United Kingdom Rocketry Association

Safety Code

Version 6.0
September 2017

This page intentionally blank

This document is published by the Council of the United Kingdom Rocketry Association and is valid with amendment slips provided as appropriate.

Amendment Status			
Revision	**Date**	**Pages**	**Comments**
1.0	20th June 1998	ALL	
2.0	10th August 1999	ALL	
3.0	25th Nov 2001	ALL	
4.2	29th August 2003	ALL	
4.21	25th Feb 2004	5	Changed model and high power rocket definitions.
5.0	4th March 2008	All	General update to style and layout. Rationalized the section numbering scheme, for easier reference by section. Significant updates to sections 2.1.9, 2.2.1, 2.2.3, 2.3.1, and 2.3.2 Additions to sections 1.1, 2.1.4, 2.2.2.1, 2.6, 4.5 and 4.11. Addition of sections 2.2.2.2, 2.2.2.3, 5.2.6.2 and 6.2 item 11 Amended Section 5 to read “Research” Amended 3.4 to “appropriate” scale maps, to enable additional detailed scale mapping sources Published as Rev 5.0
5.1	12th January 2010	Annex B	Amended to show revised ANO

6.0	September 2017	All	Amendment to multiple sections, reference to UKRA insurance changed to BMFA insurance Amendment to section 1.3, ANO sections pertinent to Rocketry Amendments to section 2.1.1, guidance on Rocket construction materials Amendment to section 2.2.1, clarification of rules for high impulse flights Simplification of section 2.3.2, hybrid ignition systems Minor clarification in section 2.6, pad base moment. Amendment to section 3.2, emphasizing the authority of the RSO Addition to section 4.3, making safe electronic devices in the event of a misfire Addition to section 5.1, definitions of research projects New Section 7 Special Projects Revision of Annex B, revised ANO 2016

Contents

This page intentionally blank

1 General Rules

1.1 Definitions

Rocket Motor — The motor which propels any rocket vehicle whether utilizing solid propellant, liquid propellant or a combination of solid and liquid (hybrid) propellant. Rocket motors are classed according to the following table:

	Propellant	
Motor Type	**Fuel**	**Oxidizer**
Solid Motor	Solid	Solid
Hybrid Motor	Solid	Liquid
Hybrid Motor	Liquid	Solid
Liquid Motor	Liquid	Liquid

Propellant — The name given to the mixture of fuel and oxidizer which react in the rocket motor to produce exhaust gases. Some propellants may be classified as an explosive in the UK.

Model Rocket — Model Rocket relates to any rocket vehicle falling into all of the following categories:

- where the combined propellant mass of rocket motors used is less than 125 grams or the total impulse is less that 160 Newton Seconds
- where all individual motors have a propellant mass of less than 62.5 grams
- where the maximum mass of the model at launch is less than 500 grams for a propellant mass of 62.5 grams or less, and less than 1500 grams for a combined propellant mass of 125 grams or less.
- uses only pre-manufactured, solid propellant motors.
- does not use metal body tubes, nose cones, or fins.

HPR Rocket — High Power Rocket (HPR) relates to any rocket vehicle in any of the following categories:

- where the combined propellant mass of rocket motors used is over 125 grams
- where any single motor has a propellant mass over 62.5 grams

- where the rocket motor propellant is liquid, gas, solid, or a hybrid of these
- where there is a single motor limit of O power (40,960NS maximum total impulse) and a total power limitation of 81,920NS total impulse.

Rocket	This means a device propelled by ejecting expanding gases, generated in its motor, from self contained propellant and not dependent on the intake of outside substances. It includes any part of the device that becomes separated during its operation.
Small Rocket	This means a rocket of which the total impulse of the motor or combination of motors, does not exceed 10,240 Newton- seconds. (ANO Definition)
Large Rocket	This means a rocket of which the total impulse of the motor or combination of motors is more than 10,240 Newton-seconds. (ANO Definition)
UKRA	United Kingdom Rocketry Association
Safety Officer	A member of the UKRA acting as Safety Officer (must be certified as a qualified Safety Officer by the UKRA Safety and Technical Committee if overseeing launches of above G class total impulse).
RSO	Range Safety Officer
Launch Site	A suitable open area for launching and recovering rockets. It must conform to the minimum dimensions laid out in the UKRA Launch Site Dimensions Table.
CAA	Civil Aviation Authority
NOTAM	Notification To Air Men (issued by the CAA) HSE Health and Safety Executive
ANO	Air Navigation Order (contains rules specifically related to the flying of rockets)
CE Mark	European Conformity mark – the product is declared by the manufacturer to comply with European product directives
Amateur	Rocketry carried out for pleasure rather than for financial gain, and where income is derived from other means than rocketry.
Professional	Rocketry carried out as a significant part of a livelihood, or sole livelihood.
S&T	The specialist sub-committee of UKRA dealing with matters pertaining to Safety and Technical issues.

1.2 Safety

Safety is the concern of all members. Members causing serious damage / injury to third parties, livestock, vehicles or property whilst involved in rocketry of any kind must report the incident in full to the Safety & Technical Committee, even if the UKRA codes of practice were not in force at the time of the incident.

The Safety & Technical Committee would appreciate reportage of minor mishaps, anonymously if preferred, to be included in any association magazine, for the education of other members.

1.3 Laws

All members of the UKRA must fly in compliance with the laws and regulations of the CAA, HSE, national and local laws, rules, regulations, statutes and ordinances.

Specifically, any member wishing to fly with motors or igniters requiring legal documentation shall ensure that they have such legal documentation, i.e.

Explosive License, Registered Explosive Store and RCA.

Your documentation should be carried with you to all launches in the event of inspection by the authorities.

The law covering the flight of rockets is described in section 96 of the Air Navigation Order 2016 (ANO). The other important existing pieces of legislation concerning rocketry are sections 240 and 241 of the ANO. These articles have been included at the rear of this safety code, in Annex B, for your reference.

Please study them carefully as they are law and breaking them will have serious implications, not only for yourself, but for the whole rocketry community.

Please be aware that there are some exemptions to Article 87A when flying rockets whose total impulse does not exceed 160 Newton-seconds.

(Specific article numbers may be subject to change throughout the life of the ANO)

1.4 Certification

Any UKRA member wishing to fly any rocket using greater than G class total impulse whilst still being covered by BMFA insurance will require HPR certification from UKRA. Certification requires a successful test flight performed before a UKRA certified Safety Officer and may also require the passing of a written multiple choice exam.

Full details of the certification process may be obtained from the UKRA Certification Guide.

UKRA members wishing to fly hybrid motors still need to be aware of the certification process and should again refer to the UKRA Certification Guide.

1.5 Insurance

BMFA cover is civil liability and personal accident insurance. Members should familiarize themselves with the scope of the cover by visiting the BMFA website (www.bmfa.org) and clicking the “Insurance” tab.

All BMFA insured flights must follow this safety code and must not fall into the Research rules of this code.

Any rocket project classified as a research rocket project may still be able to be flown

under BMFA insurance. See Section 5 - Research below.

1.6 Payloads

No UKRA member's rocket will ever carry live animals or any payload that is intended to be flammable, explosive, or harmful.

1.7 Disreputable Behaviour

If UKRA members are discovered by the Safety & Technical Committee to be employing particularly dangerous practices that could bring the British rocketry fraternity into disrepute, they will be subject to a disciplinary committee possibly leading to a ban from UKRA.

Any members found to be engaged in rocketry of a non-peaceful nature at any time, such as the fitting of explosives or incendiaries (except in very small quantities as part of a recovery / stage separation system, or as scientific payload with permission of the Safety & Technical Committee), aiming at targets, carriage of live animal payloads or members who have set out to harm others via rocketry, will face an immediate lifetime ban and may be reported to the authorities.

2 Equipment

2.1 The Rocket

2.1.1 Rocket Components / Materials

If an RSO is unhappy with a vehicle's design or structure for any reason, it is incumbent on them as a Safety Officer to take steps to ensure safe flying for all.

2.1.1.1 Strength

All rockets flown under this safety code shall be made of a minimum quantity of materials that possess suitable structural rigidity to withstand the flight stresses expected for a given rocket flight.

The Safety Officer has the right to decide, prior to a flight, that a given rocket vehicle is constructed in such a way that it is unlikely to withstand the stresses of flight and therefore prohibit the flight from taking place.

In addition to the right to cancel any flight, the Safety Officer has the right to decide that a rocket is un-flightworthy for the proposed power. This may be due to the rocket requiring additional structural reinforcement or the utilization of a less powerful motor. It could also be due to the rocket being of too heavyweight a construction to be flown safely.

2.1.1.2 Rigidity

Rockets should generally be constructed of lightweight materials capable of meeting the minimal structural loads expected during flight. The use of metal and/or highly rigid materials should be limited to the absolute minimum necessary to ensure the integrity of the rocket during flight and recovery.

The use of metal tips in nose cones is un-necessary except when transition to supersonic flight is possible. In such cases a metal tip may be required to spread out the heating from the very tip over a larger mass of heat-conductive metal, when the tip exceeds around Mach 3.

Similarly, more rigid components will tend to be required in higher impulse launches and would therefore be acceptable to ensure

UKRA will always support a safety officer who might err on the side of caution when considering if a flight can be safely made.

The Safety Officer also has the right to decide that the rocket is constructed in such a way that it must be classed as Experimental, see section 5 below.

2.1.2 Stability

Proper design procedures and tests must be undertaken to ensure the rocket's stability during flight until recovery devices are enabled. For passive aerodynamically stabilized rockets (fixed fins) the RSO must be satisfied as to the stability of the rocket.

The minimum static stability margin is between 1 calibre stable (the CP should be behind the CG by 1 body diameter). Flyers should be aware of overly stable rockets weather cocking and that the relationship between the CP and the CG changes during motor burn.

2.1.3 Structural Safety

The RSO must be satisfied that the rocket is flight worthy and sufficiently robust to survive launch, aerodynamic, and recovery system loads. Particular attention must be paid to recovery and fin attachment.

2.1.4 Recovery Devices

All rockets must use a recovery system that will return the rocket safely to the ground so it may be flown again. Rockets will use "flame-resistant recovery wadding" if wadding is required by the design of the rocket.

Where appropriate the practice of ground testing the recovery system prior to launch is recommended. This is a useful exercise, although no guarantee, to check that that the appropriate amount of black powder is used to deploy parachutes.

2.1.5 Electronic Devices

Where a rocket uses any electronic equipment, the utmost care must be taken when assembling, installing and testing. You should read the manufacturers' instructions carefully and completely, taking note of any specific points to be aware of and possess a good understanding of the device's limitations. The RSO is entitled to question you about the operation of your electronic devices.

2.1.6 Multi-Stage Rockets

For multiple stage rockets, each phase of the flight must be stable (e.g. for a 2 stage rocket, the 2 stages together must be stable as must the final stage on its own). All sections of the rocket must employ suitable recovery methods to return them safety to the ground. The RSO must be satisfied as to the stability of all phases of the rocket and the suitability of each stages recovery device.

2.1.7 Lift Generating Rockets / Boost Gliders

Winged rockets, boost gliders and rockets generating net lift are known to have especially unpredictable trajectories and extra care must be taken when flying such devices. It is recommended that when calculating the launch site dimensions for such a flight, the flyer use the next largest motor on the launch site calculation table for the determination of the required launch site dimensions.

2.1.8 Active Stabilization

Any rocket employing active stabilization will be treated as a research rocket and will operate under the rules for research flights (Section 5) detailed below.

2.1.9 Water Recovery Devices

Any rocket which is planned to land in water, should be fitted with a flotation device, a visual aid and a tracking beacon.

2.2 Motors

2.2.1 Motor General Rules

Approved solid and hybrid rocket motors may be used according to the certification levels listed below:

- All Motors up to G class Total Impulse - No certification required
- From H through to I Total Impulse - Level 1 certification required
- From J through to L Total Impulse - Level 2 certification required
- From M through to O Total Impulse - Level 3 certification required

The exception to this rule is during certification test flights when the person flying the rocket must be closely supervised by a UKRA member certified to at least the same level, to the full satisfaction of the Safety Officer.

Rockets with a total impulse of > 10,240Ns (N Class and above) will require, in addition to level certification;

- An application made to UKRA Safety and Technical committee, through the Large Rocket Scheme (See 7.1).
- Specific permission to launch from the Civil Aviation Authority (CAA).

Full details of the certification process may be obtained from the UKRA Certification Guide.

2.2.2 Solid Motors

2.2.2.1 Solid Motor Usage Rules

Within the UK, only the use of commercially available, HSE approved solid rocket motors is permitted. The motor must only be used in the manner recommended by the manufacturer. It is not permissible to alter the rocket motor, its parts or its ingredients in any way, unless following the manufacturers written instructions.

2.2.2.2 Solid Motor Classification and Authorisation

As per 2.2.2.1, within the UK, only the use of commercially available, HSE approved solid rocket motors is permitted. A commercially available solid rocket motor will only receive classification and authorisation by the HSE, once it has been granted this

HSE approval. Once a solid rocket motor has been HSE approved, classified and authorised, it will be listed by the HSE according to its United Nations Serial Number and its Hazard Classification Code.

2.2.2.3 Solid Motor CE Marking

It is the responsibility of the vendor to ensure that any solid rocket motor put on the market complies with any CE marking requirements.

2.2.3 Hybrid Motors

Only the use of commercially available hybrid motors is permitted, if a static test or a flight is not to be classed as a research static tests or a research flight. The motor must only be used in the manner recommended by the manufacturer. It is not permissible to alter the rocket motor, its parts or its ingredients in any way unless following the manufacturers written instructions.

Any static test or flight that utilises a non-commercially available or modified motor will be treated as a research static test or flight and will operate under the research rules.

To fly commercially available hybrids, the same criteria as for solid motors apply, with one addition.

- For any hybrid flight, the RSO for the flight must be certified to a minimum of UKRA Level 2, or UKRA Level 3 for flights on motors of M- class or greater.

Full details of the certification process may be obtained through the UKRA Information Pack under Section 1 – Certification.

The hybrid must also conform to the following specifications :-

i. All hybrid rocket motors must have a safe method of handling the pressurised systems associated with the hybrid rocket motor (for example; a certified pressure vessels for pre-loaded oxidiser tanks such as those used in Aerotech, Alpha and Microhybrid hybrid rocket motors, remote loading and operations of pressure systems for hybrid rocket motors such as Hypertek and Trojan, and Urbanski-Colburn valve, monotube style hybrid rocket motors such as RATTWorks, Propulsion Polymers, West Coast Hybrids, Skyripper, Contrail as well as amateur hybrid rocket motors), and the ability for the motor to be safely returned to its state prior to insertion into the rocket. The remote distance shall not, under any circumstances, be less than 100ft or 33m for both the operator, RSO and spectators. For hybrid motors of "I" and greater power, the established UKRA safe distances chart should be used in respect of anyone other than the operator and RSO.

ii. All hybrid motors used at UKRA events must either be commercially available units, or hybrids for which research approval has been explicitly issued by UKRA S&T, and should only be assembled and flown in accordance with the manufacturers instructions, or those of the builder. In the case of a commercial hybrid motor or a research hybrid motor for which UKRA S&T approval has been granted for a specific configuration, It is not permissible to alter the rocket motor, its parts or its constituents in any way.

iii. All hybrid motors constructed by UKRA members, or to the design or instruction of UKRA members, will be classified as research motors and will be subject to the research rules in Section 5.

2.2.4 Liquid Motors

All Liquid propellant static tests or liquid propellant flights will be treated as research tests and research flights and will operate under the research rules detailed below.

2.3 Igniters

2.3.1 Igniter Rules

The Safety Officer must be satisfied with the igniter system that is connected to the rocket motor. Any igniter should ignite the rocket within three seconds of the power being applied to the igniter.

Continuity tests on any motor ignition system should not be carried out whilst the igniter is fitted in the motor, unless the continuity test is an integral part of a count down sequence.

Rockets should not be left for long periods with the igniter in place.

Igniter leads should be connected / twisted together until the igniter is ready to be connected to the launch control system to prevent the risk of premature ignition from stray RF.

Motor igniters should never be installed in a solid rocket motor until the rocket is at the launch pad. Any exception to this where a rocket design does not permit this, will still not be allowed in any facility other than a safe facility designated for installing igniters for safety reasons, and separate to any rocket construction or preparation facility, spectators and non-associated personnel. If a facility is not explicitly designated as a safe facility for installing igniters, then it should never be used for installing igniters.

Igniters for ejection charges shall always be tested in designated safe facilities or designated safe areas away from third parties, and away from rocket construction or preparation facilities, spectators and non-associated personnel, as per the procedure above for igniter installation. If a facility is not explicitly designated as a safe facility for testing igniters, then it should never be used for testing igniters for ejection charges.

When an igniter test is carried out, a clear and audible warning and countdown should be give of the test, and the tester should not carry out the test until all people who are likely to see or hear the test are fully alerted and prepared for the test.

2.3.2 Hybrid Ignition Systems

In addition to the igniter guidelines issued in section 2.3.1, Hybrid rocket motors have a number of different ignition methods. The Safety Officers must be satisfied that both they and the operator understand the ignition system and that it operates safely.

2.4 Weight & Power

Any rocket must not have a mass greater than the manufacturer's recommended maximum lift-off mass for the motors used if a single motor is used. An alternative way of ensuring this for commercial kit rocket kits is to only use motors recommended by the manufacturer of the rocket kit.

For all rocket flights, the average thrust of the motor(s) being used should be at least three times the weight of the vehicle at lift off. Lower thrust/weight ratios will be classed as research flights, see the research section below.

2.5 Launch Controllers

An electrical ignition system must be used which allows for remote operation of the igniter firing. The device should be operated from at least the minimum Safe Distance as determined by the total impulse of the rocket motor(s) according to the Safe Distance Table given below. At the RSO's discretion, this distance can be reduced to 100ft (33m)

The launch controller must include a safety key to immobilise the system when removed. This key should only be in place at the time of the launch and is to be removed immediately after an ignition attempt, especially in the event of a misfire. The safety key must not be capable of being removed leaving the controller in a live firing mode.

The firing circuit must only be live for a brief period sufficient to fire the igniter and must then return to an open circuit. Where a firing button is used, it must return to the off position when released.

2.6 Launch Pad

All rocket launches will take place from a rigid launcher / launch tower / launch pad that provides rigid guidance until the rocket has reached a speed adequate to ensure a safe flight. This launch pad must be sufficiently rigid such that the top of the launch pad will not sway / deflect noticeably in the strongest launchable winds. The launcher must incorporate a blast-deflector to prevent damage to the ground.

To prevent accidental eye injury, the launch pad should be placed so the end of the rod, rail, or tower is above eye level or the end of a launch rod should be capped when approaching it. Always cap or disassemble the launch rod when not in use and never store the launch rod in an upright position.

For rockets powered with motors of M-class and above, special attention should be paid to the design of the launch pad, due to the severe forces that result from the thrust levels of a large rocket motor. The launch pad should be secured to minimize the movement of the base of the pad whilst the rocket is ascending the launch rail.

3 The Launch Site

3.1 Launch Sites

Launch sites should be a suitable open area for launching and recovering rockets. It must conform to the minimum dimensions laid out in the Launch Site Dimensions table.

Clubs and individuals are strongly recommended to register their launch sites with UKRA, who can provide advice regarding the suitability of the site and maximum size motors which can be safely flown.

Any UKRA member wishing to fly from a UKRA registered site should first liaise with the club / individual responsible for the site and should also insure that they have the land owners permission.

UKRA Registered Launch Sites must be on open, private ground and permission from the owner of the land must be obtained for access and for every launch. The site must be at least 5km from any active commercial airport.

No launch site may be used in an area where distress flares may be used by the public, such as near large lakes or mountains. Although such sites may be used if the local rescue groups / authorities, such as mountain-rescue, are given notice of the pending launch(es) and have acknowledged such notification.

The area around the location of any launch pad(s) at the site must be cleared of brown grass, dry weeds or other easy-to-burn materials to a radius of ten feet.

3.2 Range Safety Officer

A Range Safety Officer must be appointed for each launch session. This person must be a UKRA certified RSO if acting as Safety Officer during any launch of above G class Total Impulse. The Safety Officer is not permitted to fly (or have a rocket belonging to them flown) during a period of duty.

The Safety Officer should remember that he / she is in overall charge and is accountable for ensuring the safety of every launch. The Safety Officer has authority over and above all other persons present at the launch site and has the power to delay or cancel any launch until satisfied that it can proceed safely. Should other UKRA members feel that the launch would be hazardous, they should voice their concerns to the Safety Officer at the earliest point or persuade the owners of the rocket to cancel the launch.

It is important that the authority of the RSO is not understated and all UKRA members respect any decision made by an RSO on a launch day.

Any UKRA member found to be coercing, threatening or attempting to affect the decision made by an RSO may face a disciplinary hearing and probable ban from membership of UKRA.

3.3 Personnel

Only UKRA members may approach the rocket closer than the minimum safe distance during or after an igniter is being / has been installed into the rocket motor(s). Members may only approach nearer than the safe distance with the

approval of the Safety Officer. Only the minimum number of members necessary to complete the required task should approach.

The minimum safe distance is determined by the total impulse of the rocket motor(s) according to the Safe Distance Table given below.

3.3.1 Spectators

All spectators / onlookers / press at a UKRA launch must be kept at least the minimum safe distance away from the launch area as determined by the total impulse of the rocket motor(s) according to the Safe Distance Table given below.

All spectators / onlookers / press at the launch site must be warned not to recover any stage of the rocket as there may be live rocket motors and /or recovery devices onboard due to misfiring or other electronic systems failures.

3.3.2 Minders

Any persons at the launch site who cannot watch the rocket, e.g. due to their monitoring of equipment must be protected either by a physical safety barrier or by persons beside them who can watch the rocket and issue a warning or take protective action.

3.3.3 Visual Rule

All persons at the launch site are to be made aware that for their own safety they must keep their eyes on the rocket from at least two seconds before launch until either the rocket lands or until visual contact is lost.

When visual contact is lost observations must be carried out until such a point as the rocket is deemed lost or until the rocket is sighted again.

3.3.4 Disabled Spectators

Special care must be taken to ensure that any disabled spectators are catered for. Particularly, minders must be provided for disabled persons to ensure that they are aware of pending rocket launches and have the best change to avoid any incoming rockets or debris.

3.4 Documentation

If any flights are taking place that use greater than 160 Ns total impulse rocket motors, copies of the following documents should be available at the site, preferably together in a folder, for inspection by the Police and other authorities that may arrive at the site unexpectedly. Some of this documentation will be personal and some will be site specific.

- Appropriate scale maps (e.g. Ordnance Survey, Google Maps/Earth, OpenStreetMap) of the launch site and downrange area
- Aviation charts of the area
- Insurance documentation
- The Safety Officer's UKRA Safety Officer Identity Card
- This UKRA Safety Code
- Documentation for motor class, i.e. Explosives Cert, RCA and Registered Store Cert.

3.5 First Aid / Fire Prevention

A First Aid kit must be made available during every launch for minor injuries and burns, preferably with a qualified first-aid person on hand to assist.

For fire prevention, buckets of water, or preferably fire extinguishers must be available in case the ground or any other material catches fire. Pre-soaking the ground around the launcher may prevent this.

3.6 The Down Range Area

The RSO must be supplied with Ordnance Survey and aviation charts of the downrange area including the expected recovery area if these fall outside the official launch site area and he / she must be satisfied that these areas are safe.

Consideration must be given to where all stages of a multistage rocket may land. The worst case scenarios of a stage misfire or recovery device failure must be considered.

Written permission should be obtained from the owners of the land on this downrange area for access and flying of any rockets.

3.7 Dimension Tables

3.7.1 Safe Distance Table

All persons, except those required for the launch of a rocket must be kept at least the given minimum distance from the rocket motor during / after igniter installation. The launch controller should also be operated from at least this minimum distance unless express permission is obtained from the RSO. (See section 2.5 - Launch Controllers).

The RSO has the power to allow a flight of greater power than that which would be allowed by the minimum site dimensions table if he / she is happy that the proposed flight will reach an altitude equal to or less than the actual minimum site dimension of the site from which the flight is to be made. Any RSO in doubt of whether a flight can be safely made should refuse to allow the flight.

Total Impulse of all Motors (Newton-Seconds)	Equivalent Motor Type	Minimum Distance From Rocket with Single Motor in Meters (ft)	Minimum Distance From Rocket with Multiple Motors in Meters (ft)
0.00 ~ 1.25	¼A ½A	2 (7)	3 (10)
1.26 ~ 2.50	A	2 (7)	3 (10)
2.51 ~ 5.00	B	3 (10)	6 (20)
5.01 ~ 10.00	C	3 (10)	6 (20)
10.01 ~ 20.00	D	5 (16)	10 (33)
20.01 ~ 40.00	E	7 (23)	15 (50)
40.01 ~ 80.00	F	10 (33)	20 (66)
80.01 ~ 160.00	G	10 (33)	20 (66)
160.01 ~ 320.00	H	15 (49)	30 (98)
320.01 ~ 640.00	I	45 (148)	60 (197)
640.01 ~ 1,280.00	J	45 (148)	60 (197)
1,280.01 ~ 2,560.00	K	60 (197)	90 (295)
2,560.01 ~ 5,120.00	L	90 (295)	150 (492)
5,120.01 ~ 10,240.00	M	90 (295)	150 (492)
10,240.01 ~ 20,480.00	N	150 (492)	300 (984)

20,480.01 ~ 40,960.00	O	150 (492)	300 (984)

3.7.2 Launch Site Dimension Table

The Launch site should have the following minimum dimension (i.e. The launch position must be at least half the given distance from the edge of the launch site). Additionally the minimum site dimension should be equal to or greater than the predicted maximum altitude of the highest flight being made.

The largest of these two dimensions should be used.

Total Impulse of all Motors (NewtonSeconds)	Equivalent Motor Type	Minimum Site Dimensions in Meters (ft)	Equivalent Dimensions in km (miles/yards)
0.00 -- 1.25	¼A ½A	15 (49)	0.015 km (16 yards)
1.26 -- 2.50	A	30 (98)	0.03 km (33 yards)
2.51 -- 5.00	B	60 (197)	0.06 km (66 yards)
5.01 -- 10.00	C	120 (394)	0.15 km (130 yards)
10.01 -- 20.00	D	150 (492)	0.15 km (164 yards)
20.01 -- 40.00	E	300 (984)	0.3 km (328 yards)
40.01 -- 80.00	F	300 (984)	0.3 km (328 yards)
80.01 -- 160.00	G	300 (984)	0.3 km (328 yards)
160.01 -- 320.00	H	450 (1476)	0.5 km (492 yards)
320.01 -- 640.00	I	760 (2493)	0.8 km (½ Mile)
640.01 -- 1,280.00	J	1600 (5,249)	1.6 km (1 Mile)
1,280.01 -- 2,560.00	K	1600 (5,249)	1.6 km (1 Miles)
2,560.01 -- 5,120.00	L	3200 (10,498)	3.2 km (2 Miles)
5,120.01 -- 10,240.00	M	4700 (15,420)	4.7 km (3 Miles)
10,240.01 -- 20,480.00	N	6445 (21,145)	6.5 km (4 Miles)
20,480.01 -- 40,960.00	O	8045 (26,394)	8.0 km (5 Miles)

3.8 Coastal Launch Sites

For launching out to sea, care must be taken to protect any shipping in the area and for any launchings near coast, the coast guard must be warned prior to launch in case the rocket vehicle is mistaken for a maritime distress flare.

For this reason, night-time coastal launches are currently banned, unless it is November the fifth.

When launching and recovering rockets from coastal areas, please ensure you are familiar with local weather conditions and tidal patterns.

4 Flying

4.1 Launch Permission

Before launching, a UKRA member must obtain the permission to launch from the RSO.

The Safety Officer must check the rocket until he / she is satisfied that the rocket is safe and flightworthy before giving permission to launch. The Safety Officer also has the power to prohibit the use of launch equipment if he/she reasonably believes it to be unsafe.

The Safety Officer must also satisfy themselves that the person in control of the rocket is competent to do so, e.g. not under the influence of any intoxicating substance or acting in an irresponsible manner.

If any UKRA members deliberately launch a rocket, without the Safety Officer's permission, the members in question will face a disciplinary hearing and probable ban from membership of UKRA.

4.2 Launching

Before flying a rocket or commencing a launch countdown, all people in the launch area must be made aware of the impending rocket launch and must be able to see the rocket on it's launch pad.

All spectators should be at least the minimum safe distance from the rocket launch.

An electrical ignition system must be used which allows for remote operation of the igniter firing. The device should be operated from at least the minimum safe distance as determined by the total impulse of the rocket motor(s) according to the Safe Distance Table given above. This distance can be shortened with the express permission of the RSO as per section 2.5. Any igniter should ignite the rocket within three seconds of the power being applied to the igniter.

UKRA currently only recommend the use of hardwired launch systems. However, progress in stable digital control systems over recent years mean that clubs are can to use radio-controlled systems should they wish to do so. UKRA recommends that such systems are thoroughly checked and tested prior to use.

Only one person must initiate the actual launch.

The launch person must give the Safety Officer a clearly audible countdown of at least five seconds, alternatively the Safety Officer or any person recognised by all present as responsible for the countdown and authorised by the Safety Officer may announce the countdown.

4.3 Misfires

If a rocket suffers a misfire, no-one must be allowed to approach it or the launch pad until it is certain that the safety key has been removed and / or that the battery has been disconnected from the ignition system.

No one may approach the launch pad until a fixed time has elapsed. This time being, one minute for motors of G or less, or five minutes for motors

above G, after the misfire. If the rocket is a hybrid with a tank with venting capability, the RSO must ensure that the oxidiser tank has been emptied. After this time the Safety Officer should give permission for one person to approach the rocket.

Special care must be taken if the rocket employs any active electronics devices such as timers, altimeters, etc. In such cases only someone with detailed knowledge of the rockets design may approach the rocket.

All electronic systems should be capable of being disabled / disarmed, whilst still on the launch pad and without necessitating the disassembly or significant change in orientation of the vehicle.

4.4 Launch Angle

A rocket must never be launched so that its flight path will carry it against a target. Any launch pad must be pointed within 20 degrees of vertical, unless the rocket is a boost glider, rocket glider or other winged design. In this event the downrange area must be carefully considered.

4.5 NOTAM's

Where a launch may utilise airspace frequented by other air users, a NOTAM should be issued for the day and times of the rocket launch.

The CAA request that flyers inform them, ideally, four weeks in advance of the intended launch. It should be noted that for periods shorter than this, the NOTAM may not be properly distributed to all air users.

4.6 Controlled Airspace

For details of the regulations concerning launching within controlled airspace, please see Annex B, Regulation of Rockets - Article 87A of the ANO, located at the rear of this safety code.

4.7 Air Traffic

All launchings must be carried out in conditions of good visibility and clear airspace unless suitable radar equipment is available. A visual scan of the sky must be made continuously, preferable by several persons, for at least one minute before launch. The countdown should be aborted if air traffic is observed unless the traffic is clearly beyond the airspace through which the rocket will be transiting or assurances have been sought and received from Air Traffic Control that it is safe to continue.

It is the member’s responsibility to obtain aviation charts of the airspace above any proposed launch site. For more information, please see Annex B, Regulation of Rockets - Article 87A of the ANO, located at the rear of this safety code.

4.8 Flying Conditions

Rockets may be launched only in light winds of less than 20mph. Also a rocket may not be launched under conditions where the rocket will fly into clouds, unless it can be safely determined that the flight will not pose any hazard to any aircraft that may be above the cloud layer.

Rockets may not be flown when the flight might be hazardous to people, property or flying aircraft.

4.9 Recovery

If a rocket becomes entangled in a power line or any other dangerous place, no attempt should be made to retrieve it. The appropriate authority must then be informed, as soon as is reasonably practical, in order to effect a safe recovery. No attempt shall be made to catch any rocket as it approaches the ground.

Care should be taken to minimise crop damage, ground erosion and worrying livestock by members of the recovery team and their vehicles.

Only UKRA members familiar with the rocket's design should recover any stages of a rocket.

You should be aware that unfamiliar rockets may contain live motors, igniters and ejection charges which may have unpredictable results if handled. If in doubt - leave it alone.

4.10 Night Time Flying

Launching after dark is more hazardous than launching in daylight for obvious reasons. Therefore, all night-launched vehicles must be illuminated with a clearly visible active source of illumination from launch until landing. Where lights / flares would interfere with a scientific payload, for example on an astronomical mission, prior permission must be obtained from the Safety & Technical Committee for launching without lights.

The above night time rules can be waived on November the Fifth but it is still advisable to inform the Safety and Technical Committee.

This page intentionally blank

5 Research

5.1 Conditions

Any rocket or system that has been classed as a Research Rocket or Project (by a Safety Officer, the Safety & Technical Committee or it falls into a class listed below) may be allowed to fly under BMFA insurance. To qualify for such insurance this Safety Code (apart from rocket design parameters) has to be adhered to in full. The flight has also to be fully documented to the Safety & Technical Committee for their review at least thirty days before the flight and approval granted.

Any flight involving any of the following will automatically be classified as experimental:

- Powered by a Liquid propellant engine
- Powered by any motor(s) above O Class Total Impulse
- Employing active stabilization techniques
- Any home designed / built rocket of non-proven design specified as a Research Rocket or Project by the Safety & Technical Committee or the RSO.et
- Rockets containing or constructed of dense, non-deformable materials not required to ensure structural integrity of the project or required for safe and effective operation of systems such as parachute and streamer deployment, that may be considered as a Research Rocket or Project by the Safety & Technical Committee or the RSO.

The UKRA Safety & Technical Committee / RSOs have no obligation to give a member prior notice that a flight being undertaken by a member may be classified as a research flight. It is the obligation of a member to check their proposed flight with the Safety & Technical Committee (giving at least thirty days notice). The decision of the Safety & Technical Committee must be considered as final in this matter.

As the guidelines above cover such diverse and potentially complex vehicles and techniques no specific safety or technical rules can be made. It is the responsibility of the member to provide the Safety & Technical Committee with sufficient documentation and relevant research material to enable the committee to decide on the safety of the proposed flight. The Safety & Technical Committee may allow the flight to go ahead, may insist on changes before allowing the flight or may prevent the flight from taking place. The decision of the Safety & Technical Committee must be considered as final in this matter.

Upon a satisfactory review of the vehicle having taken place the Safety & Technical Committee will issue a printed and signed form, granting permission for the flight to take place. This form should be handed to the RSO on the day of the flight.

Any member found trying to circumvent this procedure or use a fraudulent form, will face a disciplinary committee and probable lifetime ban from UKRA.

5.2 Research Hybrids

The hybrid arena has in recent times become an increasingly popular area for rocketeers. The scope for designing and building your own motor is quite large with many people coming up with ever more inventive ideas and designs.

For the purpose of this document Nitrous Oxide (N_2O) based hybrids will be discussed as these comprise the bulk of the systems in use currently. The rules within this document however are to be applied to any hybrid system.

5.2.1 Pressure

One of the most important considerations is the ability of the rocket to revert to a safe and depressurised state in the event of any sort of failure.

This can be ideally be achieved, either by having a electro-mechanical device to release the nitrous oxide or by having a permanently vented system in which the pressure in the onboard tank subsides after a fixed period. Any other method of reverting to a safe state, must be satisfactorily demonstrated to the Safety & Technical Committee.

As it has been demonstrated both on paper and via live misfires, a hybrid rocket is usually of light enough construction to be propelled by escaping nitrous oxide should the worst happen and a burst disc fails or a fill stem dislodges from its seal. Due to the low thrust generated by escaping nitrous oxide, the rocket will usually be travelling at a very low speed and may have a dangerous and unpredictable trajectory.

It is therefore very important to ensure that a hybrid can be vented down to allow the safe approach of the launch crew in the event of any failure mode taking place e.g. igniter or electronics failure.

The safest and most reliable method that the Safety and Technical Committee has seen is the permanent vented onboard tank option.

5.2.2 Pressurised Gas Safety

It is very important to understand the qualities of pressurised gases such as nitrous oxide. If any part of the system leaks, the highly pressurised nitrous oxide liquid will immediately boil off to a gas. However, any exposed skin could be subject to cold burns (frostbite), if the appropriate precautions are not taken.

As with all pressure vessels, tanks should not be dropped or roughly handled and should be pressure checked and certified at fixed periods to ensure tank integrity and their continued safety in accordance with HSE legislation.

5.2.3 Manufacturing

When manufacturing your own components it is very important to recognise the conditions that you will be asking the material in question to withstand.

The Safety and Technical Committee will look closely at the nature of materials being used, not only in and around the combustion chamber (excessive heat and pressure variations), but also all parts of the nitrous oxide feed systems (excessive cold and pressure variations).

5.2.4 Ignition

There are a number of way that hybrids can be ignited but the main two are pyrotechnically and electrically.

The pyrotechnic method being the much more common option, in experimental hybrids, than the electrical method.

The Safety & Technical Committee will look carefully at the ignition method to ensure that it is the safest and most relevant method for the vehicle submitted for review.

5.2.5 Hybrid Assembly

It is important to ensure that the correct fitments are used for all fill lines, connectors and vents. The type of grease used is also very important.

Vaseline should not, under any circumstances, be used. Only the correct cryolube should be used to grease joints and fitments.

5.2.6 Specific Systems

5.2.6.1 Micro Hybrids

One of the only exceptions to the research hybrid rules and considerations is the micro hybrid. UKRA has to look at many systems on a case by case basis and in this case it was decided that these small hybrids have an inherent safety by the virtue of their low power. The modes of failure for a correctly constructed unit are no greater that the equivalently sized black powder motor. (D class)

When using the micro hybrid system, care should be take to ensure that the manufacturers / designers instructions are followed exactly.

Any member purchasing a unit and not building it, should ensure that the unit has been correctly manufactured and if the vendor is acting as a commercial venture, any appropriate legislation has been correctly followed (see section for details of appropriate legislation).

The Safety and Technical Committee would like to stress that UKRA is not endorsing this product but merely commenting on issues regarding its safety and supply.

This page intentionally blank

6 Flying Without a Safety Officer

6.1 Introduction

This set of instructions should be viewed as recommendations only and every attempt should be made to adhere to the UKRA Safety Code in full.

Where this is not possible, the member should be thoroughly familiar with the duties and responsibilities of a Safety Officer and should seek, as far as is reasonably practicable, to integrate the roles of flyer and Safety Officer.

This does not make the Flyer a UKRA certified Safety Officer, but merely makes them aware of their duties and responsibilities. It will be deemed that the flyer utilizing the following recommendations, is solely responsible for all activities concerning their launch.

It is recommended that no-one should launch a High Power Rocket whilst unaccompanied.

In practice this means the following :

6.2 In Advance of the Flight

1. Ensure correct launch site dimensions. (See UKRA Safety Code)
2. Ensure the launch site is preferably not in controlled air space and where it is, the predicted height will not impinge upon the air traffic routes. If you think it will, then permission must be gained from the appropriate ATC. UKRA can help members with assessing the suitability of flying sites.
3. Inspect the rocket, taking into consideration motor power, weight, stability and structural integrity. If at all possible show the rocket to another rocketeer, prior to the launch date, with a view to receiving suggestions and comments on features of the rocket you may have overlooked.
4. Ensure the correct functioning of all equipment especially the launch controller.
5. Ensure you have the permission of the landowner for launching and recovery.
6. Ensure the rockets total impulse is within the parameters of your current certification level.
7. Appropriate fire fighting equipment and first aid, should be on hand in the case of an emergency.
8. Ensure that there are sufficient numbers of people to keep track of all the stages of a complex vehicle. In the interests of safety, it is highly recommended that complex vehicles be launched at a UKRA event with a Safety Officer.
9. Ensure that your location and estimated timeframe are known to others.
10. Wherever possible take some form of mobile communication with you. (i.e. a mobile phone)
11. Copies of the following documents should be available at the site, preferably together in a folder, for inspection by the Police and other authorities that may

arrive at the site unexpectedly. Some of this documentation will be personal and some will be site specific.

- Appropriate scale maps (e.g. Ordnance Survey, Google Maps/Earth, OpenStreetMap) of the launch site and downrange area
- Aviation charts of the area
- Insurance documentation
- This UKRA Safety Code
- Documentation for motor class, i.e. Explosives Cert, RCA and Registered Store Cert.

6.3 Immediately Prior to, and During the Flight.

1. Make a visual check of the skies, for any aircraft.
2. Ensure that the area directly around the launch site is clear of people or animals to the UKRA Safety Distance. (see UKRA Safety Code)
3. When a Range Safety Officer is not present, always give a clear audible ten second countdown prior to launching the rocket.

6.4 After the Flight.

1. When retrieving your rocket please take into account your own personal safety when traversing difficult terrain or climbing trees.
2. Always leave the site free of litter and as you found it (especially igniter leads).

7 Special Projects

7.1 Large Rocket Scheme

The Large Rocket Scheme (LRS) is intended to be used by existing UKRA members, with level 3 certification, seeking authorization to fly certain high impulse projects (>10240 Ns) under existing BMFA insurance. Whilst such projects may not routinely be covered by their level three certification, it is possible that with approval from the Safety and Technical Committee (STC) at an early stage and mentorship through the construction process, cover can be granted. This is similar to a scheme operated by the BMFA for particularly large model aircraft projects.

Further details of the LRS and documentation are available from the UKRA web site, www.ukra.org.uk .

7.2 Team Project Support

Team project support (TPS) has been introduced to support teams of individuals, usually from a university or other recognized body, to launch a rocket safely from a UKRA supported site, with the appropriate indemnity and without the requirements normally imposed by the UKRA certification process.

Team projects have previously demonstrated detailed engineering insight and innovative solutions to the challenges of rocket flight and recovery. Nonetheless, such team projects can present significant problems for UKRA, that are not faced with individual member projects. Foremost in our concern, is that team members often lack prior rocketry experience. Furthermore, as these projects are usually to be completed in a limited period, such as the final year of a degree course, time is not available to gain sufficient experience and complete the certification process required. Finally, as certification requires an individual to have constructed a project unaided, these team projects do not conform to that certification process.

UKRA has therefore developed this process to mentor and support team-based projects. This is quite separate from high power rocketry certification but will allow access to insurance indemnity.

Further details of the TPS and documentation are available from the UKRA web site, www.ukra.org.uk .

This page intentionally blank

Annex A Launch Site Guidelines

UKRA Recommended Site Guidelines

Information Required:

- Full Affiliated Club Name or Host.
- Full contact details for club including Secretary, postal address, telephone number etc.
- Photos of the relevant flying site showing panoramic views from the launch point.
- Grid Reference Number e.g. OS Grid Ref. Cranwell N5301.80/W00028.90
- Other e.g. 9nm NE of Grantham
- State if site is in Controlled/Uncontrolled Airspace. If proposed site is in controlled airspace please state what height restrictions apply. *
- State if there are any hazardous areas e.g. Areas of special interest including intense gliding activity, parachuting and typical distance. *
- State maximum requested class of motor for site certification.
- State the times of year that the site may be used e.g. All Year round, Spring etc.
- List any facilities on or near the site for members use e.g. Toilets, telephone, car parking, pubs, shops etc.
- Full contact details for Landowners and/or Tenants if applicable.
- Permission from Landowners and/or Tenants to launch/recover rockets from the proposed site including confirmation that the proposed acts will not break local Bye Laws.
- List of local emergency services e.g. Phone Nos. and addresses of Doctors, Police, Fire Brigade, Local Airports, Electricity, Gas, Water etc.
- Copy of up to date OS Pathfinder (4cm – 1km) maps for proposed site and immediate area highlighting/indicating the following information:
- All roads and public Rights of Way.
- Proposed launch sites and access points.
- Any Site Constraints e.g. Flat, open, wooded, undulating, hedges, clear ground, arable, grass, shrub etc.
- Any Natural Hazards e.g. Ponds, lakes, rivers, marsh or wet ground, trees and hedges.
- Any Man made Hazards e.g. Overhead lines-size 240V, 33000V, telephone radio masts, towers etc.
- Information on which can be found on Air Navigation Maps.
- Please see the attached form that outlines all the relevant information.

UKRA Recommended Site Form

Full Club name or host_____

Full postal address of club secretary_____

_____

_____

Postcode_____

Telephone Number_____

Grid reference number_____

Is the site in controlled airspace? (yes/no)

If yes, state what height restrictions apply_____

State if there are any hazardous areas_____

_____

_____

What is the Maximum class of motor proposed to be flown from site_____

State the times of year that the site may be used_____

_____

_____

List any facilities on or near the site that members can use.

Where possible please indicate the positions on your site.

_____

_____

_____

Full contact details for landowners/tenants if applicable_____

_____

_____

Postcode_____

Telephone Number_____

Note: Remember to source written permission from landowners/tenants to launch/recover rockets from the site.

List of local emergency services

Doctor_____

Address_____

Telephone Number_____

Police_____

Address_____

Telephone Number_____

Fire Brigade_____

Address_____

Telephone Number_____

Local airports_____

Address_____

Telephone Number_____

Water_____

Address_____

Telephone Number_____

Electricity_____

Address_____

Telephone Number_____

Gas_____

Address_____

Telephone Number_____

Note: If you would like UKRA to assist with this process please attach relevant photographs and a copy of a map (4cm – 1km or larger scale) showing proposed site and the immediate area highlighting/indicating all roads, public rights of way, proposed launch sites and access points. Any site constraints or natural / man made hazards should also be highlighted.

This page intentionally blank

Annex B Air Navigation Order (ANO) 2016 (excerpts)

Endangering safety of an aircraft

240. A person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft.

Endangering safety of any person or property

241. A person must not recklessly or negligently cause or permit an aircraft to endanger any person or property.

Rockets

96.—(1) Subject to paragraph (2), this article applies to—

(a)small rockets of which the total impulse of the motor or combination of motors exceeds 160 Newton-seconds; and

(b)large rockets.

(2) This article does not apply to—

(a)an activity to which the Outer Space Act 1986(1) applies; or

(b)a military rocket.

(3) No person may launch a small rocket unless the conditions in paragraph (4), and any of the conditions in paragraphs (5), (6) and (7) which are applicable, are satisfied.

(4) The first condition is that the person launching the rocket is satisfied on reasonable grounds that—

(a)the flight can be safely made; and

(b)the airspace within which the flight will take place is, and will throughout the flight remain, clear of any obstructions including any aircraft in flight.

(5) The second condition is that the person launching the rocket on a flight within controlled airspace has obtained the permission of the appropriate air traffic control unit for aircraft flying in that airspace.

(6) The third condition is that the person launching the rocket on a flight within an aerodrome traffic zone of an aerodrome during its notified operating hours—

(a)has obtained the permission of the air traffic control unit at the aerodrome; or

(b)if there is no air traffic control unit, has obtained from the aerodrome flight information service unit at that aerodrome information to enable the flight within the zone to be conducted safely; or

(c)if there is no air traffic control unit and no aerodrome flight information service unit, has obtained information from the air/ground communications service unit at that aerodrome to enable the flight to be conducted safely;

(7) A flight for commercial operation purposes must be carried out under and in accordance with a permission granted by the CAA to the person launching the rocket.

(8) A flight by a large rocket must be carried out under and in accordance with a permission granted by the CAA to the person launching the rocket.