

**Date: 2015-02-17**

# **NORSOK STANDARD M-501 Edition 6 (2012)**

Surface preparation and protective coating

Frequently asked questions



## INTRODUCTION

NORSOK standard M501 Edition 6 was issued in 2012. The standard is used worldwide by many organizations and persons. Questions are being brought up both with respect to use of the standard and to the various requirements and sections in the standard. The aim of this document is to ensure uniform practicing of the standard.

M-501 clause no	Questions/answers
4.5	<p>Q: The standard does not intend to exclude other alternative systems, according to 4.5 "For those coating systems which are subject to pre-qualification, the specified coating systems are examples, and alternative coating systems may be used if the requirements of this NORSOK standard are fulfilled." Can a three-coat system without zinc rich primer be regarded as an alternative system to system no. 1?</p> <p>A: For Coating System No.1, a zinc primer shall be used (either a zinc epoxy or zinc silicate), the number of coats and the coating film thickness presented in Annex A are minimum requirements which shall apply for coating systems subject to pre-qualification testing.</p> <p>I.e. a 3-coat system without zinc rich primer cannot be regarded as an alternative system – only exception from this is that the proposed system meets the requirements in A1, Note 6.</p> <p>A1. Note 6 states that 2 coat system without zinc can be used if documentation applies and the DFT &gt; 1000 µm.</p>
4.13	<p>"Welds shall be continuous. Tack welding is not accepted."</p> <p>Q: We are of the opinion that this text must not be read so that intermittent welds cannot be used. Our reasoning is as follows;</p> <ul style="list-style-type: none"> <li>• This clause was introduced first in Rev. 6 which would imply that similar concerns were not present in the industry before this, which we believe is unlikely. We are therefore of the opinion that limitation to intermittent welding shall be agreed elsewhere between the two parties except for as now, bought equipment.</li> <li>• If the requirement is general for all structures, systems etc. it should have been presented in subclause 6.1 of M-501. Subclause 4.13 explicitly says "Additional requirements to equipment".</li> <li>• We have not been able to find this limitation to use intermittent welding under group N or M in NORSOK which further leads us to believe that structural integrity and long term corrosion resistance shall be used to evaluate if intermittent welds are permitted or not and agreed between the parties elsewhere.</li> <li>• We consider tack welding and intermittent welding two different things.</li> </ul> <p>A: The word tack welding in subclause 4.13 is unfortunate, as the intention is to avoid use of intermittent welding. The reason for the requirement is that it is impossible to obtain good corrosion preventive coating where intermittent welds are used.</p> <p>This requirement is given in subclause 4.13 (equipment) because intermittent welds are rarely used for structures, and therefore normally not relevant as a requirement for</p>

	<p>structural items. This may be incorrect and the requirement should be generalized to cover at least equipment and outfitting, and for your case also structures.</p> <p>For areas where coating system 8 is found acceptable, it is a prerequisite that the area is non corrosive. In such cases, use of intermittent welds and a subsequent poorer surface protection in crevices should not be a problem, as corrosion is not an issue in any case.</p>
5	<p>“All coating products shall as a minimum be in accordance with relevant Norwegian regulatory requirements regardless of where the coating operation takes place.”</p> <p>Q: What is meant by Norwegian regulatory requirements in this context and why does it apply to coating products in specific? Would this statement also apply to coating application and services?</p> <p>A: The reason for this statement is twofold:</p> <ol style="list-style-type: none"> <li>1. ensuring that the applied coating system meets Norwegian regulatory requirements when the item is shipped to and installed in Norway;</li> <li>2. ensuring that the minimum HSE requirements applicable in Norway are also fulfilled when coating is applied in other countries.</li> </ol>
6.2	<p>“The grit shall be non-metallic and free from chlorides when used on stainless steel substrates.”</p> <p>Q: Does NORSOK prescribe a measurable level to define ‘free from chlorides’? For instance BS EN ISO 11126-10:2004 Table 2 prescribes for water-soluble chlorides a max. 0,0025 % (25 PPM).</p> <p>A: NORSOK M-501 does not specify the way to measure this and this should be explained in next edition. The reference EN ISO 11126-10:2004 is a good suggestion.</p>
10.1 Table 1	<p>Q: In terms of corrosion from scribe (ISO 20340), 3 mm is for coating system with Zn primer, 8 mm is for coating system without Zinc primer. This is confusing. In the cases where coating system without zinc primer could be seen as alternative coating system. Why the requirement of 8 mm for coatings without zinc?</p> <p>A: Regarding the 8 mm requirement for the systems without zinc the reason is that a typical historically good zinc free system in NORSOK M-501 (system no. 7B) has a corrosion from scribe at approximately 4 to 8 mm in the ISO 20340 weather test. During the last revision of ISO 20340 8mm was decided to not rule out the at that time already proven good systems.</p> <p>Q: What is the understanding of splash zone?</p> <p>A: In the offshore industry this is defined by codes, but for all practical purposes it means the complete extension of the tidal zone + the wave zone.</p>

10.2.3, Table 2	Table 2 does only describe the qualification using TSA as coating. Please use the following (marked in red) changed version:														
<p style="text-align: center;"><b>Table 2 - Qualification of metal spraying</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%; text-align: center;">Test</th> <th style="width: 50%; text-align: center;">Acceptance criteria</th> </tr> </thead> <tbody> <tr> <td><b>Visual examination of coating</b> All test panels shall be examined without magnification and with 10X magnification.</td> <td><b>See 8.3.</b></td> </tr> <tr> <td><b>Film thickness and shape test</b> (see NOTE 2)</td> <td><b>TSA: Minimum 200 µm on all specimen surfaces</b> <b>TSZ: Minimum 100 µm on all specimen surfaces</b> (ISO 19840).</td> </tr> <tr> <td><b>Adhesion</b> (see NOTE 3) ISO 4624. All test panels shall be tested. Examination of the test specimens shall be conducted after rupture to determine the cause of failure.</td> <td><b>TSA: No single measurement less than 9,0 MPa.</b> <b>TSZ: No single measurement less than 5,0 MPa</b> Re-testing is required if the failure occurred at the adhesive/coating interface. Test equipment with an automatic centered pulling force shall be used.</td> </tr> <tr> <td colspan="2">NOTE 1 General: Test materials shall be of a comparable grade to be used in production. The coating shall be applied in accordance with this NORSOK standard and the proposed procedure.</td> </tr> <tr> <td colspan="2">NOTE 2 Specimens for shape test: One 1500 mm long "T", "I" or "H" shaped profile approximately dimensions 750 mm high and 13 mm thick. Another specimen shall be cut from a 1500 mm long 50 mm diameter pipe.</td> </tr> <tr> <td colspan="2">NOTE 3 Specimens for adhesion test: Five specimens for the adhesion test shall be prepared according to the requirements of ISO 4624 using minimum 5 mm thick panels.</td> </tr> </tbody> </table>		Test	Acceptance criteria	<b>Visual examination of coating</b> All test panels shall be examined without magnification and with 10X magnification.	<b>See 8.3.</b>	<b>Film thickness and shape test</b> (see NOTE 2)	<b>TSA: Minimum 200 µm on all specimen surfaces</b> <b>TSZ: Minimum 100 µm on all specimen surfaces</b> (ISO 19840).	<b>Adhesion</b> (see NOTE 3) ISO 4624. All test panels shall be tested. Examination of the test specimens shall be conducted after rupture to determine the cause of failure.	<b>TSA: No single measurement less than 9,0 MPa.</b> <b>TSZ: No single measurement less than 5,0 MPa</b> Re-testing is required if the failure occurred at the adhesive/coating interface. Test equipment with an automatic centered pulling force shall be used.	NOTE 1 General: Test materials shall be of a comparable grade to be used in production. The coating shall be applied in accordance with this NORSOK standard and the proposed procedure.		NOTE 2 Specimens for shape test: One 1500 mm long "T", "I" or "H" shaped profile approximately dimensions 750 mm high and 13 mm thick. Another specimen shall be cut from a 1500 mm long 50 mm diameter pipe.		NOTE 3 Specimens for adhesion test: Five specimens for the adhesion test shall be prepared according to the requirements of ISO 4624 using minimum 5 mm thick panels.	
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10.2.3, Table 2, Note 3	<p>Q: Does this mean five test plates that the dollies are glued to? Provides details of an alternative Test Panel for carrying out CPT tests. Metal Spraying needs additional requirements as per Table 2, Note 2. Does a drawing of the test panel exist?</p> <p>A: For metallic sprayed coating the additional adhesion test means 5 test panels (specimens) each have room for 6 dollies (ISO 4624). That means in total 30 adhesion measurements. The shape of the test specimens are not given and just have to be minimum 5 mm thick. So that means that any panel in right material can be used. The sizes and shapes are well defined in the standard and no picture is available at the moment.</p> <p>The need for a picture to describe will be considered in the next edition of the standard.</p>														
10.3	<p>Q: The clarification is related to the interpretation of "application contractor". Can "application contractor" be interpreted to be the company that not does the painting themselves, but the company that does the engineering design?</p> <p>A: The company that actually does the coating work shall make the CPS themselves. The reason for that is that they are the only ones to know what type of equipment etc. they use and shall show through the CPS that they have understood the requirements given in NORSOK M-501 ed. 6.</p>														
11, Note 1	<p>Q: What is the adhesion requirement for system no. 2B during CPT and production?</p> <p>A: 5 MPa as for all other systems except system no. 2A.</p>														
11, Note 4	<p>Q: What does "absolute minimum value is 5,0 MPa" mean?</p> <p>A: This means that during production the following criteria shall be met; Coating Systems No. 1, 2B, 3, 4, 5, 6, 7, 8 and 9</p> <ul style="list-style-type: none"> <li>- the minimum acceptable adhesion value shall not be less than 5,0 MPa for any single measurement Coating System No. 2A,</li> <li>- the minimum acceptable adhesion value shall not be less than 7,0 MPa for any single measurement.</li> </ul>														

# FAQ

NORSOK standard M501 Ed. 6 (2012)

11, Note 5	<p>Q: Why is the requirement for minimum glue failure 15 MPa, when the coating adhesion requirement is 5 MPa?</p> <p>A: The reason for this is that a typical system with very good adhesion may normally have an adhesion of 15 MPa and higher. If That system is measured at 5 MPa it would therefore be an indication of bad curing or at least something not good. To make sure that the 50 % value from the CPT is good enough even for those systems, this glue failure request is set. A glue failure will give lower adhesion than the actual adhesion properties for coating system, also measured during production.</p>
11 and A.3, Note 1	<p>Q: Is the holiday detection test valid for all submerged systems?</p> <p>A: The holiday test (ISO 29601) is required for the following coatings systems: Coating System no. 3A – 3F, but is not required for Coating System no. 3G.</p> <p>The test is not required for Coating System no. 7A – 7C, providing that CP system is used.</p>
11	<p>Q: What is the meaning of “spot checks”?</p> <p>A: «Spot checks» means doing the specified test at an agreed time and place/position. As Note 6 under table 3 defines, this shall be agreed upon before the start of each project and included in the inspection and test plan.</p>
A.1, Note 4	<p>Clarification: Refers to system no. 7A and the cathodic disbonding test.</p>
A.1, Note 6	<p>Q: What is the meaning of Note 6 of the tabulated system no. 1? Does it mean if the primer other than zinc rich primer is one part of alternative system of system no. 1, the alternative system should 1000 micron in DFT and meets all the requirements of the NORSOK M-501?</p> <p>A: The intention of Note 6 is that it is allowed to replace system no. 1 with system 7A (minimum 2 coats of a total of 1000 µm DFT without zinc primer). The background for this is the experience with the use of i.e. glass flake epoxies/polyesters (30 year lifetime) that can be a satisfactory and even better replacement than system no. 1.</p>
A.2, Note 1	<p>Q: The pores shall be sealed but no measurable overlay. How can an inspector test to see that this is the case?</p> <p>A: This is ensured by measuring the dry film thickness of the total system in combination with visually inspection. A good suggestion is to use an on-site 30X microscope to help with inspecting the surface visually. The color shall be so thin that the surface shines a bit through.</p> <p>If one should expect too high sealer thickness, the PIG (paint inspection gauge) can be used, but this is a destructive test.</p>
A.3	<p>Clarification: The reason for the 350 µm requirement for system 7C (≥50 °C) is that the degradation mechanism can be different for higher temperatures. To prevent those higher temperature systems to be chosen for low temperature equipment to “save” coating material, the NORSOK M-501 revision group decided to have the same thickness requirements for system 7B and C.</p>
A.5.1, Note 2	<p>“Coating alternative 2)” refers to 1 coat zinc rich epoxy +1 x epoxy tie coat in this table.</p>
A6, Note 1	<p>Q: Why cannot zinc be applied on stainless steel?</p> <p>A: Because of the potential liquid metal embrittlement of the stainless steel in the event</p>

	of high temperature exposure (e.g. fire). Melting Zinc can penetrate into the grain boundaries of the stainless alloy and weaken the material.
A.7	<p>Q: For Coating system 7B for submerged carbon and stainless steel, <math>\leq 50</math> °C, and Coating system 7C for submerged carbon and stainless steel, <math>&gt; 50</math> °C, the coating system is stated as "Two component epoxy. Minimum number of coats: 2. Complete coating system:" for both 7B and 7C. As 7C can be used at higher temperatures, shouldn't the coating system be "Two component phenolic epoxy..."?, otherwise there is no difference between 7B and 7C.</p> <p>A: Testing at Sintef shows that regular epoxies can have good properties above 50°C subsea and some phenolic epoxies have not. Therefore the only difference between system 7B and C is how the system is tested. Specifying epoxy does not rule out to use phenolic epoxy.</p>
A.7, Note 6	<p>Clarification: Refers to the specified cyclic weather test given in ISO 20340, but without chalking requirements and with the corrosion from scribe in accordance with the non-zinc requirements.</p>
Annex C	<p>Clarification regarding the high temperature cathodic disbonding test: The test method was developed in a JIP at SINTEF between 2009 and 2011. The initiative to the JIP was taken by paint suppliers and SINTEF performed the research. The JIP was open for any company to participate. The participants were Carboline, International Paint, Jotun, Hempel, PPG, ExxonMobil and Aker Solutions. The objective with the JIP was to develop a test for high temperature cathodic disbonding (HTCD) and to get the test method accepted in NORSOK M-501.</p> <ol style="list-style-type: none"> <li>1. The evaluation of the test method was done in the JIP. In the order of 15-20 coating systems were tested under various conditions and procedures. However, in such JIPs the suppliers probably do not push the limits of the products they submit, since they want their products to pass the test, when the testing is performed in front of potential customers. After publication of M-501 rev 6, SINTEF have performed a few qualification tests, now probably closer to the limits of the products. A problem with accumulation of hypochlorite in the test electrolyte was discovered that had to be amended. SINTEF performed a re-test at their own expense, and proved that the amendment solved the problem. SINTEF is not aware of any inconsistencies in the results. The method closely simulates the conditions found on hot, submerged offshore steel surfaces and is only mildly accelerated. The test is therefore expected to be relevant.</li> <li>2. Five major paint suppliers were members of the JIP and participated in developing the method and setting the test requirements. The concerns and proposals from the paint suppliers were very much included in the development of the test. E.g. the temperature gradient in the test was proposed by the paint companies. The paint suppliers were also participating in the M-501 committee that prepared Revision 6. A joint proposal to include the test method was submitted from the participants in the JIP, including the five paint suppliers.</li> <li>3. As stated above, the test method was developed to closely replicate the conditions offshore. The test parameters are therefore assumed to be relevant. The evaluation criteria are the same as in ISO 20340.</li> <li>4. At the time of the revision of NORSOK M-501, SINTEF was the only company that had an apparatus for testing coatings at steel temperatures <math>&gt; 100</math> °C. However, there is no requirement for approval of the apparatus by the NORSOK M-501 committee or any other group or committee. Hence, anyone can build an apparatus, which is described in detail in Knudsen et al: "Cathodic Disbonding at High Temperature". Paper No. 11023, CORROSION/2011. Since the method is included in M-501 the NORSOK committee expects SINTEF to be helpful to other laboratories that want to build an apparatus. For</li> </ol>

	<p>steel temperatures &lt;100 °C M-501 refers to NF A 49-711: "External three-layer polypropylene-based coating" (Appendix K), which can be performed with standard laboratory equipment. The test takes 30 days, which is rather short compared to e.g. ISO 20340 and ISO 15711 (25 weeks).</p> <p>5. The method was designed to handle different temperatures. Upper temperature limit is an important parameter when it comes to select coatings for high temperature constructions. Some coatings can handle higher temperatures than others. Performing all testing at e.g. 150 °C would then exclude a wide range of coatings that are performing well at 120 °C. Hence, the method qualifies coatings up to a maximum temperature limit, and the coatings can be used up to this limit. Constructions have different maximum operating temperatures. Hence, coatings with different upper temperature limit are required.</p> <p>Much of the testing that was performed during the development of the method was published in two papers at CORROSION in 2010 and 2011. NORSOK does not perform testing to validate test methods, but has to rely on work performed by others. Before the introduction of this test method, there were no tests available simulating steel temperatures above 100 °C on submerged structures (elevated hydrostatic pressure). It was therefore considered necessary to have a new method. Introducing a new test method necessarily means that there will be limited experiences with the test in the beginning. Having said all this, it should be emphasized that the method is not radically new. The main difference to e.g. NF A 49-711 Appendix K is the pressurized electrolyte.</p> <p>In addition to the testing performed the confidence in the test is based on Close replication of the conditions offshore Resemblance to other test methods that are well established</p> <p>When it comes to making the method more available, this is open for any laboratory to do, as discussed above.</p>
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