ISA-95 Mfg Events

Draft 0.99.86

This is not a tech report. It is simply a concept and definition development paper for the working group to determine additions to in existing ISA-95 parts in a single paper.

Once the working group agrees on the concepts and definitions, we will write comments for updates to specific sections in specific parts.

ANSI/ISA-95.00.02-ed3 WD01 (ISA 95.00.02 ed2Mod)

Enterprise-Control System Integration − Part 2: Object Model Attributes

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# Overview

This document has been prepared as a working paper of the Process-centric Messaging Working Group (PCMWG) in order to facilitate discussion amongst the working group with the aim of agreeing on content to be added to the ISA-95 Standard.

## Problem Statement

The PCMWG has agreed on the following problem statement:

1. Part 5 has no method to specify an exchange of a bundle of verb/noun messages to ensure transactional integrity.
2. This causes data inconsistencies within receiving systems.
3. The Sender is unable to specify exchange with sufficient context to the Receiver in a single transaction.

For PCMWG Consideration:

There needs to be more emphasis and description of “sufficient context” and suggest that the problem statement be updated to:

1. Part 5 has no method to specify an exchange of a bundle of verb/noun messages to ensure transactional integrity when a real-world event takes place. This causes data inconsistency within receiving systems.
2. The Sender is unable to explicitly specify the process context of the real-world event. Therefore, the Receiver(s) must infer the process context based on the data content. This often results in high cost, complex and error-prone logic in the Receiver systems.

## Scope

The scope of information exchange objects that the PCMWG is focussed on providing a normative solution for are those defined in parts 2 and 4 of ISA-95.

It is anticipated the solution proposed shall be able to be extended upon by an implementation method to support inclusion of non ISA-95 objects in a bundle if required. *Mfg profiles* shall indicate how to support this extension capability.

# Definitions

The structural definition of objects and their attributes have been separated from the description of the object as is typically represented in the ISA-95 standard. This separation is provided to enable reviewers of this document to better understand the model concepts before interpreting the structural interpretation of the model. During the integration of the document content into the standard, these two components will be implemented in a format consistent with the ISA-95 standard format.

## Event driven architecture (EDA)

The notification of manufacturing events using *mfg event object* follows an event driven architecture (EDA). EDA is an integration architecture for a message exchange pattern (MEP) promoting the creation, detection, consumption of, and reaction to real world events in a disconnected asynchronous environment. EDA is a publish-subscribe architecture.

Note: The *mfg event* notification pattern is represented in the *Notify* definition in Part 5.

The EDA pattern is applied over a variety of technology landscapes. An EDA typically consists of event publishers, event consumers and event channels, with the following characteristics:

* An event publisher should not know the event consumers or how the event is used or further processed by the consumers.
* An event channel may manage the control triggers and distribution of events. An event channel can be implemented over a wide range of technology landscapes ranging from enterprise service bus (ESB) type environments to minimal non-ESB environments such as email, RSS feeds and file shares.

Note: Publishers/senders and subscribers/receivers of events are typically composed using a hybrid of orchestration and choreography architectural approaches while request-response message exchange patterns are typically used for orchestration approaches.

Note: Level 2 systems have leveraged choreography patterns for decades. Level 3, level 4, B2B and Internet-of-Things systems are leveraging the choreography pattern due to its support of loosely coupled, distributed systems. The choreography approach involves interacting systems coordinating themselves through an end-to-end process using event-based publish-subscribe messaging[[1]](#footnote-2). In contrast, the orchestration approach has interacting systems executing commands issued to them from a central system, which coordinates the execution through the end-to-end process. Both of these architectures can and often do co-exist in a manufacturing environment.

## Manufacturing event (mfg event)

*Mfg event* is an information exchange object that provides a notification of the occurrence of a real world event. The *mfg event* explicitly provides the process context of the real world event and all pertinent information associated with the real world event. The *mfg event* information exchange object provides the ability to bundle multiple information exchange objects into a single *mfg event* information exchange message.

Note: Not all real-world manufacturing events warrant creating a *mfg event* information exchange.

A *mfg event* does not require explicit acknowledgement by the receiver of the message.

Note: If an acknowledgment of the *mfg event* is required, this can be specified in a definition attribute of the *mfg event*. The acknowledgment is a separate asynchronous *mfg event* notification.

## Manufacturing event record (mfg event record)

The *mfg event record* object represents the bundle of information exchange objects pertinent to the real world event with the same *action*. Each bundle of *ISA-95 objects* is represented as one or more *ISA-95 objects* with the *action* (Added, Changed, Deleted) applied by the publisher of the *mfg event*.

The *mfg event record* is a child object of a *mfg event* occurrence. There may be multiple *mfg event records* within a *mfg event* occurrence. Collectively, these bundles represent the bundle of all actions and data pertinent to the real world event.

The allowed content of an *mfg event record* is defined in an associated *mfg event definition record specification* and/or *mfg event class record specification*.

## ISA-95 object

The *ISA-95 object* is a single information exchange object within a *mfg event record*. There may be one or more *ISA-95 objects* in a *mfg event* *record*.

Examples are:

* Operations Schedule
* Material Lot

## Manufacturing event definition (mfg event definition)

The *mfg event definition* defines the content of, or specification for, the *mfg event* instances that are communicated in an ISA-95 message exchange.

A *mfg event definition* describes the process context of the real world event and defines the pertinent information to be represented in the corresponding *mfg event* instances.

The *mfg event definition* may contain specifications for a bundle of *ISA-95 objects* that are to be included in the *mfg event*. The specifications describe and specify the allowed content and cardinality rules of the *ISA-95 objects*.

## Manufacturing event definition record specification (mfg event definition record specification)

The *mfg event definition record specification* is a child object of a *mfg event definition*. It specifies the allowed content and cardinality rules of the *ISA-95 objects* in the corresponding *mfg event* occurrences.

## Manufacturing event class (mfg event class)

A *mfg event class* object groups *mfg event definitions* for routing, reporting and to aid processing functions (e.g. searching, organizing, identifying *mfg event* structures ...).

The *mfg event class* can have zero or more properties and/or record specifications associated with it. Properties and/ record specifications defined in the *mfg event class* will be present in the *mfg event definitions* and associated *mfg events*.

## Manufacturing event level (mfg event level)

*Mfg event level* is the functional hierarchy level from which the event notification is published. It does not define the functional hierarchy level, which may receive, or consume, the event notification.

The levels supported are:

* *Level 4* for Business Planning & Logistics. *Mfg events* published from Level 4 business functions
* *Level 3* for Manufacturing Operations Management. *Mfg events* published from Level 3 operations management functions

## Pre-defined objects

Pre-defined objects are ISA-95 defined event objects. These are to be defined in the proposed part 9 of the ISA-95 standard. Pre-defined objects can be published as nouns within a specific *Notify* transaction in the same manner as *mfg event*.

Pre-defined objects have their structure and semantics represented in the ISA-95 standard and can be implemented in two ways:

* as an **explicit**event notification where the event is notified in the same manner as the *mfg event* (the *mfg event* is the pre-defined object) e.g. *Work Alert* in an explicit transaction e.g. *Notify Work Alert*
* as a **configured** *mfg event definition*. The event is *mfg event* published in a *notify mfg event* transaction. The *definition ID* identifies the actual event being notified.

In both cases:

* The structure of the messages follows the *mfg event* object structure, only the event transaction name and noun changes between options.
* The *mfg event definition* attribute for the pre-defined type is identical to that used in the *mfg event*.
* The notification is uniquely identified by the *mfg event definition ID*. The corresponding entry in the *mfg event definition* and *mfg event class* will have a detailed specification of the *mfg event* structure.

## Manufacturing profile (mfg profile) (Under development as proposed Part 8, ISA-95 Mfg Profile)

A description of the information exchange semantics supported within a defined profile scope.

If the *mfg profile* (Proposed Part 8 working draft) specifies objects from other included profiles, the fully qualified name (FQN) of the object is proposed to be used to clarify its definition. The Proposed Part 8 will stipulate how FQNs are to be defined and used.

## Manufacturing profile scope (mfg profile scope) (Under development as proposed Part 8, ISA-95 Mfg Profile)

The extent covered by profile definitions. This may be logical groups or zones / conduits (ISA-99 concept).

For example: ISA-95 Profile, ISA-88 Profile, GS1 EPCIS, My Industry group, My Vendor Group, Vendor, manufacturer, Area X, Site Y, My Enterprise

## Manufacturing event profile (mfg event profile)

The mfg event profile partitions the mfg events into a mfg profile scope with an ontology. This partitioning allows multiple messaging implementations to be deployed in a given messaging infrastructure without ID and ontology issues.

Inclusions, specializations and extensions of ISA-95 objects are presented in a *mfg profile* under development as proposed Part 8, ISA-95 Mfg Profile). The *mfg event* profile is a section of a *mfg profile* representing the supported events with descriptions of the semantics of the events.

The *mfg event profile* describes the *mfg event definition* and *mfg event class* entries within a documented communications profile scope. A *mfg event definition* or *mfg event class* entry cannot exist without being assigned to a *mfg profile*. This association enables the semantics of the message to be clearly specified and distinguished distinct from other specifications or versions of the same *mfg profile*. This partitioning of specifications mitigates semantic clashes at all stages of the design and deployment of information exchanges.

Note: An ontology is a formal naming and definition of the types, properties, and interrelationships of the entities that really or fundamentally exist for a particular domain of discourse. (<https://en.wikipedia.org/wiki/Ontology> (information science)).

The representation of transactions, mfg event definitions, mfg event classes and mfg events as parts of a mfg profile provides a safeguard against semantic differences. ISA-95 defines data formats and base semantic definitions for information exchange. However, detailed semantics typically vary across implementations. The data specification of *mfg events* allows specification of *mfg event definitions* and *mfg event classes* to match the context of the solution, which again may vary across implementations. If two ISA-95 implementations (which may be different versions of the same specification) are deployed simultaneously in the same environment the potential for name and semantic clashes is evident. The implementation often depends on business factors such as industry vertical. E.g. Oil and Gas, Automotive, Mining, Batch, CPG, Discrete and vendor standards. Each one of these implementation scenarios contains constructs / semantics specific to that environment and some generic constructs / semantics.

*Mfg event profiles* provide a mechanism to describe these scenarios in a way that can be understood by participants (applications/companies) involved in the messaging conversations. It also provides a foundation for configuring messaging systems to allow different systems to operate without interference (i.e. loosely coupled).

The *mfg event profile* object references a corresponding *mfg events* section in an ISA-95 Mfg Profile identified by its *mfg profile ID*.

Once a *mfg profile* is published, it is versioned and cannot be changed. If changes are to be published, a new version of the *mfg profile* must be created. This avoids breaking an installed environment.

*Mfg event profiles* can reference entries in other *mfg event profiles* by specifying the FQN of the entry. These references are read only and cannot be modified.

The *mfg event profile ID* is an attribute of *mfg event class* and *mfg event definition*.

# Manufacturing event information

This section and following section are to be combined in a new normative section to ISA-95 Part 2.

## Mfg event model

The mfg event model represents a generic representation of event notifications using the *mfg event* object and the constructs required to define, group and structure the *mfg event* occurrences. A high-level view of the mfg event model is in Figure 1 and the UML representation of the mfg event model is in Figure 2.

Note: The mfg event model is intentionally structured similarly to the material model with *material class, material definition* and *material* occurrences where for each *material definition* there are many *material lot* occurrences.

The principal constructs within the Mfg Event Model are:

* *Mfg event*

The *mfg event* object is published within a *Notify* transaction (*Notify mfg event*). It provides process context and acts as a container for specific ISA-95 objects identified by the *mfg event definition*. *Mfg events* are generated during operation of the integrated environment.

* *Mfg event definition*

The definition of the event messages published that has the *Definition ID* attribute that matches its ID. Over time, there are typically many events published of a specific *mfg event definition*. *Mfg event definitions* are typically generated during configuration of the integrated environment, as part of both initial implementation project and normal integrated system maintenance.

* *Mfg event class*

Like other ISA-95 class objects, the *mfg event class* defines a grouping of *mfg event definitions* that have common meaning and / or structural components. *Mfg event definitions* can be grouped into zero, one or many *mfg event classes.*

*Mfg event classes* are typically generated during configuration of the integrated environment, as part of both initial implementation project and normal integrated system maintenance.

* *Mfg event profile*

The mechanism for describing events and transaction scenarios within a given scope (*mfg profile scope*). It enables the partitioning of definitions to avoid ID / semantic clashes. It enables multiple messaging implementations to be deployed in a given messaging infrastructure without ID and ontology issues. *Mfg event profiles* are typically generated during specification of the integrated environment, as part of both initial implementation project and normal integrated system maintenance.



Figure 1 - Mfg event model

*Mfg events* are generated as result of the occurrence of a real world event that warrants notification to interested parties. *Mfg event* messages are published as time stamped notifications to notify subscribers that the real world event has occurred. The *mfg event* exchange explicitly includes the process context of the real world event and all pertinent information actioned by the publisher that is associated with the real world event. The subsequent processing of *mfg events* by subscribers is not of concern to the *mfg event* publisher.

The structure of a *mfg event* shall always be defined by a *mfg event definition*. The *mfg event definition* provides a specification for a *mfg event* message. This includes definition of the process context of the event (e.g. Work Completed) and the set of *ISA-95 objects*, inclusive of their cardinality rules, to be included in the *mfg event*.

The *mfg event class* defines grouping of *mfg event definitions*. *Mfg event definitions* can be grouped into zero, one or many mfg event classes.

The *mfg event profile* provides a documented scope and namespace separation for the *mfg event definition* and *mfg event class* entries. The *mfg event profile* allows co-existence of notification messages defined by different standards (e.g. ISA-95, industry vertical standard, local enterprise standard, local business unit standard, etc.) to be communicated in a single messaging implementation with different standards message specifications partitioned by profile.

A *mfg event profile* typically exists in a physical *mfg profile* document or messaging requirements specification, which represents the *mfg event* profile alongside other documented characteristics (transaction profiles, message specifications, transaction channels etc.) and requirements within the operating environment.

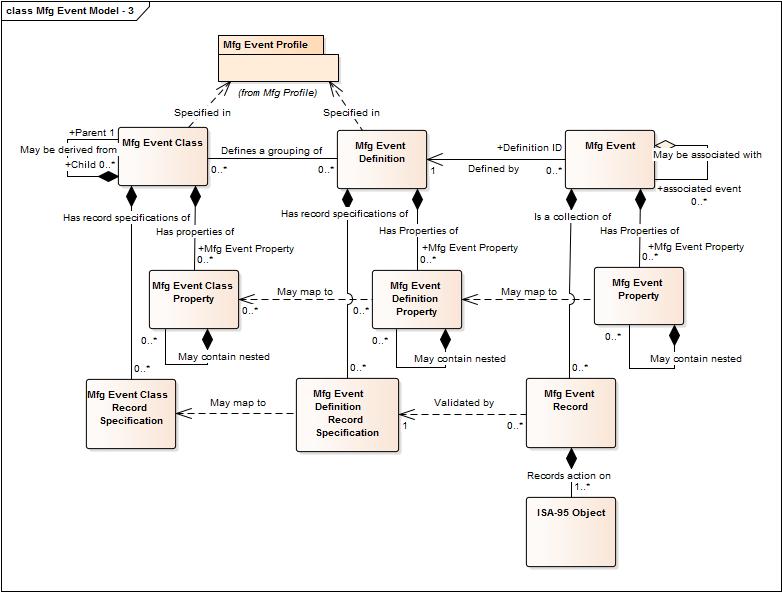


Figure 2 - Mfg event UML model

For PCMWG Consideration:

The proposed sub object names for the *mfg event class record specification* and *mfg event definition record specification* are very long. Much consideration was given to identify shorter sub object names. The PCMWG is to propose alternative names for these sub objects. Current names maintain the ISA-95 resource object naming convention of valid semantics of the main object name in the sub objects (property). These sub object names require PCMWG agreement on what names and convention is to be applied going forward.

## The object naming in the mfg event model follows the material model pattern by defining an instance (*material lot, material sublot*) using a *material definition* that can be members of *material classes*. Therefore, when a *mfg event definition* becomes a member of a *mfg event class*, it declares support for the *mfg event class property* sub objects. To fully define the *mfg event definition* and *class objects,* both their properties and their record specification sub objects are required. All *material event class* sub objects are supported by the *mfg event definition sub objects*. Mfg event

There are large numbers of real world events occurring in a manufacturing system; only some real world events are associated with manufacturing operations management activities and functions. *Mfg events* are the subset of real world events that require notification of process context specific ISA-95 information exchanges.

*Mfg events* support manufacturing activities and functions through systems that leverage EDA via the notify/event message exchange pattern (MEP). It complements the existing request-response MEP and publish-subscribe MEP of data-centric messages supported in ISA-95 standards. These MEPs co-operate in manufacturing facilities.

*Mfg events* notify subscribers of the publishers’ perspective of the real-world event and process context and pertinent information.

The following facets express the context of the mfg event:

* The ID of the *mfg event definition* – provides the process context. E.g., resource acquired, work completed, operation scheduled etc.
* The pertinent information as *mfg event records*, each containing a bundle of *ISA-95 objects*. The allowed *ISA-95 objects* in a *mfg event* occurrence are specified in the *mfg event definition record specification* and/or *mfg event class record specification*.

There are two models for conveying the *mfg event* message:

1. Self-contained: All information relating to the context of the *mfg event* is contained in the *mfg event* message.
2. Referenced: The information pertaining to the context of the *mfg event* can be accessed by the *mfg event* subscriber using a known lookup process where the *mfg event identification* is used as a token. The lookup process is outside the scope of the mfg event model.

Structural elements of the *mfg event* object depicted in Figure 3.

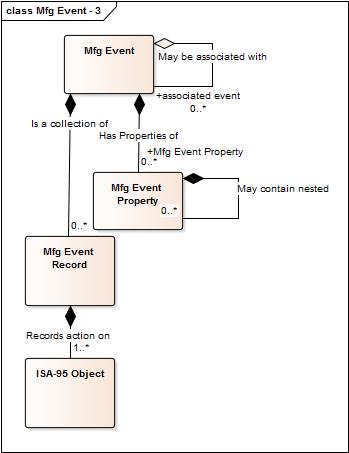


Figure 3 - Mfg event object structure

### Mfg event record

The *mfg event* *record* contains information from the publisher that is pertinent to the real world event, which triggered the *mfg event*. The bundled set of *mfg event* *records* are represented as *ISA-95 objects* to which the publisher has applied an *action* (Added, Changed, Deleted).

The data represented in an *ISA-95 object* entry is defined by and validated with the corresponding *mfg event record specification* in the *mfg event definition.*

Note: *Actions* may be recorded or be available at times after the real world event took place. Recipients of the *mfg event* may have a different record of *ISA-95 objects* at the time reported for the *mfg event* occurrence due to external factors. The *effective timestamp* attribute explicitly states the time of the real world event. The *record timestamp* attribute explicitly states the time that the publisher took the reported *action* in these cases.

If there are multiple *actions* recorded, the times of these *actions* occurred may be relevant to the interpretation of the *mfg event*.

Example:

A *production* *schedule* update (event) creates requirements for new *material lot* and a *person* objects in the source system. The publisher advises that the production schedule was created after the new *material lot* and *person* objects were created.

### Associated events

*Mfg events* may be associated with other events to advise their relationship in the system. Typical application is the representation of *mfg events* consumed by a process that then notified/published a new *mfg event* that referenced the associated consumed event(s).

An individual *mfg event* message indicates other associated events as a list of event ID’s.

Examples:

Reporting of source mfg event in mfg events

When a *mfg event* (Definition ID: Job Order Started) is generated during the execution of a job order, the ID of the associated *Work Dispatched* event that contained the job order information can be represented as an *associated event ID* in the associated event list.

Detailed Scheduling

When a *Work Dispatched* event is published after detailed scheduling of an *Operations Scheduled* event, the *Work Dispatched* event can reference the original *Operations Scheduled event ID* as an *associated event ID* in the associated event list.

Association of context with data to generate process centric events

Example 1: A MOM application suite based on process centric messaging interfaces to other MOM applications that are based on data centric messaging. The incoming data centric messages are republished as process centric events with the ID of the data centric event as an *associated event ID* in the associated event list. The data centric event may be represented as a *mfg event* for consistency.

Example 2: A scheduled data update event is received by a MOM application from another MOM application. An application receives the data event associates context with the data and republishes the event with the added context. The ID of the scheduled data update is reported as an *associated event ID* in the associated event list.

### Mfg alerts and mfg alarms

Within manufacturing systems, there are two understood forms of event being alerts and alarms. *These mfg events* can be classified as *mfg alerts* and *mfg alarms* in *mfg event classes*:

1. A *mfg alert* is distinguished from other *mfg events* (visually, audibly …) e.g.: List boxes in HMI. The *mfg alert* is identified by the corresponding *mfg event definitions* membership of a *mfg alert class*. *Mfg alerts* may be generated by any Level 3 or 4 action or activity related to Level 3 or 4 manufacturing operations activities.
2. A *mfg alarm* which is distinguished from other *mfg events* and may specify an acknowledgement *mfg event* from subscribers. The acknowledgement is generated as a separate notification. The *mfg alarm* is identified by the corresponding *mfg event definitions* membership of a *mfg alarm class*.

Note: ISA 18.02-2009 Management of Alarm Systems Process Industries represents detailed information on alarm management.

## Mfg event definition

The *mfg event definition* object documents the definition and structure of *mfg event* occurrences. The *mfg event definition* of a *mfg event* is identified by the *definition ID* attribute in the *mfg event* occurrence.

Those constructing or interpreting a *mfg event* obtain the structure and definition from the *mfg event definition*.

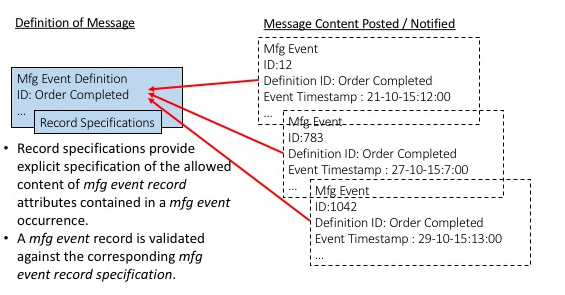


Figure 4 - Relationship of mfg event definition with mfg events

Example: XML representation extract of the *mfg event* objects as depicted in Figure 4:

<MfgEvent>

<DefinitionID>MyProfile:Order Completed</DefinitionID> // DefinitionID indicates which *mfg event definition* is followed in this message. The definition is represented as a FQN using the mfg profile name to avoid clashes with other implementations.

………

</MfgEvent>

The allowed ISA-95 objects in the *mfg event* occurrences of the *mfg event definition* are defined in *mfg event definition record specifications*.

Publishers and subscribers use this information to interpret and validate the message contents.

### Mfg event definition property

Ad hoc and unspecified data can be represented using the *mfg event property* object.

### Mfg event definition record specification

A *mfg event definition record specification* object specifies the allowed content of the *mfg event record* objects in a *mfg event* occurrence.

*ISA-95 object* contents in a *mfg event* vary depending on the process context of the *mfg event*. The *mfg event definition record specification* describes and specifies the *ISA-95 objects* and associated *actions* that are allowed to be represented in the *mfg event* occurrence The publisher follows this specification to construct the message. Subscribers use the *mfg event definition record specification* to validate the content of the message.

Valid *actions* of *ISA-95 objects* are *Added, Changed*, and *Deleted* in alignment with Part 5 actions. The number of *ISA-95 object* occurrences allowed in the *mfg event* occurrences is specified using the *cardinality* attribute of the *ISA-95 object rules*. The number of *actions* allowed for each *ISA-95 object* is represented using the *cardinality* attribute of the *action rule*. Each *mfg event record* represents a single *action*. A *mfg event definition record specification* may manage the contents of multiple *mfg event records* in a *mfg event* occurrence.

Table 1 - Example mfg event definition record specification

| **Mfg event definition entry** | **ID** | **Record content rules** | | | | | **Comment** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Action rules** | | **ISA-95 object rules** | | |
| **Action(s)** | **Cardinality** | **ISA-95 object(s)** | **Cardinality** | **Relationship** |  |
| Material Moved | A1 | Added | Min: 1, Max: \* | Operations schedule ID | Min: 1, Max: \* | Association | The schedule must be referenced. |
| C1 | Changed | Min: 1, Max: \* | Material lot | Min: 0, Max: \* | Composite | One of either object must be present with changed action. |
| Material sublot | Min: 0, Max: \* | Composite |
| Material Moved\_1 | C2 | Added, Changed | Min: 0, Max: \* | Material Lot | Min: 1, Max: \* | Composite | One or more material lots must be present with either action |

The *cardinality* column of *action rules* identifies the min/max of *actions* to be performed on the *ISA-95 object* within a *mfg event* occurrence.

The *cardinality* column of the *ISA-95 object rules* identifies the min/max number of occurrences of the *ISA-95 object* that can be represented in a *mfg event* occurrence. If no min/max entry is defined, there is no constraint on the occurrences.

Figure 5 illustrates how the *mfg event definition record specifications* describe the allowed *ISA-95 object*s in *records* and their cardinality for the event exchange.

Note: The ID entries can use the fully qualified name (FQN) syntax to avoid ID collisions.

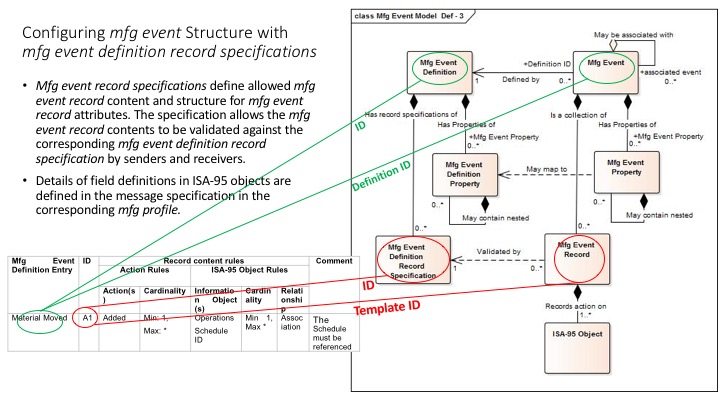


Figure 5 - Specification of mfg event contents

## Mfg event class

*Mfg event definitions* can be grouped with mfg event classes. A *mfg event definition* can be a member of multiple *mfg event classes*.

Figure 6 below represents the objects in *mfg event class* and *mfg event definition*. The *mfg event definition* and *mfg event class* objects are documented in the corresponding *mfg event profile*.

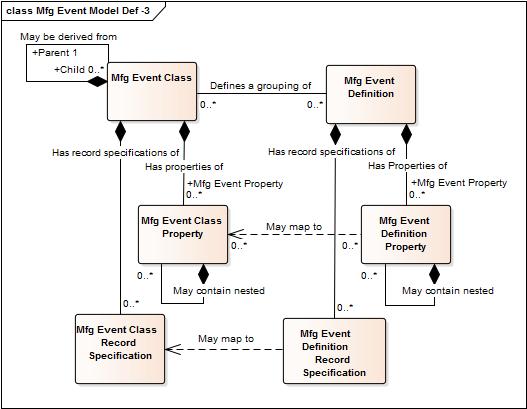


Figure 6 - Mfg event definition and mfg class objects

### Mfg event class record specifications

*Mfg event classes* define common structures of *mfg event definitions* using *mfg event class record specifications*. *Mfg event definitions* as members of a *mfg event class* that contain *mfg event class record specifications* must support the *record specification* entries indicated in the *mfg event class*.

The structure and semantics of the *mfg event class record specification* is the same as the *mfg event definition record specification*.

### Pre-defined mfg event class entries

There are pre-defined class entries represented in the mfg event model being:

* Mfg alert

Advice of an alert occurrence.

* Mfg alarm

Advice of an alarm occurrence.

* Mfg event level

*Mfg event levels* represent classifications of events relative to the activities the events are associated with the proposed defined values of *Level 4* and *Level 3*.

* Operations type

Describes the category of the event activity.

Required attribute.

Defined values are: Production, Maintenance, Quality, Inventory, Mixed.

* Category

General grouping associated with a mfg event definition. E.g. Scheduling, PM, Lab, Receiving

For PCMWG Consideration:

The above pre-defined class entries have been described as a result of an agreed outcome from the October 2015 ISA-95 Committee meeting. However, it is recommended to the PCMWG that the above entries be represented as attributes of the *mfg event*, *mfg event definition* and *mfg event class* objects. The rationale for this is that they are common pieces of information that are relevant to all *mfg event* occurrences and are of potential value for infrastructure and application components in their treatment of the events. E.g., Alarms pre-empt alerts and alerts pre-empt events. Attribute values may be used to route events to different queues or facilitate filtering of events.

*Mfg event definitions* can support the *mfg alert* and *mfg alarm* classes directly or through *mfg event classes* that have the pre-defined *mfg alert* or *mfg alarm* class as part of their parent hierarchy.

Example

A ‘*Job order checkpoint missed*’ *mfg event class* has its parent class set to the ‘*mfg alert*’ *mfg event class*. A *mfg event* declaring the event is a member of the ‘*Job order checkpoint missed*’ *mfg event class* infers that it also is a member of the *mfg alert* class and consequently is a form of *mfg alert*.

The *mfg event class* hierarchy enables representation of classes that have an enumerated set of sub classes to be represented. Table 2 below shows the representation of the *mfg event level* defined value in *mfg event class* entries. The *mfg event level* has its extension attribute set to *Level 4* and *Level 3* as defined values indicating only those children are allowed. The *Business* and *Work* entries have the extension attribute set to a defined value of *sealed* which prevents new entries to represent them as parents. This effectively locks these classes from modification.

Table 2 - Mfg event level defined values represented using mfg event class entries

|  |  |  |
| --- | --- | --- |
| **Mfg event class ID** | ***Mfg event class* parent attribute** | **Extension / defined value** |
| Mfg event level | NA | Level 4, Level 3 |
| Level 4 | Mfg event level | Sealed |
| Level 3 | Mfg event level | Sealed |

For PCMWG Consideration:

Table 2 above consciously only has defined values of *Level 4* and *Level 3* as *mfg event class* entries. These are domain focused. During the review earlier drafts of the Mfg Event Model, reviewer had suggested that defined values may be based a few different views and definitions of the value. For instance, a suggestion was to have Operations for the L3-L4 interface events. As well as to use the functions per Part 3 (Level 3) and per PERA model (Level 4). Also, even though the mfg event model is suitable to use for notification/publication of events emanating from Level 2 systems and processes for level 3 subscribers. The reason why a Control (Level 2) entry has been excluded is that there are currently no ISA-95 defined information models and objects for exchange of data across the Level 2-3 boundary. Given that the name of ISA-95 is “Enterprise–Control System Integration”, it would seem logical that information exchange models for Level 2<>3 exchanges should be defined at some point in time. The definition of such information exchange models is beyond the scope and problem statement of the PCMWG. The PCMWG is requested to consider whether a recommendation should be made to the ISA-95 Committee to commission a separate working group to investigate and propose information exchange models for Level 2<>3 exchanges.

## Mfg Event Profile

Note: The proposed *mfg event profile* object has only a preliminary definition in this paper. The purpose of this definition is to provide context by explaining to the PCMWG and the ISA-95 Committee that clear dependencies exist between the mfg event model and the mfg profile (proposed Part 8) in their separate working drafts. The dependencies in the mfg event model are only briefly defined in this discussion paper for the greater context. Since the *mfg event profile* object is under development in the Part 8: Mfg Profile working draft, the following preliminary definition and dependencies are subject to change and realignment with the mfg event model as work progresses.

The *mfg event profile* describes the events component of the *mfg profile* and is a description of the event exchange semantics supported within a defined scope. The *mfg profile* describes all message exchanges in a scope.

The *mfg profile* *scope* may be logical groups, ISA 99 zone / conduits or sections of the role based equipment hierarchy. For example: ISA 95 Mfg Profile, ISA 88 Mfg Profile, GS1, My Industry group, Vendor, Site Y, My Enterprise, Enterprise Zone, Operations Zone, Weigh and Dispense, etc.

The events and objects described may be a subset and/or extensions of those published in ISA-95 as well as custom *mfg event definitions*.

The *mfg event profile* groups the *mfg event definition* entries and *mfg class* entries into a defined namespace that fully describes the environment that these objects exist. When a *mfg event class* or *mfg event definition* is created it is a member of a *mfg event profile*. Other profiles may reference these objects in their profile using the Fully Qualified Name (FQN) that indicates the source of the object. Only the *mfg event profile* that created and published the object can modify the object. Updates incorporate version information to avoid change clashes.

Note: The FQN syntax is required to avoid name and semantic clashes and allow clear representation of object ownership.

Note: The *mfg profile* documents other information applicable to a *mfg profile scope*. Details of *mfg profiles* are presented in the under development ISA-95 Part 8 working draft.

# ISA-95 manufacturing event object relationships and attributes

## Mfg event relationships and attributes

Table 3 defines the relationship of the *mfg event* objects. Table 4 defines the attributes of *mfg event* objects*.*

Table 3 - Mfg event relationships

| Related object | Relationship | | | | Description |
| --- | --- | --- | --- | --- | --- |
| Source | Multiplicity | Role | Type |
| Mfg event record | Mfg event record | 0..n | Is a collection of | Composite | See *mfg event record* for details |
| Mfg event property | Mfg event property | 0..n | Has values for | Composite | General bag of properties associated with the event. There is no formal validation of the property contents. |
| Mfg event definition | Definition ID | 1..1 | Defined by | Association | The *mfg event definition* that defines the structure and generic context of the message. |
| Mfg event | Associated event ID | 0..n | Is associated with | Association | The events related to this message. The reference is an ID with any additional attributes required. |
| Mfg event profile ID | Profile | 1:1 | Is part of | Association | The *mfg event profile* this event is a part of. |
| Mfg event class | Class ID | 0..n | Supports | Association | The class this *mfg event* supports. May need to include the full class hierarchy to fully qualify the *class ID.* |

Table 4 - Mfg event attributes

| Attribute name | Description | Production examples | Maintenance examples | Quality examples | Inventory examples |
| --- | --- | --- | --- | --- | --- |
| ID | Unique identification of the *mfg event*. | P\_0004293 | M32D | 834 | Inven88 |
| Description | Additional information and description of the event occurrence. | The order P894 is delayed |  |  |  |
| Effective timestamp | The date and time the real world event occurred. | Mon August 16 at 01:36 PM | 2014-03-07 10:00 UTC | 2010-04-27 10:30 | 2011-01-20 14:45 UTC-10 |
| Record timestamp | The time the *mfg event* was recorded / transacted by the publisher. | Mon August 16 at 01:36 PM | 2014-03-07 10:01 UTC | 2010-04-27 10:30 | 2011-01-20 14:45 UTC-10 |
| Priority | Priority of the *mfg event.* Is a guide to the relative level of importance of a *mfg event.* | 2 | Low | Error | 9 |
| 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 |
| Source | The activity that generated the *mfg event*. This is typically a process step or system application component. | Mixing phase,  Infeed |  | Lab C |  |

## Mfg event property relationships and attributes

Table 5 defines the relationships of *mfg event property* objects. Table 6 defines the attributes of *mfg event property* objects*.*

Table 5 - Mfg event property relationships

| Related object | Relationship | | | | Description |
| --- | --- | --- | --- | --- | --- |
| Source | Multiplicity | Role | Type |
| Mfg event |  | 0..1 | Is a property of | Composite part | See relationship representation for details on composition part. |
| Mfg event definition properties | ID | 0..1 | May map to | Association | If the same ID exists in a *mfg event definition property,* the attributes of the property will be the same. |
| Mfg event property |  | 0..n | May contain nested | Composite part hierarchy | See relationship representation for details on composition part hierarchy. |

Table 6 - Mfg event property attributes

| Attribute name | Description | Production examples | Maintenance examples | Quality examples | Inventory examples |
| --- | --- | --- | --- | --- | --- |
| ID | An identification of the specific *mfg event property*. | 124 | SM | 001 | 45 |
| Description | Additional information about the *mfg event property*. | On time switch over | Scheduled maintenance | Test ready | Not applicable |
| Value | The value, set of values, or range of the property. | 99387A | 105 | 88765 | 1856 |
| Unit of measure | The unit of measure / format of the value. | number | hrs | % | Kg |

## Mfg event record relationships and attributes

Table 7 defines the relationships of a *mfg event record* objects. Table 8 defines the attributes of a *mfg event* *record* objects*.*

Table 7 - Mfg event record relationships

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Related object** | **Relationship** | | | | **Description** |
| **Source** | **Multiplicity** | **Role** | **Type** |
| Mfg event |  | 1 | Child of | Composite Part | *Mfg event records* are child elements within a *mfg event.* |
| ISA-95 object | ISA-95 object | 1..\* | Records action on | Composite | *Mfg event records* acts as a container for *ISA-95 objects* with common *action* applied. |
| Mfg event definition record specification | Specification ID | 1..\* | Validated by | Dependency | *ISA-95 objects* allowed to be contained with the *mfg event record* are defined by the specification(s) with *actions* matching the *action* attribute in this entry. |

Table 8 - Mfg event recordattributes

| Attribute name | Description | Production examples | Maintenance examples | Quality examples | Inventory examples |
| --- | --- | --- | --- | --- | --- |
| Action | The action performed on the *ISA-95 object(s)* associated with the *mfg event record*.  Defined values are:   * Added * Changed * Deleted | Deleted | Created | Changed | Changed |
| Effective timestamp | The date and time for which the *mfg event record* and its *action* was/is effective. If no entry is provided the *effective timestamp* is the *effective timestamp* represented in the *mfg event*. | Mon August 15 at 01:36 PM | 2014-03-06 10:00 UTC | 2010-04-26 10:30 | 2011-01-20 12:45 UTC-10 |
| Record timestamp | The date and time the publisher recorded/ transacted the *action*. If no entry is provided the *record timestamp* is the *record timestamp* represented in the *mfg event*. | Mon August 16 at 01:36 PM | 2014-03-07 10:05 UTC | 2010-04-27 10:00 | 2011-01-20 14:45 UTC-10 |

## ISA-95 object relationships and attributes

Table 9 defines the relationships of an *ISA-95 object* objects. Table 10 defines the attributes of an *ISA-95 object* objects*.*

Table 9 – ISA-95 object relationships

| Related object | Relationship | | | | Description |
| --- | --- | --- | --- | --- | --- |
| Source | Multiplicity | Role | Type |
| ISA-95 object | Item | 0..1 | Corresponds to an element in | Composite | An object defined in ISA-95 |

Note: The relationships populated in a *mfg event* occurrence is defined in the *mfg event record specification* entry.

Table 10 - ISA-95 object attributes

| Attribute name | Description | Production examples | Maintenance examples | Quality examples | Inventory examples |
| --- | --- | --- | --- | --- | --- |
| Confidence factor | A measure of the confidence of the *ISA-95 object* data. | Good | 100% | bad | Uncertain |
| Effective timestamp | The date and time for which the *ISA-95 object*(s) associated with the *mfg event record* was/is effective. If no entry is provided the *effective timestamp* is the *effective timestamp* represented in the either the *mfg event record* or *mfg event*. | Mon August 15 at 01:36 PM | 2014-03-06 11:00 UTC | 2010-04-26 10:30 | 2011-01-20 12:45 UTC-10 |
| Record timestamp | The date and time the publisher recorded/ transacted the action. If no entry is provided the *record timestamp* is the *record timestamp* represented in the *mfg event record* or *mfg event*. | Mon August 16 at 01:36 PM | 2014-03-07 10:00 UTC | 2010-04-27 12:30 |  |

## 

## Mfg event definition relationships and attributes

Table 11 defines the relationships for *mfg event definition* objects. Table 12 defines the attributes for *mfg event definition* objects*.*

**Table 11 - Mfg event definition relationships**

| Related object | Relationship | | | | Description |
| --- | --- | --- | --- | --- | --- |
| Source | Multiplicity | Role | Type |
| Mfg event | 1..1 to 0..n | 1..1 to 0..n | Defines | Association | The occurrences of the *mfg event definition*. There are many occurrences for each definition. |
| Mfg event class | Class ID | 0..n to 0..n | Defines a grouping of | Association | The classes this *mfg event definition* supports. |
| Mfg event profile | Profile ID | 1..1 | Corresponds to an entry in | Association | A reference to the *mfg event profile* that the *mfg event* is associated. |
| Mfg event record specification | Mfg event record specification | 0..n | Is a collection of | Composite | See *mfg event record specification* for details |
| Mfg event definition property | Mfg event definition property | 0..n | Has properties of | Composite | See relationship representation for details on representing relationships |

Table 12 - Attributes of mfg event definition

| Attribute name | Description | Production examples | Maintenance examples | Quality examples | Inventory examples |
| --- | --- | --- | --- | --- | --- |
| ID | Identification of the *mfg event definition*. | WorkAlert  ScheduleUpdate  DowntimeStart | JobCompleted | TestReport | Inven88  MaterialMovement |
| Description | Contains additional information and descriptions of the *mfg event definition*. | Notification of job started | Reminder that PM is overdue | Test setup complete | Shipment arrived |
| Priority | List of the priorities that act as a guide to the relative level of importance of a *mfg event.* | {1,2,3} | {Low, Medium, High} | {Information, Error} | {1..10} |
| 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 |
| Source | The activity, function, task or phase that generated the *mfg event*. Examples are a procedural element, equipment module, workflow step or business process activity. | Mixing phase,  Infeed | Maintenance Work Order started | Lab C received Sample A12 | Kanban Level Low |
| Acknowledgment | The *mfg event definition* ID’s of any expected subsequent notification. | MyProfile:A25 |  |  |  |

## Mfg event definition property relationships and attributes

Table 13 defines the relationships for *mfg event definition property* objects. Table 14 defines the attributes for *mfg event definition property* objects.

Table 13 - Mfg event definition property relationships

| Related object | Relationship | | | | Description |
| --- | --- | --- | --- | --- | --- |
| Source | Multiplicity | Role | Type |
| Mfg event definition |  | 0..1 | Is a property of | Composite part | See relationship representation for details on composition part. |
| Mfg event definition properties | ID | 0..\* | May map to | Association | If the same ID exists in a *mfg event class property*, the attributes of the property will be the same. |
| Mfg event properties |  | 0..\* | May map to | Association | If the same ID exists in a *mfg event property*, the attributes of the property will be the same. |
| Mfg event definition property |  | 0..\* | May contain nested | Composite Part Hierarchy | See relationship representation for details on composition part hierarchy. |

Table 14 - Mfg event property definition attributes

| Attribute name | Description | Production examples | Maintenance examples | Quality examples | Inventory examples |
| --- | --- | --- | --- | --- | --- |
| ID | An identification of the associated *mfg event definition property*. |  |  |  |  |
| Description | Additional information and description about the *mfg event definition property.* |  |  |  |  |
| Value | The value, set of values, or range of the associated property.  Examples: A range of possible numeric values, a list of possible values, or it may be empty if any value is valid. |  |  |  |  |
| Value unit of measure | The unit of measure of the associated property values, if applicable. |  |  |  |  |

## Mfg event definition record specification relationships and attributes

Table 15 defines the relationships for *mfg event definition record specification* objects. Table 16 defines the attributes for *mfg event definition record specification* objects.

Table 15 - Mfg event definition record specification relationships

| Related object | Relationship | | | | Description |
| --- | --- | --- | --- | --- | --- |
| Source | Multiplicity | Role | Type |
| Mfg event definition |  | 1 | Is a part of | Composite part | The *mfg event record definition* contains \*..n *mfg event definition record specifications.* |
| Mfg event record specification ID | ID | 0..\* | Validated by | Association | Allowed ISA-95 object in *mfg event record* defined by |
| Mfg event class record specification |  | 0..\* | May map to | Association | The *mfg event class record specification* that has defined this entry. |

Table 16 - Mfg event definition record specification attributes

| Attribute name | Description | Production examples | Maintenance examples | Quality examples | Inventory examples |
| --- | --- | --- | --- | --- | --- |
| ID | Identification within the associated *mfg event definition* *specification*.  *Mfg event* instances will include this value with their *mfg event record* object to enable recognition / validation of the message contents. | CR-87 | Uuid - 1FCF9DA1-DCC5-4012-BDEF-D76C754F4826 | 2016-03 | AB45 |
| Description | Contains additional information and description of the *mfg event definition record specification*. |  |  |  |  |
| ISA-95 object item | The *ISA-95 object* items allowed in the *ISA-95 object* occurrence.  An unconstrained set of values can be represented with the \* entry. | [Equipment, Personnel], | [JobList] | [TestSpecfication, Test Results] | [Material Lot, Material Sublot], |
| ISA-95 object  cardinality | The range of *ISA-95 object items* allowed to be represented in the *mfg event* occurrence.  If no limit is explicitly specified, the unbounded keyword is specified.  If no *cardinality* entry is specified, this is equivalent to no constraint, i.e.: {Min: 0, Max: Unbounded} | {Min: 1, Max: 1} | {Min:0, Max: 1} | {Min:0, Max: 10 } | {Min:1:Max: Unbounded} |
| ISA-95 object action | The permitted set of actions applied to the *ISA-95 object items* by the *mfg event* publisher.  Defined values for action are:   * Added * Changed * Deleted   If no *action* is specified, this is equivalent to all *actions* being allowed. | Added, Deleted, Changed | Changed | Added, Deleted, Changed | Added |
| Action cardinality | The range of *ISA-95 object actions* allowed to be represented in the *mfg event* occurrence.  If no limit is explicitly specified, the unbounded keyword is specified.  If no *cardinality* entry is specified, this is equivalent to no constraint, i.e.: {Min: 0, Max: Unbounded}. | {Min: 1, Max: 1} | {Min:0, Max: 1} | {Min:0, Max: 10 } | {Min:1:Max: Unbounded} |

## Mfg event class relationships and attributes

Table 17 defines the relationships for *mfg event class* objects. Table 18 defines the attributes for *mfg event class* objects.

Table 17 - Mfg event class relationships

| Related object | Relationship | | | | Description |
| --- | --- | --- | --- | --- | --- |
| Source | Multiplicity | Role | Type |
| Mfg event class |  | 0..n | May be derived from | Composite  part  hierarchy | See relationship representation for details on composition part hierarchy. |
| Mfg event class property | Mfg event class property | 0..n |  | Composite |  |
| Mfg event profile ID  (Profile) | Profile ID | 1..1 | Specified in | Association | A reference to the *mfg event profile* that the *mfg event* is associated with |
| Mfg event class record specification |  | 0..n | Is a collection of | Composite | See relationship representation for details on composition |

Table 18 - Mfg event class attributes

| Attribute  names | Description | Production examples | Maintenance examples | Quality examples | Inventory examples |
| --- | --- | --- | --- | --- | --- |
| ID | An identification of the associated *mfg event class.* | Production,  Deviation Alarm | Maintenance | MyOrg:Quality | MyOrg:Inventory |
| Description | Additional information and description about the *mfg event class.* |  |  |  |  |
| Extension | Defines constraints on the inclusion of the respective *mfg event class* in a hierarchy.  Defined value: sealed - no entry can use this entry as its parent.  Has a set of entries of other *mfg event classes* who are allowed to represent this entry in their parent.  No entry allows any entry to represent this entry as its parent /ancestor. | Level 4, Level 3 | Mfg Alert | Mfg Alert | Mfg Alert |

## 

## Mfg event class property relationships and attributes

Table 19 defines relationships of *mfg event class property* objects. Table 20 defines the attributes for *mfg event class* property objects.

Table 19 - Mfg event class property relationships

| Related object | Relationship | | | | Description |
| --- | --- | --- | --- | --- | --- |
| Source | Multiplicity | Role | Type |
| Mfg event class |  | 0..1 | Is a property of | Composite part | See relationship representation for details on composition part. |
| Mfg event definition properties | ID | 0..\* | May map to | Association | If the same ID exists in a *mfg event class property*, the attributes of the property will be the same. |
| Mfg event class property |  | 0..\* | May contain nested | Composite Part Hierarchy | See relationship representation for details on composition part hierarchy. |

Table 20 - Mfg event class property attributes

| Attribute name | Description | Production examples | Maintenance examples | Quality examples | Inventory examples |
| --- | --- | --- | --- | --- | --- |
| ID | An identification of the associated *mfg event class property* unique under the parent *mfg event class*. |  |  |  |  |
| Description | Additional information and description about the *mfg event class property.* |  |  |  |  |
| Value | The value, set of values, or range of the associated property.  Examples: A range of possible numeric values, a list of possible values, or it may be empty if any value is valid. |  |  |  |  |
| Value unit of measure | The unit of measure of the associated property values, if applicable. |  |  |  |  |

## Mfg event class record specification relationships and attributes

Table 21 defines the relationships for *mfg event class record specification* objects. Table 22 defines the attributes for *mfg event class record specification* objects.

Table 21 - Mfg event class record specification relationships

| Related object | Relationship | | | | Description |
| --- | --- | --- | --- | --- | --- |
| Source | Multiplicity | Role | Type |
| Mfg event definition record specification | ID | 0..\* | Mapped to | Association |  |
| Mfg event class specification |  | 1 | Is a collection of | Composite Part |  |

Table 22 - Mfg event class record specification attributes

| Attribute name | Description | Production examples | Maintenance examples | Quality examples | Inventory examples |
| --- | --- | --- | --- | --- | --- |
| ID | Identification of the *mfg event class record specification.* | CR-87 | Uuid - 1FCF9DA1-DCC5-4012-BDEF-D76C754F4826 | 2016-03 | AB45 |
| Description | Contains additional information and description of the *mfg event class record specification*. |  |  |  |  |
| ISA-95 object item | The *ISA-95 object items* allowed in the *ISA-95 object* occurrence.  An unconstrained set of values can be represented with the \* entry. | [Equipment, Personnel], | [JobList] | [TestSpecfication, Test Results] | [Material Lot, Material Sublot], |
| ISA-95 object  cardinality | The range of *ISA-95 object items* allowed to be represented in the *mfg event* occurrence.  If no limit is explicitly specified, the unbounded keyword is specified.  If no *cardinality* entry is specified, this is equivalent to no constraint, i.e.: {Min: 0, Max: Unbounded} | {Min: 1, Max: 1} | {Min:0, Max: 1} | {Min:0, Max: 10 } | {Min:1:Max: Unbounded} |
| ISA-95 object action | The permitted set of *actions* applied to the *ISA-95 object items* by the *mfg event* publisher.  Defined values for action are:   * Added * Changed * Deleted   If no *action* is specified, this is equivalent to all actions being allowed. | Added, Deleted, Changed | Changed | Added, Deleted, Changed | Added |
| Action cardinality | The range of *ISA-95 object actions* allowed to be represented in the *mfg event* occurrence.  If no limit is explicitly specified, the unbounded keyword is specified.  If no *cardinality* entry is specified, this is equivalent to no constraint, i.e.: {Min: 0, Max: Unbounded} | {Min: 1, Max: 1} | {Min:0, Max: 1} | {Min:0, Max: 10 } | {Min:1:Max: Unbounded} |

1. Although publish-subscribe messaging is typically associated with the publication of and subscription to events, it is possible to publish request/command messages. The SYNC verb in Part 5 is an example of this, where the published SYNC messages are requests for subscribing systems to add, change and delete data [↑](#footnote-ref-2)