Project i-TRACE

Implementation Guideline for standardized Identification & Marking of parts and components in the Australian Rail Industry

How to Identify and Mark Maintenance, Repair and Overhaul (MRO) materials and components using GS1 Open Global Supply Chain Standards

141 01

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[1] https://www.gs1.org/docs/rail/Identification_of_Components_and_Parts_in_Rail_Industry_Application_Standard.pdf

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Approval decision

Steering Team Member(s)	Company	Title	Date Approved
ARA Inventory Management Work Group		Work Group participants	30 August 2017
ARA i-TRACE Work Group		Work Group participants	Pending

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How to use this document

For the convenience of the reader, this document has been organised in two main sections:

Business Section

The business section provides the reader with an understanding of the background and purpose of this initiative. It outlines some examples and learnings from other industries and what the Australian rail industry can expect to gain from the implementation of GS1 supply chain standards for the management of Parts and Components.

Technical Section

The technical section is aimed at the IT departments of those organisations who have made a business decision to proceed with implementation. It outlines the technical data elements and schemas for designing how the information on barcodes and/or RFID tags should be represented and structured in enterprise systems.

The technical section outlines the minimum requirements for the Australian rail industry but   does not preclude an organisation going beyond these requirements should they wish.
Additionally, this guideline will reference other GS1 technical documentation where applicable so as not to duplicate effort. Appropriate links and references are highlighted throughout the document.
Further technical support can be obtained from GS1 Australia or any number of independent solution providers who offer GS1 standards compliance within their product/service suites. A directory of such providers can be found on the GS1 Australia website:
www.gs1au.org/what-we-do/solution-providers/find-a-solution-provider/

Business Section

Introduction

The Australian rail network is one of the largest in the world with:

- More than 2,000 locomotives - 35% less than 5 years of age and around 14% more than 30 years old
- Approximately 32,000 wagons and carriages
- Around 33,000 route km of track and 452 route km under construction (44,200km if all lines e.g. sugar cane lines are included).

Figure 1: Australian rail network

This makes the asset management task for the rail industry very large and the management of parts and components is a critical part of this task. It is estimated that the asset management task in the Australian rail industry is a multi-billion-dollar undertaking.

The task is growing! There has been significant expansion with increased levels of investment from both the private and public sector over the past decade and this is set to increase further with a range of projects in urban and interstate freight rail either underway or planned over the next 10 – 20 years.

In order to adequately plan for the entire asset life-cycle, rail asset owners need to incorporate proactive and preventative maintenance into their inventory and asset management processes from the very beginning. Asset management enables the realisation of value from assets using analytical approaches and implementation processes that have similar core characteristics, no matter what the industry.

The Australian rail industry has a long history characterised by diverse standards and requirements across state, market segment and customer boundaries resulting in a fragmented industry and small disparate markets. Increased demand for passenger and freight rolling stock has compounded the wear-and-tear of existing infrastructure, compelling asset owners to improve their planning and maintenance processes to get the most out of their assets.

Currently, in the Australian rail environment, there is no standardised approach to how parts and components are identified and marked; everyone is doing their own thing. Ambiguity of identification is having a negative impact on cost, customer service, quality and safety across the rail industry. As shown in the below example, there is no common understanding of what a material between one organisation and another is.

Figure 2: Identification without standards
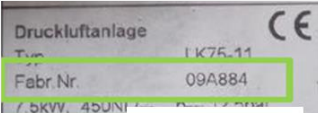
The ARA and its members have been working with GS1 Australia to lay a critical path forward that provides the rail industry with the opportunity to improve efficiency, reduce costs and offer better customer service. The industry has agreed on the type of materials and components that should be labelled and/or tagged, the identification elements to be used and the data carriers that should be adopted by the industry to ensure successful application in all environments.

The decision to apply the standards and processes outlined in this guideline is for an individual organisation to make. This guideline provides details about the process of how to mark materials should the organisation proceed along these lines.

As the rail industry in Australia seeks to adopt the key principles of global best practice inventory and asset management processes, there is increased demand for improved capture of accurate data at all points of the value chain. This should be a key objective for all trading partners if they are to effectively meet their company's needs and exceed customers' expectations.
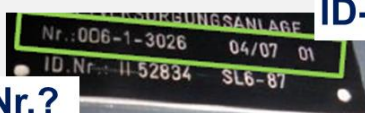
The optimal efficient servicing of customers is the process of supplying the right products, right quantity, right price and right quality at the right time and place with a minimum of effort and cost. The benefits include the avoidance of time wasting tasks, avoidable manual handling, duplication of data, measured in terms of lower costs and higher levels of service.

Achieving efficiency in the management of the supply chain relies on having fast, accurate and timely information about production, distribution, stock holdings and consumption. The need for a highly responsive supply chain is driving forward the development of communication techniques.

Technologies such as automatic data capture (ADC), using bar coding or RFID technologies, electronic business-business messaging, master data synchronisation and real-time physical event tracking are essential for this communication. Any company serious about exploiting the concepts and practices of supply chain management must be competent in the use of these technologies. Nothing is more central to the effectiveness of a supply

chain than the ability to electronically transmit accurate, relevant, understandable and timely information among its participants.

These guideline recommendations for best practice encompass the minimum requirements of the Australian Rail Industry. Adoption of these recommendations should bring improved business efficiency and effectiveness for all companies within the rail supply chain and by default, in fact significantly lower the overall cost base of the entire industry.

Why do this?

Rail operators obtain their materials from a variety of suppliers, some local, many international. This drives the need for interoperability among the stakeholders in the rail supply chain processes.
The materials used in the industry are very diverse – from small consumables, to large rotables that can be in use for decades. This means over time a substantial history is built up involving many different stakeholders and hence it is important to have a full and accurate recorded maintenance history accessible by all stakeholders along the maintenance supply chain.

Using a common, standards based approach to the identification (numbering/codification) and marking of trade items, logistic units, locations, assets, and documents, as well as the capability to capture information about them, will deliver the benefits of speed, accuracy and labour savings in the handling and distribution of goods throughout the entire value chain.

Companies should consider that the implementation of the GS1 standards is applicable not only to meet customer or trading partner requirements but also to improve internal supply chain management processes.

The benefits listed below are defined generically for users throughout the entire value chain.

- Reduced inventory costs,
- Improved inventory management and control
- Improved traceability and life cycle management
- Improved warranty management
- Improved asset management processes
- Improved stocktaking
- Reduced picking errors
- Reduced order transaction errors
- Increased delivery in full and on time KPIs
- Common identification across Industry
- More accurate, real-time information
- Reduced manual entry
- Enables anti-counterfeit and product authenticity
- Improved configuration management
- Enables predictive maintenance at a more granular level or object class

Harmonisation of the numbering schemas on bar codes and in RFID tags across the rail industry for parts, components and assemblies forming the industry's inventory will:

1. Facilitate effective tracing and tracking throughout the complete life cycle of a part/component,
2. Unify the identification process requirements of the operators and track owners regarding parts suppliers and manufacturers
3. Facilitate automated Procurement to Pay (P2P) processes

To deliver these benefits there is a need for a unified numbering structure and supplier requirements linked to it to keep transaction, administration and process costs as low as possible.

Case study examples

ATE Continental
Using GS1 DataMatrix to protect its brand and customers

In the automotive industry, low quality copies of safety-relevant spare parts can present a high risk for consumer safety. Counterfeiting can also cause immense economic losses and damage to a brand...*Read more*

MBDA Germany
Delivering expert knowledge globally with GS1 DataMatrix

MBDA needed to provide maintenance and upkeep of highly complex systems without an expert on-site, often in crisis areas or on the high seas. Even though the company deployed a tele maintenance platform, it needed to be able to clearly identify assemblies for effective repairs…*Read more*

Lenze
Drives efficiencies for outbound shipments with GS1 standards

Lenze needed to gain visibility of outbound shipments that were travelling from its 10 logistics centres to customers worldwide. The company also wanted to connect new logistics service providers to its logistics system in a much more efficient and cost-effective way…*Read more*

European regulatory requirements

Companies operating in the European market are impacted by recent European legislation outlining that rail and rail network operators must develop and maintain management systems which guarantee a safe and stable operation as well as the interoperability of the assets used.

This entails that all MRO-objects will undergo a risk analysis reflecting their potential impact on safety. Moreover, a configuration management is compulsory, as required by regulations 445/2011. 1169/2010 and 1158/2010.

Who does this involve?

The MRO management processes within the Australian rail industry involves a wide range of stakeholders. An operator can have many hundreds of suppliers. At least the following are stakeholders:

- Infrastructure Managers
- Manufacturers (rolling stock and infrastructure)
- Contractors (building and maintaining rail)
- Suppliers
- 3rd party maintenance and repair providers
- 3rd party logistics providers

It is important to recognise that in many cases material suppliers are supplying a much wider customer base than the rail industry. Where possible the guideline will align with common best practice that may already exist or can be leveraged in other sectors.

What materials should be identified?

This guideline has been developed by GS1 Australia with the help of key rail organisations in Australia including the Australasian Railway Association, railway infrastructure managers, rail operators, component manufacturers/suppliers and contractors. It also incorporates the work of the parallel EU work group initiative.

It details how to identify rail components within the framework of the GS1 System of open, global data standards.

The rail industry has nominated the materials categories that need to be identified and marked/labelled. These items are:

- Consumables
- Capital equipment
- Rotable
- Non-rotable

Figure 3: Consumables, capital equipment, rotable and non-rotable items

The Australian Rail Industry have agreed to implement standards based identification system for rail components that support the maintenance and repair of vehicles and infrastructure within the industry by 1 January 2019.[2]

MRO ("Maintenance, Repair and Overhaul") involves fixing any sort of mechanical or electrical device should it become out of order or broken (known as repair, unscheduled or casualty maintenance). It also includes performing routine actions which keep the device in working order (known as scheduled maintenance) or prevents trouble from arising (preventative maintenance). MRO may be therefore defined as all actions which have the objective of retaining or restoring an item in or to a state in which it can perform its required function. The actions include the combination of all technical and corresponding administrative, managerial and supervision actions.

The Australian Railway Industry has collaborated on the need to implement open global GS1 standards for Automatic Identification and Data Capture (AIDC) technologies such as barcodes and RFID to enable the electronic capture of data in relation to their MRO processes. The industry working group has identified the need to track MRO parts that are already-in-circulation as well as the new parts that are being produced by manufacturers.

Examples of MRO parts are:

- Wheelsets
- Bogies
- Pantographs
- Safety equipment

The MRO parts need to be read at various reading distances (short distances in storage conditions and longer distances on rolling stock). Readability will be affected by various conditions, like weather, which will influence the tracking process of the parts.

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[2] https://www.gs1au.org/uploadedFiles/Content/6.Resources/Documents(1)/Publications/ARA-GS1-call-to-action-parts-and-components-id-project.pdf

The inventory and maintenance supply chain in rail

MRO inventory for a rail organisation move through the supply chain from manufacturer to the organisation, and typically involves a variety of intermediary organisations, transport (shipping) modes and inventory control processes. This could be represented as shown below.

Figure 4: Maintenance Supply Chain

Lessons from other industries

GS1 standards have been widely applied in several sectors including (but not limited to) food and grocery, retail and healthcare. Perhaps the best known of these is bar coding on grocery items. In the early 1970s, global grocery retailers and suppliers such as Walmart and Proctor and Gamble agreed on common product identification standards to enable the implementation of automated scanning of product at the point of sale.

For example, a 375ml can of Coca Cola has the same barcode for ALL Australian retailers. This barcode contains a globally unique identification key that points to information about the supplier (Coca Cola) and the product (375ml can of Coca Cola). Additionally, a barcode applied to the logistics unit[3] (pallet containing 20 x 24 can cartons of Coca Cola) which links information to each stakeholders' IT system for their own supply chain management purposes including inventory control and procurement processes.

Figure 5: GS1 Standards in Action - Retail *http://discover.gs1.org/cpg/languages/*

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[3] *https://www.gs1.org/1/tlkeys/index.php/p=assets_list/atid=12*

Figure 6: GS1 Standards in Action - Healthcare *https://www.youtube.com/watch?v=KVlkDM_fdv8*

GS1 standards helping NHS save time, money and most importantly save lives

The GS1 System of global supply chain standards is not a software application; it is an integrated suite of data standards and code definitions that enable visibility and interoperability in the Value Chain. The GS1 Identification Keys are the foundation of the GS1 System. They, and other GS1 data standards, are defined independently of data carrier and information sharing technologies in which they are used.

The GS1 System embodies an open architecture approach. It has been carefully designed for modular expansion with minimal disruption to existing applications. Enterprise Resource Planning (ERP) and other application software drive implementation of the system.

The GS1 System is designed based on three layers (Identify, Capture and Share) which assist in establishing a modular approach where individual components of the GS1 System can be defined and documented independently of one another:

Figure 7: GS1 System of Global Data Standards

Identify - The GS1 Identification Keys offer standards for globally unique identification (numbering or codification) of trade-able items, fixed and returnable assets, shipments, consignments, locations, entities, documents etc. so that interested parties can get relevant information about them. These globally-recognised keys are the foundation of the GS1 System.

Capture - GS1 Barcodes and GS1 EPC/RFID[4] are global standards for data carriers that provide accurate and automatic capture of data. GS1 data carrier standards help companies improve many critical business processes, such as tracking product shipments, tracing medical devices in hospitals, managing inventory in warehouses or depots, facilitating maintenance & repair activities, etc.

Share - GS1 EDI[5], GS1 GDSN[6] and GS1 EPCIS[7] are global standards that enable electronic data exchange. They provide secure and efficient sharing of information to, from and between trusted and authentic sources.

Business data shared between trading partners includes:

Master data – Detailed information about a trade item or logistic unit, such as weight and size, description, brand, country of origin etc. – synchronised via the GS1 GDSN;

Transaction data – Includes purchase or service order, despatch and receival advice, transport instruction, invoice etc - exchanged automatically with GS1 EDI;

Physical event based traceability data – Information about the physical world activity or movement of an object (ideally in real-time) as it moves from origin to destination – shared with GS1 EDI or GS1 EPCIS.

Figure 8: Identify, Capture and Share

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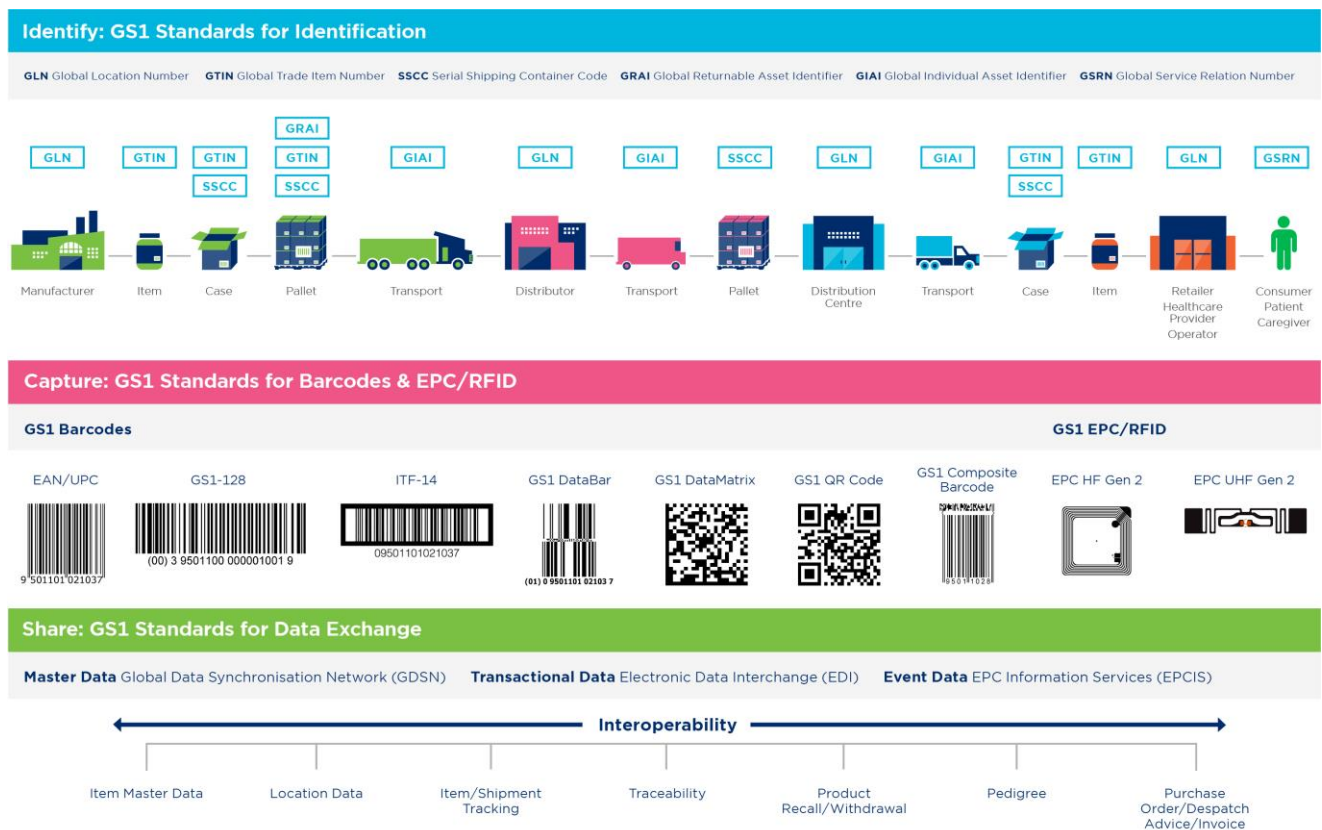
[4] EPC/RFID – Electronic Product Code Radio Frequency Identification http://www.gs1.org/epc-rfid
[5] EDI – Electronic Data Interchange http://www.gs1.org/edi
[6] GDSN – Global Data Synchronisation Network http://www.gs1.org/gdsn
[7] EPCIS – Electronic Product Code Information Service http://www.gs1.org/epcis

Technical Section

1   Introduction

This section explains how to use the GS1 identification keys and attributes for the identification of parts and components in the rail industry. Contributors have expressed their commitment to implement the approaches described in this standard to ensure interoperability among rail stakeholders and other related sectors.

In the rail sector interoperability means the ability of a rail system to allow the safe and uninterrupted movement of trains while accomplishing the required performance level. This helps to ensure that rolling stock of operator A can operate on infrastructure of infrastructure managers B, C, D, etc., because the parts where the systems meet (wheelsets, rails, ETCS-components, pantographs, switches, toilet drains, etc.) are guaranteed to be compatible. These norms also include configuration management requirements, to ensure that only compatible parts are used on interoperable sections of rolling stock / infrastructure.

The standard consists of two main parts:

■   The principles, covered in sections 4 to 5, explain the main business needs and challenges and the way these will be addressed. The principles are not rules but help to explain the logic behind the rules.

■   The rules, covered in sections 6 to 9, specify how the identification keys, data attributes and data capture standards must be applied.

This standard will periodically be updated, reflecting the learnings of initial implementations. Please see the page on the website *http://www.gs1.org/rail* for more information about GS1's projects and developments in rail.

1.1   Target audience

This standard is intended to be used by all parties involved in rail manufacturing, maintenance, repair, and overhaul processes. These include:

■   Manufacturers (system integrators, system manufacturers, component supplier),

■   Operators (rail network operators, rail operators),

■   Service providers (MRO workshops, project contractors, logistics service providers, and

■   Regulators.

1.2   Scope of the standard

Today's rail manufacturing industry and supply chain is becoming ever more open and competitive, with traditional national players being privatised, competing with new entrants and sourcing their materials from all over the world.

At the same time the rail industry is being challenged by its customers to improve reliability and quality, and by regulatory bodies to implement measures aimed at further improving safety.

As a result manufacturing and MRO processes have become far more international and complex than before. This drives the need for greater interoperability among rail manufacturing & MRO process stakeholders and among their systems and value chains.

In order to meet these challenges, the entire rail industry must improve its manufacturing & MRO processes and in particular develop capabilities for reliable life cycle tracking of components and parts (referred to as MRO-objects in this standard) across companies, supply chains and over life cycles of up to 60 years.

The critical enabler will be the ability to **unambiguously** identify MRO-objects and materials across the systems and processes of all stakeholders. Depending on the operational and safety characteristics as well any legal requirements, objects and materials will need to be identified on class-level, lot-level and more and more frequently down to serial-level.

This standard defines the rules, roles and responsibilities regarding the allocation of GS1 identification keys and regarding the marking of objects and materials using barcodes, EPC/RFID tags and plain text.

1.3 Conventions applied in the standard

1.3.1 References

References to documents, websites etc. are indicated as follows [REFERENCE, paragraph number (optional)]. The list of references with full details is included in section 2.

1.3.2 Rules and recommendations

Rules and recommendations are numbered per section. For example, clause [4-3] is the 3rd clause in section 4.

Within this specification, the terms SHALL, SHALL NOT, SHOULD, SHOULD NOT, MAY, NEED NOT, CAN, and CANNOT are to be interpreted as specified in section 7 of the ISO/IEC Directives, Part 2, edition 7.0 [ISODir2. When used in this way, these terms will always be shown in ALL CAPS; when these words appear in ordinary typeface they are intended to have their ordinary English meaning.

1.3.3 Format of element strings

The following conventions are applied to indicate the format of GS1 Application Identifiers and data fields.

To indicate the allowed characters:

- N numeric digit
- X any character, see [GENSPECS, figure 7.11 – 1] for the allowed characters.

To indicate the length:

- Nn exact number of digits
- N..n maximum number of digits
- Xn exact number of characters
- X..n maximum number of characters

Examples:

- X3 exactly 3 characters
- N..18 up to 18 numeric digits

To indicate digit / character position:

- X_n
- N_n

Examples:

- N_3 numeric digit on position 3
- X_{16} any character on position 16

2   References

Table 2-1: Normative references

REF ID	Document	Author / Year
GENSPECS	GS1 General Specifications, version 17.1	GS1, 2016
10SBI	10 steps to barcode your products *http://www.gs1.org/ten-steps-gs1-barcode-implementation*	GS1, 2015
TDS	GS1 Tag Data Standard (TDS), version 1.10 *http://www.gs1.org/epc/tag-data-standard*	GS1, 2017
GSCN	General Specifications Change Notification for MRO in Rail project	GS1, 2016
ISODIR2	ISO/IEC Directives part 2; Rules for the structure and drafting of International Standards – 7th edition, 2016	ISO, 2016
GTINMAN	GTIN management rules *http://www.gs1.org/1/gtinrules/en/*	GS1, 2016
RAILVIZ	GS1 EPCIS for Rail Vehicle Visibility Application Standard	GS1, 2015

3 Terms and definitions

For the purposes of this document the following terms and definitions apply.

3.1 General concepts

MRO-object

An MRO-object is an umbrella term used to refer to and describe the entities that need to be managed, handled or in any other way used within the context of Manufacturing and MRO processes in Rail.

Commonly used synonyms of MRO-object are article, part, component, item, Line-Replaceable Unit (LRU) and Shop-Replaceable Unit (SRU). For the purpose of this document the term MRO-object encompasses all these synonyms.

Single MRO-object

An MRO-object which in view of the describing party (for instance rail operator) cannot be further broken down into new (sub-) objects.

Examples: isolator, bolt for rail fastening materials.

Composed MRO-object

An MRO-object which in view of the describing party (for instance rail operator) can be further broken down into new (sub-) objects. A composed MRO-object may be configurable or fully pre-defined.

Example: traction motor for electrical locomotive.

Software

A type of MRO-object that is a collection of computing programs developed for the purpose of being incorporated into a composed or single MRO-object.

Examples: firmware in an ETCS beacon, software in a door control system.

Kit

A kit is a non-homogeneous combination of MRO-objects and installation tools and materials, intended for one specific purpose, and stored, moved, priced, ordered or invoiced as a trade unit.

Synonyms: Set, Pre-defined assortment

Grouping

A grouping is a homogeneous combination of MRO-objects that is stored, moved, priced, ordered or invoiced as a trade unit.

Synonym: trade item grouping (of identical trade items)

Module

A module is a composed MRO-object that is designed to allow for different configurations. The included MRO-objects, and how they are designed to interact with each other, establish the complete configurable device (module).

Object class

An object class designates MRO-objects (including software) which are:

- identical in form, fit or function,
- can be used interchangeably,
- may be stored, moved, priced, ordered or invoiced individually,
- and form a part of or are used to operate rolling stock and/or rail infrastructure.

Trade item

Any item (product or service) upon which there is a need to retrieve pre-defined information and that may be priced, or ordered, or invoiced at any point in any supply chain. [GENSPECS]

3.2 Physical objects

Instance

An instance designates an individual manufactured MRO-object belonging to an object class. The instance has all the attributes of the object class and may have additional attributes also.

Synonym: Item, Product unit

Instance group

An instance group designates a collection of instances belonging to the same class with the same (production) characteristics.

For example, instances produced as part of the same production run or batch, with the same raw / base materials, by the same manufacturer, in the same plant, ...

An instance group is created by attribution of an attribute to an object class and therefore represents a subset of an object class.

Synonym: Batch / Lot

Configuration

A configuration is a defined occurrence of a module. It consists of a combination of multiple instances interacting with each other and thereby fulfilling a defined form, fit and function.

Primary packaging

Primary packaging is the material that first envelops the product and holds it. This usually is the smallest unit of distribution or use and is the package which is in direct contact with the contents.

Secondary packaging

Secondary packaging is outside the primary packaging, and may be used to prevent pilferage or to group primary packages together.

Tertiary packaging

Tertiary packaging is used for bulk handling, warehouse storage and transport shipping. The most common form is a palletized unit load that packs tightly into containers.

3.3 Maintenance, repair and overhaul

MRO strategy

The way a company is managing an MRO-object from a maintenance, repair and overhaul perspective. For example repairable, rotable, consumable.

The MRO strategy for a particular MRO-object may vary by party, and it may change over time. For example, an object that is treated as repairable at first may be treated as consumable at the end of its lifecycle.

Consumable

A type of MRO-object that is not re-fabricated and that is discarded after replacement.

Examples: isolators for power switches, rail fastening components.

Repairable

A type of MRO-object that can be re-fabricated and does not follow a usage based maintenance strategy and does not need to have an individual track record.

Examples: compressors, electrical relays.

Rotable

A type of MRO-object that can be re-fabricated, follows a usage based maintenance strategy and needs to have an individual track record.

Examples: wheel sets, rolling stock bogies.

Refurbishment

Refurbishment is the rebuilding of a product to specifications of the original manufactured product using a combination of reused, repaired and new parts. It requires the repair or replacement of worn out or obsolete components and modules. (Wikipedia)

Synonym: Remanufacturing—(APICS), re-fabrication

3.4   Identification

Unique identification

Depending on the scope / context the term unique identification may be used to refer to a globally unique identification key for an object class, an instance group or an instance.

- When referring to the object class key, the term class-level ID is used.
- When referring to the instance group key the term lot-level ID is used.
- When referring to the instance key, the term serialised ID is used.

Automatic Identification and Data Capture (AIDC)

A technology used to automatically capture data. AIDC technologies include barcodes, smart cards, biometrics and RFID. [GENSPECS]. As technologies continue to evolve, in the future this might also include sensors etc.

GS1 identification key

A unique identifier for a class of objects (e.g. a trade item) or an instance of an object (e.g. a logistic unit). [GENSPECS]

GS1 ID key issuance and allocation

Issuance is the generation of a GS1 Identification Key based on the format and syntax for that key and on the issuance policy of the managing entity.

Allocation is the association of the issued GS1 Identification Key with an object of the type supported by the GS1 Identification Key in accordance with the GS1 rules.

Different entities may be involved in each process. For example, a computer program could be used to do the issuance and a human could be used to do the allocation. A classic example of this is one where the IT department prepares a spreadsheet of available GTINs (see definition below) for use by the Product Development department. Each GTIN in the spreadsheet is issued, but until Product Development actually has a product for it, it is not considered to be allocated. [GS1 Architecture]

Global Trade Item Number (GTIN)

The GS1 identification key used to identify trade items. The key comprises a GS1 Company Prefix, an item reference and check digit. [GENSPECS]

Global Individual Asset Identifier (GIAI)

The GS1 identification key used to identify an individual asset. The key comprises a GS1 Company Prefix and individual asset reference. [GENSPECS]

GS1 Prefix

A unique string of two or more digits issued by GS1 Global Office and allocated to GS1 Member Organisations to issue GS1 Company Prefixes or allocated to other specific areas. [GENSPECS]

GS1 Company Prefix

A unique string of four to twelve digits used to issue GS1 identification keys. The first digits are a valid GS1 Prefix and the length must be at least one longer than the length of the GS1 Prefix. The GS1 Company Prefix is issued by a GS1 Member Organisation. As the GS1 Company Prefix varies in length, the issuance of a GS1 Company Prefix excludes all longer strings that start with the same digits from being issued as GS1 Company Prefixes. [GENSPECS]

U.P.C. Company Prefix

A GS1 Company Prefix starting with a zero ('0') becomes a U.P.C. Company Prefix by removing the leading zero. A U.P.C. Company Prefix is used to issue GTIN-12. [GENSPECS]

GS1 Application Identifier

The field of two or more digits at the beginning of an element string that uniquely defines its format and meaning.

Identification Requirements for the Australian Railway Industry covered in this guideline

The following GS1 Identification Keys and data attributes can be implemented to facilitate to cater for both local and global rail industry requirements:

Primary GS1 Identification Keys:

- GLN – Global Location Number
- GTIN – Global Trade Item Number
- GIAI – Global Individual Asset Identifier
- SSCC – Serial Shipment Container Code

Application Identifiers (AIs) – additional data attributes:

- Serial numbers – AI (21)
- Country of origin – AI (422)
- Manufacturing batch and lot numbers – AI (10)
- Expiry Date – AI (17)
- Internal reference numbers - AI (91 to 99)
- Customer part numbers – AI (241)
- Date & time of production - AI (8008)
- GIAI of Assembly - AI (7023)
- GLN of Production/Service Location - AI (416)
- Refurbishment Lot ID – AI (7020)
- Functional Status – AI (7021)
- Revision Status – AI (7022)

3.5   Marking

All physical objects and materials in the Australian Railway industry will be required to be physically marked at the earliest possible point in the value chain; ideally at point of manufacture.

Marking

noun: A means of physically affixing machine-readable data and/or human readable data to a physical object. (synonym: physical data carrier)

verb: The act of physically affixing machine-readable data and/ or human readable data to a physical object.

In the context of this document, marking means the physical marking of an object to facilitate the automatic capture of the Identification codes applied, typically through the application of barcodes and/or RFID technologies.

There are a variety of options to choose from when it comes to physically marking an object; the choice will depend on a range of considerations and applications. The owner of the specifications of the object, typically the OEM or the brand owner is best placed to make this decision from the outset of the object moving into the value chain.

Figure 3-1: Illustration of main concepts

Marking	Direct marking	Barcode	Direct part marking (p or np)
			Durable barcode (np)
		EPC/RFID	Embedded tag (p)
			Affixed tag (np)
		Non-HRI text	Intrusive (p)
			Durable (np)
	Packaging marking	Barcode	
		EPC/RFID	
		Non-HRI text	

(p=permanent marking, np = non-permanent marking)

Packaging marking

Packaging marking is marking applied on the packaging of the instance.

Direct marking

Direct marking is the process of applying a permanent mark to the trade item, in order for it to be identified during its full lifetime independent of its packaging.

Direct part marking (DPM)

Direct part marking refers to the process of marking a symbol on an item using an intrusive or non-intrusive method. [GENSPECS]

Permanent marking

Permanent marking (for instance engraving or a marking via an elevated contour of an object) is a type of direct marking connected to an instance in such a way that it cannot be removed without altering the MRO-object itself and / or would normally be expected to outlive the MRO-object.

Non-permanent marking

Non-permanent marking is a type of direct marking that can be applied or removed from an MRO-object without altering the object itself (bolted, glued, banded, etc.). This type of marking may be re-applied several times during the lifetime of an MRO-object and is not expected to outlive the MRO-object.

Human readable interpretation (HRI)

Characters, such as letters and numbers, which can be read by persons and are encoded in GS1 AIDC data carriers confined to a GS1 standard structure and format. The human readable interpretation is a one-to-one illustration of the encoded data. However, start, stop, shift and function characters, as well as the symbol check character, are not shown in the human readable interpretation. [GENSPECS]

Non-HRI text

Characters such as letters and numbers that can be read by persons and may or may not be encoded in GS1 AIDC data carriers and are not confined to a structure and format based on GS1 standards (e.g., a date code expressed in a national format that could be used to encode a date field in a GS1 AIDC data carrier, brand owner name, consumer declarations). [GENSPECS]

Data titles

Data titles are the abbreviated descriptions of element strings which are used to support manual interpretation of barcodes. [GENSPECS]

3.6   Data management

Standard Bill of Material

A standard bill-of-material (BOM) defines the MRO-objects that are part of a composed MRO-object, including a hierarchical breakdown from top level to lowest level MRO-objects. The standard BOM is defined in terms of contained MRO-object classes.

Note:

The required detail included in a standard BOM will depend on the role of the party. A manufacturer will have the full detail of all components, the operator may only require full detail of components that are of relevance to them (e.g. safety critical).

Instance Bill of Material

An instance bill-of-material (BOM) defines the instances that are part of a composed MRO object, including a hierarchical breakdown from top level to lowest level instances. The instance BOM is defined in terms of contained instances.

Note:

The required detail included in an instance BOM will depend on the role of the party. A manufacturer will have the full detail of all components, the operator may only require full detail of components that are of relevance to them (e.g. safety critical).

History (of an instance or object class)

Defines all changes made to an object class specification and / or the attributes of an instance as well as maintenance activities carried out at instance level throughout its lifetime.

See version history, maintenance history, usage history, testing history.

Version history

Defines all changes made to an object class specification.

Maintenance history

Record of the maintenance activities that were carried on an instance throughout its lifetime.

Usage history

Record of the operation (e.g. number of operating hours) of an instance throughout its lifetime.

Testing history

Record of the tests performed on an instance throughout its lifetime.

3.7 List of abbreviations

Abbreviation	Full term
AI	GS1 Application Identifier
AIDC	Automatic Identification and Data Capture
BOM	Bill Of Material
DPM	Direct Part Marking
EPC	Electronic Product Code
ETCS	Electronic Train Control System
GCP	GS1 Company Prefix
GIAI	Global Individual Asset Identifier
GLN	Global Location Number
GTIN	Global Trade Item Number
HRI	Human Readable Interpretation
MB	Memory Bank (of EPC/RFID tag)
MRO	Maintenance, Repair and Overhaul
RFID	Radio Frequency identification
SKU	Stock Keeping Unit

3.8 Conceptual diagram (informative)

Figure 3-2: Conceptual diagram
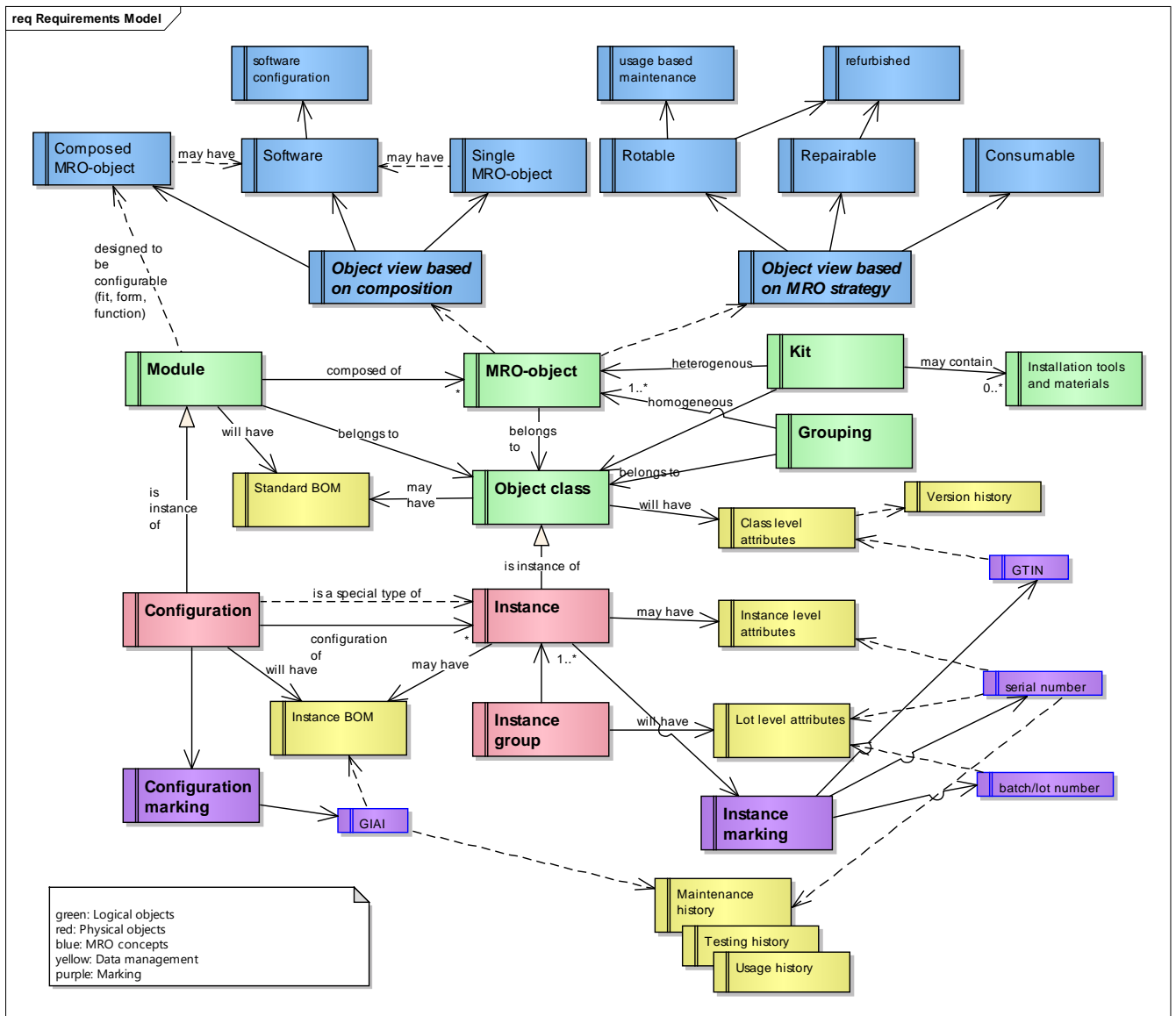
PART I - GENERAL PRINCIPLES

4 Lifecycle identification of MRO-objects

4.1 Value chain

Today's rail manufacturing and MRO industry has become global, with a relatively small number of system suppliers relying on an ever more fragmented international supply chain with a network of specialised suppliers for key components and assemblies.

Figure 4-1: Transition of the rail manufacturing and MRO industry
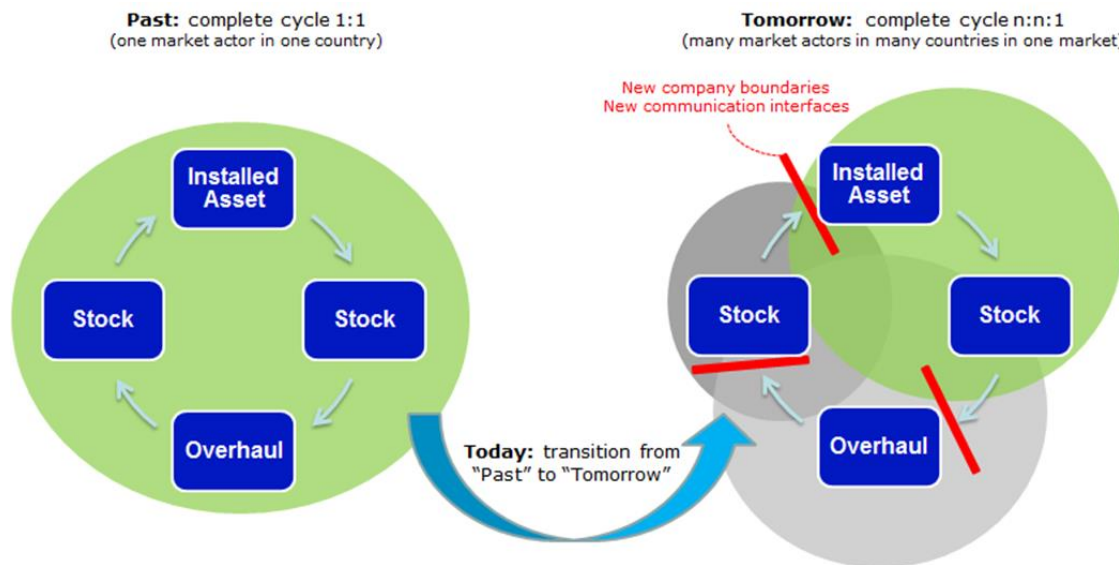
4.2 Business processes

Figure 4-2: Process roles
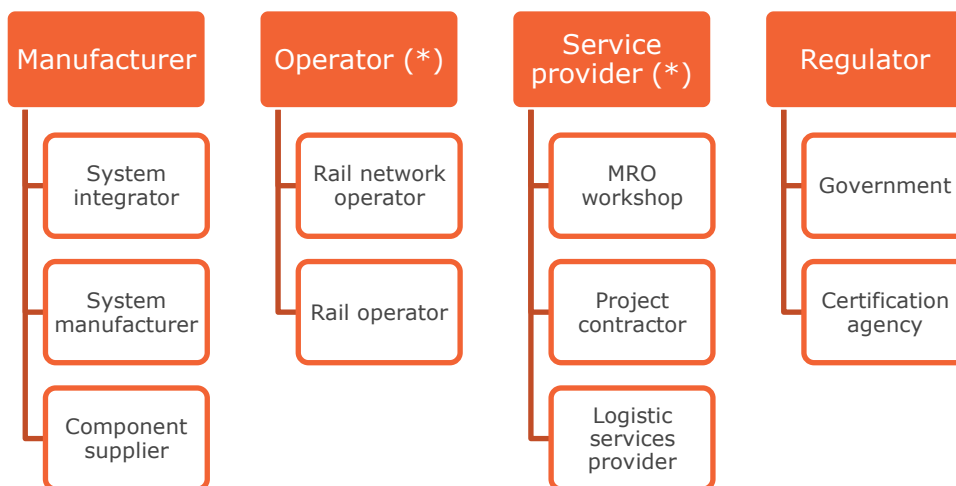
(*) Note that the diagram depicts the value chain and that the roles do not exactly mirror the ECM (entity in charge of maintenance) responsibilities.

Table 4-1: Roles and responsibilities

role	Responsibility in process
Manufacturer	
System integrator	Creates a complete, operational asset like a train, locomotive or section of complete rail track
System manufacturer	Produces complex composed MRO-objects out of a number of different MRO-objects
Component supplier	Manufactures MRO-objects without, in principle, integrating major value added MRO-objects from other sources
Operator	
Rail network operator	Manages and maintains the rail infrastructure
Rail operator	Runs, manages and maintains rolling stock operations
Service provider	
MRO workshop	Repairs and refurbishes MRO-objects
Project contractor	Carries out the project management of the rail network operator's rail infrastructure works, which need to comply with identification and marking standards.
Logistics service provider	Management of inventory, transport and procurement of MRO-objects
Regulator	
Government	Authority/overseer.
Certification agency	Organisation responsible for safety & standards. For example, ONRSR (Office of National Rail Safety Regulator)

4.3 Need for traceability

Identification and traceability requirements are driven by safety aspects and by the economic or operational relevance of an MRO-object (e.g. impacting vehicle downtimes).

Maintenance strategies

One of the main defining elements of the rail industry is the fact that a substantial number of MRO-objects (in rolling stock as well as in rail infrastructure) is procured for a long-use life cycle of up to 60 years. Such MRO-objects need to be maintained, refurbished or replaced on a regular or on an ad-hoc basis.

The maintenance organisations responsible for the objects needing maintenance will act based upon a wide variety of triggers that will signal that objects require planned or emergency or ad-hoc maintenance.

Risk Mitigation

The ability for the industry to accurately record life cycle management of parts and components will increase safety, improve productivity, be able to assure local content and product authenticity over time.

4.4   Configuration management

Another key aspect is the need for configuration management. Composite MRO-objects will be manufactured and maintained using a bill-of-material (BOM). Composite MRO-objects may contain other composite MRO-objects (produced by other manufacturers), which means that it must be possible to link BOMs.

Three types of BOMs that may be applied, each with specific characteristics, are:

1. Design BOM: A standard BOM used in conjunction with the technical design, used as a basis for the manufacturing process. It will define the MRO-objects in terms of their type and position, but will not contain any serialised IDs or lot level IDs.

2. Manufacturing BOM: An instance BOM that is created during the manufacturing process and defines the MRO-object 'as built'. It will contain a mixture of serialised and non-serialised IDs of the contained instances. Composite MRO-objects sourced from another party should have a serialised ID allowing to link to the manufacturing BOM of the supplier. This linking of instance BOMs is an essential aspect.

3. Installation BOM: An instance BOM that is used by the operator and the manufacturer's after sales service organisation and used for the maintenance process. Like the manufacturing BOM this is an instance BOM, but unlike the manufacturing BOM the installation BOM will only contain instances that can be physically identified (serialised MRO-objects).

Example

Figure 4-3: Locomotive

A locomotive will consist of several subsystems. Each subsystem will consist of several physical components.

The system integrator will have a design BOM of the locomotive, and will create a manufacturing BOM for each manufactured locomotive.

The sub system manufacturer of the brake system will have a design BOM and a manufacturing BOM for the sub system, consisting of several components that need to be integrated by the system integrator.

Based on the data from the suppliers the system integrator will create an installation BOM. In that BOM the brake system as a 'whole' will not be present, but primarily the serialised physical components that make up the system.

5   Identification and marking principles

5.1   Identification levels

A critical question is at what level physical MRO-objects will be identified. Due to the wide variety of MRO-objects in rolling stock and infrastructure management, and related variation in required level of traceability, the standard needs to provide sufficient flexibility to ensure the required safety and enable cost effective solutions.

In many situations it is sufficient to identify instances at the class level.

Lot level identification allows to distinguish narrower groupings, such as instances from a given manufacturing batch or refurbishment batch.

Serialised identification, in which each MRO-object has a globally unique identifier that is different from every other object, is the most precise and allows to link to data about the individual instance.

> **!** **Important**: The scenario to be used will depend on the most stringent scenario.
> For example: When a manufacturer applies serial level identification based on the most stringent customer requirements, other customers will in principle not be allowed to require a less granular identification (such as lot level or even class level identification). In case of conflict between different customer requirements, using the most flexible solution offered by this standard is recommended. For instance, the use of serialised GTINs instead of GIAIs, as the former allows for more flexibility for customers with less granular identification requirements.

5.1.1   Class-level identification

The object class ID (SKU number) is the primary ID used in manufacturing, ordering and warehousing processes. It also will be the main way to exchange master data about the MRO-object.

The object class ID is less important in maintenance, repair and overhaul processes. The object class ID will help to identify the type of item, but it will not provide a way to access the manufacturing and maintenance history of the instance.

> **!** **Important**: It is important to note that the master data related to the object class ID will no longer apply when the instance has been refurbished causing a change of the technical specification.

5.1.2   Lot-level identification

When the manufacturing lot ID is marked on the item, a more precise link to the manufacturing history is enabled. If the associated data have been recorded properly this will for example allow to locate and recall all instances with a specific production defect.

Similarly, marking of the refurbishment lot ID, will allow a link to the refurbishment data of a group of instances.

5.1.3   Serialised identification

A serialised ID provides the highest level of traceability. It is the only suitable identification option for MRO-objects that have an instance BOM.

Furthermore, serialised identification eliminates the need for marking of manufacturing and refurbishment lot ID, since such data can be linked to the serialised ID.

Two types of serial identification exist:

1. Class dependent serialised ID (containing the object class ID): The type of part can be recognised by reading the ID

2. Class independent serialised ID: The type of part cannot be recognised by reading the ID.

Ideally the serialised ID is allocated and marked by the manufacturer at time of production. In absence of a manufacturing assigned ID, the operator or workshop may need to assign a serialised ID, to enable recording of the maintenance and usage history.

5.1.4 Mapping to GS1 identification keys

The diagram below lists the various identification options and the way these are implemented using the GS1 standards.

Figure 5-1: Identification levels and GS1 identification keys
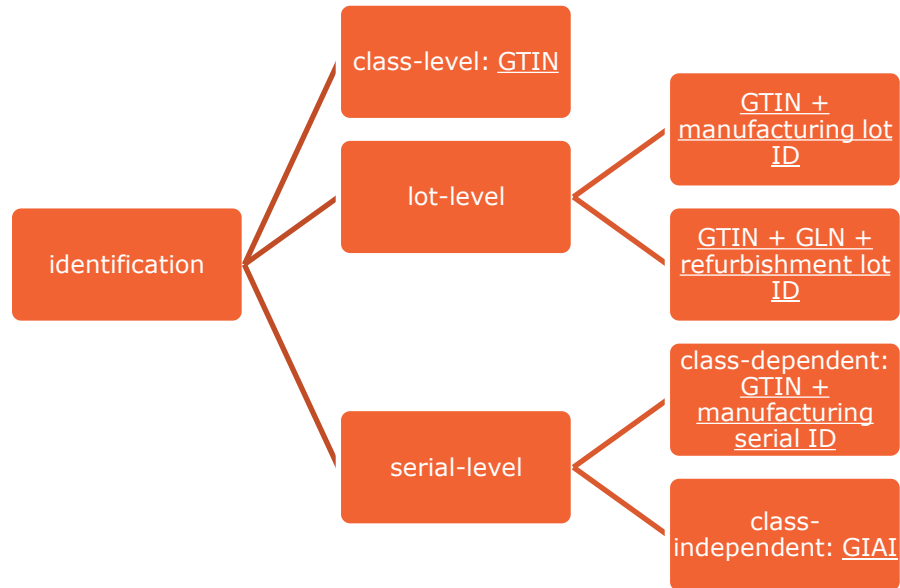
5.2 Functional status and current revision status

A type approval or certificate of conformity is granted to a product that meets a minimum set of regulatory or non-regulatory, technical and safety requirements. Generally, type approval is required before a product is allowed to be sold in a particular jurisdiction, so the requirements for a given product will vary around the world. Compliance to type approval requirements can be denoted by a marking on the back of the product, or by a type approval certificate obtained by a manufacturer and kept on file.

Regulations may exist in some jurisdictions for the various categories of rail components on the conditions for obtaining a type approval, and on the way to maintain a type approval in case changes are made to the design. In some situations, by marking the functional status (major version) and revision status (minor version), the existing type approval can be maintained and modified if applicable.

This means that besides the ID also these two attributes may be marked on newly produced items. When such items are refurbished the functional status and revision status may need to be updated as well, depending on legal requirements.

When marked on the MRO-object the functional status and revision status can only be used in combination with an object class ID (GTIN). When using serialised IDs marking of these attributes is not necessary, except when legal requirements apply.

5.3   Direct marking events

> **Important**: Best practice is to limit the number markings / marked data to a minimum, and to rely on digital data exchange to the maximum extent possible. The rules in this standard have been based on this principle.

Four main event types have been identified at which marking of unpackaged instances will occur:

- production
- receipt
- installation
- refurbishment

As illustrated in figure 5-2 the production event will occur only once during the lifetime of the instance, while the other events may occur multiple times, depending on the type of object.

Figure 5-2: Marking events during the MRO-object lifecycle
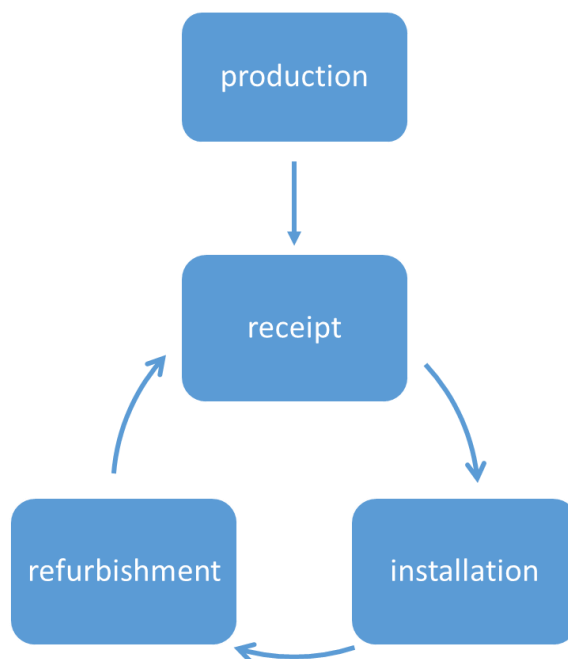
Marking at time of production

At the time of production, the ID of the instance will be marked by the manufacturer. Depending on the MRO-object type also the functional status and current revision status may need to be marked.

Marking at time of receipt

At the time of receipt, the operator may find that the marking on the instance is not readable or not of the right level of detail and needs to be complemented / replaced by a new marking. It is also possible that the supplier is not obliged to mark the instances under the current contract.

Marking at time of installation

At the time of installation, the identification marking will not be changed, but an additional marking with configuration data may need to be applied, for example for non-serialised MRO-objects or when no reliable electronic data source is available.

The ID marking may need to be repaired in case it is not readable or no longer present (e.g. lost during transport).

Marking at time of refurbishment

At the time of refurbishment any missing or unreadable marking will be added or replaced. Also, as a result of the refurbishment e.g. washing with a pressure of 2,500 bar, the marking may need to be replaced as a general routine.

For non-serialised instances the refurbishment lot ID may need to be marked (in a separate marking) in order to provide a link between the instance and its maintenance history.

5.3.1 Overview of main scenarios

The table below lists the main identification and marking scenarios that have been identified.

Table 5-1: Identification and marking scenarios

Main scenario	Sub-scenario	GTIN	Manufacturing lot ID	Manufacturing serial ID	GIAI	Refurbishment lot ID	Additional data
marking at time of production	A	X					(1)
	B	X	X				(1)
	C	X		X			(2)
	D				X		(2)
marking at time of receipt	E	(3)					
marking at time of installation	F	(3)					(4)
marking at time of refurbishment	G	(3)				(5)	(5)

Notes:

(1) Marking of additional data such as functional status and revision status linked to the instance may be needed

(2) Additional data should be avoided, since the serialised ID provides a way to associate the data digitally

(3) The original marking may need to be refreshed or updated, or an owner assigned GIAI may need to be marked

(4) Marking of configuration data may be required legally

(5) For non-serialised functional status and revision status may need to be updated, and also the refurbishment lot ID may need to be marked.

Examples

MRO-object	Scenarios
RAIL FASTENING MATERIALS These are typical consumable MRO-objects where clear part marking and identification are crucial. These are safety relevant parts (it is important the correct object classes are assembled). Instance level however is not of importance (as the failure of one instance is not critical. What is critical are repetitive / serial failures and / or mistakes).	A, B, E
ISOLATORS Another example of consumable MRO-objects are isolators for power switches. Here production batch information is important for traceability reasons, as they are manufactured in batches and are expensive parts.	B

MRO-object	Scenarios
WHEELSETS These are typical rotable MRO-objects for which maintenance history (at instance level) is kept. Wheelsets come into refurbishment approximately every 1.2 million kilometres or after a use of maximum 6 years.	D, E, F
ELECTRICAL RELAYS These are repairable MRO-objects that are refurbished in batches (washed for instance). In some refurbishments the individual serial number may be of no concern, and only the production and refurbishment batch numbers are used (for traceability reasons).	B, C, D, E, G
FIRMWARE VERSION FOR ETCS-SYSTEMS (ELECTRONIC TRAIN CONTROL SYSTEM). Here we need to know which instance (module) is configured with which firmware version. So the instance bill of material per configuration is crucial before the ETCS-system is installed on a loco and the loco re-commissioned to service.	C, D, E, F, G

5.4   Marking of composed MRO-objects

Composite MRO-objects do not have a surface uniquely belonging to the object, and not to any of its subcomponents, where a marking could be placed. Therefore, the only available surface will be on one of the subcomponents that makes up the composite MRO-object. And such subcomponents will have their own markings.

Approaches

Two main approaches are applied in practice:

1. Avoid double markings by letting one of the subcomponents (the leading part) play a double role. The ID marked on the leading part plays two roles, depending on its state (assembled or not-assembled) it identifies either the parent component or itself.
In this approach the ID marked on the subcomponent is used to identify both the subcomponent as well as the parent component. This approach fits well with the way operators look at the MRO-object, using an 'installation BOM' where only components that physically exist are identified.

2. Apply an additional marking on one of the subcomponents (the leading part) that identifies the parent object.
In this approach one of the subcomponents will have two markings. The first marking holds the ID of the subcomponent; the second marking holds the ID of the parent component. This approach fits well with the way the MRO-object is manufactured.

Solution

The standard will support both approaches and provide a bridge between the two. Two markings will be allowed, but in that case parties will have a way to easily recognise the second marking (the two barcodes will use different GS1 Application Identifiers).

Example

Figure 5-3: Side buffer (example of composed MRO-object)
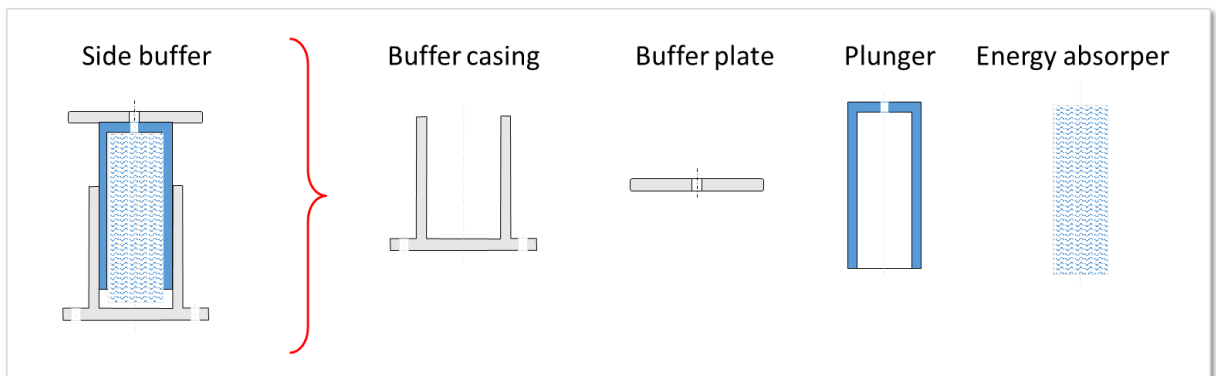
The example shows a side buffer, which is a composed MRO-object consisting of 4 subcomponents. The buffer casing is the leading part.

Option 1 (the preferred option):

The buffer casing gets one marking. In assembled state the ID identifies the side buffer, in dis-assembled state the ID identifies the buffer casing.

Option 2:

The buffer casing gets two markings, one to identify the buffer casing, one to identify the side buffer. The latter marking will be recognisable as being a 'parent mark'.

5.5 Identification and marking of packaging

MRO objects come in all sorts and sizes, and this means there is a wide variety of packaging forms.

Furthermore, the way MRO objects are handled once in inventory can vary:

- Stays on pallet
- Picked from pallet
- Picked from secondary packaging
- Secondary packaging is minimum pick quantity
- Stored in bins – either in primary packaging or unpackaged

Depending on the type of item the ID that needs to be recorded when an item is picked from inventory may vary from class level to fully serialised. This impacts the information to be marked on the packaging.

Figure 5-4: Packaging level identification

Packaging level	Marking
Primary packaging containing 1 instance	Same as unpackaged instance ID
Grouping (including primary packaging containing multiple instances)	GTIN of the grouping, optional manufacturing lot ID / serial ID (to be further specified in a future version of this standard)
Kit	GTIN of the kit, optional manufacturing lot ID / serial ID (to be further specified in a future version of this standard)

PART II - RULES

6 Identification rules

6.1 Identification keys

A key is an attribute (or group of attributes) of an entity that serves to uniquely identify that entity, within some specified domain of entities. Often a single attribute is usable as a key, but sometimes a group of attributes is required. In data modelling terminology these are called simple keys and compound keys, respectively.

Table 6-1 lists the identification keys that are applied to identify MRO-objects.

Table 6-1: Overview of identification keys

key attribute(s)	key type	level of identification
GTIN	simple key	class level
GTIN + manufacturing lot ID	compound key	lot level
GTIN + GLN + refurbishment lot number	compound key	lot level
GTIN + manufacturing serial ID	compound key	instance level
GIAI	simple key	instance level

Note: See section 9 for the data formats of the keys.

6.2 GTIN

[6-1] The GTIN SHALL be assigned in accordance with the general GTIN management rules as defined in [GTIN-MAN] and the rail sector specific rules as defined in section 7 of this standard.

[6-2] The GTIN SHALL be assigned by the party that has functional and constructional responsibility and/or is responsible for regulatory acceptance. This means one of the following parties (in order of importance) SHALL assign the GTIN using their GS1 company prefix:

   a. The brand owner who owns the specification of the MRO-object, regardless of where and by whom it is manufactured.

   b. The party manufacturing the MRO-object, the so-called Original Equipment Manufacturer (OEM).

   c. If a distributor wishes to bring an MRO-object to the market that does not have a GTIN, the distributor SHALL take steps to mandate a GTIN from the brand owner or OEM and in the meantime MAY assign a GTIN using its own GS1 company prefix.

6.3 GTIN + manufacturing lot ID

[6-3] The manufacturing lot ID SHALL be unique in combination with the GTIN, and never be reused.

[6-4] The manufacturing lot ID SHALL be assigned by the manufacturer.

[6-5] The attributes identified with the GTIN + manufacturing lot number SHALL correspond to a group of instances that were produced as part of the same production batch.

6.4 GTIN + manufacturing serial ID

[6-6] The manufacturing serial ID SHALL be unique in combination with the GTIN, and never be reused.

[6-7] The manufacturing serial ID SHALL be assigned by the manufacturer.

6.5 GIAI

[6-8] The GIAI SHALL be unique and never be reused.

[6-9] The GIAI SHALL be assigned by the operator or by the manufacturer (see rule [6-2]).

6.6 GTIN + GLN of workshop + refurbishment lot ID

[6-10] The refurbishment lot ID SHALL be unique in combination with the GLN of the workshop (production / service location) that carried out the refurbishment, and never be reused.

[6-11] The refurbishment lot ID SHALL be assigned by the workshop.

6.7 GS1 Company Prefix (GCP)

The GS1 Company Prefix is included at the beginning of the GS1 identification keys and so establishes global uniqueness (see section 9 for more information).

[6-12] The GS1 Company Prefix SHALL be only be used to issue keys by or on behalf of the company that is the licensee of the GS1 Company Prefix, in accordance with the key allocation rules specified in GENSPECS section 4 Application rules and management practices.

[6-13] When the ownership or legal structure of the company that assigned the key changes, for example due to a merger, acquisition, split or spin-off, the responsibility for the GS1 Company Prefixes SHALL be re-arranged according to the rules in GENSPECS section 1.6 Allocation.

6.8 Object Identification Wizard

An object identification wizard is available to help companies with a MRO-object identification requirement to determine the right type of GS1 identification key to use.
http://www.gs1.org/1/mro/en/object-identification

7 GTIN management rules

These rules explain the way GTINs need to be assigned to MRO-objects for catalogue and order management purposes. These rules will also be included on the GTIN management page.

7.1 General principles

At least one of the guiding principles must apply for a GTIN change to be required.

- Is a consumer and/or trading partner expected to distinguish the changed or new product from previous/current products?
- Is there a regulatory/liability disclosure requirement to the consumer and/or trading partner?
- Is there a substantial impact to the supply chain (e.g., how the product is shipped, stored, received)?

[source: GTINMAN]

7.2 Adding a new MRO-object class

[7-1] When a new MRO-object is created that is different in form, fit or function from any of the existing objects a new GTIN SHALL be assigned.

Examples:

- *Introduction class B balise 3 MM thicker, higher water resistance is introduced next to the existing class A balise*
- *Connector types supporting different voltages. Each connector type requires a separate GTIN.*
- *Copper cables with different diameters will need to be distinguishable via separate GTINs.*

[7-2] Any hierarchy level that is priced, ordered or invoiced individually at any point in the supply chain SHOULD receive its own GTIN.

Examples:

- *Carton containing 100 power relays requires a GTIN that is different from the GTIN of the individual power relay.*
- *Pack with a pair of screen wiper blades requires GTIN that is different from the GTIN of the single wiper blade.*

7.3 Changing an existing MRO-object class

[7-3] When the form, fit or function of an existing MRO-object is changed a new GTIN SHALL be assigned, unless rule 7-4 applies. The newly produced instances SHALL be marked with the new GTIN. The GTINs as marked on already produced items SHALL remain the same.

Examples:

- *For handrails for passenger coaches the colour is a critical safety feature. Therefore, a change in colour will require a GTIN change. NEW GTIN*
- *Outer case height and width changes more than 20%. NEW GTIN*
- *Modification of mobile access plate / step to train, increasing its surface roughness. SAME GTIN Note: A decrease would require a NEW GTIN.*
- *Modification to the control unit of a HVAC (heating, ventilation and air conditioning) NEW GTIN*

[7-4] When the MRO-object is marked with a GTIN as well as the functional / revision status, regulations MAY allow the GTIN to remain the same for certain types of changes to form, fit or function.

Examples:

- *Some regulatory bodies do not require a part number change if ALL of the following conditions are met:*

  - *The function does not change*

  - *The scope of use does not change*

  - *The interfaces to the outside world do not change*

  - *The risk analysis and function test documentation do not change*

  - *The risk by the MRO-object is not increased (it can be reduced or remain the same)*

  - *There is a marking which clearly allows the user to distinguish between the class ID and the revision / functional level. If there is no such composite marking on the component, a class ID change is compulsory*

[7-5] When the form, fit or function of an existing instance is changed as a result of a refurbishment, the GTIN and any function or revision levels as marked on the instance SHALL remain the same. <u>Exception:</u> See rule 8-10 for MRO-objects that are refurbished to be sold 'as good as new'.

Important: The master data related to the GTIN (and any function or revision levels) marked on an MRO object reflect the status at the time of first delivery. Special care should be taken in managing master data that can change as a result of refurbishment.

Note: If the instance is identified on object class level it is possible to add a refurbishment lot number referring to the change of the technical specification or to add the functional/revision status. If the instance is serialized, the information of the changed technical specification is recorded and shared digitally.

Examples:

- *MRO-object gets software update.*

- *MRO-object was produced as functional level A, revision status 2, and now is refurbished to meet functional level B, revision status 1.*

7.4 De-activating an existing MRO-object class

[7-6] A GTIN allocated to an MRO-object that was taken into production SHALL never be reused.

Examples:

- *MRO-object X becomes obsolete and is no longer sold. However, it is still in use. Its GTIN will not be reused to identify a different MRO-object.*

[7-7] A GTIN allocated to an MRO-object that was never taken into production MAY be reused for a different MRO-object.

7.5 GTIN Management Wizard

A GTIN management wizard is available for companies who are responsible for the management of GTINs that are marked on MRO-objects. This includes companies that supply new MRO-objects as well as companies that refurbish existing MRO-objects.

The Purpose of the wizard is to help companies evaluate whether a new GTIN is needed in case changes are made to the MRO-object. The wizard does not address serialization aspects.
http://www.gs1.org/1/mro/en/management-rules

8 Marking rules

8.1 Introduction

Information marked on objects comes in two basic forms.

1. Information to be used by people: HRI and non-HRI text.

2. Information designed for data capture by a machine: Barcodes and EPC/RFID tags.

Barcodes and RFID tags are machine readable and are a secure and efficient method for conveying structured data, while text and graphics allow people general access to basic information at any point in the supply chain and serve as fall-back positions for unreadable AIDC data. Both methods often co-exist.

This standard defines rules for the marking of unpackaged instances (direct marking) as well as for the marking of primary and secondary packaging. Figure 8-1 lists the marking scenarios that are supported in this standard. The rules for each scenario are defined in the next paragraphs.

Figure 8-1: Overview of marking scenarios

Direct marking	Marking at time of production
	Additional marking at time of receipt, installation or refurbishment
	Repairing lost or damaged markings
Packaging marking	Marking of primary packaging
	Marking of secondary packaging

8.2 Direct marking

8.2.1 General rules

[8-1] Allowed AIDC carriers for direct marking in the Australian Railway Industry:

- ☐ GS1 DataMatrix (preferred) or GS1 QR Code
- ☐ EPC/RFID as additional option (unless RFID is the only technical option)

✅ **Note**: GS1 QR code has not been endorsed by the Australian Railway Industry as a preferred data capture symbology and is therefore not featured in this guideline

8.2.2 Marking at time of production

[8-2] At the time of production a marking SHOULD be applied on each instance, containing either:

- ☐ GTIN, or
- ☐ GTIN + manufacturing lot ID, or
- ☐ GTIN + manufacturing serial ID, or
- ☐ GIAI

[8-3] The marking SHOULD contain data in AIDC and HRI format and be applied using a permanent direct marking technique.

[8-4] The identification level to be applied SHALL be determined by the manufacturer of the MRO-object, based on the most stringent customer requirements.

[8-5] Customers SHALL accept a more precise level of identification than they require for a particular MRO-object. In case of conflicting customer requirements, manufacturers MAY choose to include additional attributes. For example, GTIN + manufacturing lot number + manufacturing serial ID supports both class-level, lot-level and serial-level identification.

[8-6] In GTIN-based markings additional attributes MAY be included. Besides the functional status, revision status as listed in section 9, also additional trade item attributes as defined in [GENSPECS] MAY be included, for example production date, expiration date.

⊘ **Important**: For instances with a serialised ID there is no technical need to encode these additional attributes in the AIDC carrier, since they can be exchanged digitally and linked to the serialised ID.

[8-7] If marking according to rules [8-2] and [8-3] is not possible an alternative marking SHOULD be applied following the criteria in figure 8-2, and in bilateral agreement with the customer.

Figure 8-2: Direct marking exceptions – decision tree
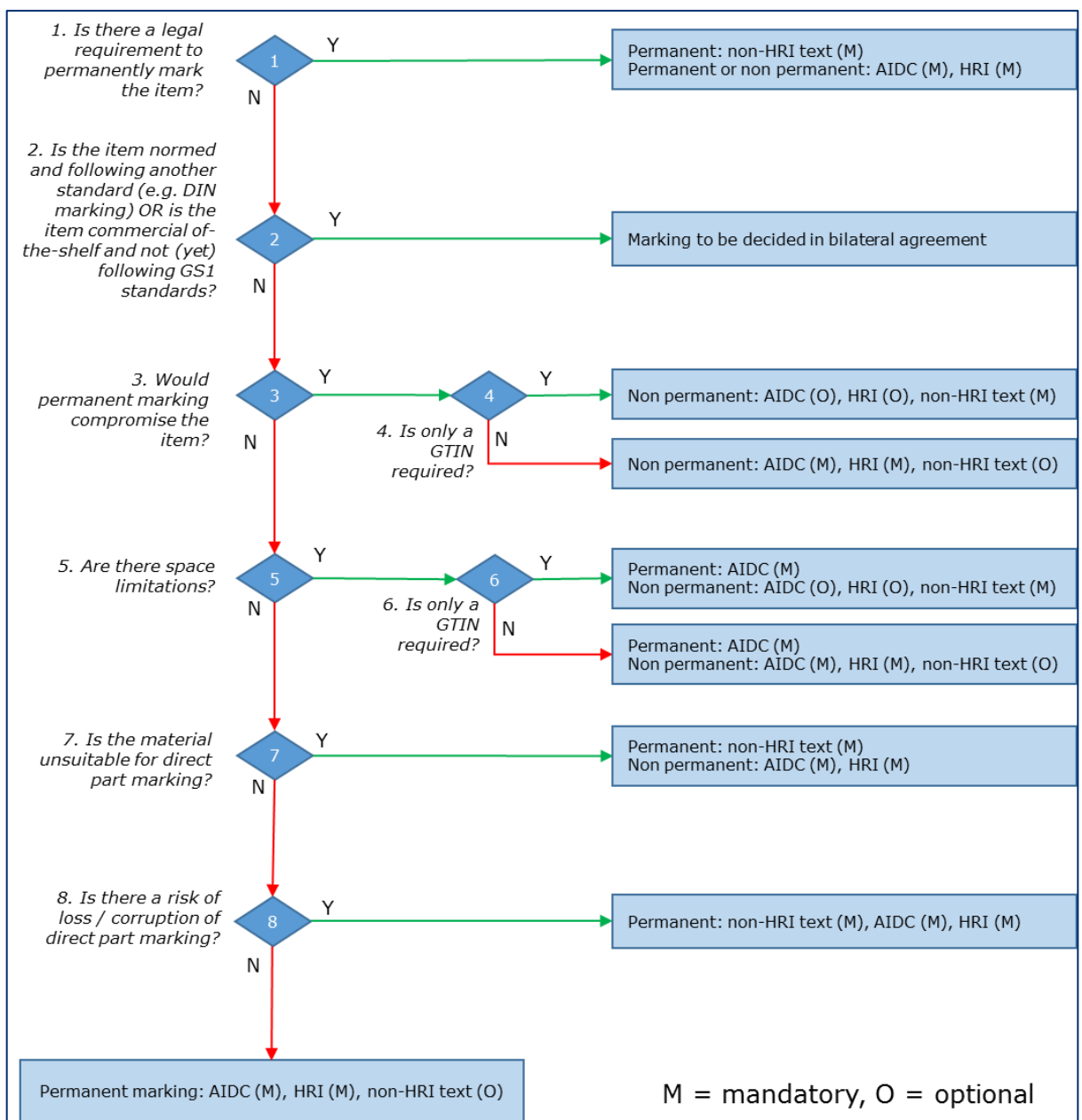
Leading parts

[8-8] If the instance is the leading part of a composed MRO-object, an additional marking containing the GIAI of the parent component MAY be applied.

[8-9] A component can only be the leading part of one higher composed MRO-object. Therefore, any MRO-object SHALL NOT have more than one parent component marking. Also see sections 5.4 Marking of composed MRO-objects and 9.1.5 GIAI of an assembly.

Remanufactured MRO-objects resold to new customers 'as good as new'

[8-10] MRO-objects that are refurbished to be sold to other clients MAY require an update of functional status and current revision status that were applied at the time of production.

8.2.3 Additional marking at time of receipt, installation or refurbishment

> **(!)** **Important**: For serialised items the inclusion of additional markings SHOULD be avoided, since such data can be exchanged digitally and linked to the serialised ID.

Additional marking at time of receipt

[8-11] In case the original ID does not provide a detailed enough level of identification an additional marking containing a GIAI allocated by the operator or MRO workshop may be applied, using a permanent or non-permanent direct marking technique.

[8-12] The marking MAY be applied using a permanent or non-permanent direct marking technique, and SHALL be clearly distinguishable from the marking containing the original ID.

Additional marking at time of installation

[8-13] At the time of installation an additional marking MAY be applied on an instance containing configuration data.

[8-14] The marking SHALL be applied using a non-permanent direct marking technique, and be clearly distinguishable from the marking containing the primary identification.

[8-15] Software, once installed and separated from its medium, packaging and documentation, SHALL remain identifiable.

Additional marking at time of refurbishment

[8-16] An additional marking MAY be applied on an instance containing the refurbishment lot ID + GLN of the production / service location.

[8-17] The marking SHALL be applied using a direct marking technique (preferably non-permanent) which will guarantee the marking readability until the next refurbishment cycle. The marking SHALL be clearly distinguishable from the marking containing the primary identification.

8.2.4 Repairing lost and damaged markings

At any time during the lifetime of an MRO-object the original marking may have gone missing or may have been damaged and become partly or fully unreadable.

[8-18] In case of lost or damaged markings a new marking SHOULD be applied, containing the original ID as allocated by the manufacturer, using direct marking technique as defined in rules [8-2] through [8-7] and in figure [8-2].

[8-19] In case the original ID cannot be reconstructed:

☐ For serialised items a GIAI allocated by the operator or MRO workshop SHALL be used.

☐ For non-serialised items a GTIN or GTIN + lot ID allocated by the operator or workshop SHALL be used.

Important: In such cases in the database and when sharing data on such MRO-objects with trading partners it SHOULD be clearly indicated that the ID of the instance is not the original ID, and that the full history of the instance is unknown.

[8-20] In case the original ID is known but reconstruction of the marking will take too much time, an additional marking containing a GIAI MAY be applied, using a permanent or non-permanent marking technique, and clearly distinguishable from the marking containing the original ID. In this case the GIAI will be linked to the original ID in the IT system, and act as a proxy.

8.2.5   Direct marking placement rules

Three main direct marking methods have been identified: Permanent marking directly on the MRO-object (such as DPM), non-permanent marking using a durable label such as a printed label or tag, and tagging using EPC-RFID.

The following rules apply to the placement of direct markings covered in this standard:

[8-21] Direct markings SHALL be attached to the MRO-objects in a way that they are easily visible even in operating mode of the identified object – for instance from the safety space alongside a track or when an object is installed on a rail vehicle.

[8-22] Direct markings SHALL not hinder any function of the object they are attached to, for example of movable equipment found in switches.

[8-23] Scan and read devices (like smart phones, tablets or similar devices) SHALL be able to retrieve data from the type plate / label from a frontal angle.

[8-24] Direct markings with barcode symbols SHOULD not be placed in a shaded location to avoid reduction of contrast and difficulties in scanning.

[8-25] Direct markings SHALL be placed on plane surfaces whenever possible. Curved surfaces may cause reduction of the readability of the barcode (thus, check the quality after attaching carefully - e.g. through the verification service provided by GS1) and complicate gluing of the plates / labels.

[8-26] Direct markings SHALL be placed in a way that protects them from mechanical damage (for instance by placing them in the shadow zone or slip stream of objects).

[8-27] Affix direct markings whenever possible at a minimum angle of 45° which allows water to drain off and prevents dust from settling. In addition, this helps to reduce the risk of damage due to flying debris.

8.3   Packaging marking

8.3.1   General rules

[8-28] Allowed AIDC carriers for packaging marking:

- GS1 DataMatrix, or GS1-128 barcode
- EPC/RFID as additional option

8.3.2   Primary packaging

[8-29] Primary packaging of MRO-objects SHALL be marked with the ID of the unpackaged instance.

[8-30] The marking SHALL contain data in AIDC and HRI format.

[8-31] In case the primary packaging contains multiple instances the primary packaging SHOULD be marked with a single marking containing a GTIN that identifies the primary packaging as trade item grouping, optionally in combination with a manufacturing lot ID or serial ID. If this is not feasible a solution will need to be chosen in bilateral agreement.

[8-32] Software distributed via a dedicated physical medium SHALL be marked with the GTIN used to identify the software. If the medium is not a dedicated medium, no marking SHOULD be applied.

8.3.3 Secondary packaging

[8-33] Secondary packaging of MRO-objects SHALL be marked with the GTIN of the trade item grouping or kit.

[8-34] The marking SHALL contain data in AIDC and HRI format.

8.4 Direct Marking Wizard

A direct marking wizard is available for companies who have a direct marking requirement for a particular MRO-object. The purpose of the wizard is to help companies to determine the right type of direct marking for the MRO-object.

Prerequisite for using the wizard is that the related business process has been analysed and the legal, commercial and operational requirements are sufficiently clear. *http://www.gs1.org/1/mro/en/direct-marking*

9 Technical standards

9.1 Data formats

9.1.1 GTIN

In this standard three GTIN formats are applied: GTIN-12, GTIN-13 and GTIN-14 (see figure 9-1).

[9-1] Classes of MRO-objects SHALL be identified with a GTIN-12 or GTIN-13 or GTIN-14.

[9-2] If the GTIN-14 is used to identify a grouping of identical trade items, the GTIN-14 SHALL be based on the GTIN-12 or GTIN-13 of the contained trade item. See *GS1 General Specifications section 2* for more information.

Figure 9-1: Overview of GTIN formats

		GS1 Company Prefix									Item reference			Check digit
(GTIN-13)		N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	N_9	N_{10}	N_{11}	N_{12}	N_{13}
(GTIN-14)	N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	N_9	N_{10}	N_{11}	N_{12}	N_{13}	N_{14}
		U.P.C. Company Prefix									Item reference			Check digit
(GTIN-12)		N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	N_9	N_{10}	N_{11}		N_{12}

[Part of figure taken from GENSPECS_v17]

Note: The GS1 Company Prefix (GCP) is a string of 4 to 12 digits. Depending on the GCP length this provides users with a basic numbering capacity of 100,000,000 items (GCP of 4 digits, item reference of 8 digits) to 1 item (GCP of 12 digits, item reference of 0 digits). Companies may license multiple company prefixes if necessary, so even with non-reuse of GTINs they will have sufficient numbering capacity.

Barcode format

[9-3] When encoded in a GS1-128 or GS1 DataMatrix, GS1 Application Identifier (01) GTIN SHALL be used.

[9-4] When encoding a GTIN-12 two leading zeroes SHALL be added, and when encoding a GTIN-13 one leading zero SHALL be added. (see figure 9-2)

Figure 9-2: GTIN formats in AI (01)

	Application Identifier	Global Trade Item Number (GTIN)													
		GS1 Company Prefix										Item reference			Check digit
(GTIN-12)	0 1	0	0	N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	N_9	N_{10}	N_{11}	N_{12}
(GTIN-13)	0 1	0	N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	N_9	N_{10}	N_{11}	N_{12}	N_{13}
(GTIN-14)	0 1	N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	N_9	N_{10}	N_{11}	N_{12}	N_{13}	N_{14}

[Part of figure taken from GENSPECS_v17]

Non-HRI format

[9-5] When indicating this element string in the non-HRI text section of a barcode label, the following data title SHOULD be used: **GTIN**

EPC/RFID format

[9-6] When encoded in an EPC/RFID tag the GTIN SHALL be encoded in combination with the manufacturing serial ID in the EPC Memory Bank (MB 01). See section 9.3.2.

9.1.2 Manufacturing serial ID

Barcode format

[9-7] When represented in a barcode GS1 Application Identifier (21) Serial number SHALL be used. The AI (21) indicates that the data field contains a serial number. The data is alphanumeric and may include all characters contained in character set 82 (see 9.6).

Figure 9-3: AI (21) Serial number

Application Identifier	Serial number
2 1	X_1 ——————— variable length——————————> X_{20}

[source: GENSPECS]

[9-8] The manufacturing serial ID SHALL be limited to a maximum 18 characters to ensure interoperability with main ERP systems.
Note: If EPC/RFID is used in conjunction with the barcode further restrictions may apply, see section 9.3.2.

[9-9] AI (21) Serial number SHALL be used in combination with AI (01) GTIN.

Non-HRI format

[9-10] When indicating this element string in the non-HRI text section of a barcode label, the following data title SHOULD be used: **SERIAL**

EPC/RFID format

[9-11] When encoded in an EPC/RFID tag the manufacturing serial ID SHALL be encoded together with the GTIN in the EPC Memory Bank (MB 01). See section 9.3.2.

9.1.3 Manufacturing lot ID

Barcode format

[9-12] When represented in a barcode GS1 Application Identifier (10) SHALL be used.

AI (10) indicates that the data field contains a batch or lot number. The data is alphanumeric and may include all characters contained in character set 82 (see section 9.6).

Figure 9-4: AI (10) Batch or lot number

Application Identifier	Batch or lot number
1 0	X_1——————> variable length ——————————>X_{20}

[source: GENSPECS]

[9-13] The manufacturing lot ID SHALL be limited to a maximum 10 characters to ensure interoperability with main ERP systems.

[9-14] AI (10) Batch / lot number SHALL be used in combination with AI (01) GTIN.

Non-HRI format

[9-15] When indicating this element string in the non-HRI text section of a barcode label, the following data title SHOULD be used: **BATCH/LOT**

EPC/RFID format

[9-16] When represented in an EPC/RFID tag the manufacturing lot ID SHALL be encoded in User Memory (MB 11), using GS1 Application Identifier (10). See section 9.3.4.

9.1.4 GIAI

Barcode format

[9-17] When represented in a barcode GS1 Application Identifier (8004) GIAI SHALL be used.

Figure 9-5: AI (8004)

Application Identifier	Global Individual Asset Identifier (GIAI)		
	GS1 Company Prefix $\longrightarrow$	Individual asset reference	$\longrightarrow$
8 0 0 4	N_1 ... N_i	X_{i+1} ... variable length	$X_{j\,(j<=30)}$

[source: GENSPECS]

A GIAI is a string of maximum 30 characters, starting with the GS1 Company Prefix (numeric) followed by the individual asset reference. The individual asset reference is alphanumeric and may include all characters contained in character set 82 (see section 9.6).

Note: If EPC/RFID is used in conjunction with the barcode further restrictions may apply, see section 9.3.3.

Non-HRI format

[9-18] When indicating this element string in the non-HRI text section of a barcode label, the following data title SHOULD be used: **GIAI**

EPC/RFID format

[9-19] When encoded in an EPC/RFID tag the GIAI SHALL be encoded in the EPC Memory Bank (MB 01). See section 9.3.3.

9.1.5 GIAI of assembly

Barcode format

[9-20] When represented in a barcode GS1 Application Identifier (7023) GIAI of an assembly SHALL be used.

Figure 9-6: AI (7023)

Application Identifier	Global Individual Asset Identifier (GIAI) of an assembly		
	GS1 Company Prefix $\longrightarrow$	Individual asset reference	$\longrightarrow$
7 0 2 3	N_1 ... N_i	X_{i+1} ... variable length	$X_{j\,(j<=30)}$

[source: GENSPECS]

A GIAI of an assembly is a string of maximum 30 characters, starting with the GS1 Company Prefix (numeric) followed by the individual asset reference. The individual asset reference is alphanumeric and may include all characters contained in character set 82 (see section 9.6).

Note: If EPC/RFID is used in conjunction with the barcode further restrictions may apply, see section 9.3.3.

Non-HRI format

[9-21] When indicating this element string in the non-HRI text section of a barcode label, the following data title SHOULD be used: **GIAI - ASSEMBLY**

EPC/RFID format

[9-22] When encoded in an EPC/RFID tag the GIAI of an assembly SHALL be encoded in the EPC Memory Bank (MB 01). See section 9.3.3.

> ✅ **Note**: Unlike barcodes, EPC/RFID tags that contain the GIAI of an assembly cannot be distinguished from EPC/RFID tags that contain the GIAI of the component.

9.1.6 GLN of production / service location

Barcode format

[9-23] When represented in a barcode GS1 Application Identifier (416) Production / Service location SHALL be used.

Figure 9-7: AI (416)

Application Identifier	GS1 Company Prefix —————————————→								←————————————— Location reference				Check digit
4 1 6	N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	N_9	N_{10}	N_{11}	N_{12}	N_{13}

[source: GENSPECS]

Non-HRI format

[9-24] When indicating this element string in the non-HRI text section of a barcode label, the following data title SHOULD be used: **PROD/SERV LOC**

EPC/RFID format

[9-25] When represented in an EPC/RFID tag the GLN of production / service location SHALL be encoded in User Memory (MB 11), using GS1 Application Identifier (416). See section 9.3.4.

9.1.7 Refurbishment lot ID

Barcode format

[9-26] When represented in a barcode GS1 Application Identifier (7020) Refurbishment lot ID SHALL be used.

Figure 9-8: AI (7020)

Application Identifier	Refurbishment lot ID
7 0 2 0	X_1 ——————————variable length ——————————→X_{20}

[source: GENSPECS]

[9-27] The refurbishment lot ID SHALL be a string of maximum 17 characters.

[9-28] AI (7020) Refurbishment lot ID SHALL be used in combination with AI (416) Production / Service location and AI (01) GTIN.

Non-HRI format

[9-29] When indicating this element string in the non-HRI text section of a barcode label, the following data title SHOULD be used: **REFURB LOT**

EPC/RFID format

[9-30] When represented in an EPC/RFID tag the refurbishment lot ID SHALL be encoded in User Memory (MB 11), using GS1 Application Identifier (7020). See section 9.3.4.

9.1.8 Functional status

Barcode format

[9-31] When represented in a barcode GS1 Application Identifier (7021) Functional status SHALL be used.

Figure 9-9: AI (7021)

Application Identifier	Functional status
7 0 2 1	X_1 ———variable length ———>X_{20}

[source: GENSPECS]

[9-32] The functional status SHALL be a string of maximum 5 characters.

[9-33] The functional status SHALL be used in combination with AI (01) GTIN.

Non-HRI format

[9-34] When indicating this element string in the non-HRI text section of a barcode label, the following data title SHOULD be used: **FUNC STAT**

EPC/RFID format

[9-35] When represented in an EPC/RFID tag the functional status SHALL be encoded in User Memory (MB 11), using GS1 Application Identifier (7021). See section 9.3.4.

9.1.9 Revision status

Barcode format

[9-36] When represented in a barcode GS1 Application Identifier (7022) Revision status SHALL be used.

Figure 9-10: AI (7022)

Application Identifier	Revision status
7 0 2 2	X_1 ———variable length ———>X_{20}

[source: GENSPECS]

[9-37] The revision status SHALL be a string of maximum 5 characters.

[9-38] The revision status SHALL be used in combination with AI (01) GTIN and AI (7021) Functional status.

Non-HRI format

[9-39] When indicating this element string in the non-HRI text section of a barcode label, the following data title SHOULD be used: **REV STAT**

EPC/RFID format

[9-40] When represented in an EPC/RFID tag the revision status SHALL be encoded in User Memory (MB 11), using GS1 Application Identifier (7022). See section 9.3.4.

9.2   Barcode symbologies

[9-41] For direct marking a GS1 DataMatrix (preferred) or GS1 QR Code barcode SHALL be used, following symbol specification table 7 [GENSPECS].

[9-42] For packaging marking either a GS1 DataMatrix, a GS1 QR Code or a GS1-128 barcode SHALL be used, following symbol specification table 4 [GENSPECS].

9.2.1   GS1 DataMatrix

Fragments taken from [GENSPECS]:

GS1 DataMatrix is a standalone, two-dimensional matrix symbology that is made up of square modules arranged within a perimeter finder pattern.

Data Matrix ISO version ECC 200 is the only version that supports GS1 system data structures, including Function 1 Symbol Character. The ECC 200 version of Data Matrix uses Reed-Solomon error correction, and this feature helps correct for partially damaged symbols.

Some of the production processes that are used to produce GS1 DataMatrix symbols are as follows:

- Direct part marking, such as is done by dot peening on items, such as automotive, aircraft metal parts, medical instruments, and surgical implants.
- Laser or chemically etched parts with low contrast or light marked elements on a dark background (e.g., circuit boards and electronic components, medical instruments, surgical implants).
- High-speed ink jet printed parts and components where the marked dots cannot form a scannable linear symbol.

GS1 DataMatrix symbols are read by two-dimensional imaging scanners or vision systems. Most other scanners that are not two-dimensional imagers cannot read GS1 DataMatrix.

Figure 9-11: GS1 DataMatrix symbol

[source: GENSPECS]

9.2.2 GS1-128

Fragments taken from [GENSPECS]:

The GS1-128 barcode has been carefully designed through joint co-operation between GS1 and AIM (Association for Automatic Identification and Mobility). Use of GS1-128 barcodes provides a high degree of security and distinguishes GS1 system element strings from extraneous non-standard barcodes.

The GS1-128 symbology is a subset of the more general Code 128 symbology. By agreement between AIM and GS1, use of the Function 1 Symbol Character (FNC1) in Code 128 symbols in the first symbol character position following the start character has been reserved exclusively for the GS1 system.

Figure 9-12: GS1-128 symbology

[source: GENSPECS]

9.3 EPC/RFID

9.3.1 Gen 2 RFID Tags

From [TDS]:

The term "Gen 2 RFID Tag" (or just "Gen 2 Tag") as used in this specification refers to any RFID tag that conforms to the EPCglobal UHF Class 1 Generation 2 Air Interface, Version 1.2.0 or later [UHFC1G2], as well as any RFID tag that conforms to another air interface standard that shares the same memory map. The latter includes specifications currently under development within EPCglobal such as the HF Class 1 Generation 2 Air Interface.

9.3.2 SGTIN

Coding schemes and limitations

The SGTIN is the EPC format to encode the GTIN + manufacturer serial ID. The Tag Data Standard [TDS] defines two coding schemes for the SGTIN:

- SGTIN-96: Numeric-only, no leading zeros, decimal value must be less than 2^{38} (i.e., decimal value less than or equal to 274,877,906,943). [TDS]
- SGTIN-198: All values permitted by GS1 General Specifications (up to 20 alphanumeric characters). [TDS]

[9-43] Use of the SGTIN-96 is not recommended, due to the aforementioned encoding limitation. To allow for full interoperability with GS1 barcodes as per the GS1 General Specification, the SGTIN-198 SHOULD be used.
Note: An EPC/RFID tag's EPC Memory Bank (MB 01) requires a minimum capacity of 240 bits to support encoding of the SGTIN-198.

Filter values

[9-44] At the present time, application of specific filter values has not yet been standardised. For this reason, when *writing* a tag, filter value '0' ("all others") SHOULD be used; when *inventorying* or *reading* a tag, the filter value SHOULD be ignored.

9.3.3 GIAI

Coding schemes

The Tag Data Standard [TDS] defines two coding schemes for the GIAI:

- GIAI-96: Numeric-only, no leading zeros, decimal value must be less than a limit that varies according to the length of the GS1 Company Prefix.
- GIAI-202: All values permitted by GS1 General Specifications (up to 18 – 24 alphanumeric characters, depending on company prefix length).

[9-45] Use of the GIAI-96 is not recommended, due to the aforementioned encoding limitation. To allow for full interoperability with GS1 barcodes as per the GS1 General Specification, GIAI-202 SHOULD be used.
Note: An EPC/RFID tag's EPC Memory Bank (MB 01) requires a minimum capacity of 240 bits to support encoding of the GIAI-202.

Filter values

[9-46] At the present time, application of specific filter values has not yet been standardised. For this reason, when *writing* a tag, filter value '0' ("all others") SHOULD be used; when *inventorying* or *reading* a tag, the filter value SHOULD be ignored.

9.3.4 User memory

Based on [TDS]:

User Memory (MB 11 of a Gen2 EPC/RFID Tag) may be used to hold supplementary information beyond the primary identifier encoded in the EPC Memory bank. This includes support for encoding of GS1 Application Identifiers, such as AI (10) BATCH/LOT.

[9-47] EPC/RFID tag support for User Memory is optional, and where present, capacity may vary between specific chip models. Vendors SHOULD be consulted about the size of available User Memory to ensure it meets the requirements.

9.4 HRI (Human Readable Interpretation)

[9-48] Barcodes SHOULD have HRI adjacent to the symbol. [GENSPECS section 4.14]. Brackets (parentheses) SHALL be printed around each AI but these SHALL not be encoded in the barcode.

[9-49] A clearly legible font SHALL be used (e.g., OCR-B as defined in ISO 1073-2) and the character set as defined in section 9.6. Reasonable alternative type fonts and character sizes are acceptable provided the interpretation is clearly legible.

[9-50] In case there is not sufficient space HRI MAY be omitted. In that case non-HRI text SHOULD be present.

9.5 Non-HRI text

[9-51] For each included data field representing a barcoded data element the GS1 data title related to the AI (see section 9.1) SHALL be included.

[9-52] Data titles SHOULD follow the format as specified in the 'GS1 General Specifications', in particular they should be presented in UPPERCASE when indicated.

[9-53] A clearly legible font SHALL be used (e.g., OCR-B as defined in ISO 1073-2). Reasonable alternative type fonts and character sizes are acceptable provided the interpretation is clearly legible.

PLEASE NOTE – If the MRO object is too small and space does not permit, both HRI and Non-HRI MAY be omitted. In that case ONLY the barcode symbol will be included.

9.6 Character set 82

Table 9-1: GS1 AI encodable character set 82

Graphic symbol	Name	Coded representation	Graphic symbol	Name	Coded representation
!	Exclamation mark	2/1	M	Capital letter M	4/13
"	Quotation mark	2/2	N	Capital letter N	4/14
%	Percent sign	2/5	O	Capital letter O	4/15
&	Ampersand	2/6	P	Capital letter P	5/0
'	Apostrophe	2/7	Q	Capital letter Q	5/1
(	Left parenthesis	2/8	R	Capital letter R	5/2
)	Right parenthesis	2/9	S	Capital letter S	5/3
*	Asterisk	2/10	T	Capital letter T	5/4
+	Plus sign	2/11	U	Capital letter U	5/5
,	Comma	2/12	V	Capital letter V	5/6
-	Hyphen/Minus	2/13	W	Capital letter W	5/7
.	Full stop	2/14	X	Capital letter X	5/8
/	Solidus	2/15	Y	Capital letter Y	5/9

Graphic symbol	Name	Coded representation	Graphic symbol	Name	Coded representation
0	Digit zero	3/0	Z	Capital letter Z	5/10
1	Digit one	3/1	_	Low line	5/15
2	Digit two	3/2	a	Small letter a	6/1
3	Digit three	3/3	b	Small letter b	6/2
4	Digit four	3/4	c	Small letter c	6/3
5	Digit five	3/5	d	Small letter d	6/4
6	Digit six	3/6	e	Small letter e	6/5
7	Digit seven	3/7	f	Small letter f	6/6
8	Digit eight	3/8	g	Small letter g	6/7
9	Digit nine	3/9	h	Small letter h	6/8
:	Colon	3/10	i	Small letter i	6/9
;	Semicolon	3/11	j	Small letter j	6/10
<	Less-than sign	3/12	k	Small letter k	6/11
=	Equals sign	3/13	l	Small letter l	6/12
>	Greater-than sign	3/14	m	Small letter m	6/13
?	Question mark	3/15	n	Small letter n	6/14
A	Capital letter A	4/1	o	Small letter o	6/15
B	Capital letter B	4/2	p	Small letter p	7/0
C	Capital letter C	4/3	q	Small letter q	7/1
D	Capital letter D	4/4	r	Small letter r	7/2
E	Capital letter E	4/5	s	Small letter s	7/3
F	Capital letter F	4/6	t	Small letter t	7/4
G	Capital letter G	4/7	u	Small letter u	7/5
H	Capital letter H	4/8	v	Small letter v	7/6
I	Capital letter I	4/9	w	Small letter w	7/7
J	Capital letter J	4/10	x	Small letter x	7/8
K	Capital letter K	4/11	y	Small letter y	7/9
L	Capital letter L	4/12	z	Small letter z	7/10

taken from [GENSPECS]

9.7 Identification of Logistic Units – Serial Shipping Container Code (SSCC)

A logistics unit is a combination of trade items compiled for distribution, storage and/or transportation. The GS1 Identification Key used to identify logistic units is a Serial Shipping Container Code (SSCC). It provides the link between the physical logistics unit and the information pertaining to the logistics unit that is communicated between trading partners using Electronic Data Interchange (EDI). The key comprises an Extension digit, GS1 Company Prefix, Serial Reference, and Check Digit.

Figure 9-13: SSCC Format

Application Identifier	SSCC (Serial Shipping Container Code)			
	Extension digit	GS1 Company Prefix ————————→	←———————— Serial reference	Check digit
0 0	N_1	N_2 N_3 N_4 N_5 N_6 N_7 N_8 N_9 N_{10} N_{11} N_{12} N_{13} N_{14} N_{15} N_{16} N_{17}		N_{18}

Logistic units typically have a label applied containing a unique SSCC identifier [a license plate].

http://www.gs1.org/docs/tl/GS1_Logistic_Label_Guideline.pdf

Figure 9-14: Logistics unit label (sample)
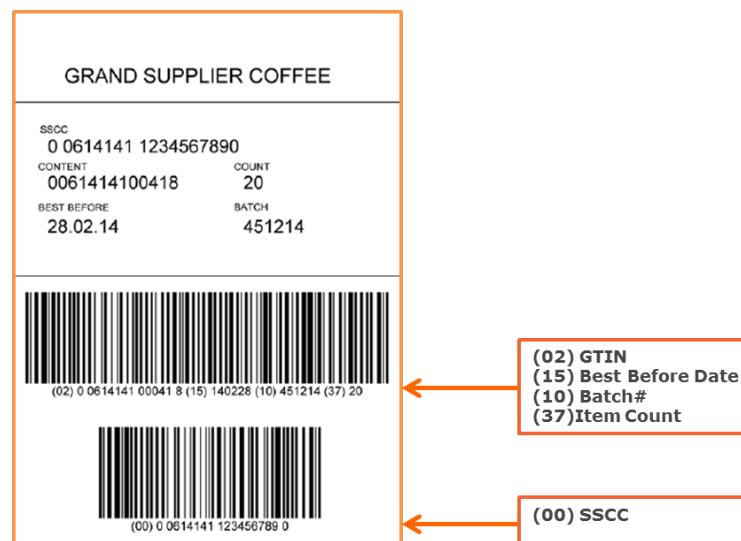
SSCC marked logistic units are optimised when information is transmitted in an electronic *Despatch Advice* message from the despatcher of the goods to the receiver of the goods as part of the order management transaction.

The Despatch Advice provides advanced electronic notification to the buyer of what is despatched, against which order number, when it is despatched and lists the SSCC numbers on the goods that the receiver should expect to receive.

The despatcher of the goods may also transmit an electronic Transport Instruction to their transport provider detailing the SSCC numbers of the goods requiring transportation and other information the transport provider requires to effectively execute the physical transport task.

An electronic Transport Status Notification exchanged between the transport provider, supplier of the goods and the buyer of the goods can provide updates to all parties on the status of the transport task (i.e. SSCCs picked up, SSCCs unloaded at an intermediate location, SSCCs delayed in transit, SSCCs delivered to final recipient/proof of delivery) etc. providing visibility over the in-transit process.

Upon physical delivery, the receiver can simply scan the SSCC on the goods received thereby executing an automatic goods receipt process. It also enables automatic inventory updates and reconciles the transaction against the pre-received Despatch Advice. If reconciliation is error free, this transaction could be automatically processed for payment.

The entire process dramatically reduces administration in the order management cycle, improves inventory accuracy and increases operational efficiencies from origin to destination.

Figure 9-15: Electronic Procurement to Pay cycle
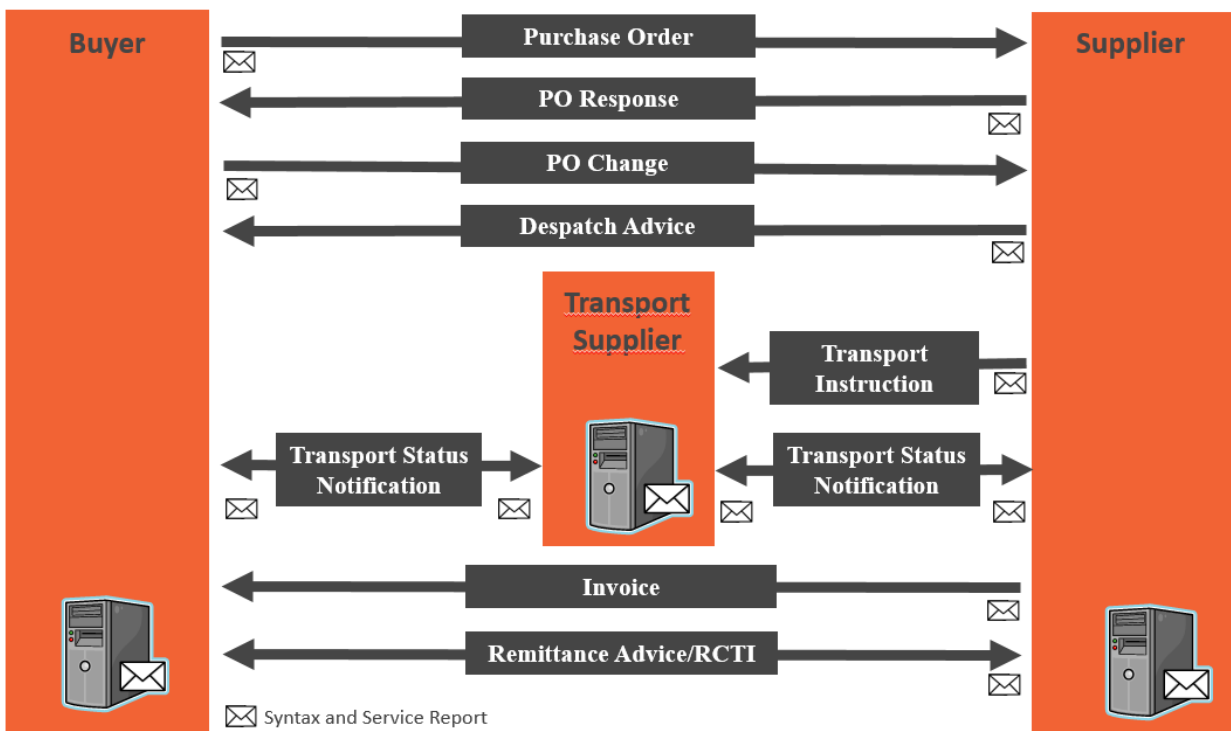
Note: In Transport Management Processes, the SSCC should be considered the only freight tracking identifier from point of origin to destination. Every transport provider in the end to end transit chain should track using SSCC and provide tracking information either via EDI or EPCIS to aid end to end visibility.

PART III – INDUSTRY REQUIREMENTS

DATA AND LABEL/PLATE DESIGNS FOR

THE AUSTRALIAN RAIL INDUSTRY

10 Data and Label/Plate Requirements

The Australian rail industry has determined the following requirements to be complied with from 1st January 2019. All stakeholders who need to identify and physically mark MRO objects in the rail industry should follow these requirements as a minimum.

10.1 Data Elements

The following table outlines the minimum data requirements to be associated with an MRO object or asset. The extent to which these are encoded into a barcode or RFID tag will be implementation specific depending on product, product type, business process etc.

The Item Identification code is the minimum but mandatory requirement that **MUST** be encoded into a data carrier (barcode/RFID tag) and applied to the physical product. Additional product information that is not encoded into a data carrier should be made available by data file transfer.

Table 10-1: Minimum Data Requirements

|	Attribute	AI	Format	Text	Barcode
ITEM IDENTFICATION	GTIN – Global Trade Item Number	01	N14	M	M
	GIAI - Global Individual Asset Identifier	8004	X..30	M	M
PRODUCT INFORMATION	Product description (short)		AN..35	M	N/A
	Manufacturing Batch	10	X..20	C	C
	Expiry Date (YYMMDD)	17	N6	C	C
	Serial Number	21	X..20	C	C
	Internal Reference No (Not to be used in open Supply Chain)	91-99	X..90	B	B
	Country of origin	422	N3	O	O
	Date of Production (YYMMDDHH)+(MMSS)	8008	N8+N4	C	C

Legend:

AN..nn	Maximum number of alpha numeric characters
B	Bilateral agreement only (Not to be used in open Supply Chain)
M	Mandatory (if applicable)
C	Conditional (must be included if used)
Nn	Numeric (exact number of digits)
N..n	Numeric (maximum number of digits)
O	Optional
Xn	Any Character (exact number of characters including symbols such as @#*)
X..n	Any Character (maximum number of characters including symbols such as @#*)

Please refer to previous sections of this document for Rules and Technical data specifications.

10.2   Label/Plate Formats

Guidance is provided here for how to display a label or plate that includes all the data elements above with notation of the position of the barcode symbology and HRI (Human Readable) information. Discretion will be the key in terms of size and encoding of data depending on the product and space availability.

Figure 10-1: Label/Plate Formats
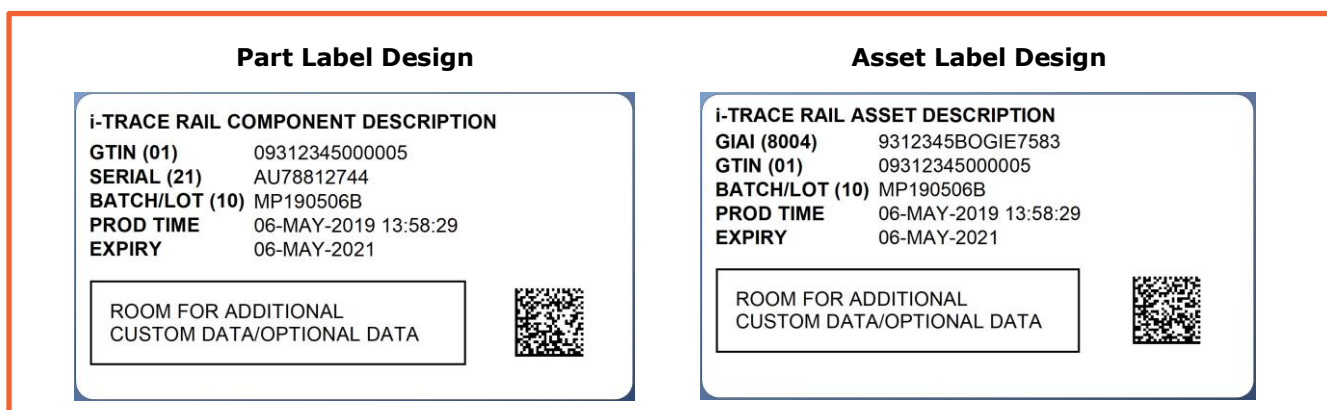
(Images are not to scale)

Important:

a)   Linear 1D barcode is optional in addition to mandatory 2D barcode on Plate/Label.

b)   Where applicable, the minimum size of GS1 DataMatrix 2D barcode (including quiet zone) required to include all above data is as follows:
   Printed (i.e. label)   - 15.2 x 15.2mm (min x-dimension 0.38mm)
   Direct Part Marking   - 10.6 x 10.6mm (min x-dimension 0.254mm)
   Minimum Font Size   - OCR-B (Optical Character Recognition) with a height of 2.75mm

c)   Practical space allowances will determine appropriate size of GS1 DataMatrix barcode and extent of Human Readable Text. If uncertain, please contact GS1 Australia or refer to *GS1 General Specifications* for more technical specifications.

Note:

These are minimum requirements as agreed by the rail industry working group; individual organisations are free to go beyond these requirements based on additional business requirements. Please refer to the GS1 General Specifications for additional data standards or contact GS1 Australia for assistance.

PART IV – DOCUMENT ADDENDUMS

11 Case Study: OneSteel – Identification of Steel Products (including rails) using GS1 keys

In Australia, Liberty OneSteel is the premier manufacturer and distributor of long steel products and is the sole Australian manufacturer of both plain Carbon and head hardened steel rails supplied from the OneSteel Whyalla Steelworks in South Australia.

For some time, Liberty OneSteel has recognised the supply chain & quality benefits that can be gained from standard product identification & barcoding and has worked closely with GS1 Australia to consistently utilise GS1 keys in the identification of its products. The examples below illustrate how these principles have been applied

STEEL RAILS

Steel rails ex OneSteel Whyalla are individually labelled on the bottom flange of the rail identifying each piece.

The label typically will look like the example below:
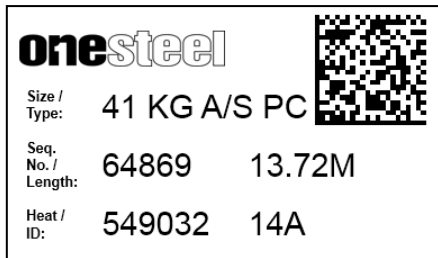
The GS1 DataMatrix applied for OneSteel rail uses the following GS1 keys:

AI Code	AI Type	Data	Comments
01	Global Trade Item Number (GTIN)	99316183038858	This is the OneSteel issued GTIN for AS 41kg Plain Carbon Steel Rail produced in 13.72m lengths to OneSteel Rail Technical Standard RT23, supplied undrilled & with a length tolerance of +150mm / -0mm
11	Production Date (YYMMDD)	150609	Production date: 9th June, 2015
21	Serial Number	54903214A	This is the combination of the cast, or heat, of steel and the production identity of the feed length of rail.
250	Secondary Serial Number	64869	The secondary serial number indicates the individual identity of the rail length cut from the production identity & combined with the Serial Number & GTIN gives the unique identity of the individual rail length.
3112	Length or first dimension, metres (Variable Measure Trade Item)	001372	This is the length of the rail in metres, the "2" in the AI (3112) string indicates that the decimal point sits between the 4th & 5th digit ==> 13.72m

MERCHANT BAR STEELS

Merchant Bar Steels supplied by the OneSteel Rod, Bar & Wire business are sold in coils or in bundles of straight bars.

Each bundle or coil; will be individually tagged as shown in the photo on the right

Typically the tag will look like the example below:

The GS1 DataMatrix applied for Liberty OneSteel merchant bar steel uses the GS1 keys detailed below.
N.B. The GS1-128 barcode shown at the bottom of the label combines the GTIN (AI 01) & Serial Number (AI 21), both of which are described below.

AI Code	AI Type	Data	Comments
01	Global Trade Item Number (GTIN)	99316266013925	This is the OneSteel issued GTIN for 16mm Deformed Bar manufactured to Australian Standard AS 4671 in Micro-alloyed 500N grade, supplied in coil
21	Serial Number	G15832430	The serial number indicates the individual production identity of the bundle or coil - combined with the GTIN gives the unique identity of the individual bundle or coil
10	Batch or lot number	165508	This is the identity of the cast, or heat, of steel that was manufactured in the steelmaking process & from which the finished product has been rolled.
30	Count of items (variable measure trade item)	01	This the count of units within the bundle, in this case the count is 1 as the product has been supplied as a single coiled piece.
3100	Net weight, kilograms (variable measure trade item)	002070	This is the net weight of the bundle or coil measured in kilograms, the second "0" in the AI (3100) string indicates that there is no decimal point ==> 2070kg = 2.070t

12 Frequently asked questions

12.1 Do I have to use a GIAI? Why can I not use an internal number instead?

Because more and more objects are identified with data carriers, the use of internal numbers increases the risks of numbers clashing and therefore capturing the wrong information. It also means that other parties wanting to take advantage of this data e.g. for safety and maintenance reasons are not able to do so.

12.2 Should I use GIAI-96 or GIAI-202?

Two coding schemes for the GIAI are specified, a 96-bit encoding (GIAI-96) and a 202-bit encoding (GIAI-202). The GIAI-202 encoding allows for the full range of serial numbers up to 24 alphanumeric characters as specified in *GS1 General Specifications*. The GIAI-96 encoding allows for numeric-only serial numbers, without leading zeros, whose value is up to a limit that varies with the length of the GS1 Company Prefix.

12.3 Do I have to pad GIAI-96 with zeroes for unallocated bits?

Just because the maximum number of digits allowed in a GIAI-96 is 25 does not mean that all the digits have to be used. This means that there is no need for zero padding to fill up unallocated bits. All serial numbers from 1 through to the maximum value (without leading zeros) may be used with 96-bit tags.

12.4 Whose company prefix is used to create the GIAI?

The GS1 Company Prefix is allocated by GS1 Member Organisations to the company that allocates the GIAI, in this case the company identifying the components.

12.5 Where do I obtain a Global Company Prefix?

Your Global Company Prefix will be allocated by GS1 Australia as the Australian Licensor of the GS1 System of Standards. Contact *GS1 Australia*

13   How to progress from here

If your organisation wishes to pursue with implementation of GS1 standards, the following steps will be required:

Step 1 - Obtain a GS1 Global Company Prefix (GCP)

The first step in assigning a GS1 Identification Keys is to obtain a **GS1 Global Company Prefix** from a GS1 Member Organisation. Costs to participate are not prohibitive; it encompasses a member joining fee and an annual subscription fee.
https://www.gs1au.org/resources/application-forms-and-fees/

Step 2 - Assign numbers

After receiving a GS1 GCP, a company is ready to begin assigning identification numbers to their trade items (products or services), themselves (as a legal entity), locations, logistic units, individual company assets, etc. Refer to Appendix 1 and 2 of this document to determine which GS1 Identification Key you should use.

Step 3 - Select a barcode/RFID printing process

To begin, you should decide what you are barcoding/tagging and if the data carrier will carry static or dynamic information inside it. An example of static information would be simply a product identification number (GTIN) on a consumable item. An example of dynamic information would be printing serial numbers on product labels.

Knowing how you will print your barcode/RFID tag is an important question to answer in developing a good implementation plan. If required, please contact GS1 Australia to assist you in making the right selection.

Step 4 – Select a "primary" scanning environment

The specifications for barcode/RFID tag type, size, placement, and quality all depend on where the item will be scanned. By knowing your scanning environment you can establish the right specifications for its production.

Step 5 – Select a data carrier (barcode or RFID tag)

The data carrier you choose will depend on the type of item you need to mark and the information you need to encode.

Step 6 – Prepare your back office systems

Your enterprise systems' database will need to be able to generate and read the information included in your barcodes and RFID tags. Your IT department will be able to assist in this regard or contact *GS1 Australia* for assistance at *www.gs1au.org/resources/contact-us/*.

Step 7 – Advise your trading partners

Be sure to advise your supply chain partners, ie. Customers and/or suppliers of the GS1 identification numbers you have allocated for specific materials, assets, locations etc. as these will be integral to good master data management for all stakeholders

Step 8 – Take advantage of your membership

Take advantage of your GS1 Australia membership; you will have access to many resources including how to guides customer care support, training, professional services and more.

14 Dos and Don'ts

	Dos	Don'ts
1	Accept both GTIN and GIAI as valid GS1 identification keys for rail parts and components.	(do not) Enforce the use of one of the keys (GTIN or GIAI), instead of supporting both.
2	Use the GTIN as non-significant identifier that is linked to the internal article number in your system	(do not) Give GTINs a "meaning" beyond being a pure identifier (do not) Try to "squeeze-in"/pack in your internal article number into the GTIN, introduce logic such as classifying elements
3	Use the GIAI as a non-significant identifier that is linked to the internal article number in your system Note: Any exceptions to this practice should be documented in official GS1 guidelines. An example is embedding the European Rail Vehicle Number (EVN) in the GIAI of a rail vehicle, as defined in the GS1 European Rail Guideline.	(do not) Give GIAI a "meaning" beyond being a pure identifier (do not) Introduce logic such as classifying elements.
4	Accept company prefixes as they are, the GS1 identification system ensures that all allocated GTINs and GIAIs will be unique across different suppliers.	(do not) Enforce your GS1 Company Prefix to be used by your suppliers
5	Limit the information marked in the GS1 DataMatrix symbol or on an EPC/RFID tag on the MRO object to the minimum necessary (data such as serial number, batch/lot, expiry date, date of production). Use a database for the additional information	(do not) Encode any extra information in the GS1 DataMatrix symbol or on an EPC/RFID tag that could be stored in a database and may change over time. (do not) Mark additional company specific identifiers on the MRO object.
6	Keep the serial number in a SGTIN (GTIN + serial number) <u>as short as possible</u> in order to overcome current limitations of some ERP systems.	(do not) Issue serial numbers that are longer than absolutely necessary.
7	Exclusively use officially approved GS1 Application Identifiers in the barcode and on EPC/RFID tags.	(do not) Mix or require mixing ANSI Data Identifiers (DIs) and GS1 Application Identifiers (AIs) in the same barcode, to avoid scanning errors.

15 About GS1 and the ARA

GS1 is an international not-for-profit association with Member Organisations in 112 countries. GS1 is dedicated to the design and implementation of global supply chain data standards and services to improve the efficiency and visibility of supply and demand chains globally and across sectors. The GS1 System of standards is the most widely used supply chain standards system in the world.

15.1 GS1 as a partner within the rail industry

- Make implementation faster and more effective;
- Help users focus on the business requirements instead of developing their own standards for identification and data communication;
- Make it easier to buy hardware, software and equipment reducing the costs of implementation, integration and maintenance;
- Facilitate collaboration between trading partners making it quicker and easier to identify objects and share information (like maintenance/repair history);
- Make it possible to build a scalable solution / system as they are interoperable with other systems and can easily connect to off-the-shelf systems and applications.
- Significantly increase the longevity of the system as components that are standards-based can be sourced from different suppliers.

GS1 creates and manages exactly these types of proper and well-designed systems of standards. For over 40 years it has provided "community management" for the adoption of barcoding/RFID, EDI and master data synchronisation solutions in many sectors. GS1's financial model is completely based on cost recovery.

It has strong links with standards organizations such as ISO and cooperates with NATO, WCO, UPU, and the FDA to name a few. The GS1 System of standards is well known and widely used in many sectors, including Transport & Logistics, retail, healthcare, defence, and many others.

In Australia, GS1 is directly represented by GS1 Australia with 150+ staff assisting members from offices in Melbourne and Sydney; this means the rail industry users of GS1 standards can get direct support from their local offices. GS1 Standards are built and maintained by experienced staff from different companies across the world and different sectors. Rail industry stakeholders are welcome to join relevant work groups to ensure that future standards meet rail requirements.

The Australasian Railway Association (ARA) is the peak body for rail in Australia, representing all sectors of the rail industry. The ARA represent an array of rail organisations, including private and public, passenger and freight operators, track owners and managers, manufacturers of rolling stock, construction companies and all other organisations supplying and contributing to the Australasian rail sector.

The ARA provide a coordinated and unified voice on relevant issues of national importance and engage political leaders at both the state and federal level in forward-looking discussions around industry potential. They bring about key policy reform to effectively enhance Australia's productivity, economic and social prosperity, as well as its international competitiveness.

The ARA creates an avenue for industry to connect, share knowledge and work together to achieve greater results for rail. As Australasia's leading voice for rail, they facilitate, coordinate, promote and communicate on behalf of the industry. The ARA work to create an environment for the rail industry to prosper; ensuring a better rail future for all.

The ARA promotes rail along with specific projects and initiatives. Policies are developed across a range of areas including safety, telecommunications, disability and infrastructure. The ARA meets with Ministers, shadow Ministers, senior bureaucrats, key organisations and decision makers regularly to promote these policies and discuss other matters raised by members.

16   Submission and standards Review Control

16.1   Submission (completed by person submitting document for review)

Submission date	Submitter name	Context of document – business owner/department, audience, usage, format (e.g. EDM, hardcopy flyer, web, etc.)	Required completion date
25-Aug-2015	Bonnie Ryan	This version (0.04) is early draft of a new industry guideline for the Australian rail sector.	
18-Dec-2015	Bonnie Ryan	This version (0.10) is final draft of the new industry guideline for the Australian rail sector.	
03-Oct-2018	Michiel Ruighaver	Added section 14 (Do's and Don'ts)	

16.2   Review comments (completed by standards reviewer)

Date	Reviewed by	Identify Capture Share General	Comments
4-Sep-2015	Ankur Vaid	Identify, Capture	See comments
21-Aug-2017	Stephan Wijnker	General	Minor comments
12-Oct-2018	Stephan Wijnker	General	Minor revision

16.3   Approval (completed by standards reviewer)

Date	Approver	Identify/Capture/Share
21-Aug-2017	Stephan Wijnker	Identify/Capture/Share
12-Oct-2018	Stephan Wijnker	Identify/Capture/Share