Avoidance of the Tropical Cyclone in Ocean Navigation

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ABSTRACT: Article presents various methods of determining the tropical cyclone avoidance manoeuvre in ocean navigation. Determining of the manoeuvre was carried out with the use of the ORS (Onboard Routing System) systems Bon Voyage 7.0 and SPOS 7.0, the 1-2-3 rule, manual graphic anti-collision plot, CYKLON programme, and shore based weather routing by AWT (Applied Weather Technologies). True weather data from the voyage of the 9000TEU POSTPANAMAX container vessel from Yantian (China) to Vancouver (Canada) in August 2015 were used. During the voyage the vessel has encountered the typhoon MOLAVE.

1 INTRODUCTION

The key decision in tropical cyclone avoidance is the determining of the moment of the beginning of avoidance manoeuvre and the determining of the correct course and speed.

In this article the determination of the typhoon avoidance manoeuvre in ocean navigation by a big (LOA=336m, GT=97500, DWT=71274MT), powerful and fast (20knots), postpanamax container vessel on a voyage from Yantian (China, ETD=07.08.2015 0300UTC) to Vancouver (Canada, ETA=19.08.2015 2100UTC) by various methods was analyzed.

The recommended route between the two above mentioned ports is the route shown on Fig. 1 (UK Hydrographic Office NP136 2014). However, in an initial, coastal stage of the voyage, typhoon SOUDELOR was encountered (Fig. 2). It prevented the vessel from using the route shown on Fig. 1. Consequently, after a number of testing and consultation with AWT, the route through the Luzon Strait was chosen, clearing the typhoon SOUDELOR from the south. In an ocean stage of the voyage the typhoon MOLAVE was encountered. It was moving from the Philippine Sea towards Japan – see Fig. 3. The route takes into consideration navigational and legal restrictions – allowed routes in the Bering Sea and Aleutian Chain and the US and Canadian ECA zone (Szymański&Wiśniewski, 2016).

Figure 1. Great circle route Yantian – Vancouver (Own study based on BVS 7.0)

Figure 2. Track of the typhoon SOUDELOR and route through the Luzon Strait (own study based on BVS)
Symbols and abbreviations used in the article:
ETD – Estimated Time of Departure
Departure – Point of departure
ETA – Estimated Time of Arrival
Arrival – Point of arrival
Troll – vessel’s own roll period (transverse) in sec
nm – nautical miles, route distance
Hrs – hours, required steaming time
T,FO – Total Fuel Oil, Total fuel consumption en route
HSFO – High Sulphur Fuel Oil, consumption en route
LSFO – Low Sulphur Fuel Oil, consumption en route
MDO – Marine Diesel Oil, consumption en route
LSMDO – Low Sulphur Marine Diesel Oil, consumption en route
SC – Calm Sea Speed, ship’s speed on calm seas for the optimized route
WxF – Weather Factor, influence of weather on ship’s speed
CuF – Current Factor, influence of ocean surface current on ship’s speed
SOG – Speed Over Ground for the optimized route
Fuel(USD) – Total fuel cost In USD for the optimized route

2 METHODOLOGY

The following tools were employed to determine the safest action to avoid the typhoon MOLAVE:
– ORS (onboard routing systems) BVS 7.0 – Bon Voyage System 7.0 (Applied Weather Technologies, 2014),
– SPOS Fleet Management 7.0.0.1 (Meteo Consult BV, 2009),
– 1-2-3 rule (Holweg, 2000),
– anti-collision plot,
– CYKLON programme (Wiśniewski & Kaczmarek 2012) (Wiśniewski 2012),
– shore based weather routing recommendations by AWT.

Weather data used were:
– the weather data file for ORS BVS containing weather analysis and prognosis up to 16 days in advance,
– the weather data file for ORS SPOS containing weather analysis and prognosis up to 9 days in advance,
– EGC forecasts, outlooks and advisories,
– surface pressure analysis and prognosis charts from JMA (Japanese Maritime Agency),
– typhoon prognosis charts from JMA (up to 120 hrs with 70% probability level),
– typhoon strong winds prognosis charts from JMA (up to 72 hrs).

Results obtained were compared. The best solution in terms of safety and possibility of route execution was chosen.

3 RESULTS

3.1 Avoidance manoeuvre by the recommendation from shore based weather routing

Shore based recommendations from AWT were received on 6th and 7th of August. They are shown on Fig 4 together with their navigational parameters.

The recommended routes were moved south due to the typhoon MOLAVE developing south of Japan. They were programmed manually in AWT. Bold route on Fig 4 is from August 7th. Its corresponding navigational parameters in the table below the weather chart are highlighted blue. The route runs too close to the typhoon and generates weather alerts – exceeding the maximum wind velocity (34kts). Alerts are marked by violet circles visible along the route on Fig 4. Finally the AWT had accepted the captain’s route passing the MOLAVE from the south and entering the Pacific via the Balintang Channel in the Luzon Strait.

3.2 Avoidance manoeuvre with the use of the BVS 7.0

Planning of the MOLAVE avoidance manoeuvre had begun on 9 August after the successful clearing of the typhoon SOUDELOR on the South China Sea (fig 5 and 6). Optimization used was least fuel with fixed arrival time. Weather limitations were set for
maximum 8m swell, seas and significant wave and wind maximum velocity for 34 knots.

Routes generated in the BVS until August 9th run along the coast of Japan from the Pacific side. They clear the MOLAVE from the polar side and place the ship between the typhoon and the land, on a narrow and restricted area (Fig. 5 and 6). The correct route clears the typhoon from the south. It is highlighted blue on Fig 4 (bold route). It was programmed manually onboard.

Figure 5. Testing results of routes passing the typhoon MOLAVE. (Own study based on BVS 7.0)

Figure 6. Result of testing in BVS from 9 August — position of the ship and typhoon for 11.08.2015, 0000UTC (Own study based on BVS 7.0)

3.3 Avoidance manoeuvre with the use of SPOS 7.0.0.1.

Ocean route testing began on 7 August. SPOS ORS enables to programme the minimum distance to the tropical cyclone and tropical depression (Szymański & Wiśniewski 2016).

Figure 7. Avoidance manoeuvre in SPOS from 7, 8 and 9 of August (Own study based on SPOS)

Maximum wave heights and wind velocity were programmed as 8m and 34 knots. Minimum distance to typhoon was determined as 250Nm. Type of a chosen optimization was Optimum High&Wide, with speed of 19.5 knots, corresponding to the calm sea speed for the route optimized in BVS 7.0 ORS. Results of testing are presented on Fig. 7. Similar to the BVS system, routes generated in the SPOS system until August 9th run along the southern and eastern coasts of Japan and were clearing the typhoon form the polar side. They placed the ship between the typhoon and the land, in a too narrow and too restricted area. Due to that the routes were finally rejected by the captain.

3.4 Avoidance manoeuvre by the 1-2-3 rule

Blue colour on Fig 8. marks the position of the typhoon MOLAVE together with the 30knots wind zone according to the warning from 8 August, 1200UTC. Green colour circles mark the further position of the typhoon together with the 35 knots wind zones. The 24hrs, 48hrs and 72 hrs predicted zones’ radii are increased by respectively 100Nm, 200Nm and 300Nm with regard to values from the warnings, in accordance with the rule methodology. For visualization of the 1-2-3 rule the CYKLON II programme was used.

Figure 8. 30 knots wind zone of MOLAVE as calculated by 1-2-3 rule from 8 August for the next 3 days (Own study based on CYKLON)

3.5 Avoidance manoeuvre with the use of CYKLON programme and manual anti-collision plot

It is shown on Fig. 9 and 10. The software was fed with the data regarding the typhoon from 8 August 1200UTC, when the voyage began.

The safe course is 065º, the software calculated initially the dangerous sector 047º and 061º (Fig. 9), and after 12hrs, for updated positions and forecasts
of MOLAVE’s movement, the dangerous sector was between 054º and 064º (Fig. 10).

Results obtained by the manual plot are comparable with those obtained by the CYKLON programme.

4 CONCLUSIONS

1 Routes generated by both Bon Voyage and SPOS ORS do not meet the safety requirements for cyclone avoidance and passes the typhoon from the polar side. Calculations are based upon the user declared maximum allowed wave heights and maximum allowed wind velocities and in SPOS additionally upon the minimum declared distance from the cyclone’s eye.

2 1-2-3 rule is very ineffective and impractical in tropical cyclone avoidance. The 35 knots wind zone to be avoided, after 72hrs is almost 1000Nm in diameter. It is too play safe. It bears also a serious mistake in methodology: lack of differentiation of strong winds zone radii with regard to cyclone’s quadrant.

3 Correct solutions to the problem were only obtained with the use of CYKLON programme and manual plot. CYKLON programme is more recommended than the manual anti-collision plot. Results obtained by both methods are identical, however accuracy in CYKLON programme, due to methodology utilized (analytical-mathematical in CYKLON against manual-graphical in manual plot) is more correct and more accurate.

4 The best route was obtained by manual programming in the BVS according to results obtained in the CYKLON programme – see Fig 5, route highlighted blue. It is the best route obtained in all the testing and of all tools utilized. It is recommended to use the tool like CYKLON programme or similar as a complement to the ship’s ORS in programming the part of the route passing in the vicinity of the tropical cyclone.

5 Shore based weather recommendations were generally correct. However, they run too close to the typhoon. Their quality is very much dependant on the knowledge and experience of the operator. Those are not known onboard and cannot be verified, thus caution is recommended.

REFERENCES