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Future Class Requirements and Support Services for Inspection and Maintenance

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ABSTRACT

The Class Rules are based on the assumption that the vessel will be competently handled and maintained. However, experience shows large variations in particular for hull structures of old ships.

Future Safety Management Systems will give a closer cooperation between class and operators. This may open up for audits of internal systems, for those who only need class verification of a high standard. On the other hand, class may also provide the operators with detailed Condition Assessment Programs (CAP) in order to guide maintenance.

In a novel probabilistic structural analysis the effects of variation in corrosion rates and coating condition can be accounted for, as can potential repairs and recoating of tanks. The results may be obtained as tons steel to be renewed. When - and not if - the class concept becomes reliability based, such analyses will also be the basis for selection of class inspection intervals and extent of surveys.

1. INTRODUCTION

This paper presents class ambitions, which somebody may feel are out of proportions. For what has class to do with maintenance ? At present actually nothing, but in reality everything. In fact, the DnV Class Rules are based on the assumption that the vessel with machinery installations and equipment will be competently handled and maintained.

What may class supply to the different types of shipowners, when they either do most things right and therefore feel they do not need the class, or they belong to those who do a lot of things wrong and, as far as possible, neglect all sorts of rules and regulations ?

In fact, recent experience shows large variations in ship conditions; - in particular the hull structure of several ships show deterioration far below acceptable level. Who is to blame for these substandard conditions, and how should such problems be avioded in the future ?

2. THE PRESENT SITUATION.

In the following we will take a closer look at different maintenance strategies in general and focus on ship structures in particular.

The three elements in the name of this Symposium - Inspection , Maintenance and Monitoring - may be considered as means of loss prevention. In fact, the selected maintenance strategy is the crucial point having both cost and risk implications.

2.1 Maintenance Strategies.

There are two basically different approaches: Preventive and Corrective Maintenance respectively. These may be subdivided into Periodical as opposed to Condition based preventive maintenance, and Expected as opposed to Unexpected corrective maintenance. Unexpected corrective maintenance is only relevant in case of sudden breakdown, often caused by accidents or negligence. Reference /1/.

As an example the airplane maintenance may be considered as the most intensive preventive maintenance scheme, mainly based on periodical overhaul and component replacements. This is well understood, knowing the possible concequences of even secondary failures.

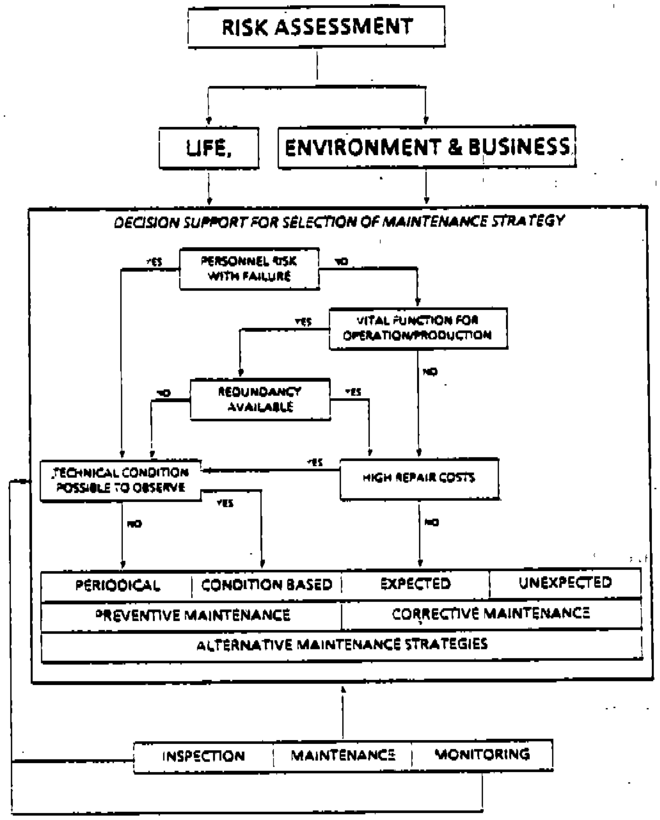

Fig. 1 Selection of Maintenance Strategy based on Risk assessment.

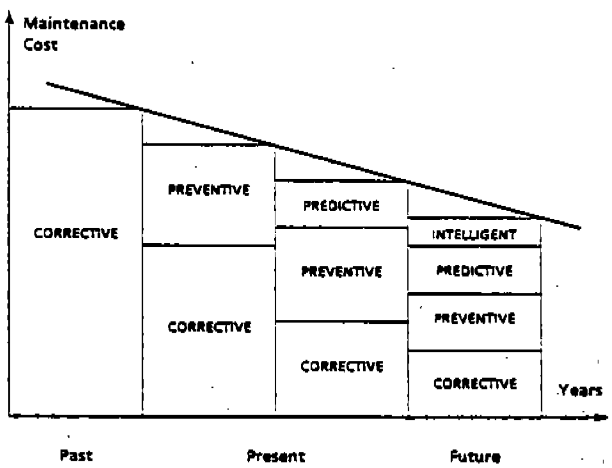

Fig. 2 Development of Maritime Maintenance Strategies over the years.

In Fig. 1 risk assessment is illustrated as basis for explanation of todays selection of technical maintenance strategies. When applied to an offshore structure, the high cost of production loss and repair will result in need for preventive maintenance. If the technical condition may be observed, a condition based strategy is followed, otherwise periodical maintenance without reference to the actual condition is the option.

Onboard ships a wide range of maintenance strategies are applied, a few examples are:

The propulsion machinery system is vital for operation, no redundancy is available and in many cases it is difficult to observe the condition without stopping and opening up. Hence, periodical maintenance is applied.

The overall hull girder strength is of vital importance for seaworthiness effecting both human and cargo safety as well as the environment. The condition of the hull structure may well be observed and therefore a condition based maintenance strategy selected.

Damage to local structural elements represent in general serviceability problems, as the hull structure redundancy is high. The repair costs of single cracks, local indents and corroded plates are relatively moderate. Thus, corrective maintenance upon request of the classification society is most common to day. Only in case of coating and cathodic protection, condition based preventive maintenance is by operators found to be more cost effective.

Figure 2. summarizes the development of maritime maintenance strategies over the years. The first and most costly strategy was the corrective approach, or maintenance by breakdown, where not only the repair and offhire cost have to be included, but also other accidental cost elements as management attention, loss of reliability image, higher insurance premiums, etc.

Accidents may be prevented by periodical maintenance, which on the other hand will result in some unnecessary replacements. Thus, whenever possible predictive maintenance based on the actual condition is the best short term choice. Finally, the level of intelligent maintenance is reached when life cycle cost analyses are applied and a corresponding long term strategy selected. This should be updated according to the actual condition.

2.2 The Responsibility for Safety.

Safety is "control of accidental loss". This includes both preventing accidents and keeping losses to a minimum when accidents do occur. An accident is "an undesired event that results in harm to people, damage to property or environment and loss of transport capability". Thus, the word "safety" covers it all.

Responsibility for safe ship operation rests with the owner. He may sometimes only be the financial owner, who has transferred the operational responsibility to a management company. In some cases even a single ship may be looked upon as an independent management unit.

The shipowner/manager is running an international business, governed by international conventions, which are turned into national law in the different countries. Some of these laws are only valid for the ships flying the flag of that country, some are also to be met by ships entering their ports.

Thus, the responsibility for a satisfactory safety regime is the joint responsibility of the national seatrade governments, and IMO is their body.

It is expected that statutory and class verification shall document that each ship is up to the relevant standards. However, a verification body can never inspect or control quality and safety into any object or system. Classification societies can therefore only be made responsible for the quality of own work. In this respect the courage to say "no" and delete class when required, is a must. Thus, the interests of the shipping industry are only served as long as full confidence in the classification certificates is achieved.

This confidence has deteriorated over the last 5 - 10 years. Vessels are discovered to have serious deficiencies in spite of clean class certificates. This is highly damaging to the credibility of the class societies. Hence, IACS in general and DnVC in particular, are at present introducing a number of measures to make sure that "things are done right". These are only the first necessary steps, the real quality and efficiency challenge being "who does what, how and when" ?

3. THE FUTURE SAFETY MANAGEMENT.

A totally integrated approach to safety includes all the elements "hardware - software - human ware". Not as separate areas but interrelated and completely dependent on each other. Thus, it is of equal importance to know if the hardware do match the people, if the procedures match the people and finally whether the procedures match the hardware.

In fact, an investigation on Norwegian ships showed that measures related to improved competence and operational practice may be estimated to give some 20% and 60% risk reduction, respectively. The ship safety challenge is to do something in these areas.

DnVC has chosen to approach three different levels in the organizational pyramid of the company, at the same time. The corresponding key class questions to be asked are:

* Is the shipping company fit to own and run ships ?
* Is the ship organized and up to standard ?
* Are the crew members qualified for their tasks ?

The relative importance of the three levels may be open to discussion. However, experience shows that most mistakes that people make are caused by factors that only management can control, e.g. operational policies related to employment, investments, maintenance strategies, etc. Most experts put this ratio as high as 80 %.

The role play for safety is a matter of interaction and delegation. This is illustrated in the "time glass" Figure 3., which is divided into three levels of safety work, strategic, tactical and operational. The upper part illustrates the convergent process resulting in maritime laws. The lower part illustrates how these requirements should be met by Quality Assurance systems and audits.

Hence, in the Maritime Administrations should carry out Audits of the performance of the Class Societies, which in the future should audit Quality Assurance systems to be implemented by the operators, (see Section 3.2 below).

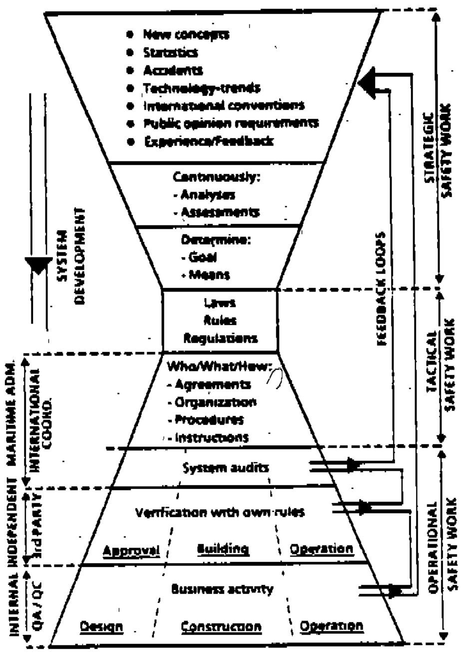

Fig. 3 Safety Interaction and Delegation Model.

3.1 Quality Assurance and Audit Schemes.

In the shipping industry the various definitions in the quality terminology may not be public knowledge. Shortly, Quality may be defined as: "conformance with specified requirements", and Quality Assurance (QA) as: "all systematic measures necessary to ensure that quality is planned and obtained".

The objective of a Quality Audit is: "to verify adequacy of, compliance with, and effectiveness of the QA system". In fact, QA relates to the quality function in the same way as financial audits to the accounting function.

Figure 4. shows that any task may be divided into definition of objective, planning and execution, in order to achieve results. In

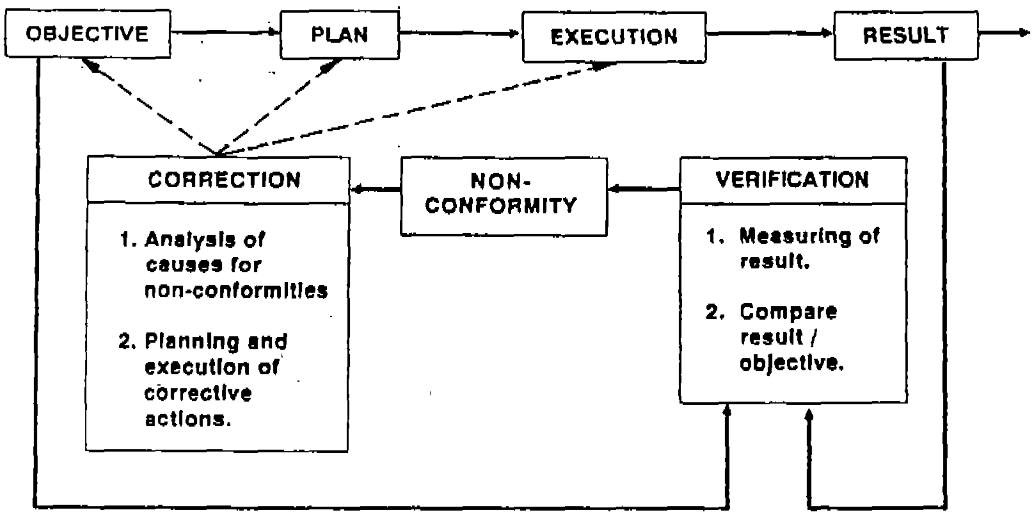

Fig. 4 The "Quality Loop", Principles for Quality Systems.

relation to this the principle for quality systems is illustrated as the feedback loop, /2/.

The terms "verification" and "audit" are often misinterpreted. The intention of both is to confirm that something meets specifications; but there are important differences.

Verification is performed for each individual task or product to verify that it meets with the specified requirements. Todays classification is in fact, verification according to own class rules and certification of compliance.

A Quality Audit may also be aimed at a particular product, but the intention is not to accept or reject the product but to appraise the quality of the system that produces or operates it. Hence, detection of non-conformity and corrective actions may be directed to any task including definition of objective and planning, as shown in Figure 4.

Audit is thus a step higher than verification: it looks at the complete system and the coordination of past activities, recognising that quality deficiencies often originate in the border areas between different physical, organizational and administrative elements.

In order to carry out an audit the Quality Standard must be defined and the system documented. In todays shipping this is normally not the case, unless the operators are involved in offshore activities where Quality Standards are specified by the authorities or oil companies.

<u>3.2 IMO - Guidelines</u>

A new initiative in ship classification was introduced in May 1990, with the DnVC Safety Management Class (SMC) and corresponding rules, which are based on generally accepted quality management principles as described above, /3/.

The objectives of maritime safety management are easily expressed: to ensure safe practices in ship operation, and that the ship and its equipment are maintained to ensure the ability to handle emergencies. To achieve these objectives, a standard for specific maritime application is needed.

The new concept has been worked out in cooperation with the shipping industry and maritime administrations. However, to many owners familiar with the technical and quantifiable aspects of classification, the new approach is a marked break with tradition.

In practice, a company meeting the new rules will receive a Safety and Environmental Protection (SEP) management certificate. Each ship complying with the rule requirements, and operated by a SEP-certified company, may receive the additional Shipboard Management (SBM) class notation.

The certification will include:
- Assessment of documentation of system,
- Implementation Audit,
- Periodical Audits for retention of certificates.

The rules cover IMO Resolution A647 (16) Guidelines for the Management for Safe Ship Operation and Pollution Prevention, /4/. To ensure that the administrative, technical and human factors affecting safety will be under control the applicable elements of the international standard ISO 9000-series have been applied.

Quality standard have sofar been based on the particular needs of manufacturing industries. Though most of the basic principles of these standards are universal and valid for all industries, their adaption to the shipping industry must encompass the specific characteristics of management of ship operation, onboard and ashore.

To take one example, the responsibility and authority of the ship's master in matters pertinent to safety is virtually without parallel in other industries, certainly not in manufacturing industries. Similarly, land-based industry has no parallel to a ship's frequent change of master, officers and crew. The master can not be expected to have his system up and running as soon as he takes command if nothing has been prepared beforehand. Rules containing criteria on shipboard and shorebased management must explicitly address such issues.

For illustration an abstract of the DnVC Rules is enclosed as Appendix. This includes the parts relevant to maintenance, inspection and reporting. Special attention is drawn to item 403, referring to a complete Ship Inspection System that contains all information relevant for inspection, assessment and documentation of condition.

3.3 The Ship Inspection System

Approval of complete QA systems and their audits calls for people with special knowledge and experience. However, the ordinary class surveyor has become well acquainted with such systems in his daily work, with manufacturers of material and components and at most of the well organized newbuilding yards. He is therefore well prepared to meet the future Shipboard Management Systems.

In the case where the surveyor meets a fully implemented Ship Inspection System, his job may be limited to satisfying himself that the system is working and gives the required results. In the near future the real life situation will seldom be like this.

The surveyor may find that in some parts of the ship operation, quality control is well taken care of. Here, he may just carry out spot checks on the company's own system and see that the standard is maintained. Elsewhere, he may find it necessary to go deeper, and in fact do a detailed verification to see if performance of work is in accordance with requirements.

In this way, he is partly auditing the operator's QA system, and partly verifying the quality of performance within the system. Reporting such an informal audit is usually by word of mouth to the master, supplemented with class recommendations when required.

A formal audit, however, will be performed in a more comprehensive way. The findings will be reported in writing to the master and the shipowner, who will be responsible for improving the system.

Only a few ships have yet received the SBM class notation, but several are expected within short time. This will gradually change the role of the class surveyor and be a challenge to his competance and flexibility.

The ultimate effect is first expected when the shipowner enters a MSA with the class society. This is known as a Manufacturing Survey Arrangement (MSA) with manufacturers or yards, but may be renamed to Maintenance Survey Arrangement with the shipowners. It may be an agreement regulating the work to be carried out by the different parties in order to obtain class. In fact, this is already introduced as PMS (Planned Maintenance System) for machinery and may now be followed by similar systems for safety equipment, cargo gear and hull structures, or even better; an arrangement to handle the complete Ship Inspection System.

4. CONDITION ASSESSMENT PROGRAM (CAP)

The variation in the standard of shipowners and management companies has been pointed out. However, it should be stressed that there is an even larger variation in the individual condition of old ships - some are nearly in perfect condition whereas others of same type and age are clearly substandard.

The condition may vary with ship type. Old ships with expensive cargo containment and piping systems such as gas carriers and product tankers, tend in general to be in a better shape than crude oil tankers and bulk carriers. But even the conditions of sister ships may vary considerably.

Previously only the "good", well maintained ships were candidates for life extension beyond 15 years; - the "poor", badly maintained ships were scrapped as the structural up-grading necessary to comply with the class requirements would have been too expensive. Today the picture has changed dramatically as a result of increased demand for tonnage, increased newbuilding prices and for some period also favourable secondhand prices.

4.1 To Extend the Class with Rating

Many shipowners operating well maintained and sometimes extensively modernized older ships, have expressed a need to have the technical standard of their ships verified and documented so that the ships can be judged on the actual condition on board rather than on their age alone.

Strictly speaking the class does not say anything about the actual condition of the ship as long as it meets the minimum requirements. Hence, it may be a well maintained ship meeting the requirements with a large margin or it may be a poor ship due for scrapping at the next class survey.

In 1989 DnVC introduced the Condition Assessment Program - CAP -as a response to this need. CAP, developed in close co-operation with shipowners, insurers and cargo owners, covers the entire ship or parts of it. So far, only hull and cargo containment CAP have been carried out, but the list may be extended with machinery, mooring and navigation equipment etc. according to the owner needs, /5/.

Based on an extensive survey carried out by 2 - 4 persons depending on ship type and size, a Statement of Facts is prepared including a brief summary of conclusions and a rating. The rating ranges from 0 to 5, 5 being the top score and 2 the minimum class standard. In detail the rating system is applied as follows:

5 - condition as "new" or better than current class requirements for new ships.

4 - very good condition, very well maintained, no apparent sign of damage or wear and tear influencing function/safety margins.

3 - good condition, well maintained, some corrosion/- wear and tear. Function and safety maintained within margins.

2 - acceptable condition, complying with Rule requirements at Special Periodical Survey and/or other relevant functional needs/ requirements.

1 - poor condition, below minimum

class requirements or other relevant functional requirements. Mainteance/repair/upgrading needed. Class Recommendation issued.

0 - **unaccepable condition,** well below minimum class requirements and/or not or hardly operable/- possible to use. Safety and function affected to such an extent that remedies are ugently needed. Class Recommendation issued.

The system also include scores in half steps (i.e. 2.5, 3.5, etc.).

Note that cumulative damage is not especially considered in connection with CAP, as only fatigue cracks can be visualy observed or measured. Only instrumented monitoring over the entire lifetime in service may give some information on the experienced cumulative damage.

Appended to the Statement of Facts is a detailed technical report covering the relevant areas with local rating and a number of photos as evidence for the description.

CAP surveys are carried out <u>independently</u> of class surveys and by a very limited and dedicated number of people in order to obtain consistency in rating. The final rating for the ship is established by a Rating Committee and the CAP surveyor. Experience gained so far suggests that there are no problems in deciding on the rating for a particular ship.

CAP does not include any advice on what to do in order to up-grade the ship. However, it is a invaluable basis for any plans on such up-grading.

A study carried out in early 1989 shows that most Norwegian shipowners considered the hull structure to be the biggest problem with respect to maintenance and repair, /5/. As a result, a research project was launched with the objective to provide the owners with up-dated information on corrosion, cracking/fracturing and coatings. The main findings, which are presented in the following, have been confirmed by CAP on several ships.

<u>4.1.1 Corrosion</u>

Local corrosion and pitting do not in general represent a safety problem due to the robustness and redundancy of the ship structure. Local corrosion may initiate cracking, and may thus as pitting corrosion, result in cargo mixing and pollution, /6/.

However, extensive corrosion of large bottom panels may result in excessive longitudinal bending stresses causing the hull girder to collapse.

Major problem areas on old ships are identified as being higly stressed areas, permanent ballast tanks, bottom structure in cargo tank, and void spaces/ballast tanks adjacent to heated cargo tanks /5/.

The corrosion is particularly severe in ullage spaces below deck. Deck head coating as well as scale is subjected to heat, and to splash erosion from the ballast water. In addition variations in still-water loading and cyclic wave loading may result in large structural deformations causing the coating and scale to crack and flake, exposing bare steel for corrosion attack. The same effect is caused by local vibrations of plates and stiffeners.

The corrosion of side structure in ballast tanks is influenced by waves breaking against the side, and by fendering operations. Pitting corrosion of the bottom of ballast tanks, and horisontal girders may be severe because of water and mud left in the tanks.

In oil cargo tanks pitting corrosion is probably the main problem. Bottom plating and flanges of bottom girders may be subject to heavy local pitting corrosion once the coating breaks as the water between the oil and the structure is acid. Using inert gas containing sulphur increases the probability for pitting corrosion in cargo tanks. The rate and extent of pitting is influenced by the effectiveness of sacrificial anodes.

In void spaces bounding to heated tanks very rapid corrosion has been registered on few occations; particularly when void spaces have not been properly coated, when drainage is poor or when water has leaked into the void space due to cracking.

4.1.2 Cracks

A review of records on fatigue cracks on ships classed with DnVC reveals that cracks are due to inadequate details e.g. brackets, lugs, cut outs etc. of doubtful design or workmanship, and not as much due to overall hull stresses, /6/. These type of cracks tend to occur relatively early in the ship's life and they do represent primarily a day-to-day operational problem rather than being important for the overall safety of the ship. The cracks in internal structures may lead to leaks and mixing of cargoes, or contamination of ballast water. Cracks in outer shell plating represent a pollution hazard.

Improved initial design has resulted in a reduced number of above type cracks. Generally it is claimed that if no cracks have been observed during the first 10 years of the ship's life, then the probability for such cracks to occur later on is very small. A word of caution seems appropriate since a recent study indicates that ships with high tensile steel in deck and bottom longitudinal members may have a fatigue life of only 50% as compared with similar details made of mild steel /7,8/. The reason for this is the higher dynamic stress amplitudes and reduced initial scantlings. Combined with corrosion, the probability of failure increases rapidly.

Concequently, one may expect an increasing number of crack to develop as ships with high tensile steel approach 15 years of age. This calls for more inspection, and supports the DnVC decision of annual class surveys of ballast tanks on ships of this age and above, /9/.

4.1.3 Coating

In Reference /5/ it is concluded that coal tar epoxies used in ballast tanks seem to have a mean life of approximately 10 years with a range from 7 to 15 years or more. The large spread in lifetime is essentially due to differences in primer and coating types, initial workmanship regarding steel structure as well as paint application, and later maintenance/touch up of the coating.

In case of recoated tanks, the lifetime of the new depends primarily on the workmanship. Alternative coatings - soft coating etc. - may be considered instead of recoating. However, a number of uncertain factors regarding the protection effectiveness and durability have to be carefully documented.

Due to large uncertainties regarding coating lifetime, and their strong influence on corrosion extent and rates, inspection of ballast tanks should be thorough until necessary documentation has been obtained. Again, this supports annual class surveys of ballast tanks on ships of 15 years or more.

4.2 Advise on repair/upgrading /maintenance

In 1990 DnVC developed a probabilistic approach for assessing the necessary up-grading of old ships for an additional 5 or 10 years safe operation, /10/. This approach, which accounts for uncertainties in corrosion extent and rates, and in the extent and condition of coating, is based upon PROBAN, a probabilistic analysis program, /8/.

As part of the hull structure CAP, the actual strength of the ship is calculated based upon extensive thickness measurements carried out prior to the CAP survey by the owner. These are spot checked by the CAP surveyors during the survey. In addition, the original strength is recalculated using initial scantlings and the current rule requirements for similar ship type. Combining the above results with information on possible previous repairs and up-grading, a mean corrosion rate may be established for plates, stiffeners and frames.

Assuming the corrosion rates vary along a given hull element and at a given location over time, a distribution may be used to describe the corrosion rate. Using these corrosion rate distributions the probability for the section modulus to be below rule requirements may be calculated. Similarly the probability for structural members to be below minimum requirements may be calculated.

Figure 5. show an example for a 280.000 dwt tanker. The probability for being below the critical section modulus is plotted as a function of time, assuming in this case that corrosion is restricted to ballast tanks only. It is observed that after 15 years service the probability is 20% and after 20 years 80%.

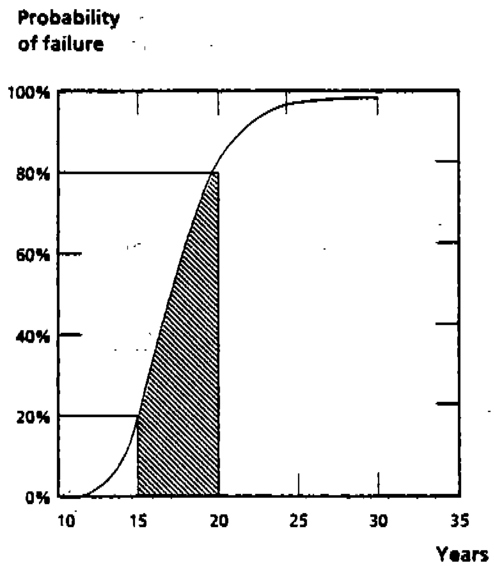

Fig. 5 The probability of hull girder strength problems as a function of time.

After repair have been made the ship will at best perform as well as a new ship, i.e. the recoated old structure will not deteriorate during the next 10 years. In the worst case the corrosion will continue as before due to poor recoating. Most ships are likely to perform somewhere in between.

The PROBAN analysis carried out suggest that in the best case upgrading the tanker from 20 to 25 years service calls for some 330 tons steel in longitudinal members and an additional 200 tons in transverse members to be substituted. Corresponding values for the worst case are 1130 tons and 710 tons respectively.

These values assume no variation in corrosion rates between different ballast tanks, and that the corrosion rate is uniform when the coating has broken down after 10 years. Mean annual corrosion rates for different members vary from 0.21 to 0.29 mm with a variation in standard deviation of 0.10 to 0.18 mm.

5. DIFFERENTIATED INSPECTION TO MATCH INTELLIGENT MAINTENANCE

The various elements in a differentiated approach to inspection and maintenance has been described above. In Figure 6. these are put together to indicate the quality assurance efforts of authorities, class and owners in order to achieve the basic safety level. In a differentiated approach the class should supplement the actual owner efforts.

If the owner has a fully implemented Ship Inspection System the class may concentrate on QA-audits. The other extreme alternative is for the owner to use full class support services with CAP as his inspection and follow-up scheme. In between are the traditional class approach and the planned maintenance arrangements.

In the future the joint efforts should not only aim at a basic safety level, but meet the needs for life time operational economy.

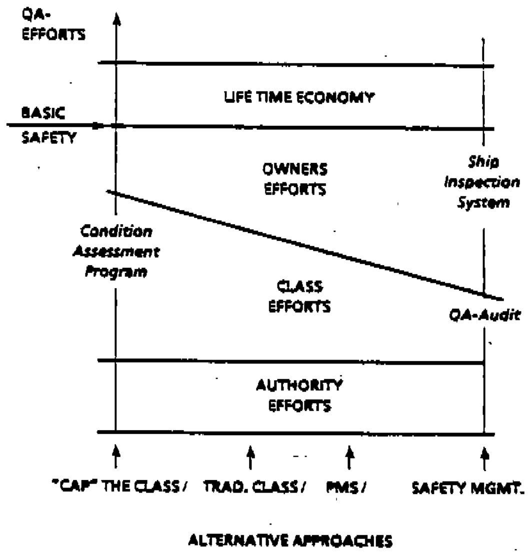

Fig. 6 Alt. combinations of QA-efforts.

5.1 Reliability Updating

The full flexibility will first be achieved when the class is able to define a reliability level to be met in all ship operations. This reliability level should be calibrated according to todays class standards. Thus, documentation of high margins in relation to these requirements will add to the reliability of the ship.

It is therefore expected that the optional CAP service soon will become the internal tool of the class surveyor. Finally, some time in the future when there is a market need, the real meaning of classification as "the art of forming or dividing things (or persons) into a rank or order", is expected to be reintroduced.

Instrumented monitoring may become a useful tool for trend analyses with respect to dynamic and static load and overload recordings, cumulative damage in relation to fatigue and possibly surveillance of corrosion rates. Such monitoring may add substantially to the reliability level obtained with visual inspection.

In fact, with a reliability based ship operation requirement the measures to be used by the class societies are the intervals and extent of surveys. The fixed five year periods may be convenient, but it should be the actual condition and not the calender which sets the criteria for class renewal.

In a co-operation between owner and class all the relevant data for intelligent planning of maintenance and repair will be available, in most cases on computer. Thus, it is expected that some computer software company will see the corresponding need for a knowledge based decision support system in this respect.

6. CONCLUSIONS

Maintenance has become a crucial factor for the long term operational economy of shipping, in particular due to the aging fleet. Several alternative strategies are possible. Thus, it is important to select the one that fit not only the operational policy of the company, but also the object in question, e.g. machinery, hull structure or tank coating. For verification of structural maintenance, condition monitoring is necessary. Visual inspection will be the most common, but instrumented monitoring should also be considered as a supplement.

Interaction and collaboration in the work for safety is needed. Note that the shipowners are responsible for safe ship operation, the authorities for laws regulating shipping and the classification societies for the quality of their certificates, i.e. the verification of a satisfactory standard.

It is of vital importance that the ship operators establish a Company and Shipboard Management System. This is expected to become mandatory for safety management within short time. It should be organized in such a way that the condition of the ship is maintained to conform with the provisions of relevant rules and regulations.

Such a system will make it possible for the class societies to carry out classification and governmental commissions based on modern Quality Assurance (QA) principles. In particular when a complete Ship Inspection System is implemented, classification may actually become a cost effective Quality Audit.

On the other hand maintenance is not only of importance to meet the mandatory minimum requirements. The investors have interest in the asset value, the insurance in the risk level and the charterers and cargo owners in the reliability and availablity of the ship. Thus, the owners and managers may want to document their ship qualities, exceeding the minimum standard. The Class Societies should therefore offer "to cap the class" with a quality rating. This is available in the DnVC Condition Assessment Program (CAP), and similar services from other societies.

Thus, future class inspection requirements and services will be highly differentiated. It will cover the mandatory requirements based on the level of shipboard quality management, ranging from inspection support services to traditional class work, and ultimately to quality audits of the complete Ship Inspection Systems.

In addition the class will offer optional inspection services aiming at quality rating, with statement of facts as basis for docking, repair or upgrading specification services. It also opens up for intelligent lifetime maintenance cost evaluations and selection of strategy by probabilistic methods. When - and not if - the class concept becomes reliability based, such analyses will also be the basis for selection of class inspection intervals and extent of survey or quality audits of Ship Inspection Systems.

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APPENDIX

ABSTRACTS OF THE TENTATIVE RULES FOR MANAGEMENT OF SAFE SHIP OPERATION AND POLLUTION PREVENTION

DnVC July 1990

Sec.1

A. Scope and application

A 100 Scope

101 These Rules stipulate requirements to Management of Safety and Environment Protection in Ship Operation (SEP Management). The objective is to prevent human injury or loss of life, to avoid damage to the environment, in particular, the marine environment, and to property.

102 These Rules cover the recommendations of the IMO Guidelines for the Management for Safe Ship Operation and Pollution Prevention. To ensure that administrative, technical and human factors affecting Safety and Environment Protection will be under control the applicable elements of the international standard ISO 9000-series have been applied.

104 The company may include quality objectives additional to those covered by the scope of these Rules. The classification services may then be used to verifiy that the arrangements needed for the achievement of such objectives are implemented and maintained.

B. Certificates and Class Notation.

B 100 Company SEP Management Certificate.

101 Companies who comply with the requirements in Sec.2, 3 and 4 may receive a Company SEP Management System Certificate. The names of the ships operated by the company holding valid Shipboard SEP Management System Certificates will be listed in an Appendix to the Certificate.

102 The Company SEP Management System Certificate will be given a validity period of four years provided the conditions for retention are complied with. Provided results for the Periodical Company SEP Management System Audits are satisfactory, the certificate may be renewed.

B 200 Shipboard SEP Management System Certificate.

201 Companies holding a valid Company SEP Management System Certificate who have implemented a Shipboard SEP Management System onboard a ship that complies with the requirements in Sec.4 may receive a Shipboard SEP Management System Certificate for that particular ship.

202 The Shipboard SEP Management System Certificate will be given a validity period of four years provided the conditions for retention are complied with. Provided results for the Periodical Shipboard SEP Management Audits are satisfactory, the certificate may be renewed.

B 300 Class Notation

301 Ships holding valid SEP Shipboard Management System Certificate and operated by a company holding a valid Company SEP Management System Certificate may receive the class notation SBM.

Sec.4

H. Maintaining the Condition of Ship and Equipment

H 100 General

101 The Shipboard Management System is to be organized in such a way that the condition of the ship is maintained to conform with the provisions of mandatory rules and regulations and with possible additional requirements established by the Company.

H 200 Essential Items and Functions

201 These are hull, equipment, systems, components and functions subject to class or statutory survey or that, if not being maintained, may result in hazardous situations or accidents.

202 Essential items and functions are to be identified and the Shipboard SEP Management System is to comprise systematic plans and actions to ensure that the condition is maintained.

203 Systematic plans and actions are at least to include:

- regular inspections i.e. examination, measurements and testing, whatever is most relevant;
- specification of methods used and where relevant, criteria for assessment of condition;
- records documenting that inspections have been carried out and where relevant, assessment of condition;
- assignment of responsibilities for the performance of the inspections to specific officers or to officers in charge of particular watches;

H 300 Critical Items and Functions

301 These are items and functions where sudden loss of functional capability or where failure to respond when activated, manually or automatically, may create hazardous situations or accidents.

H 400 Schedule of Inspection of Essential Items and Functions

401 Inspections as required above, including testing of functions, may be integrated into the ship's Planned Maintenance System, into watch-keeping routines, into specific operational procedures or into other routines, as found practical.

402 The Shipboard Management System is to contain a Schedule of Essential Items and Functions that briefly explains how inspections are taken care of and where records are filed.

403 The schedule may also be developed into a complete Ship Inspection System that contains all information relevant for inspections, assessment and documentation of condition.