NBRMAS: Rules and guidelines for operation of Gas Turbine models.

Introduction

In the UK all model flying is controlled by the Civil Aviation Authority (CAA). These rules are to be used in conjunction with the following publications, The BMFA Handbook, The NBRMAS Handbook, The CAA Air Navigation Order (ANO, CAP393), and CAA CAP658.

Gas turbine engines and model aircraft powered by them pose some specific safety issues:

- Danger of burns or damage caused by hot exhaust gases.
- Danger of fire, after a crash, ignited by hot components and made more serious by the relatively high fuel loads commonly carried.
- Danger of fire caused by overheating as a result of poor start-up procedures or engine failure.
- Dangers relating to the relatively large size, power and wing loading of many (but not all) turbine powered aircraft. These dangers are of course shared with many other large, powerful model aircraft.
- Problems of ground handling relating to the relatively high idle thrust of some engines.
- Risk of injury caused by engine parts, which may be ejected at high velocity after engine failure.

To prevent or minimise risk from all of these possibilities there are four approaches.

1. Ensure that operators and pilots have a high

level of skill, knowledge, and experience to enable them to avoid dangerous situations.

2. Ensure that failures and incidents happen as infrequently as possible by paying detailed attention to reliability issues and by careful, systematic design procedures, operational procedures and maintenance.
3. Provide fail safe and cut-off mechanisms whenever practicable to ensure that most failures follow a “low risk” path.
4. Pay attention to where and when aircraft are flown (or engines are operated) to ensure the safety of people, property and the environment.

The total safety approach is a compromise between each of these factors, although 4 remains the most critical.

In order to address these issues NBRMAS has decided to adopt the following approaches to managing the risks;

1. Pilots must demonstrate their current level flying proficiency and knowledge of safety rules before they are allowed to operate gas Turbine powered models at NBRMAS sites. To this end NBRMAS is introducing a Turbine waiver system.
2. Pilots must operate gas turbine models in accordance with the JMA code of Practice. In addition a number of the requirements of the JMA code of practice have modified and adopted as club rules. If in doubt the club rules take precedence as they have been revised in light of the situation at NBRMAS sites.
3. During the months of June July and August the club Turbine waiver assessors will decide, on a weekly basis, whether the fire risk is such that flying should be suspended. Anyone wishing to fly a turbine model must check with an assessor, in advance, whether the fire risk is deemed too high. This will normally be at harvest time but may also be required in an exceptional dry period

NBRMAS has therefore decided to introduce this supplementary rule book to deal with gas Turbine operations at its sites[1].

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[1] **Definitions**

Throughout this document there are certain words which have specific meanings, defined as follows:-

Must - These are mandatory requirements for operation of all gas turbine models at NBRMAS sites. They are rules governing all flying of gas turbine models at NBRMAS sites.

Should - Indicates an obligation to comply so far as is practicable but allows a relaxation of the requirement under exceptional circumstances. There has to be a very good reason why the requirement is not complied with.

A. Pilots Responsibilities

Pilots wishing to fly gas Turbine powered models, in addition to holding a relevant BMFA B certificate, must apply for and hold a turbine waiver before they are allowed to fly Gas Turbine models at NBRMAS. This requirement may be waived ONLY in the event of competitions and events where visiting pilots must still hold a relevant B certificate.

Inexperienced pilots should, wherever possible, seek the assistance of an experienced gas turbine model pilot before running a gas turbine. In addition gas Turbine models behave differently from other models. Gas turbine operation requires that operators must be aware of the flying characteristics that arise from the application of gas turbine power. The main characteristics are:-

- The delay in response to opening the throttle.
- The high speeds, which can result from the available thrust not decreasing with increasing airspeed.
- The high thrust at engine idle speed, which makes for difficulties in slowing the aircraft down for landing.
- The lack of prop. Wash over the tail surfaces resulting in poorer low speed control.
- Lower drag of the airframe resulting in more effort from the pilot to reduce/control airspeed. Particularly

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May - Indicates a preferred course of action**.**

relevant to the landing Phase of the flight.

Specific Requirements for Pilots

Pilots wishing to fly gas turbine models at NBRMAS sites MUST apply to the committee for a Turbine waiver before attempting to fly a Gas Turbine model at NBRMAS sites. A copy of the application form is attached at the rear of this document.

A.1 **Pilots must hold a NBRMAS Turbine waiver to fly gas turbine models at NBRMAS sites**.

A.2 Manufacturers' or designers' operating instructions must be followed at all times.

A.3 ONLY the NBRMAS committee appointed Turbine assessor is allowed to supervise prospective Gas Turbine model flying tests**.**

A.4 The ultimate responsibility for the safe operation of an aircraft rests with the pilot. If in doubt about a safety issue DO NOT Fly until the situation has been remedied.

A.5 Pilots must have a helper (who shall hold an B test certificate or be approved by a Turbine assessor) in attendance for every flight. The helper must maintain a lookout throughout the flight to warn the pilot of any circumstances that may jeopardise the safe conduct of the flight. This person may also perform the nominated fire person task (see section E). **NB The helper must stand immediately** a**djacent to the pilot for the duration of the flight and his role is to watch the airspace and surrounding area NOT to watch the model.**

Applying for a jet waiver

Apart from occasional visitors at club events who have prior agreement from the committee no gas turbine model may be flown at NBRMAS unless the pilot holds a NBRMAS Turbine waiver.

The Turbine waiver comprises three separate steps

1. Download and complete the first part of the turbine waiver application form from the club website:- www.nbrmas.co.uk/page10.html
2. Arrange a turbine waiver assessment test with one of the turbine waiver assessors appointed by the club. On successful completion of the assessment the application form is then passed to the committee, normally via the assessor. The committee will decide whether or not to award a turbine waiver.
3. The committee will decide by simple majority vote, whether it wishes to grant the applicant a turbine waiver.

You can only fly a gas turbine model at NBRMAS sites once you have been awarded the waiver by the committee.

The Club limits the number a turbine waivers it issues. This is under continuous review. The purpose of this is to integrate model turbine operations into the club in a way that allows every club member fair use of the club flying facilities

B. Gas Turbine Protection and Control

B1. Gaseous fuelled gas turbines are banned from NBRMAS sites.

B2. .For gas start engines it is preferred that external gas (Propane/Butane) be used. However a small onboard gas tank containing sufficient gas for approximately TWO auto-start sequences is allowed.

B3. Gas Turbines must be operated as follows**:**

Start up and static running

Where engines are being run statically, on a test bench or during start up procedures in a model aircraft a manual fuel shutoff mechanism must be provided. This mechanism may take any suitable form such as a fuel valve or electrical switch to cut power to the pump, but must be independent of the normal throttle control. Where a fuel valve is used in a liquid fuel system it should be located in the low-pressure part of the fuel line, between the tank and the pump. The fuel valve may also be installed in the high pressure side providing that the valve is of the Festo push fit type, and Festo or polyurethane tubing is used of the correct size for the Festo connectors. This valve provides a means of engine shut down in ground emergencies. It should also be closed while fuelling is taking place, this is to prevent fuel from leaking into the engine and possibly resulting in a wet start and possible fire caused by the wet start.

Operation under remote control,

The following paragraphs apply only to engines that are operated remotely, such that the manual control referred to above is inaccessible.

Shutdown mechanisms

The engine control function must include an independent fuel shut off device in addition to the pump speed controller, as used by the throttle control. The fuel shut off device could be a solenoid valve or a servo operated valve in the fuel line, in which case the considerations in regard of positioning given in B.1 above should apply. Alternatively a relay, servo operated switch or additional transistor in the pump circuit may be used. Engine control units (ECU's) driving fuel solenoid valves should meet this requirement.

Failsafe operation

"Failsafe" device refers to any equipment or facility associated with the radio control system that is activated by the loss of radio signal or interference to the signal. Gas turbine powered models must incorporate a radio failsafe, which is capable of shutting down the engine (preferably via both of the mechanisms described above in the event of loss of signal). In the event of loss of signal the failsafe must be set so that, after a maximum of 3 seconds the engine will stop. . Most modern engines ECUs bring the engine to idle within the first second, then the shut the engine down 1.5 seconds later if signal is not installed, this does however require that the fail safe is setup according to the engine manufacturers instructions.

This failsafe mechanism must be correctly programmed and in no circumstances should it be left at the default setting without checking. Where both fuel cut-off mechanisms are operated by a single control unit this unit should be configured so that an internal failure will activate at least one of the mechanisms.

It is the responsibility of the pilot to demonstrate these functions on request of a committee member.

The settings of failsafe devices **must be checked prior to each flying session** to confirm compliance with these rules.

Kill switch

Radio transmitters used for the control of gas turbine powered models should incorporate a control that will instantly shut the engine down when operated. This control should be easily accessible and must operate in a single action, independently of the throttle lever.

C. Fuel Systems

Gas turbine models operated at NBRMAS sites must comply with the following fuel system requirements:

C.1 Where possible fuel tank(s) should be located in a separate compartment from the engine. The tank(s) must be protected from the heat of the engine.

C.2 The fuel tank(s) and fuel system components must be adequately secured and protected to minimise the risk of rupture in the event of a crash.

C.3 Flexible fuel tanks, including plasma bags, should only be used where it is impractical to use any alternative form of fuel tank. If such tanks are used, they must be placed in a separate compartment, or protective 'shell', the construction of which shall not compromise the integrity of the tank, shall be leak-proof and be fitted with a drain to route any spilled fuel overboard.

C.4 Fuel lines, connectors and associated equipment must be tested to show the ability to withstand the pressure imposed without leakage or failure when the engine is operating at maximum safe speed. A drainage hole must be made in every part of the model where fuel could collect as a result of a leak.

C.5 Fuel lines and associated equipment must be made from materials suitable for the intended service and which can adequately cope with the environmental conditions of the installation. Typically Tygon tubing in low pressure fuel lines

and Polyurethane for high pressure fuel lines.

C.6 Separate feed lines for starting gas and liquid fuel should be used to avoid the dangers of migration of the starter gas back into the liquid fuel system.

C.7 The fuel tanks of liquid fuelled engines should not be subjected to any form of high pressure pressurisation. Low pressure pressurisation is permitted, in systems of a suitable pressure rating, up to a maximum of 5 psi (0.35bar) for the purpose of aiding fuel movement between tanks and to fuel pumps.

C.8 All tanks and fuel lines should be regularly checked for deterioration and renewed where necessary, paying particular attention to the possibility of hardening of flexible pipes and seals in the vicinity of joints which are subjected to high pressures.

C.9 Only clean, filtered fuel should be used and measures taken to prevent contamination of fuel systems.

C.10 The oil content of the fuel must be as specified by the designer or manufacturer.

C.11 Only appropriate oil suitable for use in gas turbines should be used.

D. Gas Turbine Installation

Gas turbine installations for models flown at NBRMAS must comply with the following requirements:

D.1 Engines must be securely mounted and attached in a manner to ensure that they remain so for all operating regimes.

D.2 All components anywhere in the vicinity of the engine must be adequately secured to prevent ingestion.

D.3 The engine should be protected from Foreign Object Damage (FOD) by suitable screens or by virtue of the position of the air intake(s).

D.4 Pipes, lines, wires, control cables etc., should be routed away from the hot parts of the engine or be suitable for the temperatures arising.

D.5 Until experience has been gained in operating gas turbines, engines should be mounted externally.

D.6 For internal turbine installations adequate heat protection from the hot exhaust gases must be provided.

D.7 The idle thrust of a gas turbine can be very high. If the model does not remain stationary with the engine at idle, positive measures must be taken to restrain it.

E. Fire Safety

For ALL gas turbine flights at NBRMAS sites pilots must have a competent Fire Person (see below) to stand by with an appropriate serviceable fire extinguisher for the entire duration of the preparations to fly, the take-off, the flight and landing. The nominated Fire Person must assume responsibility, under the direction of the pilot, for extinguishing any fires that may arise.

E.1 During periods of high fire risk the committee may suspend all gas turbine operation by posting a note at the affected sites. It is the pilot's responsibility to check for such a notice

which will normally be posted by the entrance or by the peg board.

E.2.1 **If there is no Fire Person present then flying is prohibited. The Fire Person** is that person nominated by the pilot to undertake the responsibility of dealing with any fire that may occur during the preparation and flying of the pilot's aircraft. The Fire Person must be familiar with the location on and around the aircraft of all equipment and substances that would represent a hazard in the event of a fire and be competent to deal with such hazards. The Fire Person must have ready access to an appropriate and serviceable fire extinguisher and be competent to operate it effectively.

A Fire Person can only be assigned to one aircraft at any one time. The Fire Person's duties will have priority over all other tasks and he will maintain an overview of all activities while the gas turbine is being operated

E.3 Gas turbines must not be run if the surrounding environment presents a fire risk unless adequate precautions are taken to negate the risk.

E.4 Smoking or other sources of ignition are prohibited within a radius of 15 metres of fuelling with liquid fuels. Signs designating the fuelling areas should be displayed if a gas-fuelled engine is being operated in public.

E.5 Any venting of liquefied gas must be conducted in a safe manner. In particular, venting must not be undertaken within a radius of 50 metres, and never upwind, of any other gas turbine which is running.

E.6 All fuels must be contained in appropriate vessels clearly marked with a description of the contents.

E.7 Fuelling of aircraft shall only be carried out by competent persons nominated by the pilot.

E.8 A nominated fire person in possession of an appropriate and serviceable fire extinguisher must be in attendance throughout all fuelling operations.

E.9 The pilot or the nominated competent person must ensure that the fuelling equipment is fit for the intended purpose before fuelling takes place.

E.10 During refuelling, the engines(s) must be shut down.

E.11 It is strongly recommended that a manually operated shut-off device is fitted in the fuel supply line to the engine(s) to prevent inadvertent fuel flow to the engine(s) during refuelling.

E.12 Engine fires constitute a major hazard and awareness of potential causes must be fully understood, they include:-

- Residual fuel in the engine leading to a "wet start".

- Incorrect starting procedure.
- Turbine rubbing.
- Excess lubrication oil introduced during the priming of the lubrication system.
- Debris partially blocking the air intake, reducing compressor performance.
- Blocked fuel jets.
- Expansion of fuel into the engine after shut-down of the fuel pump.
- Tail-pipes pointing into wind at start-up.

F. Test running of turbines

Test running of gas turbine engines at NBRMAS sites should comply with the following

F.1 A test bed should be used with the engine securely fixed and constrained and located in a controlled area.

F.2 During protracted ground running adequate eye and ear protection should be worn.

F.3 Mechanical abnormalities indicated at any time by vibration, unusual or excessive noise, excessive temperature, overspeed or any other unexpected phenomena must be investigated and corrected, before the engine is re-started.

F.4 During ground running due regard must be given to preventing noise nuisance.

F 5 A serviceable fire extinguisher must be present during all operation

G. Operational issues related to engine running

Gas turbines operated at Landmead must comply with the following

G.1 All gas turbine running must be conducted at a safe distance from non essential personnel with the jet pipe always facing away from them. When wind direction requires that tailpipes are directed towards people or property the distance from the tailpipe to people or property must be increased to the point where jet blast and temperature effects are of no consequence.

G.3 No person must be permitted to stand close to an operating engine in the rotational plane of the compressor or turbine.

G.4 Particular attention must be paid to site husbandry and cleanliness to reduce the risk of foreign object damage to the gas turbine by ingestion and to prevent any loose articles being carried in the jet efflux.

G5 At NBRMAS sites a maximum of TWO gas turbine models may be operated at any given time. In addition gas Turbines must NOT be started in the vicinity of the general pit area used by other (propeller) aircraft. Also it is the pilot's responsibility to ensure that all non-essential personnel are kept clear of the immediate vicinity of aircraft whose engines are being started and run.

G6 Gas Turbine powered Aircraft are not to be taxied without restraint in or out of the Pit Area. Engine start should be performed at the downwind end of the flight line with the jet

exhaust pointed away from the flight line and the Pits. Aircraft returning from a flight may be taxied back parallel to the flight line and along the runway Centre line, the model stopped and positioned into wind and the engine(s) shut down, followed by manual recover to the pits.

J. Pre-flight Checks

J.1 Before each flight, pilots are to ensure that their aircraft are airworthy, that their radio system functions properly and that all batteries are adequately charged.

J.2 The following gas turbine system checks **must** be made prior to every flight:

J.2.1 Visual check of the fuel and oil systems for leaks

J.2.2 Visual inspection of the compressor and turbine wheels for any signs of damage. Minor damage to a compressor blade, visible from the inlet, could indicate serious foreign object damage within the engine and must be investigated further before the engine is again operated.

J.2.3 Visual inspection of filters (if accessible and applicable) to ensure that they are contaminant free

K. Flying

Pilots must obey the following RULES for flying gas turbine models at NBRMAS sites.

K.1 Gas turbine models must be flown at least 30 metres out from

the flight line during flight. For aircraft over 7 kg, the aircraft should not, at any time during its operation, come closer than 50 metres from the flight line except during take-off and landing where they are permitted to come within 30 metres of the flight line.

K.2 Except during take-off and landing, low flying, below 3 metres above ground level, may only be undertaken with the aircraft flying on a constant heading in a direction parallel to the runway centre line.

K.3 High-speed manoeuvres must be made in a direction parallel to the flight Line or on a heading away from the pits. Such manoeuvres must be confined to the far side of a vertical plane, parallel to the flight Line, and displaced 30 metres horizontally from the flight line.

K.4 High-energy manoeuvres that would bring the aircraft on a heading towards the pits are not permitted.

K.5 Aircraft must be operated within the visual range of the pilot who must also take into account the effects of the position of the sun.

K.6 Pilots must assess the effects of the weather upon their aircraft and not make a flight in conditions in which their aircraft would not remain under full control.

K.7 If an aircraft experiences radio interference or any other form of control malfunction it must be landed as soon as is practicable and not be flown again until all faults have been rectified.

K.8 If any part, that was not designed and controlled to do so, detaches in flight then the aircraft must be landed as soon as is practicable and not be flown again until all faults have been rectified.

K.9 If an aircraft touches the ground while in flight, other than by contact involving normal use of the landing gear, the aircraft must be landed as soon as is practicable and must not be flown again until it has been checked and any damage has been

rectified.

K.10 If an aircraft catches fire on the ground the pilot must direct the nominated Fire Person to extinguish the fire.