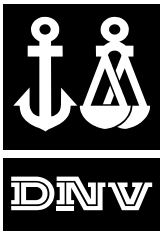

CLASSIFICATION NOTES

No. 4.3

GUIDANCE MANUAL FOR REPAIR OF SURFACE / DIMENSION BY MEANS OF METAL COATING

JANUARY 2000

DET NORSKE VERITAS
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FOREWORD

DET NORSKE VERITAS is an autonomous and independent Foundation with the objective of safeguarding life, property and the environment at sea and ashore.

DET NORSKE VERITAS AS is a fully owned subsidiary Society of the Foundation. It undertakes classification and certification of ships, mobile offshore units, fixed offshore structures, facilities and systems for shipping and other industries. The Society also carries out research and development associated with these functions.

DET NORSKE VERITAS operates a worldwide network of survey stations and is authorised by more than 120 national administrations to carry out surveys and, in most cases, issue certificates on their behalf.

Classification Notes

Classification Notes are publications that give practical information on classification of ships and other objects. Examples of design solutions, calculation methods, specifications of test procedures, as well as acceptable repair methods for some components are given as interpretations of the more general rule requirements.

A list of Classification Notes is found in the latest edition of the Introduction booklets to the ”Rules for Classification of Ships”, the ”Rules for Classification of Mobile Offshore Units” and the ”Rules for Classification of High Speed and Light Craft”. In “Rules for Classification of Fixed Offshore Installations”, only those Classification Notes that are relevant for this type of structure, have been listed.

The list of Classification Notes is also included in the current “Classification Services – Publications” issued by the Society, which is available on request. All publications may be ordered from the Society’s Web site http://exchange.dnv.com.

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1. General

This Classification Note describes DNV's policy on metal coatings, used as a technique in restoring lost material or repairing damaged surfaces. The metal coating techniques employed include gas flame spraying, electric arc spraying, plasma spraying, electrolytic deposition and clad welding.

This Classification Note is intended to act as guidance for further processing of the problem. For example, Table 5.1 is meant to show which solutions are acceptable for typical applications.

2. Background

Occasionally, the Society has been requested to approve metal coatings, and has in general, been reluctant to approve such techniques, especially spraying, due to incidents of poor service experience.

There have been a number of instances of successful repair made by metallic coating. However, it has not been possible to establish reliable evaluation criteria that can identify successful repairs at the application stage.

This Classification Note clarifies DNV's position concerning metallic coatings used for repairs to classed components.

3. Service Experience

Over the years, numerous components in classed objects have been repaired using different kinds of metallic coating. Many of these repairs have been successful. However, several failures of metal-coated surfaces have been experienced, and this has been the reason for the Society's restrictive practice. General approval has not been given for any repair method of this type. Some of the main problems are:

- lack of recognised standards
- lack of representative and standardised test methods
- lack of verified information
- poor bonding and poor fatigue properties
- lack of proper NDT methods.

The Society's approval may be achieved either through long and successful experience, or through adequate approval testing. As evident from the above, neither approach has been successful so far, for metallic coatings.

4. Basic viewpoints on coatings for repair and build-up

Experience, including general engineering considerations clearly demonstrate that a metal-coated component cannot, in general terms, be considered equivalent to what it is supposed to replace, namely, solid metal.

Therefore, discussions on such components, must be limited to fitness for purpose, consideration for a given coat type, coating procedure and application.

The following general guidance may be given:

- Where the stresses are low, and the consequences of failure are moderate, repair by use of metallic coating may be considered.
- Where the stresses are high, and the consequences of failure are serious, repair by use of metallic coating shall be avoided.
- For components subjected to special load conditions, for example contact loads (bearings) or thermal loads, special care must be taken before repair by metal coating is accepted. Loads during manufacturing, transportation, and assembly and in service must be considered.

5. Evaluation of special components

Based on the general considerations given above, the following table states DNV's position on where metallic coating repairs may be accepted for typical components for classed vessels:

Component [1]	*Electrolytic*	*Spray*	*Clad weld*
Crankshaft	No	No	No
Tailshaft [2]	No	No	Dependent upon stress
Intermediate shaft - main propulsion [2]	No	No	Dependent upon stress
Pintle / Rudder-stock water side [3]	N.A.	No	Yes
Shafts in gear - shrink fit position [4]	Dependent upon stress	Dependent upon stress	N.A.
Hub / gear wheel - shrink fit position	Yes	Yes	N.A.
Gear casings / Bores	Yes	Yes	N.A. (due to distortions)
Cylinder head / Piston crown	N.A.	No	Yes
Piston rod in diesel engines [5]	No	No	N.A.
Seal areas, low or moderate consequence of leakage.	Dependent upon stress	Dependent upon stress	Dependent upon stress

Interpretations:

No:	Repair by use of metal coating is in general not acceptable
Yes:	Repair by use of metal coating is in general acceptable (provided compatibility regarding thermal expansion and E-modulus)
Dependent on stress:	Repair by use of metal coating is acceptable if the working stresses are low (typically less than 50% of the allowable stress for the component according to the rules), and unacceptable if the stress is higher
N.A.	Not applicable, i.e. for this application the use of metal coat repair is not considered relevant for practical or other reasons

1) The table may be extended/revised based on experience and technical development.

2) Metal coating other than clad welding is not qualified by experience on tailshafts. A test program for qualifying a method for this application might be feasible but would probably become so comprehensive and time consuming that it would render it impracticable in a repair situation.

3) Electrolytic coating is considered "not applicable" for the deposit thickness that will be in question for rudderstocks.

4) In the free end (non-driving end) of a shaft, metal coat repair is usually acceptable, even on the shaft side. In the driven end, and at the gear wheel/shaft intersection, the use of metal spray, as a repair method should be restricted to the hub (female) side.

5) Poor experience is observed when using metal coat repair on the piston rod in bearing / sealing area.

Table 5-1 Evaluation of special components

6. Requirements for repair product and repair procedure

In order to satisfy the requirements for repair procedures, it must be confirmed that the experience and or test data, used as evidence, are representative of the product to be supplied. This means that a procedure must be established in such detail that the quality of the end product is reasonably well defined through the specification of the procedure.

Furthermore, it must be assured that both the references and the product to be supplied are produced in compliance with the procedure.

A procedure for metal coating repair should comprise, as a minimum, the following items:

- requirements for parent material (including limitations of allowable chemical composition and hardness)
- requirements for pre-treatment before applying the coat (including requirements for cleaning, moisture and temperature under application and tolerance band for surface roughness)
- type of deposit (chemical composition, mechanical properties and trade name)
- thickness limitations
- suppliers specification for process data (tolerance bands)
- suppliers specification for personnel qualification
- suppliers specification for limitations to areas of application.