

ANNEX 21M**GUIDANCE FOR ACTIONS IN RESPONSE TO FIRES IN GAS TURBINE MODULES****1. Introduction**

- a. These guidelines provide the basis for all gas turbine fire fighting and module recovery procedures. The fundamental principles are to maintain the module integrity while extinguishing the fire, cooling, purging and safely regaining access to the module, without re-ignition.
- b. The purge times are not statutory; management of this aspect will require careful consideration of risk balanced against the operational imperatives, to ensure safe progress is made. The procedures assume that the module integrity has not been compromised. Where integrity has been breached, a more flexible approach will be required, dependent upon the effectiveness of the fixed firefighting systems and the degree of egress of combustion products.
- c. Ships staff is to use this generic guidance to develop and practice installation specific procedures, to include all gastight gas turbine modules fitted within the vessel. The methods outlined may be slightly adapted if necessary, to take account of variations in module design.

Firefighting Actions and Recovery of GT Modules at State 3 (Peacetime)**Phase A - Initial/Watchkeeper Actions****2. Containment**

Unless the module has been breached the operation of fire suppression systems should extinguish a fire within the module. Uptakes and downtakes within the machinery space, associated ventilation trunking and all sides of the module require monitoring and, if necessary, cooling using available hoses from within the compartment. As modules are constructed from steel and are double skinned with an insulation material between the two skins, only minimal cooling effect is gained by wetting the whole module. The effort should therefore be concentrated on the areas most likely to breach and allow BCF/BTM to be lost to the Main Machinery Space (MMS). The most susceptible areas are the flexible gussets between the module and the intakes/uptakes; 2 personnel can only effectively cool these areas, each using a minimum of a centre fed hose reel (CFHR). Primary checks are to be carried out as a priority. Continual checks via module windows and all fitted/portable thermometers should confirm that temperatures are stabilising and no re-ignition has occurred. Secondary checks are then to be carried out to ensure full isolation of the module. If considered safe, machinery space ventilation may be used to clear any fumes from the machinery space and provide fresh air for personnel within the compartment. Module temperature will continue to rise initially due to a lack of cooling air. To give some additional indication of module temperature Rototherms may be placed on the module door and other suitably conductive areas.

- a. **Fire not Extinguished.** If the fire is not extinguished by the first shot of the two shot fixed firefighting system, the second shot is to be operated locally. If this fails to extinguish the fire or if the fire has not been extinguished on a single shot system, containment is to continue and boundaries are to be re-established prior to a full re-entry being conducted on the module with nozzles open. Re-entry to the module is to be conducted without going through the purge stage in this case.
- b. **Fire Extinguished.** For single shot module fixed firefighting systems, and for two shot module fixed firefighting systems where one or both shots have been operated, used bottles are to be replaced prior to purging and preparation of re-entry firefighting equipment.

Phase B: - Re-Entry and Recovery

3. Module Re-Entry Preparations

A full firefighting team in full firefighting rig is to be dressed and two hoses, 1 x Size 2 hose with firefighter nozzle for personal protection and 1 x FB5X, are to be used. Hoses previously tasked for boundary cooling may be used for the re-entry team once temperatures have reduced. In machinery spaces without hydrants then 2 x CFHR are to be used with one selected to water and one selected to foam.

4. Module Purge

- a. **Preparations.** The module fixed system BCF/BTM bottles must be renewed prior to commencing the module purge. Before starting the purge, consideration is to be given to the exit location of the purge gases. If necessary, the upperdeck in the vicinity of the module ventilation outlet is to be cleared and ships course relative to wind direction altered. The machinery space ventilation supply fans are to be started, and the exhaust fans are to be stopped, therefore pressurising the machinery space. A positive pressure must be confirmed by checking and reporting the machinery space manometers. Transit to/from the machinery space requires strict airlock discipline in order to maintain a positive machinery space pressure. The fixed hatch waterwall hose (if rigged) will have to be removed to achieve this. At least Tier 1 enhanced (cotton underwear, No.4s/overalls, firefighters hood, anti-flash gloves and BA) is to be worn by all personnel that will be in the machinery space during the purge. BA facemasks may be removed on completion of face seal checks, but must then be worn during the initial opening of the purge valve and until the airflow is seen to be in the correct direction.
- b. **Execution.** After confirmation that it is safe to purge (module temperature check, observation via module window, all non involved personnel clear of the machinery space) the ventilation flaps are to be carefully opened whilst the module interior is checked for signs of re-ignition. If no re-ignition occurs the purge may proceed. The purge team are to go 'on air', and one man is to crack open the purge valve, taking care to ensure the airflow direction is correct and no re-ignition takes place. If at any stage re-ignition occurs, the purge process is to be stopped immediately, the purge valve shut, module ventilation flaps closed and the module fixed system operated. A sentry with a minimum of an AFFF SPE is to remain in the vicinity of the purge valve throughout the purging operation. Once the purge is successfully underway then the team may notify the BA controller and come 'off air' (but are to continue to wear BA). The purge must be continued for a minimum of 10 mins and until the module temperature has reduced to an acceptable level.

To cease purging at this point, and after a (possibly protracted) delay conduct a module re-entry, would reintroduce risk to an otherwise minimal risk situation; for that reason purging is to continue throughout the re-entry and recovery phase. If at any stage re-ignition occurs, the purge process is to be stopped immediately, the purge valve shut, module ventilation flaps closed and the module fixed BCF/BTM system operated.

Notes:

1. *Purging using module ventilation fan (No current RN vessels fitted - other NATO only).*

2. *Module purging is achieved by the use of the installed module ventilation fan. This is a fully contained method with the least risk to personnel in the machinery space. After opening the ventilation flaps the module fan is started and the module interior purged. Personnel require no additional protection except Intermediate Firefighting Rig (No.4s/overalls, firefighters hood, anti-flash gloves, BA). If at any stage re-ignition occurs, the purge process is to be stopped immediately, the module vent fan stopped, module ventilation flaps closed and the module fixed system operated.*

5. Module Re-Entry

Strict air lock discipline is to be employed when transiting to and from the machinery space. When purging is assessed as effective (minimum 10 mins) and the module temperature has reduced to an acceptable level, all personnel not wearing full firefighting rig are to exit the machinery space, all accesses are to be closed and sentries posted. The module is to be unlocked and BTM/BCF re-armed prior to re-entry. Module re-entry by the firefighting team is to be authorised by the MEO and conducted 'on air' with hoses charged but nozzles shut.

6. Machinery Assessment and Recovery

Once re-entry has been achieved all machinery space ventilation is to remain running to clear any products of combustion from the machinery space. During this period the module door is to be left open and the machinery space access to remain closed. When the atmosphere is clear, the re-entry team may come off air and non-BA wearers may have normal access to the machinery space. An assessment of damage to the internal aspects of the module and engine unit is to be completed and if possible rectification action conducted to return the engine to a serviceable condition.



Note. *When BCF/BTM is discharged it leaves a harmful acidic residue. PPE is to be worn by all personnel to prevent contact with skin and eyes.*

Module Recovery at Action (State 1/2)**7. Introduction**

a. The principles of module recovery in the Action State are to be driven by the stipulated Command Aim and Priorities. Strong and effective management is essential and may require taking certain calculated risks and decisions to formulate a plan of action to achieve speedy recovery of the affected engine.

b. The drill reactions and module checks will share much with the State 3 (Peacetime) procedure, which Action personnel are to be fully conversant with. However, the imperatives of the Command Aim may necessitate more rapid entry into the module to assess serviceability and identify the relevant actions and the possible logistic/technical support required. An example algorithm is provided which should be used to develop installation specific aide-memoires and check lists.

8. Containment

a. Unless the module has been breached, the operation of fire suppression systems should extinguish a fire within the module. Uptakes and downtakes within the machinery space, associated ventilation trunking and all sides of the module require monitoring and, if necessary, cooling using available hoses from within the compartment. As modules are constructed from steel and are double skinned with an insulation material between the two skins, only minimal cooling effect is gained by wetting the whole module. The effort should therefore be concentrated on the areas most likely to breach and allow BCF/BTM to be lost to the Main Machinery Space (MMS). The most susceptible areas are the flexible gussets between the module and the intakes/uptakes; it may be necessary to cool these areas with only 1 man, using a CFHR. Should the Command veto tripping of the engine, high priority must be given to containing the fire within the module.

b. In the event of module breach, initial leak stopping should be actioned and full containment established with the aim of containing the fire to the module. The use of BA will be required in this instance.

c. To give some additional indication of module temperature, a Rototherm may be placed on the module door.

9. Firefighting Equipment Preparation

Driven by the Command Aim, the urgency to recover the module will dictate the level of fire fighting equipment deployed and whether the fixed gaseous drench bottles should be changed. The potential exposure to higher than normal temperatures and the possibility of re-ignition must be considered. A minimum of 2 CFHRs are to be used to conduct the re-entry with one on water and one on foam. Personnel involved in other urgent tasks such as blanket searching, leak stopping, etc may continue however they must carry an EEBD and should have an adjacent escape route.

10. Module Purge and Recovery

a. The Action crew should assess the situation at the scene and request permission to 'conduct action re-entry', taking account of the module temperature and timescales involved. The order from HQ1 to conduct an action re-entry authorises the Action crew to start MMS vent, purge and enter the module without further reference to the SCC/MCR/HQ1. It is therefore imperative that all factors are considered before ordering recovery. The MEO is to authorise the re entry.

b. I/C of the space should risk assess actions in line with ship priorities, including the situation with regard to personnel remaining in the space, access to EEBD or breathing apparatus and an adjacent escape route. Any personnel remaining within the space are to be informed that the re-entry is to be conducted.

Action crews must then ensure that any ratings entering or leaving the MMS are aware of the re-entry. Personnel must be nominated to start the MMS supply fans and act as sentries on the MMS access points (external assistance may be required to achieve this).

c. The method of purging recommended in order to ensure that the quickest possible recovery can be achieved is as follows: Module vent flaps should be opened and module checked for re-ignition. If no re ignition then the MMS supply fans should be started. The Action crew or the mobile repair team, with the necessary fire fighting equipment and wearing AWD with BA (on air), should then crack open the module door sufficiently to establish a purging airflow. The purging time should be at the discretion of the I/C of the space taking into account the circumstances that prevail and the priority placed on recovery. Once purged the module door is to be fully opened and re-entry undertaken. On completion of re-entry and subsequent smoke clearance, the propulsion manager is to be informed in order that GT recovery may commence.

11. Fire Not Extinguished After Use of Fixed System

If the module fire is not extinguished after operation of first or second shot of BTM/BCF, the module is to be treated as a closed compartment and re-entered using recognised techniques for an oil based fire. In this instance there is no requirement to carry out a module purge routine and personnel not involved in the re-entry must be evacuated from the compartment. If any there are any other personnel involved in urgent repairs within the space they must be wearing BA.

Gas Turbine Module State 3 (Peacetime) Recovery Procedures

PHASE A MCR/SCC ACTIONS	PHASE A LOCAL ACTIONS
Operate BCF/BTM system and confirm operation of automatic system (from local position).	Watchkeeper to local to investigate carrying AFFF SPE.
Carry out EMERGENCY SLOW on affected shaft.	Carry out PRIMARY CHECKS:
Request OOW permission to trip affected engine and select alternative drive state. Carry out actions when approved.	1. Ensure BCF/BTM has operated.
	2. Ensure module vent flaps shut.
	3. Switch off module lights, check state of fire (Extinguished/Not Extinguished). If 2 shot system and fire not extinguished, operate second shot and notify MEOOW.
	4. Check module for gastight integrity (module intact).
Crash stop all vents and conduct Fire SOPs.	Report:
Broadcast “Fire in Port/Stbd module in the.....(location). SSEP to muster.....”	“Primary Checks Complete, Fire Extinguished/Not Extinguished” (see Phase B).

Report to OOW “**Ready to obey telegraphs on affected shaft.**” Give revised limitations.

On completion carry out
SECONDARY CHECKS:

1. Once engine tripped from remote, trip from local position also.
2. Ensure HPSOC indicates shut.
3. Ensure LP fuel valve is shut.
4. Ensure HP air to engine start system isolated.
5. Ensure module drains shut.
6. Ensure module purge valve shut.
7. Check uptakes and downtakes in machinery space only.

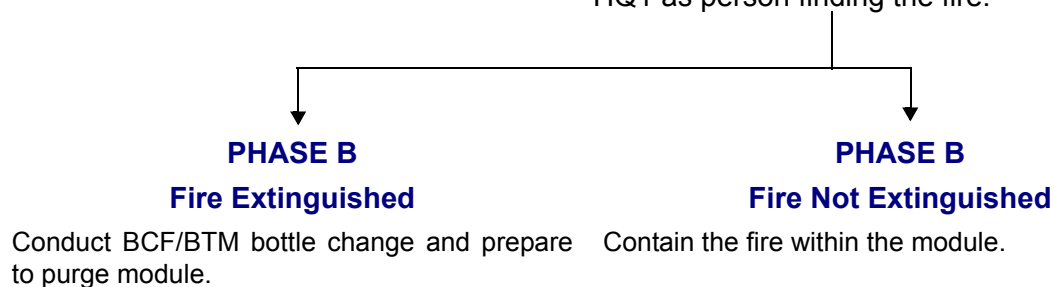
Report –
“**Secondary Checks Complete**”

Rig containment hoses on both sides of the enclosure (2 x CFHR) and continue to monitor enclosure temperature.

Report to I/C of Attack Party: “**Primary and Secondary checks complete, Fire Extinguished/Not Extinguished**”.

Handover control at the scene of the incident.

On completion proceed directly to I/C FCP for debrief, then to be escorted to DCO/MEO in HQ1 as person finding the fire.



Wait for significant drop in module temperature. This may take some time due to lack of cooling air.

Reduce personnel in the compartment to minimum. Ensure all are wearing Intermediate firefighting rig (No.4s/overalls, firefighters hood, anti-flash gloves, BA). Facemasks may be relaxed, except when opening purge valve.

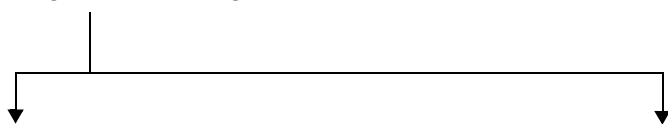
Request Command turn the ship across the wind and make a warning pipe reference module venting.

With module lights off, open module vent flaps and check viewing ports for re-ignition.

Re-establish smoke boundaries with sentries.

Clear all non-essential personnel from within the smoke boundary.

Conduct module re-entry with 2 x Size 2 hoses, one with firefighter nozzle and one with FB5X using the support party, on air, nozzles open (for T23; 2 x CFHR are to be used).



No Re-Ignition

Pressurise MMS using supply fans.

With MEO's permission open module purge valve and purge module for minimum of 10 mins (one man at purge valve, in Intermediate FF rig, on air, with an AFFF SPE).

Rig hoses and prepare for re-entry.

Support party in full FF rig to be in Main Machinery Space.

Clear all non-essential personnel from within the smoke boundary.

Re-establish smoke boundaries with sentries.

Unlock module door and re-arm BCF/BTM system.

Obtain Command approval and conduct re-entry of module with charged hoses (nozzles shut).

Re-Ignition

Crash stop all vent and shut module vent flaps and purge valve (if open).

Operate BCF/BTM and repeat Phase B.

Fig 21M-1. GT Module Recovery In Action

