BALLISTIC PARACHUTE RECOVERY SYSTEMS (BPRS)

TL 3.27
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1 INTRODUCTION

A Ballistic Parachute Recovery System (BPRS) is a parachute system designed to recover the whole aircraft - airframe and occupant(s) - to the ground in an emergency. A BPRS consists of a parachute attached by strops to hard points on the aircraft, which is deployed by pulling an emergency handle located in the cockpit. The parachute is usually ejected from the aircraft by a (chemical) rocket, although other stored energy devices - such as compressed air - have been used.

This leaflet contains important general information for pilots, builders, owners, operators and LAA Inspectors of LAA aircraft fitted with a BPRS. It includes a detailed description of the markings and placards required to be fitted to BPRS-equipped aircraft, together with guidance on placard locations (MPD 2019-005 refers). These markings are mandatory for all LAA aircraft flying on a National (UK) Permit to Fly.

The leaflet also contains detailed information about the UK CAA's airworthiness requirements for BPRS, and the LAA's interpretation of these requirements. This is primarily aimed at those intending to design a BPRS installation for an LAA aircraft (or looking to get an existing BPRS installation design accepted).

2 IMPORTANT SAFETY CONSIDERATIONS

2.1 To deploy or not to deploy

A BPRS is undoubtedly a potentially life-saving item of safety equipment in circumstances where the occupants' chance of survival is otherwise low. Such circumstances are usually due to a loss of control. Loss of control might be due to an engineering reason such as a catastrophic in-flight structural failure or control system failure or jam, or could be due to an operational reason such as a failed spin recovery, disorientation in IMC, pilot incapacitation or mid-air collision. BPRS deployment might also be appropriate in circumstances where the chance of making a survivable landing is low, such as following engine failure over mountainous terrain, or inadvertently 'stuck' over unbroken cloud.

Unfortunately, deployment of a BPRS is not without its own risks. Once the BPRS has deployed, the pilot has little control over the aircraft's impact point (although the rudder may retain some effectiveness). Also, the descent rate under the parachute is high, so the chance of injury in the impact is not insignificant - even if impacting on level ground. Significant airframe damage is almost inevitable (if the aircraft is not already damaged prior to impact). There is also a risk that the parachute only partially deploys, which may make matters worse if the aircraft is otherwise still (partially) controllable.

In conclusion, it is generally accepted that a BPRS provides a chance in an otherwise irretrievable situation. The system should only be deployed if the chance of survival is otherwise low.

2.2 Deployment actions

The BPRS system manual and/or aircraft manual should provide specific instructions regarding deployment of the BPRS system in question, including any specific instructions for the installation and aircraft type in question. The considerations below are more general.

In order to maximise the chances of successful parachute deployment it is normally strongly recommended to stop the engine prior to deploying a BPRS to ensure the propeller does not impede successful parachute deployment. This is particularly important for pusher aircraft. However, there are circumstances where delay might be fatal and the BPRS should be deployed immediately. These include where the pilot is struggling to identify or reach the ignition switches

(e.g. in a high rotation-rate spin), or where the aircraft is already travelling very fast and accelerating (e.g. following an in-flight structural failure), or in an emergency at a very low height.

Once the parachute has deployed, ensure the ignition switches are off and tighten safety harnesses. If there is time, turn the fuel off and make a mayday call. Prior to landing, brace for impact. Ballistic Recovery Systems Inc (BRS), in their owner's manual, recommend placing both hands behind the head with fingers entwined, so that the arms protect the head and face. If there is a surface in front that an occupant's head is likely to strike in the impact (e.g. an instrument panel in a 'tight' cockpit), it is generally recommended to place both hands on that surface.

2.3 Specific emergency scenarios

The circumstances under which a BPRS is deployed are always exceptional. Therefore, it is difficult to give definitive guidance about what is most appropriate in a particular situation. Nonetheless, this section provides some considerations for particular emergency scenarios.

- Ditching
  There are arguments for and against deploying a BPRS if a ditching is unavoidable; note that a large majority of occupants of light aircraft (without BPRS) involved in a ditching survive the water landing itself without serious injury (surviving the cold until being rescued is the more hazardous part of the undertaking).
  By not deploying the BPRS, the pilot can control the direction of landing with regard to wind direction and swell direction. However, the water impact will likely be at a higher forward speed than with the BPRS deployed.
  By deploying the BPRS the pilot loses control of the impact point and direction. Although the forward speed will be slower, the vertical impact speed will be much higher than in a well-executed controlled landing. Even in relatively light winds, the parachute may drag the aircraft through the water after impact, making it difficult to safely vacate.
  Before commencing a water crossing in a BPRS-equipped aircraft, consider what to do if a ditching becomes necessary, taking into account the characteristics of the aircraft, as well as the weather and water conditions on the day.
- Engine fire
  There are a number of reasons why deploying a BPRS in case of an engine fire might not be a good idea. Firstly, by not deploying the BPRS the engine can continue to be run to consume the fuel downstream of the fuel cock (whereas if the engine is turned off prematurely in order to deploy the BPRS, this fuel remains available to feed the fire). Secondly, by not deploying the BPRS a sideslip can be used to reduce the effect of the fire on the cockpit. Thirdly, if the BPRS is deployed while the aircraft is alight, the fire may burn through the BPRS strops, risers or lines. However, if the fire has not been brought under control, and the pilot is losing control, deploying the BPRS might be the last viable option.
- Pilot incapacitation
  Passengers should always be briefed before flight on the BPRS deployment handle. However, the content of the brief is very dependent on the passenger's circumstances. For example, an adult familiar with flying may be given instructions on its use, whereas a young child may just be told not to touch. If appropriate, brief the passenger on making a mayday call in case the pilot is incapacitated. Depending on their level of training, a pre-solo student pilot might be better-off attempting to land the aircraft.

2.4 Accidental deployment

If the BPRS is accidentally fired on the ground, the rocket has the potential to cause serious injury or death to anyone in its way. It will also damage the aircraft and, if outside, any wind is likely to inflate the parachute and drag the aircraft causing further damage as well as risking injury to anyone in or near the aircraft.

Therefore, the system should only be armed (usually by removing a safety pin) for flight: do not remove the safety pin until the occupants are secured in the aircraft, and replace it before the occupants depart the aircraft after flight. Add these actions to pre-take-off and shutdown checklists.

2.5 UK approval

The UK CAA takes an interesting position on approving BPRS installations. It requires that BPRS installations be safe ***when not deployed***, but does not require that the installation deploys correctly, or safely recovers the aircraft when deployed. Unfortunately, this means that UK approval does not provide much assurance that a BPRS installation will work when required. For more information on this see Section 4.

3 OWNER/OPERATOR INFORMATION

3.1 Installation approval

BPRS installations in LAA aircraft must be approved: either as a Prototype Modification (ref TL 3.01), LAA Standard Modification (listed on the LAA website), or Standard (factory) Option (listed on the TADS for the type). In some cases, the BPRS installation might be an integral part of the type design, and approved as part of the LAA's acceptance of the type.

3.2 BPRS maintenance and removal

In general, a BPRS in an LAA aircraft is considered an item of optional equipment (the exception being some Microlights that are legally required to have a serviceable BPRS fitted - see Section 3.2.3.). Unlike many items of optional equipment, which introduce only limited hazards to the aircraft, a BPRS has the potential - if carelessly operated or poorly maintained - to be extremely hazardous to the aircraft, its occupants, or third parties. The maintenance requirements for BPRS in LAA aircraft are set accordingly.

Note that, if a BPRS-equipped aircraft has operating limitations specific to the BPRS, the aircraft's Operating Limitations document may have to be amended if the BPRS is unserviceable or removed from the aircraft - contact LAA Engineering to arrange. The only exception to this is if the unserviceability/removal is both temporary and short term, while the problem with the BPRS resulting in its unserviceability/removal is resolved.

3.2.1 Maintenance

BPRS must be maintained in accordance with the manufacturer's instructions. Note that re-packing the parachute and servicing the rocket are specialised tasks that are often specified as only able to be done by the manufacturer.

If scheduled maintenance is not performed, the system must be considered unserviceable, and the deployment handle clearly marked as such. However, if required maintenance affecting the rocket is not performed (e.g. after expiry of the rocket's service life) the aircraft must not be flown unless the system is removed. This is because, without information to the contrary, the stability of the rocket may be adversely affected.

Maintenance of the BPRS system must be recorded in the airframe logbook. If the maintenance involves disturbing the system (more significant than straightforward inspection) the work must be inspected and signed-off by an LAA Inspector prior to flight.

3.2.2 Removal (and replacement)

A BPRS system may be removed, in whole or in part. This might be permanent removal, or temporary removal for maintenance/replacement. Follow the manufacturer's instructions and

take extreme care not to accidentally fire the rocket. Any parts of the installation not being removed (e.g. brackets, cables and strops) must be secured and not able to affect safe operation of the aircraft. Unless the BPRS is already listed as an item of optional equipment, an amended weight report must be generated; note that removal of the system will affect the centre-of-gravity of the aircraft as well as its empty weight. The work must be recorded in the airframe logbook, and inspected and signed-off by an LAA Inspector prior to flight.

If removal requires significant modification, or repair, of the aircraft this will require explicit approval by LAA Engineering.

3.2.3 BPRS-equipped Microlights

The UK Microlight definition contains a higher Maximum Take-Off Weight (MTOW) limit for (landplane) Microlights fitted with a BPRS. In particular, a two-seat Microlight fitted with a BPRS can have a MTOW of up to 472.5kg, whereas without a BPRS the MTOW cannot exceed 450kg.

A few BPRS-equipped LAA Microlights take advantage of this and are approved to operate at 472.5kg. Some of these aircraft require the BPRS to be fitted, because they are too heavy (empty) to operate at 450kg. (The CAA specifies a minimum difference between the basic empty weight and the maximum take-off weight of a UK Microlight, to stop aircraft that are too heavy to operate as a practical two-seater being classified as such.)

If the BPRS in a Microlight with a MTOW of 472.5kg (or other MTOW exceeding 450kg) is unserviceable, or needs to be removed, the aircraft will require its MTOW to be changed to 450kg to remain legal - contact LAA Engineering to arrange. If the aircraft is too heavy (empty) it will not be possible to permanently remove the BPRS, but it might be possible to authorise continued operation for a limited period of time while the unserviceability is resolved.

3.3 Aircraft maintenance and inspection

Whenever working on a BPRS-equipped aircraft, ensure that the BPRS is first made safe (or as safe as possible) in accordance with the manufacturer's instructions. Take great care when doing any work that could possibly interfere with the activation handle or cable, and potentially cause the BPRS to be fired.

People, such as inspectors and aircraft engineers, who work on aircraft that they may not be familiar with, should get into the habit of always checking whether a BPRS is installed before commencing work.

3.4 Rocket shipping

The rocket component of a BPRS usually contains a chemical explosive that cannot be made entirely safe, and is, therefore, classed as dangerous goods (or hazardous materials) with respect to UK and international transport and shipping legislation. If the manufacturer requires the rocket to be returned at the end of its life, ***do not*** send using a 'normal' postal/shipping service. Contact the BPRS manufacturer, or their UK agent, for advice as they normally have suitable arrangements already in place.

4 DESIGN CONSIDERATIONS

4.1 Approval basis

BPRS installations in LAA aircraft are approved against the requirements in Sub-Section K of BCAR Section S (CAP 482). Although BCAR Section S is primarily intended for Microlight aeroplanes, the BPRS requirements in Sub-Section K are also relevant and applicable to other light aircraft.

BCAR Section S considers BPRS to be 'unapproved' equipment. The scope of the requirements is limited to ensuring that 1) while the system is not deployed the installation does not compromise the airworthiness of the aircraft, 2) the risk of unintentional deployment is minimised, and 3) occupants and third parties - in particular emergency services and first responders - are aware of the presence of the system. Neither correct deployment, nor the ability of the system to safely recover the aircraft and its occupants to the ground, are addressed by the requirements.

The advantage of this very limited scope is that it is relatively straightforward to demonstrate compliance with the requirements. The disadvantage is that approval provides little assurance that the system will be successful in recovering the aircraft!

4.2 Design guidance

Despite the very limited scope of Sub-Section K, BCAR Section S does provide a useful list of design considerations for BPRS installations, which are contained in the AMC to S 2003. Although useful, these considerations offer little in the way of quantitative guidance (e.g. for parachute strop mounting point strength).

Therefore, in addition to the installation documentation specific to the particular BPRS being installed, for design guidance it is worth looking at the following documents:

- ASTM F2316 "Standard Specification for Airframe Emergency Parachutes"
  This is the standard for Light Sport Aircraft, which is called up (at issue F2316-08) by EASA's CS-LSA. At the time of writing (March 2020) the latest issue is F2316-12 (dated 2012; reapproved 2014). This standard addresses the design of the BPRS system itself in addition to the design of a particular installation. It therefore adopts a collaborative approach between BPRS manufacturer and installation designer to ensure that the BPRS deploys and recovers the aircraft successfully.
- LTF-UL
  This is the German standard for ultralight aircraft (up to 600kg). At the time of writing (February 2020) the latest issue is dated 15 January 2019. This standard contains explicit requirements on the strength of parachute strop mounting points.
- GENERAL INSTALLATION GUIDE FOR BRS-6™ EMERGENCY PARACHUTE RECOVERY SYSTEMS
  Although this document is specific to Ballistic Recovery Systems Inc (BRS) products, it contains practical design advice applicable to any BPRS installation.

4.3 Miscellaneous points

- Design of the release control (ref AMC to BCAR S 2003, item 6c)
  Unless the handle location is such that the risk of inadvertent deployment (even after an accident) is very low, the LAA normally requires a twin action to deploy the system. If the deployment mechanism does not incorporate a twin action as standard it is normally relatively straightforward to engineer. For example, addition of a cable tie that requires a twist of the handle to break before it can be pulled.
- Routing of strops and deployment paths
  The strops must be routed so that they are unlikely to injure the occupants as they deploy (in addition to supporting the aircraft satisfactorily once deployed).
- Strength of mounting structure
  The mounting structure for the BPRS must be strong enough to support the (undeployed) BPRS in all flight, ground and emergency landing cases.

5 PLACARDS AND MARKINGS

The presence of an unexploded BPRS rocket in a crashed aircraft is a significant hazard to the emergency services, first responders and members of the public who attempt to assist the occupants. Following an accident to a BPRS-equipped SportCruiser, the Air Accident Investigation Branch (AAIB) raised concerns about the warning and information markings on BPRS equipped aircraft, and made various recommendations (AAIB Report EW/C2014/08/01 in Bulletin 5/2015). The CAA responded by reviewing and updating its BPRS placard and marking requirements, which were published in issue 7 of BCAR Section S in December 2018, and subsequently mandated for all BPRS-equipped aircraft operating on a UK Permit-to-Fly by MPD 2019-005. These updated requirements are heavily based on the FAA (USA) and EASA (EU) requirements for BPRS in Light Sport Aircraft.

Note that this Technical Leaflet is only a guide; see BCAR Section S and the MPD for the definitive requirements (including minimum placard sizes).

5.1 External placards and markings

The rocket egress panel or area must be outlined with a black and yellow chequered line. Additionally, a Danger placard with a 'STAY CLEAR' information panel must be positioned on, or adjacent to, the egress area. See figure 1.

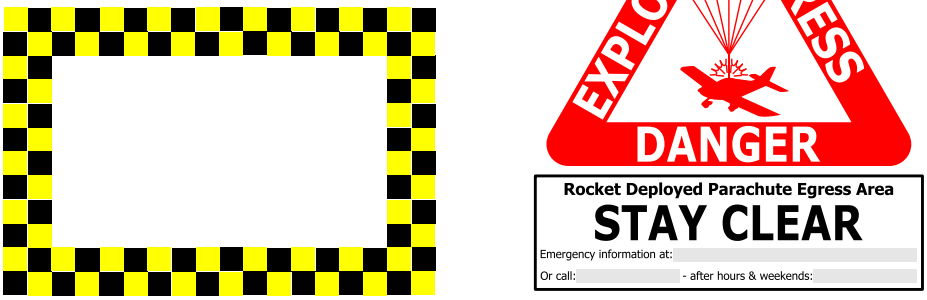


Figure 1 Egress area marking and Danger placard (not to scale)

Ensure that the markings do not accidentally reinforce any frangible egress area! The information panel on the Danger placard must contain emergency contact information for the BPRS manufacturer. These are generally available on the BPRS manufacturer's website.

In addition to the egress area, the aircraft must also display the placards shown in figure 2.

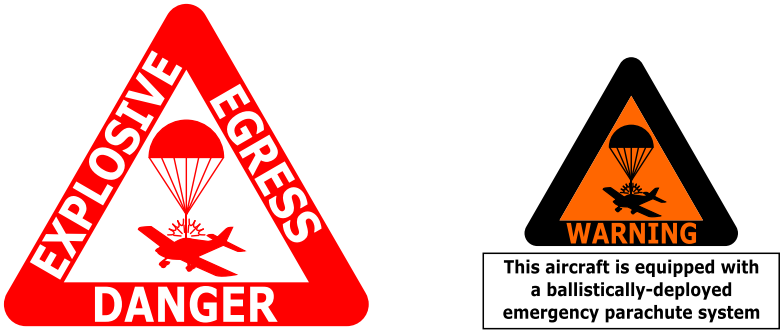


Figure 2 General Danger placard, and Warning placard (not to scale)

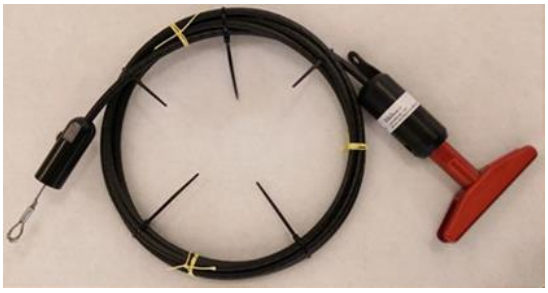
The general Danger placards are intended to warn third parties - in particular emergency services and first responders - of the presence of the system. These placards must be applied in such a manner that at least one such placard should remain visible regardless of the stationary attitude of the aircraft, which following a crash may include unusual and inverted attitudes.

The Warning placards must be placed adjacent to doors, or entry points, such that they are obvious to anyone entering the aircraft.

Note: Packs containing all the external Placards and Markings required to comply with MPD 2019-005 are available to purchase from the LAA Online Shop.

5.2 Internal placards and markings

The activation handle must be red. A Warning placard must be affixed adjacent to it. See figure 3. Note that the text '*Action to be taken*' is a placeholder for instructions on how to deploy the system.



WARNING - EMERGENCY PARACHUTE

(Action to be taken)

Unapproved Equipment - See Pilot's Handbook

Figure 3 Activation handle (image courtesy of BRS Aerospace) and Warning placard

The BPRS system rocket housing itself must have a danger placard fitted. This is a proprietary placard provided by the BPRS manufacturer. See figure 4. Note that the placard shown here is purely an example to illustrate the intention.

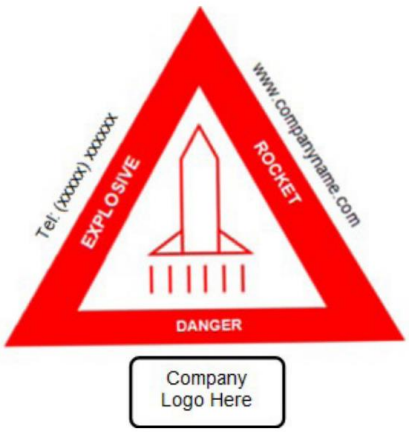


Figure 4 Rocket Danger placard (source: BCAR Section S)

APPENDIX 1 - EXTERNAL PLACARD LOCATIONS

This appendix provides general guidance on the location of external placards and markings in order to comply with BCAR Section S and MPD 2019-005. Note that this is only guidance material; see BCAR Section S and the MPD for the definitive requirements.

If unsure about placard and marking placement, please contact LAA Engineering for advice.

Note: Packs containing all the external Placards and Markings required to comply with MPD 2019-005 are available to purchase from the LAA Online Shop.

A1.1 Warning placards

A Warning placard must be placed on each occupant entry point such that it is obvious to anyone entering. Normally, the placard should be placed adjacent to a door (or opening canopy), rather than on the door itself, so that it remains visible to a person entering once the door is open.

Figure A1.1 shows the typical locations for these placards for a high wing aircraft.

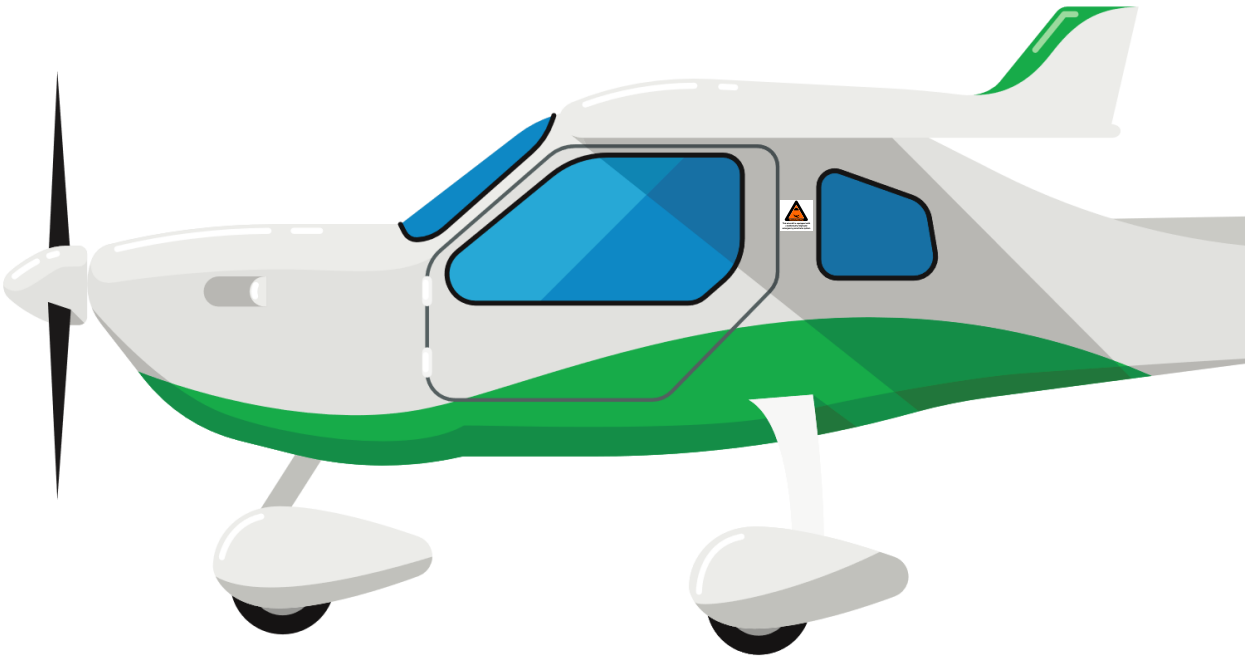


Figure A1.1 Warning placards - typical high wing aircraft

For a low wing aircraft with a canopy, the best locations will be dependent on how the canopy opens (e.g. hinged or sliding) and how people enter the aircraft (e.g. from in front or behind of the wing). Again, a placard must remain visible to a person entering the aircraft once the canopy is open.

A1.2 Egress area marking and Danger placard

The egress area must be (quote) 'outlined' using a black and yellow chequered line.

If there is a distinctive exit panel then this is straightforward. The chequered line can be located either just outside, or just inside, the edge of the panel, but make sure the tape does not reinforce the panel's attachment to the aircraft.

If the exit is more nebulous (e.g. where the rocket bursts through a fabric panel), the chequered line must highlight the actual exit point and be large enough to be clearly visible. 300mm square or diameter is a recommended minimum size for reasonable visibility. Ensure that the markings do not accidentally reinforce a frangible panel.

A Danger placard with the 'STAY CLEAR' information panel must be positioned on, or adjacent to, the egress area.
Figure A1.2 shows an aircraft where the BPRS exits from the top of the fuselage as an example. Similarly, figure A1.3 shows an aircraft where the BPRS exits from the side of the fuselage.

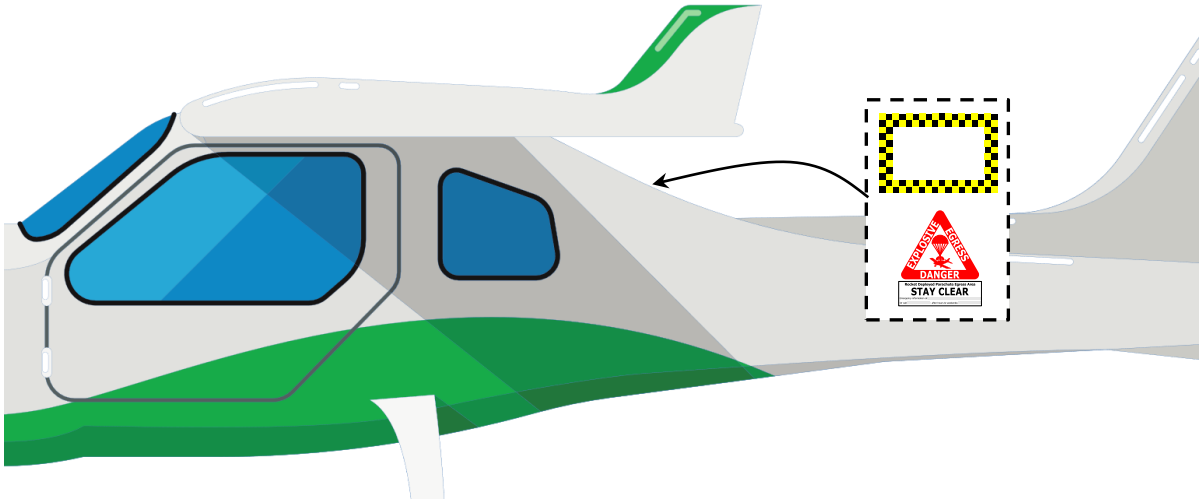


Figure A1.2 Egress area marking and placards - top of fuselage BPRS exit point

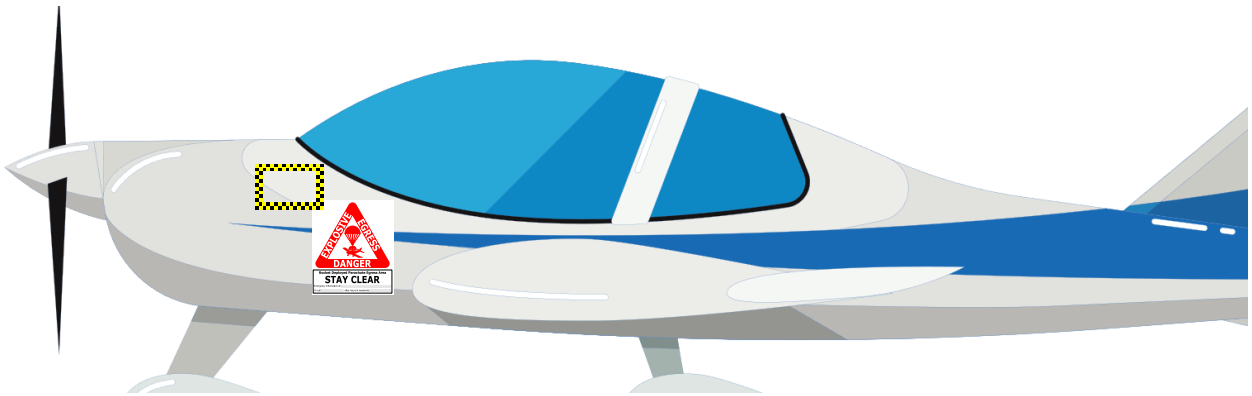


Figure A1.3 Egress area marking and placards for side-exiting BPRS - in this case there is no need for another Danger placard on this side of the aircraft

A1.3 General Danger placards

The intention of these placards is to make it abundantly clear that there is a potentially hazardous explosive device on board - particularly if the aircraft has been involved in an accident.

One of these placards should be placed on each side of the aircraft fuselage in plain view. An additional placard should be placed on the underside of the aircraft.

When deciding on Danger placard locations, things to consider include:
- Avoid placing placards where they are partially obscured, such as underneath the horizontal tail-plane, or underneath the mainplane on a mid-wing aircraft.

- A very common accident type is the forced landing into a field. The aircraft often comes to rest in long grass or crop with a collapsed undercarriage. Avoid placing placards close to the bottom of the fuselage sides where they are likely to be obscured, or even erased, in this situation.
- Avoid placing placards on engine cowlings, fairings, or any other part of the aircraft that is likely to become detached in an accident. Also, avoid the very front of an aircraft - even if not clad in detachable fairings - as this tends to be the area that takes the brunt of an accident.
- Try and avoid placing the placard on the underside of the aircraft where it will get obscured by mud kicked up by the nosewheel in winter.

To illustrate the point, Figures A1.4 and A1.5 show areas to avoid placing Danger placards on typical high-wing and low-wing aircraft respectively.

If the BPRS exits from the side of the aircraft, the Danger placard (with 'STAY CLEAR' information panel) may double as the general Danger placard for that side of the aircraft. See figure A1.3.

Figure A1.4 Typical areas to avoid placing Danger placards - see main text for details

Figure A1.5 Typical areas to avoid placing Danger placards - see main text for details

Please report any errors or omissions in this Technical Leaflet to LAA Engineering: engineering@laa.uk.com.