HYDREX WHITE PAPER N°12A

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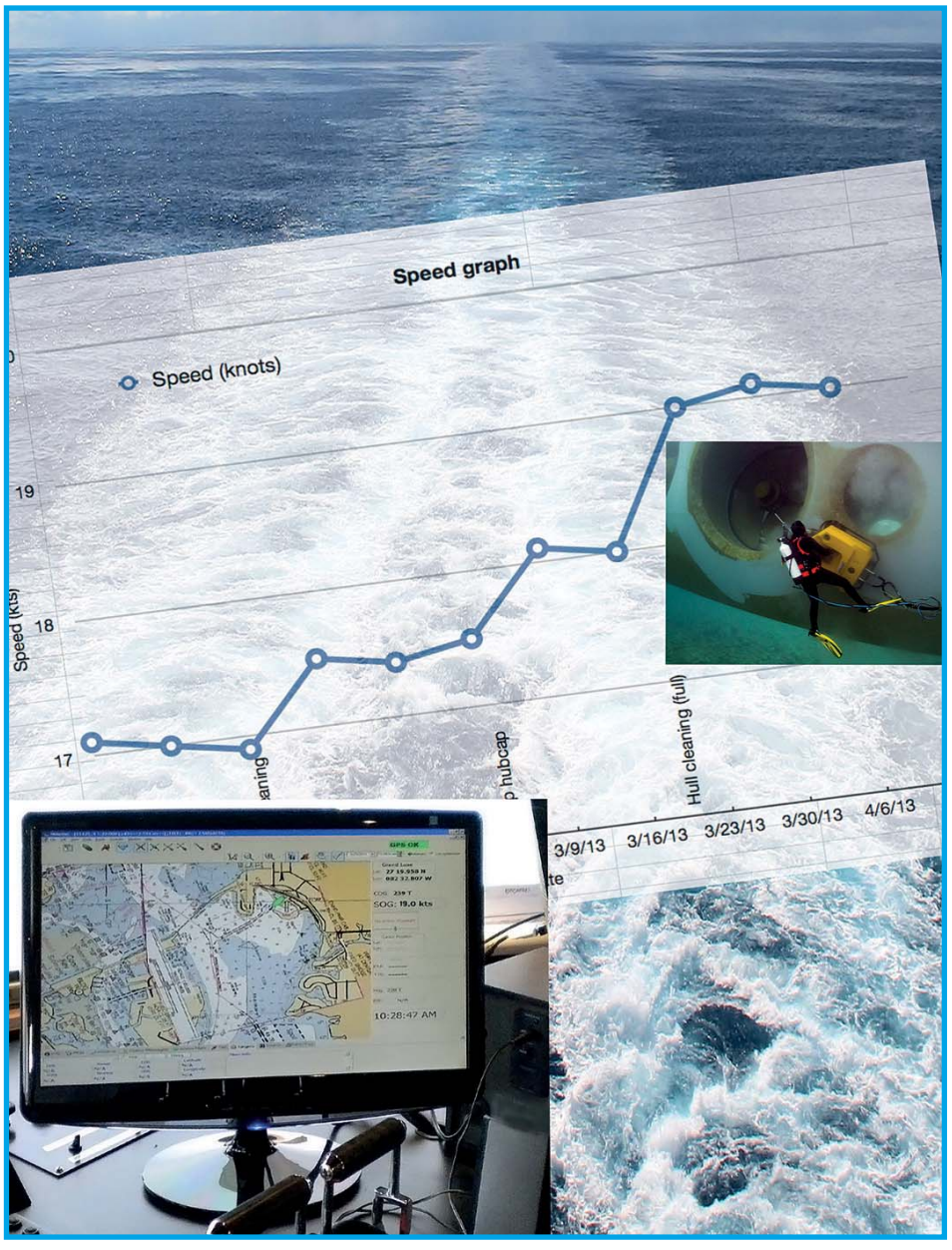
Ship-hull Performance Optimization Tool (SPOT) Quick-start Guide (PILOT)



How to get control of and optimize ship hull and propeller performance

The Hydrex Group
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HYDREX®
UNDERWATER TECHNOLOGY

Part I. Introduction

This is a brief set of instructions for rapid implementation of the Ship-hull Performance Optimization Tool – SPOT.

The full theory and practice of this system is contained in Hydrex White Paper 12 *Ship-hull Performance Optimization Tool (SPOT)*.

This system is still a pilot project. When it has been tested on various ships under a variety of conditions, the final version will be published.

Hydrex is working on a SPOT app for desktop and laptop computers and notebooks and for mobile devices. Until these are available, the system as set out here can be implemented simply and effectively and is ready to obtain immediate results.

IMPORTANT NOTE:

This is a simple approach to monitoring ship hull and propeller performance and efficiency. It is designed to be used by ship officers and crew using already available equipment. SPOT works without complex measurements of the large number of variables present in the marine environment which can all affect a ship's speed. It must be kept simple and used with a good dose of common sense.

It's a simple system. Keep it simple!

Part II. Step by step instructions

1. Assign personnel

This will vary from ship to ship, fleet to fleet. Ideally the people chosen should be familiar with the sailing of the ship, the state of the hull and propeller and a good understanding of the factors which lead to fuel efficiency. The Chief Officer, the Chief Engineer or one or more of their subordinates would be good candidates.

2. Read these instructions all the way through

The instructions can be followed as laid out here. As soon as possible, those in charge of using the SPOT system on the ship should study Hydrex White Paper No. 12 in detail as it has the full theory and expanded steps. But you can follow these steps as laid out here and it will work.

3. Make up a Changes Log

The changes log is a very simple thing. It can be in the form of a spreadsheet on a computer or a hard copy logbook. It has a column for date, a column for time, a column for the change and a column for any additional notes.

A spreadsheet on a computer would look like this:

Date	Time	Change	Notes
Feb 15, 2013	9:00 AM	Full propeller cleaning finished	
Mar 4, 2013	10:00 PM	Propeller hubcap installation completed	
Mar 22, 2013	1:00 PM	Hull cleaning completed, vertical sides and bottom, full hull cleaning	

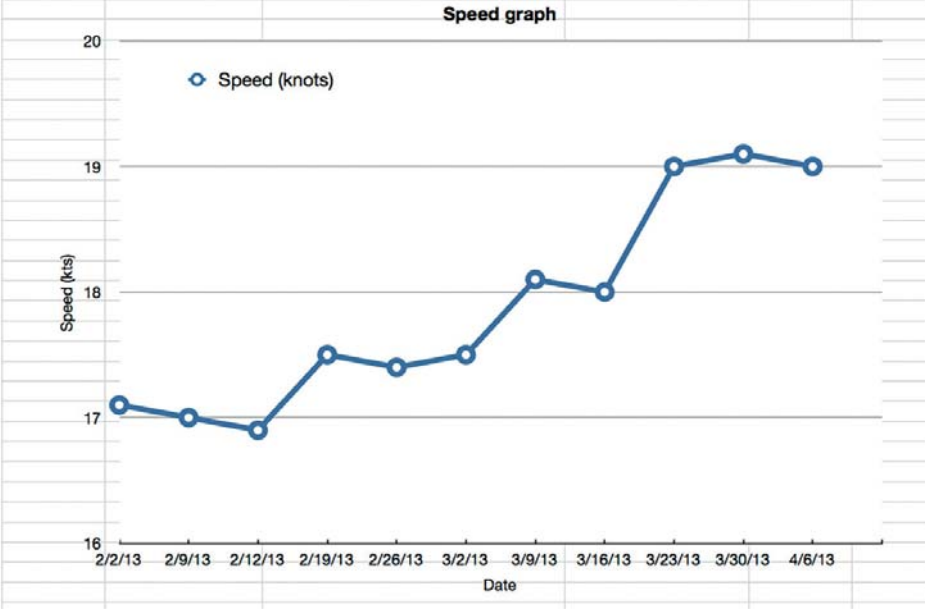
4. Set up a spreadsheet for recording and graphing ship speed

The spreadsheet for recording and graphing the ship's speed on a given date at a given time is also very simple. On the graph, along the bottom, the x axis, one has the date with a unit of perhaps weeks. On the left hand side on the y axis one has the speed in knots, maybe 3 knots less and 3 knots more than the expected speed at the usual engine rpm at which the ship steams. The actual range will be handled automatically if you are using a spreadsheet program such as Microsoft Excel or Apple Numbers. Here is a sample spreadsheet and graph. It is, as you can see, very simple.

Note: Some might prefer to set up a single spreadsheet which combines changes log and ship speed notations. There is no reason not to do this if you are sufficiently conversant with spreadsheets. But the changes log and the speed notations can just as well be kept on separate sheets.

All of this can just as easily be accomplished using a paper-based system. The principles and procedure are the same.
(See sample speed graph on next page.)

Date	Time	Speed (knots)	Notes
2/2/13	Noon	17.1	
2/9/13	Noon	17	
2/12/13	Noon	16.9	
2/19/13	Noon	17.5	
2/26/13	Noon	17.4	
3/2/13	Noon	17.5	
3/9/13	Noon	18.1	
3/16/13	Noon	18.0	
3/23/13	Noon	19	
3/30/13	Noon	19.1	
4/6/13	Noon	19.0	



5. Begin the Changes Log

Whenever this monitoring system is implemented, it is vital to begin the log with the current state of hull and propeller, the coating type, when applied originally to bare steel, when repaired and to what extent, when cleaned, last propeller cleaning or polishing and whether in drydock or under water. This will then provide a basis from which further changes can be reflected.

More specifically, these factors should be recorded at the very beginning of the changes log:

- type and brand of underwater hull coating in use
- when first applied
- when last fully reapplied to bare steel (for an older ship)
- when repaired and reapplied (possibly more than once, depending on how many times the ship has been drydocked since the coating was first applied
- the extent of the last coating repair/ reapplication
- when hull last cleaned, whether in drydock or underwater, and to what extent
- when was the propeller last cleaned or polished, whether in drydock or underwater
- any other details regarding underwater hull coating and hull and propeller maintenance.

This is quite a lot of information to gather

and record, but it is necessary so that the change log is meaningful and there is something to compare future changes to.

6. Keep the changes log up to date with any new changes

Any of the following or similar changes should be recorded with the date and time that the change is completed:

- drydock (with a list of all changes made that could affect the ship's speed, such as hull blasting, coating repair or replacement or a different coating system applied, propeller cleaning or polishing, engine maintenance)
- hull cleaning (drydock or in-water? how much of the hull's surface? how thoroughly?)
- propeller cleaning or polishing (drydock or in-water?)
- change of fuel type or quality
- change in cathodic protection system
- change of propeller type
- change of rudder type
- changes to the ship's engines.

7. Measure and record the ship's speed at given engine rpm and under generally similar conditions

This has already been covered. The speed can be measured once a week. It could be more or less frequently. Experience will show what works best.

The speed one needs to record is the speed over the ground (GPS log) corrected for current.

The ship must be steaming in roughly similar conditions. The engine rpm must be the same. If you record the speed at 175 rpm at noon on Saturday March 9th then you should record it again at 175 rpm at noon on Saturday March 16th as long as conditions are fairly similar. The conditions that should be similar include

- draft
- weather conditions
- sea state
- ballast.

Note that the conditions need only be roughly similar. This is not something to worry about too much. But if the external factors are very different it might give a false picture. This needs to be taken into account. To note the speed on one day in a calm sea with no wind and to compare that to another day in the middle of a storm with a heavy sea and strong headwind is going to throw the results off. It is better to wait and note the speed on a later day when conditions are similar.

As far as the graph is concerned, it is particularly important to note and record the speed before and after any change that might affect the ship's fuel efficiency.

For example, say the Chief Officer is the one keeping up these records. He has chosen to make observations every Wednesday at noon. He keeps this up as long as the conditions are similar as covered above. But one Wednesday at noon the conditions are very different and don't return to normal for a couple of days. He simply waits for a couple of days until he judges conditions to be similar to other times he has made his observations. He then notes this on the graph as the speed for that week.

Over a period of time, this will even out. After a few propeller cleanings, hull cleanings, drydockings and other changes, it will become abundantly clear what actions and changes improve the hull and propeller efficiency and generally how much these changes improve that efficiency. It will also

show what changes worsen that efficiency and increase fuel consumption for given engine rpm.

If one knows there are going to be more than one change implemented within the week (or other period chosen for regular speed notations) then one should take additional readings before and after each change if possible so that the effect of the different changes can be gauged separately.

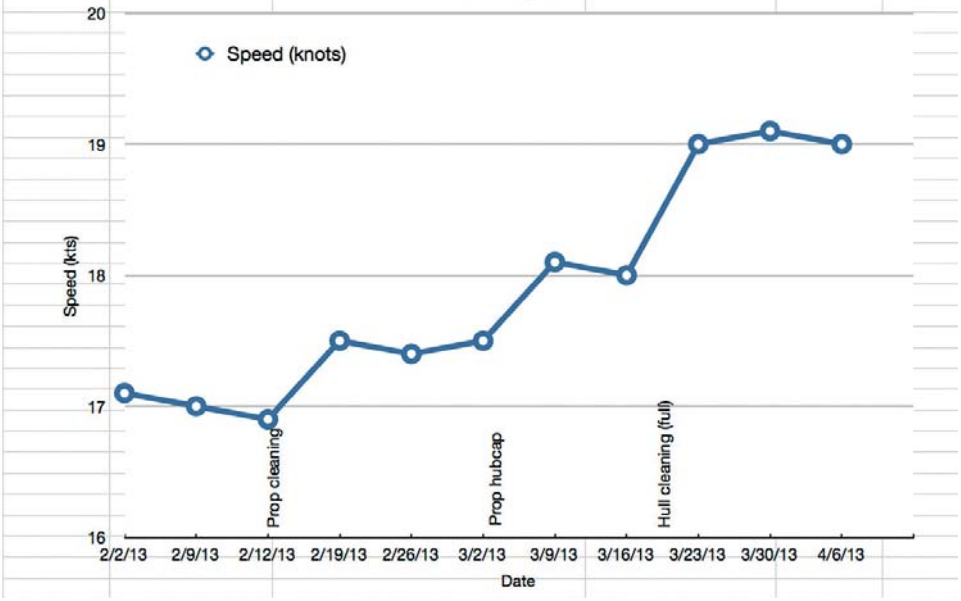
8. Keep up the graph and the changes log accurately and without fail

This system works very well with sensible observations accurately noted over time. In order for analyses to be correct, they must be based on correct data. Thus the accurate recording of changes that might affect propulsive fuel efficiency in the changes log, and correct, regular notations of speed for given engine rpm under relatively similar conditions are the key factors in the success of the approach. Whoever is put in charge of this function needs to be steady and reliable, must "get behind" this program and take care to observe and record the data accurately. It need not become a "crusade" but the person should have a strong interest in working towards achieving optimum fuel efficiency for his/her ship. Common sense is a key ingredient.

The changes noted in the changes log should be added to the speed graph for easy correlation. It need only be a brief notation and the changes log itself can be consulted for full details of a particular change.

Thus in the case of the graph above in Step 4, it would look like this:

Date	Time	Speed (knots)	Notes
2/2/13	Noon	17.1	
2/9/13	Noon	17	
2/12/13	Noon	16.9	
2/19/13	Noon	17.5	
2/26/13	Noon	17.4	
3/2/13	Noon	17.5	
3/9/13	Noon	18.1	
3/16/13	Noon	18.0	
3/23/13	Noon	19	
3/30/13	Noon	19.1	
4/6/13	Noon	19.0	



As explained in step 7 above, it may be necessary to record the speed more frequently at times. If more than one significant change is scheduled and one wants to see what effect each change has on the ship's fuel efficiency, it would be necessary to record the speed before and after each of the changes. Then one can see what change was responsible for what percentage of the improved fuel efficiency (or lack of it). The fact of some irregular intervals between notations is not important.

9. Analyze the data

The analysis of the data is also quite simple as long as one realizes that he is looking for large changes, not tiny details. The propeller is cleaned. Next speed reading shows a speed increase of 0.75 knots. The cause is obvious. Ignore the fact that there is a slight variation in speed readings for the next couple of weeks. The average speed clearly shows that there has been a speed increase of about 0.75 knots after a propeller cleaning. The propeller blades are damaged. The speed drops by 0.5 knots. The vessel goes to drydock and the coating is spot repaired. It comes out of drydock and the speed soon drops by 1 knot on average. This is due to the spot repair in drydock and the effects of long term paint degradation (LPD) on the efficiency of the hull. The person doing the analysis needs to have a good idea of what sort of things can cause improved or worsened fuel efficiency and not assign changes to the wrong cause.

The information thus analyzed, steps can be taken to keep improving the ship's fuel efficiency until it reaches the optimum for that ship. This may take years to achieve, but the information can also be used for the rest of the fleet and can help determine a shipping company's policies and procedures with regard to underwater hull coating and hull and propeller maintenance.

These instructions do not go into details on the types of changes which can be implemented in order to improve the efficiency of the hull and propeller. These are covered in exhaustive detail in the Hydrex White Papers and in the book *Surface Treated Composites White Book*.[1]

But, if this method of fuel efficiency monitoring is kept up, the results analyzed, and the analysis sensibly used to make decisions about underwater hull coating type used and hull and propeller maintenance scheme employed, it will inevitably lead to the optimum hull and propeller efficiency for any ship.

1 Boud Van Rompay, Surface Treated Composites White Book, Tahoka Press (2013).

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