

ANNEX 21D**BOUNDARY MONITORING AND COOLING****1. Fire Boundary**

The fire must be contained within the smallest possible compass by forming a fire boundary, which is the bulkheads and decks surrounding the compartment or space on fire. The temperature of these bulkheads and decks must be monitored to establish the requirement for cooling with a water spray. The priority boundary is that directly above the fire unless another boundary poses a particular hazard eg magazines, compressed gas etc. Particular note should be taken of uptakes and downtakes including any flues.

2. Boundary Cooling

The purpose of boundary cooling is to contain a fire within the smallest possible area by keeping the adjoining decks, bulkheads and deckheads cooled with water spray. Boundary cooling must be carefully controlled because indiscriminate spraying can sometimes cause unnecessary damage to electrical equipment, and create adverse conditions of ships stability. If a deck or bulkhead is cool enough to touch it does not require the application of water spray. When the use of water does become necessary the amount used must be kept to the absolute minimum required. The Containment Group should make arrangements for boundary cooling in the very early stages of a fire. The following points will assist in the management of boundary cooling:

a. Boundary cooling should be established on the Primary boundaries initially and on high risk/high value compartments (see [Para 1](#)). Once this has been correctly prioritised there is then a requirement to monitor and cool secondary and remote boundaries. This can only be effectively achieved within MMS and these high risk compartments with comprehensive, pictorial guides being made available to all boundary coolers. The provision of these guides does not negate the requirement for a comprehensive initial brief. Information contained on these cards should include a pictorial guide highlighting the specific area that is to be boundary cooled. The reverse of the card should hold a written brief, instructing the monitor and cooler on how to carry out their duty. It should also cover aspects associated with:

- (1) Keys required.
- (2) Water source and equipment to be used.
- (3) Hazards associated with spraying 'live' electrical equipment.
- (4) The correct method of covering electrical equipment. Identifying the location of the nearest plastic sheeting, when and where applicable.
- (5) The requirement to remove obstructions such as panelling should the need arise, and the location of the necessary tools. Containment bags are to be issued.
- (6) The requirement to remove and break up free surface water.
- (7) The requirement to use the minimal water necessary and to use the back of the hand to check the temperature of surfaces.

- (8) The removal of flammable objects in the immediate area.
 - (9) The requirement to be fully aware of the location of the smoke boundaries and the procedures to be followed for entering a smoke boundary if required.
 - (10) The requirement to record and pass on the Temperature Monitoring System (TMS) data when asked.
 - (11) Have the telephone number of the nominated Containment HQ available.
- b. To further assist in the marking up of incident boards and the tracking of boundary coolers, units are to adopt the routine at [Annex 8B](#) if their organisational and manning structures permit. This method allows the DCO/OOD to validate/interrogate the areas planned for containment ensuring all areas are covered. Any areas that are incorrect or missed can be identified quickly and remedial action taken.
- c. I/C Containment should move between the nominated Containment HQ and HQ1 at regular intervals, ensuring consistency between the containment incident board and the main incident board in HQ1. Deck managers are to regularly visit all boundary coolers to check on their welfare and ensure that they are going about their task correctly. The 2 I/C should remain at the nominated Containment HQ and be responsible for the deployment of the boundary cooling personnel. In addition he should also detail and control all Deck Managers including the coordination of TMS data.
- d. Deck managers are allocated a deck as their area of responsibility. If used correctly, they are an asset to the containment organisation especially when used for Main Machinery Space Fires (MMSFs) that require boundary cooling on several decks and a large number of compartments. It may be necessary to have more than one deck manager per deck subject to the location of smoke boundaries. They are responsible to the 2 I/C Containment for ensuring boundary coolers are deployed in the correct areas with the correct equipment and are monitoring the correct fire boundary. In MM/PPs it may only be practicable to have 1 Deck manager due to manpower constraints and limited size of compartments.
- e. Deck Managers should report to the 2I/C as soon as boundary cooling is established and when a set of steady TMS temperatures is achieved. Further TMS readings are taken and reported as required.
- f. On hearing the fire pipe all Officer of the Quarters (OOQs) should listen out for the location and know whether it is adjacent to their magazines or not. If the fire is adjacent to their area of responsibility they should call the I/C Containment at the HQ and proceed directly to the magazine. The I/C Containment can then allocate manpower accordingly. If the OOQ cannot contact the I/C Containment he should proceed directly to the magazine, assess the hazard and contact Containment HQ as soon as possible.
- g. Boundary coolers should carry out their duties after receiving a comprehensive verbal brief and having been given a Boundary Cooling card as previously stated. They are to cool the designated areas if they are hot to touch with the back of the hand and carry out temperature monitoring in their immediate area after TMS has been employed.

- h. A number should be assigned to each boundary cooler and noted on the containment incident board with their name and where they are cooling.
- i. Mark on the containment board the position of smoke boundaries and the FCP. Ensure HQ1 provides updates as boundaries move.
- j. Consider early provision of BA to those coolers who will be inside a smoke boundary.
- k. If re-entry is liable to affect the safety of a boundary cooler, the I/C Containment must ensure the I/C at the FCP is aware of their positions and make plans for their removal/safety.
- l. Electrical aspects:
 - (1) Electrical equipment ideally should be isolated providing such action does not jeopardise the firefighting effort.
 - (2) Where possible whole units or units within assembly racks are to be removed well clear of the area.
 - (3) Electrical equipment that cannot be isolated is to be covered with polyamide sheeting and securely taped (boundary coolers should then monitor equipment for signs of overheating).
 - (4) Avoid spraying directly onto any electrical equipment. Spray onto a deckhead or bulkhead and allow water to run down the surface.
- m. Any obstructions eg panelling should be removed prior to cooling taking place. It may not be necessary to do so immediately, in which case the panelling/insulation should be monitored closely for signs of blistering paintwork, peeling or heat transfer. Ensure containment bags have been issued and correctly stocked with tools to remove the panelling and insulation.
- n. Bathrooms, heads, sculleries and galley decks will not readily transfer heat but brackets welded to the deck, deck drains and pipes passing through the deck will.
- o. Remove flammable material, such as carpets, stores, bedding etc from the fire boundary.
- p. If the structure is cool enough to touch it does not require cooling.
- q. The minimum requirement for boundary cooling inside the ship is a CFHR or a size 2 hose with a firefighter nozzle. Cloths, mops and extinguishers are unsuitable. Water from the deck can be applied by bucket but consideration must be given to how hot the structure is and the amount of physical effort required. Nozzles should not be left unattended in the open position.
- r. Ensure the boundary coolers know how to break up free-surface using material to hand.

- s. If the fire involves aluminium structure it is most important that early boundary cooling is applied as it may collapse or melt without warning.
- t. Boundary coolers should be briefed to contact HQ1 when boundary cooling in their area has been established.
- u. Should there be a need to go to Emergency Stations it is recommended that consideration be given to detailing available spare hands to proceed to the nominated Containment HQ in order to augment the containment effort.

3. Fire Boundary Temperature Monitoring

The Temperature Monitoring System (TMS) is designed for use in Main Machinery Spaces and other high risk compartments to give the MEO, DCO and OOD the ability to assess conditions within a compartment prior to planning or committing a re-entry team. In an emergency the principles of TMS can be adapted to suit any compartment with a fire, however the inevitable delay in identifying, accessing and establishing suitable monitoring points may restrict its overall value and divert effort from the task of extinguishing the fire.

4. Material Preparations for TMS

The following are required:

- a. **HQ1 Record Sheet.** A record sheet copied from the format at [Fig 21D-2](#). This allows HQ1 to record temperatures from up to eight points, transferred from the Recorders' cards. By studying temperature trends and peaks, the HQ1 team can predict events and plan actions. The information contained on these cards should be retained for any subsequent investigation.
- b. **Recorders Card.** These are a 200 x 125 mm (to fit plastic JIC wallets) card matrix copied from the format at [Fig 21D-3](#). Each card shows the location of pre-planned temperature monitoring points covering machinery spaces fitted with fixed firefighting systems and other high risk compartments. Cards are to be indexed and tagged together, and a marker pen attached. A blank recorders card is to be included for the ad-hoc use of TMS for any compartment without pre-planned temperature monitoring points. The cards are to be retained in HQ1 until required.
- c. **Pre-planned Monitoring Points.** These are points on the outside of the perimeter bulkheads, decks and deckheads of the machinery space or high risk compartment being considered, which are suitable for monitoring temperatures of the space. These are to be identified by ships staff taking into account:
 - (1) Access to the location, once smoke boundaries are established.
 - (2) The thermal conductivity of the bulkhead material allowing accurate measurement of temperature within the compartment. Thermal conductivity through bulkheads protected by fire barrier insulation will be considerably reduced. Monitoring points on these bulkheads should be at positions with a direct heat path from the other side, eg on metal door frames.

- d. **'Doughnut' Signs.** Standard 'doughnut' signs, as illustrated at [Fig 21D-1](#) are available from Naval Stores (see BRd 2170(3)). The blank centre of the circle should be cut out to improve conductivity and thus the recording of true boundary temperature. The line at the bottom of the sign is for identifying the monitoring point.
- e. **Kill Cards.** HQ1 and AHQ/HQ2 copies of Kill Cards for compartments with pre-planned monitoring points are to be annotated to indicate that TMS could be activated if required.
- f. **Temperature Monitoring Devices.** These are:
- (1) Magnetic dial thermometers, held in HQ1/FRPP lockers, or
 - (2) Digital probe kit held in HQ1 of GRP vessels.



Note. *Difficulty may be experienced with cosmetically lined bulkheads, however, this can be overcome by installing hinged access points in bulkhead linings abutting Main Machinery Spaces and high risk compartments. The identifying 'doughnut' is to be on the hinged door.*

5. Personnel Requirements for TMS

The Containment Coordinator and the rating I/C of the Containment Party administer TMS. To ensure timely implementation, one rating should be nominated from the Containment Party to be responsible for recording temperatures from all the monitoring points. The nominated person should report to HQ1 after each set of readings and complete the HQ1 record sheet.

6. TMS Activation

TMS is activated when it is established that access into the compartment has been lost, ie Attack BA party beaten back and access closed, fixed firefighting systems have been used or no other means can be used to monitor the internal temperatures in a compartment prior to re-entry.

7. TMS Procedure

- a. The procedure for activation and implementation is:
- (1) When activated from HQ1, the nominated TMS rating (the Monitor) collects the India tagged Recorders Cards for the compartment on fire and the thermometers (or probe kit) from HQ1. The Monitor then proceeds to the locations identified on the Recorders Cards and affixes the magnetic thermometers or takes a reading with the digital probe.
 - (2) When all the magnetic thermometers are in place and have had time to settle, the Monitor takes a set of readings and records them on the Recorders Card. When all possible locations have been covered, the Monitor returns to HQ1 and transcribes the individual temperatures and the reference time onto the HQ1 Record Sheet, briefing the MEO, DCO or OOD on any specific points noted during the round.

(3) When all the temperatures have been transcribed from the Recorders Card, it is wiped clean and the reference time for the next set of temperatures written in. Readings should be taken every 15 to 20 mins depending size and complexity of the route. The monitoring cycle is repeated until ordered to cease by the MEO/DCO/OOD.

b. Care must be taken not to breach established smoke boundaries. Any pre-determined monitoring point that is inaccessible because of a smoke boundary is to have a line drawn through the relevant column on the Recorders Card and a note to that effect marked on the Record Sheet.

c. Although the Monitor will be entering compartments where boundary cooling is established he must not be employed on that task. The priority is to attach all thermometers and record temperatures. The Monitor may, however, relay messages from the Boundary Cooler to HQ1 and should take appropriate action on discovering secondary fires or casualties.

Fig 21D-1. The 'Doughnut' Sign

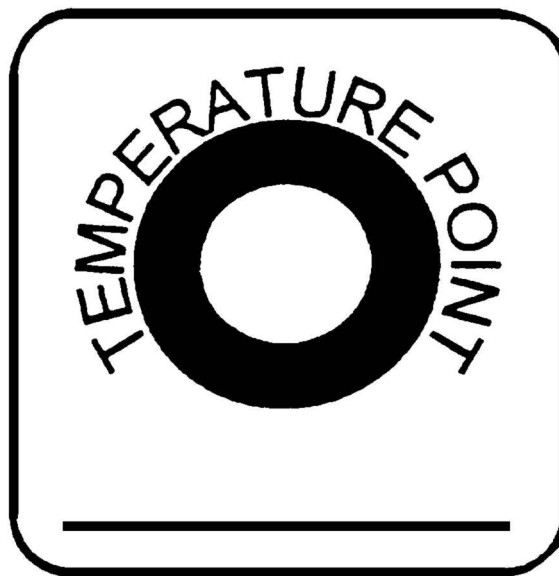


Fig 21D-2. Temperature Monitoring System - HQ1 Record Sheet

Date: _____ Sheet _____ of _____ TEMPERATURE MONITORING SYSTEM - HQ1 RECORD SHEET Compartment: _____ Fixed Firefighting System Used: Yes/No _____ Time of First shot: _____ Time of Second Shot: _____											
TIME											
POINT	LOCATION	TEMP	TEMP	TEMP	TEMP	TEMP	TEMP	TEMP	TEMP	TEMP	TEMP
1											
2											
3											
4											
5											
6											
7											
8											
9											

Fig 21D-3. Temperature Monitoring System - Recorders Card

TEMPERATURE MONITORING SYSTEM		
RECORDERS CARD		
Time:		
Point	Location	Temp
1		
2		
3		
4		
5		
6		
7		
8		