European Commission

The possible introduction of an electronic tag as a supplement or a replacement of the wheel mark in marine equipment

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EXECUTIVE Summary

1 Motivation

The basis for this study is Article 11 (2) (Electronic tag) of Directive 2014/90/EU of the European Parliament and of the Council of 23 July 2014 on marine equipment repealing Council Directive 96/98/EC (hereinafter the "New Marine Equipment Directive" - MED) which provides that "The Commission shall carry out a cost/benefit analysis concerning the use of the electronic tag as a supplement to, or a replacement of, the wheel mark."

The time frame to agree on a broadly accepted and recognized standard for electronic tags to supplement or replace the wheel mark is relatively tight, because industry has already started to apply such technology. There is a risk that manufacturers will apply different technologies in isolation with the consequence that the individual technologies might not be interoperable. The maritime industry constantly operates in a complex environment which makes it difficult to envisage all future possible uses of electronic tagging.

The implementation of electronic labelling of marine equipment products may result in new possibilities for the users and better information to market surveillance by creating a continuous information flow between manufacturers, notified bodies and authorities. Authorities and notified bodies should benefit from the enhanced and smooth market surveillance mechanism, which should ease the day-by-day survey operations, encouraging the rapid uptake of the electronic labelling. Notified bodies should benefit from the seamless notification capabilities with electronic tags pointing to an information repository where all the relevant information of the product is stored. Manufacturers should benefit from the improved notification mechanism to fight counterfeiting and the possibilities for additional after-sales market services. Ship owners/operators should be able to seamlessly check the validity of the certificates for the equipment they have on board and carry out stock control more easily

The cost benefit analysis should take into consideration of the administrative burdens, the IP protection and efficiency in fighting counterfeiting as well as the effect on international competitiveness and the technological and non-technological innovation potentials.

The study includes also the demonstration of the potentials on the use of the electronic tags for marine equipment products through a pilot demonstration.

2 Important Technologies and Infrastructure

2.1 Existing Databases and IT Architecture

Electronic tag readers are used to gather information directly at the product. A unique identification code for products allows the collection of a limited amount of data from the tag directly and from distributed databases via tag reader connections.

To obtain information already today regarding marine equipment several public information sources exist by means of databases which are offered through the Internet. Based on the electronic tag information the users (depending on their role

and access rights) may in the future be able to get access to the most important databases for marine equipment which are NANDO, MarED, RAPEX and ICSMS. Beside the public databases also industry databases are available. They are operated by marine suppliers or classification societies. Selected industry databases have been considered related to remote accessibility. The reader implementation must consider the access procedures of each database.

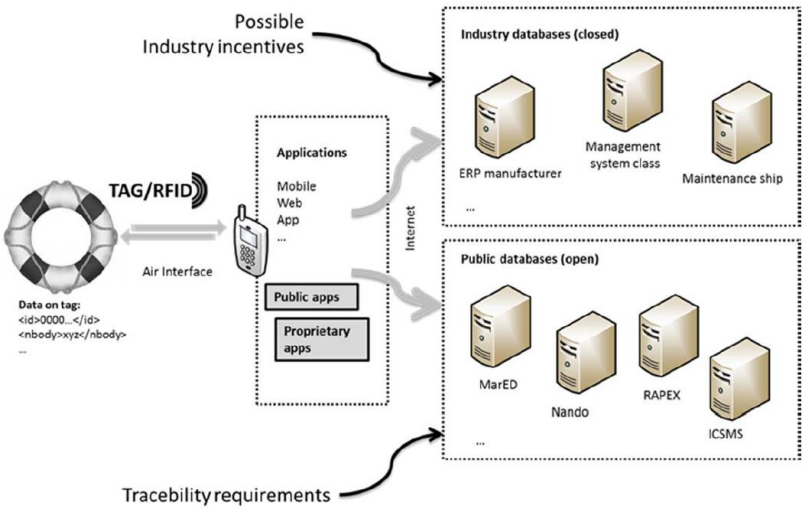


Figure 1: General concept of interlinking databases by means of electronic tags

A general architecture for the data exchange between the eTag reader and the different databases (public and industrial) are illustrated in Figure 1. Therefore, a remote database access is needed and a unique identifier (data and application identifier). The electronic tag including an identifier will be a compound attribute to query databases for further information in similar way like today, just with the difference that the manual entry to the database is replaced or enlarged by automatic identification means. Other applications to equipment industry or shipping industry internal databases may also be interlinked based on pre-agreed neutral interfaces and unique identifier.

2.2 Data Carriers

The common aspect of **A**utomatic **I**dentification and **D**ata **C**apturing (AIDC) technologies implies that information is encoded into a machine-readable format. The resulting code is according to the particular AIDC technology stored on a respective data carrier.

This leads to two recommendations for the application of AIDC technologies in the domain of marine equipment, namely 2D Data Matrix codes and RFID (Radio Frequency Identification). For both resulting data carriers, different options are known and available. Under consideration of technical limitations, market share and prospective technical progress, data carrier standards are chosen for both options.

Data Matrix		**Passive RFID in UHF band**	
	Standardised under ISO/IEC 16022:2006 - Data Matrix bar code symbiology specification		Standardised under ISO/IEC 18000 Part 6 865-868 MHz (Europe) 902-928 MHz (North America)[1]

Both data carriers are available in different forms, i.e. printed, laser-marked or peel marked in the case of Data Matrix and in the label, hard case, or flexible form for RFID. Respective mobile or stationary reading devices can read the data carrier and return the information.

For the uptake of **A**utomatic **I**dentification and **D**ata **C**apturing - AIDC technologies for equipment under the Marine Equipment Directive, we recommend:

- the use of either Data Matrix or UHF RFID according to ISO 18006-C or Data Matrix and UHF RFID in parallel.
- Specification of minimum sizes and quality criteria for Data Matrix codes.
- Recommendations for transponder types in the case of RFID with respect to different product categories.
- Advice to lock write access to product tags after delivery (RFID) as a minimum-security feature.
- Specification of general criteria for the durability of data carriers and tags: Data Carriers (RFID and Data Matrix) must be read along the complete lifecycle so that carriers need to last longer than the expected lifetime of products (up to 30 years).

3 Coding and Numbering System

The underlying principle of AIDC technology is to attach the information related to the product directly to the physical product itself by the proposed data carriers. A set of information will be encoded into a machine-readable code and stored on the data carrier. The data carrier will be attached to the product. The information can be decoded again by reading devices.

Today's technical limitation of data carriers implies, that the information directly on the carrier provides just a link to further information stored in public or private databases. Direct storage of enhanced information such as electronic versions of certificates or documentation cannot be stored directly on the carrier. One might consider the direct information analogous to an Internet URL that guides you to further information on the web page.

It is required, that this information has a structure, which is agreed upon all stakeholders of an application domain. In doing so, the provided link can be understood to get further detailed information and files in public databases or in access-restricted private databases.

[1] Image source: https://en.wikipedia.org/wiki/Radio-frequency_identification#Tags

For the considered case of a coding and numbering system under the marine equipment directive, it is recommended to consider the following steps:

1. Defining a general agreed format of the MED certificate number, that links physical objects to certificate information of marine equipment, for instance, maintained by MarED or similar databases with respect to the master data
2. Proposing a procedure and scheme to include the MED certificate number on a data carrier which uses the ISO/IEC 15418:2016 ASC MH10 Data Identifiers
3. Proposing a procedure and scheme to include the MED certificate number on a data carrier which uses the ISO/IEC 15418:2016 GS1 Application Identifiers

3.1 MED Certificate Number

A MED certificate number once agreed upon by the stakeholders, has the ability to provides links to further existing and relevant database of the European Commission. The traceability by identifying products on the certificate level would provide tools to secure compliance with regulations under the marine equipment directive. Databases such as MarED, ICSMS and RAPEX are prepared to add a field that stores a MED certificate number and allows querying of this field.
With respect to the master data of a product, when traced on certificate level, the attributes are

- Manufacturer
- Item
- Trade name
- NB/prod. Year
- Applied modules
- Notified Body B[2]
- Module B certificate
- Notified Body D, E, F or G
- Module D, E, F or G certificate

The certificate numbers are the primary keys for market surveillance. An illustrative example is given in the following Figure 2.

Manufacturer	Wuxi Xingta i Shipping
Item	A.1/1.1 Lifebuoy
Trade name	XT 5555 - Lifebouy 2,5 kg
NB/prod. year	0062/00
Applied modules	B+F
NB B	0062
Module B certificate	08581/A1 EC
NB	0062
Module D, E, F, G certificate	0535CHN2000

Figure 2: Master data example of an equipment on certificate level

The unique identification of a certificate combination and therefore as well the identification of products on certificate level is given by building a number based on the following scheme
[Applied module B][Notified Body B][Module B certificate] + [Applied module D, E, F or G][Notified Body D, E, F or G][Module D, E, F or G certificate]
This can be illustrated by the given example in Figure 2 and leads to:

[2] Not considered in case of a G module

B006208581A1EC+F00620535CHN2000

It is recommended to determine this or something similar in the regulation guidelines for applying electronic tagging under the marine equipment directive. While the certificate numbering is left open to the notified bodies, which are identified by a 4-digit number, it might be necessary to limit the possible digits and restrict special characters due to technical reasons. These limitations are deduced directly from the following concepts of including the MED certificate number under ISO/IEC 15418:2016.

3.2 ISO Standard and ASC MH10 Data Identifiers

By integrating the MED certificate number according to the ISO 15418:2016 / ASC MH10 Data Identifiers, interoperability and extensibility is ensured. A data carrier, which data is structured according to this standard, can include several application-specific fields, so-called data identifiers, which determine the type of the following information. Accordingly, the data structure is dynamic in a way that the field structure of overall data content can be very different, although a dedicated field identifier might determine that the following content describes the MED certificate number. The following Figure 3 gives a general overview of the general data structure.

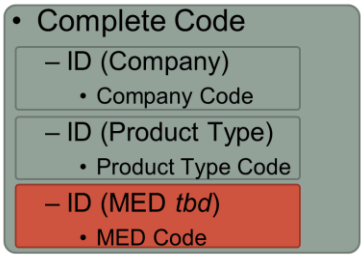


Figure 3: General data structure on a data carrier according to ISO/IEC 15434:2006 and ISO/IEC 15418:2016

Today's situation is, that neither a dedicated ID for the application of the MED certificate number does exist, nor is a data identifier available that fits in its description to something more general like "document number" or "certificate number". The following has been considered:
In the marine equipment domain, it is necessary to put a code on products that refers to a certificate number, i.e. to a certificate which has been issued by a Notified Body.
Per certificate, the number is unique and consists of alphanumerical characters and the special character "+". The length is not limited at the moment but might be limited to 30-35 characters in the future. Depending on the product, the certificate and the respective certificate number belongs to an individual item, a lot/batch or a product type.
Under consideration of the ASC MH10 Data Identifiers, we see the following general options, however, encompassing several limitations:

1. With respect to the description of the data identifier "12S – Document Number (internally assigned or mutually defined)", the reference to a certificate document by using its certificate number seems feasible. However, we have the limitation of the usage of just 18 numerical characters, while this does not meet our requirements. Certificate numbers use approx. 30-35 alphanumerical characters and the special character "+" at the moment. Furthermore, "12S" belongs to the category "19 - TRACEABILITY NUMBER FOR AN ENTITY", which will fit for individual certificates on item level. However, lot/batch or product type level has to be considered, too, so that the usage of "12S" might be inappropriate.

2. As an alternative the data identifier "30S – Additional Traceability Code For An Entity Assigned by the Supplier" in addition to or different from the traceability code(s) provided by "S" or "1S"" can be considered for the reference to a certificate document by means of the certificate number as an additional traceability code. There might be a conflict with another intended use of "30S" by some suppliers, however, 1-35 alphanumerical characters meet our requirements for the coding of the certificate number. Again, "30S" belongs to the category "19 - TRACEABILITY NUMBER FOR AN ENTITY", which might be inappropriate for our intended use.
3. Another approach using the data identifier "3Z - Free Text" is always possible. This field would also work even if it is not the favoured solution. The 3Z identifier is related to ISO and can be used for all kind of different information and is used for different applications, because there are no defined restrictions. It is not explicit reserved for MED. That makes it difficult to identify and to use it for automatic recognition. This identifier is not one of the preferred solutions for the MED certification number because within that field identification is much more complicate compared to an own MED specified identifier.

This leads to the recommendation, that the European Commission with the support of industry associations and possibly the European Maritime Safety Agency should apply for adding a new data identifier. At this, one of the following options is feasible:

1. new data identifier, especially intended for the use of a MED certificate number under the marine equipment directive
2. new data identifier as general document identifier or a certificate identifier which could be used by the MED directive, but also for the CE marking or by other certification authorities like e.g. UL (Underwriters Laboratories) in the U.S.

The enhancement of the ASC MH10 Data Identifiers by domain-specific use cases is an intended procedure under the respective ISO standard. It does not require the change of the standard as such.

3.3 GS1 Standard

ISO 15418:2016 covers, in addition, a second characteristic of its application. GS1 is an international non-profit organisation. Until 2004 it was known as European Article Numbering-Uniform Code Council. GS 1 maintains under inclusion of ISO 15418:2016 the GS 1 standards for the data structure on data carriers. Using the same principle as described Figure 3, the GS 1 standards offers dedicated and unique field identifiers that are named GS1 application identifiers.

Companies using the GS1 standards become a member of GS1 and therefore receive particular unique number ranges in order to identify company or product information. In the retail business, these standards are well established, however, also other industries including companies that manufacture marine equipment make use of GS1 maintenance of number ranges.

As ISO 15418:2016 does not allow to mix GS application identifiers with ASC MH10 data identifiers on the one hand, but the application of GS1 is widespread on the other hand, it is absolutely recommended to support the GS1 standard besides the open ASC MH10 pillar.

In detail, the recommendation is likewise, that the European Commission with the support of industry associations and possibly the European Maritime Safety Agency should apply for adding a new application identifier. The same options are feasible:

1. new application identifier, especially intended for the use of a MED certificate number under the marine equipment directive

2. new data identifier as general document identifier or a certificate identifier which could be used by the MED directive, but also for the CE marking or by other certification authorotiers like e.g. UL (Underwriters Laboratories) in the U.S.

It is further a criterion of exclusion for GS 1 as a general option if the data content after an application identifier is maintained by GS 1 and has to be decoded by querying GS1 databases. The new application identifier must support both ASC MH10 Data Identifiers and GS1 Application Identifiers allowing for a free choice for industry. We strongly recommend that the data content, which consists of the proposed MED certificate code, is directly readable and absolutely equivalent in both options.

4 Supplementation of MED Certificate Number by Further Data

If using ISO 15418:2016, both pillars of the standard enable to add further data fields with particular further content that can be encoded on the data carrier.

For all types of products, useful data on the carrier besides the MED certificate code is a manufacturer identification number and the article number as assigned by the manufacturer.

For products that are produced in batches or lots, the lot number as assigned by the manufacturer is a useful extension.

For products that are individual on entity level, i.e. that have a unique individual serial number, the encoding of the serial number as assigned by the manufacturer should be considered.

For special products or processes, the supplementation of the code with information to manufacturing data, expiration date, internal data, etc. is possible.

We generally recommend including examples and argumentation of the usefulness of guidelines and regulations as to the application of further product-related data. This can inspire the uptake of the technology within the industry. The provision of innovation.

5 Traceability, Product Recall and Anti-counterfeiting

With respect to intended effects of the technology, traceability, product recall and anti-counterfeiting are in the scope. In general, the study showed and argued that the technology is an inevitable prerequisite for enhancing the management of traceability, product recall and anti-counterfeiting on the one hand with manageable effort on the other hand.

With respect to the particular categories mentioned in this context, traceability, product recall and anti-counterfeiting characteristics are briefly described and general recommendation for an uptake within the industry are given.

5.1 Traceability

Traceability describes the ability to verify the past movements and locations of items or the application of an item in a greater context. A machine-readable code by means of data matrix or RFID technology enables a strong increase of the generation of such records. This is related to the fact that the scanning of an item and the storage of a record in a traceability database is hardly causing process operation costs. Traceability of lots or individual entities will be enabled by a digital logbook that helps to answer questions that address supply chains, distribution networks, misuse of products, product recalls and market surveillance.

Traceability databases are maintained either by manufacturers or manufacturing networks itself or by industry associations or AIDC service organisations such as GS1.

We recommend the investigation of reference architectures and systems in order to proof appropriate means for traceability.

5.2 Product Recall

Product recalls are special cases in which due to quality or safety related problems, single items or lots have to be recalled from the market. In doing so, information about past movements and locations of items help to investigate where the relevant products are. The on-site identification either by ship operator, manufacturer, market surveillance or port authority further enables faster and transparent problem-solving in the case of product recalls.

We recommend the investigation of reference architectures and systems in order to proof appropriate means for product recalls based or embedded into the traceability topic.

5.3 Anti-counterfeiting

Anti-counterfeiting or related means fulfilled for instance by market surveillance or port authorities describe the ability to verify the origin of an item.

First of all, the AIDC technology has limited security against counterfeiting because data carriers can be copied as well. Anyway, the traceability information is of great value to indirectly identify counterfeited products. This is, for instance, the case if products with a serial number are scanned on-site at a place where they have not been delivered or if products with a same serial number are scanned at the same time at different places.

For the use of RFID, there is also the possibility to enhance the security of identifying counterfeited products by using the technical characteristics. Each RFID data carrier

has an individual identification number assigned by the manufacturer and stored in a read-only memory. This number can be maintained in a database by the manufacturer and accordingly identify the origin of a product. The ID itself can also serve as a serial number without even changing any internal processes.

Latest developments proclaim artificial DNA technology which means that a private-public-key encryption is used to verify the validity of original RFID data carriers. This is a technology that will be aligned to the proposed RFID frequency range.

We recommend the investigation of reference architectures and systems. In summary, we recommend the investigation of use cases to proof appropriate means for anti-counterfeiting, possibly by the execution research, innovation and demonstration projects (depending on the readiness level).

6 Reliability Issues

General requirements and constraints for AIDC technology components in maritime environments arise from the different needs and requirements of equipment manufacturers and operators, notified bodies and port authorities.

In particular, the contemplated usage of products in harsh maritime environments implies meeting further product-relevant requirements. Transponders with different properties may be chosen for different products. Data Carriers must be resistant against different environmental conditions. These conditions may be challenging or even haphazard. Protection classes are standardised. Each class defines which environmental properties a transponder is safeguarded, so they will not destroyed or hinder its functional performance. Today's state-of-the-art shows, that data carrier technology is available for almost all equipment under the maritime equipment directive.

We recommend formulating requirements on reliability in a way that data carrier has to resist harsh environments as long as the intended lifetime of the products.

7 Targeted Consultation Frame

The study has followed as far as applicable the "Stakeholder Consultation Guidelines"[3] as issued by the Commission and based on COM(2002) 704 - Commission Communication: Towards a reinforced culture of consultation and dialogue - General principles and minimum standards for consultation of interested parties by the Commission. Basically, this is organised in three steps, namely (1) to **define the consultation strategy**, (2) to **perform the consultation** and (3) to **analyse and evaluate the results**. The consultation was divided in the following activities:

Stakeholder Workshop - Bremen with the intention to give stakeholders an overview on actual developments and projects and to introduce possibilities as well for applications of e-tags in industrial processes. During the workshop, it became apparent that this kind of a workshop also involves educational elements for participants which will help them later to evaluate proposals to accommodate e-tags in the MED.

[3] Part of the „Better regulation guidelines and associated toolbox". See: http://ec.europa.eu/info/law/law-making-process/better-regulation-why-and-how_en

Stakeholder Survey – Questionnaire: After some meetings with industry representatives at SeaEurope and Member States representative and AdCo member BSH in Germany a broader consultation process has been launched. A stakeholder survey through the Internet by a dedicated questionnaire has been conducted. As a summary of the evaluation the following basic statements can be made:

- There was a clear opinion (>80%) that e-tags should be introduced as a supplement and not as a replacement of the wheel mark.
- There was a clear opinion that e-tags are of high value or extremely high value to support market surveillance activities and may facilitate easier and quicker access to product documentation (certificates, DoC, manufacturer information, etc.) if this information is made available in databases.
- There was a majority in favour of Data Matrix code as preferred technology followed by RFID solutions. However, there is also uncertainty in the opinions because of lack of basic technological knowledge and it very much depends on the products and application cases.
- Already today manufacturers put information on their products beyond the requirements of the directive which might be integrated into e-tags in the future.
- Participants identified and nominated additional information to be integrated into e-tags, e.g. product identification number, manufacturer identification, production site, batch/lot number, serial numbers, etc.
- When reading e-tags in the future, participants expected predominantly basic and extended information on compliance – (Notified Bodies, certification regime, certificate numbers, validity, Copies of DoC and Certificates etc.), e.g. through the MarED Database (COM-Database on certified products).
- When reading e-tags in the future, participants see also the potential to have (authorized) access to proprietary information potentially available in databases managed by companies (e.g. manuals, technical information, drawings, parts lists, life cycle etc.).
- For the elaboration of further benefits of e-tags, e.g. in the context of internal business logistics, participants claimed not to have enough information/knowledge for a valuation.
- Besides quicker access to information about compliance of a product, participants see a potential benefit that counterfeiting may become more difficult by employing e-tags for easier verification of product authenticity.
- Biggest objections raised are about cost and potentially required organizational adaptions of internal processes and alignment to required external processes.
- Further concerns were addressing the durability of e-tags and missing standards.
- Most participants indicated that the level of knowledge in their organizations on e-tag technologies (Data Matrix code and RFID tags) is very low, especially with regard to RFID. Consequently, the experience with applications and e-tag solutions in the sector is very low. However, exceptions exist and there are some forerunners in the market.

In short, on the introduction of e-tags participants have high expectations and see a great potential for improvements of their own processes and beyond. However, the evaluation of answers also shows uncertainties and doubts based on a lack of knowledge.

Stakeholder Workshop – Brussels was basically addressing the results of the questionnaire, but was also giving again background information (including demos) on e-tag technologies and potential applications. Major focus was finally on the definition of a MED unique identifier as a basis for the coded information of the e-tags and as well potential structure of data-repositories and access rights. Whereas the discussion

basically confirmed the evaluation of the questionnaires given above, it is the definition of MED unique identifiers and the potential content which is of major concern of the participants. It needs to be said that the new MED does specify the information which should be available on the product. The visual wheel mark as it is at the moment only requires the coded information on the Notified Body and the date the wheel mark has been applied on the product. Regarding the expectations and wishes from the questionnaire evaluation an Implementing Regulation to the MED needs to clearly define the format and mandatory content of an e-tag. Participants very much welcomed the proposal of the consultants to base a definition on existing ISO standards. The recommendation by the consultants for the MED unique identifies is contained in this report.

Demonstrator SMM 2016 – Hamburg: To demonstrate potential market surveillance activities on trade fairs and how e-tags may facilitate these processes in the future, three show cases have been organized and performed at SMM 2016 trade fair in Hamburg. Three manufacturers supported the action by making products available for the demonstrators and by collecting the related information upfront. Selected products have been e-tag labelled in agreement with the manufacturers and potential market surveillance activities have been demonstrated. The e-tag information contained real information about the products. By reading with a mobile device access to real time information available in the MarED database and the RAPEX database could be demonstrated. This demonstration has been very well received by the participants, because it was explaining quite well how e-tags could improve future processes especially regarding market surveillance.

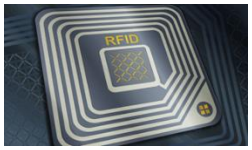
Demonstrator Baltic Sea – TT Line Ferry has been planned on board of a ferry in the Baltic Sea with in situ application of e-tags on MED products and interlinkage with remotely available information in databases. As part of the demonstrator a workshop on board of the TT-Line Ferry Nils Holgersson on the route from Trelleborg/Sweden to Travemünde/Germany and back in the Baltic Sea has been a good success and was well received by all participants. With the help of the ship operator and the Classification Society DNVGL the workshop could be well prepared. About 20 products have been identified onboard for the demonstration, representing different item categories of the MED. The categories comprised LSA, Fire Safety, radio and navigation. For all products, the consultant with support from the shipping company, Classification Society and manufacturers created complete files with the necessary information including certificates, DoC etc. All products have been labelled with Data Matrix codes and RFIDs. The MarED database was prepared to accommodate additional information and to allow online access by means of reading electronic tags. The respective reading device including the related "App" (tablet) has been prepared to allow full scope demonstrations in situ. Places visited on board comprised a muster station with multifold LSA equipment, the bridge with navigation and radio equipment and the upper deck with a locker containing firefighting products. At all locations demonstrations on reading labels and access to remote information have been performed and delivered the functional prove. Discussions with all participants lead to an overall positive evaluation of the potential of e-tags to improve processes from the different stakeholders.

8 Scenario Selection for the Cost-Benefit Analysis (CBA)

Based on the discussions during the targeted consultation it was made clear that eTags can never replace the wheel mark plate. It is necessary to work always in a traditional way without any additional equipment and to bridge technology problems (e.g. defect or missing readers). The replacement of the wheel mark by eTags would require the relabelling of all the existing equipment. Therefore, eTags can only be an additional option to optimise the processes for all parties involved. Therefore, the replacement of the wheel mark by an eTag implementation is not part of the following considerations.

Two kind of technologies have been identified for the implementation within a maritime environment. These are Data Matrix and RFID technologies:

AND



RFID

OR

Data Matrix

These technologies are considered within the following scenarios for the cost benefit analysis. The benefit and the necessary required effort depend very much on the implementation levels of the electronic tag technologies and the selected options for the MED unique identifier implementation. The implementation levels can be categorized into three possible levels (level 1– 3). These levels are reflected in the following three selected scenarios and compared with a baseline scenario:

	Baseline Scenario: No use of E-Tags	**Scenario Level 1: Electronic tags with MED Certificate number(s) only**	**Level 2: Electronic tags with MED Certificate number(s) and item code**	**Level 3: Electronic tags with MED Certificate number(s) and codes for product traceability on different level**
Marking	Wheel mark plate	MED Certificate number	MED Certificate number + product class level information	MED Certificate number + product codes (e.g. products serial codes and/or lot/batch codes and/or GS1 application identifier)
Reading:	Human	MED App	MED App++ (with extended security levels)	User applications
Access Opportunities	-	MarED database	MarED database + COM databases (RAPEX, ICSMS, NANDO)	MarED database + COM databases (RAPEX, ICSMS, NANDO) + proprietary database
Investment required	no	European Commission	European Commission DG	European Commission DG MOVE / DG Justice

		– DG MOVE / EMSA	MOVE / DG Justice / DG GROWTH	/ DG GROWTH / Industry
Potential users	Business as usual	Market Surveillance	Market Surveillance / Port State Control	Market Surveillance / Port State Control / Industrial users

Table 1: Scenario overview

As the four **main cost categories** investment, implementation, operation (incl. training) and maintenance costs have been identified.

The **improvement benefits** are very different depending on the involved parties. The market surveillance can save time for inspections, documentation requests and reviews. Identification of counterfeited products is much easier since more information is available in a shorter time. The success rate for counterfeiting identification will increase.

Equipment manufacturers can realise time savings for inspections and checks at quality gates. The production data acquisition is much easier and can optimise the production planning and control as well as the logistic processes. Finally, it will become much easier to identify counterfeiting.

The vessel operator can save time for inspection, maintenance, and repair because the actual information for the equipment installed on board can be accessed via supplier databases. Supplier parts can be ordered more focused because the equipment and the related spare parts are distinctive.

9 CBA Results and Conclusions

The implementation of e-Tags under the European Marine Equipment Directive for maritime equipment opens many opportunities and may affect processes of different stakeholders. This study has analysed all aspects related to maritime equipment products covered by the directive. It has started with the process analysis of all stakeholders involved during the marine equipment life cycle. All opportunities and challenges for the implementation of electronic tags to support the processes have been considered. For each phase of the marine equipment life cycle (equipment approval, market access and surveillance, ship construction, ship operation and ship recycling) the actual processes are analysed together with the possible existing challenges. Scenario projections (until 2030) considering the situation after around 10 years from the possible implementation of electronic tags are described.

These scenarios were the basis for several discussions with the stakeholders and different consultation actions. Requirements and benefits were estimated for every scenario and for the different parties involved (manufacturers, authorities, operators, etc.). It is shown that the benefit is very different for the main players depending on their role in each life cycle phase. We must distinguish effects directly created by implementing the e-tag option in the directive and those generated indirectly by using additional opportunities. This means efforts by manufacturers to apply e-tags on their products and efforts and benefits by authorities when using these e-tags to facilitate their processes. Indirect effects can be generated by manifold other stakeholders in the process (manufacturers, authorities, customs, etc.) in case they capitalise on the existing e-tags and develop/adapt their processes accordingly. Therefore, only a broad

and generic approach will assure that all stakeholders can benefit from the implementation of electronic tags.

The technological section of the study gives a comprehensive overview of exiting data carriers and data exchange architectures. Some of the technologies are not applicable for the marine environment (harsh conditions, costly installations for energy supply, etc.). Nevertheless, there are different technologies which can be used based on the targeted future scenarios. After serveral expert discussions and best practice experiences from other industrial sectors the favoured technologies recommended for implementation are based on RFID and Data Matrix labelling. These two technologies cover the whole range from simple and cheap solutions (Data Matrix) to costlier (RFID) but also more flexible solutions.

The implementation of the labelling technology as such will not be beneficial for the processes. The key factor is easy access to data and traceability. But the support of traceability and a continuous information flow requires a standardised code structure independent from the electronic tag type. A unique identifier must be defined. It must be flexible enough to support many different processes and to enable the direct access to the most important maritime equipment databases. Several different coding possibilities have been discussed within different workshops. At least three possibilities have been chosen for the impact analysis. The main differences are the degree of detail level of information represented on the tag in the future. The more information on the eTag available, the more applications can be covered, the more processes can be supported and the higher is the expected benefit.

Beside the identification code the databases involved in the different processes are important. RAPEX, ICSMS, MarED and NANDO have been identified as the most important marine equipment publicity assessible databases. The discussions with the operator of these databases have shown that there are no technology limitations in respect of eTags. Some of them are already prepared. It has been figured out that the effort necessary to make use of the eTag technology is quite low. All these databases need to support the unique identifier to make use of the new technology.

Within the consultation phase of the study some test connections have been realized and have shown that the defined approach works. Nevertheless, only demonstrator installations for some selected marine equipment have been realized. During those demonstrators, the proactive inspection work of market surveillance has been shown on the SMM exhibition in Hamburg and a sea trial demonstrator has been realized on board a ferry between Trelleborg and Travemünde. Both demonstrators have proven that the eTag implementation for Maritime equipment works very well for different scenarios.

As part of this study a problem tree has been generated to show the future challenges for the global implementation of electronic tags for marine equipment. This tree has been adapted during the stakeholder discussions.

It must be assured that the wheel mark information can be read independent from the availability of technological equipment. Consequently, it is recommended that the present visual Mark of Conformity (Wheel mark) should not be replaced by eTags. Only the combination of the wheel mark plus eTag is a workable solution, where the eTag offers additional information to support processes electronically.

For the quantitative assessment of the technology three different implementation scenarios have been defined and evaluated by a costs and benefits calculation per stakeholder (see Table 2). All three scenarios have been compared with the base line scenario which is the cheapest solution.

Summary of the CBA (Scenario figures for 5 years in Mio €)	Cost in Mio €	Benefit in Mio €	Main Benefits
Baseline Scenario	0	0	No potential benefit and high costs for a later integrated solution
Scenario 1: MED Certificate number	0,71	28,70	**Faster data acquisition:** Marine equipment inspections will be much faster than today **Reduction of market damage:** IP protection and fighting counterfeiting increases
Scenario 2: MED certificate number + item code	5,49	32,70	Scenario 1 benefits plus **More focused product recalls:** Identification and tracking on product class level **Faster identification of counter fight products:** Tracing & tracking opportunities
Scenario 3: MED Certificate number + codes for product traceability on different levels	89,00	148,70	Scenario 1 +2 benefits plus **Effort reduction for certificate search and related** information (e.g. test reports): **Improvement of service quality:** eTag implementation can optimise logistic, service, maintenance, and repair processes **Reduction of batch products counting time:** Collect number of items and their registration numbers within one reading operation (life vests)

Table 2: Summary of cost/benefit calculations for all scenarios

The **baseline scenario** covers the continuation of the as-is situation without any eTags. There are no additional costs but there is also no additional potential benefit. But in some years from now it might be too late to implement eTags for maritime equipment as an integrated approach. Some of the partners involved in the processes might have implemented their own solutions. When this is done an integrated solution for all maritime equipment processes will require a lot of adaptation and will be very costly.

Scenario 1 takes only care of the MED Certificate number. Therefore, the expected benefit is quite high but can only be realised by the market surveillance. It is assumed that the motivation of the manufacturers to participate will be quite low.

Scenario 2 considers the implementation of the MED Certificate number plus company and item code of the product. Beside the benefits of the first scenario is will enable stakeholders to identify product batches and the related production sites. Within this scenario implementation will optimise product recall procedures very much and can also support logistical tasks. Manufacturers can realise a considerable benefit and it is expected that a larger group of manufactures will take part in this implementation.

Scenario 3 implements the MED Certificate number plus company and product code which allows the identification of every single product of the manufacturer. This most advanced scenario includes a very detailed numbering system and opens a lot of application opportunities. The benefit will be very different for the participants

involved. The highest benefit is related to the market surveillance authorities which could speed up their processes when analysing products and identifying counterfeited and dangerous items. Much quicker database access to the mentioned public databases would be a major advantage. But it would also require that certificates and test reports are available in these databases. Other partners of the processes (manufacturers, port state control, ship operators, etc.) could also benefit from scenario 3 implementations based on their individual goals. It is the most expensive scenario but with the highest benefit potentials. The cost for the realisation concerns mainly the user's application app development and the database interfaces.

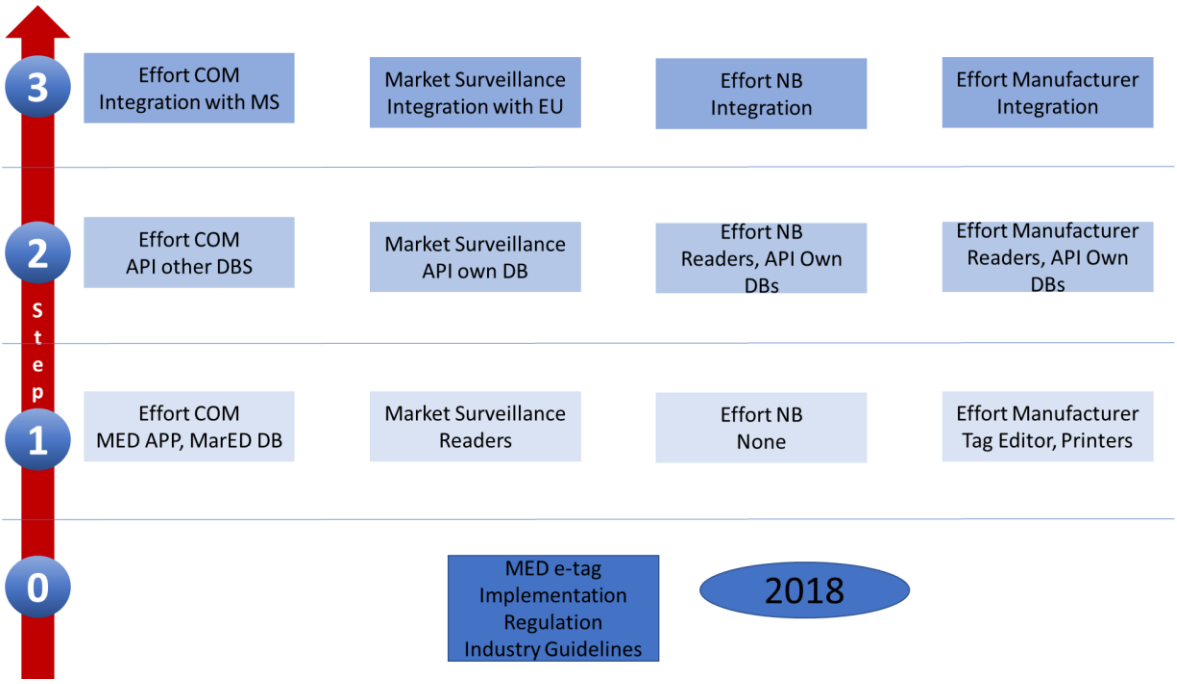


Figure 4: Stepwise approach for the eTag implementation

It is recommended that the ID codes of scenario 3 should be part of the implementation guidelines. In this case, the decision is left to the stakeholders to what extent they perform the implementation (scenario 1 to scenario 3) (see Figure 4). A stepwise implementation reduces the risks and ensures realisation of the potential benefits step-by-step.

The introduction of electronic tags as a supplement of a wheel mark in maritime equipment would require different activities:

1 Final definition and approval of an MED unique identifier structure with Member States (based on the proposal contained in this study);

2 Agreeing the data identifier with ISO according to the basic structure from the standard;

3 All relevant databases should support the MED unique identifier (MarED database has also to store test reports and Declaration of Conformity). Related actions need to be taken by COM and Member States;

4 Define eTags, the related technology and the content as complementary label to the wheel mark for marine equipment by means of an Implementing Regulation;

5 Create common understanding and continuous reporting between all bodies at COM and Member States (especially ADCO) to early applications.

Overall, the investments are on a low level compared to the expected benefits. Costs for authorities and industry are affordable because of the stepwise voluntary implementation in accordance with the planned application. The equipment manufacturer can start with some low investments but through further investments additional benefits can be realised. But it could also be envisaged to make the use of eTags as an additional mandatory label in the future to achieve a higher take-up by the market. Only a large dissemination can indeed unleash the full potential of the application of eTags for marine equipment.

FINAL Report

10 Introduction

The goal of the study is to evaluate the application of electronic tags for the wheel marking of marine equipment. The three main objectives are:

- Assess the possible impacts including a cost/benefit analysis to explore the uptake of electronic tags as a supplement to or a replacement of the existing labelling;
- Demonstrate its potential through a pilot project on the use of the electronic tags for marine equipment products;
- Assist the Commission in making consistent and optimal parameter choices across all dimensions of options, while taking into account related costs and benefits.

The implementation of electronic labelling of marine equipment products may result in new possibilities for the users and better information to market surveillance by creating a continuous information flow between manufacturers, Notified Bodies and authorities. Authorities and Notified Bodies should benefit from an enhanced and smooth market surveillance mechanism which should ease day-by-day survey operations, encouraging the rapid uptake of electronic labelling.
This final report documents all activities in the context of the possible introduction of electronic tags for marine equipment.

11 Context

11.1 Motivation

The legal basis for this study is Article 11 (2) (Electronic tag) of Directive 2014/90/EU of the European Parliament and of the Council of 23 July 2014 on marine equipment repealing Council Directive 96/98/EC (hereinafter the "New Marine Equipment Directive" - MED) which provides that "The Commission shall carry out a cost/benefit analysis concerning the use of the electronic tag as a supplement to, or a replacement of, the wheel mark."
The time frame to agree on a broadly accepted and recognized standard for electronic tags to supplement or replace the wheel mark is relatively tight, because industry has already started to apply such technology. There is a risk that manufacturers will apply different technologies in isolation with the consequence that the individual technologies might not be interoperable. The maritime industry constantly operates in a complex environment which makes it difficult to envisage all future possible uses of electronic tagging. However, the following positive basic impacts are expected regarding the potential benefits of the application of electronic tagging solutions for the stakeholders:

- **Notified Bodies** should benefit from the seamless notification capabilities embedded into the system with electronic tags pointing to an information repository where all the relevant information about the product is available (such as type approval certificates);

The implementation of electronic labelling of marine equipment products may result in new possibilities for the users and better information to market surveillance by creating a continuous information flow between manufacturers, notified bodies and authorities. **Authorities and Notified Bodies** should benefit from the enhanced and smooth market surveillance mechanism, which should ease the day-by-day survey operations, encouraging the rapid uptake of the electronic labelling. Notified bodies should benefit from the seamless notification capabilities with electronic tags pointing to an information repository where all the relevant information of the product is stored. **Ship owners/operators** should be able to seamlessy check the validity of the certificates for the equipment they have on board and carry out stock control more easily. The direct and easy access to the relevant databases will improve the validation checks of certificates and speed up the equipment identification. The cost benefit analysis should provide additional, specific means to facilitate the tasks of the **market surveillance authorities**. An electronic tag could supplement or replace[4] the wheel mark (refer to Chapter 2, Art. 9, 10 and 11 take into consideration of the MED 2014/90/EC) to prevent administrative burdens, the IP protection and efficiency in fighting counterfeiting as well as the effect on international competitiveness and the technological and non-technological innovation potentials.
The specific items of the study include also the demonstration of the potentials on the use of the electronic tags for marine equipment. Counterfeit products will be identified much quicker and therefore safety at sea will be improved; through a pilot demonstration.

- **Manufacturers** should benefit from the improved notification mechanism for the prevention of counterfeiting and the opportunity for more focused product recalls. Additionally, the electronic label can be used to support logistics, service, maintenance, and repair processes of the manufacturers;

[4] Wheel mark replacement is a topic for further discussions

- **Ship owners/operators** should be able to carry out equipment traceability and stock control more easily.

The implementation of electronic labelling of marine equipment products may introduce a new approach to the users and better information to market surveillance, creating a continuous information flow between manufacturers, Notified Bodies and authorities.

11.2 General Market Dimension

The potential market for an electronic identification system for marine supplies are given in the recent study ("COMPETITIVE POSITION AND FUTURE OPPORTUNITIES OF THE EUROPEAN MARINE SUPPLIES INDUSTRY") performed for the European Commission in 2013/2014 (see Figure 5). The figure shows the geographical market distribution of the marine suppliers related to the product categories and market values. The study estimates the market for ship newbuilding to be about 250 bn USD for a five years' period. It includes the whole marine supply. The MED related equipment is spread over the different groups. The number of certificates for MED equipment is shown in chapter 12.1.

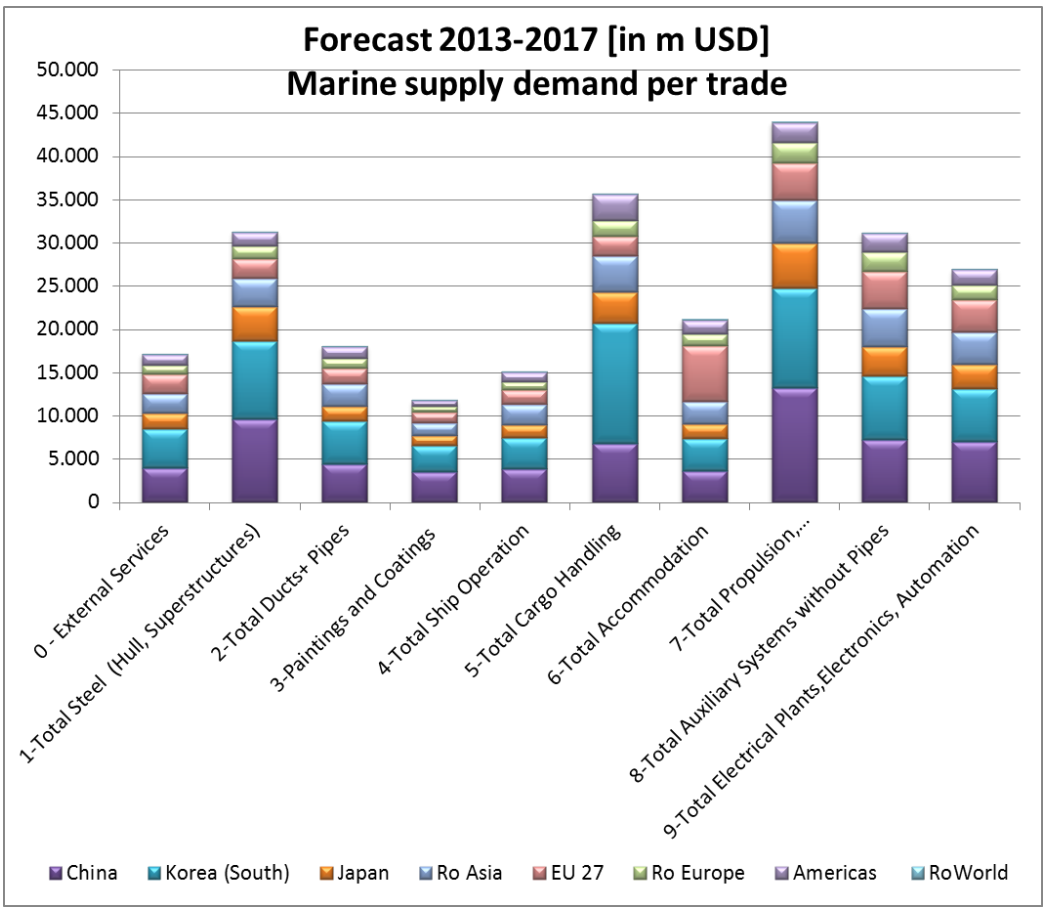


Figure 5: Forecast of Marine Supplies Market Volume per major trade based on Ship Newbuilding Market projections[5]

[5] Source: "COMPETITIVE POSITION AND FUTURE OPPORTUNITIES OF THE EUROPEAN MARINE SUPPLIES INDUSTRY", BALance Technology Consulting GmbH, public contract European Commission DG Enterprise, 2014

11.3 The Old Marine Equipment Directive, 96/98/DC, as amended

Amongst others, one of the European Union (EU) policies concern the free circulation of goods within the Single Market. New Approach Directives address the mechanisms to achieve this aim are based on prevention of new barriers to trade, mutual recognition and technical harmonisation. In respect to marine equipment this means it can only be installed on board ships registered under the flags of EU Member States and additional EFTA (European Free Trade Association) member states like Iceland, Lichtenstein and Norway if it is marked with the MED mark of conformity, known as the "wheel mark".

The Marine Equipment Directive (MED) - Council Directive 96/98/EC, as amended,- came into force beginning of 1999 and covers a range of equipment carried on board ships registered under the flags of the European Union Member States. It was established to ensure that equipment which must comply with the requirements of international conventions (SOLAS, MARPOL and COLREG, etc.) agreed by the International Maritime Organization (IMO) also meets common standards of safety and performance across the EU.

Detailed performance and testing standards for certain types of marine equipment have been developed by the International Maritime Organization (IMO) and by the international and European standardization bodies. However, the international instruments leave a significant margin of discretion to the flag states. Council Directive 96/98/EC thus laid down common rules to eliminate differences in the implementation of international standards by means of a clearly identified set of requirements and uniform certification procedures. Approval requirements are harmonized across the EU Member States. Therefore, a manufacturer only has to gain approval for a certain type of equipment from one single Notified Body[6].

This is only possible if an up-to-date list of approved or refused equipment is available to interested parties. To fulfil this requirement, the Commission (nowadays through EMSA) has set up a Technical Secretariat currently operated by BALance Technology Consulting. It is to manage the Group of Notified Bodies (MarED) and to set up a database for the collection; processing and distribution of information on approved equipment and applications withdrawn or refused (the MarED Product Database).

The MarED Product Database will also facilitate the exchange of information among MED stakeholders on a wide range of subjects on international standardization, common interpretations and participation to further progress. It will also support the fight against counterfeit products. The MED applies to the following equipment:

1. Life-saving appliances (SOLAS Ch. III),
2. Marine pollution prevention (MARPOL),
3. Fire protection equipment (SOLAS Ch. II-2),
4. Navigation equipment (SOLAS Ch. V), and
5. Radio-communication and radio equipment (SOLAS Ch. IV).
6. Equipment required under COLREG 72,
7. Bulk carrier safety equipment and
8. SOLAS Chapter II-1 equipment.

[6] Notified body is an organisation which has been designated by a Member State to assess the conformity of a product to the applicable regulatory requirements before being placed on the market.

The compliance with the MED's requirements is to be demonstrated for each equipment item by choosing one of the conformity assessment procedures (modules) as defined in Annex B of the Directive (details see chapter 12.1). When the Notified Body has verified that all the applicable standards have been complied with, it will hand over an EC Certificate of Conformity to the manufacturer. At this point the manufacturer is then allowed to issue a "Declaration of Conformity" and affix the "Mark of Conformity" to his product according to Directive 96/98/DC Article 11/Annex D (Directive 2014/90/EU Article 9, 10/Annex I). The mark shall be followed by the identification number of the Notified Body and by the last two digits of the number of the year in which the equipment was marked.

Figure 6: Mark of Conformity (Example for GL Lux 1999)

11.4 The New Marine Equipment Directive, 2014/90/EU

One of the aims of the Directives is to make sure that a free circulation of marine equipment through the EU is possible whilst maintaining a common safety level. The new Equipment Directive is a package of measures that aim to improve market surveillance and boost the quality of conformity assessments.

The new MED under Article 11 now provides the possibility for electronic tagging of equipment by saying "In order to facilitate market surveillance and prevent the counterfeiting of specific items of marine equipment […] manufacturers may use an appropriate and reliable form of electronic tag instead of, or in addition to, the wheel mark." Article 11 further includes provisions allowing the Commission "to identify the specific items of marine equipment which can benefit from electronic tagging" and "to lay down […] appropriate technical criteria about the design, performance, affixing and use of electronic tags".

Article 11 of the new MED is the basis for carrying out the present cost-benefit analysis looking into the possible introduction of an electronic tag as supplement or replacement of the wheel mark in marine equipment.

11.5 Challenges to be addressed

Electronic tags (e-tag) enable the connection between the physical product on board (electronically tagged) and information available in the MarED Product Database and other databases, as provided by the Commission (e.g. RAPEX) or proprietary solutions offered by the manufacturers for after sales and maintenance purposes. An e-tag technology will enable faster equipment identification and more efficient processes for all parties involved is expected to facilitate MED stakeholders to enhance the identification of lawful marine equipment. This might result in better identification of counterfeit products and therefore for a higher safety at sea and a reduction of economic harm. The recall of unsafe commercial products, could be specifically managed within a selective approach by removing them from the market and decommissioning them from on board ships.

It must be assured that the basic wheel mark's e-tagged information (see Figure 6) will be readable without the need of additional equipment (like exclusively dedicated readers) but by using any regular electronic device providing access to electronic

information. To support also the traditional way of working (visual checks), the electronic tags should be preferably implemented together with the existing ink-based wheel mark plate. The electronic tags must be expected to work reliably over a long time (up to 30 years) in the harsh maritime environment, longer than the useful life of the marine equipment.

Additionally, the implementation of electronic tags requires the specification of a MED identifier to assure a standardised access to the different information sources.

12 Life Cycle Scenarios for Marine Equipment

There is a large number of companies developing marine equipment in the world. Depending on the equipment type, certificates are required before installing the products on board a vessel. Equipment to be carried on vessels subject to the principal IMO Conventions and flying the flag of an EU Member State has to be certified under the European Marine Equipment Directive. This procedure is the starting point of the marine equipment life cycle (see Figure 7) which includes (1) approval process, (2) market access, (3) ship construction, (4) ship operation and (5) ship recycling. In all phases, information is collected or required to complete the related processes: a number of databases, which will be introduced later in this study, are used to this purpose.

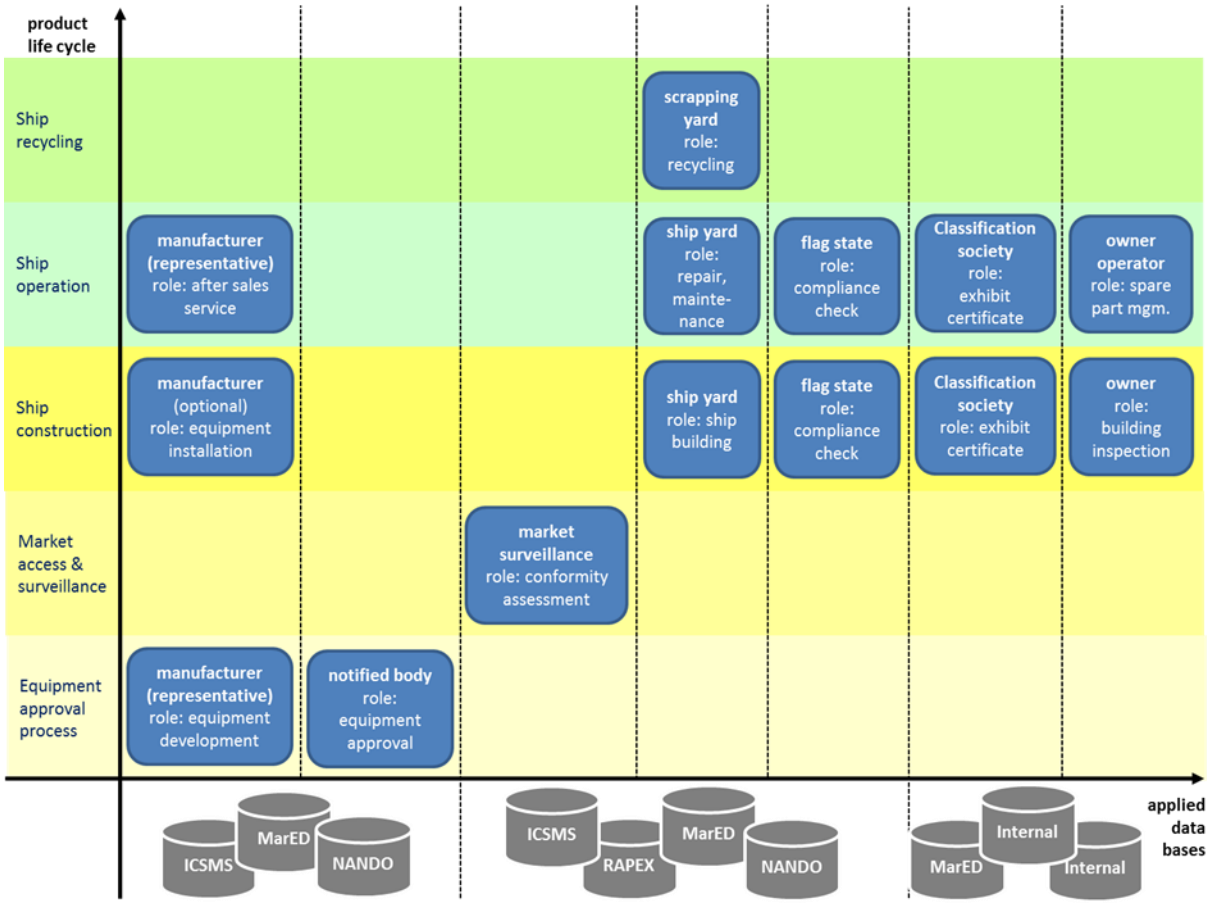


Figure 7: Life cycle of marine equipment

(1) Approval process: The marine equipment supplier must follow different steps (measurement, tests, etc.) during the certification process. The Notified Body will check the different steps and will finally approve the product. The technical documentation must be kept by manufacturer for at least ten years and in addition for as long as the lifecycle of the approved products lasts. After a successful approval process the manufacturer receives a Declaration of Conformity (DoC) which allows him to offer his products for European flagged ships. Information about products having a MED approval certification (conformity assessment) is available on the MarED Product Database (www.mared.org).

(2) Market access: While manufacturers offer marine equipment products, the national market surveillance authorities have to proactively control products placed on the market. The focus is on product safety, fulfilment of requirements laid down in the MED and combating counterfeiting. The manufacturers have the obligation to cooperate with the national market surveillance authorities and to adapt their product if necessary in case they do not fulfil the approval requirements. The necessary information is stored in existing, publicly accessible databases (e.g. ICSMS, RAPEX, MarED Database, NANDO) or in internal databases at manufacturers' sites as well as Notified Bodies' sites. While the MarED Database includes product information, ICSMS and RAPEX contain information related to product non-conformities and safety alerts respectively. The public databases will be explained in more detailed in chapter 13.1.

(3) Ship construction: During ship construction the owner, the Classification Society and the flag state authority check compliance, rules and regulations. The Classification Society makes the technical review of the designs and related documents. Classification Society surveyors accompany the construction of the vessel in the shipyard (from production start to final sea trails) to verify that the vessel is constructed in accordance with the approved design plans and Classification Society rules. Before installation on board, market surveillance tasks are also performed by the flag state authorities in order to check whether or not equipment is entitled to be offered on the market and to check whether or not equipment fulfils the technical requirements.

(4) Ship operation: Once bought and installed on board the equipment undergoes the acceptance and survey of flag state authorities and classification societies (according to regulation 391/2009) which accept the equipment to be on board and apply continuous survey over the life cycle of the vessel. These surveys are performed with a different motivation. The classification societies perform surveys to frequently update the class of the ship, or in case of repair and conversion issues.

Flag State authorities frequently check the status of equipment on board of the vessels under their flag or go on board of foreign flagged vessels (port state control checks). It already nowadays happens quite frequently that these instances consult the MarED Product Database as well as the other public databases in order to obtain information on certain certificates, e.g. to check the validity of certificates, authorisation of the Notified Body related to the product group, alert information for the specific equipment etc.

(5) Ship recycling: Ship recycling is becoming a more important issue in Europe. In line with the Ship recycling regulation No 1257/2013 - Annex II, ship yards and their suppliers need to offer information about hazard materials within their products. Especially an inventory list of hazardous materials on board and inventory surveys are required in the future. Both can be supported by electronic tags (e.g. indications of hazardous materials on the tag).

For all these tasks a proper and quick identification of equipment is required. This goes along with the identification of the manufacturer and the production site, the quick access to all available information including documents, certificates, technical files etc. Even though a number of sources to obtain this information exist today, electronic tagging could play an important role in order to accelerate all these processes through facilitated access to information.

The following chapter will describe the different life cycle phases in more detail. Especially the existing process characteristics in respect of marine equipment are described. In chapter 17.1 the influences of future eTag applications within the mentioned processes are derived.

12.1 Conformity Assessment of Marine Equipment

Similarly, to some other industrial sectors, the marine equipment industry is a network of multi-tier supplier-customer relations with shipyards and shipping companies at the top of the supply chain. Just for manufacturing logistics complex requirements exist to trace material and to control throughout the entire production process. Globalisation trends also increasingly affect this process. At the same time, equipment needs to fulfil multiple technical requirements to meet regulatory requirements as established by IMO, flag states and pure industrial needs. Therefore, and before entering the markets, manufacturers have to obtain different kinds of certificates for different markets and regions of the world. The conformity assessment procedure is a multilateral exercise involving multiple instances.

More than 127,000 products have a conformity assessment certificate issued under the European Marine Equipment Directive[7]. These products only cover part of the equipment to be carried on board of sea going vessels under European flag. The number of companies worldwide with certificates in the maritime markets is well beyond 11.000 of which about 6.000 are located in Europe[8]. About 40% of the maritime equipment suppliers with MED certified product (MED) are based in Europe. Figure 8 shows the geographical distribution of companies with maritime certificates.

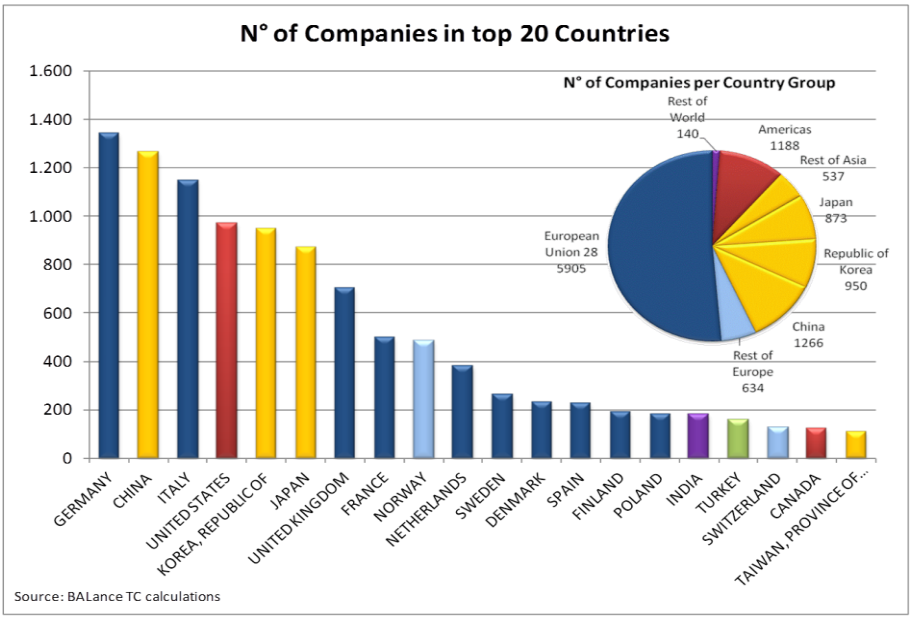


Figure 8: Number of companies with certificates for marine equipment worldwide[9]

[7] Source: MarED Technical Secretariat, EMSA public service contract to BALance Technology Consulting GmbH, Oct 2015

[8] Source: "COMPETITIVE POSITION AND FUTURE OPPORTUNITIES OF THE EUROPEAN MARINE SUPPLIES INDUSTRY", BALance Technology Consulting GmbH, public contract European Commission DG Enterprise, 2014

[9] Source: "COMPETITIVE POSITION AND FUTURE OPPORTUNITIES OF THE EUROPEAN MARINE SUPPLIES INDUSTRY", BALance Technology Consulting GmbH, public contract European Commission DG Enterprise, 2014

Another analysis shows the increasing importance of product conformity assessment under the MED on the international market. In particular, Asian applicants show significant growth rates over the last 5 years (see Figure 9). The amount of data sets per applicant has increased by more than 150 % for manufacturers based in China and in Korea. In Japan, it has increased by 175%. Germany is far behind these figures with a growth rate of 27 %.

This alone reinforces the need to keep control on MED approved marine equipment in the market and by this also provide better traceability of equipment applied on board.

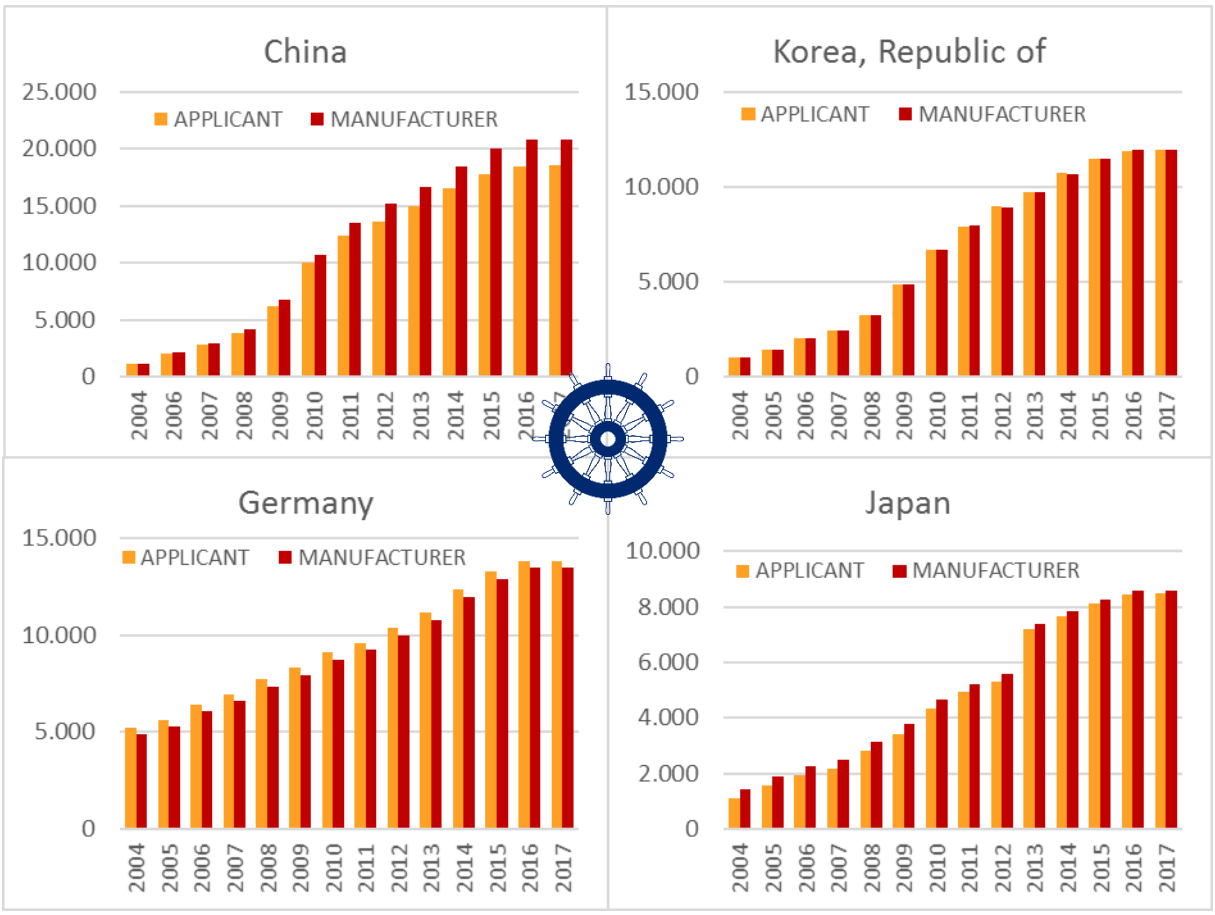


Figure 9: MED database entries (approvals), 5 years growths[10]

[10] Source: MarED Product Database, Oct 2015

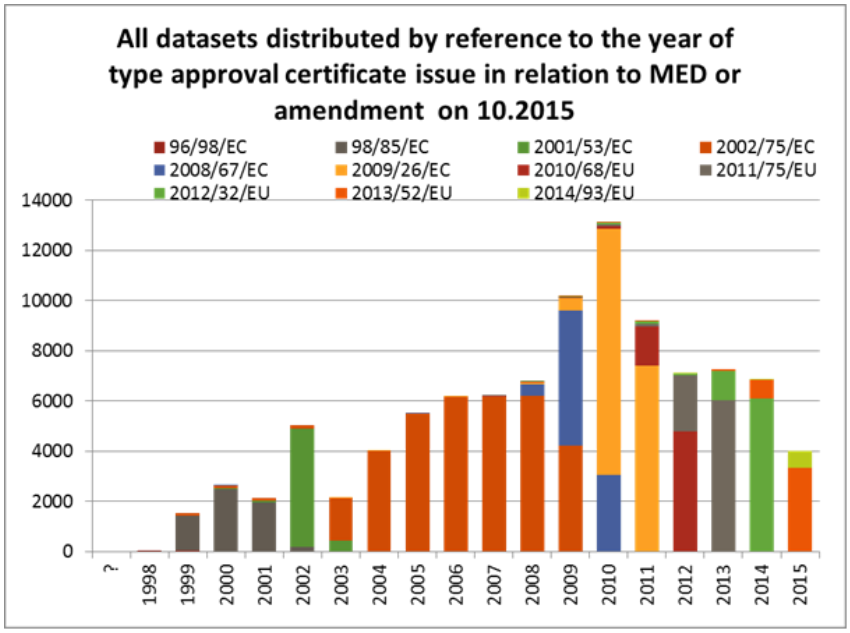


Figure 10: MED data sets distributed by refeence of the year

Following the publication of the European Marine Equipment Directive in 1996, manufacturers must apply for the certification of their products at one of the today 42 Notified Bodies notified by the different European Member States (see Figure 10 for the amount of data sets). MED 's Notified Bodies certify the pieces of equipment following a set of rules and regulations as outlined in the MED. By obtaining these certificates, manufacturers gain the right to issue a Declaration of Conformity (DoC) which allows them to lawfully offer their products in the market for European flagged ships.

Paper-based processes with lots of documents and information distributed over different sources are to be effectively managed. Enforcing electronic-based data flow with direct access to the different databases, might prevent the procedures from being outdated after some time. While other involved parties e.g. manufacturers improve their information and their logistics processes, the MED approval processes should also phase in the existing proven technology. This approach would facilitate the control of the involved parties carrying out those processes within a vast geographical distribution area (see Figure 8).

Through conformity assessment the manufacturer of a product collects technical evidence on that his product conforms to the requirements as expressed in the provisions of the relevant legislation. The conformity check must be finalised before the product is placed on the market. The assessment is under the responsibility of the manufacturer and includes the design and production phase. Across the board, the MED's conformity assessment procedures are composed of one or two conformity assessment modules (see Figure 11). A module may cover either the design or the production phase (in this case a conformity assessment procedure is composed of two modules) or both phases (in this case a conformity assessment procedure is composed of one module).

The module selection for the conformity assessment of marine equipment depends on the equipment and on the decision of the manufacturer. In general, "the complexity of the modules selected should be proportional to the risk (impact on public interest, health, safety, and environment) of the product, its design complexity, the nature of

its production (large series vs small series, custom-made, simple vs complex production mechanism etc.)"[11].

The first module selection criteria relate to the product quantities (see Figure 11). In case of mass/serial production the manufacturer has only the choice to select module B.

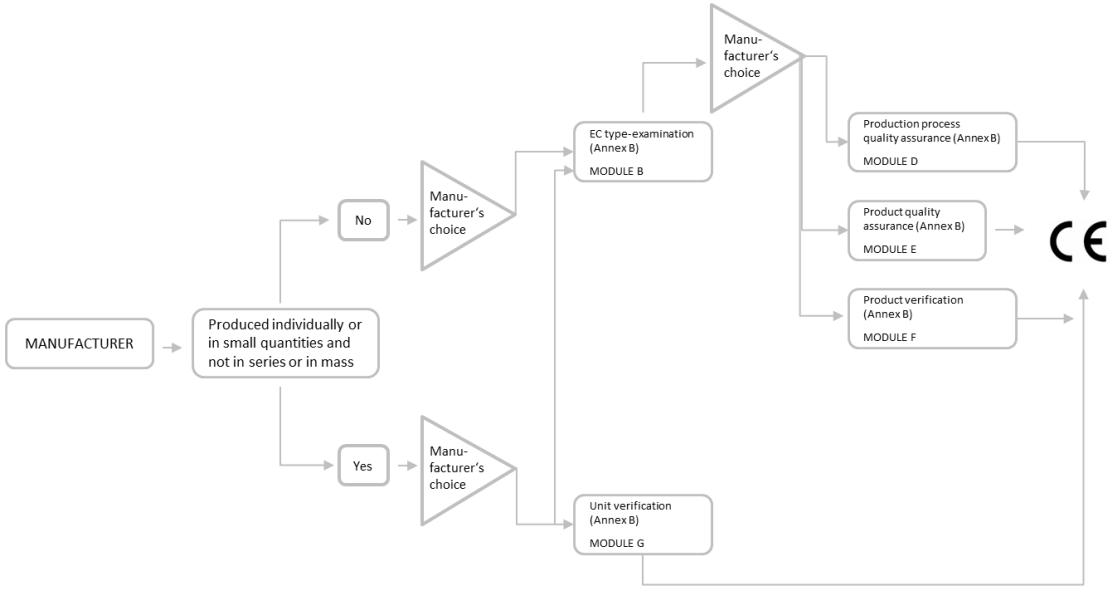


Figure 11: Conformity assessment procedures provided for marine equipment (Directive 2009/26/EC)

Within **Module B** a Notified Body examines alternatively

a) the specimen of a type and/or

b) the technical design and one or more critical parts of the product (details see Annex II I.2 of 2014/90/EU).

Based on this examination the Notified Body verifies and attests that the type meets the requirements of the legislative instrument.

The module B examination is always followed by one of the following modules:

- **Module D** (quality assurance of the production process) where a Notified Body assesses the quality assurance system of the manufacturer. The quality assurance system ensures the conformity to the EC-type.

- **Module E** (product quality assurance) where a Notified Body assesses the quality system. Module E assessment procedures are similar to the ones under module D. Both are based on the quality assurance system of the manufacturer. But module E aims to ensure the quality of the final product, while the quality system under module D aims to ensure the whole production process quality. The assessment includes the part production and the test of the final product.

[11] Source: The 'Blue Guide' on the implementation of EU product rules 2014

- **Module F** (product verification) where the Notified Body carries out systematic product examinations. In order to control the product conformity to EC-type the Notified Body carries out product checks (testing of every product or statistical checks). It basically corresponds to a time-limited production of product batches.

There are three possible module combinations of conformity assessment procedures based on type examination and conformity of production assessment:

- **Module B+D** = EC-type examination (B) followed by Conformity to EC-type based on quality assurance of the production process (D)
- **Module B+E** = EC-type examination (B) followed by Conformity to EC-type based on product quality assurance (E)
- **Module B+F** = EC-type examination (B) followed by Conformity to EC-type based on product verification (F)

For individual or small quantity production manufacturers, can also select **module G** (conformity based on unit verification) as a stand-alone module for conformity assessment (Figure 11). It covers the design and production phase. The Notified Body verifies every individual product in order to ensure conformity to legislative requirements. There is no EC-type examination. The manufacturer ensures compliance of the manufactured products to the legislative requirements.

During the conformity assessment procedures, the required tests (testing of every product or statistical checks) are carried out. This generates data which is used by the equipment manufacturer and the Notified Bodies to verify the compliance of the manufactured products with the EC-type regulations.

12.2 Market Surveillance of Marine Equipment

MED addresses EU Member States to carry out market surveillance. As a result of the implementation of that obligation, EU National Market Surveillance Authorities are in the position of identifying 'not in conformity' equipment and counterfeit equipment, placed on the market. Market surveillance is organised on a national level. Therefore, the Member States are obliged to set up the process for that purpose and to prepare national market surveillance programmes.

The MED applies to all commercial vessels flying the flag of a European Member State engaged in international maritime transport. The aim of these measures is to improve safety at sea, protection against marine pollution etc. and to ensure commercial competition.

In general **market surveillance processes** consist of:

- regular visits of commercial, industrial and storage premises of the manufacturer and the distributor sites;
- regular visits, if appropriate, of work places, i.e. the premises of the client and other premises where products are put into service. This is important for products (for example machinery and marine equipment) that are directly, after being manufactured, installed and put into service;
- random and spot checks at exhibitions to verify if approvals of presented products exist;
- sample collection of products, and examination and testing of these; and
- request of all necessary information (reasoned request).

If there are doubts about the conformity of the products the market surveillance authority of a member state is required to perform a detailed review. Therefore, two different tools are provided that enable market surveillance authorities to **receive information** on the product and make a decision on the compliance of the product:

- the ***technical product documentation*** made available by the manufacturer, and
- the EU ***declaration of conformity*** (delivered according to the procedures detailed under chapter 12.1).

The technical product documentation must be made available by the manufacturer or the authorised representative in a reasonable period. In general, the authority cannot request the technical documentation systematically. It can only be requested during market surveillance random checks, or when there are reasons for a concern that a product does not offer the level of protection required in all respects.

The market surveillance authority may also request the Notified Body to provide information on the ***conformity assessment*** for the product. The EU Declaration of Conformity must be made available for the market surveillance authority without delay upon reasoned request. Two general cases of non-compliance have to be distinguished:

1. **Formal non-compliance:** Non-compliant products are subject to corrective measures, such as bans, withdrawals or recalls. The level of the sanctions is determined at Member States level. Market surveillance authorities should first instruct the manufacturer to adapt the product to the regulatory requirements before offering it on the market. If no result can be achieved, the market surveillance authority has to restrict or prohibit the placing on the market. The Commission and the other Member States will be informed by means of the information support system (see Article 23 of the Regulation). The information could include:
   a. a detailed description and photograph of the product in order to facilitate its identification by the enforcement authorities;
   b. the results of the risk assessment carried out by the authority that justify the measure adopted;
   c. the scope, nature, duration and follow-up of the measure taken in order to avoid the risk;
   d. information enabling the product's distribution channels and origin to be identified, and other information relating to its traceability.

   The Commission will distribute the notification to the other Member States not later than 15 days of its reception.
2. **Serious risk:** In case the market surveillance authorities consider a serious risk it has to notify it to the Commission through the RAPEX system. Also, the procedures laid down to reduce or avoid the risk have to be reported (see Article 22 of the Regulation). The market surveillance authorities have to verify that adequate corrective measures have been taken.

Market surveillance is not harmonized throughout Europe to the same degree as the conformity assessment procedures for marine equipment. Regulation (EC) No 765/2008 requires the Member States to set up market surveillance programmes. In accordance with the principle of subsidiarity however, it is left largely to the individual Member States to set priorities and set measures for monitoring their own markets.

Administrative Co-operation ("AdCo") groups have been established to develop joint strategies and positions. The experts in the groups are appointed by Member States and represent national authorities competent for market surveillance in a given sector like e.g. marine equipment. The AdCo groups in general share the wide range of tasks

to be completed between them in order to overcome the constraints of their personnel resources. This includes agreeing on what product areas are to be monitored more closely, agreeing on measures for responding to certain product faults, and sharing the task of creating model risk assessments. In addition, the AdCo groups formulate joint positions on how the European body of regulations governing market surveillance should be developed further.

The work of the AdCo groups is not limited to agreeing market surveillance measures in the narrow sense. A task force convened by the AdCo group for machinery is also addressing how the market surveillance authorities could exert greater influence upon the content of standards in order to ensure that the authorities' observations are incorporated into standards as swiftly as possible.

12.3 Ship Construction

The classification of new ship buildings is a complex process with surveys for each construction phase of the ship. The ship designs must be approved, for example, by the technical staff of the Classification Society. Once the construction of the vessel has begun the surveyor has to certify that all materials, components and equipment are properly certified. During the construction process the Classification Society surveyor visits the yard regularly and checks that materials and installed equipment have valid certificates. The newbuilding classification process is completed after the vessel has passed all reviews from the design approval to the sea trails. The following table shows the important steps of the Classification Society involvement:

Shipbuilding phase	**Classification Society Activity**
Signed contract between owner and shipyard	Technical review of the design plans and related documents for a new vessel to verify compliance with the applicable rules.
Construction	Surveyor accompanies the construction of the vessel in the shipyard to verify that the vessel is constructed in accordance with the approved design plans and Classification Society specification rules. This includes the inspection of steel blocks and sections (incl. leak and non-destructive testing), final approval of tanks and cargo holds; inspection of shaft alignment as well as stern tube sealing and centring of the wheel bearing; keel inspection and measurement of the main vessel dimensions; inspection of propeller and rudder mounting, free board inspection, etc. Surveyor visits the relevant production facilities that provide key components such as the steel, engine, generators and castings to verify that the component conforms to the applicable rule requirements.
Sea trails including their preparation	Surveyor attends the sea trials and other trials relating to the vessel and its equipment prior to delivery to verify conformance with the applicable rule requirements. This includes survey of equipment, on board checks, hydraulic tests of tanks and cargo holds, stability checks, etc.

After the surveyor is satisfied with all the described tests the Classification Society assignment will be approved and a certificate of classification will be issued. The vessels will be included in the register of the Classification Society. Such a registration

ensures that the vessel will be accepted by port authorities, flag state administrations and insurances worldwide.

12.4 Ship Operation

After the successful registration and classification, the ship operator obtains a classification certificate which is valid for 5 years. In order to ensure that the classified vessels operate in accordance with the classification rules these vessels must undergo regular as well as unscheduled surveys. There is a clearly specified programme of periodical classification surveys, carried out on board the vessel, to verify that the ship continues to meet the relevant rule requirements for the classification. Also, the fulfilment of additional obligations (ISM, etc.) is checked, but they are not in focus of this study. The surveys are to be carried out in accordance with the relevant classification requirements to confirm that the condition of the hull, tail shaft, boiler, machinery, equipment and appliances is in compliance with the applicable rules. The extent of any survey depends upon the condition of the ship and its equipment. There are different kinds of surveys during the vessel life cycle (see following table).

Types of survey	Survey activities
Annual Survey	The ship is generally examined during the annual surveys. The survey involves a sampling based on existing guidelines and empirical experiences. Usually the survey includes an inspection of the hull, equipment and machinery of the ship and some witnessing of tests. Depending upon the age, size, type and condition of the vessel, an annual survey may take from several hours to a few days to complete.
Intermediate Survey [Instead of second or third annual classification]	The intermediate survey includes examinations and checks on the structure as specified in the rules to verify that the vessel is in compliance with the applicable rule requirements. The rule criteria become more stringent with age. The intermediate survey is an inspection of the items relating to the particular certificate like e.g. marine equipment to ensure that they are in a satisfactory condition and fit for the ship operation. A renewal survey is the same as an intermediate survey but also leads to the issue of a new certificate. According to the type and age of the ship the examinations of the hull may be supplemented by thickness measurements as specified in the rules and where deemed necessary by the attending surveyor.
Bottom/docking survey [Two times in the five-year period of the Classification Society certificate]	A bottom/docking survey is the examination of the outside of the ship's hull and related items.
Classification Society renewal/special survey [every 5 years]	The Classification Society renewal surveys/special surveys include extensive in-water and, in most cases, out-of-water examinations to verify that the structure, main and essential auxiliary machinery, systems and equipment of the ship remain in a condition which satisfies the relevant rules.

Types of survey	Survey activities
	Depending upon the age, size, type and condition of the vessel, the renewal/special survey may take several weeks to complete.
Non-periodical surveys	Non-periodical surveys are usually carried out: • to update Classification Society documents (e.g. change of owner, name of the ship, change of flag); • to deal with damage or suspected damage, repair or renewal work, alterations or conversion, postponement of surveys or outstanding recommendations/conditions of Classification Society; • at the time of port state control inspections.

12.5 Ship Recycling

Vessels are mainly scrapped in Pakistan, Bangladesh and India without much regard to the life and health of the workers. The IMO (International Maritime Organisation) has reached an agreement on the introduction of mandatory requirements for ship recycling at a global level, but it remains to be seen whether this agreement, the Hong Kong Convention, will be ratified by enough countries in order to enter into force.

On a European level, the EU's Ship Recycling Regulation regulates the recycling of ships flying the flag of the EU Member States. It requires the availability of an inventory of hazardous materials on board of the vessel which needs to be verified by an administration or a recognised organisation authorised by it. The details are described within the projection scenarios (see chapter 17.1.5).

13 Important Technologies and Infrastructure Existing Databases and IT Architecture

13.1 Exiting databases

Electronic tag readers are used to gather information directly at the product. A unique identification code for products allows the collection of a limited amount of data from the tag directly (storage capacity see page 58 - Table 5) and also from distributed databases via tag reader connections.

To obtain information already today regarding marine equipment several public information sources exist by means of databases which are offered through the Internet. Based on the electronic tag information the users (depending on their role and access rights) may in the future be able to get access to the most important databases for marine equipment which are NANDO, MarED, RAPEX and ICSMS. The reader implementation must consider the access procedures of each database.

The **NANDO (New Approach Notified and Designated Organisations)** database (http://ec.europa.eu/growth/tools-databases/nando/index.cfm) provides information on those organisations which have been notified and are authorised by their Member States to issue certificates under certain legislation. NANDO is operated by DG Growth.

Information on Notified Bodies can also be found on the **MarED (Marine Equipment Directive)** database (www.mared.org) which is the website of the Group of Notified Bodies established under the MED in order to ensure a harmonised implementation of the rules and regulations. The MarED website also hosts the so called MarED Product Database, which fulfils a duty of the European Commission under the MED to trace equipment approved under the MED (DIR 96/98/EC, Article 10.4). MarED belongs to DG Move/EMSA and is operated by the technical secretariat - actually by BALance Technology Consulting GmbH.

The **RAPid EXchange of information system (RAPEX)** is the EU rapid alert system (http://ec.europa.eu/consumers/consumers_safety/safety_products/rapex/index_en.htm) for all dangerous consumer products, except food, medicine and medical equipment. It allows a quick exchange of information between Member States and the Commission about the measures that have been taken to prevent or restrict the marketing or use of dangerous products. Here RAPEX covers both measures ordered by national authorities and measures taken voluntarily by producers and distributors. The Commission publishes a weekly overview of dangerous products which have been notified to it by the national authorities. RAPEX is operated by DG Justice.

Finally **ICSMS (Information and Communication System for the pan-European Market Surveillance of products)** is an internet based database (https://ec.europa.eu/growth/single-market/goods/building-blocks/icsms_de) which contains product information, test results, official measures taken, etc. For consumers and manufacturers, it offers a public area with official information about dangerous products, reliable information about unsafe products as well as voluntary industry recalls and postings made by manufacturers drawing attention to pirated copies. A closed area of the system is for the use of market surveillance bodies, customs authorities, and the EU Commission – e.g. official agencies. An extensive search tool allows the search according individual products, test results for entire product groups,

test results for products from specific countries; information for products coming under certain directives, safeguard clause notifications, RAPEX notifications, as well as information about manufacturers, importers and dealers. The system and the data contained in it are protected against un-authorised access. ICSMS is hosted by DG Growth and DIGIT in the future (starting in 2017). National authorities input, read and process data in ICSMS.

Other applications to equipment industry or shipping industry internal databases may also be interlinked based on pre-agreed neutral interfaces and unique identifier.

13.1.1 NANDO (New Approach Notified and Designated Organisations) information system

A Notified Body is an organisation designated by an EU country to assess the conformity of certain products before being placed on the market. These bodies carry out tasks related to conformity assessment procedures set out in the applicable legislation, when a third party is required. The European Commission publishes a list of such Notified Bodies. EU countries, EFTA countries (EEA members), and other countries with which the EU has concluded Mutual Recognition Agreements (MRAs) and Protocols to the Europe Agreements on Conformity Assessment and Acceptance of Industrial Products (PECAs) have designated Notified Bodies per directive or regulation. They must inform the Commission and the other Member States that a body, which fulfils the relevant requirements, has been designated to carry out conformity assessment according to a directive. All Notified Bodies are listed in NANDO including the identification number of each Notified Body as well as the tasks for which it has been notified.

The **NANDO** database (http://ec.europa.eu/growth/tools-databases/nando/index.cfm?fuseaction=directive.main) provides information on all organisations which have been notified and are authorised to issue certificates. Each Notified Body as well as the tasks for which it has been notified are stored in NANDO including the identification number. The NANDO database is used by:

- companies, to search a list of Notified Bodies (including the scope of their notification -http://ec.europa.eu/growth/tools-databases/nando/index.cfm) that can assess the conformity of their products;
- public authorities responsible for market surveillance;
- customers to check that a conformity assessment body has indeed been notified.

Also Notified Bodies where the notification has expired or been withdrawn can be found here. This information is subject to regular updates.

13.1.2 MarED (Marine Equipment Directive) Database

Conformity in Accordance with the Marine Equipment Directive

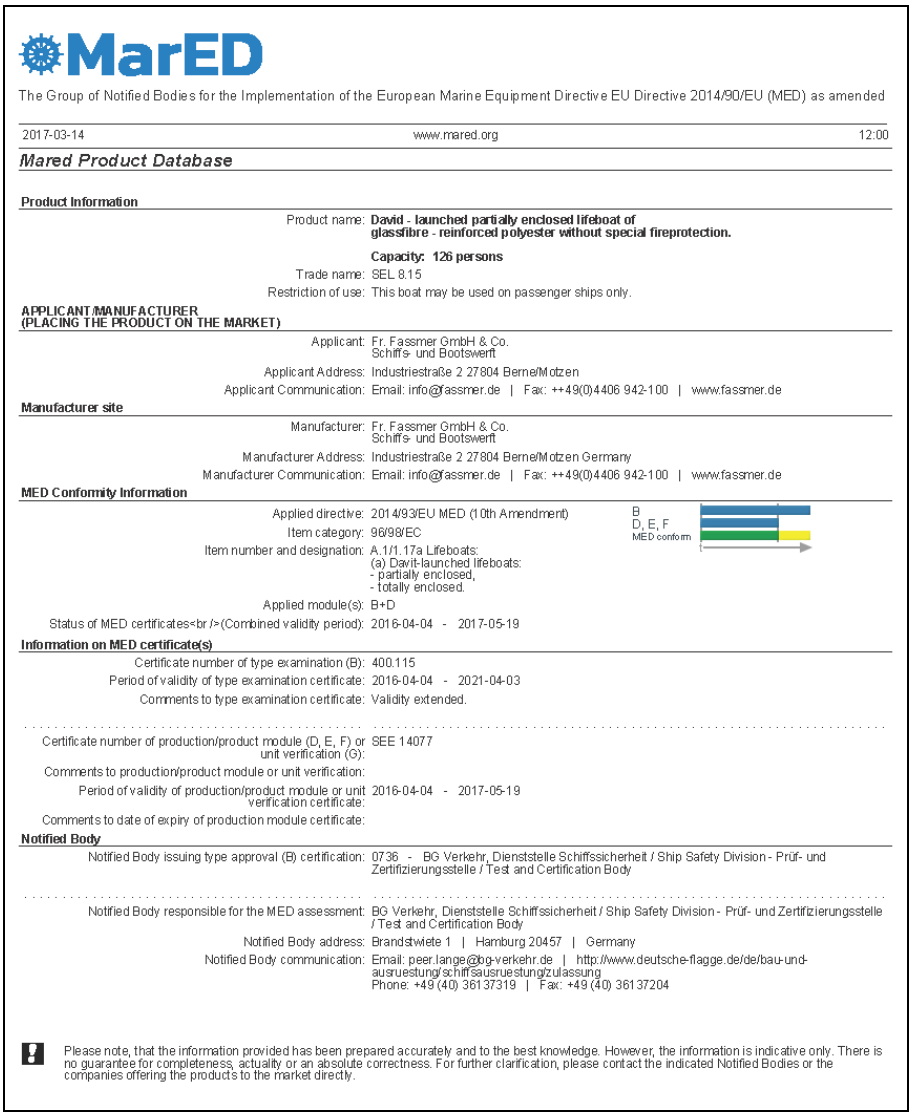
Information on Notified Bodies can also be found on MarED (www.mared.org) which is the website of the Group of Notified Bodies established under the MED in order to ensure a harmonised implementation of the rules and regulations. The MarED website also hosts the so called MarED Product Database, which fulfils a duty of the European Commission under the MED to trace equipment approved under the MED (DIR 96/98/EC, Article 10.4: "The Commission shall keep an up-to-date list of approved

equipment and applications withdrawn or refused and shall make it available to interested parties." The MarED Product Database is owned by DG MOVE/EMSA operated by the Technical Secretariat.

As marine equipment can be placed on board of EU ships at the time of their construction or repair all over the world, market surveillance becomes particularly difficult. Therefore, Member States have to ensure that only compliant equipment is installed on board ships flying their flags and that this obligation is fulfilled through issuance, endorsement or renewal of the certificates. Member States should be supported in fulfilling those obligations by the information systems (i.e. MarED Product Database) made available by the Commission for the assessment, notification and monitoring of bodies authorised to carry out conformity assessment tasks, the sharing of information in relation to approved marine equipment, applications withdrawn or refused, and non-compliance of equipment [DIRECTIVE 2014/90/EU of 23 July 2014].

Marine equipment can only be installed on board ships sailing under the flag of EU Member States and additional EEA (European Economic Area) member states (i.e. Norway, and Iceland) if it is marked with the MED mark of conformity, known as the "wheel mark". All marine equipment certified and notified is documented within the MarED Product Database. The MarED Product Database contains information about authorized equipment to be installed on EU flagged merchant vessels according to the Directive.

Based on Article 25 [DIRECTIVE 2014/90/EU - EU market surveillance framework] the Member States shall undertake market surveillance in accordance with the EU market surveillance framework laid down in Chapter III of Regulation (EC) No 765/2008 [paragraphs 2 and 3 of this Article]. The market surveillance may include documentary checks as well as checks of marine equipment which bears the wheel mark, whether or not it has been placed on board ships. Checks of marine equipment already placed on board shall be limited to such examination as can be carried out while the equipment concerned remains fully functional on board [EN 28.8.2014 Official Journal of the European Union L 257/161]. Figure 12 shows typical information on certified equipment which can be found in the MarED Product Database by using the offered search functions.



MarED

The Group of Notified Bodies for the Implementation of the European Marine Equipment Directive EU Directive 2014/90/EU (MED) as amended

2017-03-14 www.mared.org 12:00

Mared Product Database

Product Information

Product name: **David - launched partially enclosed lifeboat of glassfibre - reinforced polyester without special fireprotection.**

Capacity: 126 persons

Trade name: SEL 8.15

Restriction of use: This boat may be used on passenger ships only.

APPLICANT/MANUFACTURER (PLACING THE PRODUCT ON THE MARKET)

Applicant: Fr. Fassmer GmbH & Co. Schiffs- und Bootswerft

Applicant Address: Industriestraße 2 27804 Berne/Motzen

Applicant Communication: Email: info@fassmer.de | Fax: ++49(0)4406 942-100 | www.fassmer.de

Manufacturer site

Manufacturer: Fr. Fassmer GmbH & Co. Schiffs- und Bootswerft

Manufacturer Address: Industriestraße 2 27804 Berne/Motzen Germany

Manufacturer Communication: Email: info@fassmer.de | Fax: ++49(0)4406 942-100 | www.fassmer.de

MED Conformity Information

Applied directive: 2014/93/EU MED (10th Amendment)

Item category: 96/98/EC

Item number and designation: A.1/1.17a Lifeboats: (a) Davit-launched lifeboats: - partially enclosed, - totally enclosed.

Applied module(s): B+D

Status of MED certificates
(Combined validity period): 2016-04-04 - 2017-05-19

B D, E, F MED conform

Information on MED certificate(s)

Certificate number of type examination (B): 400.115

Period of validity of type examination certificate: 2016-04-04 - 2021-04-03

Comments to type examination certificate: Validity extended.

Certificate number of production/product module (D, E, F) or unit verification (G): SEE 14077

Comments to production/product module or unit verification:

Period of validity of production/product module or unit verification certificate: 2016-04-04 - 2017-05-19

Comments to date of expiry of production module certificate:

Notified Body

Notified Body issuing type approval (B) certification: 0736 - BG Verkehr, Dienststelle Schiffssicherheit / Ship Safety Division - Prüf- und Zertifizierungsstelle / Test and Certification Body

Notified Body responsible for the MED assessment: BG Verkehr, Dienststelle Schiffssicherheit / Ship Safety Division - Prüf- und Zertifizierungsstelle / Test and Certification Body

Notified Body address: Brandstwiete 1 | Hamburg 20457 | Germany

Notified Body communication: Email: peer.lange@bg-verkehr.de | http://www.deutsche-flagge.de/de/bau-und-ausruestung/schiffsausruestung/zulassung Phone: +49 (40) 3613 7319 | Fax: +49 (40) 3613 7204

Please note, that the information provided has been prepared accurately and to the best knowledge. However, the information is indicative only. There is no guarantee for completeness, actuality or an absolute correctness. For further clarification, please contact the indicated Notified Bodies or the companies offering the products to the market directly.

Figure 12: Content of MarED Prodcut Database[12]

The database can be used for any conformity check and market surveillance by using the available product information immediately. The MarED product database is updated on a regular basis to ensure the availability of actual data. Based on electronic tag environment any kind of verification can be realised much faster and more efficient. The product can be identified at any place any time. Therefore, product traceability can be realised in a smart way which would be very beneficial. The DECISION No 768/2008/EC of 9 July 2008 chapter 28 already stated clearly that "Ensuring traceability of a product throughout the whole supply chain helps to make market surveillance simpler and more efficient. An efficient traceability system facilitates market surveillance authorities' task of tracing economic operators who made non-compliant products available on the market."

Just as an indication the following figures give an overview of the timely development of datasets for approved products and in the second figure the assignment to the different product categories and Notified Bodies. Provided the electronic tags would

[12] Source: MarED Product Database, Oct 2015

allow the identification of the certificate and the Notified Body, information contained in databases of the Commission (MarED, RAPEX) and/or the manufacturer could be interlinked and mapped on mobile devices.

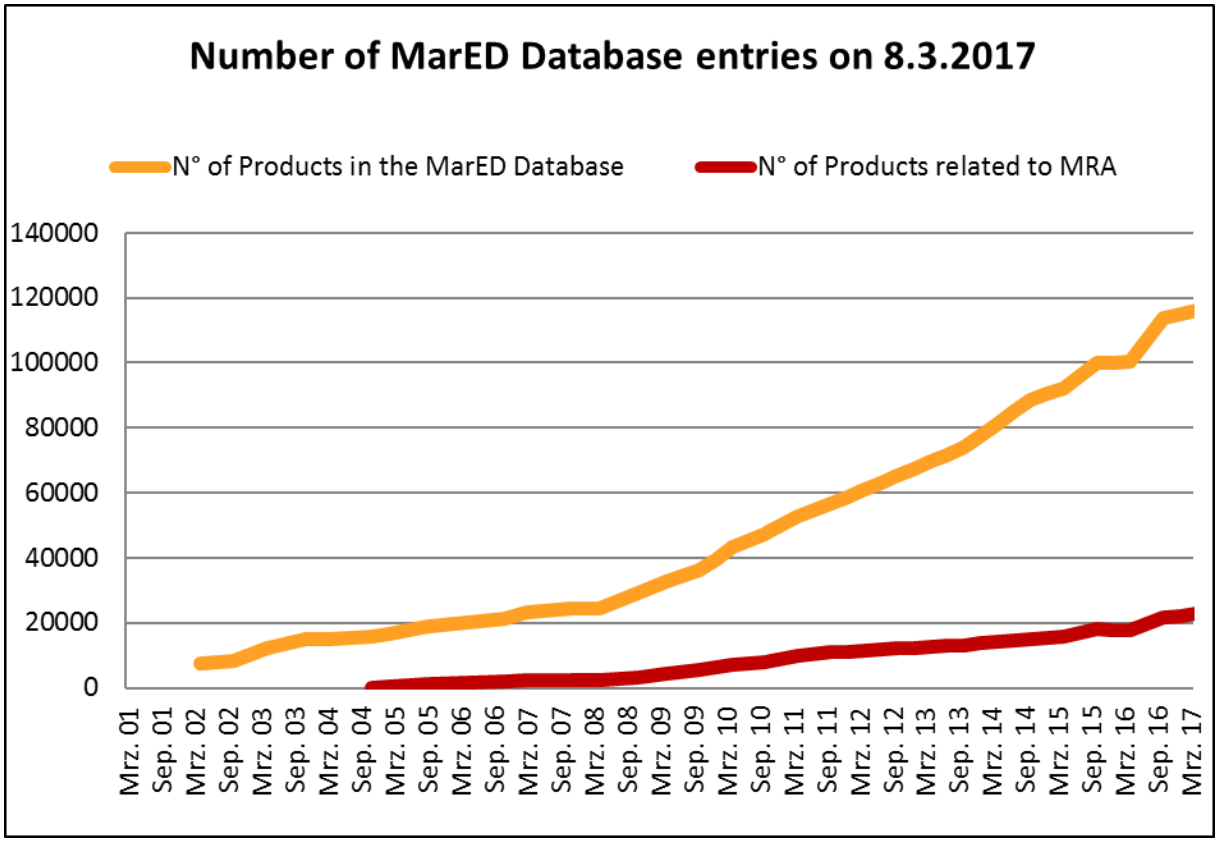


Figure 13: Number of entries in the MarED Product Database[13]

It is very feasible to automatically search the MarED Product Database when equipment has been identified in the field by means of reading an electronic tag and automatically trigger a query to the database through some kind of a communication link (Internet, GSM etc.). This for instance could be a typical exercise by market surveillance inspections, technical surveys, port state control etc.

[13] Source: MarED Product Database, statistical report, Oct 2015

A.1/1	A.1/2	A.1/3	A.1/4	A.1/5	A.1/6	A.1/8	Totals	Notified Body
17254	1332	14307	1408	77	25	29	34432	0062 - BV
8108	897	8781	773	66	12	6	18643	0575 - DNV GL AS
2104	181	12925	789	0	12	1	16012	0474 - RINA
3515	1690	5676	282	0	66	6	11235	0038 - LRVL
3289	254	1619	554	5	34	0	5755	0098 - DNV GL SE
3748	612	847	134	12	6	0	5359	0801 - GL Lux
18	0	0	4613	61	51	0	4743	0735 - BSH-Cert
2223	486	1139	0	0	0	0	3848	0729 - ABS
579	370	2304	0	0	0	0	3253	0736 - BG Verkehr
2060	99	218	19	4	3	6	2409	2198 - KR HELLAS
984	425	751	8	0	2	0	2170	0849 - NKK
245	0	1382	6	0	0	0	1633	0200 - FORCE
0	0	1063	0	0	0	0	1063	0426 - ITALCERT
0	0	863	0	0	0	0	863	0987 - LAPI
66	0	0	397	197	0	0	660	0168 - TUV SUD BABT
4	0	0	469	100	6	0	579	0191 - QinetiQ
139	1	418	3	0	0	0	561	1463 - PRS
0	0	551	0	0	0	0	551	0497 - CSI SPA
0	0	462	0	0	0	0	462	0029 - APRAGAZ
42	0	387	0	0	0	0	429	0086 - BSI
0	0	420	0	0	0	0	420	1121 - WFRC
0	0	0	68	223	0	0	291	0560 - Telefication
2	0	240	3	0	0	0	245	1347 - DNV Denmark
0	0	215	0	0	0	0	215	0338 - BTTG
0	0	172	0	0	0	0	172	2531 - DBI Certification
0	0	144	0	0	0	0	144	0832 - BRE
9	0	123	0	0	0	0	132	0809 - VTT
23	0	78	2	0	0	0	103	0437 - MIRTEC S.A. (EBETAM A.E.)
0	0	78	0	0	0	0	78	0845 - DBI
12	0	56	1	0	0	0	69	0407 - GIORDANO
2	0	6	32	12	0	0	52	0470 - NEMKO
18	2	12	17	0	0	0	49	2489 - CRS
0	0	41	0	0	0	0	41	0068 - Istituto Masini
0	0	36	0	0	0	0	36	1112 - CNMIS
9	3	18	2	0	0	0	32	2690 - BV Marine & Offshore
0	0	30	0	0	0	0	30	2434 - CTO
0	0	27	0	0	0	0	27	0194 - INSPEC
0	0	27	0	0	0	0	27	0493 - CTB
19	0	0	0	0	0	0	19	0843 - UL
15	0	1	0	0	0	0	16	0403 - FIOH
0	0	13	0	0	0	0	13	1084 - SPFR
0	0	9	0	0	0	0	9	0161 - aitex
0	0	9	0	0	0	0	9	0402 - SP
0	0	7	0	0	0	0	7	0099 - AENOR
0	0	0	4	0	0	0	4	0700 - Phoenix
4	0	0	0	0	0	0	4	0514 - FTH
1	0	0	0	0	0	0	1	0434 - DNV GL Norway

Figure 14: Number of entries in the MarED Product Database per Notified Bodies

13.1.3 ICSMS (Information and Communication System for the pan-European Market Surveillance)

For the communication between market surveillance bodies in the EU and in EFTA countries the ICSMS Internet platform offers information on compliant and non-compliant products. The platform should speed up the detection of unsafe and other non-conforming products from the market. It consists of an internal and a public area. The closed part includes mainly product information, test results and official measures taken in respect to non-compliant products. The internal part of the database is mainly used by market surveillance authorities, customs and the European Commission.
For consumers, distributors and manufacturers it offers public information about non-conforming products.
An extensive search tool allows the search of individual products, test results for entire product groups, test results for products from specific countries; information for products coming under certain directives, safeguard clause notifications, RAPEX notifications, as well as information about manufacturers, importers and distributors.

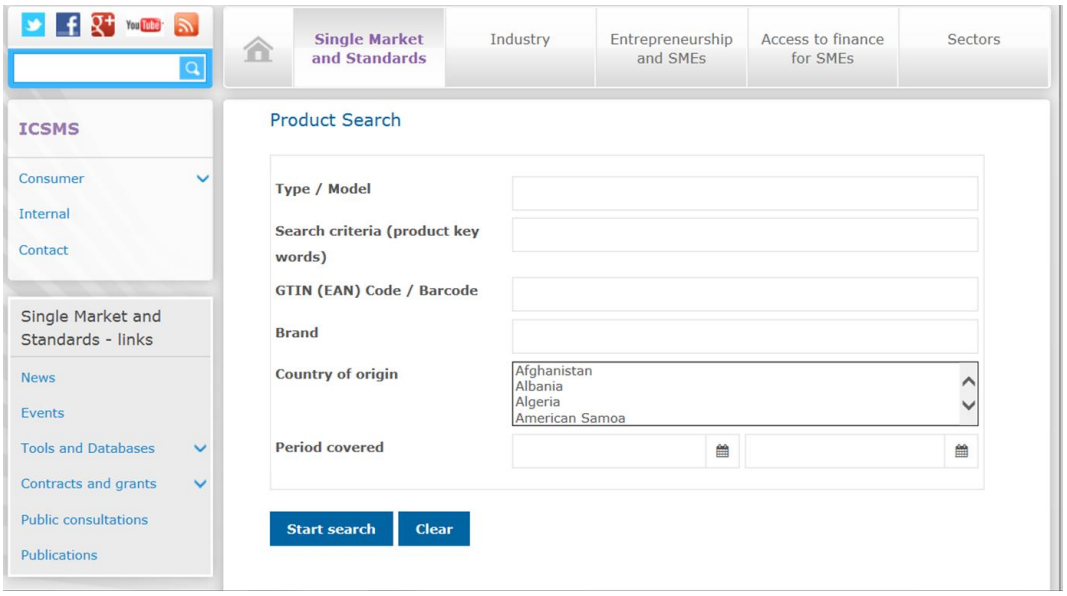


Figure 15: ICSMS product search interface

Users can search also by the country's competent authority in their area for the equipment and product safety.

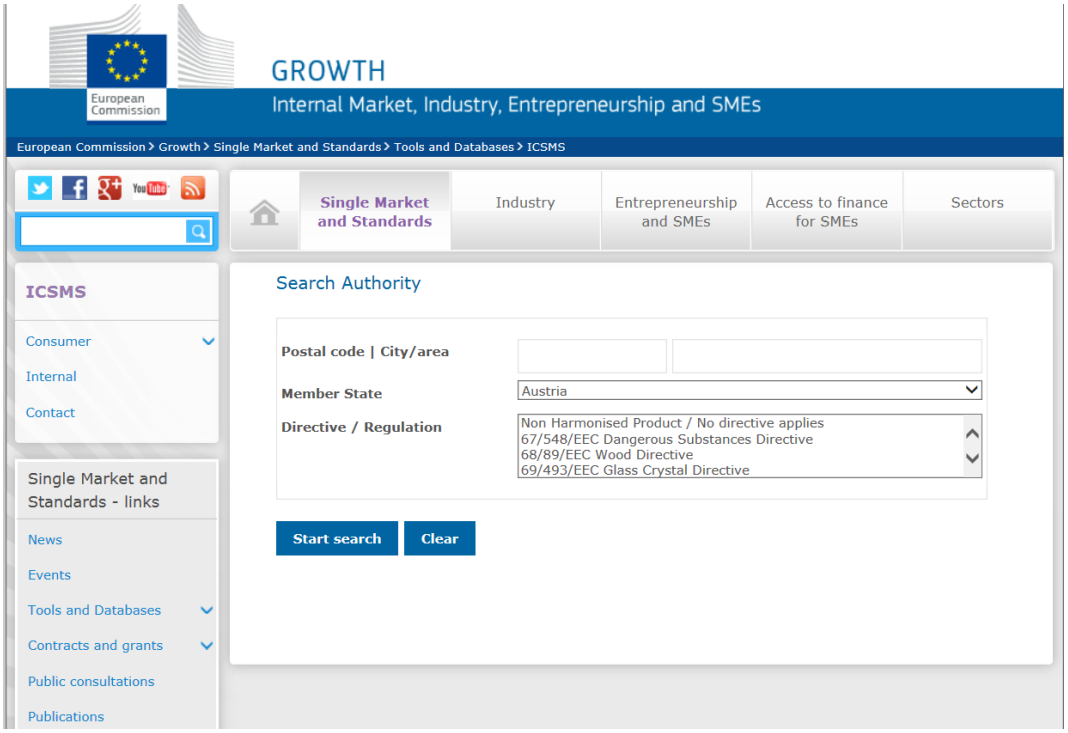


Figure 16: ICSMS Authority search interface

For the traceability of marine equipment, the database can be used to collect the information of available product data. Within this study investigations for traceability, recall practices and interface flexibility of ICSMS have been made. By using tags and the adequate access rights, access to all available information about marine equipment will be possible much quicker than today.

13.1.4 RAPEX (Rapid Alert System for dangerous non-food products)

The Rapid Alert System offers information on products posing risk to health and safety of consumers and professional users and to other public interests protected by relevant EU legislation (e.g. environment). RAPEX allows 31 participating countries (EU countries, Norway, Iceland and Liechtenstein) and the European Commission to exchange information on products posing a risk to health and safety and on the measures taken by these countries to eliminate that risk. The available information includes:

- information on the product, identified risk and measures taken in the notifying country;
- list of other countries where the notified product was found on their market and where measures were also taken;
- notifications on products posing serious risk and less than serious risk;
- notifications on professional products and on those posing risks to other public interests.

National authorities take measures to prevent or restrict the distribution or the use of those dangerous products. Also measures taken 'voluntarily' by producers and distributors are reported via this system.

Marine equipment with electronic tags would offer surveyors direct access to RAPEX and to receive immediately the actual information on risk to health and safety (proposed architecture see chapter 13.2.5.1). Within this study an assessment on traceability, recall and warning practices as well as interface flexibility of RAPEX has been made. The opportunity of single product or batches traceability capabilities has been considered especially under cost/benefit criteria (see impact analysis). It is expected that the amount of marine equipment products registered in the database will increase by more and faster survey processes.

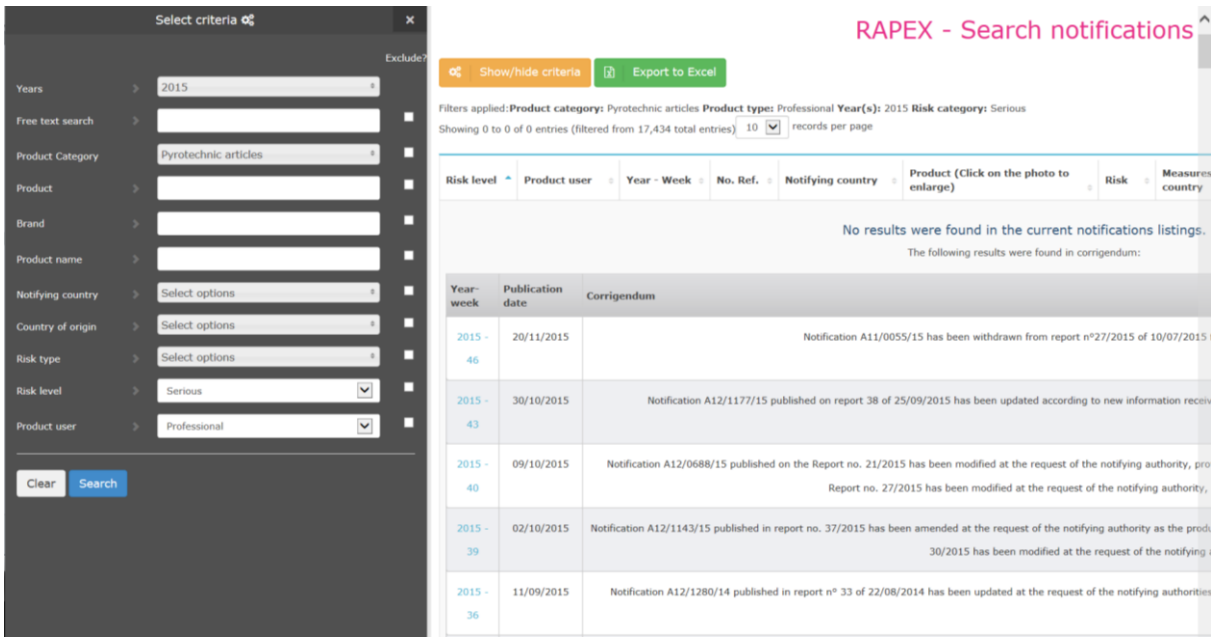


Figure 17: RAPEX Search Criteria

The following statistics show that the numbers of serious risk notifications are increasing year by year.

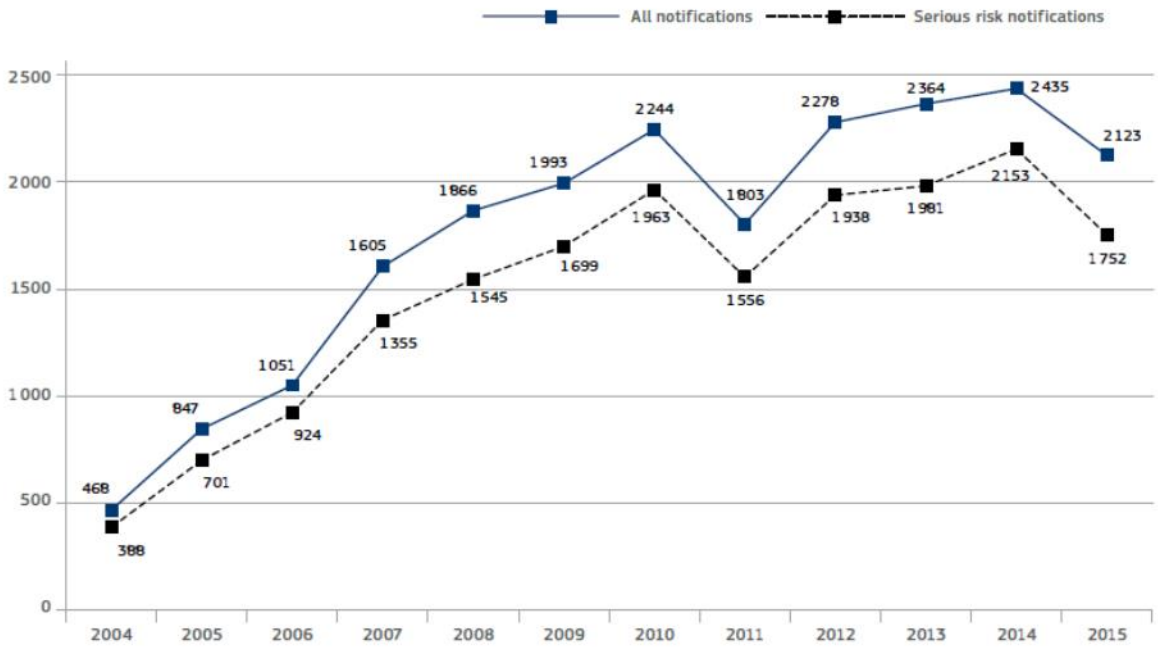


Figure 18: Total number of notifications and serious risk notifications (absolute vlues 2004-2015
[Source: 31 countries + 1 internal market of safe products - 2015 results]

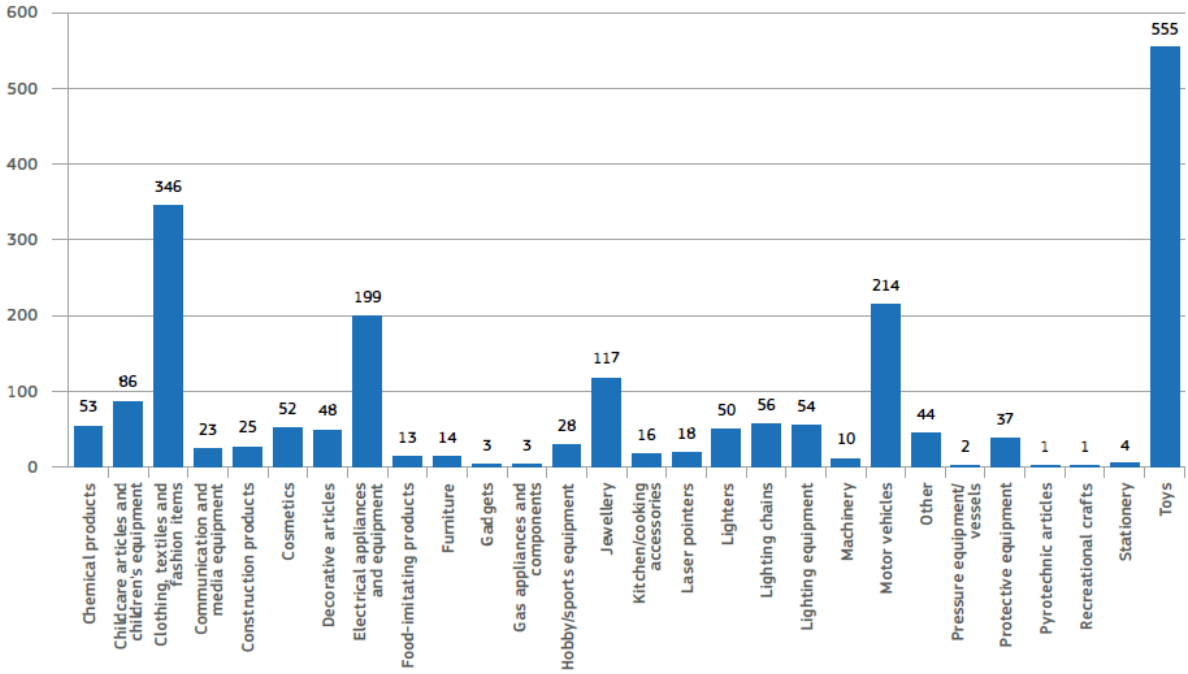


Figure 19: Number of notifications in 2015 by product category of the dangerous products
[Source: 31 countries + 1 internal market of safe products - 2015 results]

It would be useful to automatically check RAPEX to get warnings about dangerous products.

13.1.5 Industry Databases

Beside the public databases also industry databases are available. They are operated by marine suppliers or classification societies. Selected industry databases have been considered related to remote accessibility. The reader implementation must consider the access procedures of each database.

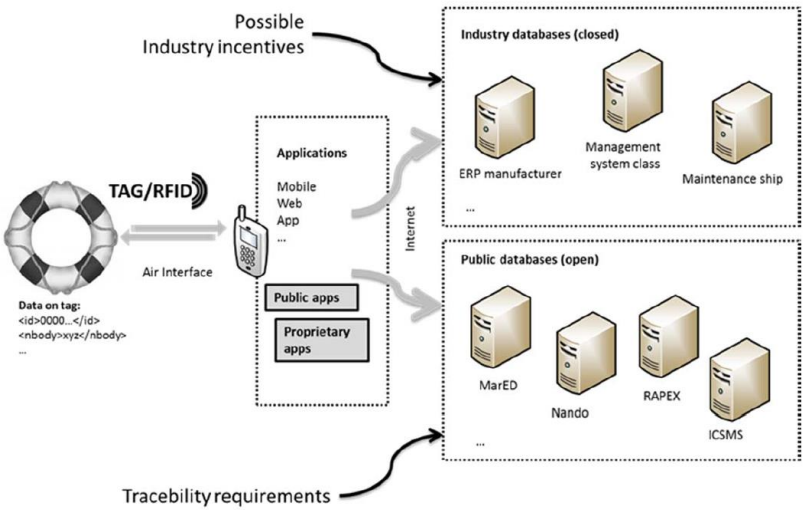


Figure 20: General concept of interlinking databases by means of electronic tags

A general architecture for the data exchange between the eTag reader and the different databases (public and industrial) are illustrated in Figure 1. Therefore, a remote database access is needed and a unique identifier (data and application identifier) (see chapter 13.2.5).

13.2 Data Carrier Technologies and Architectures

13.2.1 Identification of the Data Carriers (Electronic Tag - Labels)

13.2.1.1 General Technologies for Automatic Identification (AutoID)

Automatic identification (also commonly referred to as "Auto-ID") refers to the methods of automatically (i.e. without human involvement) identifying objects and determining their belonging to a certain type or class of objects or their individual identity that differs from all other objects. In addition, it often includes automatically collecting data about them ("automatic data capture").

Objects may include people, animals, goods and products in transit. Automatic identification of objects may use a characteristic or unique property of the object itself (like e.g. the voice or fingerprint of a human being) or of an affixed coding device (e.g. a label or tag), which encodes the object related data. The identification device is normally connected to a data processing or computer system for further processing and manipulation of the object data.

Technologies typically considered as part of auto-ID include barcodes, Radio Frequency Identification (RFID), smart cards, magnetic stripes, machine vision, biometrics, touch memory, optical character recognition (OCR), and voice recognition[14].

In recent years, automatic identification procedures (Auto-ID) have been introduced in many service industries, purchasing and distribution logistics, industry, manufacturing companies and material flow systems.

Optical Systems (Barcode and Data Matrix)

A **barcode** is a machine-readable, optical representation of data formed by combinations of high and low reflectance regions on the surface of an object according to a predetermined, geometrical pattern. Barcodes are read by optical laser scanning, i.e. by the different reflection of a laser beam from the dark (low reflectance) bars and light (high reflectance) gaps. Barcode scanners and interpretive software have become available on many deviceses including smartphones.

Barcodes may be distinguished according to the geometry of the optical data representation[15]: A linear or **one-dimensional (1D) barcode** is a binary code comprising a field or sequence of lines (bars) and gaps arranged in a parallel configuration. The data is represented by the varying widths and spacing within the sequence of wide and narrow bars and gaps and can be interpreted numerically and alphanumerically.

Most barcode systems only identify classes of products, not individual items. The most widely used barcode is the EAN-13 (International Article Number, formerly named European Article Number) code. The identifier will be a compound attribute to query databases for further information in similar way like today, just with the difference that the manual entry to the database is replaced or enlarged by automatic identification means. Other applications to equipment industry or shipping industry internal databases may also be interlinked based on pre-agreed neutral interfaces and unique identifier.

Two-dimensional (2D) barcodes use geometric patterns in two dimensions, like e.g. rectangles, dots, or hexagons, to code information, so it can represent more data per unit area. A Data Matrix code is a two-dimensional matrix barcode consisting of dark and light "cells", little squares arranged in either a square or rectangular pattern that represent bits. The information to be encoded can be text or numeric data (see Figure 21). Compared to one-dimensional barcodes, they can represent more data per unit area. Usual data sizes range from a few bytes up to 1556 bytes. They need a scanning device capable of simultaneous reading in a vertical and a horizontal direction.

[14] Agarwal, V.: Assessing the benefits of Auto-ID Technology in the Consumer Goods Industry. Cambridge University Auto-ID Centre Report, 2001. URL: http://cocoa.ethz.ch/downloads/2014/06/None_CAM-WH-003.pdf, Access: 2015/10/19.

[15] Kato, H.; Tan, K.; Chai, D. (2010): Barcodes for Mobile Devices. Cambridge University Press, Cambridge a.o.

Figure 21: Illustration of ECC200 Data Matrix code

Radiofrequency-based Systems (passive RFID in HF and UHF band)

In Radio Frequency Identification (RFID), an object is identified via an attached electronic device (Transponder, or tag) that uses radio frequency or magnetic field variations to communicate to a reading device.

First, transponders contain an integrated circuit or an electronic microchip for storage of data and processing data and modulating and demodulating a radio-frequency (RF) signal, collecting DC power from the incident reader signal. The tag information is stored in a non-volatile memory. Second, they contain a coupling element, such as a coiled antenna, used to communicate via radio frequency waves by receiving and transmitting the signals. The data capacities of RFID transponders range from a few bytes to several kilobytes. In addition, 1-bit transponders are used in electronic article surveillance, e.g. to protect goods in shops. Depending on their power supply, transponders may be either active or passive. Passive transponders obtain all their power from the interrogation signal of the reader. Conversely, active transponders incorporate a battery or a solar cell, which supplies all or part of the power for the operation of a microchip.

The reading device (transceiver, interrogator or reader), which may be a read or write/read devices consists of a radio frequency module, a control unit, and a coupling element to interrogate electronic tags via radio frequency waves for information stored on them. The readers can communicate their received data to the data processing subsystem via a fitted interface. Readers emit an interrogation signal, which forms an interrogation zone within which the transponders may be read. The size and geometry of the interrogation zone is a function of the transceiver and transponder characteristics. The general system configuration is presented in the following Figure 22:

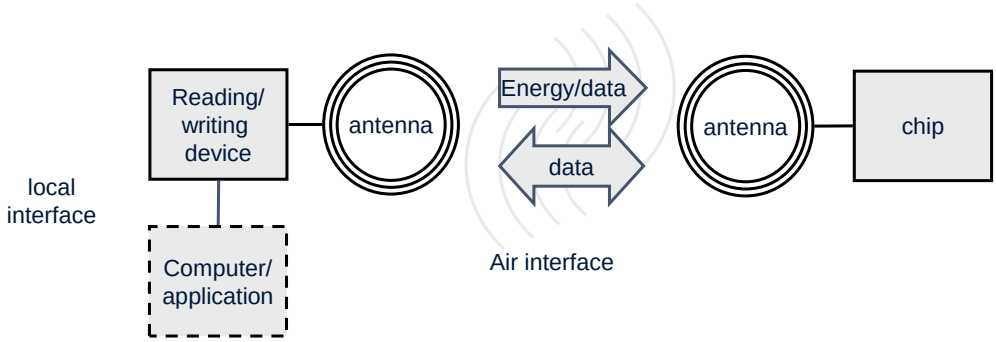


Figure 22: General system configuration of RFID

Numerous different RFID systems and RFID transponders systems are available on the market. The technical parameters of these systems are often optimised for specific fields of application, e.g. industrial automation or access control. The technical requirements of different fields of application however often partially overlap, making clear distinction between different systems difficult at times.

One of the most important characteristic of an RFID system is its operating frequency, which is the frequency at which the reader transmits. The transmission frequency of the transponder is in most cases the same as the transmission frequency of the reader (load modulation, backscatter). However, the transponder's 'transmitting power' may be set several powers of ten lower than that of the reader. The different transmission frequencies are classified into the three basic ranges, LF (low frequency, 30–300 kHz), HF (high frequency)/RF radio frequency (3–30MHz) and UHF (ultra-high frequency, 300MHz–3 GHz)/microwave (>3 GHz). According to range RFID systems can be subdivided into close-coupling (0–1 cm), remote-coupling (0–1 m), and long-range (>1m) systems. Passive RFID transponders can be read at small to medium distances and active RFID tags at small to large distances.

Data carriers

The common aspect of **A**utomatic **I**dentification and **D**ata **C**apturing (AIDC) technologies implies that information is encoded into a machine-readable format. The resulting code is according to the particular AIDC technology stored on a respective data carrier.

This leads to two recommendations for the application of AIDC technologies in the domain of marine equipment, namely 2D Matrix codes and RFID (see Table 3). For both resulting data carriers, different options are known and available. Under consideration of technical limitations, market share and prospective technical progress, data carrier standards are chosen for both options.

2D Matrix Code		**Passive RFID in UHF band**	
	Standardised under ISO/IEC 16022:2006 - Data Matrix bar code symbiology specification		Standardised under ISO/IEC 18000 Part 6 865-868MHz in 868 MHz (Europe 915MHz in the US) 902-928 MHz (North America)[16]

Table 3: RFID operating frequency classes

[16] Image source: https://en.wikipedia.org/wiki/Radio-frequency_identification#Tags

RFID transponders can be classified according to their possibility of writing data to the transponder. In non-writable transponders, the transponder's data record, usually a simple (serial) number, is incorporated when the chip is manufactured and cannot be altered thereafter.

In writable transponders, the reader device can write data to the transponder. Three main procedures are used to store the data: in passive RFID systems **EEPROMs** (electrically erasable programmable read-only memory) are dominant. Data stored in an EEPROM is retained for several years without a power supply. The energy required for writing to or reading from a transponder using EEPROM technology is transmitted by inductive coupling. The guaranteed number of write access operations to a memory address is typically around 105 cycles.

FRAMs (ferromagnetic random access memory) have recently been used in isolated cases. The read power consumption of FRAMs is lower than that of EEPROMs by a factor of 100 and the writing time is 1000 times lower. Over 1010 write cycles have been being achieved.

Particularly in active microwave systems, **SRAMs** (static random access memory) are used for data storage as well. They allow very rapid write cycles. However, data retention requires an uninterruptible power supply from an auxiliary battery, as SRAM memory cells require a constant power supply to retain stored data. Therefore, transponders using this memory technology always have their own battery. Data transmission between reader and transponder employs either inductive coupling or the backscatter procedure (microwave). SRAM memory can be reprogrammed any number of times with high write speeds. However, the integral battery limits the temperature range of this transponder to 0–60 ◦C.

Further identification systems

Optical character recognition (OCR) uses special fonts with stylized characters so that they can be read automatically by machines. One application example is the registration of cheques in banking, where personal data, such as name and account number, is printed on the bottom line of a cheque in OCR type.

Advantages of OCR systems are the high density of information and the possibility of reading data visually. However, OCR systems have failed to become more universally applied because of their high price and the complicated readers that they require in comparison with other ID procedures.

In the context of identification systems, **biometrics** refers to all procedures that identify people by comparing unmistakable and individual physical characteristics. In practice, these are fingerprinting and hand printing procedures, voice identification and retina (or iris) identification. Voice identification converts the words spoken by an individual human being into a computer linked microphone to into digital signals, which are evaluated by the identification software in order to check the speech characteristics of the speaker for correspondence to an existing reference pattern. Biometrics is mostly suited to identifying human beings.

A **smart card** is an electronic data storage system, possibly with additional computing capacity (microprocessor card), which is normally incorporated into a plastic card the size of a credit card. Smart card systems are similar in characteristics and often considered a subclass of RFID systems. Their main difference from other RFID systems however is their small reading range due to contact based reading. Smart

cards are placed in a reader, which makes a galvanic connection to the contact surfaces of the smart card using contact springs. Like a passive RFID transponder, the smart card is supplied with energy and a clock pulse from the reader via the contact surfaces. Data transfer between the reader and the card takes place using a bidirectional serial interface (I/O port). It is possible to differentiate between two basic types of smart card based upon their internal functionality: the memory card and the microprocessor card. In memory cards the memory is accessed using a sequential logic (state machine). Microprocessor cards contain a microprocessor connected to a segmented memory.

13.2.1.2 General Requirements and Constraints for AutoID in Maritime Environments

General requirements and constraints for AutoID technology components in maritime environments arise from the different needs and requirements of equipment manufacturers and operators, Notified Bodies and port authorities.

In particular, the contemplated usage of products in harsh maritime environments implies meeting further product-relevant requirements. The following Table 4 gives a general overview about the assessment of further influences on the products and tags.

Class of influences	**Influences**
atmospheric, weather related conditions	humid salty sea air, rain, fog salty water, spray water, standing water, steam snow, ice, frost salt solar radiation
thermic conditions, temperature range (Remark: matter of discussion during the workshops)	operating temperature range: -30°- +150° C storage temperature range: -30°- +50° C
mechanical conditions	hit impacts vibrations pressure friction rolling (ocean waves)
chemical conditions	oil detergents, cleansers lubricants acids leaches alcohol tensids solvents, solutions
electromagnetic conditions	reflecting/electrically conducting surfaces absorbing materials radio frequency spectrum, electromagnetic noise, electrostatic discharges
other	non-line of sight (los) readability
other	tag size(s) for the application on different objects

Table 4: Definition of operator requirements

13.2.1.3 Preliminary Assessment and Selection of Appropriate General Technologies

The AutoID technologies differ in their basic characteristics, which makes them more suitable or less suitable for the intended purpose of providing unique identification of maritime equipment. A comparison of the basic capabilities of the different auto-ID technologies, as included in Table 5, shows the particular suitability of either barcode or RFID technologies.

System parameters	1D Barcode	2D Barcode	OCR	Biometry	Voice recognition	Smart card	RFID systems
typical data quantity (bytes)	1–100	10-~5 k	1–100	–	–	16–64 k	16–64 k
data density	medium	medium	Low	High	High	Very high	Very high
machine readability	Good	Good	Good	Expensive	Expensive	Good	Good
readability by people	Limited	Limited	Simple	Difficult	Simple	Impossible	Impossible
influence of dirt/damp	high	high	Very high	–	–	Possible (contacts)	No influence
influence of (optical) covering	Total failure	Total failure	Total failure	Possible	–	–	No influence
influence of direction and position	Low	Low	Low	–	–	Unidirectional	No influence
degradation/wear	Limited	Limited	Limited	–	–	Contacts	No influence
purchase cost/reading electronics (rough cost estimations are given in chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**)	Very low	Very low	Medium	Very high	Very high	Low	Medium
operating costs (e.g. printer)	Low	Low	Low	None	None	Medium (contacts)	None
unauthorized copying/modification	Slight	Slight	Slight	Impossible	Possible* (audio tape)	Impossible	Impossible
reading speed (including handling of data carrier)	Low ~4 s	Low ~4 s	Low ~3 s	Very low >5–10 s	Very low >5 s	Low ~4 s	Very fast ~0.5 s
maximum distance between data carrier and reader	0–50 cm	0–50 cm	<1 cm Scanner	Direct contact**	0–50 cm	Direct contact	HF. 0-1 m, UHF: 0–12m, 0-100 m (microwave, active systems)
Overall assessment	✓	✓	✓	✗	✗	✗	✓

* The danger of 'replay' can be reduced by selecting the text to be spoken using a random generator, because the text that must be spoken is not known in advance.

** This only applies for fingerprint ID. In the case of retina or iris evaluation direct contact is not necessary or possible.

✓ very suitable

✓ suitable, but with limitations in particular in comparison with other technologies

✗ not suitable

Table 5: Comparison of different RFID systems showing their advantages and disadvantages[17]

Based on the listed characteristics, in particular the reading distances as well as the influences of dirt, of direction and position and of optical covering, the identification

[17] Finkenzeller, K. (2010): RFID Handbook - Fundamentals and Applications in Contactless Smart Cards, Radio Frequency Identification and Near-Field Communication. Third Edition, Giesecke & Devrient GmbH, Munich, Germany, p. 7. Summary assessment (last line) added by authors of this report.

technologies OCR, biometry, voice recognition, and smart cards can be considered to be insufficiently suited to application with marine equipment. Consequently, they will no longer be considered in this report. Barcode and RFID technologies in turn can be rated as well suited for marine equipment and will be considered in more detail in this report. Depending on their power supply, transponders may be either active or passive. Considering RFID systems, active transponders need to incorporate a battery or a solar cell, which supplies all or part of the power for the operation of a microchip. As the power supply needs regular replacement (in case of battery) or at least regular check (in case of solar cells), active transponders are not well suited to marine equipment and are no longer considered in this report.

Microwave systems have a significantly higher range than inductive systems, typically 2–15 m. However, in contrast to inductive systems, microwave systems require an additional backup battery. The transmission power of the reader is generally insufficient to supply enough power for the operation of the transponder.

13.2.1.4 Detailed Options and Implications for Selected Technologies

This section provides more details on the two technologies selected as the potentially most suitable technologies: passive UHF-RFID transponders and matrix (two-dimensional) barcodes.

13.2.1.4.1 Passive UHF-RFID

An Active Reader Passive Tag RFID system has an active reader, which transmits interrogator signals and receives authentication replies from passive tags.

The required range of an application is dependent upon several factors:

- positional accuracy of the transponder;
- minimum distance between several transponders in practical operation; and
- speed of the transponder in the interrogation zone of the reader.

Passive UHF-RFID transponders are produced and used in many different varieties, differing in many important properties. Some different properties of such transponders are listed in Table 6.

Aspect	Options
protection classes	IP66: Dust tight, Powerful water jets IP67: Dust tight, Immersion up to 1 m IP68: Dust tight, Immersion beyond 1 m IP69K: Dust tight, Powerful high temperature water jets
temperature resistance	Operating temperature: - 50°C up to 100°C Storage temperature: up to 240°C for 30s

Aspect	**Options**
materials	polyamide PVC PPS + epoxy PVC, OEM stainless steel fiberglass FR4 copper/polyimide (CU/PI) silicon poly-oxymethylene glass acrylonitrile butadiene styrene (abs) aluminium and polymer polypropylene
designs	disk disk sticker tag disk with hole disk with 2 holes screw dry inlay wet inlay smart card rod smart label glass rod key fob coin tag half lens form
dimensions	L/⌀: 2,6mm-126mm, H: 0,5mm-22mm L/⌀: 3,15mm, W: 13,3mm
mounting	self-adhesive magnetic screws or rivets zip-ties wire sticky foam
environment	readable in wet environments shock resistant resistant against chemicals screwable in metal

Table 6: Alternative characteristics of transponders

Transponders with different properties may be chosen for different products or applications within the tagging of maritime equipment.
Transponders must be resistant against different environmental conditions. These conditions may be challenging or even haphazard. Protection classes are standardised. A transponder is safeguarded, so they will not destroy it or hinder its functional performance. More information on different tag protection classes and the kind of protection they offer is provided in Table 7:

Protection classes			
IP66	Dust tight	Powerful water jets	can be installed in Ex zones 1, 2, 21 and 22
IP67	Dust tight	Immersion up to 1 m	suited for outdoor use can be used in Ex zones 0, 1, 2, 20, 21 and 22
IP68	Dust tight	Immersion beyond 1 m	suited for outdoor use
IP69K	Dust tight	Powerful high temperature water jets	suited for outdoor use

Table 7: Tag protection classes

Transponders belonging to different protection classes may be needed for different applications within the tagging of maritime equipment.

Standards

Relevant standards for UHF-RFID transponders have been issued by following standardization bodies:

- International Organization Standards (ISO),
- International Electrotechnical Committee (IEC).

ISO/IEC 18000 is an international standard that describes a series of diverse RFID technologies, each using a unique frequency range. The standard consists of several different parts, under the general title Information technology — Radio frequency identification for item management. The various parts of ISO/IEC 18000 describe air interface communication at different frequencies in order to be able to utilize the different physical behaviours. The various parts of ISO/IEC 18000 are developed by ISO/IEC JTC1 SC31, "Automatic Data Capture Techniques". The most important parts of this report are the following:

ISO/IEC 18000 Part 1: Reference architecture and definition of parameters to be standardized.

ISO/IEC 18000 Part 6: Parameters for air interface communications at 860 MHz to 960 MHz.

ISO/IEC 18046 defines performance test methods.

ISO/IEC 18047 in its corresponding parts conformance test methods for the various parts of ISO/IEC 18000.

Appropriate Carrier

The primary function of the transponder's carrier and housing is to ensure cohesion of the various components, such as antenna and chip. However, the use of certain

materials may also protect against external influences and increase, for example, insulation from metal influences. In addition, the housing may consciously enlarge the transponder to achieve, for example, better capacities for assembly. The antenna is the largest transponder component and determines its size. Different transponder carrier forms are listed in Table 8:

Carrier form	**description**	**Rating (comments)**
disks and coins	The transponder is housed in a round (ABS) injection moulded housing; Alternatively, polystyrol or even epoxy resin may be used to achieve a wider operating temperature range. The diameter of disks/coins is ranging from a few millimetres to 10 cm. Usually contains a hole for a fastening screw in the centre.	✓ e.g. suitable for: • A1/3.3 Fire fighter's outfit: protective clothing • A.1/1.4 Lifejackets
glass housing	Used for identification of animals or further processing into other construction formats. Glass tubes contain a microchip mounted upon a carrier (PCB) and a chip capacitor to smooth the supply current obtained. The transponder coil incorporates wire of 0.03mm thickness wound onto a ferrite core. The internal components are embedded in a soft adhesive to achieve mechanical stability. Length of glass tubes normally in range 12–32mm	✗ / ✓
plastic housing	For applications involving particularly high mechanical demands. Plastic housings can easily be integrated into other products. Greater functional range than glass housings; ability to accept larger microchips and greater tolerance to mechanical vibrations.	✓ e.g. suitable for: • A.1/1.17a Lifeboats • A.1/1.32 9GHz SAR transponder
inductively coupled transponders in metal surfaces	The transponder coil is wound in a ferrite pot core. The transponder chip is mounted on the reverse of the ferrite pot core and contacted with the transponder coil. In order to obtain sufficient mechanical stability, vibration and heat tolerance, transponder chip and ferrite pot core are cast into a PPS shell using epoxy resin.	✓ e.g. suitable for: • A.1/3.16 Fire doors • A.1/3.22 Fire dampers • A.1/1.17a Lifeboats

Carrier form	**description**	**Rating (comments)**
smart labels	Paper-thin transponder format. The transponder coil is applied to a plastic foil of just 0.1mm thickness by screen printing or etching. The foil is often laminated using a layer of paper and its back is coated with adhesive. Smart labels are thin and flexible enough to be stuck to luggage, packages and goods of all types. They are normally supplied in the form of self-adhesive stickers on an endless roll.	/ e.g. suitable for: • A.1/4.1 Magnetic compass • A.1/4.14 GPS equipment
coil-on-chip	Integration of the coil onto the chip is made possible by a special micro galvanic process that can take place on a normal CMOS wafer. The coil is placed directly onto the isolator of the silicon chip. Extreme miniaturisation of transponders is possible using coil-on-chip technology. The size of the entire transponder is just 3 x 3mm. The transponders are frequently embedded in a plastic shell and are among the smallest RFID transponders available.	

Legend:

	very suitable
	suitable, but with limitations in particular in comparison with other devices
	not suitable

Table 8: Transponder carrier forms[18]

[18] Finkenzeller, K. (2010): RFID Handbook - Fundamentals and Applications in Contactless Smart Cards, Radio Frequency Identification and Near-Field Communication. Third Edition, Giesecke & Devrient GmbH, Munich, Germany, pp. 13-21.

Possible dimensions

The approximate dimensions of the different transponder carrier forms are compared in Table 9:

Carrier form	**Dimensions (diameter x height or length x width x height)**	**Rating (comments)**
disks and coins	diameter of disks/coins: few mm - 1 0 cm height of disks/coins: few mm – 1 cm	✓
glass housing	length of glass tubes: 12–32mm diameter of glass tubes: 1-5 mm	✓
plastic housing	Length, width: e.g. 12 x 6 mm Height: 3 mm	✓
inductively coupled transponders in metal surfaces	diameter of disks/coins: few mm height of disks/coins: less than 1 mm	✓
smart labels	Length, width: a few cm each thickness of plastic foil: ~ 0.1mm	✓
coil-on-chip	Length, width: ~3 x 3mm thickness of plastic foil: ~ 0.1mm	Still rarely used, so that no rating is available

Legend:

✓	very suitable
✓	suitable, but with limitations in particular in comparison with other devices
✗	not suitable

Table 9: Approximate dimensions of different transponder carrier forms

Permanent mounting options

Transponders of normal sizes can be mounted in several permanent or removable ways. The mounting options applicable to RFID transponders are compared in Table 10.

method	conditions	benefits	rating/comments
gluing	clean prepared surface	fast, cheap	✓ according to scenario, high requirements on adhesive material; high risk atmospheric or weather related failure
riveting	sufficient area for receiving the transponder and the ability to bore holes	removal difficult	✓ drillings necessary within object; special tools necessary for mounting; disassembly is difficult; drillings may foster corrosion
screws	sufficient area for receiving the transponder to the bore and the possibility of Holes and optionally introduction of threads must be given	easy disassembly removal impossible without tools	✓ drillings necessary within object; drillings may foster corrosion
hooking	sufficient surface for receiving the transponder and the possibility for attachment appropriate holder must be given	flexible use multiple use of transponders	✗ no fixed mounting high risk of loss removable without tools
inserting	sufficient surface for receiving the transponder and the possibility for attachment a tab must be added	flexible use multiple use of transponders	✗ no fixed mounting high risk of loss removable without tools
magnetic fixing	sufficient space for accommodating the transponder as well as a magnetic Substrate must be added	flexible use multiple use of transponders	✗ mounting possible only on magnetic substrates high risk of loss removable without tools

Legend:

✓	very suitable
✓	suitable, but with limitations in particular in comparison with other devices
✗	not suitable

Table 10: Transponder mounting methods

With respect to the durable lifelong usage of transponders on the product, a later implementation guideline could request for permanent mounting options.

Scenarios of counterfeiting

Attacks on RFID transponders (cf. Figure 23) can occur due to the following reasons:[19]

- Spying out: The attacker tries to get unauthorized access to information and data of the active and passive file.
- Deception: The attacker tries to feed incorrect information into the RFID system in order to deceive the active party, i.e. the RFID system operator, or the passive party, i.e. the user of the RFID system.
- Denial of service: This kind of attack affects the availability of functions of the RFID system.
- Protection of privacy: The attacker considers the RFID system to be a threat to her privacy and tries to protect herself with attacks on the RFID system.

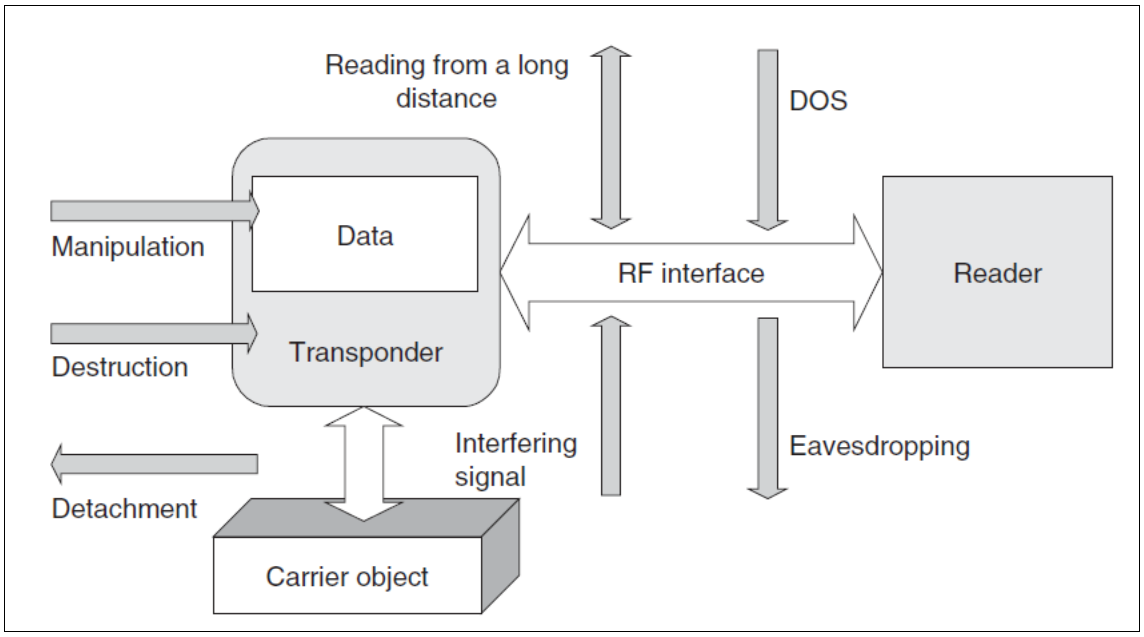


Figure 23: Some attack options on RFID systems[20]

[19] Finkenzeller, K. (2010): RFID Handbook - Fundamentals and Applications in Contactless Smart Cards, Radio Frequency Identification and Near-Field Communication. Third Edition, Giesecke & Devrient GmbH, Munich, Germany, p. 215.

[20] Rikcha (2004): Risiken und Chancen des Einsatzes von RFID-Systemen, Studie des Bundesamtes für Sicherheit in der Informationstechnik in Zusammenarbeit mit dem Institut für Zukunftsstudien und Technologiebewertung (IZT) und der Eidgenössischen Materialprüfungs- und Forschungsanstalt (EMPA),November

Often transponders are physically accessible to attackers and can be attacked by varying methods or with varying objectives. Potential attacks and countermeasures are listed in Table 11:

Type of attack	**Description**	**Countermeasures**
mechanical or chemical **destruction**	The antenna can be easily severed or cut off, for instance. The chip can be easily snapped or smashed.	protected or resistant carrier and mounting
skimming	Removal of a transponder in order to clone and/or modify data.	non-removable mounting of transponders
cloning of read-only transponders	The attacker can replace the PROM containing a read-only transponder's serial number with a multi-programmable memory (EPROM) and program this serial number into the transponder clone. The transponder clone can send the serial number previously read out from the genuine transponder and thus pretend the presence of this genuine transponder to the reader. The reader is not able to determine whether the currently received serial number was sent by a genuine transponder or a transponder clone. The attacker does not have to have physical access to the transponder, but only needs to use a suitable reader in order to enter the read range of the transponder to be cloned, without being detected.	Protection by Cryptographic Measures: • Mutual Symmetrical Authentication between reader and transponder via three-pass mutual authentication, in which both participants in the communication check the other party's knowledge of a secret cryptologic key. • Authentication using Derived Keys: Each transponder is secured with a different cryptologic key. A key is calculated using a cryptologic algorithm based on the serial number of the transponder and a master key, and the transponder is thus initialised. Each transponder thus receives a key linked to its own ID number and the master key.
cloning re-writable transponders	If the memory sections of a transponder can be read or written without any restrictions, i.e. without requiring a password or key, an attacker can manipulate stored data for his personal advantage or produce copies of the attacked transponder by reading data and copying them to other transponders. Cloning of transponders can be efficiently prevented by using authentication and encrypted data transmission.	Encrypted Data Transfer: During the writing or re-writing process, the transmission data (plain text) is transformed into cipher data (cipher text) using a secret key and a cryptographic algorithm. Without knowing the encryption algorithm and the secret key K a potential attacker is unable to interpret the recorded data. It is not possible to recreate the transmission data from the

Type of attack	Description	Countermeasures
eavesdropping	As RFID systems communicate with electromagnetic waves, systems can be generally intercepted with very basic means and the data replayed in order to imitate a genuine data carrier (‘replay and fraud’).	cipher data.

Table 11: Potential attacks on RFID transponders and countermeasures

13.2.1.4.2 Data Matrix

As already mentioned, two-dimensional (2D) barcodes use geometric patterns in two dimensions, like e.g. rectangles, dots, or hexagons, to code information, so it can represent more data per unit area. The most relevant matrix barcodes are Aztec, Data Matrix, QR-Code and PDF 417, ECC200 and GS1 Data Matrix. An overview of different two-dimensional barcodes (or matrix barcodes) is given in Table 10:

2d barcode	Example symbol	Most relevant standard(s)	Description/comments
Aztec		ISO/IEC 24778:2008	Potential to use less space than other matrix barcodes as no surrounding blank "quiet zone" required
Data Matrix		ISO/IEC 16022:2006—Data Matrix bar code symbol specification	ability to encode fifty characters in a symbol readable at 2 or 3 mm² code can be read with only a 20% contrast ratio highly scalable (300 micro meters (laser etched) to 1 meter square)
QR-Code		ISO/IEC 18004	developed by Toyota subsidiary Denso Wave Can encode music, images, URLs, emails most frequently used type to scan with smartphones
PDF 417		ISO 15438	stacked linear barcode

Table 12: Overview of different two-dimensional barcodes

Aztec Code is a type of 2D barcode that was published by AIM, Inc. in 1997 and is public domain. Aztec code has the potential to save space, as it does not require a surrounding blank "quiet zone". The symbol is built on a square grid with a bulls-eye pattern at its centre for locating the code. Data is encoded in concentric square rings around the bulls-eye pattern. The central bulls-eye is 9×9 or 13×13 pixels, and one row of pixels around that encodes basic coding parameters, producing a "core" of 11×11 or 15×15 squares. Data is added in "layers", each one containing two rings of pixels, giving total sizes of 15×15, 19×19, 23×23, etc.

The corners of the core include orientation marks, allowing the code to be read if rotated or reflected. Decoding begins at the corner with three black pixels, and proceeds clockwise to the corners with two, one, and zero black pixels. The variable pixels in the central core encode the size, so it is not necessary to mark the boundary of the code with a blank "quiet zone", although some bar code readers require one.

Additional capabilities that differentiate ECC 200 symbols from the earlier standards include inverse reading symbols (light images on a dark background), a specification of the character set (via Extended Channel Interpretations), rectangular symbols and structured append (linking of up to 16 symbols to encode larger amounts of data).

QR-Code (Quick Response Code) was developed by Denso Wave in 1994. QR-Code is a quadratic matrix code including three corner marks, which can be read even if up to 30% of the mark has been destroyed. QR-Code's (177x177 elements, with error correction level „L") allows to code up to 2953 Byte or 4296 ASCII signs (with 7 Bit per sign).

PDF417 is a stacked linear barcode symbol format used in a variety of applications, primarily transport, identification cards, and inventory management. PDF stands for Portable Data File. The 417 signifies that each pattern in the code consists of 4 bars and spaces, and that each pattern is 17 units long. A symbol consists of 3 to 90 rows, each of which is like a small linear bar code. Each row includes a quiet zone (a mandatory minimum amount of white space before the bar code begins), a start pattern which identifies the format as PDF417 and a "row left" codeword containing information about the row (such as the row number and error correction level). These are followed by 1-30 data codewords: Codewords are a group of bars and spaces representing one or more numbers, letters, or other symbols. The row ends with a "row right" codeword with more information about the row, a stop pattern and another quiet zone.

PDF417 uses a base 929 encoding. Each codeword represents a number between 0 and 928 inclusive. The code words are represented by patterns of dark (bar) and light (space) regions. Each of these patterns contains four bars and four spaces (where the 4 in the name comes from). The total width is 17 times the width of the narrowest allowed vertical bar (the X dimension); this is where the 17 in the name comes from. Each pattern starts with a bar and ends with a space. All rows are of the same width; each row has the same number of code words. Of the 929 available codewords, 900 are used for data, and 29 for special functions. Three different encoding schemes are defined and can be mixed as necessary within a single symbol:

- Text: each codeword represents one or two characters.
- Byte: each group of 5 codewords represents 6 bytes.
- Numeric: groups of up to 15 codewords represent as many as 44 decimal digits.

GS1 Data Matrix is a two-dimensional (2D) matrix barcode which may be printed as a square or rectangular symbol made up of individual dots, cells or squares. This representation is an ordered grid of dark and light dots bordered by a finder pattern. The finder pattern is partly used to specify the orientation and structure of the symbol. The data is encoded using a series of dark or light dots based upon a pre-determined size. The size of these dots is known as the X-dimension.

ECC 200 is the newest version of Data Matrix and uses Reed-Solomon codes for error and erasure recovery. ECC stands for Error Checking and Correcting. ECC 200 allows the routine reconstruction of the entire encoded data string when the symbol has sustained 30% damage, assuming the matrix can still be accurately located. Data Matrix has an error rate of less than 1 in 10 million characters scanned.

Symbols have an even number of rows and an even number of columns. Most of the symbols are square with sizes from 10×10 to 144×144. Some symbols however are rectangular with sizes from 8×18 to 16×48 (even values only). All symbols utilizing the ECC 200 error correction can be recognized by the upper right corner module being the same as the background colour (binary 0).

Standards

A comprehensive set of matrix barcode related standards has been issued by following standardization bodies:

- American National Standards Institute (ANSI),
- International Organization Standards (ISO),
- International Electrotechnical Committee (IEC).

The most relevant standards for Data Matrix barcodes are listed in Table 13:

standard	**Topic, description**
ANSI MH10.8.6	Bar Codes and Two-Dimensional (2D) Symbols for Product Packaging
ANSI X12.3	Data Element Dictionary
ISO/IEC 16022:2006	Data Matrix bar code symbology specification
ISO/IEC 15415	Information Technology – Automatic Identification and Data Capture Techniques – Bar Code Print Quality Test Specification – Two-Dimensional Symbols (2-D Print Quality Standard)
ISO/IEC 15416	Information Technology – Automatic Identification and Data Capture Techniques - Bar Code Print Quality Test Specification – Linear Symbols
ISO/IEC 15418:2009	Information Technology - Automatic Identification and Data Capture Techniques - Symbol Data Format Semantics (GS1 Application Identifiers and ASC MH10 Data Identifiers and maintenance)
ISO/IEC 15424:2008	Information Technology - Automatic Identification and Data Capture Techniques - Data Carrier Identifiers (including Symbology Identifiers) [IDs for distinguishing different bar code types]
ISO/IEC 15434:2006	Information Technology – Automatic Identification and Data Capture Techniques - Syntax for high-capacity ADC media (format of data transferred from scanner to software, etc.)
ISO/IEC 15438	Information Technology - Automatic Identification and Data Capture Techniques - Bar Code Symbology Specification – PDF417
ISO/IEC 15459	Information Technology - Automatic Identification and Data Capture Techniques - Unique Identifiers
ISO/IEC 16022:2006	Information technology -- Automatic identification and data capture techniques -- Data Matrix bar code symbology specification

standard	Topic, description
ISO/IEC 16388	Information Technology - Automatic Identification and Data Capture Techniques - Bar Code Symbology Specification – Code 39
MHIA MH10.8.1	Linear Bar Code and Two-Dimensional Symbols Used in Shipping, Receiving, and Transport Applications
MHIA MH10.8.2	Data Application Identifier Standard
GS1 Data Matrix Guideline	Overview and technical introduction to the use of GS1 Data Matrix. Release 2.2.1, Ratified, July 2015

Table 13: relevant standards for Data Matrix barcode

Appropriate Carrier and placement of the mark

In the most general terms, it is required that a Data Matrix applied to an object fulfils the following minimal conditions[21]:

- remains readable throughout the object's normal life cycle.;
- withstands all environmental conditions to which the object will be exposed under normal operating conditions; and
- does not damage or detriment the functional performance, reliability, or durability of the object.

These minimal conditions should guide the selection of appropriate carriers for the Data Matrix barcodes. In terms of the carrier of the mark, the most important distinction is between non-intrusive marking and intrusive marking.

Non-intrusive marking methods add material to the surface of the item. These material additions can be applied either directly, e.g. by stencilling, laser bonding, or direct ink jet, or indirectly in form of a label or data plate. An intrusive marking method either deforms or removes material from the surface of the item. Methods include dot peening, stamping, abrading, scribing, or etching.

Generally, non-intrusive marking methods should be applied, unless intrusive marking is specifically authorized by quality assurance, safety, and engineering competencies of the relevant program. Often, labelling will be the easiest and cheapest method to implement. However, to determine the best marking solution for a specific type of equipment, many factors about the item to be marked should be considered. These include the function the item has to fulfil and the environment in which the item is stored or operated, the available marking area, material type, colour and mechanical properties of the material (like hardness, surface roughness/finish or surface thickness).

Placement of the Mark: Where the mark is placed on the item strongly influences the mark's durability and usefulness. Therefore, when determining where to place the

[21] Compare for the analogous minimal requirements set up by: Department of the Navy: Item Unique Identification (Iuid) Marking Guide: Applying Data Matrix Identification Symbols to Legacy Parts.

mark, many aspects should be considered. Some useful general advice for placement of marks may be given as follows[22]:

- Apply marks in protected areas, when possible.
- Apply marks on flat areas when possible.
- The mark should be readable when the marked item is in-service.
- The mark should be readable when the marked item is stowed.
- Multiple identical marks can be applied to the same item.

Unless directed to the contrary by the technical authority, marks/labels should not be placed on the following item parts or surfaces:

- On components or pieces authorized to be replaced during field maintenance.
- Over vents and/or air intakes.
- Over other information.
- Covering windows, view ports, access ports, or fastener holes.
- Over seams between separable pieces of the item.
- In direct air streams (for example, leading edge of wings, helicopter rotors, exposed portions of turbine blades, and so forth).
- On sealing surfaces.
- On wearing surfaces.
- Near high heat sources.
- Over lenses, optics, or sensors.
- On surfaces with dimensional tolerance requirements.
- On precision cleaned parts in hermetically sealed packaging.

Other placement considerations become important in specialized circumstances, such as when marking curved, rough, or shiny surfaces or marking items that are sensitive to electrostatic discharge. Many placement considerations stem from a technical understanding of how 2D barcode readers (scanners) decode symbols as well as understanding efforts taken to maximize the reliability of decoding the Data Matrix. For information about mark placement on curved, rough, or irregularly shaped items see [22].

[22] Compare for the analogous advice for placement of marks in: Department of the Navy: Item Unique Identification (Iuid) Marking Guide: Applying Data Matrix Identification Symbols to Legacy Parts.

Scenarios of counterfeiting

Barcodes (in particular two-dimensional barcodes), when applied as labels, can be destroyed or detached from the object to be identified. When using labels, in contrast to direct part marking, the obstacles for reproducing unauthorized pirated copies of products are low, because counterfeiting of tags is simple. While protection against removal of label marks, or replacement by unauthorized marks is very difficult, a minimal level of protection may be achieved by following the advice given in the sections on data carriers and placement of marks, or in the section on printing options in chapter 13.2.2.

The reading process itself can be seen as relatively unattractive for attacks. However, using backend IT systems for providing further information and making validation of possible codes and their conformity to the predefined code scheme could be of interest.

13.2.1.5 Assessment of Compliance and Legal Aspects in the Maritime Domain

Legal aspects arise from different categories and lead to exemplary questions which have to be analysed and answered in the following. An overview, including exemplary legal questions that have been identified so far, is provided by the following Table 14:

Category	**Exemplary questions**
certification of tags	According to the European databases[23], RFID transponders do not need to have a CE marking, so they are standardized against the ISO norm for the tag and the particular air interface. Standards apply in case transponders meet particular requirements for explosive environments, heat, etc. For instance, there are respective protection class that transponders have to fulfil. • What standards need to be applied for maritime equipment? Need transponder be certified according to MED? Do transponders for marking different types of equipment must fulfil different standards or standards?
certification of readers	Although readers (essentially mobile readers) do not need to be operated at sea (i.e. normally they will be operated just at ports) it is important to make sure that typical CE marking of devices is sufficient for operation according to MED. Relevant standards for CE in Europe are for instance: • ETSI EN 301 489-1 V. 1.9.2:2011 • ETSI EN 301 489-3 V. 1.6.1:2013 • ETSI EN 301 489-17 V. 2.2.1:2012 • ETSI EN 302 208-2 V. 1.4.1:2011 • ETSI EN 300 328 V1.9.1:2015 • CEI EN 60950-1:2007 + VAR • CEI EN 50364:2011 • CEI EN 55022:2014. Relevant standards for FCC are also respected by the most available readers on the market. • Are applied standards sufficient for maritime equipment? Need reader be recertified according to MED?
data privacy	With respect to the implementation of a complete market surveillance system based on electronic tags: • Which data privacy standards have to be respected?

Table 14: General legal aspects

[23] Cp. http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:31999L0005 or http://www.newapproach.org/ProductFamilies/Keywords.asp

13.2.1.6 Conclusion and Recommendation for Action

With respect to the investigation of the basic characteristics of different AutoID technologies in conjunction with the consultation of stakeholders at the workshop held 17/12/2015 in Bremen and 31/05/2016 in Brussels, the findings can be concluded as follows:

For the reliable automated reading of information on MED items by using electronic devices, the technologies have to show

- Robustness against mechanical and environmental influences,
- Good reliable reading rates,
- Correction algorithms essentially in case of optical codes to overcome dirt or small damages on the code,
- Reliable readings in an appropriate reading distance of 1 to 2 meters essentially in the case of RFID.

Based on the consultation results two technologies can be prioritized. First the implementation of **reliable, passive and standardized UHF RFID** tags that are relatively cheap, interoperable with different tags and readers, available from a broad selection of manufacturers. As a substitution or supplement, also 2D optical codes can be recommended. To be more precise, **Data Matrix** is proposed due to higher acceptance in the industry, license free usage possibilities and better correction algorithms. These systems are different from the technical perspective and accordingly at least one option fits to the requirements of the different MED items. Furthermore, from the logical data perspective, both technologies are interoperable and both are able to link and interface further databases using the same semantics of the code.

13.2.2 Tag Interrogators (readers), Interface Protocols & Registrations of the Reading Events

Reading devices are relevant technical systems to decode information on data carrier. They generally must fit to the selected technology in terms of supporting the interface protocols. This is true for optical techniques as well as for electronical ones. The following overview characterizes (per technology) the general reader properties and common designs. Furthermore, technical limitations are discussed.

13.2.2.1 Barcode and Data Matrix Technology

Reading devices

Barcode and Data Matrix are established technologies. Thus, a broad selection of reading devices is available for the most common code types. Regarding the handling of devices one can distinguish between mobile and stationary readers, which can be further divided into categories as depicted in the following Figure 24:

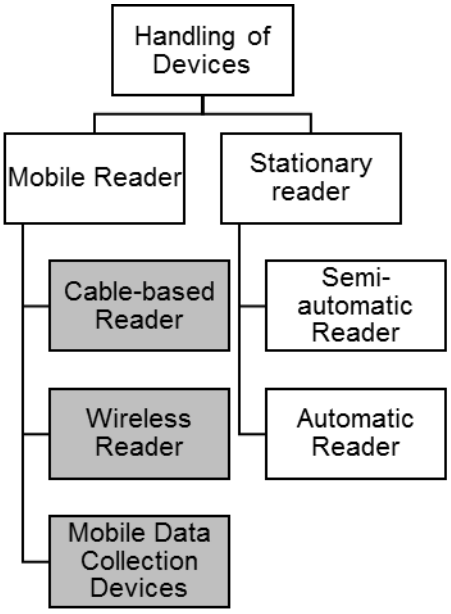


Figure 24: Classification of optical reading devices based on their handling options

Regarding the application in maritime environments, the following handling options seem feasible:

- Cable-based mobile readers, e.g. as a supplement to notebooks (USB device or similar).
- Wireless readers, e.g. as a supplement to notebooks via radio such as WLAN/Bluetooth.
- Mobile Data Collections Devices with integrated computing power for running applications (e.g. smartphone, industrial MDEs).

In addition, readers can be distinguished concerning the basic technologies which are used to actually scan the black and white parts of the code. First, there are laser-based scanners and sensor-based scanners. While laser scanners are line scanners and as such used for 1D barcodes, sensor scanners can be further divided into line scanners and matrix scanners (see Figure 25). Matrix scanners are required for 2D codes such as Data Matrix.

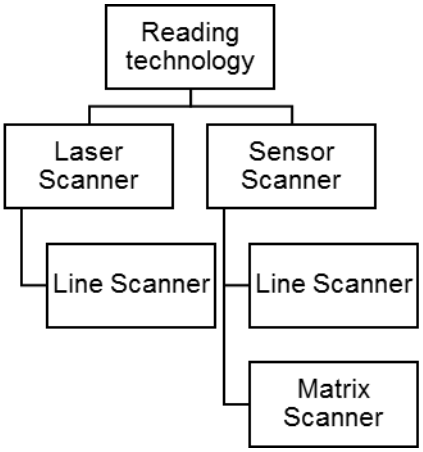


Figure 25: Classification of optical reading devices according to their basic reading technology

In general, all technologies are applicable on the previous selected mobile devices of interest. Image-based Matrix Scanners are more favourable in terms of costs and robustness as well as applicability for 2D codes. The following three options promise to be most suitable for the application domain considered here.

Professional mobile readers (laser based technology)

Mobile readers are available in several types and from several manufacturers. The housings are robust and available in protection classes for harsh environments (e.g. IP 65), especially when they are integrated mobile data collection devices. Most professional reader run Windows CE or Windows Embedded and provide a Software development kit for the development of special application that run directly on the device.

Cable-based or wireless systems that are linked with a PC provide a keyboard interface or a Software Development Kit so that they can be easily integrated into new or existing applications.

The laser-based technology uses a distracted laser to query the light and dark parts of a 1D code. The resolution is generally very good so that also codes with much information can be read with laser scanner. The technology comprises moving parts for the laser sampling which are weak in comparison with sensor based technology.

Professional mobile reader (sensor based technology)

As for the laser based technology, professional mobile reader with imaging sensors are available in different versions from different manufacturer. The handling is similar to that of the above-mentioned systems. However, no moving parts weaken the equipment. The line scanner based on sensor technology, also referred to as CCD (charge-coupled device) scanner, lose market share as imaging sensors are a cost-effective alternative which also allow the scanning of 2D codes such as Data Matrix and QR. In most cases, systems are cheaper compared to laser technology. Regarding the possible scanning resolution, long 1D code, such as Code 128, could pose difficulties for fast and reliable scanning.

State-of-the-art smartphones

The camera systems of modern smartphones independent from the operating system (i.e. iOS, Android and Windows Phone) enable the scanning and decoding of 1D and 2D barcodes with general barcode apps or with embedded functions in specialized domain-specific apps. As decoding is a software-based function there are no limits regarding the encoding standards, anyway most common are EAN, Code 128, Interleaved, QR-Code and Data Matrix.

The reading capabilities with respect to reading rates are acceptable which means that today's smart phone devices can handle decoding of codes even under difficult circumstances like low light or missing contrast. However, determined by the underlying imaging technology there is a much better performance on 2D barcodes like QR and Data Matrix.

While smartphones mainly focused on using Auto-ID for marketing activities, in industrial environments it is already used for a backup solution in contrast to industrial readers and for users that are not regularly considered with scanning activities such as shop floor managers or quality managers. Applied to the application scenario considered in this report, smartphones promise to be adequate devices for market surveillance or sporadic inspections.

Reading performance of different standard coding schemes

The following Table 15 gives an overview about most common code schemes their relation to the expected reading performance of different scanner technologies:

Code	Laser-based	Sensor-based		Smart Phone
	Line Scanner	Line Scanner	Matrix Scanner	
Code 39 	✓	✓	✓	✓
Code 2/5 Interleaved 	✓	✓	✓	✓
Code 128 	✓	✓	✓	✓ / ✗
EAN-13 	✓	✓	✓	✓
Aztec 	✗	✗	✓	✓
Data Matrix 	✗	✗	✓	✓
QR-Code 	✗	✗	✓ / ✓	✓
PDF 417 	✗	✗	✓	✓

Legend:

✓	very suitable
✓	suitable, but with limitations in particular in comparison with other devices
✗	not suitable

Table 15: Reading performance of different standard coding schemes

Printing options and durability of tags in relation to reading rates

With respect to the application domain considered in this document, an assumption contains individual labels. This means that printing of codes should be done online in-process, so that individual tags with unique numbering are created. The general printing options are presented in the following Table 16:

Printing method	Applicability	Comments
Direct thermal printing		Most labels are paper-based and accordingly not applicable for harsh environments. Moreover, papers are heat-sensitive.
Thermal transfer printing		Most labels are paper-based and accordingly not applicable for harsh environments. There are some special providers for very durable tags on the market.

Table 16: Printing options and applicability for maritime environments

Direct Part Marking (DPM) describes the permanent identification of components. This includes the direct linkage between material and information for different purposes:

- production planning and control,
- quality management,
- after sales service,
- traceability,
- protection against plagiarism.

The methods used for Direct Part Marking are listed in Table 17:

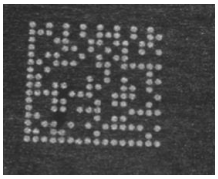
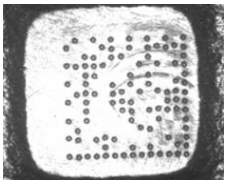
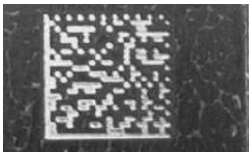
DPM method	Example	Costs/Comments
Inkjet printing		Moderate costs, but comparably less durable
Dot peen marking		Higher costs, expensive equipment, applicable for metals only
Laser marking		Higher costs, but equipment costs fall, applicable for metals and plastics

Table 17: Direct Part Marking methods

13.2.2.2 LF RFID Technology

The most common application domains for LF RFID systems are animal identification, electronic immobilizer in cars and some industrial applications mainly with fixed readers. With respect to these examples, mobile reading devices applicable for the maritime domain can be rarely found. The market is declining.

Readers/client interface requirements

The LF technology uses frequencies from 30–500 kHz. Reading distances have a maximum of 1 meter while most of the application just show distances of a few centimetres. There are different communication standards and proprietary protocols common. LF systems are relatively insensitive with respect to metal and water.

Reading devices

Professional mobile LF readers are available, but there are relatively few suppliers and products on the market.

13.2.2.3 HF RFID Technology

RFID in the HF band at 13.56 MHz is a worldwide standard (according to ISO/IEC 14443). Due to that a huge amount of different transponder types, smart labels and reading devices is available and interchangeable.

Readers/client interface requirements

The most common and standardized readers operate according to ISO/IEC 14443 at 13.56 MHz and show reading ranges up to 2 meters (depending on the hardware). Compared to UHF systems, reading ranges are less. Moreover, bulk reading is possible and data transfer rate are acceptable for most standard applications. The reader air interface is weak with respect to metal environments.

Reading devices

With respect to the handling of reading devices, mobile solutions are in focus. Professional mobile HF readers are available, either wired or wireless systems as a complement to notebooks or as integrated MDE. The reader modules are normally operated by the end-user application interfacing a software development kit.

Tiny professional mobile HF reader are also available which operate e.g. via Bluetooth with smartphone devices. The end-user application on an Android or iOS phone interfaces the Bluetooth device via a software development kit.

Smartphones with a NFC interface are furthermore in general able to read HF transponder according to ISO 14443 as they operate at the same frequency. The practical limitations consist of a small reading range. Anyway, smartphone with NFC are cost-effective essentially in case of rare usage (e.g. for quality assurance or market surveillance).

13.2.2.4 UHF RFID Technology

Passive UHF RFID as known from the most applications in production and logistics operate at 850–950 MHz depending on the country. Transponders are standardized according to ISO/IEC 18000–6C.

Readers/client interface requirements

For the given transponder according to ISO/IEC 18000-6C a worldwide usage is possible although operating frequencies slightly differ from 850-950 MHz. The air interface is also standardized in this document. This air interface provides good reading ranges up to 6 meters in practical scenarios and the ability to read in bulks (e.g. 200+ transponders on one pallet). High throughput rates furthermore allow applications with very fast movements, i.e. short timeframes of a transponder in the reading field (toll collection of cars at speeds of 250 km/h). Although the technology is normally influenced by water or metal, a broad selection of special transponders is available that make the use of UHF RFID possible even in technically difficult environments (on-metal-transponder, high temperature transponder, flexible transponder, encapsulated transponder, etc.). The market of reader of any type is huge and broad selection of different devices is available. Tags and devices according to the standards are interoperable without known significant obstacles.

Reading devices

Again mobile solutions are relevant for matching the most requirements of the application domain. Professional mobile UHF readers are available, either wired or wireless systems as a complement to notebooks or as integrated MDE. The reader modules are normally operated by the end-user application interfacing a software development kit. Compared to HF, we see a bigger market of UHF devices.

As for HF, tiny professional mobile UHF readers are also available that can be connected via Bluetooth to smartphones. The end-user application on an Android or iOS phone interfaces the Bluetooth device via a software development kit.

While for the MED policy objectives (market surveillance, port authority control, etc.) mobile systems are relevant, manufacturer and logistics provider (e.g. for spare parts) can profit from already tagged equipment. They can be used to plan, monitor and control the internal processes and backend IT systems, so that stationary readers (so called RFID gates) are also relevant. Here again we see a huge and growing market of different devices and manufacturers all over the world.

13.2.2.5 NFC Technology

Near field communication (NFC) is a technology internally standardized for the wireless exchange of data. Compared to electronic tagging, NFC offers more applications like micropayment, emulating transponder via smartphone, data exchange between active devices, etc. As such it is standardized in several standards, e.g. ISO/IEC 13157, 16353, 22536, 28361.

Readers/client interface requirements

Relevant for the present analysis of applicability is the use of NFC with respect to an active device as reader and a transponder or smart label as passive "device". The NFC transponder and simple air interfaces are standardized within the norm ISO/IEC 14443 according to the HF standards at 13.56 MHz. In general, the NFC Data Exchange Format (NDEF) is used.

Reading devices

A growing number of smart phones from all relevant manufacturers and operation systems (Android, iOS, Windows Phone) are supporting NFC at least in the version for identification of NFC transponder.

13.2.2.6 Assessment of Applicability

A set of different criteria describe the requirements of the relevant work processes of the considered application domain. Table 18 gives indications to what extent the selected technologies meet these criteria:

Criteria	Barcode, Data Matrix, etc.	LF RFID	HF RFID	UHF RFID	NFC
Suitable in harsh environments	✓ (depending on the carrier)	✓	✓	✓	✓
Data Capacity	✓	✓	✓	✓	✓
Spread	✓	✗	✓	✓	✓
Technical reliability	✓	✓	✓	✓	✓
Clear regulations	✓	✓	✓	✓	✓
Suitable devices	✓	✗	✓	✓	✓
Suitable transponder/data carrier	✓	✓	✓	✓	✓
Bulk reading	✗	✗	✓	✓	✓
No-line-of-sight required	✗	✗	✓	✓	✓
Manually readable	✓	✗	✗	✗	✗

Table 18: Assessment of applicability in the application domain

13.2.2.7 Conclusion and Recommendation for Action

The assessment of different technologies shows a general suitability of **RFID** and **2D-Barcodes** for the observed application domain. According to the above illustrated Table 18 and the detailed explanations, a special suitability is ensured by the application of **Data Matrix** and passive **UHF RFID**.

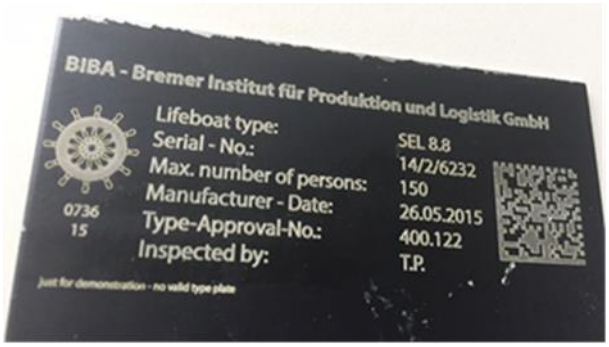
Both data carriers are available in different forms, i.e. printed, laser-marked or peel marked in the case of Data Matrix and in the label, hard case, or flexible form for RFID. Respective mobile or stationary reading devices can read the data carrier and return the information.

For the uptake of **A**utomatic **I**dentification and **D**ata **C**apturing - AIDC technologies for equipment under the Marine Equipment Directive, we recommend:

- Usage of either Data Matrix or UHF RFID according to ISO 18006-C or Data Matrix and UHF RFID in parallel.
- Specification of minimum sizes and quality criteria for Data Matrix codes.
- Recommendations for transponder types in the case of RFID with respect to different product categories.
- Advice to lock write access to product tags after delivery (RFID) as a minimum-security feature.
- Specification of general criteria for the durability of data carriers and tags: Data Carriers (RFID and Data Matrix) must be read along the complete lifecycle so carriers need to last longer than the expected lifetime of products (up to 30 years).

In addition to this proposed actions we provide the following preliminary selection guide for products under the MED according to ANNEX I of this report:

1. Transponders for products under MED have to fulfil different criteria to meet the required general durability along the lifecycle depending on the product category, which are
    - Robust against environmental impact
    - Appropriate size
    - Mounting possibility
    - Coding and numbering system
2. Following this argumentation, the following selection of transponder types is appropriate to fulfil requirements of the different product categories, which are

Transponder type	**Exemplary picture**
Type plate with RFID	
Type plate with Data Matrix	
Encapsulated transponder for rough environments (e.g. with additional wheel mark)	

Smart label	
Label with Data Matrix	
Identification for flexible materials	
Identification as additional part of the product marking	

3. Matching these transponder types with the MED item list according to the ANNEX I (of this report) provides a selection guide for manufactures of products under MED. For each product category, the respective transponder types according to the list above are investigated and assessed with

   Most likely appropriate, with almost no additional effort +

   Likely appropriate, with acceptable effort ○

   Most likely not appropriate or with very high effort -

4. Furthermore, the special characteristics of the operating environments in which the particular equipment under MED is used are assessed against the following aspects

   - Environmental influences possible (items that are operated under rough environments);
   - Small area for application of identification means possible (small products or products with complex shapes that make applications of identifiers relatively difficult);
   - Not identifiable due to changes in the product characteristics (products that lose their shapes such as coatings or products that will be assembled as part of more complex systems directly in the ship);
   - Metal environments possible (Products that are integrated in metal environments or have metal surfaces, as this influences the reliability of RFID).

   The assessment per item in each of the above-mentioned categories is simply done by either

   Present ✓ or Not present x

Limitation: There are a few items under MED that lose their (former packaging) shapes when they are used on ships, e.g. coatings. For these products, the eTags can be placed close to their application area on a wall or on the floor corner to ensure the identification along the product lifecycle.

13.2.3 Data Exchange Methodologies

13.2.3.1 General Data Exchange Scenarios

The underlying principle of AIDC technology is to attach the information related to the product directly to the physical product itself by the proposed data carriers. A set of information will be encoded into a machine-readable code and stored on the data carrier. The data carrier will be attached to the product. The information can be decoded again by reading devices (e.g. Data Matrix readers) at any time and any place according to the following figure.

Figure 26: Basic principle of coding on data carriers

Possible information that could be considered for attaching them to equipment are manifold which could be certificates, Notified Bodies, manufacturer, operator, last check dates, etc. The presented AutoID technologies though are limited regarding their data capacity. Besides the extreme case of storing all information on the carrier, a common practice is to introduce unique identifiers which are stored on the data carrier and link information stored in one or more backend systems. As the data capacity is not limited at this point and the data can be distributed on server systems worldwide which provide a particular querying interface, the idea of the so-called Internet of Things was born. The principle of coding on data carriers changes according to the following Figure 27:

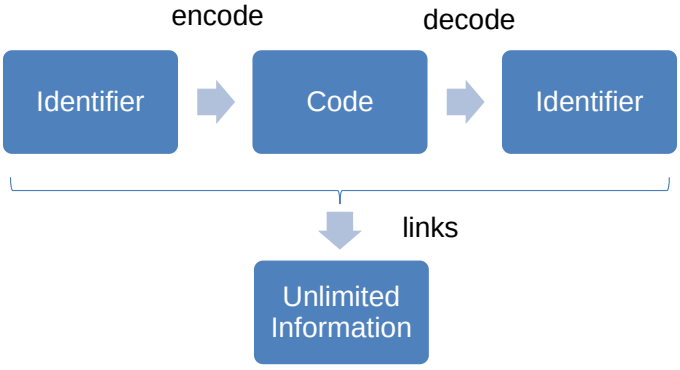


Figure 27: Basic principle of coding on data carriers including link to further information

Centralized data management

The centralized data management is one extreme case for AutoID-based data exchange. Data will be collected in a central database operated by a central organization, e.g. Notified Bodies or administration. Data will be delivered by industry, Notified Bodies, and administrations without losing their access rights. The data carrier

will have a unique identifier which is also handled by the database operator. The operation principle mainly applies for closed-loop purposes such as internal material flow handling systems, etc. The main disadvantage is that integrated solutions and usage of the data carrier for further purposes, e.g. across company borders, can be just realized quite difficult. This is due to interfacing problems regarding the unique identifier in context of the backend systems.

De-centralized data management

De-centralized data management describes, that all relevant data will be collected on the transponders itself or in decentralized databases operated by the individual partners of the value chain. The accessibility based on a particular rule and access framework is not guaranteed but technically possible. However, agreed interface protocols support flexibility and compatibility but need to be defined.

Combined approaches for centralized and de-centralized data management

Combinations of the general approaches centralized vs. de-centralized data management specify that certain data is stored on tags. The semantics of this data (i.e. the meaning behind a number) need to be defined along the complete application domain. Additional data can be stored in local databases or in central databases. Today's Internet of Things platforms operate huge databases in the cloud as centralized databases. Electronic Product Code Information Services (EPCIS) however proposes a d-centralized database structure with centralized components such as repositories and name services, so that also all local databases can be queried based on the product code which serves as the key for all further data.

13.2.3.2 Data on Tag

In all variants of data storage, certain data has to be stored on the tag. As this data is the actual key link to further information, it should uniquely define the product on which it is attached.

General requirements

For traceability of products different options are available. A unique identification is possible on the following levels:

- Product class (e.g. all lifejackets ABC1234 of a manufacturer XYZ have the same code).
- Lot/batch number (e.g. all lifejackets ABC1234 of a manufacturer XYZ that were produced in lot 1 of 2015 have the same code).
- Item number (e.g. all lifejackets ABC1234 of a manufacturer XYZ have a unique serial number).

According to the further requirements of the marine equipment directive it could also be useful to mark product groups based on a certification number.

- Certification number (e.g. some lifejackets ABC1234 of manufacturer XYZ have a common certification number).

Anyhow, this makes sense if there are also other lifejackets ABC1234 of manufacturer XYZ that have another certification number, i.e. that the certification number is the only diversification criterion. Further, the certification number can be linked 1-to-1 to product class, lot/batch number or item number (depending on the approval type) so that it could be accessible via backend databases. The other way around, storing just the certification number cannot guarantee that one can find the according linked product as it is not clear if the number describes product class, lot/batch number or item number.

With respect to the later options for traceability (see chapter 13.2.4 and chapter 13.2.5) the preliminary considerations concerning mandatory numbers which are required to identify products are listed below in Table 19:

• Country and production site (unique) • Identification number of the product (given by the producer) ○ → both together give a unique identifier for a product	equals	• Approval number on item level
• Lot number (given by the producer) ○ → all three together give a unique identifier for a lot	equals	• Approval number on lot level
• Serial number (given by the producer) ○ → all four together give a unique identifier for an item	equals	• Approval number on item level

Table 19: Mandatory numbers to identify products (preliminary)

Both mentioned options will be further investigated and discussed in the next chapters.

13.2.3.3 Overall Chain of Custody Capabilities

The proposed chain of data access and exchange along different stakeholders requires the specification of following custody aspects, which must be considered in the evaluation of the technological options as follows:

Data security and safety aspects

Data security and safety aspects mainly affect the central storage of enhanced information in databases, i.e. access and transfer of data between databases, clients and user interfaces must be secured according to the state- of the art. However, this is an independent requirement from the use of Data Matrix and RFID. According to the

architecture proposals in the next chapters, the data carrier will only have identifier information which will link to further information in databases but just in the case the user of the code is authorized to do so. The simple reading of the number information on the code will not be restricted on the on hand but alone without access to databases there is no risk for misuse.

Reliability aspect regarding distributed data

Data which is stored on data carrier on individual products can theoretically be lost, for instance by removing or destroying the data carrier. Essentially in the case of optical codes (such as Data Matrix) there is the risk of destroying the data carrier just by means of normal usage or ageing of the labels. There is no effective measure against this problem so that reliability of distributed data is an issue. Anyway, same is true for human-readable information on labels for instance which can be removed, too. As data on data carrier encompasses a link to further information in databases, data access in the central storage is reliable but the direct link to this data directly on the object might be lost.

Revision safety of data

Revision safety of data affects mainly the central storage of enhanced information in databases. Changes and removals in database entries should be tracked and can be retraced accordingly. On data carriers attached to objects, the storage limitations restrain to set up a retraceable repository for data changes. Usually this is not necessary, because data on the carriers will be written one and in case of RFID in most cases protected against changes using a special password.

Archiving process

As for revision safety of data, archiving processes affects mainly the central storage of enhanced information in databases. Archiving mechanisms must be defined on the individual database levels that will be linked to the identifiers of the object.

Access, role and security system

On the one hand, access, role and security systems affect the central storage of enhanced information in databases. Today’s public databases have already limited access to registered users. Access and security mechanisms should therefore in principle be build according to the state of the art. For an extensive use of Data Matrix or RFID to link to databases, so-called application programming interfaces (API) have to be introduced. Broadly spoken, these interfaces have to fulfil same state-of the-art access, role and security requirements like the human interfaces of the databases todays.

On the other hand, with respect to the individual data carriers, optical codes like Data Matrix are not affected by access, role and security issues as the encoded information can be read by any standard device. Almost same is valid for RFID, however, programming the transponder with a new or changed code should be limited to authorized persons. At this, RFID standards provide the possibility to secure the data with a (very simple) password.

13.2.3.4 Experimental Demonstrator

In order to ensure the applicability of the selected technological options, two experimental demonstrators have shown integrated data access from the tag to the already available databases. For MarED, BALance and BIBA have realised these demonstrations. For other public databases, the accessibility depends on the availability of state-of-the-art APIs. Same is valid for manufacturer databases or management systems of ships.

13.2.3.5 Conclusion and Recommendation for Action

The mandatory data which is needed on the transponder has been clarified. The challenge is to use the limited storage capacity of the data carriers in a way that reliable links to the available databases can be provided. The different tasks related to MED requires information stored in different databases. By reading the data carrier on a product (and the necessary access database rights provided) connections to the relevant databases can be established and the necessary information can be collected immediately.
Central databases will be operated in future but there are no unique identifiers available to link the objects to the databases. Standards provide solutions for that, using a composed identifier with a unique production site (e.g. delivered via the D-U-N-S number[24]), an identification number of the product class and an optional lot number or serial number. The D-U-N-S number (Data Universal Numbering System) is a non-classifying 9-digit key that uniquely identifies companies by means of business units worldwide. Nowadays it includes more than 120 million companies worldwide.

Theoretically, every composed unique identifier has a 1-to-1 relation to a unique certificate or certificate combination. It might be comfortable to store redundantly this information on the data carriers but this faces problems:

- There is no unique certification identifier available, so that the industry must agree upon one.
- A composed unique identifier can be built by using the unique number of the Notified Body and the free but also unique number for the certificate which is assigned by the Notified Body. This might be problematic in terms of special characters used or character length.
- A certification identifier is not directly supported by the available standards.

Today's technical limitation of data carriers implies, that the information directly on the carrier provides just a link to further information stored in public or private databases. Direct storage of enhanced information such as electronic versions of certificates or documentation cannot be stored directly on the carrier. One might consider the direct information analogous to an Internet URL that guides you to further information on the web page.
It is required, that this information has a structure, which is agreed upon all stakeholders of an application domain. In doing so, the provided link can be understood to get further detailed information and files in public databases or in access-restricted private databases.
For the considered case of a coding and numbering system under the marine equipment directive, it is recommended to consider the following steps:

4. Defining a general agreed format of the MED certificate number, that links physical objects to certificate information of marine equipment, for instance, maintained by MarED database or similar databases with respect to the master data;

[24] For details related to the DUNS number see https://www.upik.de/en/

5. Proposing a procedure and scheme to include the MED certificate number on a data carrier which uses the ISO/IEC 15418:2016 ASC MH10 Data Identifiers;
6. Proposing a procedure and scheme to include the MED certificate number on a data carrier which uses the ISO/IEC 15418:2016 GS1 Application Identifiers.

A detailed structure of a MED certificate number is proposed within the next chapters.

13.2.4 Traceability, Product Recall and Anti-counterfeiting

13.2.4.1 Product Recall

Product recalls are special cases in which due smart querying of data bases, product recalls can be supported by a lot of possible information sources like:

- is the scanned/investigated product certified at all,
- is there a geographical distribution that has no logical sense (on a single item or lot level) etc.

We recommend the investigation of reference architectures and systems. In summary, we recommend the investigation of use cases to proof appropriate means for anti-counterfeiting, possibly by the execution research, innovation and demonstration projects (depending on the readiness level).

13.2.4.2 Industry Standards for Traceability

Different open standards and industry standards are available to support traceability of items.
ISO 22005-2007: This standard gives the principles and specifies the basic requirements for the design and implementation of a feed and food traceability system. It can be applied by an organization operating at any step in the feed and food chain.
GS1-GTS: GS1 offers traceability solutions for healthcare and retail.
The general principles of traceability systems rely on the same principles and requirements described above. In the further course of the study, we will compare best practice examples on traceability with the MED situation.

13.2.4.3 The Role of Databases for Traceability and Product Recall

With respect to the tractability of items along its lifecycle, the relevant databases for MED items must be considered in general. They can provide further extensive information on manufacturers, certification, certification problems and products itself. While this information does not guarantee consistent traceability on its own, the joined information of the different databases enhances a lifecycle folder on items, lots or individual entities that make traceability easier. As described, the eTag transponder serves as a single point of entry to all this information by providing a unique identifier that helps querying the databases. The different databases (detailed database description see chapter 13.1) provide traceability information as follows:

ICSMS (information and communication system for the pan- European market surveillance): The internet based database contains product information, test results, official measures taken, etc. For consumers and manufacturers, it offers a public area with official information about dangerous products, reliable information about unsafe products as well as voluntary industry recalls and postings made by manufacturers drawing attention to pirated copies. The platform can be used to

exchange information among market surveillance authorities on investigations/inspections on products.

For the *traceability of marine equipment*, the database can be used to collect the information of available product data. By using the unique identifier under consideration of the adequate access rights, it is possible to trace the market surveillance related data of products very quick by just scanning items.

RAPEX (Rapid Alert System for dangerous non- food products): The system offers information on products posing risk to health and safety of professional users and to other public interests protected by relevant EU legislation (e.g. environment and security). RAPEX allows 31 participating countries (EU countries, Norway, Iceland and Liechtenstein) and the European Commission to exchange information on products posing a risk to health and safety of consumers and on the measures taken by these countries to eliminate that risk.

Marine equipment with electronic tags would offer surveyors direct access to RAPEX and to receive immediately the actual information on risk to health and safety. Again, the unique identifier of Data Matrix or RFID serves as a single-entry point to the above-mentioned information and can be accessed very quickly by just a scan. The opportunity of single product or batches traceability capabilities is a huge advantage for the further expansion of RAPEX.

MarED (Marine Equipment Directive) Database: All marine equipment certified and notified is documented within the MarED Product Database. The MarED Product Database contains information about authorized equipment to be installed on EU flagged merchant vessels according to the Directive.

The database can be used for any conformity check and market surveillance by using the available product information immediately. *Based on electronic tag environment* any kind of verification can be realised much faster and more efficient. The product can be identified at any place any time. Therefore, product traceability can be realised in a way which would be very beneficial. At least the access to MarED has been demonstrated in the pilots (essentially the market surveillance demo on the SMM 2016) which were part of this study.

NANDO (New Approach Notified and Designated Organisations) information system: The EU Member States inform the Commission and the other Member States that a conformity assessment body, which fulfils the relevant requirements of the respective legal act, has been notified to carry out conformity assessment according the directive through NANDO.

By *electronic tags* it can be checked in situ if a Notified Body (mentioned on a tag for a selected product) has the necessary notifications to carry out conformity tests for that product. This makes the procedure much faster than today.

Industry databases: Beside the public databases also industry databases are available. They are operated by marine suppliers or class societies. Industry databases can be adapted to unique identifiers of Data Matrix and RFID on MED items to access the stored information quicker. For the operator of these databases also the storage of database entries to events that occur to the items is quicker and cost efficient. Some examples have been demonstrated on the SMM exhibition and a Baltic ferry Figure 28.

Figure 28: Database access as part of the Baltic Sea demonstrator

It has been shown that with one eTag reading process information from several databases can be collected. During the demonstration, the MarED database, the public area of the DNV-GL website and the supplier database have been addressed. Product related information have been collected. The access to the internal databases would also be possible after the implementation of the registration and access procedures. The demonstrators didn't consider all details because they were only implemented for demonstration purposes. The advantages of eTag technologies have been proven within the two demonstrators. Other databases could also be added like the ship operating system to administrate the equipment on board.

13.2.4.4 Reliability Issues

General requirements and constraints for AutoID technology components in maritime environments arise from the different needs and requirements of equipment manufacturers and operators, Notified Bodies and port authorities.

Data Carrier must be resistant against different environmental conditions. These conditions may be challenging or even haphazard. Protection classes are standardised and define which environmental properties a transponder is safeguarded, so they will not destroy it or hinder its functional performance. Today's state-of-the-art shows, that data carrier technology is available for almost all equipment under the maritime equipment directive.

We recommend formulating requirements on reliability in a way that data carrier must resist harsh environments as long as the intended lifetime of the products.

13.2.5 Implementation Options

13.2.5.1 General Considerations for an Appropriate Architecture

There is different heterogeneous equipment with different individual requirements regarding approval and certification under MED, so that identification and traceability should work on different levels. Again, these are:

- on product class level,
- on batch/lot level,
- on item level,
- on certificate level.

Todays and tomorrows databases are used or can be used to store further information of the objects so that with respect to a hybrid centralised/decentralised approach, the main question is "How to define a unique identifier to link to further information?"

A unique identifier allows links to objects:

- on product class level:
    - by linking many objects of one type to a data source (e.g. type approvals)
- on batch/lot level:
    - by linking many objects of one lot size to a data source (e.g. manufacturer data)
- on item level:
    - by linking one single object to a data source (e.g. manufacturer data)

A unique identifier under MED has to meet all three requirements at the same time and should be applicable for all mentioned purposes. Figure 29 shows a general scenario independent from particular standards, where data on the tag is used to link to further applications and databases:

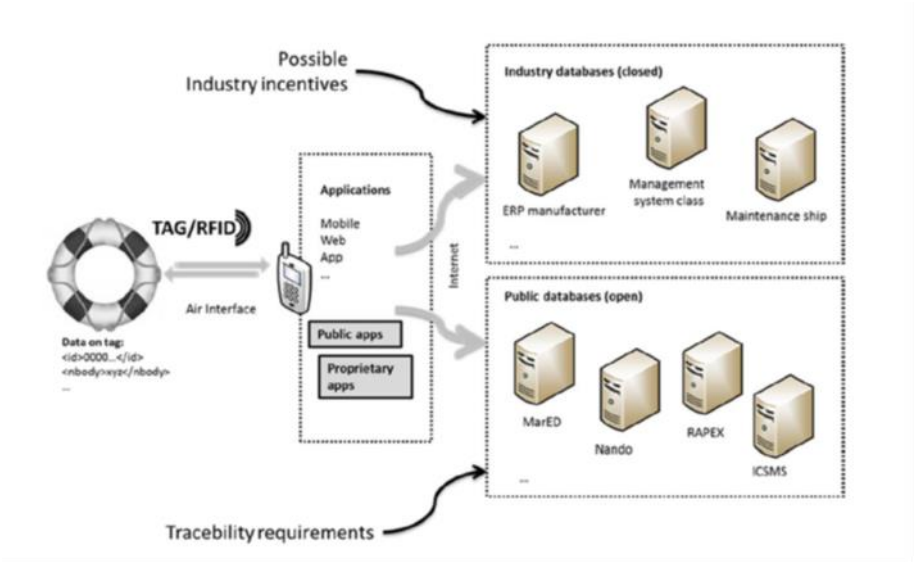


Figure 29: General approach for data exchange between tag/reader combination and data handling and storage

According to ISO/IEC 15418/ANSI MH10.8.2 or GS1 standards proven concepts for traceability of items are already available and they support the different requirements for product classification, batch/lot identification or single item identification. This can be theoretically applied out of the box but shows limitations:

1. The numbering structure under each category is not harmonized yet.
2. There is no maritime industry labelling standard or recommendation on top of ISO/IEC 15418/ANSI MH10.8.2 or GS1 available

Assuming that due to policy requirements, a MED certificate number encoded on the tag is necessary, a unique identifier could look like illustrated in Figure 30.

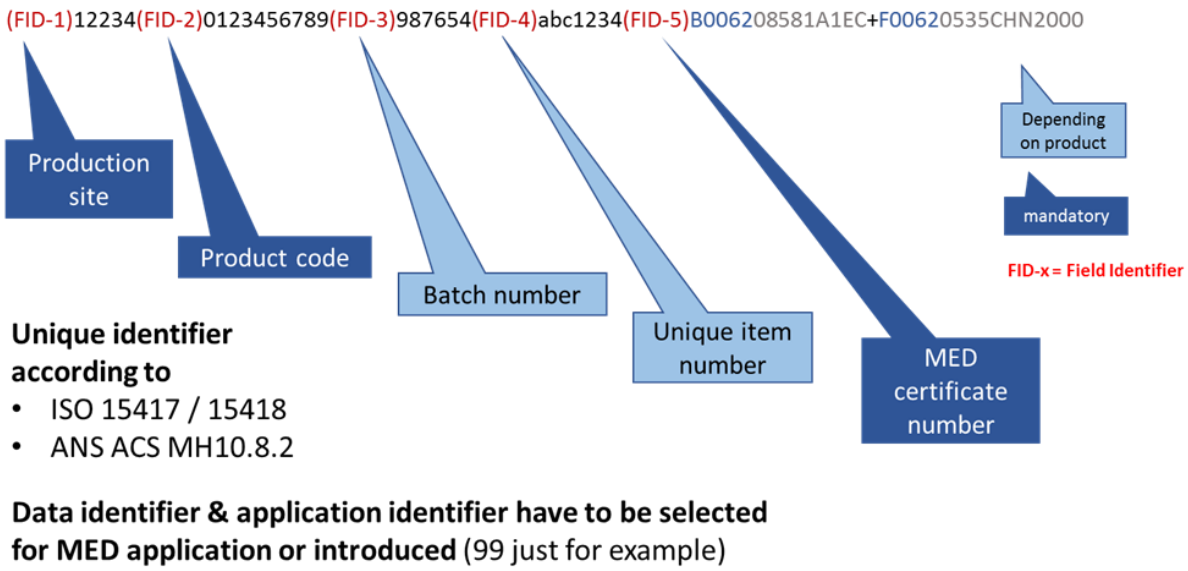


Figure 30: Towards an application standard under MED (Preliminary concept)

13.2.5.2 Neutrality with Respect to Products, Open Standards

According to ISO/IEC 15418/ANSI MH10.8.2, the following requirements are generally met, so that neutrality and open usage can be assured:

- Further fields can be added if necessary.
- The application guideline for MED would just define mandatory field and proposes further fields.
- GS1 standard can be integrated if necessary.
- Implementation is independent from the technology (barcode vs. RFID) and interoperable.

13.2.6 MED Certificate Number

A MED certificate number once agreed among the stakeholders has the ability to provide links to existing databases of the European Commission. The traceability by identifying products on the certificate level would provide tools to secure compliance with regulations under the marine equipment directive. Databases such as MarED, ICSMS and RAPEX are prepared to add a field that stores a MED certificate number and allows querying of this field.
With respect to the master data of a product, when traced on certificate level, the attributes are:

- Manufacturer
- Item
- Trade name
- NB/prod. Year
- Applied modules
- Notified Body B[25]
- Module B certificate
- Notified Body D, E, F or G
- Module D, E, F or G certificate

The certificate numbers are the primary keys for market surveillance. As a final recommendation within the study, we investigated the following illustrative example, which is given in the following Figure 31 and contains the minimum master data attributes to form a unique identification on the certificate level.

Manufacturer	Wuxi Xingta i Shipping
Item	A.1/1.1 Lifebuoy
Trade name	XT 5555 - Lifebouy 2,5 kg
NB/prod. year	0062/00
Applied modules	B+F
NB B	0062
Module B certificate	08581/A1 EC
NB	0062
Module D, E, F, G certificate	0535CHN2000

Figure 31: Master data example of an equipment on certificate level

The unique identification of a certificate combination and therefore as well the identification of products on certificate level is given by building a number based on the following scheme

[25] Not considered in case of a module G

[Applied module B][Notified Body B][Module B certificate] + [Applied module D, E, F or G][Notified Body D, E, F or G][Module D, E, F or G certificate]
This can be illustrated by the given example in Figure 2 and leads to:

B00620858 1A1EC+F00620535CHN2000

It is recommended to determine this or something similar in the regulation guidelines for applying electronic tagging under the marine equipment directive. While the certificate numbering is left open to the notified bodies, which are identified by a 4-digit number, it might be necessary to limit the possible digits and restrict special characters due to technical reasons. These limitations are deduced directly from the following concepts of including the MED certificate number under ISO/IEC 15418:2016.

13.2.7 Interoperability Including Interfaces with Existing Databases such as ICSMS, RAPEX, MarED, NANDO

The preliminary concept has been checked against database keys and query interfaces of existing databases. From the technical perspective, databases must provide application programmable interfaces (APIs). A general concept of the API is described in Annex II of this study. It is important for the queries that the database keys meet the data on the tag or can at least be transferred 1-to-1.

With respect to this, all relevant public database providers were asked to provide information on their data management. Based on the feedback it can be assumed that databases such as MarED, ICSMS and RAPEX are prepared to add a field that stores a MED certificate number and allows querying of this field.

ISO Standard and ASC MH10 Data Identifiers

By integrating the MED certificate number according to the ISO 15418:2016 / ASC MH10 Data Identifiers, interoperability and extensibility is ensured. A data carrier, which data is structured according to this standard, can include several application-specific fields, so-called data identifiers, which determine the type of the following information. Accordingly, the data structure is dynamic in a way that the field structure of overall data content can be very different, although a dedicated field identifier might determine that the following content describes the MED certificate number. The following Figure 32 gives a general overview of the general data structure.

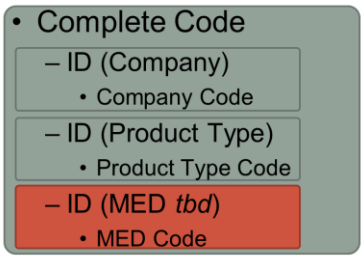


Figure 32: General data structure on a data carrier according to ISO/IEC 15434:2006 and ISO/IEC 15418:2016

Today's situation is, that neither a dedicated ID for the application of the MED certificate number does exist, nor is a data identifier available that fits in its description to something more general like "document number" or "certificate number". The following has been considered:

In the marine equipment domain it is necessary to put a code on products that refers to a certificate number, i.e. to a certificate which has been issued by a Notified Body.

Per certificate, the number is unique and consists of alphanumerical characters and the special character "+". The length is not limited at the moment but might be limited to 30-35 characters in the future. Depending on the product, the certificate and the respective certificate number belongs to an individual item, a lot/batch or a product type.

Under consideration of the ASC MH10 Data Identifiers, we see the following general options, however, encompassing several limitations:

1. With respect to the description of the data identifier "12S – Document Number (internally assigned or mutually defined)", the reference to a certificate document by using its certificate number seems feasible. However, we have the limitation of the usage of just 18 numerical characters, while this does not meet our requirements. Certificate numbers use approx. 30-35 alphanumerical characters and the special character "+" at the moment. Furthermore, "12S" belongs to the category "19 - TRACEABILITY NUMBER FOR AN ENTITY", which will fit for individual certificates on item level. However, lot/batch or product type level has to be considered, too, so that the usage of "12S" might be inappropriate.
2. As an alternative the data identifier "30S – Additional Traceability Code For An Entity Assigned by the Supplier" in addition to or different from the traceability code(s) provided by "S" or "1S"" can be considered for the reference to a certificate document by means of the certificate number as an additional traceability code. There might be a conflict with another intended use of "30S" by some suppliers, however, 1-35 alphanumerical characters meet our requirements for the coding of the certificate number. Again, "30S" belongs to the category "19 - TRACEABILITY NUMBER FOR AN ENTITY", which might be inappropriate for our intended use.
3. Another approach using the data identifier "3Z - Free Text" is always possible. This field would also work even if it is not the favored solution. The 3Z identifier is related to ISO and can be used for all kind of different information and is used for different applications, because there are no defined restrictions. It is not explicit reserved for MED. That makes it difficult to identify and to use it for

automatic recognition. This identifier is not one of the preferred solutions for the MED certification number because within that field identification is much more complicate compared to an own MED specified identifier.

This leads to the recommendation that the European Commission with the support of industry associations and possibly the European Maritime Safety Agency should apply for adding a new data identifier. At this, one of the following options is feasible:

1. new data identifier, especially intended for the use of a MED certificate number under the marine equipment directive
2. new data identifier as general document identifier or a certificate identifier which could be used by the MED directive, but also for the CE marking or by other certification authorotiers like e.g. UL (Underwriters Laboraties) in the U.S.

The enhancement of the ASC MH10 Data Identifiers by domain-specific use cases is an intended procedure under the respective ISO standard. It does not require the change of the standard as such.

GS1 Standard

ISO 15418:2016 covers, in addition, the second characteristic of its application. GS1 is an international non-profit organisation. Until 2004 it was known as European Article Numbering-Uniform Code Council. GS 1 maintains under inclusion of ISO 15418:2016 the GS 1 standards for the data structure on data carriers. Using the same principle as described Figure 32, the GS 1 standards offer dedicated and unique field identifiers that are named GS1 application identifiers.

Companies using GS1 standards become a member of GS1 and therefore receive particular unique number ranges in order to identify company or product information. In the retail business, these standards are well established, however, also other industries including companies that manufacture marine equipment make use of GS1 number ranges.

As ISO 15418:2016 does not allow mixing GS application identifiers with ASC MH10 data identifiers on one hand, but the application of GS1 is widespread on the other hand, it is absolutely recommended to support the GS1 standard besides the open ASC MH10 pillar.

In detail, the recommendation is likewise, that the European Commission with the support of industry associations and possibly the European Maritime Safety Agency should apply for adding a new application identifier. The same options are feasible:

1. new application identifier, especially intended for the use of a MED certificate number under the marine equipment directive
2. new data identifier as general document identifier or a certificate identifier which could be used by the MED directive, but also for the CE marking or by other certification authorotiers like e.g. UL (Underwriters Laboraties) in the U.S.

It is further a criterion of exclusion for GS 1 as a general option if the data content after an application identifier is maintained by GS 1 and has to be decoded by querying GS1 databases. The new application identifier must support both ASC MH10 Data Identifiers and GS1 Application Identifiers allowing for a free choice for industry. We strongly recommend that the data content, which consists of the proposed MED certificate code, is directly readable and absolutely equivalent in both options.

14 Supplementation of MED Certificate Number by Further Data

If using ISO 15418:2016, both pillars of the standard enable to add further data fields with particular further content that can be encoded on the data carrier.

For all types of products, useful data on the carrier besides the MED certificate code is a manufacturer identification number and the article number as assigned by the manufacturer.

For products that are produced in batches or lots, the lot number as assigned by the manufacturer is a useful extension.

For products that are individual on entity level, i.e. that have a unique individual serial number, the encoding of the serial number as assigned by the manufacturer should be considered.

For special products or processes, the supplementation of the code with information to manufacturing data, expiration date, internal data, etc. is possible.

We generally recommend including examples and argumentation of the usefulness of guidelines and regulations as to the application of further product-related data. This can inspire the uptake of the technology within the industry. The provision of innovation

15 Traceability, Product Recall and Best Practise

With respect to intended effects of the technology, traceability, product recall and anti-counterfeiting are in the scope. In general, the study showed and argued that the technology is an inevitable prerequisite for enhancing the management of traceability, product recall and anti-counterfeiting on the one hand with manageable effort on the other hand.

With respect to the particular categories mentioned in this context, traceability, product recall and anti-counterfeiting characteristics are briefly described and general recommendation for an uptake within the industry are given.

15.1 Traceability

Traceability describes the ability to verify the past movements and locations of items or the application of an item in a greater context. A machine-readable code by means of data matrix or RFID technology enables a strong increase of the generation of such records. This is related to the fact that the scanning of an item and the storage of a record in a traceability database is hardly causing process operation costs. Traceability of lots or individual entities will be enabled by a digital logbook that helps to answer questions that address supply chains, distribution networks, misuse of products, product recalls and market surveillance.

Traceability databases are maintained either by manufacturers or manufacturing networks itself or by industry associations or AIDC service organisations such as GS1.

We recommend the investigation of reference architectures and systems in order to proof appropriate means for traceability.

15.2 Product Recall

Product recalls are special cases in which due to quality or safety related problems, single items or lots have to be recalled from the market. In doing so, information about past movements and locations of items help to investigate where the relevant products are. The on-site identification either by ship operator, manufacturer, market surveillance or port authority further enables faster and transparent problem-solving in the case of product recalls.

15.3 Smart Querying of Unique Identifiers on MED Items

Based on the discussed aspects in the general considerations and the consultation of best practices, the unique identifier on the Data Matrix or RFID transponder provides different tangible options according to existing standards. These options are presented below. All options are still preliminary and might need to involve the respective standardisation organisations for verification or adoptions.

Current technical limitation of data carriers implies, that the information directly on the carrier provides just a link to further information stored in public or private product databases.

It is required, that this information has a structure, which is agreed upon all stakeholders of an application domain. In doing so, the provided link can be understood to get further detailed information and files in public databases or in access-restricted private databases.

The direct encoding of certificate information (e.g. a certificate number) in a dedicated field under consideration of known standards like ISO/IEC 15418:2016 ASC MH10 Data Identifiers or ISO/IEC 15418:2016 GS1 Application Identifiers is not considered at the moment. The following options that just define the mandatory encoding of a MED approval number explain the general options that can be considered.

<table>
<tr><td>OPTION 0A</td><td colspan="2">Coding scheme according to GS 1 application identifiers for MED approval</td></tr>
<tr><td>Description:</td><td colspan="2">GS1 is an organisation which manages a range of numbers for the unique identification of items, lots or entities. Membership is normally obligatory. Nevertheless, the orientation to the GS1 standard can help to reduce implementation problems later on. The European Commission’s Directives on explosives (Directive 2008/43/EC) e.g. foresees a) two digits identifying the Member State, b) three digits identifying the manufacturing site attributed by the national authority and c) unique product code and logistical information designed by the manufacturer but it does not prescribe to follow GS1 format.</td></tr>
<tr><td>Used standard:</td><td colspan="2">According to GS1 application identifiers</td></tr>
<tr><td rowspan="2">State</td><td>Codes defined, immediately useable</td><td>Adoptions required</td></tr>
<tr><td>yes</td><td></td></tr>
<tr><td>Code Example</td><td>(01)12345678901234(98)B006208581A1EC
+F00620535CHN2000</td><td>  </td></tr>
<tr><td>Code Explanation</td><td colspan="2">Unique item identifier comprised of a sequence of different data elements, partly not mandatory
(xx) not mandatory fields of the GS1 standard (e.g. 01 as an example in the code above)
(98) Internal Use, here agreed upon the industry to encode a MED certificate number type B certificate (2-30 alphanumerical character possible, first 6 characters encode the Notified Body)</td></tr>
<tr><td>Limitations</td><td colspan="2">Use of the GS1 application identifiers and accordance with ISO standards has to be checked. Identifiers above the 90 numbers are just for internal use and should not leave company borders. Other industries might use the same application identifier in a different way.</td></tr>
<tr><td>Conclusion</td><td colspan="2">Not possible to identify and trace products on every required level (just on a free basis) but the link to MED certificate information is possible.</td></tr>
</table>

OPTION 0B	**Data Identifier and Application Identifier Standard with additional MED number**		
Description:	In addition to already existing data identifiers under ANSI MH10.8.2-2013, referenced by standard ISO/IEC 15418, an existing general purpose identifier or a new data identifier could be introduced that stores the MED certificate number either in a specific MED field or in a generic field "certificate information" as		
Used standard:	ANSI MH10.8.2-2016, referenced by standard ISO/IEC 15418		
State	Codes defined, immediately useable	Adoptions required	
	Depends on the particular configuration	yes	
Code Example	**3Z**|B006208581A1EC+F00620535CHN2000		
Code Explanation	Unique item identifier comprised of a sequence of different data elements with a new Data Identifier or an existing general purpose one like 3Z in this example 3Z MED approval number type B or G certificate (first 6 characters encode the Notified Body), + as a separator, additional MED certificate number type D, E, F if applicable (all in all 2-30 alphanumerical character possible), a particular data identifier for certificate numbers should be proposed to ISO		
Limitations	Data identifier has to be agreed upon ISO body or respective organisation responsible for maintaining the data identifier fields in case of acquiring a dedicated field for MED certificate information. ISO norms do not have to be adopted. Applying for the introduction of new industry-specific data identifier is regulated part of the ISO norm.		
Conclusion	Not possible to identify and trace products on every required level (just on a free basis) but the link to MED certificate information is possible. Perspective towards standardised usage also under CE directives and further regulations. The combination with item, lot and entity traceability possible.		

There are further options available as substitution or supplement to just introducing a MED certificate number. These options must be considered very seriously because they offer greater impact and value on requested issues like traceability and, recalls. Therefore existing identifier standards have to be extended by a lot of possible information sources like:

- is the scanned/investigated product certified at all,
- on a single item or lot level, is there a geographical distribution that makes no logical sense (e.g. same products are scanned same time in different places),

- open issues in RAPEX or ICSMS can be queried fast and also opened very fast by scanning and a mobile application, etc.

We recommend the investigation of reference architectures and systems in order to proof appropriate means for product recalls based or embedded into the traceability topic.

15.4 Anti-counterfeiting

Anti-counterfeiting or related means fulfilled for instance by market surveillance or port authorities describe the ability to verify the origin of an item.

First of all, the AIDC technology has limited security against counterfeiting because data carriers can be copied as well. Anyway, the traceability information is of great value to indirectly identify counterfeited products. This is, for instance, the case if products with a serial number are scanned on-site at a place where they have not been delivered or if products with a same serial number are scanned at the same time at different places.

For the use of RFID, there is also the possibility to enhance the security of identifying counterfeited products by using the technical characteristics. Each RFID data carrier has an individual identification number assigned by the manufacturer and stored in a read-only memory. This number can be maintained in a database by the manufacturer and accordingly identify the origin of a product. The ID itself can also serve as a serial number without even changing any internal processes.

Latest developments proclaim artificial DNA technology which means that a private-public-key encryption is used to verify the validity of original RFID data carriers. This is a technology that will be aligned to the proposed RFID frequency range.

OPTION 1	**Data Identifier and Application Identifier Standard Category 16 (Item Information)**	
Description:	The category 16 relates to the identification or characteristics of an item such as its part number. An item in the sense of this category is not a unique entity but a representative of all other like items	
Used standard:	ANSI MH10.8.2-2013, referenced by standard ISO/IEC 15418	
State	Codes defined, immediately useable	Adoptions required
	yes	
Code Example	**25P**|UN|965878916|1409ECA	

Code Explanation	25P is the combined issue agency code, followed by the manufacturer identification code (9-digit D-U-N-S® number[26]) and the item code/part number (assigned by the manufacturer)
Limitations	The reference to this number in the databases might be missing, however, the information is implicitly included (e.g. in MARED the manufacturer (in clear text) and the product trade name is included)
Conclusion	Possible to identify and trace products on product class label. There cannot be stored further information on lot level or serial number level.

OPTION 2	**Data Identifier and Application Identifier Standard Category 19 (Traceability Number for an Entity)**	
Description:	Category 19 relates to the identification of a specific item (entity) in a unique manner for purposes of tracking that entity. If a Data Identifier from this category is used, an identical message on another entity should never be found within the originating system.	
Used standard:	ANSI MH10.8.2-2013, referenced by standard ISO/IEC 15418	
State	Codes defined, immediately useable	Adoptions required
	yes	
Code Example	**37S**|UN|965878916|1409ECA**+**13ENS1105813MED	
Code Explanation	Unique item identifier comprised of a sequence of 5 data elements: (1) issuing agency code (here UN for D-U-N-S® [26]) (2) company identification code as defined by the issuing agency (here: 965878916) (3) part number as defined by the manufacturer (x alphanumeric characters, here: 1409ECA) (4) separator + and (5) part serial number as defined by the manufacturer (y alphanumeric characters, here: 13ENS1105813MED)	
Limitations	No direct encoding of the certificate information, no encoding on lot level. The reference to this number in the databases might be missing, however, the information is implicitly included	
Conclusion	Possible to identify and trace products on unique item level via serial codes.	

[26] The Data Universal Numbering System (D-U-N-S®) is a nine-digit number which allows companies to be uniquely identified worldwide. By registering every company site every location can be clearly identified. The registration is free of charge.

OPTION 3	**Data Identifier and Application Identifier Standard Category 20 (Traceability Number for Groups of Entities)**	
Description:	Category 20 relates to the identification of a lot, batch or another grouping of entities.	
Used standard:	ANSI MH10.8.2-2013, referenced by standard ISO/IEC 15418	
State	Codes defined, immediately useable	Adoptions required
	yes	
Code Example	**25T**|UN|965878916|08HS3593841EC	
Code Explanation	Unique item identifier comprised of a sequence of 3 data elements: (1) issuing agency code (here UN for D-U-N-S® [26]) (2) company identification code as defined by the issuing agency (here: 965878916) (3) traceability number as defined by the manufacturer (x alphanumeric characters, here: 08HS3593841EC)	
Limitations	No direct encoding of the certificate information, no encoding on serial number level. The reference to this number in the databases might be missing, however, the information is implicitly included	
Conclusion	Possible to identify and trace products on lot level.	

Option 1-3 can be used together with respect to the required degree of traceability.

15.5 Best Practice from Other Sectors

In the following three examples the individual objectives in different application domains (explosives, automotive and defence) are illustrated and the applicable marking requirements are briefly characterized.

15.5.1 Explosives

In order to prevent theft and misuse, the European Commission's Directives 2008/43/EC and 2012/4/EU oblige producers of civil explosives within the European Union to put in place a system to identify and trace each individual explosive product (i.e. several millions each year) throughout each stage of the entire supply chain until their use. In order to guide the producers of explosives implementing the Directives the Federation of European Explosives Manufacturers (FEEM) has published the guidance note "FEEM European Explosives Code Structure". Within the guidance a system for identifying and tracing explosives is described, nevertheless it is not binding for meeting the Directives.

In order to comply with the Directives it is necessary to attach humanly readable information and electronically readable information for identifying the explosive. Electronically readable information can be provided by using barcodes and/or matrix codes as well as RFID. FEEM recommends using barcode technology. Regarding the code structure the FEEM recommends a structure orientated on the GS1 standards. The code structure can be encoded with GS1 Data Matrix or GS1-128 symbols. Figure 33 and Figure 34 are showing examples how the mandatory data can be encoded with optical codes:

Figure 33: Example of barcode for identifying and tracing explosives

Figure 34: Example of Data Matrix code for identifying and tracing explosives

For identifying the data within the electronical codes GS1, "Application Identifiers" (AI) are suggested (e.g. (90) = Country & Production Site No). AIs are defined for mandatory data, being needed to meet the Directives requirements, as well as for optional data, which could be of interest for obtaining additional benefits. The following information is mandatory:

1. Country,
2. Production site number,
3. Unique item number in combination with country and production site.

The Directives defines, that the country and the production site number must be the first fields of the human readable identification. Table 20 shows a list of all AIs recommended by the FEEM.

AI Application Identifiers	**Description**	**Characters**	**Format** (an = alpha-numerical n = Numerical)	**Length**	**Characteristic**
(90)	Country & Production Site No.	5	an	fixed	mandatory
(250)	Unique Item No	30	an	variable	mandatory
(20)	Determination of items and logistical units	2	n	fixed	optional
(11)	Production Date	6	n	fixed	optional
(240)	Product Code	30	an	variable	optional
(10)	Batch Number	20	an	variable	optional
(37)	Trade Quantity	8	n	variable	optional
(30)	Quantity	8	n	variable	optional
(310n)	Net Explosive Quantity	6	n	fixed	optional
(311-316n)	Unit of Measure	6	n	fixed	optional
(330n)	Gross Weight	6	n	fixed	optional
(91) – (99)	Internal Use	30	an	variable	optional

Table 20: Application Identifiers recommended by the FEEM

When companies already use GS1 identifiers, the AIs pictured in Table 21 can be used as well.

AI Application Identifiers	**Description**	**Characters**	**Format** (an = alpha-numerical n = Numerical)	**Length**	**Characteristic**
(01)	GTIN	14	an	variable	optional
(21)	Serial Number for GTIN items	20	an	variable	optional
(00)	SSCC – Serialized Shipping Container code	18	n	variable	optional

Table 21: Application Identifiers according to GS1 definition recommended by the FEEM

In the following paragraphs the two mandatory fields are described in detail:

The **"Country & Production Site No."** consists of two alpha characters representing the country where the manufacturer or the importer is situated. Three numeric characters do follow, representing the production site within the country. This number is issued by national authorities. The AI used is defined as "Information Agreed between Trading Partners" by ANSI MH10.8.2.

The **"Unique Item Number"** can have up to 30 alphanumeric characters. This provides companies the possibility to design a system for the unique identification of each explosive object according to their individual needs. Within ANSI MH10.8.2 the AI used is described as "Secondary Serial Number". The same AI can be used for identifying and tracing logistical units like bags, cases or pallets.

In addition to the recommendations regarding the identification of the explosive objects FEEM is giving some suggestions for exchanging information between companies. Therefore, FEEM recommends using XML files and provides some structure examples.

15.5.2VDA 5510

In order to realize efficient cross company supply chains within the automotive industry the "Verband der Automobilindustrie e.V. (VDA)", representing the German automotive industry, has published recommendations for the implementation of RFID. Those recommendations enable automotive companies to set up RFID implementations based on common standards ensuring the use of RFID in cross company applications. The RFID recommendation published by the VDA are currently the newest recommendations within the global automotive industry, that is why they are considered within this report. Most interesting for this report is the recommendation VDA 5510 for tracking parts and components in the automotive industry as well as the general recommendation for the use of UHR RFID VDA 5500.

Within VDA 5500 it is stated that the use of UHF RFID transponders according to ISO/IEC 18000-63/ EPC Class 1 Gen 2 (Air Interface) is suggested. The recommendation supports the implementation of RFID. General information about possible transponder types, positions and mounting options are given. Moreover, general challenges for the use of RFID are expressed.

Regarding the encoding of the information within the RFID transponder the VDA suggests using ISO/IEC standards. Based on this suggestion the encoding of Memory Bank (MB) 01 (UII) and 11 (User Memory) is described. The encoding of MB 01 is already well defined within the VDA recommendations. When using MB 11, the automotive industry has not yet agreed on binding application standards, therefore the precise definition of the encoding of MB 11 needs to be agreed bilaterally between the supply chain partners. In order to protect the UII against misuse it is suggested to apply appropriate read-/write protection. Moreover, it is suggested to deactivate the transponders Kill-Password to ensure that the transponder could not be deactivated. This description is included in the VDA recommendation.

For having the option to identify the object manually or with optical identification the encoded data should be visible in plain writing and as Data Matrix code having Data Identifiers according to ISO/IEC 15418. An example of the label for tracking parts and components according to VDA 5510 is pictured in Figure 35.

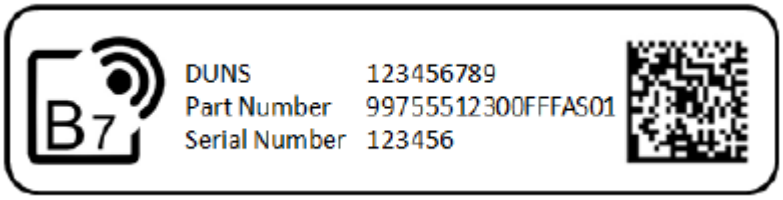


Figure 35: Example of label for tracking parts and components according to VDA 5510

In addition to the description how RFID should be implemented it is described briefly how RFID-specific data exchange within companies and in cross company applications should be realized. Therefore the VDA recommends using EPC Information Services (EPCIS) and EDI standards.

The data on the RFID transponder for tracking parts and components according to the VDA recommendations is 6-bit encoded and structured like pictured in Table 22. According to ISO 17367 the Application Family Identifier (AFI) A1 or A4 (for hazardous materials) should be used when tagging parts and components with RFID transponders.

DI	IAC	CIN	PN	+	PSN
Data Identifier	Issuing Agency Code	Company Identification Number	Part Number	Separator	Part Serial Number
37S	UN	Variable	Variable	Fix	Variable
3 char (an)	2 char (an)	9 char (n)	X char (an)	1 char (an)	Y char (an)

Table 22: UII data structure for parts and components according to VDA

The Data Identifier 37S used according to ISO/IEC 15418/ANSI MH10.8.2 enables the filtering for parts and components when identifying a huge number of RFID transponders. Moreover it indicates the data structure (see Figure 35). Dun & Bradstreet is the issuing Agency recommended by the VDA, nevertheless the use of other agencies is possible. Company Identification Number is depending on the Issuing Agency. The length of the Part Number and the Part Serial Number is variable by separating them with "+". Nevertheless the length of the UII is limited by the storage capacity of the RFID transponder. As storing capacity for MB 01, where the whole UII is stored, the VDA recommends to use a maximum of 40 alphanumerical characters, resulting in the need for 240 bits of memory in MB 01.

15.5.3Item Unique Identification at the Department of Defence

The so called Item Unique Identification (UID) policy of the U.S. Department of Defense (DoD) is aiming at marking each item with acquisition costs of $5,000 or more as well as other items being of special interest as defined by the DoD. By marking each item, the inventory management and purchasing should be improved. Moreover audits, data capture, operational readiness, life cycle management costs should be improved. For marking military items the DoD has published the Standard Practice "Identification Marking of U.S. Military Property - MIL-STD-130".

Therefore, each item should be marked with an Item Unique Identification (IUID) being machine-readable as well as human readable information. The Data Matrix Code with Error Correction Code 200, using ISO 15434 syntax and ISO 15418 semantic, was chosen as standard for automatic identification. For naming the data areas, a machine and human readable list of preferred data area titles is published within the standards appendix. Marking of the items can be done by direct parts marking or by affixing a label or plate. The method for attaching the marking is not strictly defined, but it should be assured, that it is as permanent as the item to which it is affixed.

The data structure encoded in the Data Matrix Code can be done in three different ways.

Serialization can be done within the Enterprise Identifier. The structure of this option, named as Construct #1, is pictured in Figure 36:

Issuing Agency Code	**Enterprise Identifier**	**Serial Number**

Figure 36: Serialization within the Enterprise Identifier according to DoD

The Issuing Agency has been listed in ISO/IEC 15459-2 and issues the Enterprise Identifier (also named as Company Identification Number). In order to ensure that the IUID is unique, the company itself has to ensure that the Serial Number used is unique within the Enterprise Identifier. Characters of the Serial Number can be alphanumeric.

Serialization can be done as well within the Original Part, Lot or Batch Number. The structure of this option, named as Construct #2, is pictured in Figure 37:

Issuing Agency Code	**Enterprise Identifier**	**Part Number**	**Serial Number**

Figure 37: Serialization within the Original Part, Lot or Batch Number according to DoD

According to the Issuing Agency Code and the Enterprise Identifier the characteristics are the same as those for a serialization within the Enterprise Identifier. The Part Number and the Serial Number can also have alphanumeric characters. Different to the serialization within the Enterprise Identifier is, that the Part Number is assigned to a class of objects. For identifying each item a unique Serial Number is needed additionally. The company assigning the Part Number and the Serial Number has to ensure that the combination of Part and Serial Number is unique within the Enterprise Identifier.

Serialization can be done as well with IUID Equivalents. This offers the possibility to use already well established identifiers to meet the DoD requirements. Therefore the identifiers have to meet the following criteria:

1. Contains an Enterprise Identifier,
2. Identifies an item uniquely within an Enterprise Identifier,
3. Having a Data Identifier (DI) or Application Identifier (AI) listed in ANSI MH10.8.2.

Currently the following four unique identifiers do meet the mentioned criteria:

1. The Global Individual Asset Identifier (GIAI) according to GS1 for serially-managed assets,
2. The Global Returnable Asset Identifier (GRAI) according to GS1 for serially-managed returnable assets,
3. The ISO Vehicle Identification Number (VIN) for vehicles,
4. The Electronic Serial Number (ESN) for cellular phones.

For encoding the data qualifiers have to be used to name the data elements. By the use of the data identifiers the imaging devices can determine, which type of IUID is used for interpreting the code in the right way. As data qualifiers Data Identifiers (DI) and Application Identifier (AI) according to ISO/IEC 15418, listed in ANSI MH10.8.2-2013 are used as well as Text Element Identifier (TEI) according to ATA SPEC2000 CSSD. The data qualifiers to realize an IUID according to DoD are pictured in Table 23:

Data Qualifiers	**Construct #1**	**Construct #2**	**DoD Recognized IUID Equivalents**
Data Identifiers	18S 25S	17V, 12V, 3V, 7L, 18V 1P or 1T S 25S	I 22S
Application Identifiers			8002, 8003, 8004
Text Element Identifiers	MFR , SPL, CAG , DUN, EUC, SER or UCN, UID, USN or UST	MFR, SPL, CAG, DUN, EUC, SEQ, PNO, LOT, LTN, or BII, UID	

Table 23: Data qualifiers for IUID constructs or equivalents according to DoD

In the following figures some examples of labels for item marking are depicted:

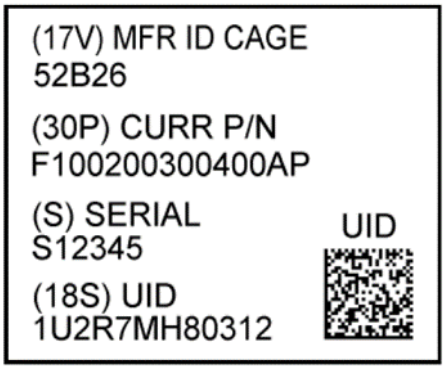


Figure 38: Example of a label for item marking according to DoD Construct #1

Figure 39: Example of a label for item marking according to DoD Construct #2

Figure 40: Example of a label item marking according to DoD IUID Equivalents

15.6 Commission Initiatives and Directives

15.6.1 Commission Initiatives on E-market Surveillance

In 2014 the Commission used a consultation in order to receive opinions of Member States, consumers and (economic) operators such as manufacturers, traders/authorised representatives, third party assessment bodies for a European eCompliance system. Since product life cycles become shorter it seems to be necessary to explore how compliance with EU harmonisation legislation can be demonstrated/controlled electronically ("eCompliance" concept).
The new system is supposed to reduce administrative burden for equipment manufacturers and support the control activities for market surveillance operators, notified bodies and port authorities. This activity resulted in a "Provisional options regarding a future eCompliance system" issue by the Directorate-General (DG) for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW) which will be due for an impact assessment in the near future. It is foreseen that the assessment will be carried out once the options are finalised and following a wider consultation of interested parties. As far as possible these activities have been taken into consideration within this study.

15.6.2 Commission Directives on Eco-design and Energy Labelling

The eco-design Directive (Directive 2009/125/EC) and the energy labelling Directive (Directive 2010/30/EU) are very important in the European strategy to reduce energy and resource consumption. Both harmonised European standards are complement regulations. These technical standards indicate that a product complies with the mandatory requirements. The manufacturer can only affix the CE marking and sell the product in the EU if the compliance with the standard is detected. The eco-design directive is focusing on two categories of products; energy-using products (products which generate, transfer or measure energy or have an impact on energy consumption).
The EC plans to update the energy labelling to increase the transparency. In addition, the market surveillance should be strengthened and digitized. Therefore, a new centralised or de-centralised database should be established. Every supplier should upload his conformity documentation. The national market surveillance authorities as well as the EC should get access to the database. This approach is still under discussion.

16 Introduction of Electronic Tags

16.1 General Characteristics of Electronic Tags for MED Applications

The previous chapters include the description of the different types of electronic tags including their advantages and disadvantages. Independent from the selected technology the electronic tag includes a unique identifier with a product reference. This reference allows the collection of all available data by establishing connections to all or to selected databases. It will also support the clear identification of a product and the reporting procedures in case of conformity doubts. The scenario projections 2030 (see chapter 17.1) assume that the following requirements can be fulfilled:

- all marine equipment is marked with electronic tags,
- electronic tags fulfil all maritime requirements (low maintenance, Classification Society acceptance[27] and resistant against harsh environmental conditions),
- the electronic tags are readable by different kind of readers,
- the tag readers can be combined with a camera to support the product identification (in case of counterfeiting) and reporting [mainly market surveillance],
- the tags readers are simple to use, small and light weight as well as mechanically robust,
- the tag readers have direct access to all important databases (unified database interface),
- a unique identifier has been defined for electronic tags which is flexible enough to support existing and future processes for all involved parties and
- a unique identifier has been defined for electronic tags which can carry also information of hazardous materials [mainly for ship recycling].

Some of these requirements are similar to other industrial application areas while other require additional activities (e.g. unique identifier for marine equipment).

16.2 Challenges to be Considered Related to Electronic Tags for MED Applications

The implementation of eTags for marine equipment products will:

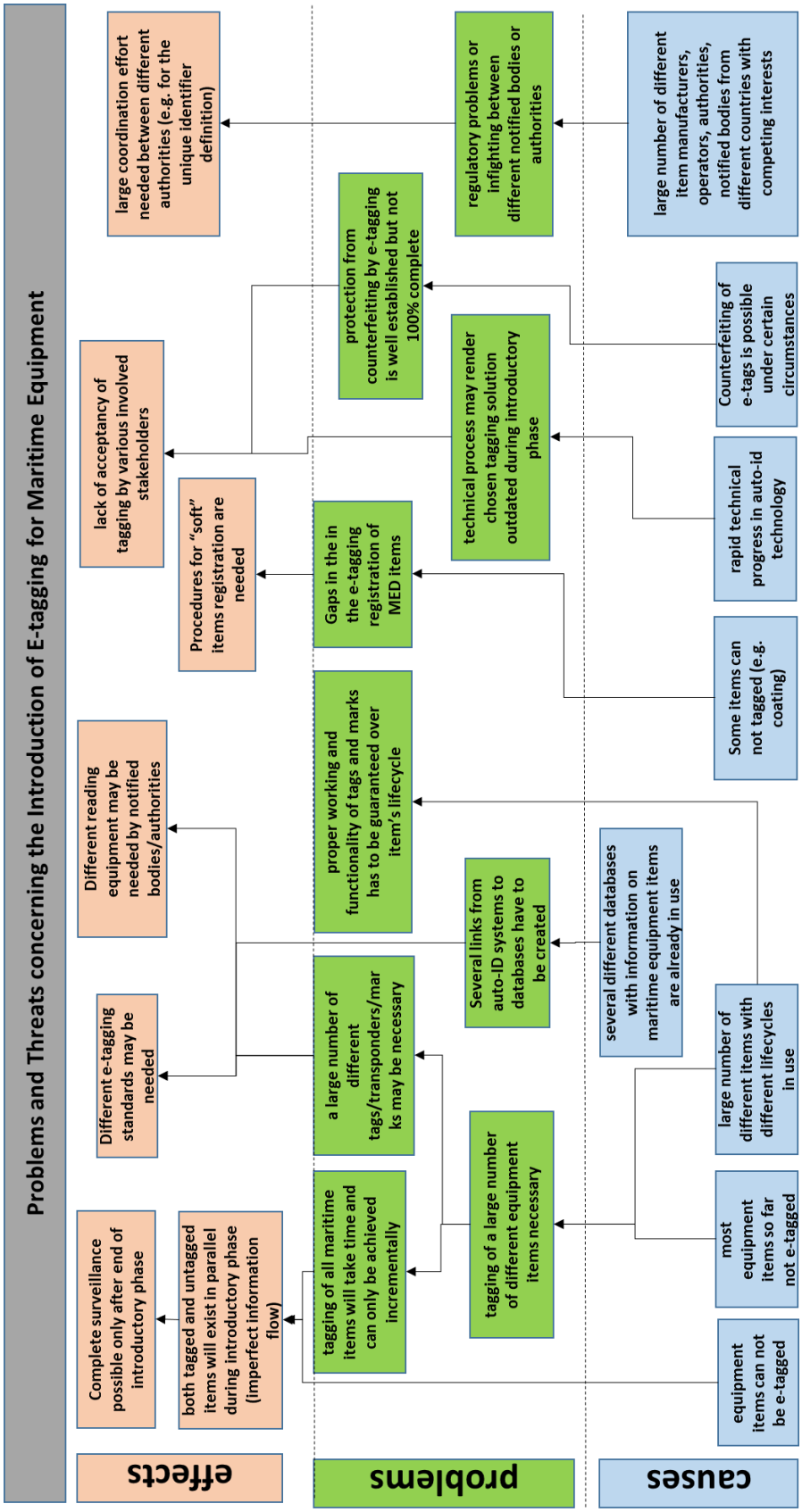
- introduce a new approach for all stakeholders involved
- assure better information to market surveillance
- create continuous information flow between manufacturers, Notified Bodies and authorities;
- improve the fight against product piracy.

But wheel marks plus eTags are always required to work in a traditional way without any additional equipment and to bridge technology problems. An example is shown in the following figure.

[27] Classification society acceptance: It needs to be clarified if active eTags need a class approval before on board installation.

Figure 41: Example for eTag plus wheel mark identifier

16.3 Problems and Threats



17 Cost/Benefit Analysis

The principle Cost-Benefit Analysis (CBA) includes four main areas. The initial basis for the CBA calculations is the different **application scenarios and the involved technologies** (top left quadrant). During the analysis, the scenarios can be adapted or additional scenarios can be defined to find the best benefit-cost ratio (B/C). This analysis step includes a first brainstorming for the not quantified costs and benefits per application scenario. The second step (top right quadrant: financial analysis) includes the **assignment of monetary values to the different cost categories**. Within this step monetary values will be assigned to the benefits and the **costs and benefits will be compared** (economic analysis - lower right quadrant). This includes also the consideration of social opportunities costs and externalities. *Externalities* are defined as losses or profits in the welfare of one party resulting from activities of another party, without compensation for the losing party. Finally, the CBA includes a **risk assessment and mitigation strategy discussion** (lower left quadrant) in respect of cost and benefit for the selected application scenarios.

Scenario definition and selection

A typical selected scenario should ascertain that the demand for services in the future will be adequate (long run forecasts), appropriate technology is available, the utilisation rate will not reveal excessive resources (e.g. personnel skills, spare capacity) plus additional criteria t.b.d. The justification of the project design (scale, location, etc.) against alternative scenarios ('business as usual', 'do-minimum', 'do-something' and 'do-something else') should be assured.

1

Financial Analysis

Cash inflows and outflows should be calculated related to:

- investment costs;
- implementation costs (incl. training)
- operating costs and revenues;
- financial return on the investment costs: FNPV (Financial Net Present Value) and FRR (Financial Rate of Return of the Investment)
- financial return on capital

2

Risk Assessment

The risk assessment includes:

- sensitivity analysis (identification of critical variables, elimination of deterministically dependent variables, elasticity analysis, choice of critical variables, scenario analysis);
- assumption of a probability distribution for each critical variable;
- discussion of results, acceptable levels of risk and of ways to mitigate risks.

4

Economic Analysis

Investigation of economic welfare is done in five steps:

- observed prices or public tariffs are converted into shadow prices, that better reflect the social opportunity costs;
- externalities are taken into account and given a monetary value;
- indirect effects are included if relevant
- costs and benefits are discounted with a standard discount rate (actual rate will be considered)
- calculation of economic performance indicators: economic net present value (ENPV), economic rate of return (ERR) and the benefit-cost (B/C) ratio.

3

Figure 42: Cost-Benefit Analysis

Based on this structure the study "Assessing the costs and benefits of regulation"[28] has been considered within the CB Analysis were appropriate.

The costs/benefits analysis bases on monetary values. Nevertheless, the analysis includes also critical reviews to check if the assumptions behind the monetarization are robust. Therefore, additional cost categories like e.g. the "standardisation costs" is

[28] Study for the European Commission, Secretariat General - Research Team 2013

separated as a specific cost category (also because reduction of administration is probably the main benefit from introducing an electronic system).

17.1 Scenario Projections 2030

Within this chapter, the different phases defined in chapter 12 form the basis for the scenario projection 2030 (i.e. after around 10 years from the possible implementation). The scenario gives a rough outline how the individual processes may change under the application of eTags.

17.1.1 Effect of the eTag Implementation on Approval Process

The implementation of electronic tags will bring very limited changes to the approval processes. The eTag will first be attached to the device when all tests have been passed and the equipment is approved.

In general, electronic tags can be used for internal processes and improved access to quality data (at supplier site) of similar equipment. It can also support the identification of an equipment type at different places in the company.

17.1.2 Effect of the eTag Implementations on Market Surveillance

In 2030 eTags will be used for the market surveillance processes. The tags will influence the processes through faster access to more actual information. The following table defines the parties involved in the market surveillance processes, the related processes, the activities which could be supported by eTags in the future and the databases involved.

Involved parties	Process	Activity	Involved data sources
Market surveillance	Assurance of equipment conformity and safety	Assure equipment conformity by checking equipment certificates at every time and every place by direct access to the MarED Product Database and NANDO (to verify Notified Body authorisation). >Speed up the surveillance processes by direct access to databases via electronic tag readers	MARED NANDO
		Location-based alerts in case of product safety problems by direct access to RAPEX database. The warnings (including the problem description) appear every time the market surveillance reads the tag. >Speed up the processes to prohibit the placing on the market of products by direct access to database via electronic tag readers	RAPEX

Involved parties	Process	Activity	Involved data sources
	Reporting process	The identification of the equipment is easier by electronic tags. The information needed to inform the Commission and the Member States of formal non-compliance products or products with a serious risk can be generated automatically. >Reduction of reporting time.	Process has to be defined

17.1.3 Effect of the eTag Implementations on Ship Construction

While the electronic tags will not be used during the vessel specification phase (contract preparation), eTags used during the construction and the sea trial phase will ease the processes through faster access to more current information. The electronic tag includes a unique identifier with a product reference. This reference allows the collection of all available data by establishing connections to all or to selected databases. This includes the internal databases of the manufacturer and the suppliers to track each and every instance of the product by means of its serial or contract number. Depending on the agreed unique identifier (see chapter 13.2.5) every product can be tracked individually without additional costs. The direct access to the MarED database via the eTag reader allows tracking the validity of the certificate.

Within the different ship construction processes different actors will benefit more or less from the application of electronic tags (see following table). The more product groups and processes are supported the higher is the benefit from this technology.

Involved parties	Process	Activity	Involved data sources
Equipment manufacturer	Logistic	Contract related tracking and tracing of the equipment from manufacturer production sites to the shipyard. Even if different batches of the same MED equipment are produced at different sites it could be tracked. This requires that the production site information is part of the unique identifier (see chapter 13.2.5). >Improvement of logistical processes.	Internal database
	Installation	Installation support by electronic installation manuals available on manufacturer public databases. >Reduction of installation and troubleshooting time.	Internal/ public database

Involved parties	**Process**	**Activity**	**Involved data sources**
	Quality Assurance	Failure reports and debugging procedures available on manufacturer internal databases >Reduction of installation and troubleshooting time.	Internal database
	Warnings	Location-based alerts in case of product safety problems by direct access to RAPEX database. The warnings (including the problem description) appear every time the manufacturer reads the tag at installation site. This requires a unique identifier as described in chapter 13.2.5. >Reduction of reaction time to safety related problems	RAPEX
Ship yard	Assurance of valid certificates	Assure valid equipment certificates at every time and every place during the ship construction by direct access to the MarED Product Database and NANDO (to verify Classification Society responsibility). >Speed up the production processes by reducing waiting times for certificates and certificate reviews	MARED NANDO
	Logistic	Tracking and tracing of the equipment on yard site >Improvement of internal logistical processes.	Internal database of the ship yard/ supplier
	Installation	Installation manuals and documentations available on manufacturer public databases can support the final installation. >Reduction of installation and troubleshooting time.	Public database of the manufac-turer
Flag state and Classificatio n Society	Assurance of valid certificates	Assure valid equipment certificates at every time and every place by direct access to the MarED Product Database and NANDO (to verify Classification Society responsibility). > Reducing waiting times for certificates and certificate reviews	MARED NANDO ICSMS
	Approval process	Failure reports as results of on board checks (during sea trails) can be distributed electronically to all participating. >Reduction of troubleshooting time and decreasing of approval process time.	Process has to be defined

Involved parties	**Process**	**Activity**	**Involved data sources**
	Warnings	Location-based alerts in case of product safety problems by direct access to RAPEX database. The warnings (including the problem description) appear every time the manufacturer reads the tag at installation site. >Reduction of reaction time to safety related problems	RAPEX
Ship owner	Assurance of valid certificates	Assure valid equipment certificates at every time and every place during the ship construction by direct access to the MarED Product Database and NANDO (to verify Classification Society responsibility). >Speed up the production processes by reducing waiting times for certificates and certificate reviews	MARED NANDO
	Logistic	Tracking and tracing of the equipment on board (including internal failure reports/statistics) >Improvement of spare part logistical processes.	Internal database
	Mainte-nance and repair	Maintenance and repair support by electronic installation manuals available on manufacturer databases. >Reduction of maintenance and troubleshooting time.	Public database of the manufac-turer
	Warnings	Location-based alerts in case of product safety problems by direct access to RAPEX database. The warnings (including the problem description) appear every time the manufacturer reads the tag at installation site. >Reduction of reaction time to safety related problems	RAPEX

17.1.4Effect of the eTag Implementations on Ship Operation

As well as in the ship construction scenario projection the ship operation can be improved by faster access to more up-to-data information. Within the ship operation phases different involved parties will benefit more or less from the application of electronic tags. The following table shows the different processes and the related involved parties which would benefit from the introduction of eTags.

Involved parties	Process	Activity	Involved data sources
Equipment manufacturer	After sales support	Maintenance and repair support by electronic manuals available on manufacturer databases. Existing failure reports and already documented solutions can be offered to the vessel crew. Spare part management by exact identification of the installed parts. Vessels crew can read the unique identifier equipment and order the right spare parts. >Reduction of repair and troubleshooting time.	Internal/ public database
Ship yard [docking & repair]	Assurance of valid certificates	Assure valid equipment certificates at every time and every place during the ship construction by direct access to the MarED Product Database and NANDO (to verify Classification Society responsibility). >Speed up the production processes by reducing waiting times for certificates and certificate reviews	MARED NANDO
	Logistic	Tracking and tracing of spare parts on yard site >Improvement of internal logistical processes.	Internal database
	Installation	Installation support for spare parts by electronic installation manuals available on manufacturer public databases. >Reduction of installation and troubleshooting time.	Public database of the manufac-turer
Flag state and Classification Society	Assurance of valid certificates	Assure valid equipment certificates at every time and every place during the ship construction by direct access to the MarED Product Database and NANDO (to verify Classification Society responsibility). >Speed up the non-periodical surveys processes by immediate certificates and compliance checks	MARED NANDO

Involved parties	**Process**	**Activity**	**Involved data sources**
	Continuous checks of valid certificates	There is no need to find all the equipment on board the vessels. In the future the surveyor walks into a technical equipped room in a vessel with a list on his reader. The list includes all equipment relevant for certification. The reader receives automatically signals from all electronic tags in the room and produces a list of all valid and invalid certificates Incl. expiry date) in that room. Therefore direct connections to all relevant databases (MARED, NANDO and RAPEX) are necessary. >Speed up the non-periodical surveys processes by immediate certificates and compliance checks	Process has to be defined
	Warnings	Location-based alerts in case of product safety problems by direct access to RAPEX database. The warnings (including the problem description) appear every time the manufacturer reads the tag at installation site. Therefore the RAPEX database needs the operational capacity to support a lot of requests without downtime. >Reduction of reaction time to safety related problems	RAPEX
Ship owner	Assurance of valid certificates	Assure valid equipment certificates at every time and every place during the ship operation by direct access to the MarED Product Database and NANDO (to verify Classification Society responsibility). >Reducing waiting times for certificates and certificate reviews	MARED NANDO
	Logistic	Tracking and tracing of the equipment on board (including internal failure reports/statistics) >Improvement of spare part logistical processes.	Internal database
	Mainte-nance and repair	Maintenance and repair support by electronic installation manuals available on manufacturer databases. >Reduction of maintenance and troubleshooting time.	Public database of the manufac-turer

Involved parties	Process	Activity	Involved data sources
	Warnings	Warnings will be submitted in case of product safety problems by direct access to RAPEX database. The warnings (including the problem description) appear every time the manufacturer reads the tag at installation site. >Reduction of reaction time to safety related problems	RAPEX

17.1.5Effect of the eTag Implementations on Ship Recycling

In Europe the mandatory requirements for ship recycling are defined in Regulation No 1257/2013 [Regulation (EU) No 1257/2013 of the European Parliament and of the Council of 20 November 2013 on ship recycling and amending Regulation (EC) No 1013/2006 and Directive 2009/16/EC (1)]. It enters into force end of 2018 for newbuilt vessels and end of 2020 for other vessels (as far as practicable). The goal of this regulation is to enhance safety, the protection of human health and marine environment; in particular to ensure that hazardous waste from ship recycling is managed environmentally friendly. Two aspects of the regulation are mainly interesting for electronic tag applications.

1. **Inventory of hazardous materials** (Article 5 of the regulation) has to be on board of each new ship. This list should include the hazardous materials (defined in Annex II of the regulation) contained in the structure or equipment of the ship, their location and approximate quantities. The inventory of hazardous materials shall be properly maintained and updated throughout the operational life of the ship, reflecting new installations and relevant changes in structure and equipment of the ship containing any hazardous materials.
2. The second aspect is the **inventory survey** which leads to the inventory certificate. Before a ship is put in service an initial survey shall be conducted. The survey shall verify that the inventory of hazardous materials complies with the requirements of the regulation and the required ship recycling plan has been properly defined. After the successful completion of an initial or renewal survey the administration shall issue an inventory certificate which is valid for maximal 5 years.

During the operation of the vessel Port State Control has to review that the valid inventory certificate or a ready for recycling certificate is kept on board. A detailed inspection can be carried out by the Port State Control where a ship does not carry a valid certificate.

A ship may be detained, dismissed or excluded from the ports in the event that it fails to submit a copy of the inventory certificate or the ready for recycling certificate to the relevant authorities. In such a case the Member State shall immediately inform the flag state administration concerned.

The ship recycling scenario projection 2030 includes three different processes (see following table). While the inventory list of hazardous materials has to be prepared by the ship builder or owner the authority and the port state control can be supported by eTags for a rapid and comprehensive verification of the inventory lists.

Involved parties	Process	Activity
Equipment manufacturer Ship operator	Inventory list of hazardous materials	The inventory list of hazardous materials as part of the equipment can be offered via a manufacturer database. By reading the electronic tag the database can offer the required information. The electronic tag includes the list of hazardous materials (abbreviations for the substances – see Annex I+II of the regulation) or the CAS (Chemical Abstracts Service) registry number which is a unique numerical identifier to every chemical substance. The information can be collected over the whole ship by a reader and can be integrated into the inventory list. For every equipment change and new installation during the life cycle the inventory list can be easily completed by reading the electronic tag.
Relevant authority (Flag state and Classification Society)	Inventory survey	During the inventory survey the surveyor can check the correctness of the list by reading the electronic tags of the equipment. If a list per room is electronically available the reader can check out a complete room by entering that room.
Port state control	Detailed inspection where a ship does not carry a valid certificate	During the inspection the port state control can check the correctness of the list by reading the electronic tags of the equipment. The tag reader can check out a complete room by entering that room if a list per room is electronically available

The regulation for ship recycling is in place but the processes and tools for the definition of Inventory lists and inventory survey are still under development.

17.2 Scenarios for the CBA

Based on the discussions during the workshops Data Carriers must be resistant against different environmental conditions. These conditions may be challenging or even haphazard. Protection classes standardise the environmental properties a transponder is safeguarded, so they will not destroyed or hinder its functional performance. Today's state-of-the-art shows, that data carrier technology is available for almost all equipment under the maritime equipment directive.

The benefit and the necessary required effort depends very much on the implementation levels of the electronic tag technologies and the selected options for the MED unique identifier implementation. The implementation levels can be categorized into three possible levels (level 1– 3) which are the basis for Cost/Benefit Analysis. The three selected scenarios are compared to the baseline scenario. The following implementation scenarios have been selected for a deeper analysis:

	Baseline Scenario: No use of E-Tags	**Scenario Level 1: Electronic tags with MED Certificate number(s) only**	**Level 2: Electronic tags with MED Certificate number(s) and item code**	**Level 3: Electronic tags with MED Certificate number(s) and codes for product traceability on different level**
Marking	Wheel mark plate	MED Certificate number	MED Certificate number + product class level information	MED Certificate number + product codes (e.g. products serial codes and/or lot/batch codes and/or GS1 application identifier)
Investment required (detailed costs calculations are part of the detailed scenario descriptions)	no	European Commission – DG MOVE / EMSA	European Commission DG MOVE / DG Justice / DG GROWTH	European Commission DG MOVE / DG Justice / DG GROWTH / Industry

Table 24: Scenario overview

The cost benefit analysis follows the logic of Figure 42. Four main cost categories have been identified:

- Investment
- Implementation
- Operation (incl. training) and
- Maintenance

The **investment costs** include the necessary hardware and software to use the electronic tag technologies. Two kinds of data carriers have been recommended within chapter 13.2.1.6 and 13.2.2.7 These are Data Matrix and RFID. For the first cost estimations, only these two kinds of carriers including the necessary hardware are considered and the average investment costs are listed to get an estimation of the necessary investments. Hardware for special environments like for explosive environments (e.g. oil rigs, tankers) will be more expensive and will not be in the focus of the study.

The **implementation costs** include the required effort to adapt the processes, implement database interfaces or develop additional applications. The scenario descriptions and the experiences of demonstrators have shown indicators for the implementation costs. Nevertheless, there are always organisation specific costs involved which can only be calculated after an internal processes review.

Operational costs include the prices for the different label types and the training for the operation of the technology. In general, a **training session** of 2 person days should be sufficient (expert judgement). It might be more if the implementation of

electronic tag technology becomes part of a complex production line (automatic application of labels). The estimated daily training costs of 1.000 € include 800 € for the trainer (market price - Germany) and 200 € for the employee of the organisation (average rate from EUROSTAT 2015[29])

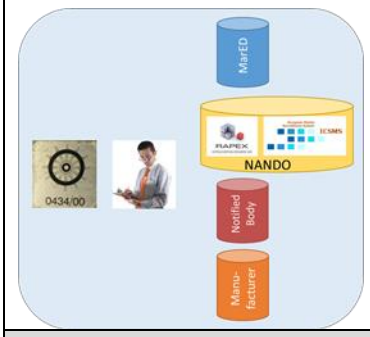
The **prices of the labels** differ depending on the technology used. The basis for the study are average prices. For higher order volumes, there might economy of scale.

Label type	**Prices per unit (estimated prices)**
Type plates with RFID	0,5 - 2 € (additional)
Type plates with data matrix 0	no additional costs
Encapsulated transponders	up to 1 €
Smart labels with RFID option	0,2 – 1 €
Label with data matrix	no additional costs

The costs for **maintenance & administration** are usually around 10% of the investment costs per year (estimations based on industrial eTag project implementations).

[29] http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Estimated_labour_costs_for_the_whole_economy_in_EUR,_2015.png#filelinks

17.3 Baseline Scenario Implementation

<table>
<tr><td>Baseline Scenario
<table><tr><td>Scenario</td><td>Finance</td></tr><tr><td>Risk</td><td>Economic</td></tr></table></td><td colspan="2">Electronic tags will not be used for the MED Certificate Number – Business as usual</td></tr>
<tr><td rowspan="2"> 
</td><td colspan="2">Description: There will be no implementation of eTags. All procedures will be handled as today.</td></tr>
<tr><td>Marking:
Wheel mark - Mark of Conformity plate</td><td>Reading:
Human</td></tr>
</table>

The baseline scenario includes business as usual. All MED items are marked with the wheel mark plate. Consequently, all stakeholders involved in the management of marine equipment must read the marking information manually. If they need additional product related information they must search within the different databases by taking the wheel mark or related product information (manufacturer name, type of equipment, etc.). The search process is time consuming for market surveillance, Notified Bodies, classification societies, flag states, etc. and it requires a lot of effort. The user must manage different search mechanism and interfaces for the public databases but also for the private databases.

Information management processes in respect of maritime equipment will be slow, will require a lot of manual effort and provide reduced information quality (because items might not be identified in the related databases) and no continuous information flow between manufacturers, Notified Bodies and authorities. A continuous information flow would however enable product traceability and therefore a reduction of counterfeits and the support of product recall procedures.

Within the baseline scenario no activities are required from the stakeholders. All partners will do their business as usual. The search of documents will be time consuming as well as the identification of counterfeited products. Improvements for the COM databases (NANDO, RAPEX, ICSMS and MarED) in respect of user interfaces and the interconnections will lead only to marginal improvements.

Equipment manufacturer will define their own labelling procedure to optimise their logistical and other processes. This has already been started. Later eTag implementations may require different reading procedures in parallel which already have been established by the manufacturer at that time.

Another way could be to impose the manufacturers to use procedures and technologies defined by the Notified Bodies. Both approaches require much more investments as required today, because all partners must support multiple tagging procedures or must define migration services or procedures.

17.4 Scenario Implementation Level 1

Scenario Level 1 Scenario / Finance / Risk / Economic	**Electronic tags will only be used for the MED Certificate number**	
	**Description:** An electronic tag will be used bearing only the MED Certificate number. The information could be stored on an RFID tag or as Data Matrix code. The eTag will always be combined with a "Mark of Conformity Plate" which opens the opportunity to read it without technical equipment like e.g. readers, Apps, etc*. In short words: The "wheel mark" on the label becomes electronical readable.*	
Marking: *MED certificate number* • eTag plus • Wheel mark - Mark of Conformity plate	**Reading:** • Reader device & MED App • Human	**Access Opportunities:** • MarED database

Implementation Option	**Required Actions**
Level 1 – Option 0A: Identifier implementation based on GS-1	GS1 coding scheme will be used to reduce the implementation effort. The predefined approach (coding structure) must be adjusted with GS1 based on their recommendation for the data exchange and number structure.
Level 1- Option 0B: Identifier implementation according standards	Existing data identifier structures defined by ISO standards will be used. A MED data identifier must be agreed upon ISO body. The solution is independent from specific service suppliers.
General requirement for both options	General MED data identifier and its structure needs to be defined and must be specified in a recommendation.

Scenario Level 1 Scenario / Finance / Risk / Economic	Financial analysis includes the **assignment of monetary values to the different cost categories**. Only additional costs arising from application of eTags are mentioned. Remark: Within this table only the cost per stakeholder and unit are mentioned. The overall number of manufacturers willing to introduce electronic tagging is given in a summary table at the end of every scenario description.		
Cost categories	**Topic**	**Cost Range**	**Concerned Institutions**

Investments	Printer for eTags • Professional writer/printer for Smart labels or DataMatrix labels • Professional mobile RFID writer	1.500 €	Manufacturer
	Reader • RFID reader: 1.500 € • Data Matrix Reader: 300 € (SmartPhone) to 1.200 €	300 € – 1.500 €	Manufacturer; Market Surveillance
	MED App (for Apple & Android operation systems): Software for mobile devices to collect the eTag information and access the MarED database. Cost of an average App. are mentioned here.	10.000 €	European Commission – DG MOVE / EMSA
	Development of a MarED database interface to enable access based on eTag data	38.000 €	European Commission – DG MOVE / EMSA
Implementation costs	Setting up the technical format with ISO Reference: *"Support Study for the Fitness Check (FC) - Evaluation of passenger ship safety legislation."* Remark: The data structures are predefined and require not a complete standardisation process. Therefore, we expect that 50% of the cost for a complete standardisation process will occur.	12.000 €	European Commission – DG MOVE / EMSA or industry
Operational costs	Costs for RFID eTags per unit	0,5 € - 1,0 €	Manufacturer
	Costs for DataMatrix per unit	0 €	Manufacturer
	Training (up to 2 days) Remark: A training session of 2 person days should be sufficient (expert judgement). It might be more if the implementation of electronic tag technology becomes part of a complex production line (automatic application of labels). The estimated daily training costs of 1.000 € include 800 € for the	1.000 €	Manufacturer, Market Surveillance

	trainer (market price - Germany) and 200 € for the employee of the organisation (average rate from EUROSTAT 2015[30])		
	Service fee for GS1 (only for option 0A) GS1 basic fee (only once) for • Up to 1.000 numbers 230 € • Up to 10.000 numbers 330 € • Up to 100.000 numbers 530 € Plus, a yearly fee (depending on the actual company turn over) • up to 25 Mio € -> 420 € • up to 50 Mio € -> 670 € • up to 250 Mio € -> 1.900 € Source: https://www.gs1-germany.de/gs1-complete/konditionen/ The selection of a commercial service for the implementation and operation is a company's own decision. Nevertheless, for using the MED approval number it is not mandatory. Therefore, the service costs will not further discussed within the CBA.	330 € (up to 10.000 numbers) 670 € (annual fee for companies up to 50 Mio € turnover)	Manufacturer
	Communication costs (per year and reader) for all mobile connections to the MarED database (Communication tariffs based on Deutsche Telekom for unlimited data volume)	270 €	Market Surveillance
Maintenance costs	Maintenance costs per year (software updates and user support) for RFID reader and	240 €	Manufacturer

30 http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Estimated_labour_costs_for_the_whole_economy_in_EUR,_2015.png#filelinks

	printer (10% of investment coasts)		
	Maintenance costs per year (software updates and user support) for Data Matrix code reader (if smart phone is not used) (10% of investment coasts)	90 €	Market Surveillance
	Maintenance costs per year (software updates and user support) for Data Matrix code reader on smart phones	0€	Market Surveillance
Benefits			
Faster data acquisition	Marine equipment inspections will be much faster than today (from several weeks down to a couple of days). But this requires that test reports and DoC are also available in the MarED database.	Reduction of economic harm of 5,74 Mio € yearly (0,1% higher success rate)	Market Surveillance
Market damage would be reduced	More equipment can be analysed within the same time and therefore more counterfeit products will be recognised. The discovery of additional 0,1 % counterfeit products would reduce the market damage by 5,74 Mio €.		Market Surveillance

Background:

MED App: Basis for the calculation are simple Apps for Apple and Android mobile systems. The final price depends very much on the specification and is always subject to specific contractual arrangements. The Apps will be offered free of charge by the European Commission – DG MOVE / EMSA.

MarED Database: The MarED database requires some additional interface functions to enable the access based on eTag data. Additional security levels must be implemented. The costs for the database adaptations are rough estimations. The final price depends on the detailed specification of the required functionality.

Counterfeit products: A VDMA study found out that 71 percent of companies affected by product or brand piracy. The estimated loss only for the German machine and plant construction industry is 7.9 billion euros annually (related to a turnover of 205.8 billion Euros) (VDMA Studie Produktpiraterie 2014). A turnover of 7.9 billion Euro would save almost 38,000 jobs to the industry. In addition to the loss of sales and jobs, there are also consequences that are difficult to assess like e.g. loss of image, loss of market leadership or unjustified regress requirements. The amount of companies that have encountered plagiarism after complaints or information about security deficiencies are growing continuously. More than 25% of all companies had to ward off unjustified claims (e.g. product liability, guarantee). Based on the study in

around 4% of all cases manufacturers have been made aware by authorities (market surveillances).

The overall global production value, which by the same time represents the average world market figure for marine supplies is calculated to 149,06 billion Euros (Source: COMPETITIVE POSITION AND FUTURE OPPORTUNITIES OF THE EUROPEAN MARINE SUPPLIES INDUSTRY" – 2014). If 3,85 % of that market is related to product piracy it would mean the market damage includes 5,74 Billion Euros. (0,1% correspond to 57,4 Mio €).

Summary table of cost/benefit per categories and stakeholder:

Cost categories (average values)	Manufacturer	Market Surveillance	European Commission – DG MOVE / EMSA
Investments	1.500 € (printer) + 900 € (average reader) = 2.400 €	900 €	48.000 €
Implementation	-	-	12.000 €
Training	1.000 €	1.000 €	-
Operation	75 € for 100 units (average price) Remark: The amount of units depends very much on the product category. Some manufacturers might need only a few units per year while others require much more than the defined 100 units per year.	270 € (communication costs)	-
Maintenance	240 € per year (10 % of investment)	90 € per year (10 % of investment)	-
Amount for ISO standard implementation (first year) per stakeholder	3.715 €	2.260 €	60.000 €
Number of users	60 (1 % market penetration) (6.000 European suppliers are registered in the MarED database) A low market penetration is expected from the manufacturer side because of the low benefit.	20 (70 % market penetration) (28 organisations are listed for Maritime equipment (sector 26)	1
Costs for the first year based on expected market penetration	**222.900 €**	**45.200 €**	**60.000 €**
Yearly costs based on expected market penetration	60 * 315 € = 18.900	20*360 € = 7.200 €	0 €

Quantifiable benefits	-	Reduction of economic harm up to 5,74 Mio € yearly.	-

Yearly figures	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5 (replacement of hardware)**	**Summary after 5 years**
Cost	328.100 €	26.100 €	26.100 €	26.100 €	294.200 €	700.600 €
Benefit	5.740.000 €	5.740.000 €	5.740.000 €	5.740.000 €	5.740.000 €	28,70 Mio €

Scenario Level 1 Scenario / Finance Risk / Economic	Costs and benefits will be compared and evaluated. This includes also the consideration of social opportunity costs and other externalities (as losses or profits in the welfare of one party resulting from activities of another party).
Qualitative assessment	**Manufacturer:** No benefit within this scenario **Market surveillance:** Higher amount of pro-active checks without additional personnel Positive effect for the market surveillance More maritime equipment can be analysed within the same time and therefore more counterfeit products will be recognised (High externalities benefits). **European Commission:** Improvement of market surveillance and reduction of the amount of counterfeit products

Scenario Level 1 Scenario / Finance Risk / Economic	Risk level	Risk assessment and mitigation strategy discussion in respect of cost and benefit for the selected application scenario.
Equipment cannot be tagged	Low	There is a very low amount of equipment which cannot be tagged by nature (e.g. colour) or for different other reasons. But tagged and untagged items can be analysed because of the coexistence of eTagging and the wheel mark - Mark of Conformity plate.
Maritime equipment has a long lifecycle and eTags need to be readable for a long time	Low	The eTags have a nearly unlimited notability guarantee. As a back-up, the wheel mark - Mark of Conformity plate is always available.
Several different databases are in use and need to be addressed by the eTag.	Low	If a general MED data identifier and structure is defined and the database can serve that number, it will be possible to access all databases.
Unified identifier	Medium	Different MED data identifier would require

definition between the different authorities failed.		additional effort to translate the different identifier (one ident number info into another ident number and vice versa), but it would not stop the implementation.

SUMMARY: With a limited investment, the analysis of counterfeit products becomes much quicker and the success rate will increase. The disadvantage of this scenario is the low flexibility for additional applications. Only MarED database related processes are supported.

17.5 Scenario Implementation Level 2

<table>
<tr><td>Scenario Level 2
<table><tr><td>Scenario</td><td>Finance</td></tr><tr><td>Risk</td><td>Economic</td></tr></table></td><td colspan="2">Electronic tags with MED Certificate number and item code</td></tr>
<tr><td> 
</td><td colspan="2">Description: An electronic tag will be used which includes the MED certificate number and the item code stored on an RFID tag or as Data Matrix code. The eTag will always be combined with a “Mark of Conformity Plate” which opens the opportunity to read it without technical equipment like e.g. readers, Apps, etc. The “wheel mark” on the label becomes electronical readable with additional information (D-U-N-S® [26] number plus item code). The D-U-N-S® number allows to identify the manufacturer site. The item number allows to identify a product class (a group of similar products).</td></tr>
<tr><td>Marking:
MED Certificate number + D-U-N-S® [26] number + item code
• eTag and
• Wheel mark - Mark of Conformity plate</td><td>Reading:
• Reader device & MED App++ (with extended security levels)
• Human</td><td>Access Opportunities:
• MarED database + COM databases (RAPEX, ICSMS, NANDO)</td></tr>
<tr><td>Implementation Option</td><td colspan="2">Required Actions</td></tr>
<tr><td><u>General requirement</u></td><td colspan="2">General MED data identifier and its structure needs to be defined and must be specified in a recommendation.</td></tr>
</table>

Scenario Level 2 Scenario / Finance / Risk / Economic	Remark: Within this table only the cost per stakeholder and unit are mentioned. The overall number of manufacturers willing to introduce electronic tagging is given in a summary table at the end of every scenario description.		
Cost categories	**Topic**	**Cost Range**	**Concerned Institutions**
Investments	Printer for eTags • Professional writer/printer for Smart labels or DataMatrix labels • Professional mobile RFID writer	1.500 €	Manufacturer
	Reader • RFID reader: 1.500 € • Data Matrix Reader: 300 € (SmartPhone) to 1.200 €	300 € – 1.500 €	Manufacturer, Market Surveillance
	MED App (for Apple & Android operation systems): Software for mobile devices to collect the eTag information and access the MarED database. Cost of a complex App. (Remark: It is assumed that one APP can be used to access MarED + COM databases)	20.000 € - 40.000 €	European Commission – DG MOVE / EMSA / DG Justice / DG ENTERPRISE
	Development of a MarED database interface to enable access based on eTag data	38.000 €	European Commission – DG MOVE / EMSA
	Development of NANDO and ICSMS database interfaces to enable access based on eTag data	10.000 € – 18.000 €	European Commission – DG GROW & DG MOVE
	Development a RAPEX database interface to enable access based on eTag data	5.000 € – 9.000 €	European Commission – DG Justice
Implementation costs	Setting up the technical format with ISO Reference: *"Support Study for the Fitness Check (FC) - Evaluation of passenger ship safety legislation."* Remark: The data structures are predefined and require not	12.000 €	European Commission – DG MOVE / EMSA or industry

	a complete standardisation process. Therefore, we expect that 50% of the cost for a complete standardisation process will be occur.		
Operational costs	Costs for RFID eTags per unit	0,5 € - 1,0 €	Manufacturer
	Costs for DataMatrix per unit	0 €	Manufacturer
	Training (up to 2 days) Remark: A training session of 2 person days should be sufficient (expert judgement). It might be more if the implementation of electronic tag technology becomes part of a complex production line (automatic application of labels). The estimated daily training costs of 1.000 € include 800 € for the trainer (market price - Germany) and 200 € for the employee of the organisation (average rate from EUROSTAT 2015[31])	1.000 €	Manufacturer, Market Surveillance
	Service fee for GS 1 (only for option 0A) GS-1 basic fee (only once) for • Up to 1.000 numbers 230 € • Up to 10.000 numbers 330 € • Up to 100.000 numbers 530 € Plus, a yearly fee (depending on the actual company turn over) • up to 25 Mio € -> 420 € • up to 50 Mio € -> 670 € • up to 250 Mio € -> 1.900	330 € (up to 10.000 numbers) 670 € (annual fee for companies up to 50 Mio € turnover)	Manufacturer

[31] http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Estimated_labour_costs_for_the_whole_economy_in_EUR,_2015.png#filelinks

	€ Source: https://www.gs1-germany.de/gs1-complete/konditionen/ The selection of a commercial service for the implementation and operation is a company's own decision. Nevertheless, for using the MED approval number it is not mandatory. Therefore, the service costs will not further be discussed within the CBA.		
	Communication costs (per year and reader) for all mobile connections to all database (Communication tariffs based on Deutsche Telekom for unlimited data volume)	270 €	Market Surveillance
Maintenance costs	Maintenance costs per year (software updates and user support) for RFID reader	240 €	Market Surveillance
	Maintenance costs per year (software updates and user support) for Data Matrix code reader (if smart phone is not used)	90 €	Market Surveillance
	Maintenance costs per year (software updates and user support) for Data Matrix code reader on smart phones	0€	Market Surveillance
Benefits			
Faster data acquisition	Marine equipment inspections will be much faster than today (form several weeks down to a couple of days). But this requires that test reports and DoC are also available in the MarED database. Dangerous products can be found much faster because of the complete access to all COM databases.	Reduction of economic harm of 5,74 Mio € yearly (0,1% higher success rate)	Market Surveillance
Market damage would be reduced	More equipment can be analysed within the same time and therefore more counterfeit products will be recognised. The discovery of additional 0,1		Market Surveillance/ European Maritime Market

	% counterfeit products would reduce the market damage by 5,74 Mio €.		
More focused product recalls and therefore reduction of product recall costs	Possible to identify and trace products on product class level (a group of similar products from one manufacturer). In this case a product recall can be very specific because of the product class level (same batch of products) and the manufacturing site (D-U-N-S® [26] number) defined on the eTag. Otherwise all similar products of one manufacturer would be object of the recall. (Remark: There are no official studies related to products recall costs. The costs depend on the product value and the product costs (factor 5-10). It is also important if the product must be taken off the market or if it must be modified. It is assumed that the recall costs can be reduced 50% as a minimum.)	Reduction of 2.000.000 € per product recall (based on product costs of 200.000 € one product recall (factor 10) would cost 2 Mio. €)	Manufacturer
Improved product counterfeiting	Tracing & tracking of products (on products class level) as method against product counterfeiting.	Faster identification of counterfeit products	Manufacturer

Background:

MED App: This scenario includes an extended app which allows the access to MarED and all COM databases. Basis for the calculation are Apps for Apple and Android mobile systems considering the data database access policy. The final price depends very much on the specification and is always subject of a public procurement procedure. The Apps will be offered free of charge by the European Commission – DG MOVE / EMSA (DG Justice & Enterprise may take a share).

ICSMS offered already different access opportunities with a well-defined documentation. Most of the adaptation work to be done is the implementation of the MED unique identifier.

RAPEX: The Rapid Exchange of Information System is divided into a public and an internal area. The public area offers already the possibility to download data in different formats. This allows companies to integrate the information of dangerous goods into their internal databases. Importers already use this function. For the market surveillance, the internal area of the database is the most important part. A semantic interface based on XML is under development which will enable a smarter access to the database. There are different access rights (read, write, create, administrator access, public interface) which must be managed via the interface via eTag reader application. Additionally, the MED unique identifier has to be implemented and has to be utilized by the users.

Product recall: When a product must be withdrawn from the market, the immediate costs are easy to anticipate:

- bringing together the crisis team;
- removing the product from the market;
- investigating the cause, and
- managing the PR.

The more focused the recall can be organised the less cost intensive is the procedure. The amount of money to spend depends very much on the number of products and the product values.

Recognise product counterfeiting: Counterfeit products can be recognized if an eTag reader tries to get information about a product group from strange locations or copied numbers. The manufacturer will recognize copied products much quicker than today.

Cost categories (average values)	**Manufacturer**	**Market Surveillance**	**European Commission – DG MOVE / EMSA**	**European Commission – DG ENTERPRISE**	**European Commision – DG JUSTICE**
Investments	1.500 € (printer) + 900 € (average reader) = 2.400 €	900 €	68.000 €	14.000 €	7.000 €
Implementation	-	-	12.000 €		
Training	1.000 €	1.000 €	-		
Operation	75 € for 100 units (average price) Remark: The amount of units depends very much on the product category. Some manufacturers might need only a few units per year while others require much more than the defined 100 units per year.	270 € (communication costs)	-		
Maintenance	240 € per year (10 % of investment)	90 € per year (10 % of investment)	-		
Amount for ISO standard implementation (first year) per stakeholder	3.715 €	2.260 €	80.000 €	14.000 €	7.000 €
Number of users	600 (10 % market penetration) (6.000 European suppliers are registered in the MarED database)	20 (70 % market penetration) (28 organisations are listed for Maritime equipment	1	1	1

		(sector 26)			
Costs for the first year based on expected market penetration	**2.229.000 €**	**45.200 €**	**80.000 €**	**14.000 €**	**7.000 €**
Yearly costs based on expected market penetration	600 * 315 € = 189.000	20*360 € = 7.200 €	0 €	0 €	0 €
Quantifiable benefits	Reduction of costs for product recall costs and faster identification of product copies: > 2.000.000 €. One product recall every 3years is assumed for the calculation	Reduction of economic harm up to 5,74 Mio € yearly.	-	-	-

Table 25: Summary table cost/benefit per categories and stakeholder

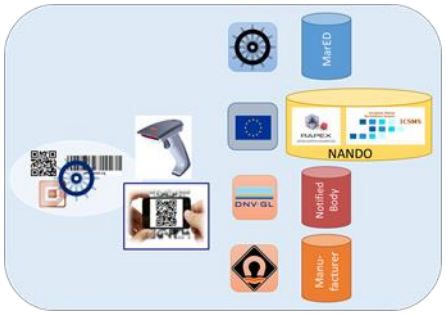
Yearly figures	Year 1	Year 2	Year 3	Year 4	Year 5 (replacement of hardware)	Summary after 5 years
Cost	2,38 Mio €	196.200 €	196.200 €	196.200 €	2,08 Mio €	5,49 Mio €
Benefit	5.740.000 €	7.740.000 €	5.740.000 €	5.740.000 €	7.740.000 €	32,70 Mio €

Scenario Level 2 Scenario / Finance Risk / Economic	Costs and benefits will be compared and evaluated. This includes also the consideration of social opportunity costs and other externalities (as losses or profits in the welfare of one party resulting from activities of another party).
Qualitative assessment	**Manufacturer:** In case of product recalls the benefit will be very high. Consider that every recall can be very much focused on a product produced at a specific manufacturing site. Copied products will be identified much faster. **Market surveillance:** More maritime equipment can be analysed within the same time and therefore more counterfeit products will be recognised (High externalities benefits). **European Commission:** No direct benefit within this scenario but improvement of market surveillance as general interest.

Scenario Level 2 Scenario / Finance Risk / Economic	Risk level	Risk assessment and mitigation strategy discussion in respect of cost and benefit for the selected application scenario.
Equipment cannot be tagged	Low	There might be some equipment which cannot be tagged by nature (e.g. colour) or for different other reasons. But tagged and untagged items can be analysed because of the coexistence of eTagging and the Wheel mark - Mark of Conformity plate.
Maritime equipment has a long lifecycle and eTags needs to be readable for a long time	Low	The eTags have a nearly unlimited notability guarantee. As a back-up the Wheel mark - Mark of Conformity plate is always available.
Several different databases are in use and need to be addressed by the eTag.	Low	If a general MED data identifier and structure is defined and the database can serve that number, it will be possible to access all databases.
Unified identifier definition between the different authorities failed.	Medium	Different MED data identifiers would require additional effort to translate the different identifier (one ident number info into another ident number and vice ersa), but it would not stop the implementation.
Counter fighting of eTags	Medium	The copy protection of eTags is established but not 100% complete (see presentation of the Baltic Sea demonstrator)

SUMMARY: Relevant public databases can be accessed to identify dangerous and counterfeit products. The market surveillance processes can be completely supported. The manufacturer can reduce product recall costs dramatically and can become aware of copied products in an early stage. The implementation costs are primarily for the European Commission.

17.6 Scenario Implementation Level 3

<table>
<tr><td>Scenario Level 3
<table><tr><td>Scenario</td><td>Finance</td></tr><tr><td>Risk</td><td>Economic</td></tr></table></td><td colspan="2">Electronic tags with MED Certificate number and codes for product traceability on different level</td></tr>
<tr><td> 
</td><td colspan="2">Description: An electronic tag will be used which includes the MED certificate number and product codes stored on an RFID tag or as Data Matrix code. The eTag will always combined with a “Mark of Conformity Plate” which opens the opportunity to read it without technical equipment like e.g. readers, Apps, etc. The “wheel mark” on the label becomes electronical readable with additional information (D-U-N-S® [26] number plus product tracebility code). The D-U-N-S® number allows to identify the manufacturer site. The product traceability number allows the product identification on a lot, batch level or with a serial number on an unique item level.</td></tr>
<tr><td>Marking:
MED Certificate number + D-U-N-S® [26] number +
product codes (e.g. products serial codes and/or lot/batch codes and /or GS1 application identifier)
• eTag and
• Wheel mark - Mark of Conformity plate</td><td>Reading:
• User applications
• Human</td><td>Access Opportunities:
• MarED database + COM databases (RAPEX, ICSMS, NANDO) + proprietary databases</td></tr>
<tr><td>Implementation Option</td><td colspan="2">Required Actions</td></tr>
<tr><td><u>General requirement</u></td><td colspan="2">General MED data identifier and its structure needs to be defined and must be specified in a recommendation.</td></tr>
<tr><td colspan="3"></td></tr>
</table>

Scenario Level 3 Scenario / Finance / Risk / Economic	Remark: Within this table only the cost per stakeholder and unit are mentioned. The overall number of manufacturers willing to introduce electronic tagging is given in a summary table at the end of every scenario description.		
Cost categories	**Topic**	**Cost Range**	**Concerned Institutions**
Investments	Printer for eTags • Professional writer/printer for Smart labels or DataMatrix labels • Professional mobile RFID writer	1.500 €	Manufacturer
	Reader • RFID reader: 1.500 € • Data Matrix Reader: 300 € (SmartPhone) to 1.200 €	300 € – 1.500 €	Manufacturer, Notified Bodies
	MED App (for Apple & Android operation systems): Software for mobile devices to collect the eTag information and access the MarED database. Cost of a complex App. (Remark: It is assumed that one APP can be used to access MarED + COM databases)	20.000 € - 40.000 €	European Commission – DG MOVE / EMSA / DG Justice / DG ENTERPRISE
	Development of a MarED database interface to enable access based on eTag data	38.000 €	European Commission – DG MOVE / EMSA
	Development of NANDO and ICSMS database interfaces to enable access based on eTag data	10.000 € – 18.000 €	European Commission – DG GROW &DG MOVE
	Development a RAPEX database interface to enable access based on eTag data	5.000 € – 9.000 €	European Commission –DG Justice
	Development of a manufacturer specific App (for Apple & Android operation systems) and an industrial database interface to enable access based on eTag data	25.000 € – 40.000 €	Manufacturer
Implementation	Setting up the technical format	12.000 €	European

costs	with ISO Reference: *"Support Study for the Fitness Check (FC) - Evaluation of passenger ship safety legislation."* Remark: The data structures are predefined and require not a complete standardisation process. Therefore, we expect that 50% of the cost for a complete standardisation process will be occur.		Commission – DG MOVE / EMSA or industry
Operational costs	Costs for RFID eTags per unit	0,5 € - 1,0 €	Manufacturer
	Costs for DataMatrix per unit	0 €	Manufacturer
	Training (up to 2 days) Remark: A training session of 2 person days should be sufficient (expert judgement). It might be more if the implementation of electronic tag technology becomes part of a complex production line (automatic application of labels). The estimated daily training costs of 1.000 € include 800 € for the trainer (market price - Germany) and 200 € for the employee of the organisation (average rate from EUROSTAT 2015[32])	1.000 €	Manufacturer, Notified Bodies
	Service fee for GS 1 (only for option 0A) GS-1 basic fee (only once) for • Up to 1.000 numbers 230 € • Up to 10.000 numbers 330 € • Up to 100.000 numbers 530 € Plus, a yearly fee (depending on the actual company turn over) • up to 25 Mio € -> 420 € • up to 50 Mio € -> 670 € • up to 250 Mio € -> 1.900 € Source: https://www.gs1-	330 € (up to 10.000 numbers) 670 € (annual fee for companies up to 50 Mio € turnover)	Manufacturer, Notified Bodies

[32] http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Estimated_labour_costs_for_the_whole_economy_in_EUR,_2015.png#filelinks

	germany.de/gs1-complete/konditionen/ The selection of a commercial service for the implementation and operation is a company's own decision. Nevertheless, for using the MED approval number it is not mandatory. Therefore, the service costs will not further discussed within the CBA.		
	Communication costs (per year and reader) for all mobile connections to all databases (Communication tariffs based on Deutsche Telekom for unlimited data volume)	270 €	Notified Bodies Manufacturer
Maintenance costs	Maintenance costs per year (software updates and user support) for RFID reader	240 €	Notified Bodies
	Maintenance costs per year (software updates and user support) for Data Matrix reader (if smart phone is not used)	90 €	Notified Bodies
	Maintenance costs per year (software updates and user support) for Data Matrix reader on smart phones	0€	Notified Bodies
Benefits			
Faster data acquisition	Marine equipment inspections will be much faster than today (form several weeks down to a couple of days). But this requires that test reports and DoC are also available in the MarED database. Dangerous products can be found much faster because of the complete access to all COM databases.	Reduction of economic harm of 5,74 Mio € yearly (0,1% higher success rate)	Market Surveillance
Market damage would be reduced	More equipment can be analysed within the same time and therefore more counterfeit products will be recognised. The discovery of additional 0,1 % counterfeit products would reduce the market damage by 5,74 Mio €.		Market Surveillance/ European Maritime Market

More focused product recalls and therefore reduction of product recall costs	Possible to identify and trace each product because of the product serial code which is uniquely for every product of the manufacturer. In this case a product recall can be very specific because of the product serial code and the manufacturing site (D-U-N-S® [26] number) defined on the eTag. Remark: There are no official studies related to products recall costs. The costs depend on the product value and the product costs (factor 5-10). It is also important if the product must be taken off the market of if it must have modified. It is assumed that the recall costs can be reduced by 50% as a minimum.	Reduction of 2.000.000 € per product recall (based on product costs of 200.000 € one product recall (factor 10) would cost 2 Mio €)	Manufacturer
Improved product counterfeiting	Tracing & tracking of products (on products class level) as method against product counterfeiting.	Faster identification of counterfeit products	Manufacturer
Reduction of search time for certificate related information (e.g. test reports)	All certificates and additional information related to the eTag information is immediately available from different databases (see SMM demonstrator). Search work will be reduced from 10 to less than 1 working day.	Approx. 10.000 €	Manufacturer
Reduction of counting time for batch products like life vest.	Instead of counting batch products manually the eTag reader counts the numbers of items and their registration numbers within one reading operation (see SMM demonstrator)	Reduction of inspection time	Port state control, ship owner
Improvement of logistic, service maintenance and repair	Manufacturer can use the MarED eTag for the support of logistic, maintenance and repair by offering product information via the company web site. The information can also be used by the vessel operator	Improvement of service quality	Manufacturer / vessel operator

Background:

During the **SMM demonstrator** pro-active market surveillance in accordance with this scenario has been simulated. Different equipment has been chosen like e.g. immersion suit, cranes, and winches as well as light and smoke signal equipment. The direct access to different certificates in the MARED database and to public available DNV/GL data as well as to manufacturer technical files has been presented (details see Annex).

The **Baltic Sea trail demonstrator** has shown the benefits of on board tag applications for ship operators and class on board. The equipment identification based on registration number and batch/serial number is much easier than today. The time for completeness checks at Muster stations can be reduced. Instead of counting swim vests manually the eTag reader counts the numbers of items and their registration numbers within one reading operation. For class surveys the certificates must be on board but copies are accepted and access to pdf files are sufficient. Lists of equipment on board could be checked directly and logistical processes can be improved. For the time being RFID tags should be excluded from the bridge equipment until the EMC has been clarified. But Data Matrix can be used instead (details see Annex).

Manufacturer: Manufacturers can improve their logistical processes by tracking and tracing. The installation can be much quicker in some cases if troubleshooting failure reports and manuals are online available (accessed via the eTag). Reaction time to safety related problems can be reduced as well as product recalls costs because of a more focused product registration. The manufacturer can introduce a counterfeiting procedure on different levels.

Port State Control must check the availability and functionality of equipment on board. Therefore, eTags are less relevant for the port state control.

Shipyards can reduce the installation and troubleshooting time by direct access to the right documentation via eTags.

Flag states and class can speed up the non-periodical survey processes by immediate certificates and compliance checks (assurance of valid certificates). MarED ID number includes the Notified Body and the year of market placement but for some requests the certification number makes it easier to find the producer for a specific product. Both is accessible at the same time via eTags.

Ship operators can identify equipment which is subject of recall actions, because RAPEX notified equipment can be identified much quicker.

Cost categories (average values)	**Manufacturer**	**Market Surveillance**	**European Commission – DG MOVE / EMSA**	**European Commission – DG ENTERPRISE**	**European Commission – DG JUSTICE**
Investments	1.500 € (printer) + 900 € (average reader) + 35.000 € (interface) = 37.400 €	900 €	68.000 €	14.000 €	7.000 €
Implementation	-	-	12.000 €		
Training	1.000 €	1.000 €	-		
Operation	75 € for 100 units (average price) + 270 € (communication costs) = 345 € Remark: The amount of units depends very much on the product category. Some manufacturers might need only a few units per year while others require much more than the defined 100 units per year.	270 € (communication costs)	-		
Maintenance	240 € per year (10 % of investment)	90 € per year (10 % of investment)	-		
Amount for ISO standard implementation (first year) per stakeholder	38.985 €	2.260 €	80.000 €	14.000 €	7.000 €
Number of users	2.000 (30 % market penetration) (6.000 European suppliers are registered in the MarED database)	20 (70 % market penetration) (28 organisati	1	1	1

		ons are listed for Maritime equipment (sector 26)			
Costs for the first year based on expected market penetration	**77,97 Mio. €**	**45.200 €**	**80.000 €**	**14.000 €**	**7.000 €**
Yearly costs based on expected market penetration	2000 * 585 € = 1,17 Mio. €	20*360 € = 7.200 €	0 €	0 €	0 €
Quantifiable benefits	Reduction of costs for product recall costs and faster identification of product copies: > 10. Mio. €. Five product recall every 3years is assumed for the calculation Effort reduction for certificate search 10.000 € for 2.000 manufacturers (20 Mio. € incl. optimisation opportunities for the product logistic); Improvement of service quality	Reduction of economic harm up to 5,74 Mio € yearly.	-	-	-

Table 26: Summary table cost/benefit per categories and stakeholder

Yearly figures	Year 1	Year 2	Year 3	Year 4	Year 5 (replacement of hardware)	Summary after 5 years
Cost	78,12 Mio €	1,17 Mio. €	1,17 Mio. €	1,17 Mio. €	7,45 Mio. €	89,08 Mio €
Benefit	25,74 Mio €	35,74 Mio. €	25,74 Mio €	25,74 Mio €	35,74 Mio. €	148,70 Mio €

Scenario Level 3 	Costs and benefits will be compared and evaluated. This includes also the consideration of social opportunities costs and externalities (as losses or profits in the welfare of one party resulting from activities of another party).
Qualitative assessment	**Manufacturer:** In case of product recalls the benefit will be very high. Consider that every recall can be very much focused on a product call produced at a specific manufacturer site. Additional service can be offered and all product related information (incl. certificates, test reports etc.) can be found much quicker Beside of the positive effects from scenario 2 additional services and cost reduction (search of documentation) can be realised. Additional investments are required to implement database interfaces. **Market surveillance:** More maritime equipment can be analysed within the same time and therefore more counterfeit products will be recognised (High externalities benefits). **European Commission:** No direct benefit within this scenario but improvement of market surveillance as general interest

Scenario Level 3 Scenario / Finance Risk / Economic	Risk level	Risk assessment and mitigation strategy discussion in respect of cost and benefit for the selected application scenario.
Equipment cannot be tagged	Low	There might be some equipment which cannot be tagged by nature (e.g. colour) or for different other reasons. But tagged and untagged items can be analysed because of the coexistence of eTagging and the Wheel mark - Mark of Conformity plate.
Maritime equipment has a long lifecycle and eTags needs to be readable for a long time	Low	The etags have a nearly unlimited notability guarantee. As a back-up the Wheel mark - Mark of Conformity plate is always available.
Several different databases are in use and needs to be addresses by the eTag.	Low	If a general MED data identifier and structure is defined and the database can serve that number, it will be possible to access all databases.
Unified identifier definition between the different authorities failed.	Medium	Different MED data identifier would require additional effort to translate the different identifier (one ident number info into another ident number and vice ersa), but it would not stop the implementation.
Counter fighting of eTags	Medium	The copy protection for eTags is established but not 100% complete (see presentation of the Baltic Sea demonstrator)

SUMMARY: The unique identifier structure determines the flexibility of eTag applications in the marine equipment industry. Electronic tags with MED Certificate number and codes for product traceability on different level offer the highest flexibility for all parties involved. The participating partner can optimise the implementation cost themselves. Low investments lead to low benefit and higher level implementations will cost more but promise also a higher benefit. Therefore scenario 3 is the implementation level with the highest flexibility.

17.7 Cost Benefit Comparison for 5 Years

Costs	Manufacturer	Market surveillance	EC-DG MOVE/ EMSA	EC-DG DIGIT	EC_DG JUSTICE	Cost per Scenario for 5 years
Baseline-Scenario	0 €	0 €	0 €	0 €	0 €	**0 €**
Scenario 1: MED Certificate number	0,52 Mio. €	0,12 Mio. €	0,06 Mio. €	0 €	0 €	**0,71 Mio. €**
Scenario 2: MED certificate number + item code	5,27 Mio €	0,12 Mio. €	0,08 Mio. €	0,014 Mio. €	0,007 Mio. €	**5,49. Mio €**
Scenario 3: MED Certificate number + codes for product traceability on different levels	88,78 Mio €	0,12 Mio. €	0,08 Mio. €	0,014 Mio. €	0,007 Mio. €	**89,00 Mio. €**
Benefit						**Benefit per Scenario for 5 years**
Baseline-Scenario	0 €	0 €	0 €	0 €	0 €	**0 €**
Scenario 1	-	28,70 Mio €	-	-	-	**28,70 Mio €**
Scenario 2	4,00 Mio. €	28,70 Mio €	-	-	-	**32,70 Mio €**
Scenario 3	120,00 Mio. €	28,70 Mio €				**148,70 Mio**

Table 27: Cost/benefit for all scenarios

Beside the economic impacts there are also safety and innovation impacts:

Economic Impacts	Other Impacts
Costs for the public authorities and industry (with particular focus on SMEs): The costs for authorities and industry are affordable => Stepwise implementation in accordance with the planned application is possible. The costs are independent from the size of the company.	**Access to services for market surveillance (increased/decreased product safety and information to citizens):** The access to services for market surveillance will increase by more efficient and direct data collection. Also, the interlink between data sets in different databases will be improved very much.
Administrative burden: The burden is manageable. The Commission or industry may take the standardisation lead; while the stakeholders have to maintain the ID codes.	**Technological and non-technological innovation potential (more innovative products, branding of electronic wheel mark):** Technological and non-technological innovation potential is high due to the improvement of processes (product service, market monitoring, branding, new business models etc.)
Protection of the intellectual property and efficacy in fighting counterfeiting: The IP protection and fighting counterfeiting increases very much because of more efficient and faster maritime equipment checks.	
Effect on international competitiveness: The effect is very high. The product safety will increase by more efficient market monitoring;	

Table 28: Economic and social impacts

18 Targeted Consultation Frame

The study has followed as far as applicable the "Stakeholder Consultation Guidelines"[33] as issued by the Commission and based on COM(2002) 704 - Commission Communication: Towards a reinforced culture of consultation and dialogue - General principles and minimum standards for consultation of interested parties by the Commission. Basically, this is organised in three steps, namely (1) to **define the consultation strategy**, (2) to **perform the consultation** and (3) to **analyse and evaluate the results**.

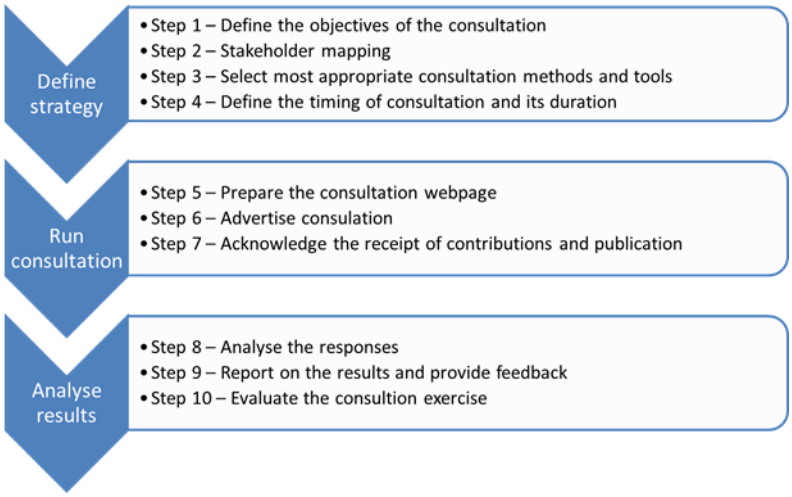


Figure 43: Consultation process steps

18.1 Consultation Strategy Definition

Step 1: Define the objectives: The consultation was divided in the following activities:

Step 2: Stakeholder mapping:

The different consultation actions did involve all kinds of stakeholders involved in the execution of the Marine Equipment Directive, namely COM, EMSA, Member States (e.g. members of the Marine Equipment Expert Group, COSS, the newly established AdCo group and/or experts and observers nominated to accompany the Notified Bodies in MarED), the Notified Bodies and/or classification societies, the Marine Equipment manufacturers, Flag state or port State control, flag state market surveillance, ship operator and others.

Step 3: Select most appropriate consultation methods and tools

The different actions resulted in feedback related to proposed technology alternatives of electronic tags and their implementation, which has been used to elaborate final

[33] Part of the „Better regulation guidelines and associated toolbox". See: http://ec.europa.eu/info/law/law-making-process/better-regulation-why-and-how_en

recommendations of the study. The following table provides an overview on the actions.

Step 4: Define the timing of consultation and its duration

Method/tool	Duration	Date
Information meeting/session (Agenda see ANNEX C of this study)	one day	December 17th, 2015
Questionnaire (Questionnaire see ANNEX D of this study)	22nd days	April 21st to May 22nd, 2016
Stakeholder meeting/workshop (Agenda see ANNEX F of this study)	one day	May 31st, 2016
Exhibition demonstrator for stakeholder on the SMM (Shipbuilding, Machinery and Marine Technology) trade fair	one day	September 9th, 2016
Baltic Sea demonstrator for stakeholder	two days	September 29th/ 30th 2016
Workshop on Results of the Study	one day	February 28th, 2017

18.2 Perform the Consultation

Step 5 – Prepare the consultation webpage

- Mailboxes for completed questionnaires and for information purposes have been set up.
- Data protection rules have been respected: For all personal data collected and processed, the processing has been complied with Regulation (EC) 45/2001 on the protection of personal data.
- Decision has been taken on who will collect the responses and answer queries. Reminders about the ongoing consultation have been sending out after the consultation has already been running for some time.

Consultation webpage is part of ANNEX II of this study.

Step 6 – Advertise consultation

Advertisement of consultation and communication channels is adapted to all target audiences has been ensured. Communication about the consultation process towards manufacturers have been facilitated through the European and national associations for marine equipment or through the MarED website, where more than 10.000 individual professional users are registered as frequent visitors.

STEP 7 – Acknowledging the receipt of contributions received and publication

Whenever stakeholders deliver completed questionnaires or provide contributions to any type of consultation it is best practice to send an acknowledgement of receipt. To minimize work, individual or collective acknowledgments of receipt will be (automatically) generated at the entry point.

18.3 Analyse and Evaluate the Results

STEP 8 to 10 - Analysing the responses, reporting the results and evaluate the exercise

Stakeholder Workshop - Bremen with the intention to give stakeholders an overview on actual developments and projects and to introduce possibilities as well for applications of e-tags in industrial processes. During the workshop, it became apparent that this kind of a workshop also involves educational elements for participants which will help them later to evaluate proposals to accommodate e-tags in the MED.

Stakeholder Survey – Questionnaire: After some meetings with industry representatives at SeaEurope and Member States representative and AdCo member BSH in Germany a broader consultation process has been launched. A stakeholder survey through the Internet by a dedicated questionnaire has been conducted. As a summary of the evaluation the following basic statements can be made:

- Section A – Professional activity of the participants
- Section B – Marking of products under MED provisions
- Section C - Questions on e-tag Application and e-tag content
- Section D – Questions on e-tag reading and interlinkage to further information sources (as private and public databases) and potential cost/benefits (for all stakeholders to reply)
- Section E – Questions on your familiarity with e-tagging options

The detailed questionnaire is part of Annex II. As a summary of the evaluation the following basic statements can be made.

- About 50 answers from the full range of stakeholder groups have been received;
- There was a clear opinion (>80%) that e-tags should be introduced as a supplement and not as a replacement of the wheel mark;
- There was a clear opinion that e-tags are of high value or extremely high value to support market surveillance activities and may facilitate easier and quicker access to product documentation (certificates, DoC, manufacturer information, etc.) if this information is made available in databases;
- There was a majority in favour of Data Matrix code as preferred technology followed by RFID solutions. However, there is also uncertainty in the opinions because of lack of basic technological knowledge and it very much depends on the products and application cases;
- Already today manufacturers put information on their products beyond the requirements of the directive which might be integrated into e-tags in the future;
- Participants identified and nominated additional information to be integrated into e-tags, e.g. product identification number, manufacturer identification, production site, batch/lot number, serial numbers, etc.

- When reading e-tags in the future, participants expected predominantly basic and extended information on compliance – (Notified Bodies, certification regime, certificate numbers, validity, Copies of DoC and Certificates etc.), e.g. through the MarED Database (COM-Database on certified products);

- When reading e-tags in the future, participants see also the potential to have (authorized) access to proprietary information potentially available in databases managed by companies (e.g. manuals, technical information, drawings, parts lists, life cycle etc.);

- For the elaboration of further benefits of e-tags, e.g. in the context of internal business logistics, participants claimed not to have enough information/knowledge for a valuation;

- Besides quicker access to information about compliance of a product, participants see a potential benefit that counterfeiting may become more difficult by employing e-tags for easier verification of product authenticity;

- Biggest objections raised are about cost and potentially required organizational adaptions of internal processes and alignment to required external processes;

- Further concerns were addressing the durability of e-tags and missing standards;

- Most participants indicated that the level of knowledge in their organizations on e-tag technologies (Data Matrix code and RFID tags) is very low, especially with regard to RFID. Consequently, the experience with applications and e-tag solutions in the sector is very low. However, exceptions exist and there are some forerunners in the market.

Although not a representative consultation with a high number of participants it seems from additional discussions and sector knowledge of the consultants to be a fair evaluation of the situation. In short, on the introduction of e-tags participants have high expectations and see a great potential for improvements of their own processes and beyond. However, the evaluation of answers also shows uncertainties and doubts based on a lack of knowledge.

Stakeholder Workshop – Brussels was basically addressing the results of the questionnaire, but was also giving again background information (including demos) on e-tag technologies and potential applications. Major focus was finally on the definition of a MED unique identifier as a basis for the coded information of the e-tags and as well potential structure of data-repositories and access rights. Whereas the discussion basically confirmed the evaluation of the questionnaires given above, it is the definition of MED unique identifiers and the potential content which is of major concern of the participants. It needs to be said that the new MED does specify the information which should be available on the product. The visual wheel mark as it is at the moment only requires the coded information on the Notified Body and the date the wheel mark has been applied on the product. Regarding the expectations and wishes from the questionnaire evaluation an Implementing Regulation to the MED needs to clearly define the format and mandatory content of an e-tag. Participants very much welcomed the proposal of the consultants to base a definition on existing ISO standards. The recommendation by the consultants for the MED unique identifiers is contained in this report.

Demonstrator SMM 2016 – Hamburg: To demonstrate potential market surveillance activities on trade fairs and how e-tags may facilitate these processes in the future, three show cases have been organized and performed at SMM 2016 trade fair in Hamburg. Three manufacturers supported the action by making products available for the demonstrators and by collecting related information upfront.

More than 20 participants basically from industry listened to an introduction by the German market surveillance representative and the consultants at their booth. This was followed by a walk around the fair and visits to the three manufacturers' booths. Selected products have been e-tag labelled in agreement with the manufacturers and potential market surveillance activities have been demonstrated. The e-tag information contained real information about the products. By reading with a mobile device access to real time information available in the MarED database and the RAPEX database could be demonstrated. This demonstration has been very well received by the participants, because it was explaining quite well how e-tags could improve future processes especially regarding market surveillance.

Demonstrator Baltic Sea – TT Line Ferry has been planned on board of a ferry in the Baltic Sea with in situ application of e-tags on MED products and interlinkage with remotely available information in databases. However, only the demonstrator in the Baltic Sea attracted enough participation and took place. Although already organized the demonstrator in the Mediterranean Sea had to be cancelled due to too low participation by Member States.

However, as part of the demonstrator a workshop on board of the TT-Line Ferry Nils Holgersson on the route from Trelleborg/Sweden to Travemünde/Germany and back in the Baltic Sea has been a good success and was well received by all participants. With the help of the ship operator and the Classification Society DNVGL the workshop could be well prepared. About 20 products have been identified onboard for the demonstration, representing different item categories of the MED. The categories comprised LSA, Fire Safety, radio and navigation. For all products, the consultant with support from the shipping company, Classification Society and manufacturers created complete files with the necessary information including certificates, DoC etc. All products have been labelled with Data Matrix codes and RFIDs. The MarED database was prepared to accommodate additional information and to allow online access by means of reading electronic tags. The respective reading device including the related "App" (tablet) has been prepared to allow full scope demonstrations in situ. Places visited on board comprised a muster station with multifold LSA equipment, the bridge with navigation and radio equipment and the upper deck with a locker containing firefighting products.

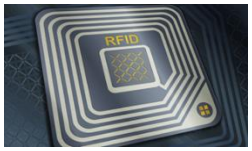
At all locations demonstrations on reading labels and access to remote information have been performed and delivered the functional prove. Discussions with all participants lead to an overall positive evaluation of the potential of e-tags to improve processes from the different stakeholders.

19 Scenario Selection for the Cost-Benefit Analysis (CBA)

Based on the discussions during the targeted consultation it was made clear that eTags can never replace the wheel mark plate. It is necessary to work always in a traditional way without any additional equipment and to bridge technology problems (e.g. defect or missing readers). The replacement of the wheel mark by eTags would require the relabelling of all the existing equipment. Therefore, eTags can only be an additional option to optimise the processes for all parties involved. Therefore, the replacement of the wheel mark by an eTag implementation is not part of the following considerations.

Two kind of technologies have been identified for the implementation within a maritime environment. These are Data Matrix and RFID technologies:

AND



RFID

OR

Data Matrix

These technologies are considered within the following scenarios for the cost benefit analysis. The benefit and the necessary required effort depend very much on the implementation levels of the electronic tag technologies and the selected options for the MED unique identifier implementation. The implementation levels can be categorized into three possible levels (level 1– 3). These levels are reflected in the following three selected scenarios and compared with a baseline scenario:

	Baseline Scenario: No use of E-Tags	**Scenario Level 1: Electronic tags with MED Certificate number(s) only**	**Level 2: Electronic tags with MED Certificate number(s) and item code**	**Level 3: Electronic tags with MED Certificate number(s) and codes for product traceability on different level**
Marking	Wheel mark plate	MED Certificate number	MED Certificate number + product class level information	MED Certificate number + product codes (e.g. products serial codes and/or lot/batch codes and/or GS1 application identifier)
Reading:	Human	MED App	MED App++ (with extended security levels)	User applications
Access Opportunities	-	MarED database	MarED database + COM databases (RAPEX, ICSMS, NANDO)	MarED database + COM databases (RAPEX, ICSMS, NANDO) + proprietary database
Investment required	no	European Commission	European Commission DG	European Commission DG

		– DG MOVE / EMSA	MOVE / DG Justice / DG GROWTH	MOVE / DG Justice / DG GROWTH / Industry
Potential users	Business as usual	Market Surveillance	Market Surveillance / Port State Control	Market Surveillance / Port State Control / Industrial users

Table 29: Scenario overview

As the four **main cost categories** investment, implementation, operation (incl. training) and maintenance costs have been identified.

The **improvement benefits** are very different depending on the involved parties. The market surveillance can save time for inspections, documentation requests and reviews. Identification of counterfeited products is much easier since more information is available in a shorter time. The success rate for counterfeiting identification will increase.

Equipment manufacturers can realise time savings for inspections and checks at quality gates. The production data acquisition is much easier and can optimise the production planning and control as well as the logistic processes. Finally, it will become much easier to identify counterfeiting.

The vessel operator can save time for inspection, maintenance, and repair because the actual information for the equipment installed on board can be accessed via supplier databases. Supplier parts can be ordered more focused because the equipment and the related spare parts are distinctive.

20 CBA Results and Conclusions

The implementation of e-Tags under the European Marine Equipment Directive for maritime equipment opens many opportunities and may affect processes of different stakeholders. This study has analysed all aspects related to maritime equipment products covered by the directive. It has started with the process analysis of all stakeholders involved during the marine equipment life cycle. All opportunities and challenges for the implementation of electronic tags to support the processes have been considered. For each phase of the marine equipment life cycle (equipment approval, market access and surveillance, ship construction, ship operation and ship recycling) the actual processes are analysed together with the possible existing challenges. Scenario projections (until 2030) considering the situation after around 10 years from the possible implementation of electronic tags are described.

These scenarios were the basis for several discussions with the stakeholders and different consultation actions. Requirements and benefits were estimated for every scenario and for the different parties involved (manufacturers, authorities, operators, etc.). It is shown that the benefit is very different for the main players depending on their role in each life cycle phase. We must distinguish effects directly created by implementing the e-tag option in the directive and those generated indirectly by using additional opportunities. This means efforts by manufacturers to apply e-tags on their products and efforts and benefits by authorities when using these e-tags to facilitate their processes. Indirect effects can be generated by manifold other stakeholders in the process (manufacturers, authorities, customs, etc.) in case they capitalise on the existing e-tags and develop/adapt their processes accordingly. Therefore, only a broad and generic approach will assure that all stakeholders can benefit from the implementation of electronic tags.

The technological section of the study gives a comprehensive overview of exiting data carriers and data exchange architectures. Some of the technologies are not applicable for the marine environment (harsh conditions, costly installations for energy supply, etc.). Nevertheless, there are different technologies which can be used based on the targeted future scenarios. After several expert discussions and best practice experiences from other industrial sectors the favoured technologies recommended for implementation are based on RFID and Data Matrix labelling. These two technologies cover the whole range from simple and cheap solutions (Data Matrix) to costlier (RFID) but also more flexible solutions.

The implementation of the labelling technology as such will not be beneficial for the processes. The key factor is easy access to data and traceability. But the support of traceability and a continuous information flow requires a standardised code structure independent from the electronic tag type. A unique identifier must be defined. It must be flexible enough to support many different processes and to enable the direct access to the most important maritime equipment databases. Several different coding possibilities have been discussed within different workshops. At least three possibilities have been chosen for the impact analysis. The main differences are the degree of detail level of information represented on the tag in the future. The more information on the eTag available, the more applications can be covered, the more processes can be supported and the higher is the expected benefit.

Beside the identification code the databases involved in the different processes are important. RAPEX, ICSMS, MarED and NANDO have been identified as the most important marine equipment publicly accessible databases. The discussions with the operators of these databases have shown that there are no technology limitations in respect of eTags. Some of them are already prepared. It has been figured out that the

effort necessary to make use of the eTag technology is quite low. All these databases need to support the unique identifier to make use of the new technology.

Within the consultation phase of the study some test connections have been realized and have shown that the defined approach works. Nevertheless, only demonstrator installations for some selected marine equipment have been realized. During those demonstrators, the proactive inspection work of market surveillance has been shown on the SMM exhibition in Hamburg and a sea trial demonstrator has been realized on board a ferry between Trelleborg and Travemünde. Both demonstrators have proven that the eTag implementation for Maritime equipment works very well for different scenarios.

As part of this study a problem tree has been generated to show the future challenges for the global implementation of electronic tags for marine equipment. This tree has been adapted during the stakeholder discussions.

It must be assured that the wheel mark information can be read independent from the availability of technological equipment. Consequently, it is recommended that the present visual Mark of Conformity (Wheel mark) should not be replaced by eTags. Only the combination of the wheel mark plus eTag is a workable solution, where the eTag offers additional information to support processes electronically.

For the quantitative assessment of the technology three different implementation scenarios have been defined and evaluated by a costs and benefits calculation per stakeholder (see Table 27). All three scenarios have been compared with the base line scenario which is the cheapest solution.

Summary of the CBA (Scenario figures for 5 years in Mio €)	Cost in Mio €	Benefit in Mio €	Main Benefits
Baseline-Scenario	0	0	No potential benefit and high costs for a later integrated solution
Scenario 1: MED Certificate number	0,71	28,70	**Faster data acquisition:** Marine equipment inspections will be much faster than today **Reduction of market damage:** IP protection and fighting counterfeiting increases
Scenario 2: MED certificate number + item code	5,49	32,70	Scenario 1 benefits plus **More focused product recalls:** Identification and tracking on product class level **Faster identification of counter fight products:** Tracing & tracking opportunities
Scenario 3: MED Certificate number + codes for product traceability on different levels	89,00	148,70	Scenario 1 +2 benefits plus **Effort reduction for certificate search and related** information (e.g. test reports): **Improvement of service quality:** eTag implementation can optimise logistic, service, maintenance, and repair processes **Reduction of batch products counting time:** Collect number of items and their registration numbers within one reading operation (life vests)

Table 30: Summary of cost/benefit calculations for all scenarios

The **baseline scenario** covers the continuation of the as-is situation without any eTags. There are no additional costs but there is also no additional potential benefit. But in some years from now it might be too late to implement eTags for maritime equipment as an integrated approach. Some of the partners involved in the processes might have implemented their own solutions. When this is done an integrated solution for all maritime equipment processes will require a lot of adaptation and will be very costly.

Scenario 1 takes only care of the MED Certificate number. Therefore, the expected benefit is quite high but can only be realised by the market surveillance. It is assumed that the motivation of the manufacturers to participate will be quite low.

Scenario 2 considers the implementation of the MED Certificate number plus company and item code of the product. Beside the benefits of the first scenario is will enable stakeholders to identify product batches and the related production sites. Within this scenario implementation will optimise product recall procedures very much and can also support logistical tasks. Manufacturers can realise a considerable benefit and it is expected that a larger group of manufactures will take part in this implementation.

Scenario 3 implements the MED Certificate number plus company and product code which allows the identification of every single product of the manufacturer. This most advanced scenario includes a very detailed numbering system and opens a lot of application opportunities. The benefit will be very different for the participants involved. The highest benefit is related to the market surveillance authorities which could speed up their processes when analysing products and identifying counterfeited and dangerous items. Much quicker database access to the mentioned public databases would be a major advantage. But it would also require that certificates and test reports are available in these databases. Other partners of the processes (manufacturers, port state control, ship operators, etc.) could also benefit from scenario 3 implementations based on their individual goals. It is the most expensive scenario but with the highest benefit potentials. The cost for the realisation concerns mainly the user's application app development and the database interfaces.

It is recommended that the ID codes of scenario 3 should be part of the implementation guidelines. In this case, the decision is left to the stakeholders to what extent they perform the implementation (scenario 1 to scenario 3) (see Figure 44). A stepwise implementation reduces the risks and ensures realisation of the potential benefits step-by-step.

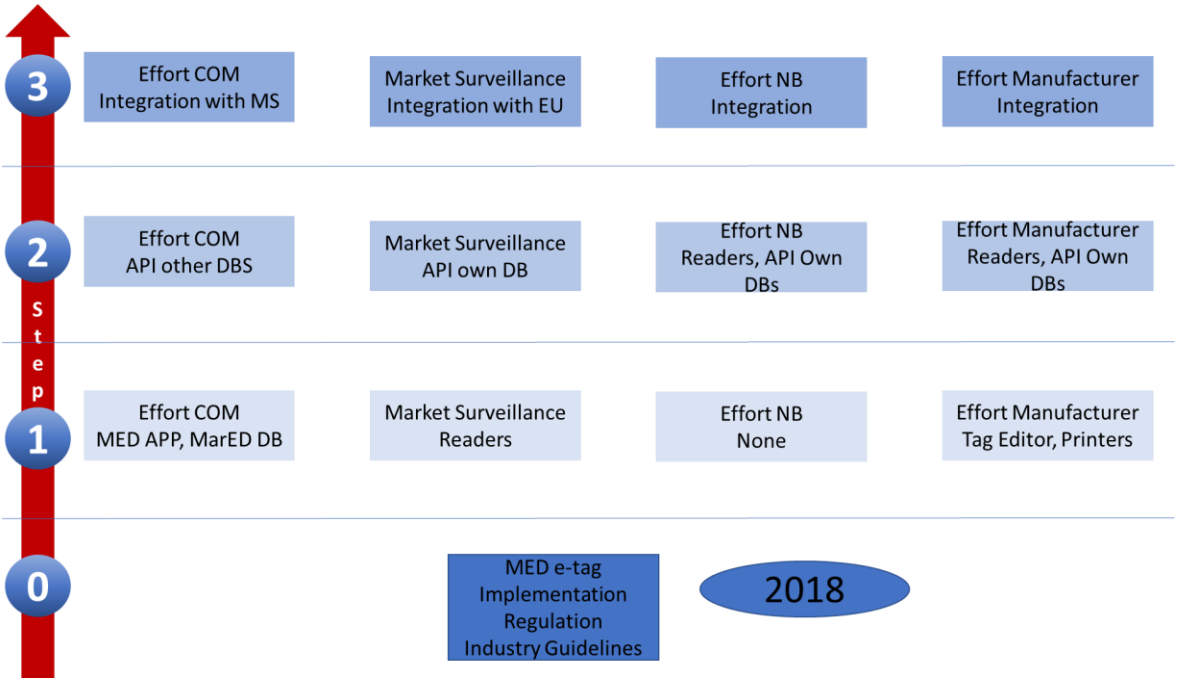


Figure 44: Stepwise approach for the eTag implmentation

The introduction of electronic tags as a supplement of a wheel mark in maritime equipment would require different activities:

1. Final definition and approval of an MED unique identifier structure with Member States (based on the proposal contained in this study);
2. Agreeing the data identifier with ISO according to the basic structure from the standard;
3. All relevant databases should support the MED unique identifier (MarED database has also to store test reports and Declaration of Conformity). Related actions need to be taken by COM and Member States;
4. Define eTags, the related technology and the content as complementary label to the wheel mark for marine equipment by means of an Implementing Regulation
5. Create common understanding and continuous reporting between all bodies at COM and Member States (especially AdCo) to promote early applications.

Overall, the investments are on a low level compared to the expected benefits. Costs for authorities and industry are affordable because of the stepwise voluntary implementation in accordance with the planned application. The equipment manufacturer can start with some low investments but through further investments additional benefits can be realised. But it could also be envisaged to make the use of eTags as an additional mandatory label in the future to achieve a higher take-up by the market. Only a large dissemination can indeed unleash the full potential of the application of eTags for marine equipment.

21 Note of Thanks

We would like to thank all supporters of this study for their contributions and recommendations as well as for their participation in the consultations. We extend our special thanks to all companies given us the opportunity to include them into our presentation at the SMM exhibition and supporting our sea trails. Thank you very much to all manufacturers providing us with product demonstrators.

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