Related Object	Role	Multiplicity	Relationship Name	Description
Resource network connection	NA	1	Connects to	The <i>resource network connection</i> defined in part by this <i>to resource reference</i> .
To resource reference property	To resource reference property	0..*	Has properties of	The <i>to resource reference property(s)</i> defines in part this <i>to resource reference property</i> .
[Resource] class	[Resource] class	0..*	Corresponds to	A cross-model association to element in the [resource] model as explained in Clause 3.3.8.
[Resource]	[Resource]	0..*	Corresponds to	A cross-model association to element in the [resource] model as explained in Clause 3.3.8.

In Table 14, [Resource] shall apply to the similar object in the following models: *personnel, equipment, material, physical asset, operational location, work definition, process segment, operations definition or process segment*.

Table 15 – To resource reference attributes

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification of a <i>to resource reference</i> . Required attribute.	12345	12346	A123	S7728
Resource ID	The ID of a resource.	B5Tank08	B5V480Box	Supervisor	Line3EndOfLine

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
Resource type	The type of the resource. Defined types are: • <i>personnel class</i> • <i>person</i> • <i>equipment class</i> • <i>equipment</i> • <i>physical asset class</i> • <i>physical asset</i> • <i>material class</i> • <i>material definition</i> • <i>material lot</i> • <i>material subplot</i> • <i>work master</i> • <i>process segment</i> • <i>operation definition</i> • <i>operational location</i> • <i>operations segment</i> • <i>test specification</i> • <i>test result</i>	Equipment	Physical asset	Personnel class	Equipment

5.9 To resource reference property

A property of a *to resource reference* shall be defined as a *to resource reference property*.

A *to resource reference* with one or more *to resource reference property*(s) shall define the subset of the *resource* that has the defined *resource property* values.

A *to resource reference property* may contain nested *to resource reference property*(s).

Table 16 defines the relationship roles for the *to resource reference property*.

Table 17 defines the attributes for the *to resource reference property*.

Table 16 – To resource reference property relationships roles

Related Object	Role	Multiplicity	Relationship Name	Description
To resource reference	NA	1	Has properties of	The <i>to resource reference</i> defined in part by this <i>to resource reference property</i> .
To resource reference property	To resource reference property child	0..*	Contains	The nested <i>from resource reference properties</i> of this <i>from resource reference property</i> .
[Resource] class property	[Resource] class property	0..*	Maps to	A cross-model dependency to element in the [Resource] model as explained in Clause 3.3.8.
[Resource] property	[Resource] property	0..*	Maps to	A cross-model dependency to element in the [Resource] model as explained in Clause 3.3.8.

In Table 16, [Resource] shall apply to the similar object in the following models:

Personnel, equipment, material, physical asset, operational location, work definition, process segment, operations definition or process segment.

Table 17 – To resource reference property attributes

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification of a <i>to resource reference property</i> . Required attribute.	A7872	CB101	Hhjjw78	N/A
Value	A value of a property that is used to identify the subset of the resources that are referenced.	200	40	First	N/A
Value unit of measure	The unit of measure of the associated property value.	L/min	A	N/A	Boolean

5.10 Resource network connection type

A definition of a type of a *resource network connection* shall be defined as a *resource network connection type*.

A *resource network connection type* may be composed of zero or more *resource network connection type properties*.

Table 18 defines the relationship roles of the *resource network connection type*.

Table 19 defines the attributes of the *resource network connection type*.

Table 18 – Resource network connection type relationship roles

Related Object	Role	Multiplicity	Relationship Name	Description
Resource network connection	NA	0..*	Defined by	The <i>resource network connection(s)</i> derived from this <i>resource network connection type</i> . Only applied, if navigation is required.
Resource network connection type property	Resource network connection type property	0..*	Has properties of	The <i>resource network connection type property(s)</i> related to this <i>resource network connection type</i> .

Table 19 – Resource network connection type attributes

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification of a <i>resource network connection type</i> . Required attribute.	PC01	ME1	QE1	IE1
Description	A description of a <i>resource network connection type</i> .	Distribution piping	40 A breakers	N/A	WIP replenishment stops
Type	The connection type	Piping connection	Electrical connection	N/A	WIP-STOPS

5.11 Resource network connection type property

A property of a *resource network connection type* shall be defined as a *resource network connection type property*.

Resource network connection type properties may be used to specify the defined properties that can be associated with the specific *resource network connection type*.

A *resource network connection type property* may contain nested *resource network connection type property(s)*.

Table 20 defines the relationship roles of the *resource network connection type property*.

Table 21 defines the attributes of the *resource network connection type property*.

Table 20 – Resource network connection type property relationship roles

Related Object	Role	Multiplicity	Relationship Name	Description
Resource network connection type	NA	1	Has properties of	The <i>resource network connection type</i> defined in part by this <i>resource network connection type property</i> .
Resource network connection property	NA	0..*	Maps to	The <i>resource network connection property(s)</i> derived from this <i>resource network connection type property</i> supporting its parent object. Only applied, if navigation is required.
Resource network connection type property	Resource network connection type property child	0..*	Contains	The nested <i>resource network connection type properties</i> of this <i>network connection type property</i> .

Table 21 – Resource network connection type property attributes

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification of a <i>resource network connection type property</i> . Required attribute.	Pipe type	LowArc	N/A	Inside
Description	Additional information about the <i>resource network connection type property</i> .	Type of piping	Breaker low arc	N/A	Location
Value	The default value, set of values, or range of the property.	53	1	N/A	TRUE
Value unit of measure	The unit of measure of the associated property value.	Steel grade	Type	N/A	Boolean

6 Work definition information

6.1 Work definition model

An identification of the resources and workflow required to perform a specified unit of work shall be defined as a *work definition*. The *work definition* may apply to production, maintenance, quality test, and inventory operations activities.

Figure 3 below is the common work definition model; objects shown as gray boxes are defined in ISA-95 Part 2.

Table 22 lists the relationships of the objects in the work definition model.

Work definitions are modeled as an abstract class. There are two types of *work definitions* that are modeled as non-abstract classes: *work master* and *work directives*.

Work masters are template information not associated with any specific *job order*. *Work directives* start as copies of *work masters* and are augmented with information for a specific *job order*.

A *work master* may have a reference to one or more *operations definitions* or *operations segments*. In this situation, the *work master* defines the detailed steps needed to accomplish all or part of the operation.

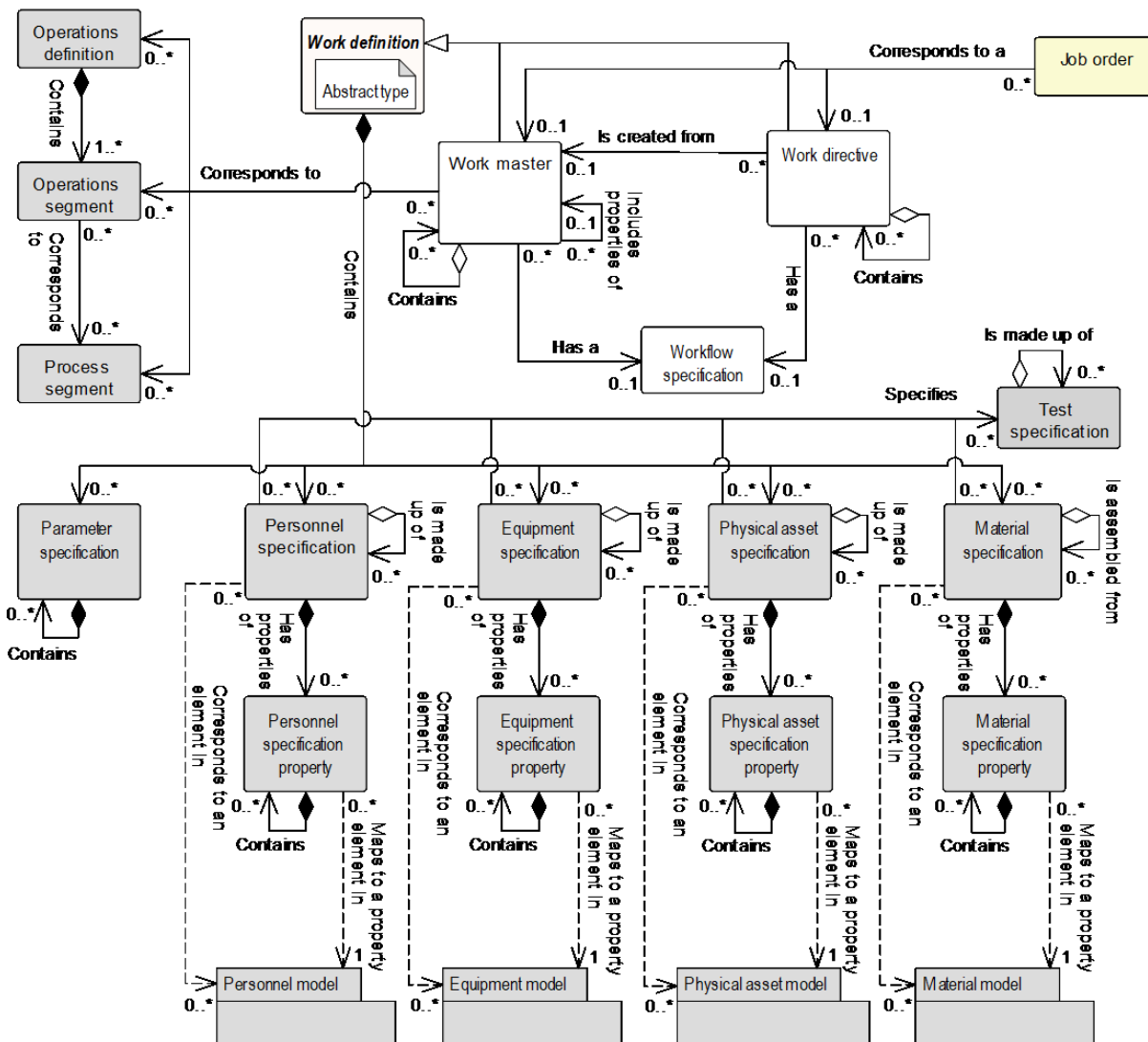


Figure 3 – Work definition model

NOTE The object color convention used in the Part 2 and Part 4 UML diagrams for information models is as shown in Clause 3.3.3.

To simplify Figure 3, the following relationships between *work definition* objects and the operations test model objects are not shown. For the complete contextual view of these relationships, each relationship is listed in Table 22 with the relationship roles defined in each object subclass in their relationship role table.

a) resource specification objects and *test specification* (defined in ISA-95 Part 2);

- b) resource specification objects and *test result* (defined in Part 2);
- c) *work definition* (*work master* and *work directive*) and *evaluated property* (defined in Part 2);
- d) *work definition* (*work master* and *work directive*) and *property measurement* (defined in Part 2).

All *work definition* relationships to *test specification* and *test result* are shown in Part 2 in Figure 16 – Operations test model and listed in Table 99 – Operations test requirement relationship roles.

Table 22 – Work definition model relationships

From	To	Type	Relationship Name
Work master	Work definition		(Abstract type)
Work directive	Work definition		(Abstract type)
Work definition	Parameter specification	Composition whole	Contains
Work definition	Personnel specification	Composition whole	Contains
Work definition	Equipment specification	Composition whole	Contains
Work definition	Physical asset specification	Composition whole	Contains
Work definition	Material specification	Composition whole	Contains
Work master	Operations definition	Association	Corresponds to
Work master	Operations segment	Association	Corresponds to
Work master	Process segment	Association	Corresponds to
Work master	Work master	Association	Includes properties of
Work master	Work master	Composition hierarchy	Contains
Work master	Workflow specification	Association	Corresponds to
Work directive	Work master	Association	Is created from
Work directive	Work directive	Composition hierarchy	Contains
Work directive	Workflow specification	Association	Corresponds to a
Job order	Work master	Association	Corresponds to a
Job order	Work directive	Association	Corresponds to a
Personnel specification, equipment specification, physical asset specification, and material specification.	Test specification (Defined in Part 2)	Association	Specifies
Test specification (Defined in Part 2)	Personnel specification, equipment specification, physical asset specification, and material specification.	Association	Specifies test for
Test result (Defined in Part 2)	Personnel specification, equipment specification, physical asset specification, and material specification.	Association	Generated in context of
Evaluated property (Defined in Part 2)	Work definition	Association	Measured with method of
Property measurement (Defined in Part 2)	Work definition	Association	Measured with method of

From	To	Type	Relationship Name
Parameter specification	Parameter specification	Composition hierarchy	Contains
Personnel specification	Personnel specification	Aggregation hierarchy	Is made up of
Personnel specification	Personnel specification property	Composition whole	Has properties of
Personnel specification property	Personnel specification property	Composition hierarchy	Contains
Personnel specification	Personnel class	Association (A)	Corresponds to
Personnel specification	Person	Association (C)	Corresponds to
Personnel specification property	Personnel class property	Dependency (B)	Maps to
Personnel specification property	Person property	Dependency (D)	Maps to
Equipment specification	Equipment specification	Aggregation hierarchy	Is made up of
Equipment specification	Equipment specification property	Composition whole	Has properties of
Equipment specification property	Equipment specification property	Composition hierarchy	Contains
Equipment specification	Equipment class	Association (A)	Corresponds to
Equipment specification	Equipment	Association (C)	Corresponds to
Equipment specification property	Equipment class property	Dependency (B)	Maps to
Equipment specification property	Equipment property	Dependency (D)	Maps to
Physical asset specification	Physical asset specification	Aggregation hierarchy	Is made up of
Physical asset specification	Physical asset specification property	Composition whole	Has properties of
Physical asset specification property	Physical asset specification property	Composition hierarchy	Contains
Physical asset specification	Physical asset class	Association (A)	Corresponds to
Physical asset specification	Physical asset	Association (C)	Corresponds to
Physical asset specification property	Physical asset class property	Dependency (B)	Maps to
Physical asset specification property	Physical asset property	Dependency (D)	Maps to
Material specification	Material specification	Aggregation hierarchy	Is assembled from
Material specification	Material specification property	Composition whole	Has properties of
Material specification property	Material specification property	Composition hierarchy	Contains
Material specification	Material class	Association (A)	Corresponds to
Material specification	Material definition	Association (A)	Corresponds to
Material specification	Material lot	Association (C)	Corresponds to
Material specification	Material subplot	Association (C)	Corresponds to
Material specification property	Material class property	Dependency (B)	Maps to

From	To	Type	Relationship Name
Material specification property	Material definition property	Dependency (B)	Maps to
Material specification property	Material lot property	Dependency (D)	Maps to

6.2 Work master

The resources and instructions required to perform a unit of work without reference to a specific *job order* shall be defined as a *work master*. A *work master*

- identifies *material classes* or *material definitions*,
- identifies nominal production run sizes (standard job order size),
- identifies *equipment classes* for work centers and work units, and
- may identify other information required to execute the *work definition* for a *job order*.

EXAMPLE 1 Instructions, automation procedures, SOPs, recipes, drawings, CNC programs, packaging specifications, label specifications, and transition specification.

A *work master* may contain zero or more *work masters* defining a hierarchy of *work masters* with the hierarchy defined through *workflow specification nodes* in the *workflow specification*.

A *work master* may include properties of another *work master* as a parent type.

A *work master* shall be defined as pattern or instance. A pattern *work master* defines a “template,” upon which other pattern or instance *work masters* may be based. Unlike instance *work masters*, pattern *work masters* shall not be directly scheduled or executed. Therefore, *job orders*, *job responses* and *work directives* shall not reference pattern *work masters*.

The *parameter*, *personnel*, *equipment*, *physical asset* and *material specifications* of a *work master* may map to those of any pattern *work master* upon which the *work master* is based.

EXAMPLE 2 A pattern *work master* can contain *material specifications* that reference *material classes*, while an instance *work master* based on this pattern *work master* can contain *material specifications* that reference *material definitions* belonging to those *material classes*.

EXAMPLE 3 A mining organization could define the following pattern and instance *work masters*:

1. extraction (pattern);
2. coal extraction (pattern), specialization of extraction (pattern);
3. Iron ore extraction (pattern), specialization of extraction (pattern)
4. coal site S1 extraction (instance), specialization of coal extraction (pattern);
5. iron ore site S2 extraction (instance), specialization of iron ore extraction (pattern).

Pattern *work masters* provide a basis for standardization and reuse of pattern *work masters* across many instance *work masters* across and between plants.

6.3 Work directive

The resources and instructions required to perform a unit of work for a specific *job order* shall be defined as a *work directive*. A *work directive*

- is created as a copy of a *work master*,
- is used to control one *job order* or part of a *job order*,
- defines exact batch sizes or production run sizes,
- may identify *material lots* or *material sublots* for the *job order*,
- may identify specific work centers and/or work units for the *job order*,

- may identify specific *personnel* for the *job order*, and
- contains the actual executed information after execution of the *job order*.

A *work directive* may contain zero or more *work directives*, defining a hierarchy of *work directives* with the hierarchy defined through *workflow specification nodes* in the *workflow specification*.

There is one *work directive* for each *job order*. It contains the specific information required to perform the *job order* and the *workflow specification* associated with the *job order*. Figure 4 illustrates the recursive nature of *work masters* and *work directives*.

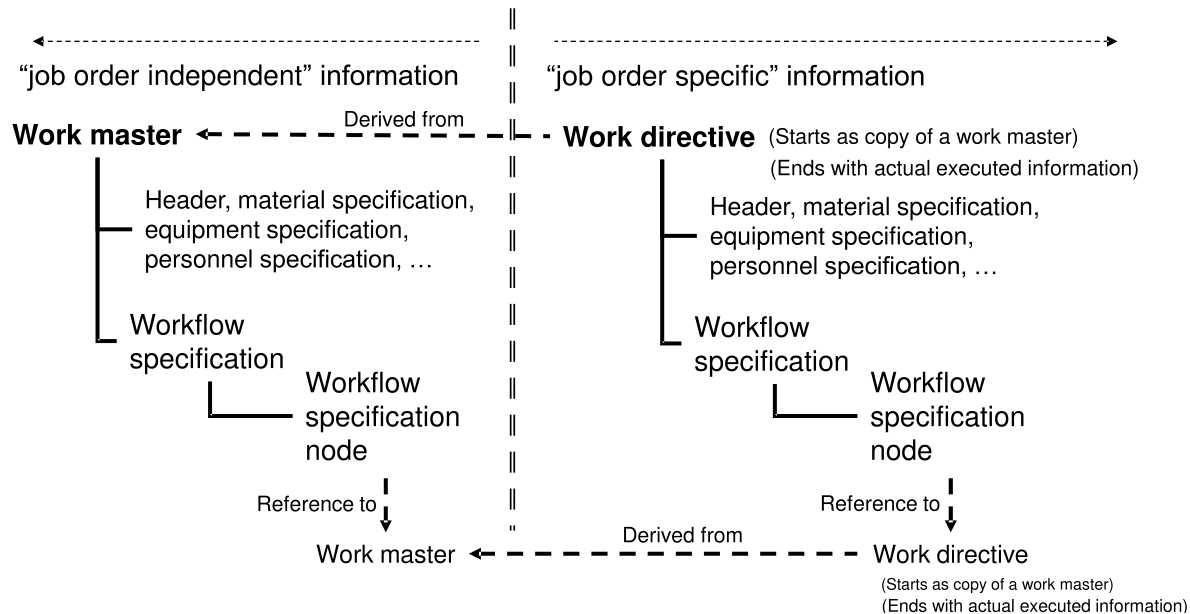


Figure 4 – Relationship of work master to work directive

NOTE 1 The dashed vertical line in Figure 4 represents the tasks in *operations execution management* that create a *work directive* from a *work master* based on the requirements of the *job list*.

NOTE 2 A common scenario is where ad hoc work is performed with no *work master* or *operations definition* associated such as a material spills or unplanned and undefined movements of *material* or use of *equipment*. This scenario requires a 0..1 relationships between a *work master* and *work directive / job order*. The process of ad hoc work can be recorded in a *work directive* to an ad hoc *job order*.

Table 23 defines two additional attributes for *material specification* objects to support the *material lot* and *material subplot* information used in *work directives*.

Table 23 – Additional material specification attributes

Attribute Name	Description
Material lot	Identifies the associated <i>material lot</i> or set of <i>material lots</i> of the specification for a <i>work directive</i> .
Material subplot	Identifies the associated <i>material subplot</i> or set of <i>material subplots</i> of the specification for a <i>work directive</i> .

6.4 Work definition

Table 24 defines the relationship roles for the *work definition* that are common to both *work master* and *work directive*.

Table 25 defines the attributes for *work definition*.

The *work master* and *work directive* objects are specialized types of the super class of *work definition*, and the *work definition* attributes shall be included in the *work master* and *work directive* attributes.

The *work definition* is an abstract object that cannot be instantiated. Only the specialized objects (*work master* and *work directive*) can be instantiated and, therefore, is referenced within a relationship.

Table 24 – Work definition relationship roles

Related Object	Role	Multiplicity	Relationship Names	Description
Parameter specification	Parameter specification	0..*	Contains	The <i>parameter specifications</i> related to this <i>work definition</i> .
Personnel specification	Personnel specification	0..*	Contains	The <i>personnel specifications</i> related to this <i>work definition</i> .
Equipment specification	Equipment specification	0..*	Contains	The <i>equipment specifications</i> related to this <i>work definition</i> .
Physical asset specification	Physical asset specification	0..*	Contains	The <i>physical asset specifications</i> related to this <i>work definition</i> .
Material specification	Material specification	0..*	Contains	The <i>material specifications</i> related to this <i>work definition</i> .
Evaluated property (Defined in Part 2)	NA	0..*	Measured with method of	This work master ID or work directive ID which is applied test method to obtain the measurement of the <i>evaluated property</i> for <i>test specification</i> of the testable object property ID.
Property measurement (Defined in Part 2)	NA	0..*	Measured with method of	This work master ID or work directive ID which is applied test method to obtain the measurement of the <i>property measurement</i> for <i>test specification</i> of the testable object property ID.

Table 25 – Work definition attributes (common in work master and work directive)

Attribute Name	Description	Production examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification as the <i>work master</i> ID or <i>work directive</i> ID. Required attribute.	Export quality widget	Medium size AC motor overhaul	Potency test procedure	Tank transfer procedure
Version	An identification of the version of the <i>work master</i> version or <i>work directive</i> version. In cases where there are multiple versions of a <i>work definition</i> , then the version attribute shall contain the additional identification information to differentiate each version.	1.0	1.4	1.1	1.1
Description	Contains additional information and descriptions of the <i>work master</i> or <i>directive</i> .	“Information defining resources required for work of a single ‘export quality widget’”	For overhauls of motors less than 200 HP.	Test for potency of product	Movement of material from one tank to another

Attribute Name	Description	Production examples	Maintenance Examples	Quality Examples	Inventory Examples
Hierarchy scope	Identifies where the exchanged information fits within the role-based equipment hierarchy.	East Wing manufacturing line #2	CNC Machine Asset ID 13465	Test cell 4 Receiving	Warehouse B
Work type	Describes the category of work. Defined values are • production • maintenance • quality • inventory • mixed “Mixed” can be used when the <i>work definition</i> contains resources and routing information required to perform several types of work.	Production	Maintenance	Quality	Inventory
Duration	Duration, if known.	25	4	1	40
Duration unit of measure	The units of measure of the duration, if defined.	Minutes	Hours	Day	Minutes
Published date	The date and time on which the <i>work master</i> or <i>work directive</i> was published or generated.	12-30-1951 18:30 UTC	10-17-2005 18:30 UTC	10-17-2005 18:30 UTC	10-17-2005 18:30 UTC

NOTE A MIMOSA *solution package* is the equivalent of a work definition for maintenance.

6.5 Work master relationship roles and attributes

Table 26 – Work master relationship roles, in combination with Table 24 – Work definition relationship roles, defines the complete set of relationship role for the *work master*.

Table 27 – Work master attributes, in combination with Table 25 – Work definition attributes (common in work master and work directive), defines the complete set of attributes for the *work master*.

A *work master* may contain *work masters*, defining a hierarchy of *work masters*. A *work master* may be defined as pattern or instance. An instance *work master* may include some of the properties of a pattern *work master*.

Table 26 – Work master relationship roles

Related Object	Role	Multiplicity	Relationship Name	Description
Work master	Work master child	0..*	Contains	The related object(s) makes up part of this <i>work master</i> as the whole.
Work directive	NA	0..*	Is created from	The <i>work directive</i> (s) created from this <i>work master</i> . in cases where there are multiple <i>work directive</i> versions of a <i>work directive</i> , then the <i>work directive version</i> attribute shall contain the additional identification information to differentiate each version. The multiplicity of 0..1.
Work master	Work master parent type	0..1	Includes properties of	This <i>work master</i> (s) <i>includes properties of the parent work master</i> .
Process segment	Process segment	0..*	Corresponds to	The <i>process segment</i> (s) associated to this <i>work master</i> .

Related Object	Role	Multiplicity	Relationship Name	Description
Operations definition	Operations definition	0..*	Corresponds to	The <i>operations definition(s)</i> associated to this <i>work master</i> .
Operations segment	Operations segment	0..*	Corresponds to	The <i>operations segment(s)</i> associated to this <i>work master</i> . If the <i>operations segment</i> reference is insufficient to identify the <i>operations segment</i> , then this <i>work master</i> should also identify the <i>operations definition</i> reference.
Workflow specification	Workflow specification	0..1	Corresponds to	This <i>work master</i> defined in part by the <i>workflow specification(s)</i> . The version attribute of the <i>work specification</i> may be specified. In cases where used in multiple <i>workflow master</i> versions, then the <i>version</i> attribute shall contain the additional identification information to differentiate each version.

Table 27 – Work master attributes

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
Definition type	Defines the type of the <i>work master</i> . Defined types are - pattern: a <i>work master</i> used as a template for other <i>work masters</i>; - instance: a <i>work master</i> directly scheduled, dispatched and executed.	Pattern	Instance	Instance	Pattern

6.6 Work directive relationship roles and attributes

Table 28 – Work directive relationship roles, in combination with Table 24 – Work definition relationship roles, defines the complete set of relationship roles for a *work directive*.

Table 25 defines the attributes for the *work directive*. A *work directive* may contain *work directives*, defining a hierarchy of *work directives*.

Table 28 – Work directive relationship roles

Related Object	Role	Multiplicity	Relationship Name	Description
Work master	Work master	0..1	Is created from	The <i>work master</i> used to create this <i>work directive</i> . in cases where there are multiple <i>work master versions</i> , then the <i>work master version</i> attribute shall contain the additional identification information to differentiate each version
Work directive	Work directive child	0..*	Contains	The related object(s), <i>work directive</i> , makes up part of this <i>work directive</i> as the whole.
Workflow specification	Workflow specification	0..1	Corresponds to	This <i>work directive</i> defined in part by the <i>workflow specification(s)</i> . The version of the <i>work directive</i> may be specified in the attribute of this object.

Related Object	Role	Multiplicity	Relationship Name	Description
Job order	NA	0..*	Corresponds to	A unique identification of the <i>job order</i> associated with this <i>work directive</i> . The ID is used in other parts of the model when the <i>job order</i> needs to be identified.

6.7 Parameter specification

The definition of this object, the relationship roles, and the attributes for this object are defined in ISA-95 Part 2.

A parameter specification may be made up of zero or more nested parameter specifications.

6.8 Personnel specification

The definition of this object, the relationship roles, and the attributes for this object are defined in ISA-95 Part 2.

6.9 Personnel specification property

The definition of this object, the relationship roles, and the attributes for this object are defined in ISA-95 Part 2.

6.10 Equipment specification

The definition of this object, the relationship roles, and the attributes for this object are defined in ISA-95 Part 2.

6.11 Equipment specification property

The definition of this object, the relationship roles, and the attributes for this object are defined in ISA-95 Part 2.

6.12 Physical asset specification

The definition of this object and the attributes for this object, the relationship roles, are defined in ISA-95 Part 2.

6.13 Physical asset specification property

The definition of this object, the relationship roles, and the attributes for this object are defined in ISA-95 Part 2.

6.14 Material specification

The definition of this object, the relationship roles, and the attributes for this object are defined in ISA-95 Part 2.

A material specification may be an assembly of zero or more nested material specifications.

6.15 Material specification property

The definition of this object, the relationship roles, and the attributes for this object are defined in ISA-95 Part 2.

6.16 Workflow specification information

6.16.1 Workflow specification model

A workflow specification is represented as a collection of nodes and connections. Each node is defined by a type definition, and each connection is defined by a type definition. A node may contain a reference to a work definition.