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AUTOPILOTS, WATCHKEEPING AND VOYAGE PLANNING

An automatic pilot or ñautopilotò is an automatic electronic device that steers vessels of all sizes in the direction selected by the Master or watch officer and carries out most of the routine human functions normally performed by a helmsman in steering the vessel. No matter how useful, the autopilot does not have a brain capable of replacing an intelligent human.

An automatic pilot provides the necessary course correction to the vesselôs steering system relative to her speed and the amount that the boat moves off the pre-set course.

An autopilot controls the electrical and hydraulic power needed to move the vesselôs rudder to the right or left to ensure that the vessel maintains its preset heading. Advanced models use positional information from GPS to adjust the vesselôs heading to make good a desired track. Earlier models used positional information from loran, gyrocompasses and magnetic compasses to attain the best possible results that technology allowed. Improvements made in the autopilot over the years reflect improvements in technology.

There are a number of advantages to having an autopilot as well as some serious disadvantages.

ADVANTAGES OF AN AUTOPILOT

In general, the principal advantages of using an autopilot are that ité

- ð Relieves the helmsman of the monotony of steering the boat over long distances.
- ð Allows the helmsman to perform other tasks in the pilothouse including answering the vesselôs radios, checking the vesselôs progress along its track, evaluating radar targets as the vessel maintains a steady course.
- ð Allows the helmsman the freedom to serve as a more effective lookout, and monitor other navigational equipment more closely if he is the only person in the pilothouse.

CAPABILITIES OF AN AUTOPILOT

There are a variety of autopilots already installed on vessels and currently on the market with different capabilities that are best described in the operating manuals that accompany the equipment. Some autopilots are designed better, maintained better, or simply work better than others. Some autopilots are more trustworthy than others.

Modern autopilots have computers or processors that receive electronic input signals from sensors like GPS, Loran, magnetic or gyrocompasses and match them with the command signals from the pilothouse. When input and output signals balance each other, the vessel steers on its intended course. The processor sends signals that start or stop electric motors, hydraulic pumps and valves that then activate the vesselôs rudder.

Aside from steering a straight course, the autopilot must also consider the vesselôs primary motions in a seaway such as roll, pitch, yaw, heave, sway and surge. Most of these motions relate to each other while others appear as entirely independent motions that affect the vessel. Any automatic pilot must compensated properly for these movements.

An autopilot may be able to perform a number of different navigational tasks depending upon the capabilities developed by its manufacturer including the capabilityé

- ð To be switched from automatic steering to manual steering.
- ð To accurately steer the selected course over a period of time.
- ð To maintain the selected course and automatically compensate for the effects of wind and current.
- ð To maintain a course to a pre-set waypoint identified by its coordinates in latitude and longitude.
- ð To display the course information on a GPS plotter and display any cross-track error.
- ð To display the rudder angle on a rudder angle indicator (RAI).
- ð To sound an alarm as you approach a waypoint.
- ð To sound alarms for other navigational functions that fall outside the limitations you set into the autopilot.
- ð To switch from one waypoint to the next automatically when you reach the first waypoint.
- ð To dodge an obstacle in the water by taking manual control and then resume your original track by an action as simple as flipping a switch.
- ð To steer your vessel in several selected patterns including a circular pattern, or in a progressing series of circles (ñorbitò) along a course line, or in a ñFigure 8ò pattern if desired.
- ð To program a 180° turn either clockwise or counterclockwise if desired.
- ð To establish a set rate of turn.
- ð To operate from one or more remote control locations on the vessel.

DANGERS OF MISUSING AN AUTOPILOT

In general, the principal disadvantages of using an autopilot are that ité

- ð Allows the helmsman to become too comfortable, complacent, and dependent on its capabilities.
- ð Allows the helmsman to undertake more tasks than he may be able to manage successfully

- ð Requires the watchstander to set priorities for other tasks rather than concentrate on steering the vessel or monitoring its course closely.
- ð While it frees the watchstander to answer the vesselôs communications equipment (including cell phones), this task may distract him from monitoring the course of the vessel or checking the vesselôs progress along its track, or effectively evaluating radar targets.
- ð Allows the helmsman the freedom to work at the chart table which clearly detracts from maintaining an effective lookout.
- ð It allows employers to reduce their manning on some vessels to a dangerous degree and facilitates maintaining only one person on watch in the pilothouse. This led to a number of serious accidents where watchstanders fall asleep, suffer strokes, heart attacks, etc. incapacitating them.

The best known example of an accident where an autopilot may have contributed to the accident was the grounding of the tank ship EXXON VALDEZ in Prince William Sound, Alaska, on March 24, 1989 spilling over ten million gallons of crude oil and motivating Congress to pass the Oil Pollution Act of 1990 (OPA-90). The details of this accident appear in our Pollution Control chapter.

The third mate and the helmsman were on the bridge at the time of the grounding and there was a serious question of whether the autopilot was ñonò or ñoffò in the critical moments before the accident. In any event, the third mate gave an order to change course to the helmsman and then turned his back on the rudder angle indicator to finish plotting his vesselôs position. When the mate turned around and discovered the vessel apparently had not answered her helm about a minute and a half later, he ordered hard right rudder, but it was too late.

There are other examples taken from a report by a company in the offshore oil industry. On June 1, 2002, the M/V OIL TRADER, an offshore supply boat, struck a fixed platform in west Africa causing serious personal injury as well as extensive damage to the vessel and the platform.

The investigation into this accident raised several points. It was apparent that at the time of the allision with the platform, the pilothouse was unmanned and that the vessel's autopilot was in operation. The fully manned vessel with its crew of 13 had been in port the entire night before the accident. The vessel left port at 0500 and the accident occurred about 1200. The weather was good with a 1-meter swell and unlimited visibility. The mate took the helm watch and had an able seaman (AB) in the wheelhouse with him at the change of watch.

The M/V OIL TRADER accident was a terrible tragedy. The master suffered severe injuries which will heal over time but which also had a big impact on his family. The mate apparently felt so badly about his actions that he took his own life. The vessel sustained major damage and was put out of service as was the platform the vessel hit. The accident also reportedly damaged the boat companyôs reputation.

On June 11, 2002, another vessel from the same company grounded while en route to an anchorage. The autopilot was not in use and two ABs were in the wheelhouse with a "training" mate. The master was assigned duties as the officer of the watch, but was in his quarters at the time of the grounding. The master had periodically visited the wheelhouse prior to the grounding but was not on the bridge when the grounding occurred.

In this case, the master failed to prepare a voyage plan and then left the wheelhouse during navigation. In this case, standing a proper watch in conjunction with voyage planning, could have prevented the accident.

While on the surface both accidents might appear to have little in common, there are key issues in both that, if addressed, might have prevented either one or both accidents. These issues are use of the autopilot, proper watchkeeping, and route or voyage planning.

Use of Autopilots. Autopilots are a great benefit to vessel crews, particularly on ocean crossings and other times when the duration of trips is very long. However, as is evident in the M/V OIL TRADER accident as well as others, misuse of the autopilot can lead to serious accidents involving harm to people and property damage. Over the years, the offshore oil industry has seen misuse of the autopilot lead to numerous accidents. In almost every case, the damage is great in both monetary terms and its impact on human life as seen in the M/V OIL TRADER incident.

There were a number of accidents where improper use of the autopilot was the root cause. These include the M/V SEABULK GEORGIA that struck a platform in the Gulf of Mexico resulting in the vessel's wheelhouse being folded back, like the top of a sardine can, and the mate on watch losing both his legs. Although never proven, the autopilot on the vessel was driven by input from a magnetic compass that may have been attracted by the steel on a production platform that the vessel passed too close to.

One company reported the M/V OXENTURM, operating in Nigeria, struck a platform causing extensive damage, and the M/V GULF FLEET 65 struck a glancing blow on a small platform in Nigeria. In each of these cases, problems reportedly revolved around crew training and awareness. This is consistent with the root causes that were identified as improper use of the autopilot and improper watchkeeping procedures.

Since their training program did not effectively address the situation, this company began disconnecting and even removing the autopilots from their vessels.

If you work on a vessel with an autopilot, consider these factors before using this equipment:

- ð Ensure that all watchstanding personnel are fully familiar with the change-over procedures required to switch from automatic pilot to manual steering, from manual to automatic.
- ð Check the procedures required to switch to emergency steering.
- ð Remember that fatigued personnel are likely to make simple errors like forgetting to throw a switch as may have happened in the EXXON VALDEZ accident.
- ð Make the changeover to manual steering in ample time before approaching your destination whether it is in the oilfield, in an anchorage, or entering a harbor to ensure that the manual steering system is fully operational.
- ð Know the maneuverability and sea-keeping qualities of your vessel in the existing wind and sea conditions and re-check the settings on the autopilot controls so they reflect the expected wind, current and sea conditions.

- ð Do not use the automatic pilot in areas of high traffic density or in restricted waters. This was one of the finding in the EXXON VALDEZ accident.
- ð Test the steering system and the ship's whistle before you arrive in or depart from port.
- ð The light conditions and distance of visibility.
- ð Be sure you always know how close you are to charted navigational hazards.

Autopilots and watchkeeping. It is clear that autopilots in and of themselves do not cause accidents. While autopilots are useful devices, relying on them without constantly monitoring their effect on steering the vessel and your progress along your track line can get you into serious trouble. In the case of the EXXON VALDEZ, the third mate should knew the maneuver he was trying to make but failed to monitor whether it was having the desired effect by paying attention to reports his trained lookout was giving him from the bridge wing or monitoring his rudder angle indicator. In addition, the mateøs fatigue was also an issue.

Many companies require that there be at least two people on watch in the wheelhouse at all times while underway. This is a wise policy but not always supported by regulations. In the example of the M/V OIL TRADER, two people were initially on watch to conform to company policy. However, the mate instructed the able seaman on watch with him to go to the aft deck to help prepare cargo to transfer at the next stop. Consequently, the able seaman was on deck, not in the wheelhouse. The mate was left alone to hold his watch and, with the vessel on autopilot, he must have believed that he was safe in leaving the wheelhouse to perform some other task. Considering the resulting allision, he was wrong in this assumption.

Helm watch. The M/V OIL TRADER carried a crew of thirteen**.** The companyøs operations manual stated that where crew size permits, the helm watch must consist of a deck officer as Officer of the Watch (OOW), a deck rating as lookout, and another deck rating as helmsman. For vessels with a crew of seven or less, the function of lookout falls to the helmsman and to the Officer of the Watch. The company stated that a helm watch must always be maintained by at least the Officer of the Watch and one lookout (i.e., two live bodies!). In addition, if one of two watchstanders must leave the wheelhouse for any length of time, the engineroom watch or another member of the crew must take his place to maintain the two-man helm watch.

Clearly, mate violated the company policy in the case of the M/V OIL TRADER. The company stated that any breech of their policy provided grounds for immediate dismissal. In addition, the Coast Guard can act against an American marinerøs license or z-card if an accident results from violating company policy.[1] *[[1] Refer to 46 CFR §5.27, "Misconduct."]*

Voyage planning. Any time a vessel leaves on a voyage, some planning must take place. In some cases, you may prepare a voyage plan for the first trip to a particular destination never review it after successfully completing the trip. However, it is important to review voyage plans before every departure to ensure all factors such as potential traffic, rig or platform locations (in oilfield work), the effects of set and drift, height of tide, and closest points of approach are correctly evaluated. Review your route, cargo and planned stops to ensure that the route does not bring the vessel too close to structures or other hazards to navigation. Be sure you address all other tasks such as securing your cargo and establishing the watches. Don't assume that, because you completed a trip a number of times, that hazards don't exist, or that conditions did not change. By reviewing run schedules and the order of your stops, you can load, configure and secure your cargo to ensure the safest most efficient operation.

The master should consider the areas where he can safely use the autopilot and convey that message in his night orders to the watch officer.

Once you make a voyage plan, monitor its progress underway. Otherwise you may find that even though you steered the proper course, you did not adhere to the route you planned because of the effects of wind, seas and current. This does not mean that you should devote an inordinate amount of time to monitoring the voyage against the plan. However, do not allow yourself to be distracted at the chart table(as in the case of the EXXON VALDEZ) or elsewhere to the detriment of the vessel's safety!

OTHER CONSIDERATIONS

ð Distraction can occur when the Officer of the Watch (OOW) is the only person on watch in the pilothouse and must try to perform all the functions of a lookout, helmsman, pilot, and navigator at the same time ï especially in a close quarters situation. It would be nice if Coast Guard manning requirements addressed that problem realistically.

ð All vessels should have sufficient manning to allow a licensed deck officer and a rating to stand watch without violating work-hour regulations. It would be nice if Coast Guard regulations required it! (Refer to GCMA Report #R-279.)

ð In the M/V SEABULK GEORGIA accident, the lookout was dispatched to make routine checks in the engineroom while the mate remained on watch in the pilothouse. (For further information on this accident refer to GCMA Report #R-299.)

ð All mariners assigned as lookouts must be specifically trained in how to perform all lookout duties. (Refer to GCMA Report #R-294, 45 Musts for Effective Watchkeeping.)

ð International & Inland Rule 5 states: ñEvery vessel shall at all times maintain a proper lookout by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.

VOYAGE PLANNING REGULATIONS FOR TOWING VESSELS

The Coast Guard promulgated formal ñvoyage planningò requirements for towing vessels in 2003 as follows:.

33 CFR §164.80 Tests, Inspections, And Voyage Planning.
(a) The owner, master, or operator of each towing vessel of less than 1,600 GT shall ensure that the following tests and inspections of gear occur before the vessel embarks on a

voyage of more than 24 hours or when each new master or operator assumes command:
(a)(1) Steering-systems. A test of the steering-gear-control system; a test of the main steering gear from the alternative power supply, if installed; a verification of the rudder-angle indicator relative to the actual position of the rudder; and a visual inspection of the steering gear and its linkage.
(a)(2) Navigational equipment. A test of all installed navigational equipment.
(a)(3) Communications. Operation of all internal vessel control communications and vessel-control alarms, if installed.
(a)(4) Lights. Operation of all navigational lights and all searchlights.
(a)(5) Terminal gear. Visual inspection of tackle; of connections of bridle and towing pendant, if applicable; of chafing gear; and of the winch brake, if installed.
(a)(6) Propulsion systems. Visual inspection of the spaces for main propulsion machinery, of machinery, and of devices for monitoring machinery.
(b) The owner, master, or operator of each towing vessel of 1,600 GT or more shall ensure that the following tests of equipment occur at the frequency required by **§164.25** and that the following inspections of gear occur before the vessel embarks on a voyage of more than 24 hours or when each new master or operator assumes command:
(b)(1) Navigational equipment. Tests of onboard equipment as required by **§164.25.**
(b)(2) Terminal gear. Visual inspection of tackle; of connections of bridle and towing pendant, if applicable; of chafing gear; and of the winch brake, if installed.
(c) Towing vessels described in paragraphs (b)(1) through (4) of **§164.01** are exempt from the voyage-planning requirements outlined in this section. If any part of a towing vesselôs intended voyage is seaward of the baseline (i.e., the shoreward boundary) of the territorial sea of the U.S., then the owner, master, or operator of the vessel, employed to tow a barge or barges, must ensure that the voyage with the barge or barges is planned, taking into account all pertinent information before the vessel embarks on the voyage. The master must check the planned route for proximity to hazards before the voyage begins. During a voyage, if a decision is made to deviate substantially from the planned route, then the master or mate must plan the new route before deviating from the planned route. The voyage plan must follow company policy and consider the following (related requirements noted in parentheses):
(c)(1) Applicable information from nautical charts and publications (also see **paragraph (b) of §164.72)**, including Coast Pilot, Coast Guard Light List, and Coast Guard Local Notice to Mariners for the port of departure, all ports of call, and the destination;
(c)(2) Current and forecast weather, including visibility, wind, and sea state for the port of departure, all ports of call, and the destination (also see **paragraphs (a)(7) of §164.78 and (b) of §164.82);**
(c)(3) Data on tides and currents for the port of departure, all ports of call, and the destination, and the river stages and forecast, if appropriate;
(c)(4) Forward and after drafts of the barge or barges and under-keel and vertical clearances (air-gaps) for all bridges, ports, and berthing areas;
(c)(5) Pre-departure checklists;
(c)(6) Calculated speed and estimated time of arrival at proposed waypoints;
(c)(7) Communication contacts at any Vessel Traffic Services, bridges, and facilities, and any port-specific requirements for VHF radio;
(c)(8) Any masterôs or operatorôs standing orders detailing closest points of approach, special conditions, and critical maneuvers; and
(c)(9) Whether the towing vessel has sufficient power to control the tow under all foreseeable circumstances.
[61 FR 35064, July 3, 1996; 68 FR 22604, Apr. 29, 2003]

OTHER REFERENCES CITED IN THIS RULE

33 CFR §164.25 Tests Before Entering Or Getting Underway.
(a) Except as provided in paragraphs (b) and (c) of this section no person may cause a vessel to enter into or get underway on the navigable waters of the United States unless no more than 12 hours before entering or getting underway, the following equipment has been tested:
(a)(1) Primary and secondary steering gear. The test procedure includes a visual inspection of the steering gear and its connecting linkage, and, where applicable, the operation of the following:
(a)(1)(i) Each remote steering gear control system.
(a)(1)(ii) Each steering position located on the navigating bridge.
(a)(1)(iii) The main steering gear from the alternative power supply, if installed.
(a)(1)(iv) Each rudder angle indicator in relation to the actual position of the rudder.
(a)(1)(v) Each remote steering gear control system power failure alarm.
(a)(1)(vi) Each remote steering gear power unit failure alarm.
(a)(1)(vii) The full movement of the rudder to the required capabilities of the steering gear.
(a)(2) All internal vessel control communications and vessel control alarms.
(a)(3) Standby or emergency generator, for as long as necessary to show proper functioning, including steady state temperature and pressure readings.
(a)(4) Storage batteries for emergency lighting and power systems in vessel control and propulsion machinery spaces.
(a)(5) Main propulsion machinery, ahead and astern.
(b) Vessels navigating on the Great Lakes and their connecting and tributary waters, having once completed the test requirements of this subpart, are considered to remain in compliance until arriving at the next port of call on the Great Lakes.
(c) Vessels entering the Great Lakes from the St. Lawrence Seaway are considered to be in compliance with this sub-part if the required tests are conducted preparatory to or during the passage of the St. Lawrence Seaway or within one hour of passing Wolfe Island.
(d) No vessel may enter, or be operated on the navigable waters of the United States unless the emergency steering drill described below has been conducted within 48 hours prior to entry and logged in the vessel logbook, unless the drill is conducted and logged on a regular basis at least once every

three months. This drill must include at a minimum the following:
(d)(1) Operation of the main steering gear from within the steering gear compartment.
(d)(2) Operation of the means of communications between the navigating bridge and the steering compartment.
(d)(3) Operation of the alternative power supply for the steering gear if the vessel is so equipped.
(92 Stat. 1471 (33 U.S.C. 1221 et seq.); 49 CFR 1.46(n)(4))

[CGD 77-183, 45 FR 18925, Mar. 24, 1980, as amended by CGD 83-004, 49 FR 43466, Oct. 29, 1984]

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33 CFR 164.01 Applicability
(b) Sections 164.70 through 164.82 of this part apply to each towing vessel of 12 meters (39.4 feet) or more in length operating in the navigable waters of the United States other than the St. Lawrence Seaway; except that a towing vessel is **exempt** from the requirements of §164.72 if it is--
(b)(1) Used solely within a limited geographic area, such as a fleeting-area for barges or a commercial facility, and used solely for restricted service, such as making up or breaking up larger tows;
(b)(2) Used solely for assistance towing as defined by 46 CFR 10.103;
(b)(3) Used solely for pollution response; or
(b)(4) Any other vessel exempted by the Captain of the Port (COTP). The COTP, upon written request, may, in writing, exempt a vessel from §164.72 for a specified route if he or she decides that exempting it would not allow its unsafe navigation under anticipated conditions.
[CGD 83-004, 49 FR 43466, Oct. 29, 1984; 61 FR 35064, July 3, 1996; 66 FR 21862, May 2, 2001; 68 FR 39353, July 1, 2003]

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33 CFR §164.72 Navigational-Safety Equipment, Charts Or Maps, And Publications Required On Towing Vessels.
(b) Each towing vessel must carry on board and maintain the following:
(b)(1) Charts or maps. Marine charts or maps of the areas to be transited, published by the National Ocean Service (NOS), the ACOE, or a river authority that satisfy the following requirements:
(b)(1)(i) The charts or maps must be of a large enough scale and have enough detail to make safe navigation of the areas possible.
(b)(1)(ii) The charts or maps must be either--
(b)(1)(ii)(A) Current editions or currently corrected editions, if the vessel engages in towing exclusively on navigable waters of the U.S., including Western Rivers; or
(b)(1)(ii)(B) Currently corrected editions, if the vessel engages in towing seaward of navigable waters of the U.S. or more than three nautical miles from shore on the Great Lakes.
(b)(1)(iii) The charts or maps may be, instead of charts or maps required by paragraphs (b)(1)(i) and (ii) of this section, currently corrected marine charts or maps, or applicable extracts, published by a foreign government. These charts or maps, or applicable extracts, must contain information similar to that on the charts or maps required by paragraphs (b)(1)(i) and (ii) of this section, be of large enough scale, and have enough detail to make safe navigation of the areas possible, and must be currently corrected.
(b)(2) General publications. A currently corrected edition of, or an applicable currently corrected extract from, each of the following publications for the area to be transited:
(b)(2)(i) If the vessel is engaged in towing exclusively on Western Rivers--
(b)(2)(i)(A) U.S. Coast Guard Light List;

(b)(2)(i)(B) Applicable Notices to Navigation published by the ACOE, or Local Notices to Mariners (LNMs) published by the Coast Guard, for the area to be transited, when available; and
(b)(2)(i)(C) River-current tables published by the ACOE or a river authority, if available.
(b)(2)(ii) If the vessel is engaged other than in towing exclusively on Western Rivers--
(b)(2)(ii)(A) Coast Guard Light List;
(b)(2)(ii)(B) Notices to Mariners published by the National Imagery and Mapping Agency, or LNMs published by the Coast Guard;
(b)(2)(ii)(C) Tidal-current tables published private entities using data provided by the NOS, or river-current tables published by the ACOE or a river authority:
(b)(2)(ii)(D) Tide tables published private entities using data provided by the NOS; and
(b)(2)(ii)(E) U.S. Coast Pilot.
[61 FR 35064, July 3, 1996; 62 FR 40270, July 28, 1997; 64 FR 34710, June 29, 1999; 66 FR 33637, June 25, 2001]

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33 CFR §164.78 Navigation Under Way: Towing Vessels.
(a)(7) Proceeds at a safe speed taking into account the weather, visibility, density of traffic, draft of tow, possibility of wake damage, speed and direction of the current, and local speed-limits;é
[61 FR 35064, July 3, 1996; 68 FR 22604, Apr. 29, 2003]

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33 CFR §164.82 Maintenance, Failure, And Reporting.
(b) Failure. If any of the navigational-safety equipment required by §164.72 fails during a voyage, the owner, master, or operator of the towing vessel shall exercise due diligence to repair it at the earliest practicable time. He or she shall enter its failure in the log or other record carried on board. The failure of equipment, in itself, does not constitute a violation of this rule; nor does it constitute unseaworthiness; nor does it obligate an owner, master, or operator to moor or anchor the vessel. However, the owner, master, or operator shall consider the state of the equipment-along with such factors as weather, visibility, traffic, and the dictates of good seamanship-in deciding whether it is safe for the vessel to proceed.
[61 FR 35064, July 3, 1996]