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1. **What can be done to improve the fire detection in a container cargo under deck?**

   Fire detection in cargo holds currently works on the same principles as when smoke aspiration systems were first designed around 1918.

   The principle issue is the lag time:

   a. Smoke production in container

   b. Smoke escaping from container

   c. Smoke being carried into extraction system, and

   d. Smoke travelling through pipe system to detection

   The spread of smoke and detection may also be affected by ambient temperatures and natural air flows in the hold. In the early stages of a fire the smoke is typically cooler and less buoyant, this and natural air flows may further delay transport of smoke to extraction system.

   The longer the delay in detection and alarm, the longer to deploy CO2, the less likely it is to be effective.

   - Any system must be capable of detecting trace amounts of smoke and gases from incipient fires and raise the alarm from within the hold of origin.
   - The detection system and the alarm system must be closer in proximity, reducing the lag time from detection to alarm
   - Consideration of network of distributed sensors
   - Thermal imaging cameras
   - CO detection – useful in smouldering fires
   - VESDA systems – series of smoke sampling pipes at high level, perhaps under hatch cover, designed for very early detection of smoke. Operation may also be influenced by some factors outlined above, maintenance and keeping sampling holes clean may be an issue.
   - Video detection

2. **What can be done to improve the fire detection in a container cargo on deck?**

   - Must be capable of detecting trace amounts of smoke and gases from incipient fires
   - Network of distributed sensors/zones/addressable system
   - Heat tracing
   - Thermal imaging cameras
   - CO Detection – useful for smouldering fires
   - Video smoke detection

3. **What can be done to enable a more precise and quick fire localisation?**

   a. Network of distributed sensors

   b. Zones

   c. Addressable detection

d. Thermal imaging

e. Linking of detection to ventilation systems for automatic operation, closing/stopping when fire detected. System could be linked to voice messaging alerting crew to fire and location

4. What can be done to compensate the deficiencies of CO_2 with regard to smothering a fire in a container stow under deck?

The assumption is that CO2 is ineffective, largely due to the very serious casualties that occur such as, Flaminia, Honam etc. There are many casualties where CO2 is successful and we hear little about why, influencing factors could be:

- Speed of detection
- Speed of alarm
- Speed of muster
- Speed of deployment fire teams
- Speed that vents are closed
- Location of fire
- Speed of C02 release
- Adherence to CO2 release instructions and frequency of top ups
- Crew training
- Competence of crew
- Command training
- Competence of Command team
- Adequacy and detail of emergency response plans

Understanding why some responses are successful and some are not, may inform future plans.

From a firefighting perspective CO2 is an effective extinguishing medium, could be augmented from exhaust gas ventilation

In 1994 Class NK undertook some tests regarding the control of fire in engine rooms using CO2. The test results indicated that the faster the release of CO2 into the space, the greater the chance of success. Whilst I am not aware of any similar studies looking at hold fires, it seems reasonable to assume this same principle will apply. Therefore any changes must be geared towards faster detection and response

5. What can be done to improve the confinement of a fire in containers under deck to the particular cargo hold?

- Early detection and response are key to minimising fire size.
- The use of water spray/drenching to provide water curtains and protect water tight or intermediate bulkheads . Associated risk of capsize to be considered and ability of bilge system to manage excess water and dispose/recycle
- Structural insulation enhanced.

- Very early detection of fire could provide opportunity for fire teams to enter hold. Availability of firefighting equipment in hold would reduce arduous nature of hold, confined space entry, with fire hose. However, there is no certainty that box of origin will be accessible, and that crew are not being exposed to greater risk with limited escape route and potentially unknown cargo.

6. **What can be done to improve the confinement of a fire in containers on deck to the particular bay or section thereof?**

- Early detection and response (2/3 above)
- Use of water sprays, drenchers at intermediate positions could provide water curtains from, typically tier 3, down. Upper tiers would require water monitors at frequent intervals to keep fire size to minimum area.
- Remote operated water monitors

7. **What can be done to improve active firefighting on deck bearing in mind reduced crew and local conditions?**

- Remote operated water monitors-current portable provision too heavy and cumbersome
- Increased no. of fire lockers along length of ship to improve accessibility and reduce travel times to scene of operations
- Improved fire training day/night
- Consideration needs to be given to adequacy of equipment provision, ppe, duration of Breathing apparatus sets, spare cylinders, replenishment of air
- Increase provision of hose and modernise firefighting branches/nozzles, combined straight stream and spray
- Provision of thermal imaging cameras for firefighting teams
- Consider no. and positioning of fire hydrants
- Consider fire hydrants on lashing bridges – riser systems fed by hose or fixed pipework

8. **What can be done to protect vital ship structures under deck and on deck from excessive heat?**

- Drencher systems to protect external exposures
- Increased structural fire protection accommodation block/navigation bridge
- Blast protection – accomodation block/navigation bridge – create place of safety
- Placement of remote monitors on top of accomodation block

9. **What can be done to improve the protection of deck house and life-saving appliances?**

- Water spray/mist to protect fire lockers/Lifeboats
- Drencher systems

- Protection of windows
- Positive pressure in accomodation and passageways to prevent ingress of smoke
- Automate ventilation closure
- Ensure hazardous cargo not stowed adjacent to accomodation block/near engine room

Additional comment

No single solution, must consider:

- Regulatory framework – are regulations adequate/can IMO keep pace with change requirements
- Design of ships – increasing ship size increases time to respond allowing fire growth which makes successful outcome more difficult. Should SOLAS require companies and builders to consider ship design impact on ability to fight fire? An example could be, increased size imposes longer response times, company and builders must look to introduce compensating measures. Class/competent 3rd party must consider if measures are adequate.
- Fire protection
    - Passive
    - Active
- Crew training/competency
- Safe carriage of cargo

Emerging risks

- Green fuels
    - Hydrogen
    - Ammonia
    - Electricity
    - Other
- All introduce new risks/hazards that ship, and crew will need to be equipped to deal with. Implications for emergency response training/firefighting equipment/techniques/

Whilst there may be many possible solutions, it is likely that testing will have to be undertaken to assess suitability for this environment.