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DP Classification

Presentation of DP Class 2 and Class 3

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INTRODUCTION

This contribution is to be particularly concerned with the hierarchy of requirements for DP vessels established in the IMO Guidelines, popularly referred to as DP Classes 1, 2, and 3.

The time allocated for the verbal presentation of this subject does not leave room for any extensive historic review, but this restriction is less critical in this written text. Not that history is in itself all that important, but it is necessary to gain understanding of the DP Class concept. If one understand the concept, one may be more motivated to accept it, and in the end maybe also directly gain from applying it. This writer has lived with the NMD guidelines from their initiation, and our DNV rules for years prior to that, and has fully experienced the misunderstanding, lack of understanding, even some cases of satisfaction of being ignorant, that has been associated with all attempts to regulate the design and operation of DP vessels. That still leaves room for the opinion that the guidelines are out of touch with reality, that they shoot far above the target, and is a general nuisance. But this writer is not willing to accept that view from sources that do not know what they critisize. Furthermore, he is not willing to agree either.

Whether one will express praise or grief over the DP Guidelines, it should be directed to NMD, the Norwegian Maritime Directorate. They started the whole thing in 1984, and sought the assistance of DNV in developing the first version of their guidelines, and the second, and subsequently the draft IMO Guidelines. That explains why the guidelines gained remarkable similarity to the DNV DP rules that had already existed since 1977. However, we shall be quick in moderating this apparent self-satisfaction from DNV´s side; our rules came out of an international co-operation in the DP business in 1974-75. Hence, the guidelines you read today are very much an extrapolation of accepted practices from the early seventies.

This writer has few chances to meet with the American DP-environment, and will express pleasure of having this opportunity to do so. It brings back pleasant memories from visits to Honeywell in Seattle in the late seventies. Looking back, in the light of today’s resources, the equipment of that time was not all that much, but the people definitely were.

DP CLASS CONCEPT

The introduction was intended to point out that there is very little new under the sun. The <u>technical</u> requirements are very much the same as they were 20 years ago. The fundamental thought that NMD introduced was that no DP operation should be conducted if the results of the maximum defined failure could lead to unacceptable consequences. That is the core of the whole concept. The rest is how to go about it.

Initially, NMD established Consequence Classes of <u>operations</u>, and the vessels were to be built according to requirements to enable them to undertake these various classes of operations.

Class 0 was a sort of “never mind” operations where nothing could go seriously wrong. Any vessel that could operate in DP mode at all, could not avoid meeting Class 3 requirements. That class disappeared with the introduction of the IMO Guidelines.

Class 1 operations are those where loss of position may cause some pollution and minor economical damage, but excluding severe harm to people.

Class 2 operation are those where loss of position may cause severe pollution, large economical damage, and accidents to people.

Class 3 operations are those where major damages may occur, severe pollution, and fatal accidents.

These hazard definitions are not well quantified, except for fatalities. But the NMD interpretation of damage was on a grand scale, using a national yardstick of magnitude of damage. The economic fate of a ship owner or an offshore operator did not warrant a specific class, that was a consideration left to the owner/operator. But it is a fact that DP vessels are able to cause damage to offshore installations that can make a sizeable dent in the national income, without necessarily killing anyone, and that is not to take place.

With the IMO Guidelines, the term equipment class was introduced, which is an inversion of the concept. A vessel is now equipped according to a chosen set of class requirements, and that will allow the vessel to undertake the corresponding consequence class of operations. The assessment of the hazard level of the operation still has to be done by involved parties, which include owner, operator, and national authorities.

The major difference between Class 1 and Class 2 is that Class 1 vessels are allowed to fail completely, i.e. lose both position and heading. The Class 2 vessel is not expected to do that. The maximum failure that can be defined is assumed to be feasible, it will happen, and it is not to be ignored with reference to optimistic statistics. Once this failure occurs, the vessel shall still be able to maintain both position and heading, at least initially. For how long this ability shall remain, is governed by the time required to secure the operation.

The major difference between Class 2 and 3 is the definition of relevant failure modes.

For Class 2 all failures of a technical nature are relevant, but certain types of equipment of a passive nature are trusted to stay out of harms way. For Class 3 vessels, all of the Class 2 requirements are adopted, and then is added failures that are brought about by fire and flooding events. This latter requirement results in need of physical separations that are not necessary for Class 2.

For both Class 2 and 3, *single acts of maloperation* are defined as relevant failure modes.

Hence, the difference between Class 2 and 3 is the failure mode definition, which briefly said consists of the need for physical separation of redundant components/systems in case of Class 3.

REDUNDANCY REQUIREMENTS

The consequence class concept for Class 2 and 3 is entirely based upon redundant solutions, which make it possible to retain a minimum range of equipment and functions is in operation when others have failed.

The redundancy requirements reach into all systems that are necessary for DP operation. The range of systems that are relevant comes as a surprise to some, which is a direct consequence of not having given the matter any thought. In classification work, we still encounter people who believes that our DYNPOS notations are only concerned with the control system, e.g. the Nautronix system to use a local reference.

The fact is that there shall be redundant equipment for power production and distribution, a redundant thruster configuration, and finally a redundant control system.

The typical redundant DP vessel, e.g. most drill ships, are based on two almost identical half systems for power generation and thruster configuration, which are controlled by a dual control system. When done properly, each half system shall carry on after full failure of the other half. Both halves will normally continue undisturbed after failure of one of the control systems.

This solution is acceptable for Class 2, and the vessel will be quantified by the smaller of the half systems, if they are unequal. Strictly speaking, systems are never equal. The thruster configuration will consist of units that will have variable efficiency, depending on external circumstances. In simple terms, if there are two equal bow thrusters, the forward one will be most valuable in situations where yawing moment is critical. Therefore, the most valuable system is not a static choice. This selection is taken care of by the “consequence analysis”, which will be explained later, if time permits.

For such a vessel to comply with Class 3, there must be physical separation of the two half systems, both with regard to fire and flooding hazards. There is common agreement that this would require no less than two engine rooms, with fire separation by A-60 protection. Less obvious is that there should also be watertight separation of engine rooms below waterline, and thruster rooms. The excuse for not having that is often reference to bottom and side tanks that will protect against collision damage. That is not adequate, there are ample cases of flooding caused by inboard water sources.

For Class 2, there is not a requirement for redundant piping, fixed piping comes into the category of passive components. However, for various reasons there are not many cases of common piping in a Class 2 vessel. Common piping is also acceptable for Class 3, but there it is even of less value as a simplification. Obviously, it is difficult to arrange common piping in separate compartments.

Common thinking of redundancy stops at two, although triple control systems have been in fashion for some time. The Class 2/3 concept has caused interest in, and benefit from, a wider degree of redundancy. If the vessel consists of two equal halves, only one half is given credit as operational after failure. If the vessel was instead built as three equal systems, two of these will be given credit for remaining operational. With a four-split system, only one quarter is considered to fail for one single reason. Hence, the degree of utilization of the installed resources in power and thrust has been increased.

It is difficult to arrange a monohull in more than two separate systems, but for semi-subs there are successful cases of three-split and four-split systems.

Class 3 vessel has the particular requirement that there shall be a back-up DP-system. This system is motivated by the argument that the redundant main system may suffer fire damage. This is often a difficult system to arrange so that it will function as intended, if it is ever called on duty. One feature which is overlooked is that the back-up is useless as an automatic control system if it does not have a working position reference system at the critical moment.

It is not the intension of the writer to list the number of control equipment required for the different DP-classes. But it is important to observe that the Class 3 back-up should be interfaced to at least one position reference system. That may look like a simple requirement. It is not; the problem being which reference(s) to select. If one selects only one, this must be one that is operational in all Class 3 operations. If that position reference is not operational, the vessel is not a Class 3 vessel for the time being.

REDUNDANCY AND FMEA

DNV introduced the requirement for FMEA for the DYNPOS AUTR notation when the class notation was established in 1977. It was supposed to be a piece of documentation that should support the designer´s claim for a redundant system.

When NMD brought out the first DP Guidelines, they opened up for the choice of either providing an FMEA or to prepare and conduct a failure mode test procedure at sea trials. DNV then adopted the same choice in the DYNPOS rules, and have exercised the builder´s right to choose. NMD has, however, practised to require both, first the written analysis, and then the test.

DNV has had mixed experience with FMEA´s. The yards are, generally, reluctant to engage themselves in any FMEA work. We have tried to bring across the idea that a FMEA that is carried out during the design process may be beneficial to the yard, at least in avoiding design shortcomings that will require rework when detected. A very hard idea to sell. The

FMEA is considered to be an evil that some academic has dumped upon them, and the solution is to hire somebody else to produce it, since it will not go away by itself.

In principle, it should be irrelevant who produces the FMEA, as long as the product is acceptable. It is not, however, irrelevant who learns from it. The task of producing an FMEA is quite educational, and it is valuable for both yard designers and subsequent owner/users to partake in that education.

POWER AND THRUSTER SYSTEMS

This writer is not about to state the requirements for power and thrust resources in DP-vessels, simply because there are none. In DNV, we are often confronted with the question of how many thrusters, and how big, do we require.

The answer is that it is not our business. It is the owner who decides how much of a DP vessel he wants, according to his evaluation of what the market will require. Therefore, there are no requirements to a specific performance level in either classification rules or governmental (IMO) guidelines, and consequently no specific requirement to the thrust that would have given that performance level.

But, if the vessel is to comply with Class 2 or 3, a redundant thruster configuration is required. Then there will be some distinct minimum acceptable number of units.

Not being involved in dimensioning of thrusters is unquestionably a simplification for both classification societies and authorities. If the combination of a specific performance level and thruster requirements should be established by these agencies, who would pick up the responsibility if it turned out to be bad advice. Such computations are not always representative of the results.

In DNV, we did realize that the complete lack of quantification of a DP vessel was not satisfactory in combination with a classification of the vessel. Therefore, the ERN concept was introduced as a rule requirement. The ERN, short for *environmental regularity number*, is a quantification of the balance of thruster resources and environmental loads on the vessel. The concept is based on specific definitions, e.g. it is a worst case computation, the weather components wind-wave-current are coincident in direction, and current is always 0.75 m/s. Of course, all of this is not true at the same time, and the ERN is at best indicative of performance level. Still, the concept has definite merit as a quick and relative comparison of different DP vessels.

NMD did not want to pursue this practice of ERN, or anything similar. Their attitude was that they do not care how powerful the vessel is, they only want to be sure that it is not over-exploited and therefore getting into trouble. This eventuality they aim to avoid by the on-line *consequence analysis.*

This analysis is a software routine that is executed in the DP system at short intervals, monitoring the power and thrust consumption at all times during Class 2 and 3 operations. The analysis is familiar with the failure modes in power and thruster systems and run calculations to check that the current power and thrust demand can be produced with the generators and thrusters in operation after a possible failure,
If the answer is no, a warning will be produced. There is no automatic response to the consequence analysis; it is left to the operator to decide if it is necessary to act upon the warning, and also to sort out what he can do. The consequence analysis is, therefore, the tool that monitors that the operational side of the Class 2 and 3 used and respected.

WHEN TO USE CLASS 2 OR 3, OR NEITHER ONE

The writer has indicated that Class 2 and 3 seem to be applied in operations for which NMD may have intended something simpler. NMD has always been reluctant to put in writing what their requirements are, but when asked, they have been quite clear about using Class 3 for drilling operations and any involvement with live wells. In Norway, the operators have joined in a list of operations and corresponding vessel equipment classes. It is presented in the NORSOK STANDARD.

The IMO Guidelines states, however, that the class assessment should be done by owner and operator, or be settled by the national authority. The latter statement indicates that there may well develop different interpretations of class selections in various operating areas around the world.

Just to have it said; DNV can advice on practice, but have no authority in the matter of class assignment unless expressly authorized by the national authority.

CONCLUSION

This has been a quick review of a large subject, which is quite relevant at this time. There is more going on in the DP business right now than anyone can remember, and terms like Class 2 versus 3, failure modes, reliability, redundancy requirements are being tossed about in all directions.

The writer thank you for your attention, and hopes that he will at the time of presentation manage to convey the message that DNV is engaged in all this, and we enjoy being a part of it, and accepts that it will also place demands upon us.