Cruise Ship Fire Safety Design and Recent Casualties

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SOLAS Fire safety objectives and functional requirements

- Division of the ship by thermal and structural boundaries
- Detection and containment of fire in the zone of origin
- Restricted use of combustible material
- Protection of the means of escape
- Crew training for fire emergencies

Division of the ship by thermal and structural boundaries

- A-class boundaries - 1 hour of protection
- B-class – 30 minutes of protection
- High hazard areas (machinery spaces, galleys, storerooms) separated from passenger areas by A-class boundaries
- Passenger cabins separated by B-class boundaries
- Ventilation systems control spread of fire and smoke

Recent regulatory changes affecting fire barriers

Fire Test Procedures (FTP) Code revised in 2010 based on improved testing methods :

- Fire testing procedures in harmony with ISO test standards
- Ensures uniform application of the SOLAS requirements among different Administrations
- Periodic retesting required

Performance based fire protection option

Regulation II-2/17 permits alternate design and arrangements -

- Allows novel and unique features not considered by the prescriptive regulations
- Performance based analysis used to demonstrate equivalent safety
- Recent examples
  - Larger main vertical zones
  - Open main vertical zones with sliding fire doors
  - Mono-space elevators
  - FRP contruction?

Detection and Containment of fire in the zone of origin

- Fire detection in all accommodation, service, and control areas
- Fire main and hydrants throughout ship
- Automatic sprinklers or water mist in all accommodation, service, and control areas, including corridors and stairways
- Fixed gas systems in machinery spaces

Star Princess fire success

Water mist operated

Water mist failed

Recent CO_2 system issues
Carnival Splendor

Remote operator failure

Internal corrosion

Recent CO2 system issues
Inadequate maintenance

July 2013 guidance to USCG PSCOs in response to CO2 issues

- Evaluate ship's maintenance plan and inspection records
- Verify crew understands normal and emergency system operation
- Verify accuracy of system instructions
- Examine CO2 control piping for tightness
- Confirm valve operating mechanisms are functional including manual override

(Combustible) FRP construction?

- Proposed by some Scandinavian/N. European countries using SOLAS Reg. II-2/17

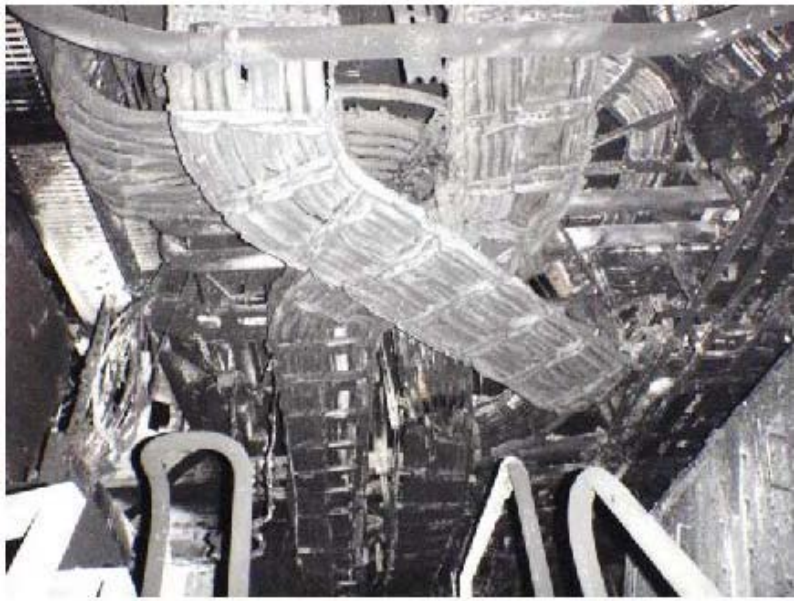
- US has opposed, as misapplication of the regulation
  - Cautious approach recently gaining traction

Fire protection for systems essential for safe return to port

- No fire performance criteria for cables on ships built before safe return to port regulations
- New regulation II-2/21 requires redundancy of systems needed for safe return to port
- Redundant cables must be a separate fire area, or within A-60 trunk or meet IEC standards 60331-1 and 2 for fire resistance

Single point failure of cables

Recent casualties – main and emergency power cables routed through same area



US NRC cable damageability studies

- Performed by Sandia National laboratory
- Evaluated performance of coated cables exposed to diesel fuel fires
- Electrical shorting occurred in as little as 3 minutes
- Intumescent coatings determined not equivalent to A-60 protection

Protection of means of escape

- Fire-protected route from point of origin to survival craft embarkation station
  - Passenger notification
  - Corridors and stairways are fire rated
  - Passengers first travel to assembly areas
  - Crew takes small groups to assigned embarkation station
  - Passengers board survival craft

Evacuation analysis

- Consists of four elements, from the time an emergency is identified and alarm sounded:
  - *Awareness time (A)*
  - *Travel time (T)*
  - *Embarkation time (E)*
  - *Launching time (L)*

Evacuation performance standard

- *Calculated total evacuation time: 1.25 (A + T) + 2/3 (E + L) ≤ n , where*
- *E+ L ≤ 30 min*

- Awareness time for daytime is 5 minutes. Nighttime is 10 minutes
- For large cruise ships, n = 80 minutes

Crew training for fire emergencies

- SOLAS regulation II-2/15 requires onboard-
  - Crew training manual
  - Fire control plans
  - Weekly fire drills emphasizing need to direct passenger travel to assembly stations

Questions?