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 construction?
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 CO2 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: $1.25 (A + T) + \frac{2}{3} (E + L) \leq n$, where
- $E + L \leq 30$ 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?