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COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS AND ON THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS

Sub-Committee of Experts on the Transport of Dangerous Goods
(Twentieth session, 3-12 December 2001, agenda item 7 (d)

LISTING AND CLASSIFICATION

Testing of liquid and solid substances as dangerous goods of class 8, packing group III, according to their corrosive properties on steel or aluminium Specification of the Test regulations

Transmitted by the expert from Germany

Background

On the 21st session of the Committee of Experts the expert from Germany reiterated the request he had made at the last session of the Sub-Committee for comments on his proposal "Testing of liquid and solid substances as dangerous goods of class 8, packing group III, according to their corrosive properties on steel or aluminium Specification of the Test regulations".
and asked that this topic should be placed on the Committee's programme of work for 2001 – 2002; his request was accepted (see ST/SG/AC.10/27, para. 23). Furthermore he invited interested experts to an informal working group to be convened in Germany.

On the 19th session of the Sub-Committee of Experts on the Transport of Dangerous Goods the expert from Germany stated to submit an Inf document regarding the outcome of the international meetings in Germany.

Report of the 1st and 2nd meeting of the international informal working group on corrosiveness of liquids and solids belonging to Class 8, Packing Group III, for steel and aluminium

The chairman of the working group explained the background leading to the German document concerning "Testing of liquid and solid substances as dangerous goods of class 8 - packing group III, according to their corrosive properties on steel or aluminium - Specification of the test regulations".

General

The majority of the working group agreed that the testing instructions to determine the corrosion of class 8, packing group III apply to the testing of liquid substances, to substances which become liquid on transport and to hygroscopic solid substances. As the German proposal should apply to amendments of the UN Recommendations, amendments concerning provisions for the land mode (ADR/RID (GGVS, GGVE)) and the sea mode (IMDG-Code (GGVSee)) will not be proposed.

The working group confirmed, that:

a.) in the dangerous goods provisions compatibility of the containments and of their materials with the content can be requested only for substances, which have to be assessed as dangerous goods. Therefore the working group stressed that a test to determine the corrosive properties on steel or aluminium is necessary.

b.) the criterium of corrosiveness of steel and aluminium depends on the mode of transport.

Presentation of Inf Documents

The following Inf Documents were distributed by the chairman of the working group:

a) Inf1 "Viewpoints of Metal Corrosion - Provided by Charles Ke for considerations at the BAM working group meeting" (U.S.A.)
b) Inf2 "Viewpoints on metal corrosiveness to assess caustic/corrosive substances" (VCI/CEFIC)
c) Inf3 "Corrosiveness for steel and aluminium - Remarks to the change in concentration/composition by reaction with the testing plates (some approximations and simplifications are used for the calculations)" (Austria)

After the presentation of the Inf Documents the working group agreed to work on the basis of the German document ST/SG/AC.10/C.3/2000/24 and on the basis of Inf1, because the German document lists the fields of problems and Inf1 includes an specific proposal for a new test method.

Discussion on fields of problems

The following fields of problems have been discussed by the working group:

Provisions for testing substances of class 8, packing group III with regard to their corrosive properties on steel or aluminium. Test criteria, material, reaction receptacle, volume/surface relation, preparation of metal samples, test temperature, operation period, test evaluation, test evaluation at local corrosion, test of corrosive properties of liquids which react corrosive under the influence of water, test of corrosive properties of solids and test of corrosive properties of substances being chemically unstable should be discussed.

Check of test method and of reference materials

A check of the test method according to 2.8.2.4 (c) (ii) of the Model Regulations, the IMDG code and RID/ADR according to ASTM G31-72 (reapproved in 1990) showed, that this ASTM-standard (reapproved in 1995) and is written more like a guideline rather than a test method. This fact is stated clearly in the beginning of that standard, sections 3 and 4. **Therefore the ASTM-standard is not suited as a test method to determine corrosive properties on steel and aluminium.**

The type of steel to be used in the existing regulations "**steel type P235 [ISO 9328 (II):1991]**" is neither available in the United States nor in Europe. It was confirmed that this type of steel is used for pressure vessels and therefore the use of P235 for corrosion testing of chemical containers is questionable. After a thorough check made in co-operation with steel companies the working group agrees to adopt the American proposal to use as reference material the steel type **SAE 1015 (0,12 – 0,18 % carbon, 0,3 – 0,6 % manganese, no chromium or molybdenum)** or the type **AISI 1015** respectively. This reference material is available worldwide and is offered with different denominations. According to DIN the steel's name is Ck 15 in Germany and has the material number 1.1141 (copy of the steel code, see **Annex 1** to this document).

The working group recommends to introduce a new test method including criteria and reference materials for section 37 of the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, third revised edition.

Results of the discussion with reference to the German document ST/SG/AC.10/C.3/2000/24

Test criteria

The test in order to determine the corrosion rate on steel and aluminium surfaces at contact with the substances to be assessed at a test temperature of 55 °C is described in ADR/RID, the UN Model Regulations and the IMDG Code and this description is relatively insufficient because for different test methods different results are obtained.

The test of the corrosive effect of liquids on steel and aluminium surfaces shall presently be carried out according to 2.8.2.4 (c) (ii) of the Model Regulations, the IMDG sub-section 2.8.2.4.3.2 (Amdt. 30/00) or ADR/RID sub-section 2.2.8.1.5 c) second indent (test criteria of class 8, packing group III) according to ASTM G31-72 (re-approved in 1990). This standard is nearly unknown in Europe and contains only general hints for the execution of corrosion tests. Criteria concerning test period, immersion depth of metal samples and evaluation are not sufficiently determined. This standard corresponds to a large extent to the German standard DIN 50 900 and the following, which describe the fundamentals of the corrosion tests. The corrosion test necessary for the classification (permanent immersion test) in liquids, without mechanical load, may be carried out according to the above mentioned DIN standards.

Material

The Model Regulations provide for the tests **steel type P235 [ISO 9328 (II) : 1991] or a similar type and for testing aluminium, non-clad types 7075-T6 or AZ5GU-T6**.
As the unalloyed steel P 235 (ISO 9328 (II): 1991) is hardly known in Europe or not available. After checking the worldwide availability of uncoated steel, the following steel types 1.1141 (Ck 15 resp. SAE 1015 resp. AISI 1015), 1.0037 (St 37-2) or 1.0144 (St 44-3) are recommended. The corrosion behaviour of both unalloyed steels may be considered to be equivalent. **The aluminium alloys are available worldwide**.

Reaction receptacle

The reaction receptacle should be of glass or PTFE. In the ASTM Standards as well as in the DIN 50 905, part 4, reaction receptacles are described. The design of the receptacle is insignificant. 3 liter cup-like reaction receptacles with face cut top and three necks NS 29/32 (to be wide enough for insertion and removing of samples) as well as one neck NS 14 have proved successful on the market. The entrance of air, however, into the receptacle has to be guaranteed. Aluminium- and steel-samples have to be tested in different reaction receptacles. To prevent liquid loss a reflux condenser should be attached.

Volume/surface relation

In order to carry out the corrosion test the corrosive medium shall have a minimum volume of 1,5 l to ensure enough reactive agent during the whole exposure time. This is even more important if the corrosion is not caused by the material to be tested but by its quantitatively small amount of impurities. This matches the recommended 10 ml/cm² stated in DIN 50 905 part 1. Volume/surface ratio of 20 resp. 40 ml/cm² as stated in the ASTM G31-72 are not sufficient, based on the expe riences of BAM (Germany) as well as of BPA (Austria). A volume surface ratio of 50 ml/cm² is recommended.

Preparation of metal samples

Metal sheets with the dimensions 50 x 20 x 2 (1.6) mm are considered to be of a suitable size and availability (thickness). 20 mm width and not 25 mm as in American procedure are required to fit through the neck of receptacle. After polishing with grinding paper of 120 grid, the removal of grinding remainings with alcohol in the ultrasound bath and the degreasing with acetone the metal samples shall be weighed out

to ? 0.0002 g. No chemical surface preparation (pickling, etching etc.) shall be performed to prevent surface "irritations" (inhibition, passivation). For the fixing the sheets inside the receptacle non extruded PTFE-threads have proved to be suitable. Metal wire shall not be used. The test with the so prepared metals shall be initiated the same day to prevent reformation of oxide layer (especially on Al-samples). Now one metal sample has completely to be dipped into the liquid phase, another one only half way and a third one shall hang in the gas phase.

> NOTE: BAMs experiences especially with composed liquids have shown, that sometimes (in vapour or intermediate phase, where they exists purely) evaporating parts of the liquid were stronger aggressive than mixed in liquid.

The distance between the upper edge of the completely inserted specimen and the surface of the liquid is supposed to be 10 mm. Losses of liquid shall be avoided.

Test temperature

The test temperature of 55 °C ? 1 should be maintained constant and should be reached in the vapour phase as well.

Operation period

The test standard ASTM G31-72 mentioned in the Model Regulations gives no information concerning the operation period. For choosing the operation period, it has to be considered that the corrosion may take the following different courses:

a) The surface related mass loss rate is proportional to the time like, for instance, in the case of the effect of an acid on metal. The resulting corrosion products are soluble in the acid and there will be no protective layer.
b) The surface related mass loss rate is low but after an incubation time a local corrosion attack will be registered (e.g. pitting corrosion).
c) At the beginning a relatively high surface related mass loss rate will be noticed with constant data later. This effect may occur due to a protective layer.

The extrapolation of the results of a corrosion test does not only show the statistic spread of the test results but differs the more from the annual statement according to the corrosion course the shorter the test period is. The test period should be chosen such that the effect of the initial corrosion in relation to the complete result is negligible. Due to these considerations a test period of 1 week (168 hours; +/- 1 hour) seems to be sufficient and necessary as a minimum.

Test evaluation

After finishing the test the metal samples shall be rinsed off and cleaned with a brush with synthetic or natural bristles (no metal). Only in case of not mechanically removable remainings (adherent corrosion product or depositions) inhibited pickling solutions should be used. In those cases a not exposed reference sample needs to be treated in the same manner (time, temperature, concentration, surface preparation) to determine the weight loss caused by pickling solution. This value needs to be subtracted before evaluating the corrosion rate. After the final cleaning with alcohol and acetone in the ultrasound bath and drying the metal samples are going to be weighed. The resulting weight under consideration of the specific weight of the metal leads to the corrosion rate.

Test evaluation at uniform corrosion

In case of uniform corrosion attack weight loss of strongest attacked sample shall be used. Solution passes the test if weight loss on 50 x 20 x 2 mm sheet is less than amount stated in the following table

exposure time	weight loss
7 days	13,5 %
14 days	26,5 %
21 days	39,2 %
28 days	51,5 %

NOTE: Those values are calculated based on a 6,25 mm/year corrosion rate. I.e. 0,12 mm/week (7 days). So within exposure time sample size decreases to following dimensions

exposure time		specimen dimensions				
7 days		49,76 mm	X	19,76 mm	x	1,76 mm
14 days		49,52 mm	X	19,52 mm	X	1,52 mm
21 days		49,28 mm	X	19,28 mm	X	1,28 mm
28 days		49,04 mm	X	19,04 mm	X	1,04 mm

Test evaluation at localised corrosion

In case of localised corrosion besides or instead of uniform corrosion attack of surface, the depth of the deepest hole respectively the strongest thickness reduction will be added or only be used to determine the intrusion. Deepest intrusion (to be determined metallographically) within 1 week testing time shall not exceed values shown in following table.

exposure time	max. intrusion depth
7 days	120 µm
14 days	240 µm
21 days	360 µm
28 days	480 µm

Test of corrosive properties of liquids which react corrosive under the influence of water

Acid chlorides belong to the substances which react corrosive with water, evolving hydrochloric acids. Therefore these substances have to be tested according to their corrosive properties in water. The aqueous solution with the highest corrosion rate which mostly is in the middle concentration range, has to be determined by a test (see test of corrosive properties of solids).

Test of corrosive properties of solids

Solids which are hygroscopic **do not react corrosive in a totally dried state** on the above mentioned steel and aluminium materials **but they do so in a semi-liquid state**. Depending on the transport conditions the hygroscopic solid substances sometimes decompose or stick on. The surrounding material (material of the packages or packagings) may be corroded by the corrosive solution so that it may leak. As the mentioned corrosion tests refer to liquid mediums only the aqueous solution with the highest possible corrosive effect on metals has to be determined.

Established by experiences, aqueous solutions in the middle concentration range have the highest corrosive effect on metallic materials. In case the most aggressive concentration is not known by the tester he has to approach the concentration with the highest corrosiveness in steps of 10%. Therefore two or three tests have to be carried out at the same time.

Dry solids are classified as being non dangerous.

Test of the corrosive properties of substances being chemically unstable

The decomposition of chemically unstable substances is normally prevented by adding stabilisers or inhibitors or cooling. In case a chemically unstable product flows out of a tank or a packaging it has to be taken into account that the product itself as well as the reaction product(s) may damage the material of the transport unit.
Therefore in case of chemically unstable products the substance as well as the reaction product(s) have to be tested according to their corrosive effect on steel and aluminium. The corrosion test has to be carried out with the necessary safety precautions.

Classification of liquid substances, substances liquifying during transport, hygroscopic substances and solid substances

A flow chart for the classification of corrosive substances is attached as **Annex 2** to this document.

Test for determining corrosive properties of liquid substances, substances liquifying during transport, hygroscopic substances and solid substances in terms of requirements for classification as dangerous goods of class 8, packing group III

A complete test for the classification of corrosive substances is attached as **Annex 3** to this document.

Proposal

The Sub-Committee of Experts on the Transport of Dangerous Goods is requested to consider the above decribed testing procedure and the reference materials for determining corrosive properties of liquid substances, substances liquifying during transport, hygroscopic substances and solid substances in terms of requirements for classification as dangerous goods of class 8, packing group III.

For the 21st session the expert from Germany offers to submit a detailed proposal to amend the Model Regulations as well as the Manual of Tests and Criteria.

Annex 1 (Steel code)

U.S.A.			U.S.A.										U.S.A.
Baustähle				**Aciers de construction**									**Structural and constructional steels**
No.	US-Norm Norme Standard		Unified Numbering System	Analyse				Analyse				Composition	WNr. No. du mat.
	SAE	AISI	UNS	C %	Si %	Mn %	P ≤ %	S ≤ %	Cr %	Mo %	Ni %	Sonstige Autres – Others %	Mat. no. ~
1	J 403 (1995)			**Kohlenstoffstähle (nur anwendbar für Halbzeug zum Schmieden, warmgewalzte und kalt nachgearbeitete Stäbe, Drähte und nahtlose Rohre – Aciers au carbone (applicable seulement pour demi-produits pour forgeage, barres l.à.c. et usiné à froid, fil, tubes sans soudure – Carbon steels (applicable only for semifinished products for forgings, hot rolled and cold finished bars, wire rods, seamless tubing**									
2	1005	1005	G10050	≤ 0,06	a; b	≤ 0,35	0,030	0,050	–	–	–	–	1.0314
3	1006	1006	G10060	≤ 0,08	a; b	0,25–0,40	0,030	0,050	–	–	–	–	1.0313
4	1008	1008	G10080	≤ 0,10	a; b	0,30–0,50	0,030	0,050	–	–	–	–	1.0204/1.0330/1.0318/ 1.0211/1.0212
5	1010	1010	G10100	0,08–0,13	a; b	0,30–0,60	0,030	0,050	–	–	–	–	1.1121/1.0301/1.0308/1.0032
6	1012	1012	G10120	0,10–0,15	a; b	0,30–0,60	0,030	0,050	–	–	–	–	–
7	1015	1015	G10150	0,13–0,18	a; b	0,30–0,60	0,030	0,050	–	–	–	–	1.1141/1.0413/1.0037
8	1016	1016	G10160	0,13–0,18	a; b	0,60–0,90	0,030	0,050	–	–	–	–	–
9	1017	1017	G10170	0,15–0,20	a; b	0,30–0,60	0,030	0,050	–	–	–	–	1.1141
10	1018	1018	G10180	0,15–0,20	a; b	0,60–0,90	0,030	0,050	–	–	–	–	–
11	1020	1020	G10200	0,18–0,23	a; b	0,30–0,60	0,030	0,050	–	–	–	–	1.0402/1.0414/1.0408/1.0044
12	1021	1021	G10210	0,18–0,23	a; b	0,60–0,90	0,030	0,050	–	–	–	–	–
13	1022	1022	G10220	0,18–0,23	a; b	0,70–1,00	0,030	0,050	–	–	–	–	1.1133
14	1023	1023	G10230	0,20–0,25	a; b	0,30–0,60	0,030	0,050	–	–	–	–	1.1151
15	1025	1025	G10250	0,22–0,28	a; b	0,30–0,60	0,030	0,050	–	–	–	–	1.1158/1.0415
16	1026	1026	G10260	0,22–0,28	a; b	0,60–0,90	0,030	0,050	–	–	–	–	–
17	1029	1029	G10290	0,25–0,31	a; b	0,60–0,90	0,030	0,050	–	–	–	–	–
18	1030	1030	G10300	0,28–0,34	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1178/1.0528
19	1035	1035	G10350	0,32–0,38	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1181/1.0501
20	1038	1038	G10380	0,35–0,42	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1176
21	1039	1039	G10390	0,37–0,44	a; b	0,70–1,00	0,030	0,050	–	–	–	–	1.1157
22	1040	1040	G10400	0,37–0,44	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1186/1.0511
23	1042	1042	G10420	0,40–0,47	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1191
24	1043	1043	G10430	0,40–0,47	a; b	0,70–1,00	0,030	0,050	–	–	–	–	1.0503
25	1044	1044	G10440	0,43–0,50	a; b	0,30–0,60	0,030	0,050	–	–	–	–	–
26	1045	1045	G10450	0,43–0,50	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1191/1.0503
27	1046	1046	G10460	0,43–0,50	a; b	0,70–1,00	0,030	0,050	–	–	–	–	–
28	1049	1049	G10490	0,46–0,53	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1206/1.0540
29	1050	1050	G10500	0,48–0,55	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1206/1.0540
30	1053	1053	G10530	0,48–0,55	a; b	0,70–1,00	0,030	0,050	–	–	–	–	–
31	1055	1055	G10550	0,50–0,60	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1203/1.0535
32	1060	1060	G10600	0,55–0,65	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.0601
33	1065	1065	G10650	0,60–0,70	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1230
34	1070	1070	G10700	0,65–0,75	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1231/1.0603
35	1078	1078	G10780	0,72–0,85	a; b	0,30–0,60	0,030	0,050	–	–	–	–	1.1248/1.0622
36	1080	1080	G10800	0,75–0,88	a; b	0,60–0,90	0,030	0,050	–	–	–	–	–
37	1086	1086	G10860	0,80–0,93	a; b	0,30–0,50	0,030	0,050	–	–	–	–	1.1269/1.0616
38	1090	1090	G10900	0,85–0,98	a; b	0,60–0,90	0,030	0,050	–	–	–	–	1.1273
39	1095	1095	G10950	0,90–1,03	a; b	0,30–0,50	0,030	0,050	–	–	–	–	1.1274/1.0618
				Manganstähle (nur anwendbar für Halbzeug zum Schmieden, warmgewalzte und kalt nachbearbeitete Stäbe, nahtlose Rohre – Aciers au manganèse (applicable seulement pour demi-produits pour forgeage, barres l.à.c. et usiné à froid, tubes sans soudure – Manganese carbon steels (applicable only for semifinished products for forging, hot rolled and cold finished bars, seamless tubing									
40	1522	1522	G15220	0,18–0,24	a; b	1,10–1,40	0,030	0,050	–	–	–	–	1.1133
41	1524	1524	G15240	0,19–0,25	a; b	1,35–1,65	0,030	0,050	–	–	–	–	1.1160
42	1526	1526	G15260	0,22–0,29	a; b	1,10–1,40	0,030	0,050	–	–	–	–	1.1161
43	1527	1527	G15270	0,22–0,29	a; b	1,20–1,50	0,030	0,050	–	–	–	–	1.1161
44	1541	1541	G15410	0,36–0,44	a; b	1,35–1,65	0,030	0,050	–	–	–	–	1.1167
45	1548	1548	G15480	0,44–0,52	a; b	1,10–1,40	0,030	0,050	–	–	–	–	1.1226
46	1552	1552	G15520	0,47–0,55	a; b	1,20–1,50	0,030	0,050	–	–	–	–	1.1226
47	1566	1566	G15660	0,60–0,71	a; b	0,85–1,15	0,030	0,050	–	–	–	–	1.1260
				Automatenstähle (nur anwendbar für Halbzeug zum Schmieden, warmgewalzte und kalt nachgearbeitete Stäbe, Drähte und nahtlose Rohre – Aciers de décolletage (applicable seulement pour demi-produits pour forgeage, barres l.à.c. et usiné à froid, fil, tubes sans soudure – Free cutting steels (applicable only for semifinished products for forgings, hot rolled and cold finished bars, wire rods, seamless tubing									
48	1117	1117	G11170	0,14–0,20	a; c	1,00–1,30	0,030	0,08–0,13	–	–	–	–	–
49	1118	1118	G11180	0,14–0,20	a; c	1,30–1,60	0,030	0,08–0,13	–	–	–	–	–
50	1137	1137	G11370	0,32–0,39	a; c	1,35–1,65	0,030	0,08–0,13	–	–	–	–	–
51	1140	1140	G11400	0,37–0,44	a; c	0,70–1,00	0,030	0,08–0,13	–	–	–	–	1.0726
52	1141	1141	G11410	0,37–0,45	a; c	1,35–1,65	0,030	0,08–0,13	–	–	–	–	–
53	1144	1144	G11440	0,40–0,48	a; c	1,35–1,65	0,030	0,24–0,33	–	–	–	–	–
54	1146	1146	G11460	0,42–0,49	a; c	0,70–1,00	0,030	0,08–0,13	–	–	–	–	1.0727
55	1212	1212	G12120	≤ 0,13	–	0,70–1,00	0,07–0,12	0,16–0,23	–	–	–	–	1.0711
56	1213	1213	G12130	≤ 0,13	–	0,70–1,00	0,07–0,12	0,24–0,33	–	–	–	–	1.0715
57	1215	1215	G12150	≤ 0,09	–	0,75–1,05	0,04–0,09	0,26–0,35	–	–	–	–	1.0736
58	12L14	12L14	G12144	≤ 0,15	–	0,85–1,15	0,04–0,09	0,26–0,35	–	–	–	Pb 0,15–0,35	1.0737
				(nur anwendbar für Formstähle, Blech, Band und geschweißte Rohre) (seulement applicable pour profilés, tôles, bandes et tubes soudées) (applicable only to structural shapes, plates, strip, sheet and welded tubing)									
59	1006	1006	G10060	≤ 0,08	d	≤ 0,45	0,030	0,035	–	–	–	–	1.0313
60	1008	1008	G10080	≤ 0,10	d	≤ 0,50	0,030	0,035	–	–	–	–	1.0204/1.0330
61	1009	1009	G10090	≤ 0,15	d	≤ 0,60	0,030	0,035	–	–	–	–	–
62	1010	1010	G10100	0,08–0,13	d	0,30–0,60	0,030	0,035	–	–	–	–	1.1121/1.0310
63	1012	1012	G10120	0,10–0,15	d	0,30–0,60	0,030	0,035	–	–	–	–	–
64	1015	1015	G10150	0,12–0,18	d	0,30–0,60	0,030	0,035	–	–	–	–	1.1141/1.0413
65	1016	1016	G10160	0,12–0,18	d	0,60–0,90	0,030	0,035	–	–	–	–	–
66	1017	1017	G10170	0,14–0,20	d	0,30–0,60	0,030	0,035	–	–	–	–	1.1141
67	1018	1018	G10180	0,14–0,20	d	0,60–0,90	0,030	0,035	–	–	–	–	–
68	1019	1019	G10190	0,14–0,20	d	0,70–1,00	0,030	0,035	–	–	–	–	–
69	1020	1020	G10200	0,17–0,23	d	0,30–0,60	0,030	0,035	–	–	–	–	1.0402/1.0414
70	1021	1021	G10210	0,17–0,23	d	0,60–0,90	0,030	0,035	–	–	–	–	–
71	1022	1022	G10220	0,17–0,23	d	0,70–1,00	0,030	0,035	–	–	–	–	1.1133
72	1023	1023	G10230	0,19–0,25	d	0,30–0,60	0,030	0,035	–	–	–	–	1.1151
73	1025	1025	G10250	0,22–0,28	d	0,30–0,60	0,030	0,035	–	–	–	–	1.1158/1.0415
				0,22–0,28	e	0,60–0,90	0,030	0,035	–	–	–	–	–

INTERNATIONALER NORMENVERGLEICH		COMPARAISON INTERNATIONALE DES NORMES		INTERNATIONAL COMPARISON OF STANDARDS					
Baustähle		**Aciers de construction**					**Structural and constructional steels**		
Die Möglichkeit einer Austauschbarkeit muß von Fall zu Fall entschieden werden.		Interchangeabilité est seulement admissible après examen soigneux du cas singulier.					Exchangeability only possible after a thorough examination of the individual case.		
Bundesrepublik Deutschland République Fédérale d'Allemagne Federal Republic of Germany		Frankreich France France	Großbritannien Grande-Bretagne Great Britain	Italien Italie Italy	Japan Japon Japan	Schweden Suède Sweden	Russland Russie Russia	Spanien Espagne Spain	U.S.A. U.S.A. U.S.A.
W.-Nr.	DIN	AFNOR	B.S.	UNI	JIS	SS	GOST	UNE	AISI/SAE/ASTM
1.0605	C75	C 75	1449 80 HS	C 75	–	–	75	–	1074 1075
1.0614	C 76 D (D 75-2)	XC 75	–	–	–	–	75	–	1074
1.0616	C 86 D (D 85-2)	XC 80	1449 80 HS, CS	C 85	–	–	85	–	1086
1.0618	C 92 D (D 95-2)	XC 90	1449 95 HS, CS	–	–	–	–	–	1095
1.0715	9 SMn 28 (11SMn30)	S 250	230 M 07	CF 9 SMn 28	SUM 22	1912	–	F. 2111 – 11 SMn 28	1213
1.0718	9 SMnPb 28 (11SMnPb30)	S 250 Pb	–	CF 9 SMnPb 28	SUM 22 L SUM 23 L SUM 24 L	1914	–	F. 2112 – 11 SMnPb 28	12 L 13
1.0721	10 S 20	10 F 2	(210 M 15)	CF 10 S 20	–	–	–	F. 2121 – 10 S 20.	1108 1109
1.0722	10 SPb 20	10 PbF 2	–	CF 10 SPb 20	–	–	–	F. 2122 – 10 SPb 20	11 L 08
1.0723	15S22 15 S 20	–	210 A 15 210 M 15	–	SUM 32	1922	–	F. 210.F	–
1.0726	35 S 20	35 MF 6	212 M 36	–	–	1957	–	F. 210.G	1140
1.0727	45 S 20 (46S20)	45 MF 4	–	–	–	–	–	–	1146
1.0736	9 SMn 36 (11SMn37)	S 300	–	CF 9 SMn 36	SUM 25	–	–	F. 2113 – 12 SMn 35	1215
1.0737	9 SMnPb 36 (11SMnPb37)	S 300 Pb	–	CF 9 SMnPb 36	–	1926	–	F. 2114 – 12 SMnPb 35	12 L 14
1.0972	S315MC (StE 300 TM)	E 315 D	1449-43F30	–	–	–	–	–	–
1.0976	S355MC (StE 360 TM)	E 355 D	1449-43F35; 46F40	FeE 355TM	–	2642	–	–	–
1.0982	S460MC (StE 460 TM)	E 445 D	1449-50F45; 50/45	–	–	–	–	–	–
1.0984	S500MC (StE 500 TM)	E 490 D	–	FeE 490 TM	–	2662	–	–	–
1.0986	S550MC (StE 550 TM)	E 560 D	1449 60/55, 60F55	FeE 560 TM	–	–	–	–	–
1.1121	C10E / Ck 10	C 10 XC 10	040 A 10	C 10 2 C 10 2 C 15	S 9 CK S 10 C	1265	08; 10	F. 1510 – C 10 k	1010
1.1133	20Mn5	20 M 5	120 M 19	G 22 Mn 3 20 Mn 7	SMnC 420	2132	20GSL	F. 1515 – 20 Mn 6	1022 1518
1.1141	C15E / Ck 15	XC 12 XC 15 C 16; XC 18	040 A 15 080 M 15	C 15 C 16	S 15 S 15 CK	1370	15	F. 1110 – C 15 k F. 1511 – C 16 k	1015
1.1151	C22E Ck 22	2 C 22 XC 18 XC 25	055 M 15 (070 M 20)	C 20 C 25	S 20 C S 20 CK S 22 C	1450	20	F. 1120 – C 25 k	1020 1023
1.1157	40Mn4	35 M 5 40 M 5	150 M 36	–	–	–	40G	–	1035 1041
1.1158	C25E Ck 25	2 C 25 XC 25	(070 M 26)	C 25	S 25 C S 28 C	–	25	F. 1120 – C 25 k	1025
1.1165	30Mn5	35 M 5	120 M 36 (150 M 28)	–	SMn 433 H SCMn 2	–	27ChGSMMOTL 30GSL	F. 8211 – 30 Mn 5 F. 8311 – AM 30 Mn 5	1036 1330
1.1166	34Mn5	–	–	–	SMn 433 H	–	–	T0.8	1536
1.1167	36Mn5	35 M 5 40 M 5	150 M 36	–	SMn 438 (H) SCMn 3	2120	35G2 35GL	F. 1203 – 36 Mn 6 F. 8212 – 36 Mn 5	1335
1.1170	28Mn6	20 M 5 28 Mn 6	(150 M 28) (150 M 19)	C 28 Mn	SCMn 1	–	30G	28 Mn 6	1330
1.1178	C30E; Ck 30	XC 32	080M30	C 30	S 30 CM	–	–	2 C 30	–
1.1180	C35R Cm 35	3 C 35 XC 32	060 A 35	–	–	1572	–	F. 1135 – C 35 k-1	1035
1.1181	C35E	C 35; 2 C 35 XC 32	080 A 35	C 35	S 35 C	1550	35	F. 1130 – C 35 k	1035

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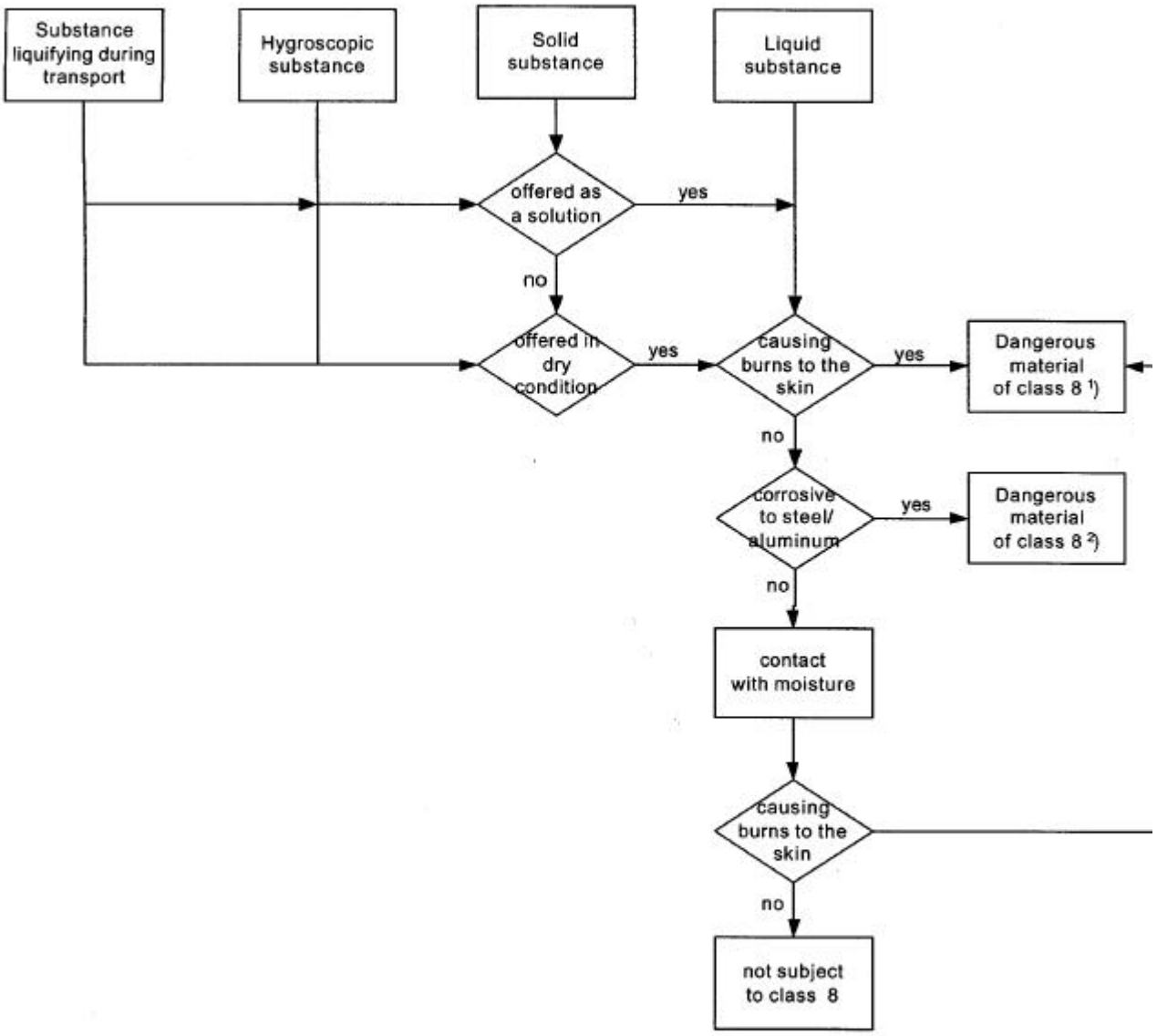
Annex 2

Classification of corrosive substances

Flowchart



[1]) Dangerous to humans/animals due to corrosion to living tissue (OECD 404).
[2]) Dangerous due to corrosion to mild steel/aluminum monitored over a period of one year

Annex 3

Test for determining corrosive properties of liquid substances, substances liquifying during transport, hygroscopic substances and solid substances in terms of requirements for classification as dangerous goods of class 8, packing group III

Introduction

This test is used to determine corrosive properties of liquid substances, substances liquifying during transport, hygroscopic substances and solid substances in terms of requirements for classification as dangerous goods of class 8, packing group III.

Apparatus and material

For exposure to medium being classified specimen of 2 mm thick plates shall be made of the following materials:
- Aluminium, non-clad types 7075-T6 or AZ5GU-T6 and
- Uncoated steel, 1.1141 (Ck 15 resp. SAE 1015 resp. AISI 1015), 1.0037 (St 37-2) or 1.0144 (St 44-3) (Fig. 1)

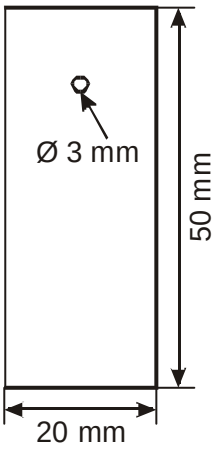


Fig. 1: specimen

At least 3 sets (9 specimens) of each material shall be used.
3 l cup-like reaction receptacles with face cut top and three necks NS 29/32 as well as one neck NS 14 made of glass or PTFE shall be used. The entrance of air, however, into the receptacle has to be guaranteed. Aluminium- and steel-samples have to be tested in different reaction receptacles. To prevent liquid loss a reflux condenser should be attached (Fig. 2).

In order to carry out the corrosion test, corrosive medium shall have a minimum volume of 1,5 l to ensure enough reactive agent during the whole exposure time. This is even more important if the corrosion is not caused by the material to be tested but by its quantitatively small amount of impurities.

Procedure

Metal sheets shall be polished with grinding paper of 120 grid. After removal of grinding remainings with alcohol in the ultrasound bath and the degreasing with acetone the metal specimens shall be weighed out to ? 0.0002 g. No chemical surface preparation (pickling, etching etc.) shall be performed to prevent surface "irritations" (inhibition, passivation). Sheets shall be fixed inside the receptacle by non extruded PTFE-threads. Metal wire shall not be used. The test with the so prepared metals shall be initiated the same day to prevent reformation of oxide layer (especially on Al-samples). For each set one metal specimen has completely to be dipped into the solution, another one only half way and a third one shall hang in the gas phase. The distance between the upper edge of the completely inserted specimen and the surface of the liquid is supposed to be 10 mm. Losses of liquid shall be avoided.
The test temperature of 55 °C ? 1 should be maintained constant and should be reached in the vapour phase as well.
Sheets shall be exposed at these stable conditions for one week (168 ? 1 hour).
After finishing the test the metal specimens shall be rinsed off and cleaned with a brush with synthetic or natural bristles (no metal). Only in case of not mechanically removable remainings (adherent corrosion product or depositions) inhibited picklin g solutions should be used. In those cases a not exposed reference specimen needs to be treated in the same manner (time, temperature, concentration, surface preparation) to determine the weight loss caused by pickling solution. This value needs to be subtracted before evaluating the corrosion rate. After the final cleaning with alcohol and acetone in the ultrasound bath and drying the metal samples are going to be weighed. The resulting weight under consideration of the specific weight of the metal leads to the corrosion rate.

Test criteria and method of assessing results

Based on different corrosion behaviour 2 types of attack needs to be distinguished.

Test evaluation at uniform corrosion

In case of uniform corrosion attack weight loss of strongest attacked sample shall be used. Solution passes the test if weight loss on 50 x 20 x 2 mm sheet is less than amount stated in the following table

exposure time	**weight loss**
7 days	13,5 %
14 days	26,5 %
21 days	39,2 %
28 days	51,5 %

NOTE: Those values are calculated based on a 6,25 mm/year corrosion rate. I.e. 0,12 mm/week (7 days). So within exposure time sample size decreases to following dimensions

exposure time		**specimen dimensions**				
7 days		49,76 mm	X	19,76 mm	x	1,76 mm
14 days		49,52 mm	X	19,52 mm	X	1,52 mm
21 days		49,28 mm	X	19,28 mm	X	1,28 mm
28 days		49,04 mm	X	19,04 mm	X	1,04 mm

Test evaluation at localised corrosion

In case of localised corrosion besides or instead of uniform corrosion attack of surface, the depth of the deepest hole respectively the strongest thickness reduction will be added or only be used to determine the intrusion. Deepest intrusion (to be determined metallographically) within 1 week testing time shall not exceed values shown in following table.

exposure time	max. intrusion depth
7 days	120 µm
14 days	240 µm
21 days	360 µm
28 days	480 µm

Test of corrosive properties of liquids which react corrosive under the influence of water

Substances reacting corrosive with water have to be tested according to their corrosive properties in water. The aqueous solution with the highest corrosion rate which mostly is in the middle concentration range, has to be determined by a test (see test of corrosive properties of solids).

Test of corrosive properties of solids

To evaluate solids which do not react corrosive in dry state on the above mentioned materials but may become corrosive while consuming humidity the aqueous solution with the highest possible corrosive effect on metals has to be determined.

Established by experiences, aqueous solutions in the middle concentration range have the highest corrosive effect on metallic materials. In case the most aggressive concentration is not known by the tester, he has to approach the concentration with the highest corrosiveness in steps of 10%. Therefore two or three tests have to be carried out at the same time.

Test of the corrosive properties of substances being chemically unstable

In case of chemically unstable products the substance as well as the reaction product(s) have to be tested in the same manner as described above. The corrosion test has to be carried out with the necessary safety precautions.