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INTRODUCTION

These notes are specific to this edition of the publication and changes have been made for consistency with the 1999 edition of the Rules and Regulations for the Classification of Ships, Part 2, "Rules for the Manufacture, Testing and Certification of Materials", hereafter referred to as the Materials Rules.

The welding consumables and consumable combinations listed have complied with the approval requirements set out in the relevant Sections of Chapter 11 of the Materials Rules. The consumables are retained in these lists subject to satisfactory annual tests made in accordance with the Materials Rules, the results of which are reported to the Head Office of Lloyd's Register. Further information may be found in the Materials and Qualification Procedures for Ships, Book J, Procedures for Approval of Welding Consumables and Manufacture of Fabricated Steel Sections.

The responsibility for compliance with national or other standards indicated by labelling or implied by the trade name rests with the Manufacturer.

It should be noted that unaccountable delays in the receipt of satisfactory annual test results will lead to deletion from the approved list.

The Sections are numbered in accordance with the numbering of the respective Sections of the Materials Rules, Chapter 11, namely:

Section 3:	Consumables for Manual and Gravity Metal Arc Welding of Steels.
Section 4:	Consumables for Submerged Arc Welding of Steels.
Section 5:	Consumables for Gas Tungsten Arc, Gas Shielded Metal Arc and Self Shielding Metal Arc Welding of Steels.
Section 6:	Consumables for Electroslag and Electrogas Welding of Steels.
Section 7:	Consumables for One-Side Welding of Steels with Temporary Backing Materials.
Section 8:	Consumables for Welding Austenitic and Duplex Stainless Steels.
Section 9:	Consumables for Welding Aluminium Alloys.

The Section number and title (in brief) is repeated at the head of each page.

The continuing process of new approvals and up-grading, deletions and down-grading means that this published list records the status only at the deadline for printing.

Any queries concerning the validity of an approval can be resolved by reference to one or more of the following:-

- a) The initial approval certificate, for 12 months from the date of issue.
- b) The annual re-approval certificate, taking due note of the period of validity indicated on it by the "year ending" date.
- c) The local office of Lloyd's Register.
- d) Materials and Non Destructive Examination Department,
Lloyd's Register,
71 Fenchurch Street
London, EC3M 4BS
Telephone: 020 7709 9166
Telex: 888379 LR LON G
Fax: 020 7488 4796

The use of approved welding consumables in a shipyard should be subject to satisfactory results being obtained from welding procedure tests carried out in that shipyard. Such tests are always to be carried out where the shipyard has not previously welded that particular material or where a welding process or technique is newly introduced to that shipyard.

The explanatory notes and abbreviations set out below are applicable to most Sections. Where they are not, this is clearly indicated.

EXPLANATORY NOTES AND ABBREVIATIONS

Names

Within each Section, welding consumables or consumable combinations are listed, in alphabetical order, under Country, Supplier (including Plant if required) and Trade Name. Sub-headings separate different welding consumable combination types and processes. A supplier is not necessarily the manufacturer.

Some manufacturers, in some countries, may not have listed all of the approved products which they sell. This can occur where products manufactured in one country are sold by an associated company of the same (or similar) name in another country. In such cases, the status of approval can be found by identifying the country of manufacture from the packaging and examining the listing under the name of the supplier in the country identified.

Welding Positions

Consumables are approved for welding only in those positions which are specifically indicated by one or more of the following letters:

D	approved for Downhand (flat) welding. Where approved for fillet welding as well as, or instead of, butt welding, this designation refers to downhand and horizontal-vertical fillet welding.
X	approved for horizontal-vertical welding.
Vu	approved for Vertical welding with progression in the upward direction only.
Vd	approved for Vertical welding with progression in the downward direction only.
Vud	approved for Vertical welding with progression in either upward or downward direction.
O	approved for Overhead welding.

Joint Type

Approval applies only to the joint type indicated by the following letters:

B	approved for welding Butt joints.
F	approved for Fillet welding.

Grade + Technique

The consumable Grade description differs according to the Section as described later. For special purposes "dual grading" involving a two-line entry is employed.

The Grade may be modified by appended letters which indicate the post weld condition for which approval has been given:-

sr	stress relief heat treated after welding.
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The welding Technique is indicated by a letter added to follow the Grade:-

p	manual electrodes suitable for deep penetration welding.
m	manual welding using electrodes for normal penetration, or consumables for manual gas tungsten arc welding.
G	Gravity or contact welding.
S	Semi-automatic multi-run welding.
M	automatic Multi-run welding (submerged arc, gas tungsten arc and gas metal arc).
T	Two-run technique welding (submerged arc, and gas metal arc).
A	Automatic high heat input welding, used for one-side welding, Section 7.

Low Hydrogen Approval

This appears as a column heading for approvals under Sections 3, 4, 5, and 7. It does not appear for approvals under Section 6, 8 and 9 as the significance of hydrogen content is unclear and there are no currently agreed test methods for electroslag and electrogas welding and for the welding of austenitic and duplex stainless steels and aluminium alloys.

No	No hydrogen approval.
H15	low Hydrogen approved, conforming to standard weld metal containing not more 15 cm ³ of hydrogen in 100 g of weld deposit.
H10	low Hydrogen approved, conforming to standard weld metal containing not more 10 cm ³ of hydrogen in 100 g of weld deposit.
H5	low Hydrogen approved, conforming to standard weld metal containing not more 5 cm ³ of hydrogen in 100 g of weld deposit.
NR	testing for low hydrogen approval is Not Required , because the consumable and process in which it is used are not considered to involve a risk of hydrogen cracking in normal construction.

Maximum Thickness

The “**t max**” entry indicates the **maximum thickness** for which the consumable is approved in conjunction with the relevant Section and Grade + Technique as described later.

NA **Not Applicable** because there is no thickness limit relevant to the approval.
35 where the Grade + Technique is approved but is limited to plates with a maximum thickness of 35 mm.

Use on greater thickness than that indicated, will be subject to satisfactory welding procedure tests.

Grades for Steels, Sections 3, 4, 5, 6 & 7.

The Grade for consumables suitable for welding **normal strength steels** consists of a single digit number from 1 to 3 referring to the notch impact test temperature (which may be followed optionally by the letter **N**).

- 1** tested at 20°C suitable for welding Grade A steel.
- 2** tested at 0°C suitable for welding Grades B and D steel.
- 3** tested at -20°C suitable for welding Grade E steel.

The Grade for consumables suitable for welding **higher strength steels** consists of a single digit number from 1 to 5 referring to the toughness level followed by the letter **Y** for consumables approved for the welding of Grade 32 and Grade 36 steels. For other higher strength steels the letter Y is followed by a two digit number indicating the approved specified minimum yield strength in N/mm² divided by 10.

- 4Y** tested at -40°C.
- 5Y40** tested at -60°C.

The Grade of a consumable approved for the welding of a nickel alloy steels is indicated by the nominal alloy content.

The consumable approval Grades and the steel Grades for which they are considered suitable, are shown in the following table.

Consumable grade	Suitable for steel grades
1 (N)	A
2 (N)	B, D
3 (N)	E
1Y	AH32 (LT-AH32), AH36 (LT-AH36)
2Y	DH32 (LT-DH32), DH36 (LT-DH36)
3Y	EH32 (LT-EH32), EH36 (LT-EH36)
2Y40	AH40 (LT-AH40)
3Y40, 3Y42, 3Y46, to 3Y69	DH40 (LT-DH40), DH42, DH46, to DH69
4Y	FH32 (LT-FH32), FH36 (LT-FH36)
4Y40	EH40 (LT-EH40)
4Y42, 4Y46 to 4Y69	EH42, EH46, to EH69
5Y40	FH40 (LT-FH40)
5Y42, 5Y46, to 5Y69	FH42, FH46, to FH69
1½Ni	1½Ni
3½Ni	3½Ni
5 Ni	5 Ni
9 Ni	9 Ni
(N) Use of N is optional.	

For joining different Grades of steel of a given strength, consumables suitable for the lower toughness Grade are generally acceptable, except at discontinuities or other points of stress concentration, where the Grade appropriate to the tougher steel will be expected.

For the joining of steel of different tensile strengths, the consumables are to be suitable for the strength of the weaker member, or in the case of fillet welded connections, on the strength of the component used as the basis for the fillet size.

Manual and Gravity Electrodes, Section 3

The steel Grade is used with an appended letter corresponding to one of the welding techniques m, p and G. The use of the technique as part of the Grading is optional for manual electrodes so that, for example, 3m can be expressed as 3 and 3Ym as 3Y.

3m = 3 ; 3Ym = 3Y ; 3YG = 3G + 3YG

Submerged Arc Consumables, Section 4

The steel Grade is used with an appended letter corresponding to one of the welding techniques M and T. The use of the Grade + Technique is mandatory. Note that abbreviations of Grade + Technique combinations are common and that for the M technique the approval covers two strength levels below that tested so that 3YM covers both 3M and 3YM.

3T, 3M = 3TM ; 3YT, 3YM = 3YTM ; 3T, 3M, 3YM, 3YT = 3TM, 3YTM ;
3M, 3YM = 3YM ; 3T, 3YM, 3YT = 3TM, 3YTM

Approval for the M technique does not have any restriction on thickness.

Approval for the T technique is limited to the maximum thickness entered in the "tmax in T technique" column.

Gas Shielded Metal Arc Etc., Section 5

The steel Grade is used with an appended letter corresponding to one of the welding techniques m, S, M or T.

Approval for the m, S or M techniques do not have any restriction on thickness.

Approval for the T technique is limited to the maximum thickness entered in the "t max in T technique" column.

Unless otherwise expressed, consumables for downhand semi-automatic welding are also approved for downhand automatic multi-run welding.

DXVuO; 3S; 3YS; etc. also means: D; 3M; 3YM; etc.

Electroslag and Electro gas Consumables, Section 6

Steel Grades are used without any appended technique letter.

Superscript numbers are applied to the "Y" of higher strength steel consumables, e.g. 2Y¹, to indicate the type of parent steel for which approval is applicable:-

- Y¹ approval Grade for higher strength steel is limited to parent steel which has been treated only with **aluminium**.
- Y² approval Grade for higher strength steel is appropriate to **niobium**-treated steels, whether aluminium-treated or not. It also covers steels treated only with aluminium.

The approval is limited to the maximum thickness entered in the "tmax" column.

Consumables for One-Side Welding, Section 7

The steel Grade is used with an appended letter corresponding to one of the welding techniques m, S, M or A.

Technique A, Automatic high heat input welding, is used only for one-side welding, Section 7, for which not more than 4 runs are used to complete a butt weld in 20 mm plate, or 8 for 35 mm. Approval for the A technique is limited to the maximum thickness entered in the "t max in A technique" column.

Where S and M are used in Section 7, these refer to semi-automatic and automatic multi-run welding in which a greater number of runs are used than for Technique A.

Consumables for Stainless Steels, Section 8

Chemical Use, Cryogenic Use The Grade and appended technique letter are entered in each column in accordance with the application approved. The Grade corresponds to the type of approved stainless steel parent material for which the welding consumable is approved.

The available Grades are: Austenitic: 304L, 304LN, 316L, 316LN, 317LN, 321, 347, S 31254, N 08904.
 Duplex: S 31260, S 31803, S 32550, S 32750, S 32760.

SS/CMn in the Chemical Use column indicates approval for joining any of the austenitic types of stainless steel to any of the normal or higher strength ship steels up to and including Grade EH36.

Where "SS/CMn" appears in the Cryogenic Use column, it indicates approval for joining any of the austenitic stainless steels to ship steels up to and including Grade FH40 (LT-FH40) for low temperature applications for which the ship grade used is suitable.

Dup/CMn indicates approval for joining any of the duplex types of stainless steel to any of the normal strength or Grade 36 higher tensile ship steels. Approval is currently available only for "Chemical Use". Approval for cryogenic applications must be obtained as part of normal welding procedure qualification for each application.

CPT, the **Critical Pitting Temperature** is the maximum temperature at which pitting was not observed in a standard corrosion test to ASTM G48 Method C.

Consumables for Welding Aluminium Alloys, Section 9

The Grade of approval is indicated by the alloy type and condition of the parent material with an appended letter corresponding to one of the welding techniques m, S, M or T.

The available Grades are: 5083-O & F, 5083-H321, 5086-O & F, 5086-H112, 5086-H321, 6061-T6, 6082-T6.

HIGHER STRENGTH STEEL

The weldability of high strength steel of the carbon-manganese type has been assessed from the carbon equivalent value calculated using the formula:

$$\text{Carbon equivalent} = C + \frac{\text{Mn}}{6} + \frac{\text{Cr}+\text{Mo}+\text{V}}{5} + \frac{\text{Ni}+\text{Cu}}{15}$$

This is relevant to the avoidance of hydrogen induced delayed cold cracking during fabrication of ship structures and similar applications.

The following table summarises the minimum hydrogen requirements for approval in accordance with the Materials Rules.

Approval Grade	Process & Technique			
	SMAW,m GMAW,S	SAW,M GMAW,M	SAW,T&A GMAW,T&A	ES EG
N Y (CE<0.41) Y (CE>0.41) Y40 1.5 Ni steel	NR	NR	NR	NR
Y42 Y46 Y50 Y55 Y62 Y69	H10	H10	H15 H10	Not Applicable
	H5	H5	H5	
Austenitic & Duplex Stainless Steels	Not Applicable			

Use of consumables presumes that their low hydrogen condition will be safeguarded up to and including the point of use, and that welding procedures will be set to minimise the risk of hydrogen cracking by controlling the weld heat input and preheat to appropriate levels for the joints being made. These procedures will take into account also the steel being welded and the actual low hydrogen approval of the consumables used. In highly critical situations the manufacturer may be willing to supply and certify consumables subjected to batch control testing.

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