Dangers of power operated watertight doors

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Watertight door of ro-ro/passenger ferry
Watertight, power operated door of ro-ro/passenger ferry (1988 built, 400 pax)
Watertight door on board a new cruise vessel mounted in corridor of crew cabins

- Door has an opening of 2m height and 900mm width, positioned one to two decks below the bulkhead deck of a cruise ship
- “Flush-type”, meaning there is no recess at bottom and thus no obstruction for the users
- Lower handle is for normal operation, the upper handle for emergency manual opening

Photo by IMS, Norway
Watertight door in Engine Room
Watertight door on board a cruise vessel
Working areas for crew (galley, laundry etc)

• Flush-type with a 12 mm sill, so there is no recess in the deck for the passing of the door and thus no need for an obstructing, hinged cover plate. A modern door with an opening of 2m X 1.2m

• Number of stiffeners indicate this is a door in the lower part of the vessel, two decks below the bulkhead deck

Photo by IMS, Norway
Vessels having power operated watertight doors

- Cruise ships have a large number of watertight doors

- A large number of doors may also be found in ro-ro passenger vessels, ferries, large supply ships, special purpose ships, crane ships, oil exploration vessels etc.

- Some container vessels may have doors in fore and aft passage ways under deck. Modern, large container vessels may have at least one watertight door, in the aft bulkhead of the engine room, leading to tunnel/space for long propeller shaft, e.g. “Emma Maersk”

- Offshore installations may have a large number of watertight doors. One huge unit for removing old oil rigs, etc is under construction with 100 watertight doors
Many watertight doors in cruise vessels

• For many years 20-30-40 doors in large cruise vessels have been common, doors within engine rooms, in service areas and in crew quarters below the waterline. Some ships may also have doors in passenger areas

• Building larger vessels has led to the number of doors growing. While spaces on higher decks are used for “shopping malls”, casinos, auditoriums, staterooms, restaurants, etc., lower decks are used for service facilities like food storage and handling, garbage handling, sewer treatment plants, laundries etc., as well as for crew cabins. These areas below the waterline, below the bulkhead deck, are subdivided by bulkheads fitted with watertight doors

• The 2012 record number of doors on board a cruise vessel: 74
Types of power operated watertight doors

- Doors may be hydraulically or electrically operated
- For tightness they may use a rubber O-ring type of packing or a wider rubber lip type
- Doors may be wedged into the door frame steel to steel or steel to metal

- Hydraulically operated doors are usually closing with 2 tons power, or even more, depending on size and location (distance below waterline)
- Electrically operated doors may close with less power, for instance 1 ton
- Apparently there are no regulations concerning the power used to close watertight doors
Safety of the ship – a priority

• A vessel is subdivided by watertight bulkheads to survive an ingress of water, following a grounding or collision. The more watertight bulkheads there are, the safer is the ship against capsizing and sinking if the underwater hull is punctured.

• A high number of bulkheads may however limit the commercial use of spaces on board and make it cumbersome for the crew to move around between the subdivided spaces. So, watertight doors are fitted in subdivision bulkheads, bulkheads which should be watertight.

• Doors can be closed from the bridge for the purpose of saving the ship, and can also be opened and closed locally, allowing personnel to pass through during their work, as well as to escape in an emergency.

• Saving the ship has priority, so the bridge can take control of all doors to close them.
Watertight doors may represent a danger to personnel and to the ship

- Power operated watertight doors in ships represent a risk to personnel passing through and they may reduce a ship’s survival capability in case of water ingress.

- People have been trapped, maimed and killed in such doors.

- In cases when doors have been left open or been leaking, they have contributed to the capsizing and sinking of ships.

- Watertight doors are not a new invention, SS “Titanic” had watertight doors, closing vertically. In that century old, world’s best known disaster at sea, the doors were not the main problem, but a man was trapped in a door when it closed.
IMO regulations
SOLAS: Subdivision and stability

• SOLAS Ch II-1, Part B deals with “Subdivision and stability”. Regulation 4.3 provides the general requirement that “Ships shall be as efficiently subdivided as is possible having regard to the nature of the service for which they are intended”

• The latest SOLAS regulations on subdivision and damage stability are now based on a probabilistic concept, not that easy to understand, but let us just say that the longer the vessel, and the more passengers are carried, the higher is the degree of subdivision required

• There are also requirements for a vessel’s stability after damage and flooding, in regulation 27 of the Load Line Convention
Passenger ships: Number of openings in watertight bulkheads to be at a minimum

- Regulation 13.1 of Part B-2 deals with Openings in watertight bulkheads below the bulkhead deck in passenger ships: **“The number of openings in watertight bulkheads shall be reduced to the minimum compatible with the design and proper working of the ship”**

- Reduced to a minimum? How is this requirement observed by ship designers and of those authorities approving the designs, when a vessel ends up with such high numbers of doors as 30-40-74?

- In transverse bulkheads dividing cargo spaces no doors are in principle allowed, but may still be fitted if “the Administration is satisfied that such doors are essential” (Reg. 13.3 and 13.9.1)
Cargo ships: Number of openings in watertight bulkheads to be at a minimum

- Regulation 13-1.1 deals with openings in bulkheads in cargo ships, and again starts with a firm statement: "The number of openings in watertight subdivisions is to be kept to a minimum compatible with the design and proper working of the ship."

- From the above we draw the conclusion that the regulators initially wanted to have as few watertight doors as possible in subdivision bulkheads, regarding them as a certain risk.

- It appears to be relatively easy, dependant on the policy of the flag State, to obtain a relaxation. The high number of watertight doors on board certain ship types points to that.
Operation of doors
SOLAS regulations are not consistent

• For Passenger and Cargo Ships, watertight doors below the bulkhead deck are to be capable of being closed from the bridge and opened and closed from the location of the door.

• For Passenger ships SOLAS Reg 13.1.8.3 specifies that “it shall not be possible to remotely open any door from the central operating console”. There is no such clear requirement for Cargo Ships.

• For Passenger Ships SOLAS has detailed requirements for local control handles and how they are to be arranged and working. There are no such details for watertight doors of Cargo Ships.
Control of position of watertight doors
SOLAS regulations are not consistent

- The central operating console for watertight doors, both in cargo ships and passenger ships, is located on the bridge. This console is provided with a diagram showing the location of each door, with indicators to show whether each door is open or closed.

- In Passenger Ships there must be a “Master switch” for “Local control” and “Doors closed”, but that is not defined for Cargo Ships.

- A red light indicates that the door is open, and a green light that it is closed. This is defined for Passenger Ships, but not for Cargo Ships.

- Older systems have unfortunately no definitions for red and green functions, and may have push buttons instead of a Master switch.
Modern control panel on bridge with Master switch for “Local control” and Doors closed”

Note the wording on the panel:

“The “Doors closed” mode shall only be used in an emergency or for testing purposes
Ref: SOLAS Ch. II-1 Reg. 13.8.1”
Master mode switch on bridge
Switch is accessible to anyone - not protected

- The switch has two modes:
  - The “Local control” will allow any door to be locally opened and closed after use by the person passing the doorway. In “Local control”, the door will stop moving when the local lever is released.
  - The “Doors closed” mode will close all doors being in open position, and also doors in the process of being opened if the local lever is released. A person passing a door in “Doors closed” mode is risking his life if shortcutting the opening procedure.
Bridge panel of ro-ro pax ferry (1981 built) (New SOLAS reg applicable 1 February 1992)

- No standard for red and green indicators
- The push buttons for closing and opening doors are all green
- Two doors are red, open(?) at sea
- No light for door 14
- No master switch for bridge/local control
- Doors can be opened from bridge
Container vessel MSC Bremen, built 2007
5,000 TEU, Liberian flag, 4 watertight doors

Panel on bridge:

- No master switch (not required for cargo ships)
- No remote closing of door (required by SOLAS Reg 13.1.2)
- Switch on bridge can be placed in “Port” and “Voyage” functions
- “Voyage” function is only used when machinery automation is placed in Wheel House mode. “Voyage” function will not close the doors but sounds alarm on bridge if door is opened locally. Closing of door is only locally
Control panel and door switches on bridge for WT doors deck 1 and 2

Passenger/car ferry, built 1987 - this and the next 4 slides.
Watertight door no 11 in Passenger cabin area - Deck 2
Door 11 is an emergency exit and is to be kept closed at sea(!)

- Instruction states: “The door is to be closed and all closing devices locked before leaving dockside”

- The key to the locker containing the operating lever is kept on the bridge
Inside the locker (key kept on the bridge)
Need key on Bridge for emergency opening of watertight door
Most accidents happen when doors are under bridge control

- Whenever a door is closed remotely by power, there is to be an audible, distinct alarm at the door, sounding for at least 5 seconds, but no more than 10, before the door begins to move and until the door is completely closed. With the ship in upright position, all doors should be able to be closed from the bridge in no more than 60 seconds.

- It shall not be possible to open the doors from the bridge, but the “Doors closed” mode will still allow a door to be opened locally, for the safety of an escaping person. But the door will then automatically start to close upon release of the local control lever.

- Most accidents happen with the doors in bridge control (“Doors closed”). People trapped by the doors tend to have passed through the doors before they are fully open.
Old habits difficult to change

• In earlier days there may have been an understanding among deck officers that the bridge always should have overall control of the watertight doors. The doors were closed from the bridge, for instance at night time, in congested waterways, near land etc.

• SOLAS regulations for passenger vessels built after 1st Feb. 1992 do not allow such use of the “Master mode switch”, unless there is an emergency

• Regulation 13.7.8 states: “The “master mode” switch shall normally be in the “local control” mode. The “doors closed” mode shall only be used in an emergency or for testing purposes. Special consideration shall be given to the reliability of the “master mode” switch”
Local operation of doors
SOLAS Requirements for Passenger Ships

• As for local control, each watertight door is to be able to be opened and closed by power from both sides of the door. Time for opening or closing should in no case be less than 20 seconds and not more than 40 seconds

• Control handles are to be provided at a minimum height of 1.6m above the floor and shall be so arranged as to enable persons passing through the doorway to hold both handles in the open position and without being able to set the power closing mechanism in operation accidentally

• The direction of movement of the handles for opening and closing the doors shall be in the direction of the door movement and shall be clearly indicated
Manual opening of doors in an emergency  
SOLAS requirements for Passenger Ships

• Doors are to have sufficient power for 3 door movements, closed-open-closed, in case of black-out

• Each door is also to be provided with an individual hand-operated mechanism, so the door can be opened and closed by hand at the door itself, from either side. The time necessary for the complete closure of the door by hand gear is not to exceed 90 seconds with the ship in upright position

• In addition, watertight doors in bulkheads of passenger ships are to be able to close by a hand-operated mechanism from an accessible position above the bulkhead deck. That location is also to have means of indication showing doors open or closed
Instructions for local and remote control, and for emergency operation - new ship
Doors to be kept closed at sea

Part B-4, Reg. 22 “Prevention and control of water ingress, etc.”, requires all watertight doors to be kept closed at sea, with the following exceptions:

• To permit the passage of passengers and crew, or when work in the immediate vicinity of the door necessitates it being opened. The door must be immediately closed when the transit through the door or when the work is completed.

• Flag Administrations may also permit certain doors to remain open during navigation if considered absolutely necessary, determined essential to the safe and efficient operation of the ship’s machinery or to permit passengers normally unrestricted access throughout the passenger area, but “only after careful consideration of the impact on ship operations and survivability”. Such doors allowed to be open shall be clearly indicated in the ship’s stability information(!) and shall always be ready to be immediately closed.
IMO Guidance for watertight doors allowed to be open in passenger ships

- IMO has in reference to SOLAS Ch II-1, Reg 22.4 issued MSC.1/Circ.1380 “Guidance for watertight doors on passenger ships which may be opened during navigation”

- The Guidelines start with a statement worth repeating: “Watertight subdivision is vital to ship stability and survivability to protect life, property and the marine environment in cases of hull damage after collision or grounding. The number of openings in watertight bulkheads on passenger ships is to be kept to a minimum in accordance with SOLAS regulation II-1/13.1”

- Furthermore, concerning the importance that watertight doors are in closed position if a structural damage should occur to the ship: Failure to recognize the importance of watertight doors can have great impact on the watertight integrity of the ship and have catastrophic consequences
Doors to be kept closed are sometimes manipulated to be permanently open

- 4 consecutive electric watertight doors in a crew corridor are left permanently open. By manipulating 2 magnet switches in the coaming, doors appear as closed, and alarms by bell and flashing light will not function.

Witnessed during an inspection of a cruise ship August 2012.

The doors in the crew cabin area are required to remain closed at all times. The crew ignore this by activating the locking mechanism so the bell is turned off. The Chief Engineer said he can not stop this practice as the crew have a bad Philosophy regarding the WTDs. How right he is!!!!

- On the Bridge, the control panel will show doors in closed position!
Doors in bulkheads of cargo spaces

- Watertight doors in watertight bulkheads dividing cargo spaces, if considered essential to be fitted by the Flag Administration (Reg. 13.1.4 for cargo ships and reg. 13.9.1 for passenger ships), shall be closed before the voyage commences and shall be kept closed during navigation.

- Such doors are not to be remotely controlled and are to be fitted with a device which prevents unauthorized opening.

- The time of opening such doors in port and of closing them before the ship leaves port shall be entered in the log book (Reg. 22.6 and 24.3).
Watertight doors and fire protection

• SOLAS Chapter II-2 Part C deals with suppression of fire and regulation 9 with how to contain a fire in a space of origin and how a vessel is to be divided by thermal and structural boundaries. Watertight doors to be fitted below the bulkhead deck need not to be tested to the Fire Test Procedures Code (Ref: IMO FP 46/5). The doors are therefore steel doors without insulation.

• In our opinion watertight doors in watertight steel bulkheads represent a certain weakness in case of fire, not just because they are not insulated, but because if the door is not closed, smoke, poisonous gas and fire could go through the door to other spaces of the ship. We have experienced cases of ships having a fire in the engine room and the crew being forced to leave the engine room by a watertight door, without closing the door behind them.
Doors only A-0, regardless of bulkhead insulation

- Should a higher fire class than A-0 be required of a bulkhead below the bulkhead deck, like A-15, A-30 or A-60, there is still no requirement for the watertight door to be insulated. A separate fire door could be fitted in sequence with the watertight door to achieve a desired fire class, but that does not seem to be required.

- Watertight doors of older designs meet steel to steel, and may not be absolutely watertight. Modern doors today close by a compression of a rubber seal, but there is no precise requirement for the rubber seal to withstand a fire.

- Having fire and a water ingress to the engine room at the same time, may not have been considered by the regulators.
Vessel sank with open watertight doors

• In 1982 the ro-ro passenger ferry EUROPEAN GATEWAY collided with a vessel at the entrance to the port of Harwich. The hull of EUROPEAN GATEWAY was badly breached and the ship capsized and sank in shallow water with the loss of 6 lives
• In the investigation that followed it was revealed that a number of watertight doors giving access between machinery spaces were open at the time of collision
• The doors complied with the regulations of that time, but could only be closed by manual means. Attempts had been made to close 2 of the doors, but in vain
• Following the sinking of EUROPEAN GATEWAY and the capsizing and sinking of HERALD OF FREE ENTERPRISE in 1987, UK approached IMO for new regulations (in force from 01.02.1992)
Were watertight doors closed on ESTONIA?

- In 1994 the ro-ro passenger ferry ESTONIA sank in the Baltics with the loss of 852 lives. In addition to the official report, there have been other opinions expressed concerning the sequence of events that led to the sinking. At a Lloyd’s List Event Conference in London in 2003, Anders Bjørkman of Heiwa Co informed that the vessel had 22 doors in 12 watertight bulkheads, and that those doors could be opened from the bridge. The vessel had 10 watertight doors on the tanktop level of the ship.

- Bjørkman was of the opinion that the vessel must have had a severe leakage of the hull below the waterline and that water must have spread to several compartments through open watertight doors.

- Bjørkman criticized the investigating commission for not establishing if doors were closed or not.
ESTONIA’s watertight doors: The conclusion of the confusion

- The status of watertight doors should of course always be questioned in any case involving a vessel sinking.

- The document “Research study on the Sinking Sequence of MV ESTONIA”, issued in 2008 by Safety at Sea Ltd, concluded that it was unclear if the watertight doors (all or some) were closed, but did not see the closure of the doors to be detrimental to the loss.
Bridge panel of ESTONIA: Confusion of red and green lights

• There may have been confusion about the colour of indicating lights on the bridge panel for doors open or closed doors

• It was international practice to use green lights for closed doors and red lights for open doors, but it has been alleged that it was the opposite on board ESTONIA

• Watertight doors on board ESTONIA could be opened from the bridge (which is no longer allowed for passenger ships built after 1992), and it is possible that closed doors may have been opened by mistake, due to the confusion of the meaning of red and green indicators. New regulations no longer allow doors to be opened from the bridge of passenger ships
QUEEN OF THE NORTH (ex Stena Danica)
Sailed with open doors, sank after grounding

- Passenger and car ferry, Canadian flag, 125 m long, built 1969
- Two compartment ship, 11 transverse bulkheads with 11 sliding doors
- On board: 59 passengers (of max 650) and 42 crew members
- Struck Gil Island 22.03.2006, extensive damage to hull, initial water ingress to at least 3 main compartments, lost propulsion, sank in 430 m water
- 2 persons not accounted for, declared dead
- At the time of accident several watertight doors were open
  - Watertight door between main engine room and auxiliary engine room was closed manually, after ingress of water
  - Watertight door between engine room and workshop obstructed by debris, not closed
EXPRESS SAMINA: Open doors, 82 deaths

• In 2000 the Greek ro-ro passenger ferry EXPRESS SAMINA with 534 people on board hit rocks and sank in 45 minutes. The vessel was 34 years old and more than one thing went wrong

• The rocks tore a 6m long, 1m wide hole in the hull, but well above the waterline. After impact, the rocks also bent the starboard stabilizer fin backwards, resulting in another hole, this time below the water line and next to the engine room

• The water ingress caused the electrical supply to stop. The ship had 11 watertight doors in subdivision bulkheads, 9 of which were open and could not close due to lack of power. An expert opinion at the time was that the vessel sank as a result of the doors being open. 82 people died, in what is considered to be the worst ever Greek ferry disaster
SEA DIAMOND
Were doors closed? If so, at what time?

• In 2007 the cruise vessel SEA DIAMOND ran aground on a volcanic reef near the Greek island Santorini, with 1,195 passengers on board. Water entered the vessel which took on a list of 12° before watertight doors were reportedly closed

• Following massive ingress of water, the vessel sank. A father and daughter did not survive and were never found

• It has later been disputed whether the watertight doors were closed, and if they were, at what time they were closed
PRIDE OF TELEMARK
Norwegian roro/pax, built 1980

• Contact damage with pier foundation, Hirtshals 11.09.07
• Hull penetrated, black out. All passengers and crew successfully evacuated. Vessel pumped out
• 15 doors on the two lowermost decks
• Tightness by steel to steel:
  – Door no 9 leaking with 3.5m water pressure
  – Door no 7 not fully closed
  – Door no 2 open as handle did not return to neutral, so door could not be closed from control centre
Gard vessel almost lost, due to watertight door leaking (one compartment ship)

In 2011 Gard experienced a passenger vessel taking in water in 1 of the 2 cargo holds, following a fire and subsequent grounding at quay. There were 2 door issues:

1. The vessel was punctured at the location of the extracted stabilizer fin and took a dramatic listing of 21-22°, unexplained until it was discovered that the water leaked to the other cargo hold through a closed, but leaking watertight door in a watertight bulkhead between the vessel’s cargo holds. The vessel was very close to capsizing.

2. Engine room staff escaped from the fire in the E.R. through a watertight door in the fore engine room bulkhead. As door was not closed, the smoke from the fire went through the door and into the ship.
Doors are dangerous to people
Deaths and injuries due to crushing

Deaths:
• 1981 Canadian vessel
• 1990 Canadian vessel
• 1998 Ro-Ro pax P&OSL Kent
• 1999 FSO Nordic Apollo
• 2001 Mobile Offshore Drilling Unit
• 2002 Passenger vessel (DNV rep.)
• 2005 Offshore installation Kristin
• 2006 Container vessel (Britannia)
• 2008 Ro-ro cargo Ark Forwarder
• 2009 Pax vessel Oceanic Discoverer

Injuries:
• 20 cases found of serious injuries, resulting in amputations, crushed lungs, head injuries
• Cases were found by searching the internet in English
• VIDEOTEL issued crew training video, claiming at least 1 person is killed by power-operated watertight doors every year
A well meaning “Safety Strip” invention
Need for regulations

- The oil rig “Fortuna Ugland” had 2 power operated watertight doors, controlled from the bridge. During pre-delivery tests at the Gøtaverken yard in 1983, a worker was seriously injured when a door closed on him.
- When the rig started operating, a monthly test of the doors were initiated. For safety, a watchman in radio contact with bridge was placed on each door. Good!
- A protection of the master switch on bridge was installed. Good!
- A “safety device” was invented and installed on the door, to open the door if anything came in between. The device was a thin, springy plate, covering a by-pass valve, reducing the oil pressure when pressed.
- The device made the door very safe for people on board, but less safe for the rig in case of water ingress. Not so good!
Anti-crushing device - a possible solution

- Following an accident on board the offshore installation “Kristin” in Norway in 2005, the manufacturer of the door developed an anti-crush protection called the “IMS safety strip”, using laser beam sensors. This device was then fitted to the doors of the “Kristin” as well as on board other Statoil-operated rigs in the North Sea, reducing the risk of injury to personnel.

- Doors will open if there is an obstruction within the door frame, they will close and open repeatedly, even if in bridge control. The Bridge has the possibility to switch off the anti-crush safety protection.

- Such a device may already have been fitted on board certain ships, but should be evaluated and regulated by IMO.
Anti-crushing device - laser emitter/receiver

- Will be demonstrated by IMS
- Improves the safety of people
- Is it acceptable in view of the safety of the ship?
• The presenter has written 4 articles on the subject of dangerous watertight doors in Gard News No 207, with more details of cases where people have been killed or injured by power operated watertight doors and of the ship disasters where open doors have been a contributing factor to the loss or the near loss of the ship.

• Please refer to:

• http://www.gard.no/Webzine/GardNews/GN207/index.html#/1/

Thank you for your attention!

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