



BSI Standards Publication

Guidance for the selection, installation and use of vehicle security barrier systems

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Summary of pages

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Foreword

This PAS was sponsored by the UK Government's Centre for the Protection of National Infrastructure (CPNI). Its development was facilitated by BSI Standards Limited and published under licence from the British Standards Institution. It came into effect on 31 August 2013.

Acknowledgement is given to the following organizations that were involved in the development of this guide as members of the steering group.

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- Transport Research Laboratory (TRL).

Acknowledgement is also given to the valuable contribution made by those organizations that reviewed the working drafts of PAS 69 and who submitted comments for consideration.

Supersession

This PAS supersedes PAS 69:2006, which will be withdrawn on publication of this PAS.

Information about this document

PAS 69 has been updated and extended in the light of recent industry developments and changes to good practice for the installation, selection and use of vehicle security barriers.

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This PAS is not to be regarded as a British Standard. It will be withdrawn upon publication of its content in, or as, a British Standard.

The PAS process enables a document to be rapidly developed in order to fulfil an immediate need in industry. A PAS may be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

Relationship with other publications

PAS 68 was originally developed alongside PAS 69 and is an impact test specification for vehicle security barriers.

An international workshop agreement (IWA) is currently in development for the International Organization for Standardization (ISO) that covers similar content to PAS 68 and PAS 69. However, both PAS 68 and PAS 69 are well-established in the UK and they are being revised to meet immediate industry requirements and developments in the vehicle secure barrier (VSB) industry since their last publication.

Presentational conventions

The guidance in this standard is presented in roman (i.e. upright) type. Any recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a PAS cannot confer immunity from legal obligations.

Particular attention is drawn to the following specific Acts:

- The Data Protection Act 1998 [1];
- The Equality Act 2010 [2].

Introduction

The purpose of PAS 69 is to provide guidance on the effective specification and implementation of vehicle security barrier (VSB) systems. It has been developed with the intention of being used by security practitioners such as project managers, planners, architects, civil engineers, VSB designers, installers, security managers and facilities managers within the public and private sectors.

PAS 69 has been developed to complement PAS 68, *Impact test specifications for vehicle security barriers*, which addresses the needs of organizations requiring VSB systems with a specific level of resistance to hostile vehicle impact.

PAS 69 highlights the numerous issues to be addressed when considering the implementation of VSB systems as part of a holistic security system. The topics considered are by no means exhaustive, and the practitioner is encouraged to consider additional questions and responses to cater for specific requirements.

A holistic security system is likely to require integration of a VSB system with one or more security features including: pedestrian perimeter barriers, building fabrics, perimeter intruder detection systems (PIDS), intruder detection systems (IDS), access control, CCTV and security lighting. All of these features require appropriate management throughout their life cycle and are directed by clearly defined security procedures.

The mitigation of all vehicle-borne threats whilst maintaining all other needs can be difficult, especially when numerous project constraints are applied. Competing needs and the requirement to ensure fully integrated security can compromise the effectiveness of individual elements. In order to achieve an integrated system it is imperative from the outset to define the requirements of the site in terms of security and operational performance. This is where careful thought and production of an operational requirements document (OR) can add significant value to the whole process, from specification through to installation, commissioning, implementation and planning for future threats.

This edition of PAS 69 introduces the concept of a VSB system scoping document, based on the OR, which can be used by security practitioners to analyse and compare the precise design and functionality of each proposed VSB system.

1 Scope

PAS 69 provides information and guidance for the selection, installation and use of vehicle security barrier (VSB) systems deployed to mitigate threats from vehicle-borne attack as part of a holistic security system.

NOTE The detailed process of producing operational requirements is given in the CPNI documents, Guide to producing operational requirements for security measures [3] and Level 2 operational requirements for hostile vehicle mitigation measures [4]. A VSB scoping document that can be used by security practitioners to compare and contrast proposed VSB solutions from suppliers is given in the CPNI document, Vehicle security barrier scoping document [5].

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

PAS 68, *Impact test specifications for vehicle security barrier systems*

3 Terms and definitions, and abbreviations

3.1 Terms and definitions

For the purposes of this PAS, the terms and definitions given in PAS 68 and the following apply.

3.1.1 **operational requirements document (OR)**

statement of needs based upon a thorough and systematic assessment of the problems to be solved and the desired solutions

3.1.2 **blast stand-off distance**

defined distance between a critical asset and the enforceable secure perimeter

3.1.3 **secure area**

area surrounded by a secure perimeter

3.1.4 **secure perimeter**

boundary consisting of one or more physical security features (e.g. pedestrian perimeter barrier combined with one or more VSB systems)

Note See also 11.2.

3.1.5 **site**

location within which a secure area could be situated

3.1.6 **traffic calming**

intelligent highway design or deployment of physical measures on the highway such that vehicles are encouraged to reduce speed

3.1.7 **traffic management**

segregation, guidance and diversion of vehicles to help mitigate potential hazards, reduce congestion and enhance the safety of road users and personnel working close to, or on, the highway

3.1.8 **vehicle**

3.1.8.1 **hostile vehicle**

vehicle used with malicious intent to access a secure area or deliver an explosive device

3.1.8.2 **legitimate vehicle**

vehicle which has been permitted access to a secure area not being directly used with malicious intent to access a secure area

3.1.9 **vehicle security barrier (VSB) system**

physical vehicle barrier, operating mechanism, power source and associated controls used to prevent or control vehicle access

3.2 Abbreviations

For the purposes of this PAS, the abbreviations given in PAS 68 and the following apply.

AACS	automatic access control system
ANPR	automatic number plate recognition
CAD	computer aided design
CCTV	close-circuit television
GPR	ground penetrating radar
HVM	hostile vehicle mitigation

IDS	intruder detection system
IED	improvised explosive device
MO	modus operandi
O and M	operation and maintenance
OR	operational requirements document
PC	personal computer
PCB	printed circuit board
PIDS	perimeter intruder detection system
PLC	programmable logic controller
UPS	uninterruptible power supply
VACP	vehicle access control point
VBIED	vehicle borne improvised explosive device
VDA	vehicle dynamics assessment
VRM	vehicle restraint measure
VSB	vehicle security barrier

4 Vehicle restraint measure (VRM)

4.1 General

Vehicle restraint measure (VRM) is a term used to describe any physical feature or system that is employed to influence driver behaviour or affect their vehicle movement, such as:

- horizontal deflections (e.g. corners or chicanes);
- traffic control barriers (e.g. for car park control);
- road kerbs;
- earthworks (e.g. ditches and bunds).

A VRM could have a minor effect on vehicle speed or direction if struck, but should be considered ineffective against determined encroachment or penetrative vehicle attack.

Security threats have encouraged the rapid development of VSB systems. Under the umbrella term VRM, VSB systems can also be split into three categories (see 4.2 to 4.4).

4.2 Access control

Access control VSB systems are used to control the movement of vehicles and are typically used as revenue control systems, e.g. at a public car park. These types of barrier tend not to have any structural resilience for prevention of unauthorized vehicle access, tamper or vandalism.

4.3 Anti-ram

Anti-ram VSB systems are often used at sites where it is necessary to control the movement of vehicles and also to deter and provide delay to vehicle-borne attack at the site perimeter. These types of barrier typically appear structurally robust though they might or might not have been tested against vehicle impact. These systems typically take the form of bollards, road blockers or heavy duty gates.

4.4 Counter-terrorist

Counter-terrorist VSB systems aim to mitigate both terrorist and criminal threats from vehicle-borne attack. The majority of these VSB systems are designed to be structurally resilient to vehicle impact and aim to provide enforcement to traffic calming as well as deterrence and delay to determined hostile vehicle attack. These VSB systems are typically deployed at sites deemed to be critical to national infrastructure. They are increasingly used in crowded places, transport interchanges, military and foreign locations.

NOTE Further information regarding protection against terrorism and business continuity can be found in the following publications: Pursue, prevent, protect, prepare – The United Kingdom’s strategy for countering international terrorism [6], Protecting against terrorism [7], Secure in the knowledge – Building a secure business [8], Expecting the unexpected – Business continuity in an uncertain world [9].

5 Types of VSB system

5.1 General

A VSB system stops encroachment and penetrative vehicle-borne attack. A VSB system is structural in nature and can be passive (static, fixed, not operable, but can be moved or removed manually; see 5.2) or active (moving, operable either manually or powered; see 5.3). VSB system designs are continually being developed, resulting in the availability of a wide range of products with different specifications.

For new build developments in the public realm, VSB system selection should be incorporated at the initial design stage so that the VSB systems can be fully integrated from the outset. A balance should be struck between proportionate security measures, and, for example, the needs of the local businesses and functionality of public space.

NOTE Further information regarding VSB system design can be found in the CPNI publication, Integrated security – A public realm design guide for hostile vehicle mitigation [10], Vehicle security barriers within the streetscape [11]. See also the CPNI and DfT traffic advisory leaflet, Bollards and pedestrian movement [14].

Bespoke VSB systems can be integrated into public sites, and often they can be developed to be multi-functional. Examples include:

- 1) integrated street furniture;
- 2) decorative, structural or energy-absorbing planters;
- 3) strengthened light-weight structures;
- 4) shrouded or cosmetically clad bollards;
- 5) landscaping features.

If practicable, a design that includes only passive VSB systems that restrict all vehicle access is preferable as it automatically removes threats to the site from deception, duress, tailgating or tampering with control apparatus. There are also other operational benefits, including: reduced maintenance costs, fewer operators and a lower risk of accidental misuse.

5.2 Passive VSB systems

5.2.1 General

Passive VSB systems include the following:

- a) earthworks (e.g. ditches or bunds);
- b) bollards (e.g. fixed or removable);

- c) planters;
- d) integrated streetscape elements (e.g. seating, walls, balustrades);
- e) wire-rope fencing;
- f) re-deployable barriers (e.g. modular units that can be built up to the required dimensions).

Some of these passive VSB systems are discussed in more depth in 5.2.2 to 5.2.6.

5.2.2 Earthworks

There might be naturally formed barriers located around a site that could be used as part of a secure perimeter. Natural barriers include: rivers, ponds, lakes, densely-wooded areas, steep slopes or changes in ground level that either divert attack or that preclude vehicle passage.

Where these features do not naturally occur, it might be feasible to engineer them. The recommended solutions are to construct a ditch or a bund, or a combination of the two. These are often preferred solutions due to:

- cost (simple designs reduce costs for long perimeters);
- availability of local materials or lack of production facilities (e.g. in remote locations);
- ground conditions (e.g. underground services preclude excavation for VSB system foundation construction); and
- architectural advantage (e.g. to blend in with the landscape).

5.2.3 Ditches

A ditch can prevent or delay a hostile vehicle from gaining access to a secure area. Assuming that the ground level is equal on either side of the ditch, the speed required for a vehicle to successfully traverse the ditch increases in proportion to the ditch width.

The approach to a ditch should be rendered smooth and, wherever practicable, include a downhill slope leading to the ditch. If the approach to the ditch is uneven, there is potential for the vehicle suspension to compress on approach and then rebound. If this happens just before reaching the front edge of the ditch, launching of the vehicle occurs, taking the vehicle up and across the ditch.

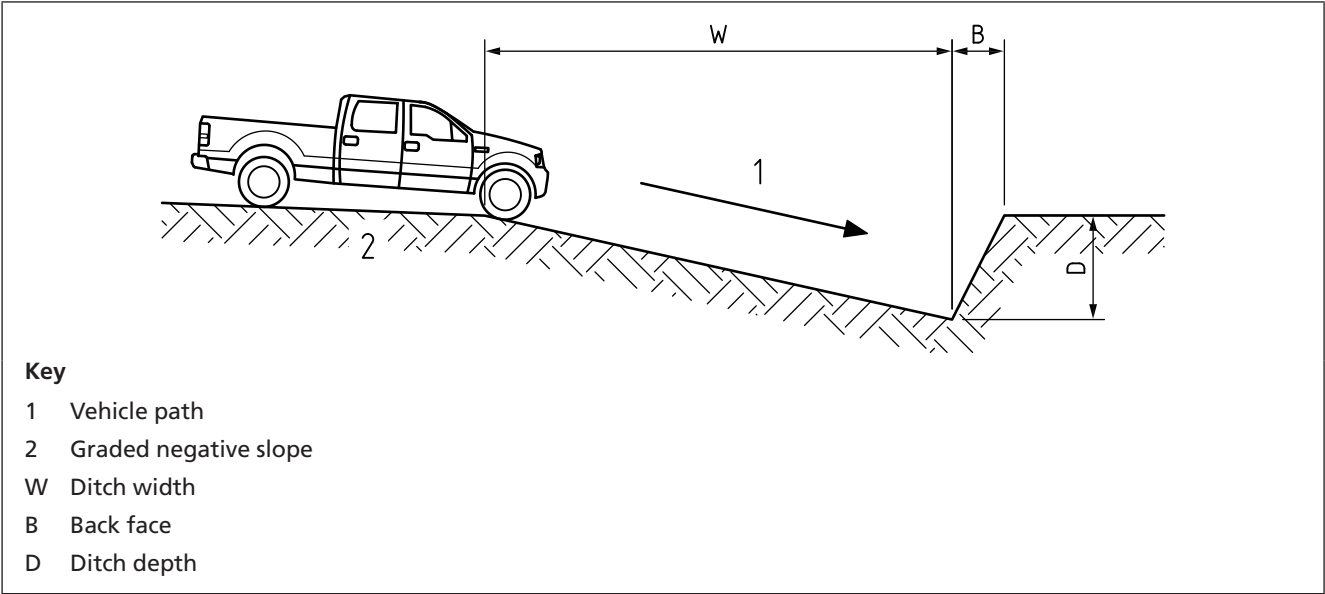
If the ditch is too narrow, on approach, the suspension and wheels might drop down into the ditch but the main vehicle body would not have time to react and fall. As the vehicle traverses, the dropped suspension could allow the wheels to contact the back face of the ditch and compress, allowing the vehicle to cross the ditch without effect or restraint.

NOTE 1 The suspension characteristics of 4x4 vehicles play an important role in the vehicle's ability to traverse a ditch. A shallow entry "V" ditch, as shown in Figure 1, offers the optimum ditch protection against an attack from a 4x4 hostile vehicle.

A ditch is specified by the following dimensions (see Figure 1 and Figure 2):

- *ditch width (W)*. This should be measured from the front edge of the ditch where the down-slope begins, to the bottom of the back face;
- *back face (B)*. This should be sufficiently steep angled at a minimum of 50°, as measured at a horizontal from the lowest point of the ditch. such that a vehicle cannot continue to drive up and out of the ditch;
- *ditch depth (D)*. This should be measured as the depth of ditch below ground level and should be a minimum of 1.25 m.

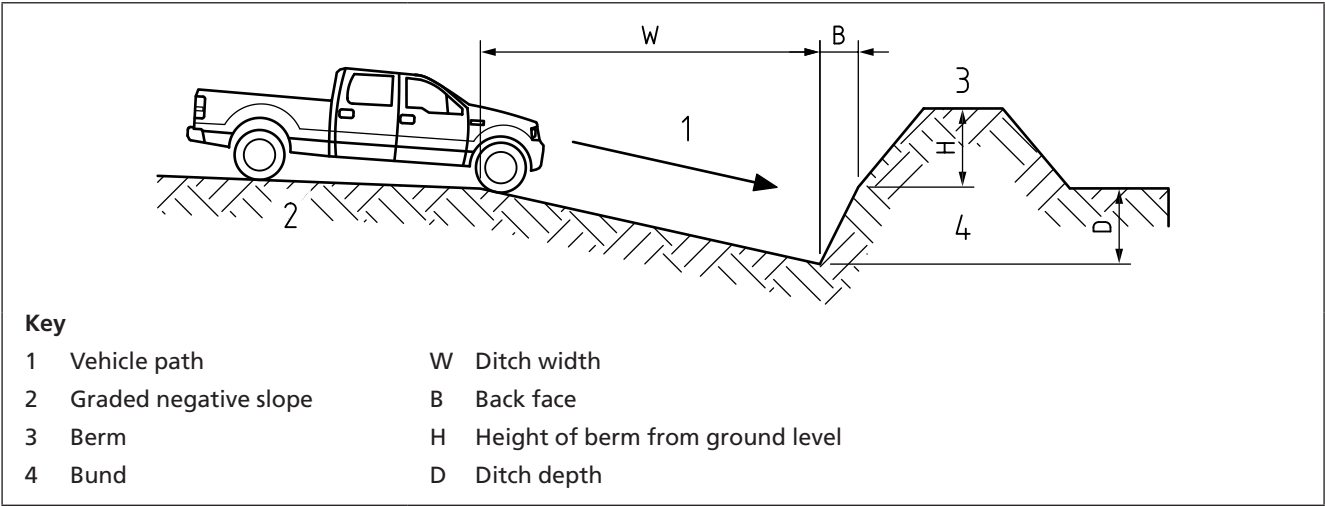
Figure 1 “V” ditch profile



The ability of the ditch design to mitigate against hostile vehicle attacks can be further improved by introducing a graded negative slope and a bund of appropriate dimensions (see 5.2.4). Constructing a graded negative slope on the approach side introduces a shallow slope, which helps to draw the hostile vehicle down into the ditch. Constructing a bund of appropriate dimensions to the defence side (see Figure 2) presents a raised level to a hostile vehicle on the approach side of the ditch. The bund increases the chance of vehicle impact, minimizing penetration and preventing encroachment.

NOTE 2 A bund can be constructed using material excavated from a ditch, therefore minimizing the need to ship material to or from the site.

Figure 2 “V” ditch with bund



The ditch profile dimensions should be determined by an assessment of the following:

- a) *hostile vehicle type*: this would determine the hostile vehicle’s ability to drive across rough terrain, steep gradients and traverse ditches;
- b) *surface characteristics*: these affect a hostile vehicle’s ability to traverse the terrain approaching the ditch (especially larger hostile vehicles);

- c) *approach speed*: a hostile vehicle might have little space in which to manoeuvre or accelerate on approach to the ditch. The maximum approach speed for each hostile vehicle should be assessed by undertaking a vehicle dynamics assessment (VDA);
- d) *soil characteristics*: local soil characteristics might also affect the practicability of constructing the ditch to the recommended dimensions;
NOTE 3 Ditch profiles with steep faces might also require fortification or stabilization.
- e) *site space*: the physical footprint and space required to construct a ditch is relatively large in comparison with other VSB systems.

5.2.4 Bunds

By itself, a well-designed bund can prevent hostile vehicle encroachment by presenting a raised, steep-angled profile. This causes an encroaching vehicle to:

- a) engage the front overhang of the vehicle body with the bund front face;
- b) engage the rear overhang of the vehicle body with the ground level;
- c) lose traction when attempting to climb up the front face; and
- d) ground the underside of the chassis when surmounting the top of the bund.

A minimum front face angle of 50° should be maintained. The height of the berm from ground level (see Figure 2, H) should be a minimum of 1.25 m. Bund designs should be selected that take into account the following local material (soil) properties and environmental conditions:

- 1) *compaction*: consolidation of soil (under its own weight) over time;
- 2) *erosion*: removal or displacement of solids through weathering, vegetation or the activity of local wildlife; and
- 3) *slump*: gravity causing the sliding of materials down the front face of a bund.

The use of cellular geo-textile materials can be employed to support and stabilize the main body of the bund.

5.2.5 Trees

The use of individual trees as a VSB is not generally recommended. This is because full-scale impact testing has shown that even mature trees of similar dimensions to a VSB system do not perform well against a determined hostile vehicle impact.

Where an existing tree cannot be moved and forms part of the physical perimeter (thereby acting as a VSB system), an acceptable level of the following elements should be determined and regularly checked:

- a) the health of the tree (including inspection for evidence of deliberate tamper such as pre-cutting that could aid a penetrative vehicle attack);
- b) the stability of local ground conditions around the tree roots;
- c) the length of the branches;

NOTE Long branches can act as climbing aids (e.g. over a perimeter fence) and therefore the frequent trimming and cutting of branches is important.

- d) the clear lines of sight for security guards and CCTV surveillance.

Where areas of forest or other densely-packed trees are present, then the combined resistance is likely to be more effective against determined hostile vehicle impact. Furthermore, any gaps between trees might only need infill VSB systems to prevent a slow speed encroachment attack.

5.2.6 Pedestrian perimeter barriers

Pedestrian perimeter barriers (e.g. security fences) provide a physical demarcation for a secure area and provide a measure of deterrence and delay to criminal activity. They can also be used as the means of supporting perimeter intruder detection systems (PIDS) such as motion sensors.

NOTE Conventional security fences (designed to deter or to delay climb or cut attack) provide very limited protection against penetrative vehicle-borne attack.

A 4x4 pick-up is able to breach a variety of security fences (performance rated for climb or cut attack) with ease, and at relatively low speeds [security fences have been breached by vehicle impact at speeds lower than 16 kph (10 mph)] in comparison to VSB systems that have typically been designed to mitigate against a penetrative vehicle impact at 48 kph (30 mph) or more.

Pedestrian perimeter barriers should not be relied on as the only HVM measure and other means of preventing or delaying hostile vehicle access should also be considered and implemented. However, where there is limited space for vehicles to accelerate up to a fence boundary or where the terrain restricts maximum vehicle speed, an assessment might indicate that a conventional pedestrian perimeter barrier is an appropriate HVM measure.

5.3 Active VSB systems

In order to control vehicle access, an active VSB system should be selected and installed.

NOTE 1 The term “active” refers to the system’s ability to operate from closed access (secure) to open access. See also PAS 68 for definitions of active and passive VSB systems.

Active VSB systems can include:

- a) retractable bollards;
- b) retractable blockers;
- c) folding, sliding, swinging, rising-arm gates.

NOTE 2 Further information regarding retractable VSB systems can be found in the CPNI publication, Retractable vehicle security barriers – Maintaining road surface friction [12].

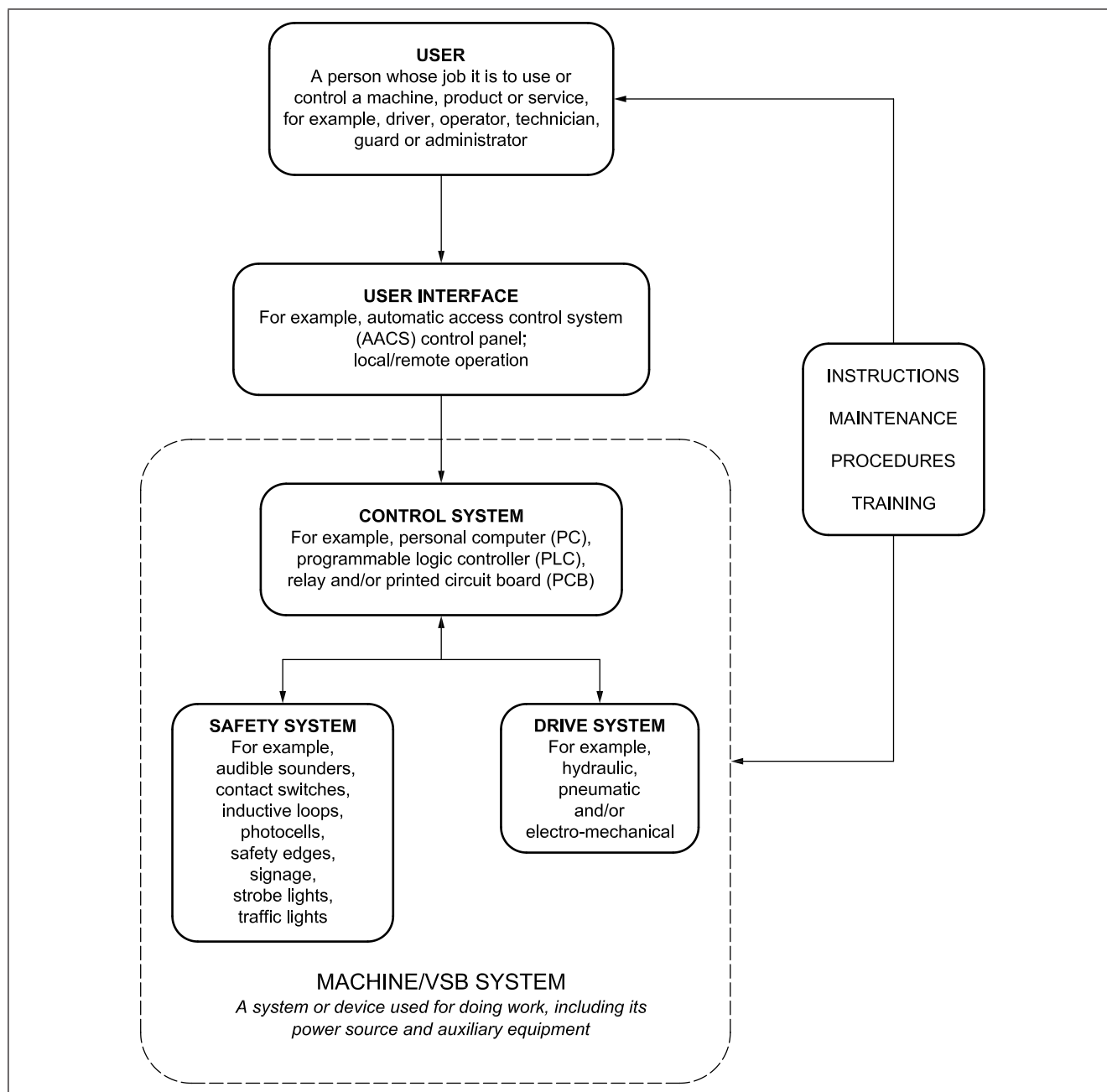
An active VSB system can be either manually operated or powered by an external source (hydraulic, pneumatic, electric). Although manual and powered VSB systems might look very similar and perform equally well under vehicle impact, there are often significant differences in their respective whole life costs. Such whole-life costs take into consideration installation, set up, operation and on-going maintenance.

A powered VSB system, by the nature of its design, should be considered to be machinery and therefore should be designed, maintained and operated accordingly. Figure 3 highlights the common elements of an active VSB system and machinery.

Drainage from a retractable VSB system might be required to maintain its operation and prevent blockage due to detritus. It is important to be aware of the drainage discharge point to prevent contaminants from having a negative impact on the environment.

When the controls cannot be located within a secure area, it is important to check the security of the VSB system control box. Increased distance between the control pumps and a VSB system might impact on the design of the control mechanisms and might offer tamper opportunities.

Figure 3 Commonalities between an active VSB system and machinery



As with machinery, a VSB system should be selected not only on the basis of performance or operational requirements (see 6.1), but also cost. An analysis of the full cost of a VSB system should be made during, or prior to, the selection process. The cost analysis should include post-installation costs and the cost of long-term requirements such as:

- 1) training;
- 2) service requirements;
- 3) maintenance and repairs; and
- 4) spare parts.