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Control Systems

Dynamic Positioning Systems - Consequence Analysis

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Background

The concept of the DP control system including a consequence analysis function was first introduced though Lloyds and DNV DP rules in the 1980s. These applied to class 2 and 3 systems or to be more specific Lloyd's AA and AAA and DNV's AUTR and AUTRO. ABS - DP2 and DP3 also have a consequence analysis requirement. Consequence analysis is also called for in the industries own DPVOA's 'Guidelines for the Design and Operation of Dynamically Positioned Vessels'. The guidelines have now been imbedded in the IMO guidelines for dynamic positioning systems.

All have a common theme as to what is required similar to the IMO guidelines:

'The analysis should verify that the thrusters remaining in operation after the worse case failure can generate the same resultant thruster force and moment as before the failure'

The others are very similar, except that IMO takes it further for operation that are going to take a long time to safely terminate then in these long term situations the analysis must be able to consider manually specified future weather conditions'.

Typically the worst case failures considered by the DP control system suppliers in their systems have been:

- Failure of the most critical thruster
- Failure of one thruster group
- Failure of one power bus

The first and last are generally self evident. The thruster group may need careful consideration for each vessel where the design may be such that the failure of one piece of equipment may fail more than one thruster e.g. outstation, analogue board, cooling water, etc.

The results of this type of analysis are fairly clear, either there is enough thruster or there is not enough thrust and therefore position will be lost. No attempt is made to predict how fast position will be lost or in what direction.

The DNV Posmoor rules for vessels with anchor assist systems have however taken significantly further. The consequence analysis includes the same worst case failures but also necessarily includes line break. However with a mooring spread the consequences of a failure are less clear cut. The consequence analysis is therefore required to predict into the future the following.

- Transient line tensions
- Position and heading trajectories
- Final tension
- Final position

This not only requires the consequence analysis to model the vessel and the mooring spread, but also the action of the control system, and its thruster allocation logic and power limiting scheme.

Other Possibilities

There are now suggestions that the DP consequence analysis should be taken further. It is generally obvious to an operator that if he has two bow thrusters and both are above fifty percent then he cannot afford to have one trip. He may also understand that if a HV switchboard is lost the vessel may still be capable of staying on station. In either event the consequence analysis may serve as a useful reminder, but it may also be treated as a self evident nuisance. However what often catches an operator by surprise are the more subtle situations where more significant failures are lurking which are not self evident. The following gives some examples, that have caught operators off guard:

- Both of a ‘dual’ acoustic system on the same VRU
- Both of a ‘dual’ acoustic system on the same beacon
- Both of a dual DGPS on the same satellite dome
- All operational position references on the same UPS
- Thruster fails to full thrust
- Set up of load sharing such that if one generator takes all the load the others will trip
- All thruster pitch pumps on the same MV switchboard
- Sudden wind shift or change in weather.