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**Ships and marine technology —  
Marine NO<sub>x</sub> reduction agent AUS 40 —**

**Part 3:  
Handling, transportation and storage**

*Navires et technologie marine — Agents réducteurs NO<sub>x</sub> marins AUS 40 —*

*Partie 3: Manipulation, transport et stockage*



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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 8, *Ships and marine technology*, Subcommittee SC 2, *Marine environment protection*.

ISO 18611 consists of the following parts, under the general title *Ships and marine technology — Marine NOx reduction agent AUS 40*:

- *Part 1: Quality requirements*
- *Part 2: Test methods*
- *Part 3: Handling, transportation and storage*

## Introduction

In order to protect the environment and to enhance air quality, exhaust emissions regulations around the world are continuously strengthened. For ships with large combustion engines, particulate matter (PM), nitrogen oxide (NO<sub>x</sub>) emissions, and sulfur dioxide emissions are the main concern, and efforts have been focused on the development of technology that can reduce them effectively with minimum fuel economy penalty. Selective catalytic reduction (SCR) converters using a urea solution as the reducing agent is considered to be a key technology for reducing NO<sub>x</sub> emissions. The quality of the urea solution used for that technology needs to be specified to ensure reliable and stable operation of the SCR converter systems. The ISO 18611 series provides the specifications for quality characteristics, for handling, transportation, and storage, as well as the test methods needed by manufacturers of SCR converters, by engine producers, by producers, distributors of the urea solution, and by fleet operators/ship owners.

Efficient expanding of the use of urea SCR technology requires a consolidated framework that can be followed by producers, end users, OEMs, and catalyst suppliers.

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# Ships and marine technology — Marine NO<sub>x</sub> reduction agent AUS 40 —

## Part 3: Handling, transportation and storage

### 1 Scope

This part of ISO 18611 describes best practice recommendations and requirements for handling, transportation, and storage of NO<sub>x</sub> reduction agent AUS 40 (aqueous urea solution), specified in ISO 18611-1. These recommendations and requirements are necessary to preserve the specified quality of AUS 40 from any point of production to the point where it is filled into the on-board tank of the vehicle, in order to ensure the proper function of the selective catalytic reduction (SCR) converter systems.

This International Standard is covering quality requirements and guidelines for AUS 40 for marine applications, irrespective of manufacturing method or technique.

### 2 Normative references

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

ISO 18611-1, *Ships and marine technology — Marine NO<sub>x</sub> reduction agent AUS 40 — Part 1: Quality requirements*

ISO 18611-2, *Ships and marine technology — Marine NO<sub>x</sub> reduction agent AUS 40 — Part 2: Test Methods*

### 3 Terms and definitions

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

#### 3.1

##### **bulk operation**

handling of AUS 40 in large containers

Note 1 to entry: Examples of large containers are road tankers, rail cars, storage tanks, and tank vessels.

#### 3.2

##### **packaged shipment**

handling of AUS 40 in small containers

Note 1 to entry: Examples of small containers are drums, cans, bottles, intermediate bulk containers (IBCs).

#### 3.3

##### **production batch of AUS 40**

quantity of AUS 40 produced at one operation at a site where the product has (last) been physically or chemically modified to reach compliance with the specifications defined in ISO 18611-1

Note 1 to entry: Mixing of AUS 40 volumes does not constitute a physical or chemical modification, so long as the quality of the volumes before mixing complies with the specifications given in ISO 18611-1.

### 3.4 shelf life

period of time starting with the completion of the production of the batch in which AUS 40, stored under specific conditions, remains within the specifications defined in ISO 18611-1, Table 1

## 4 General requirements and recommendations

### 4.1 Requirements for the use of materials compatible with AUS 40

#### 4.1.1 General

To avoid contamination of AUS 40 and to resist corrosion of the devices used (containers, tubes, valves, fittings, gaskets, hoses, etc.), all materials in direct contact with AUS 40 during handling, transportation, and storage, including sampling, shall be compatible with AUS 40.

It is the responsibility of the user of this International Standard to ensure that the correct materials are used. The list of the materials given in [Tables 1](#) and [2](#) shall be used for guidance only until such time as more definitive information is established.

Any material with uncertain compatibility with AUS 40 shall be tested. The test conditions should reflect the intended temperature range and contact time, in order to evaluate possible influences on the product quality as specified in this International Standard. In addition, this test shall ensure that the integrity of the material in contact with AUS 40 is maintained. Accelerated tests using higher temperatures can be used, as appropriate.

If a contamination of AUS 40 is detected during handling, transportation, and storage, an investigation shall be carried out to determine the causes of contamination and to take appropriate corrective actions.

NOTE Choice of materials for the purpose of storing/distributing AUS40 on-board a vessel might be subject to special authority and /or certification body requirements.

#### 4.1.2 Recommended materials

Examples of materials recommended for use with AUS 40 are given in [Table 1](#).

NOTE This list has been compiled in accordance with best available knowledge about state-of-the-art materials at the time of publication of this part of ISO 18611.

**Table 1 — Examples of recommended materials**

|                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Highly alloyed austenitic Cr-Ni-steels and Cr-Ni-Mo-steels, for example, in accordance with EN 10088-1, EN 10088-2, and EN 10088-3 (i.e. 1.4541 and 1.4571), or stainless steel 304 (S30400), 304L (S30403), 316 (S31600), and 316L (S31603) in accordance with ASTM A240, ASTM A276, and ASTM A312                                                                       |
| Titanium                                                                                                                                                                                                                                                                                                                                                                  |
| Ni-Mo-Cr-Mn-Cu-Si-Fe alloys, e.g. hastelloy c/c-276                                                                                                                                                                                                                                                                                                                       |
| Polyethylene, free of additives                                                                                                                                                                                                                                                                                                                                           |
| Polypropylene, free of additives                                                                                                                                                                                                                                                                                                                                          |
| Polyisobutylene, free of additives                                                                                                                                                                                                                                                                                                                                        |
| Perfluoroalkoxyl alkane (PFA), free of additives                                                                                                                                                                                                                                                                                                                          |
| Polyfluoroethylene (PFE), free of additives                                                                                                                                                                                                                                                                                                                               |
| Polytetrafluoroethylene (PTFE), free of additives                                                                                                                                                                                                                                                                                                                         |
| NOTE 1 The sequence given in this list does not constitute a ranking of the recommended materials.                                                                                                                                                                                                                                                                        |
| NOTE 2 Materials made of plastics can contain various kinds of additives used either for processing or for special kinds of serviceability. These additives can possibly migrate into AUS 40. For this reason, it is advisable that special care be taken for testing the contamination of AUS 40 by additives from plastic materials used in direct contact with AUS 40. |

**Table 1** (continued)

|                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Copolymers of vinylidene fluoride and hexafluoropropylene, free of additives                                                                                                                                                                                                                                                                                              |
| FIBREGLOSS based on a proper resin                                                                                                                                                                                                                                                                                                                                        |
| NOTE 1 The sequence given in this list does not constitute a ranking of the recommended materials.                                                                                                                                                                                                                                                                        |
| NOTE 2 Materials made of plastics can contain various kinds of additives used either for processing or for special kinds of serviceability. These additives can possibly migrate into AUS 40. For this reason, it is advisable that special care be taken for testing the contamination of AUS 40 by additives from plastic materials used in direct contact with AUS 40. |

#### 4.1.3 Materials not recommended

Examples of materials not recommended are given in [Table 2](#).

NOTE This list has been compiled in accordance with best available knowledge about state-of-the-art materials at the time of publication of this part of ISO 18611.

**Table 2 — Examples of materials not recommended**

|                                                                                                                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Materials forming compounds as a result of reaction with ammonia, which might negatively interfere with the SCR converter system: carbon steels, zinc coated carbon steels, mild iron |
| Non-ferrous metals and alloys: copper, copper alloys, zinc, lead                                                                                                                      |
| Solders containing lead, silver, zinc, or copper                                                                                                                                      |
| Aluminium, aluminium alloys                                                                                                                                                           |
| Magnesium, magnesium alloys                                                                                                                                                           |
| Plastics or metals coated with nickel                                                                                                                                                 |

## 4.2 Physical conditions during transportation and storage

### 4.2.1 General recommendation

In order to avoid any impairment of the AUS 40 quality during transportation and storage, the following conditions should be taken into account:

- in order to prevent decomposition of the urea, as well as the evaporation of water in the case of vented containers, prolonged transportation or storing above 25 °C should be avoided;

NOTE 1 Insulation can be required, especially in hot areas of the world.

NOTE 2 In hot areas of the world where there is a real risk of recommended long-term storage temperatures being exceeded, temperature monitoring of the AUS 40 is recommended.

NOTE 3 Prolonged storage at temperatures above 25 °C can reduce the shelf life (see [Table 3](#)). However, temporary exposure to higher temperatures does not necessarily influence the quality of AUS 40.

- in order to prevent solidification of AUS 40, storage below 1 °C should be avoided;

NOTE 4 Insulation or means of heating the AUS 40 can be required.

NOTE 5 Solidified AUS 40 has a larger volume than the liquid and, therefore, can cause a fully filled, closed container to burst. Solidified AUS 40, which has been warmed up carefully at temperatures not exceeding 30 °C will not be impaired in quality and can be used as soon as the warmed up solution is free from solids.

- in order to avoid excessive temperature rise, AUS 40 should be protected from sunlight;
- in order to protect AUS 40 from any contamination carried by the air, well-closed containers or vented containers with filters should be used.

#### 4.2.2 Shelf life

Throughout the entire distribution chain, AUS 40 is expected to remain within the specifications given in this part of ISO 18611 for at least the time periods specified in Table 3 as a function of the constant fluid temperature, or if fluid temperature is not known, average ambient temperature at which the AUS 40 is stored provided it is not exposed to direct sunlight.

In any case, the time at which AUS 40 is stored above 40 °C should be limited as the degradation of the AUS 40 is strongly increasing above this temperature.

**Table 3 — Shelf life as a function of temperature**

| Constant ambient storage temperature<br>°C                                                                                                                                                                                                                        | Minimum shelf life<br>months                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| 0–25                                                                                                                                                                                                                                                              | 18                                                                    |
| <30                                                                                                                                                                                                                                                               | 12                                                                    |
| <35                                                                                                                                                                                                                                                               | 6                                                                     |
| >35                                                                                                                                                                                                                                                               | Possible significant loss of shelf life: check every batch before use |
| NOTE The main factors taken into account to define the shelf life in this table are the ambient storage temperature and the initial alkalinity of AUS 40. The difference in evaporation between vented and non-vented storage containers is an additional factor. |                                                                       |

#### 4.3 Cleanness of surfaces in contact with AUS 40

All surfaces in direct contact with AUS 40 shall be free of foreign matter (fuel, oil, grease, detergent, dust, and any other substance).

To avoid any contamination of AUS 40 with trace elements, particles, and foreign matter, surfaces of equipment not exclusively used with AUS 40 shall be cleaned with distilled or de-ionized water and AUS 40 in the last cleaning step immediately before the use with the AUS 40 to be handled with the equipment.

The use of tap water should especially be avoided due to the high concentrations of alkali and alkali earth metal ions therein. However, if distilled water or de-ionized water is not readily available, the material can be cleaned with tap water, provided the last rinse is done using the AUS 40 to be handled with the equipment.

If it is necessary to clean a system regardless of whether detergents are used or not, it should be verified that the trace elements specified in ISO 18611-1, Table 1 in the AUS 40 that is used for a last rinsing are within the specification using the methods specified in ISO 18611-2.

For storage and transportation facilities, the result of the cleaning can be verified by analysing the AUS 40 used for a last rinsing using the methods specified in ISO 18611-2.

#### 4.4 Recommendation on further properties

Information on further properties of AUS 40 should be given in the material safety data sheet (MSDS), which contains indications on the hazard ranking and regulations to be respected, as well as measures required to be taken for the protection of persons and of the environment when handling the product.

## 5 Quality assurance

### 5.1 General

Each container of AUS 40 brought to the market shall be traceable back to production batches of AUS 40 by way of a unique batch number. It is recommended to include the date of original manufacturing or the date of last certification.

The quality of AUS 40 taken at any point in the distribution chain shall meet the specifications defined in this International Standard. 5.2 to 5.5 describe the recommendations related to sampling, testing/checking, and monitoring of *bulk operations* (3.1) or *packaged shipments* (3.2), as well as the procedures for re-testing and/or re-checking of quality in the case of intermediary manipulations (i.e. intermediate tank storing, filling or re-filling).

### 5.2 Sampling

In addition to the sampling instructions given in ISO 18611-2, Annex A, the instructions below apply to any sampling.

- Written operating procedures should be available.
- The details of the sampling procedures should be adapted to the purpose of the sampling.

EXAMPLE 1 If it is intended to determine the quality of AUS 40 in a bulk container, discarding the first 2 l to 3 l taken from the outlet is appropriate.

EXAMPLE 2 If sampling is conducted to determine the compatibility of materials in direct contact with AUS 40, discarding the first 2 l to 3 l taken from the container outlet is not appropriate.

EXAMPLE 3 If it is intended to determine the quality of AUS 40 out of the dispenser's filling nozzle, taking a sample from the first 3 l of delivery volume is appropriate.

- After the loading of any means of bulk transportation at the production site, a sample should be taken from the filled container. This should be done according to a standard operating procedure that ensures that the sample is representative. An analysis of this sample should be performed before the delivery of the AUS 40 if non-dedicated means of bulk transportation are being used.

### 5.3 Quality verification

The quality of the AUS 40 shall be verified prior to shipment. The quality shall be in accordance with the specifications defined in this International Standard.

Necessary quality verification routines shall be established by the producer. Quality verification shall primarily be performed by means of testing by chemical analytical procedures, either by the reference methods given in this International Standard, or methods that are proven to perform at the same level, or better than, the reference methods. Statistical Process Control (SPC) can be used a valuable tool for quality verification.

The necessary testing frequency shall be determined by the producer and will depend on the stability of the production process (a stable, non-variable process may allow for a lower testing frequency). Necessary testing frequency shall be established based on statistical methods and provide better than 95 % certainty that the chosen product release routines ensure conformity with specification.

In case of dispute, the reference methods described in this International Standard shall be used, and a qualified, third-party laboratory shall be used.

Qualified laboratories for verification are

- laboratories that have implemented and validated the reference methods described in this International Standard,

- laboratories that have a quality management system, e.g. in accordance with ISO 9001, and
- laboratories certified by national authorities.

#### 5.4 Procedures for product release and handling of non-conforming product

AUS 40 may be released for the intended use if the verification procedure described in 5.3 confirms that the AUS 40 is fulfilling the specification of this International Standard. Should there be any parameter deviating from specification or any doubt about the quality of the product, e.g. due to containers without labels, coloured or cloudy product, uncharacteristic smell, or a shelf life being exceeded, the AUS 40 in the container shall be withheld and stored separately and labelled accordingly. Further investigations should then be carried out.

To re-enter the distribution chain, the product quality shall be checked again and it shall be verified that the quality standards defined in this International Standard are fulfilled.

If the results of an analysis reveal that the AUS 40 from the same production batch has the same fault, the shipments concerned shall be recalled.

To minimize the risk of overlooking an unidentified contaminant, a product that is recalled in this way and that is judged not to be in compliance with the specification shall be downgraded and shall no longer be designated as AUS 40 meeting the requirements of this International Standard.

NOTE For closed containers with an expired shelf life, it is sufficient to test the alkalinity as  $\text{NH}_3$  of the AUS 40 in the containers in accordance with this International Standard for a decision about further use.

#### 5.5 Quality assurance

##### 5.5.1 Documentation

The manufacturer shall ensure that production and release of product (Quality Verification) is done in accordance with established written procedures and documented accordingly. Upon request from a third-party, the quality documentation shall be sufficient to provide certification of quality in terms of a Certificate of Conformity or Certificate of Analysis (only for analytical parameters actually performed).

Procedures and records of the distribution chain of AUS 40 concerning production, product delivery, loading, storage, sampling, testing, product release, and handling, as well as audits, shall be documented, e.g. in accordance with the guidelines of ISO 9001.

##### 5.5.2 Audits

All parties of the distribution chain have the responsibility to audit their portion of the chain so as to ensure the quality of the AUS 40.

Actions should be taken by the responsible parties to resolve any problems identified.

##### 5.5.3 Maintenance of documents

Quality documents should be kept on file for 5 years.