



# The Equipment Contribution to Risk to Life – Guidance on Mandated Terms and Taxonomies

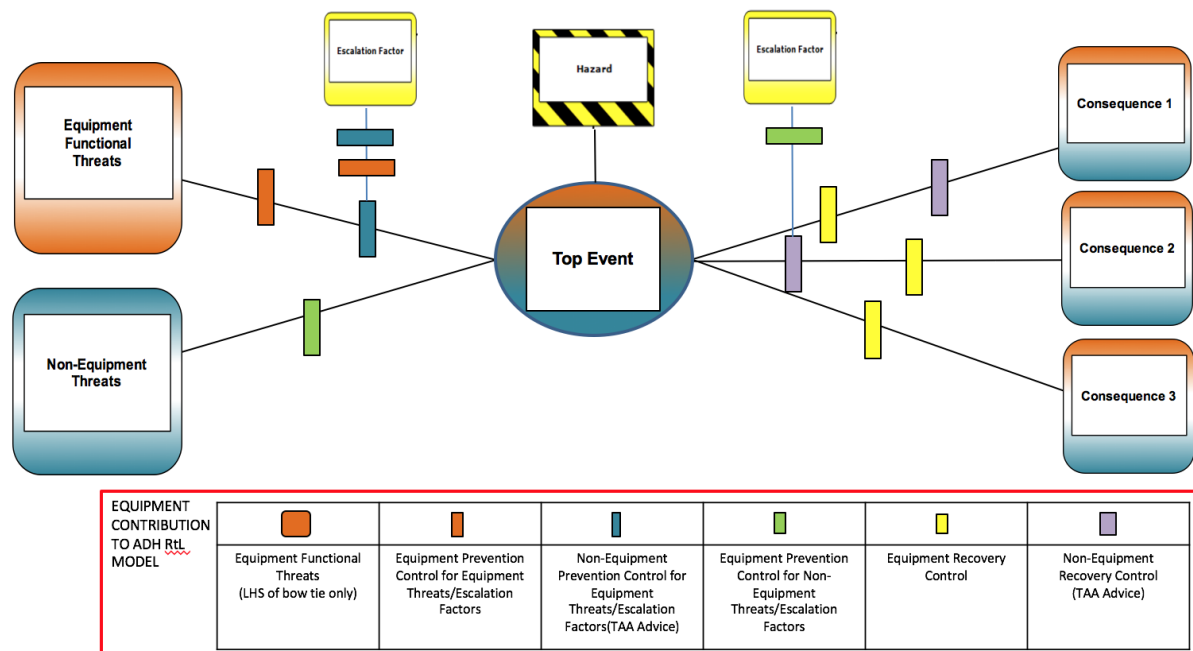
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## PURPOSE

1. This document provides guidance on the ASPIRE Equipment Contribution to Risk To Life (RtL) Terminology and Taxonomy. The terms and taxonomies have been provided separately as a specific ASPIRE Tool '**Managing the Equipment Contribution to RtL – Terminology and Taxonomy**' in the **Air Engineers' Toolkit**. This document gives detailed guidance to support users in understanding the tool and its intended use. Additionally, it provides contextual information on the rationale and origin of key elements of the tool.
2. Within the APSIRE project the following basic definitions have been applied:
  - a. Terms – Definitions of the various types of entity that contribute to RtL.
  - b. Taxonomy – Lists of entities that are to be used.
3. The guidance is presented under the following headings:
  - a. Why We Need a Standard Terminology/Taxonomy.
  - b. Basic Architecture.
  - c. Terminology.
  - d. Taxonomies.
  - e. General Guidance.

## WHY WE NEED A STANDARD TERMINOLOGY/TAXONOMY

4. The ASPIRE programme seeks to deliver Air Safety in DE&S in a more effective and efficient manner. Early work on the 'Equipment Contribution to RtL' process highlighted the diversity of terminologies and taxonomies in use across DE&S and across the various customer organisations. To realise the benefits sought, a need for a common language was identified. It was judged that this would lead to more efficient use of resources within DE&S, while at the same time improving the effectiveness of the communications between DE&S DTs and their Aviation Duty Holder (ADH) customers. Additionally, the standard terminology and taxonomy represented in the '**Managing the Equipment Contribution to RtL – Terminology and Taxonomy**' ASPIRE Tool is a robust structure on which other ASPIRE tools can be founded. It is recognised that, for the terminology and taxonomy to achieve the required benefits, it needs to be recognised and used by ADHs, as well as by DE&S. To that end, the DE&S Airworthiness Team (DAT) has established a dialogue with the various ADH communities to achieve their convergence on the common language represented in Tool 17A. The terminology and taxonomy below has been influenced by extensive engagement with stakeholders **within DE&S and ADH communities**.



Note: The diagram is focused on the equipment contribution and therefore certain non-equipment elements have been removed for clarity.

Figure 1 – Basic Architecture

5. Figure 1 shows a conceptual bow tie model illustrating the approach ASPIRE has taken. It assists users in understanding how the equipment contribution to Air Safety integrates with non-equipment contributions to influence overall Risk to Life. The language contained in the model broadly follows that used in the bowtie approach but has been adapted where necessary in order to remain consistent as far as possible with the existing language contained in the MRP, and the working practices of DTs and ADHs.

6. The diagram shows threats originating on the left-hand side of the model. They are categorised ‘equipment’ or ‘non-equipment’ according to the nature of their source. In reality, the equipment and non-equipment threats are much more intertwined that the diagram may at first suggest. However, the separation between these 2 parts of the diagram has been introduced to establish a manageable way of working. The primary area of DE&S influence is the equipment part of the diagram. Source information for analysis of equipment threats will exist at the component and system levels. It may include, but not be limited to, Loss Models, Fault Trees and in-service information available from Design Organisation analysis or broader in-service experience held by the DT. The analysis related to component and system level threats will often represent a significant body of information, the format and structure of which will vary considerably between air systems, hence it remains outside the boundary of mandated ASPIRE terms and taxonomies. The intent is that DE&S standardises its analysis of the equipment contribution to Rtl upon a common set of threats at the air system function level.

7. It is possible to take a number of different approaches to standardising equipment threat analysis. ASPIRE considered two options; standardising according to a common list of system threats or a common set of functional threats. An assessment of the relative merits of the two approaches made by the ASPIRE technical team is shown at Annex A. The assessment confirmed the merits of the latter approach.

8. Equipment functional threats are potentially mitigated by equipment and non-equipment controls that together seek to prevent a top event arising. In the event that these preventative controls are ineffective, a top event is likely to arise. A top event represents a point in time that describes the release or loss of control over a hazard. Recovery controls, to the right of the hazard/top event, attempt to prevent the hazard from becoming a

consequence by mitigating the hazardous state that has been released, either through equipment or non-equipment measures. In the event that none of these recovery controls are successful an accident or incident will occur and harm could be caused. The harm that arises as a result of the accident/incident is defined as an outcome, the two entities when combined create a consequence in the ASPIRE and ADH models.

9. This basic architecture is described in greater depth in the remainder of this guidance material. Firstly, the guidance provides further definition of the terminology introduced above. Secondly, it defines the taxonomy to be used.

## TERMINOLOGY

10. There are a number of terms that are mandated for use within the ASPIRE Equipment Contribution to RtL process. The consistent use of these terms is particularly important in order to bring standardisation to the communication that takes place between DE&S and the ADH community. The relationships between the terms and the basic architecture introduced above is shown at Table 1.

Table 1 – ASPIRE Terms and Definitions

TERM	DEFINITION
Accident Sequence	A THREAT (e.g. equipment failure, human error, external event), a HAZARD (an intermediate state where potential for harm exists) and an ACCIDENT (the realization of the Hazard becoming a harmful outcome)
Threat	A possible direct cause that will potentially release a hazard by producing a top event
Air Safety Function	A specific or discrete action (or series of actions) performed within the air system boundary that contributes to air safety
Prevention Control	A measure which reduces the likelihood of a Threat developing into a top event
Hazard	An intermediate state where potential for harm exists
Top Event	A point in time that describes the release or loss of control over a hazard
Recovery Control	Any measure which reduces the likelihood of the hazard developing into a consequence (accident/incident) as well as mitigating the severity of the consequence
Escalation Factor	A condition that leads to increased risk by defeating or reducing the effectiveness of controls
Consequence	The undesirable events (usually accidents and safety related incidents) that may potentially result from the top event

11. Expanding on the terminology described above, threats and controls fall into a number of categories, as shown in Table 2 below.

Table 2 – ASPIRE Terms and Definitions - Detailed

THREATS		
HIGH LEVEL TERM	DETAILED TERM	DESCRIPTION
THREAT	Functional Threat	The loss or malfunction of an air safety function

CONTROLS		
HIGH LEVEL TERM	DETAILED TERM	DESCRIPTION
PREVENTION CONTROL	Equipment Prevention Control for Equipment Threat	A function performed by equipment which reduces the likelihood of an equipment Threat leading to a hazardous situation.
	Non-Equipment Prevention Control for Equipment Threat	A non-equipment measure which reduces the likelihood of an equipment Threat leading to a hazardous situation. – The need for these controls may be highlighted to the ADH by the TAA but not necessarily delivered by the TAA.
	Equipment Prevention Control for Non-Equipment Threat	A function performed by equipment which reduces the likelihood of a non-equipment Threat leading to a hazardous situation.
RECOVERY CONTROL	Equipment Recovery Control	A function performed by equipment which reduces the likelihood of the hazardous situation developing into a consequence and/or which mitigates the severity of the consequence.
	Non-Equipment Recovery Control	An non-equipment measure which reduces the likelihood of the hazardous situation developing into a consequence and/or which mitigates the severity of the consequence. The need for these controls may be highlighted to the ADH by the TAA but not necessarily delivered by the TAA.

## TAXONOMIES

12. The taxonomies to be used by DE&S DTs are shown in tool 17A. The guidance that follows is intended to give users more detailed information that allows them to put the mandated taxonomies into use in a consistent manner. In recognition of the primacy of the ADH risk register the different taxonomies have a different level of mandate when viewed from a TAA's perspective, see Table 3.

Table 3 – Status of Taxonomies from a TAA's Perspective

TAXONOMY	STATUS
Hazard and Top Event	Guidance
Consequence	Guidance
Equipment Functional Threats	Mandated
Equipment Functional Controls	Guidance

## CONSEQUENCES

13. This part of the taxonomy has drawn on the Defence Air Accident Taxonomy (DAAT) and also the CAA significant 7 in order to offer a fully standardised model that can be used by both DE&S DTs and ADHs alike. In a similar manner to the DAAT, each entity is presented in a common format, as follows:

- a. TITLE: As defined in Tool 17A1.
- b. DESCRIPTION: A short description that gives further definition to the title in order to provide the reader a clear understanding of where the entity sits in the ASPIRE architecture.
- c. INCLUSIONS/EXCLUSIONS: Examples of sufficient granularity to give the reader a clear understanding of the scope of the entity within the ASPIRE architecture for managing the equipment contribution to Rtl.

Table 4 – Consequence Taxonomy

GROUPING	TAXONOMY	GROUPING	TAXONOMY
CFIT	CFIT resulting in catastrophic harm	UNCONTROLLED FIRE OR EXPLOSION	Uncontrolled fire or explosion resulting in catastrophic harm
	CFIT resulting in critical harm		Uncontrolled fire or explosion resulting in critical harm
	CFIT resulting in major harm		Uncontrolled fire or explosion resulting in major harm
	CFIT resulting in minor harm		Uncontrolled fire or explosion resulting in minor harm
	CFIT resulting in no harm and aircraft damage (Cat 1,2,3)		Uncontrolled fire or explosion resulting in no harm and aircraft damage (Cat 1,2,3)
	CFIT resulting in no harm and aircraft loss (Cat 4 or 5)		Uncontrolled fire or explosion resulting in no harm and aircraft loss (Cat 4 or 5)
MAC	MAC resulting in catastrophic harm	COLLISION ON THE GROUND	Collision on the ground resulting in catastrophic harm
	MAC resulting in critical harm		Collision on the ground resulting in critical harm
	MAC resulting in major harm		Collision on the ground resulting in major harm
	MAC resulting in minor harm		Collision on the ground resulting in minor harm
	MAC resulting in no harm and aircraft damage (Cat 1,2,3)		Collision on the ground resulting in no harm and aircraft damage (Cat 1,2,3)
UNCONTROLLED IMPACT WITH TERRAIN	MAC resulting in no harm and aircraft loss (Cat 4 or 5)	PERSONAL INJURY	Collision on the ground resulting in no harm and aircraft loss (Cat 4 or 5)
	Uncontrolled impact with terrain resulting in catastrophic harm		Catastrophic personal injury
	Uncontrolled impact with terrain resulting in critical harm	Critical personal injury	
	Uncontrolled impact with terrain resulting in major harm	Major personal injury	
	Uncontrolled impact with terrain resulting in minor harm	Minor personal injury	
	Uncontrolled impact with terrain resulting in no harm and aircraft damage (Cat 1,2,3)	No Accident	No Accident
Uncontrolled impact with terrain resulting in no harm and aircraft loss (Cat 4 or 5)			

14. The ASPIRE Taxonomy contains the consequences shown in Table 4. The majority of the statements in Table 4 are a combination of an accident event and the harm that will be caused. The taxonomy of harm is aligned with those given in RA1210, these definitions

should be used at all times, the guidance that follows relates to the first half of the consequence statement i.e. the accident.

15. 'Controlled Flight Into Terrain (CFIT)' is defined as follows:

<b>TITLE</b>	<b>Controlled Flight Into Terrain</b>
<b>DESCRIPTION</b>	Accidents/Incidents involving inflight collision or near collision with terrain, water, or ground obstacle without loss of control
<b>INCLUSIONS</b>	<ul style="list-style-type: none"> <li>• Collisions with those objects extending above the surface (for example, towers, trees, power lines, cable car support, transport wires, power cables, telephone lines and aerial masts)</li> <li>• Occurring during IMC or VMC</li> <li>• Cockpit crew being affected by visual illusions or degraded visual environment (e.g., black hole approaches and helicopter operations in brownout or whiteout conditions) that result in the aircraft being flown under control into terrain, water, or obstacles</li> <li>• For helicopter and VTOL operations, flying into terrain without indication of loss of control during transition into forward flight</li> <li>• Intentional flight into/toward terrain – e.g. for suicides</li> </ul>
<b>EXCLUSIONS</b>	<ul style="list-style-type: none"> <li>• Where control of the aircraft is lost - use Uncontrolled Impact with Ground</li> <li>• Rotorcraft and VTOL air taxi phase of flight on designated taxiways – use Uncontrolled Impact with Ground</li> </ul>
<b>CLARIFICATION</b>	<ul style="list-style-type: none"> <li>• 'Terrain' includes water, vegetation, rocks, and other natural elements lying on, or growing out of, the earth.</li> </ul>

16. 'Mid Air Collision (MAC)' is defined as follows:

<b>TITLE</b>	<b>Mid Air Collision</b>
<b>DESCRIPTION</b>	Accidents/Incidents involving collisions between Air System and other airborne objects in flight
<b>INCLUSIONS</b>	<ul style="list-style-type: none"> <li>• Where both the air system and the object are airborne</li> <li>• Resulting from avoidance of MAC, such as resultant loss of control, structural failure, or resulting pax injury</li> <li>• Collisions with birds</li> </ul>
<b>EXCLUSIONS</b>	<ul style="list-style-type: none"> <li>• Any aircraft on or attached to the ground (e.g. tethered balloon) – use CFIT</li> </ul>
<b>CLARIFICATION</b>	<ul style="list-style-type: none"> <li>• Examples of 'Objects' in the context of the ASPIRE taxonomy may be birds, aircraft, drones or other airborne matter.</li> </ul>

17. 'Uncontrolled Impact with Terrain' is defined as follows:

<b>TITLE</b>	<b>Uncontrolled Impact with Terrain</b>
<b>DESCRIPTION</b>	Accidents/Incidents resulting directly from a loss of control in the air
<b>INCLUSIONS</b>	<ul style="list-style-type: none"> <li>• Where the Air System is airborne</li> <li>• Resulting from major equipment threats such as structural and systems failures</li> <li>• Includes accidents during the take-off and landing phase where the Air System is outside the ground handling definition.</li> </ul>
<b>EXCLUSIONS</b>	<ul style="list-style-type: none"> <li>• Any interaction with another airborne object – use MAC</li> </ul>

	<ul style="list-style-type: none"> <li>Resulting from fire or explosion as the threat of control loss – use Uncontrolled Fire or Explosion</li> </ul>
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18. 'Uncontrolled Fire or Explosion' is defined as follows:

<b>TITLE</b>	<b>Uncontrolled Fire or Explosion</b>
<b>DESCRIPTION</b>	Accidents/Incidents involving fire or explosion in or on the aircraft, in flight, or on the ground. Including Ordnance, Munitions and Explosives carried as stores or Dangerous Air Cargo
<b>INCLUSIONS</b>	<ul style="list-style-type: none"> <li>Fire resulting from a combustive explosion from an accidental ignition source</li> <li>Fire from system/component failures/malfunctions in the cockpit, passenger cabin, or cargo area (e.g. flammable fluids)</li> <li>Airframe fire caused by an engine malfunction or catastrophic failure where the loss of the engine would not otherwise have caused the accident had there not been a fire</li> </ul>
<b>EXCLUSIONS</b>	<ul style="list-style-type: none"> <li>Non-combustive explosions such as tyre burst and pressure bulkhead failures – use loss of control and uncontrolled impact with the ground</li> <li>Fire and explosion resulting from an accident impact is coded under the relevant accident category</li> <li>Fire/explosion resulting directly from engine failure(s) where failure of the engine(s) alone was sufficient to cause the accident through loss of thrust – use loss of control as the hazard and uncontrolled impact with the ground</li> </ul>

19. 'Collision on the Ground' is defined as follows:

<b>TITLE</b>	<b>Collision on the Ground</b>
<b>DESCRIPTION</b>	Collisions while the Air System is manoeuvring, or being manoeuvred on the ground
<b>INCLUSIONS</b>	<ul style="list-style-type: none"> <li>Collisions with an aircraft, person, animal, ground vehicle, obstacle, building, structure, etc, while on the ground</li> <li>Involving ground and air taxiing for rotorcraft and VTOL ac on designated taxiways</li> <li>Relating to ground handling</li> <li>Ground collisions resulting from Runway Incursion</li> </ul>
<b>EXCLUSIONS</b>	<ul style="list-style-type: none"> <li>Loss of control on the ground as a result of runway incursion or excursion – Use uncontrolled impact with ground</li> </ul>

20. 'Personal Injury' is defined as follows:

<b>TITLE</b>	<b>Personal Injury</b>
<b>DESCRIPTION</b>	All harm to persons not occurring as a direct result of one of the other Accident/Incident types.
<b>INCLUSIONS</b>	<ul style="list-style-type: none"> <li>Slips, Trips, Falls, Burns, Fumes and Shocks</li> <li>Injury caused by and occurring as a result of operating or servicing the Air System</li> <li>Long term health issues</li> </ul>
<b>EXCLUSIONS</b>	<ul style="list-style-type: none"> <li>Unrelated underlying health issues for non-operating crew or passengers</li> </ul>

## HAZARDS AND TOP EVENTS

21. The ASPIRE Taxonomy, Table 5, contains the taxonomy of hazards and top events. The tables that follow give a detailed definition of each top event.

Table 5: Hazards and Top Events

HAZARD	TOP EVENT
Aircraft Operations (Airborne)	Aircraft unintentionally deviates from intended flight path
	Loss of safe separation with terrain
	Separation with other airborne objects reduces below normal requirements
Aircraft Operations (Protected Manoeuvring Area)	Aircraft unintentionally deviates <b>beyond the bounds of manoeuvring area</b>
	An aircraft, vehicle or person is present in a prohibited <b>manoeuvring area</b>
Aircraft Operations (General)	An undesired ignition of combustible/explosive material occurs
	Loss of Security of Items Fitted or Loaded to Aircraft
Ground Operations	Deviation from intended safe ground track or 3 <sup>rd</sup> party collision
Individuals Carried Within or In Close Proximity to Aircraft	Individual exposed to personal hazard (not leading to loss of control)

22. 'Aircraft unintentionally deviates from intended flight path' is defined as follows:

TITLE	<b>Aircraft Unintentionally Deviates from Intended Flight Path</b>
DESCRIPTION	Loss of air system control, or deviation from intended flightpath, whilst in-flight.
INCLUSIONS	<ul style="list-style-type: none"> <li>• In-flight only but during any flight conditions (VMC/IMC)</li> <li>• Deliberate manoeuvres (e.g., stall/spin practice)</li> <li>• Originating from the configuring of the aircraft (e.g., flaps, slats, on-board systems, etc) as well as rotorcraft retreating blade stall</li> <li>• Rotorcraft threats which involve power settling (vortex ring), or settling with power to ground contact</li> <li>• Rotorcraft involving "Loss of Tail Rotor Effectiveness"</li> <li>• Related to pilot human factors</li> <li>• For unmanned aircraft, deviation from intended flightpath associated with anticipated or unanticipated loss of datalink</li> <li>• Where loss of control is as a result of partial or total failure of systems or components and where inappropriate handling contributed to the outcome</li> </ul>
EXCLUSIONS	<ul style="list-style-type: none"> <li>• Relating to external loads – use Loss of Security of items fitted or loaded to aircraft</li> <li>• Cockpit crew vision-related issues and flight in degraded visual environments (for example, obscuration, black hole approach events, brownouts, or whiteout events), where the aircraft is flown under control into terrain, water, or obstacles - use loss of safe separation with terrain</li> <li>• Where the loss of control is related to fire or explosion – use Fire and Explosion</li> </ul>

23. 'Aircraft unintentionally deviates beyond the bounds of manoeuvring area' is defined as:

TITLE	<b>Aircraft Unintentionally Deviates Beyond the Bounds of Manoeuvring Area</b>
DESCRIPTION	Loss of air system control, or deviation from intended path, whilst on the ground.

INCLUSIONS	<ul style="list-style-type: none"> <li>• Veer off, or overrun off, the runway surface</li> <li>• Involving abnormal runway or landing surface contact</li> <li>• Where the excursion is unintentional</li> <li>• Hard/heavy landings, long/fast landings, off-centre landings, crabbed landings, nose wheel first touchdown, tail strikes, and wingtip/nacelle strikes, including those caused by a stall or other loss of control in the flare</li> <li>• Unintentional gear-up landings, including where indicated failures are not actioned</li> <li>• <b>Gear-up landings if a result of a system/component failure or malfunction when no back-up system is available</b></li> <li>• Resulting from gear collapses following heavy crabbed or nose-wheel first landings</li> <li>• Resulting from (tail) rotor striking the intended landing surface during take-off and landing</li> </ul>
EXCLUSIONS	<ul style="list-style-type: none"> <li>• Where the excursion is intentional, for example, the deliberate veer off to avoid a collision, brought about by a Runway Incursion – use Runway Incursion</li> <li>• Touchdown off the runway/helipad/helideck surface but within the immediate vicinity – use loss of safe separation with terrain</li> <li>• Helicopter for hard/heavy landings after an off-field emergency autorotation when there was no intention to land before the autorotation was entered – use loss of safe separation with terrain</li> <li>• Helicopter for collisions with obstacles, such as trees or walls, during take-off and landing - use loss of safe separation with terrain</li> </ul>

24. 'Loss of Safe Separation with Terrain' is defined as:

TITLE	<b>Loss of Safe Separation with Terrain</b>
DESCRIPTION	Controlled but unintentional loss of safe separation from terrain, water, or ground obstacle
INCLUSIONS	<ul style="list-style-type: none"> <li>• Loss of separation with objects extending above the surface (for example, towers, trees, power lines, cable car support, transport wires, power cables, telephone lines and aerial masts)</li> <li>• Cockpit crew being affected by visual illusions or degraded visual environment (e.g., black hole approaches and helicopter operations in brownout or whiteout conditions) that result in the aircraft being flown under control into terrain, water, or obstacles</li> <li>• For helicopter and VTOL operations, the potential to result in flying into terrain without indication of loss of control during transition into forward flight</li> <li>• Intentional flight into/toward terrain – e.g. for suicides</li> <li>• <b>Flying into terrain without indication</b></li> </ul>
EXCLUSIONS	<ul style="list-style-type: none"> <li>• Where control of the aircraft is lost (induced by crew, weather or equipment failure) - use Loss of Control in Flight</li> <li>• Where aircrew are incapacitated or impaired due to technical system failure use Loss of Control in Flight</li> <li>• Rotorcraft and VTOL air taxi phase of flight on designated taxiways – use Loss of Control in Flight</li> </ul>

25. 'An aircraft, vehicle or person is present in a prohibited manoeuvring area' is defined as:

TITLE	<b>An Aircraft, Vehicle or Person is Present in a Prohibited Manoeuvring Area</b>
DESCRIPTION	Potential collision with, or evasive action taken by an aircraft to avoid, an aircraft, vehicle, person or animal on a surface designated for the landing and take-off of aircraft
INCLUSIONS	<ul style="list-style-type: none"> <li>• Wildlife on a runway in use</li> <li>• Evasive action taken by the flight crew that leads to a collision off the runway or to consequences other than a collision (e.g., gear collapsing)</li> <li>• Incursions at controlled or uncontrolled airports</li> </ul>
EXCLUSIONS	<ul style="list-style-type: none"> <li>• Movement of air systems not under the powered or direct control of aircrew – use ground handling operations</li> </ul>

26. 'Separation with other airborne objects reduces below normal requirements' is defined as:

TITLE	<b>Separation With Other Airborne Objects Reduces Below Normal Requirements</b>
DESCRIPTION	Potential for near collisions or actual collisions between Air System and other airborne objects in flight
INCLUSIONS	<ul style="list-style-type: none"> <li>• Where both the air system and the object are airborne</li> <li>• Resulting from avoidance of MAC, such as resultant loss of control, structural failure, or resulting pax injury</li> <li>• Relating to collisions with birds</li> </ul>
EXCLUSIONS	<ul style="list-style-type: none"> <li>• Threats linked to an object attached to the ground (e.g. tethered balloon) – use loss of safe separation with terrain</li> </ul>
CLARIFICATION	<ul style="list-style-type: none"> <li>• Examples of 'Objects' in the context of the ASPIRE taxonomy may be birds, aircraft, drones or other airborne matter.</li> </ul>

27. 'Deviation from intended safe ground track or 3<sup>rd</sup> party collision' is defined as:

TITLE	<b>Deviation From Intended Safe Ground Track Or 3<sup>rd</sup> Party Collision</b>
DESCRIPTION	Potential for harm to persons or loss of air system to be caused by handling operations, maintenance or servicing activities.
INCLUSIONS	<ul style="list-style-type: none"> <li>• Loss of control prior to take off run (including start up and taxi) or after completion of landing (i.e. taxi back to dispersal and shut down)</li> <li>• Collisions while servicing, boarding, loading, and deplaning the aircraft or during boarding and disembarking while helicopter is hovering</li> <li>• Activities relating to pushback/powerback/towing collisions</li> <li>• Jet blast and prop/rotor down wash during ground handling</li> <li>• Aircraft external pre-flight configuration errors (examples: improper loading, and improperly secured doors and latches) that lead to subsequent events</li> <li>• In the maritime environment, failure to remove restraining tie-downs prior to launch where this activity is the sole responsibility of ground handlers</li> <li>• Losses of control during ground movements and re-spotting</li> </ul>

	<ul style="list-style-type: none"> <li>• All incidences of ground crew handling external loads as a result of contact with/dropping/inadvertent release of external load</li> <li>• All cargo load failures including those involving Dangerous Air Cargo</li> <li>• All embarked movements and loss of control up to the point of removal of lashings or post application of lashings</li> <li>• Any loss of control during ground runs / engaged ground runs where there is nil intent to commence a take off</li> </ul>
EXCLUSIONS	<ul style="list-style-type: none"> <li>• Activities that may instigate injuries to people from propeller/main rotor/tail rotor/fan blade strikes – use exposure of individuals to health hazard</li> <li>• Collisions where the aircraft is moving under its own power in the gate, ramp, or tie-down area, other than during powerback – use loss of control on the ground</li> </ul>

28. 'An unintended ignition of combustable/explosive material occurs' is defined as:

TITLE	<b>An Unintended Ignition of Combustable/Explosive Material Occurs</b>
DESCRIPTION	Ignition or combustion of air system material on the aircraft, in flight, or on the ground. Including Ordnance, Munitions and Explosives carried as stores or Dangerous Air Cargo
INCLUSIONS	<ul style="list-style-type: none"> <li>• Fire resulting from a combustive explosion of an accidental ignition source</li> <li>• Fire from system/component failures/malfunctions in the cockpit, passenger cabin, or cargo area</li> <li>• Airframe fire as a result of by an engine malfunction or catastrophic failure where the loss of the engine would not otherwise have caused the accident</li> </ul>
EXCLUSIONS	<ul style="list-style-type: none"> <li>• Non-combustive explosions such as tyre burst and pressure bulkhead failures – use loss of control and uncontrolled impact with the ground</li> <li>• Fire and explosion resulting from an accident impact is coded under the relevant accident category</li> <li>• Fire/explosion hazards resulting directly from engine failure(s) where failure of the engine(s) alone was sufficient to threat the accident through loss of thrust – use loss of control as the hazard and uncontrolled impact with the ground</li> </ul>

## FUNCTIONAL THREATS

29. The functional threat taxonomy is designed to give a focus for existing DT information and analysis at system and component level. Mapping to the functional threat taxonomy allows a standardised level of interaction with ADH top event taxonomies in order to allow more coherent and consistent outcomes from ASPIRE. However, before they can be meaningful a functional threat must be 'constructed' using a combination of the high-level function and associated functional failure type. The following taxonomy, Figure 2, appears in the tool and is mandated by the ASPIRE project:

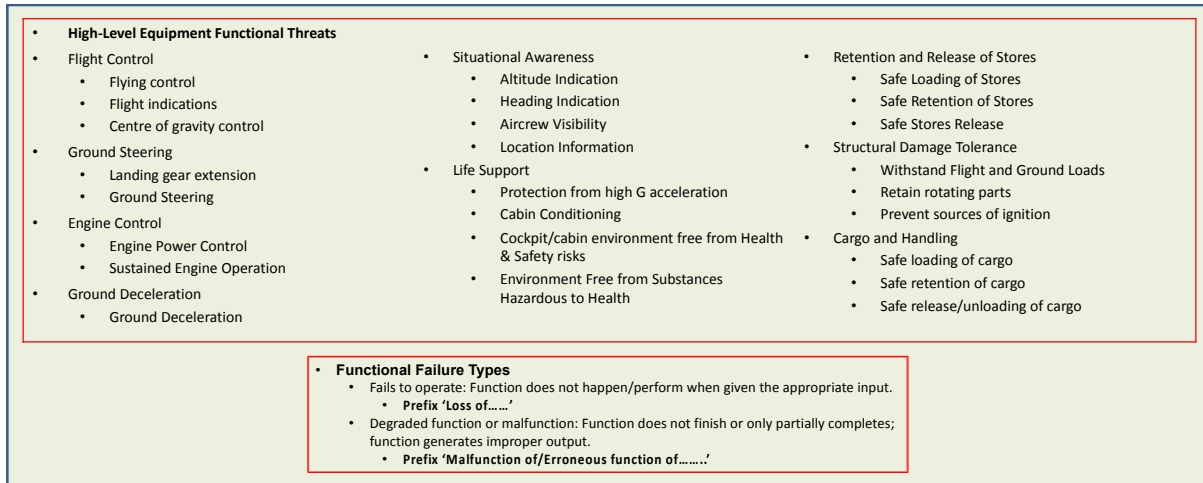


Figure 2 – High Level Functional Threats

30. It should be emphasised that the functions are deliberately set at a high level. This has the dual benefits of easing their introduction within existing DT equipment analysis (which typically has been undertaken at a systems level) while also providing a meaningful 'interface' with the top level events defined above. However, this approach means that the taxonomy offers room for interpretation, which could dilute the benefit of the standardisation generated by the taxonomy. It is therefore necessary to provide guidance on the description of each function, as well as some examples of the typical equipment systems that might be expected to be related to the high-level function.

31. Guidance on functions, and examples of associated systems, is shown below:

FUNCTION	Flying Control
DESCRIPTION	The provision of systems required to achieve in-flight stability and handling qualities to enable operator to control the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Primary flying control systems</li> <li>• Secondary flying control systems</li> <li>• Autopilots</li> <li>• Airbrakes</li> <li>• Auto-stabilisation</li> <li>• High lift devices</li> <li>• Electrical systems</li> <li>• Basic air system design (flying qualities, flutter etc)</li> <li>• Datalinks</li> </ul>

FUNCTION	Flight Indications
DESCRIPTION	The provision of primary flying control information to the operator of the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Artificial horizon</li> <li>• Airspeed indicators</li> <li>• Mach indicators</li> <li>• Angle of attack indicators</li> <li>• G-meters</li> <li>• Head up displays</li> <li>• Air data systems</li> <li>• Databuses</li> <li>• Datalinks</li> </ul>

FUNCTION	Centre of Gravity Control
DESCRIPTION	The provision of systems required to maintain control of the Air System's centre of gravity.

EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>Fuel transfer systems</li> </ul>
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FUNCTION	Landing Gear Extension
DESCRIPTION	The provision of systems required to extend, lock and retain landing gear.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>Undercarriage</li> <li>Undercarriage extension systems</li> <li>Hydraulic systems</li> <li>Pneumatic systems</li> <li>Datalinks</li> </ul>

FUNCTION	Ground Steering
DESCRIPTION	The provision of systems required to give directional control to an Air System on the ground.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>Nosewheel steering systems</li> <li>Braking systems</li> <li>Flying control systems (rudder)</li> <li>Hydraulic systems</li> <li>Datalinks</li> </ul>

FUNCTION	Engine Thrust
DESCRIPTION	The provision of systems required to ensure sufficient thrust control during all phases of flight and related transitions.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>Fuel control units</li> <li>Full Authority Digital Engine Controls (FADEC)</li> <li>Main engines</li> <li>Helicopter transmissions &amp; rotables</li> <li>STOVL systems</li> <li>Datalinks</li> </ul>

FUNCTION	Sustained Engine Operation
DESCRIPTION	The provision of systems required to sustain the engine system.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>Fuel systems</li> <li>Engine cooling systems</li> <li>Fuel feed systems</li> <li>Oil feed systems</li> <li>Engine integrity</li> </ul>

FUNCTION	Ground Deceleration
DESCRIPTION	The ability to bring the Air System to a controlled stop when required, including shipborne operations.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>Braking systems</li> <li>Airbrakes</li> <li>Reverse thrust</li> <li>Drogue parachutes</li> <li>Datalinks</li> </ul>

FUNCTION	Altitude Indication
DESCRIPTION	The provision of systems required to display altitude indication to the operator of the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>Barometric altimeters</li> <li>Radio altimeters</li> <li>GPS altimeters</li> <li>Rate of climb and descent indications</li> <li>Datalinks</li> </ul>

FUNCTION	Heading Indication
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DESCRIPTION	The provision of systems required to display heading indication to the operator of the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Compass systems</li> <li>• <b>GPS Systems</b></li> <li>• Navigation systems</li> <li>• Datalinks</li> </ul>

FUNCTION	Aircrew Visibility
DESCRIPTION	The provision of systems required to ensure the operator of the Air System maintains the required view of their surroundings.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Basic Air System Design</li> <li>• Winscreen Heating</li> <li>• Datalinks</li> </ul>

FUNCTION	Location Information
DESCRIPTION	The provision of systems required to display location information to the operator of the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Navigation systems</li> <li>• <b>GPS Systems</b></li> <li>• Electrical systems</li> </ul>

FUNCTION	Protection from High G Acceleration
DESCRIPTION	The provision of systems required to protect individuals from the affects of high G environments.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Anti-G suits</li> </ul>

FUNCTION	Cabin Conditioning
DESCRIPTION	The provision of systems required to maintain a suitable cabin environment within the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Cockpit/cabin pressurisation systems</li> <li>• Oxygen systems</li> </ul>

FUNCTION	Cockpit/Cabin Environment Free from Health & Safety Risks
DESCRIPTION	The provision of design and systems required to maintain an internal aircraft environment suitable for personnel.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Basic air system design (H&amp;S design)</li> </ul>

FUNCTION	Provide for environment free from substances hazardous to health
DESCRIPTION	The provision of design and systems required to maintain an internal aircraft environment suitable for personnel.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Basic air system design (COSHH)</li> </ul>

FUNCTION	Safe Loading of Stores
DESCRIPTION	The provision of the systems required to safely load expendable stores.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Stores loading systems</li> <li>• Weapons bay door mechanisms</li> <li>• Weapons carriers</li> <li>• Stores Management Systems</li> </ul>

FUNCTION	Safe Retention of Stores
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DESCRIPTION	The provision of the systems required to safely retain expendable stores.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Stores retention systems</li> <li>• Weapons bay door mechanisms</li> <li>• Weapons carriers</li> <li>• Stores Management Systems</li> </ul>

FUNCTION	Safe Release of Stores
DESCRIPTION	The provision of systems required to achieve safe separation of expendable stores from the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Stores release systems</li> <li>• Weapons bay door mechanisms</li> <li>• Weapons carriers</li> <li>• Stores Management Systems</li> <li>• Datalinks</li> </ul>

FUNCTION	Withstand Flight and Ground Loads
DESCRIPTION	The provision of systems and design suitable to withstand air and ground design loads.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Basic air system design (structure, damage tolerance, security of panels, flutter characteristics)</li> </ul>

FUNCTION	Retain Rotating Parts
DESCRIPTION	The provision of design and systems suitable to retain rotating parts during the application of design loads.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Basic air system design (integrity of rotor blades, turbines, compressors etc)</li> </ul>

FUNCTION	Prevent Sources of Ignition
DESCRIPTION	The provision of systems and design required to ensure the appropriate containment of sources of ignition within the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Basic air system design (absence of combustible materials; absence of electrical sparking; containment of fuels, oils, other fluids and pressurised gasses)</li> </ul>

FUNCTION	Safe Loading of Cargo
DESCRIPTION	The provision of the systems required to safely load cargo.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Hoists</li> <li>• Dipping sonar systems</li> <li>• HUSLE</li> </ul>

FUNCTION	Safe Retention of Cargo
DESCRIPTION	The provision of the systems required to safely retain cargo.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Hoists</li> <li>• Dipping sonar systems</li> <li>• HUSLE</li> </ul>

FUNCTION	Safe Release/Unloading of Cargo
DESCRIPTION	The provision of systems required to achieve safe release/unloading of cargo from the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Hoists</li> <li>• Dipping sonar systems</li> <li>• HUSLE</li> </ul>

## CONTROLS

32. Controls are divided into two different groups; equipment controls that relate directly to EFTs and equipment controls for non-equipment threats. These two sets of controls are different in nature, with the controls that relate directly to the EFTs being generic and the second group being much more specific to the air system in question. As a consequence of this difference ASPIRE applies a taxonomy to the first group and for the second group gives examples of the type of equipment controls that could be considered.

### EQUIPMENT CONTROLS RELATING TO EFTs

33. Controls that relate directly to EFTs will be generic controls that prevent the release of the threat. These controls will focus on the effectiveness of the design and the Technical Information that is issued by the TAA in order to ensure that the design is operated and maintained as intended. The taxonomy for EFT generic controls is shown in Figure 4.

Family	Title	Description/Context
Design	Processes and Procedures	The equipment/system has been designed in accordance with recognised processes, procedures and standards.
	Materials	Material specification to meet performance, structural integrity etc. requirements.
	System Architecture	Design system architecture to meet functional and redundancy requirements e.g. system configuration (simplex/duplex architecture, etc.).
	System Installation	Design to meet segregation requirements for common cause failure events e.g. uncontained engine rotor failure (UERF) and zonal safety issues.
	Test & Analysis	Design to meet performance, structural integrity, fail safe etc. requirements.
	Alerts (Advisory/Caution/Warning)	Provision of alerts for system status, significant failures or exceedance of operating limits.
Technical Information	Interactive Electronic Technical Publications (IETP)	IETPs are technical publication documents, books and manuals that are provided in a format that is optimized for manipulation and display on desktop PCs, laptops, tablets and mobile devices. IETPs provides data divided into topics about the Merlin aircraft and the maintenance data which is approved to keep it in a serviceable condition (maintenance procedures and periodicities).
	Digital Air Publications (DAP)	Digital Air Publications (DAPs) provide technical information concerning aircraft equipment required by planning staff, unit users/operators and technicians involved with operational use, maintenance or repair of the equipment.
	Publication Amendment	Correction (and/or enhancement) of data in Technical or Aircrew publications typically utilising MF765/MF765X actions to initiate Signal Amendments (intended to be short term pending formal schedule amendment), AIL, ANA, etc. Note: DO utilises NCRAP process to initiate a formal publication amendment.
	Warnings and Cautions	Warning and Cautions included in publications e.g. Hazardous materials, RadHaz, Moving parts etc. (OSHA). Kept as a discrete barrier, separate to the CIETP barrier as warnings/cautions are directly attributable to a specific hazard/threat and to enhance barrier granularity.
	Topic 2(N/A/R) - General Orders, Special Instructions and Modifications	The aircraft and/or equipment Topic 2 deals with Design Organization modifications. However, there are instances where Delivery Teams (DTs) need to promulgate specific information relating to their aircraft and/or equipment. The Topic 2(N/A/R) series – General Orders, Special Instructions and Service Modifications, is a tri-Service publication, which provides the means for DTs to publish their aircraft and/or equipment-specific orders, special instructions and modifications.

Figure 4 – Equipment Controls Relating to EFTs

### EQUIPMENT CONTROLS FOR NON-EQUIPMENT THREATS

34. In a similar manner to threats, the level at which controls are defined seeks to make best use of existing DT information and analysis when communicating with the ADH. However, the same potential exists for interpretation as a result of the high level at which the controls are set. Therefore, examples of controls that may appear in ADH risk registers are shown in this section of the guidance in order to assist users to achieve consistent application.

35. The following information is therefore provided as examples of equipment controls for non-equipment threats:

FUNCTION	Indicate Terrain/Air Traffic in Close Proximity
DESCRIPTION	The provision of the systems required to indicate the proximity of terrain and air traffic to the operator of the Air System.

EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Traffic Alert &amp; Collision Avoidance System (TCAS)</li> <li>• Auto-Ground Collision Avoidance Systems (Auto-GCAS)</li> <li>• Low altitude alerts</li> </ul>
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FUNCTION	Prevent Accumulation of Airframe Ice
DESCRIPTION	The provision of systems required to prevent the accumulation of airframe ice.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Airframe anti-icing systems</li> </ul>

FUNCTION	Stall Warning Indication
DESCRIPTION	The provision of systems required to indicate the approach of stall conditions to the operator of the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Stall warning system</li> </ul>

FUNCTION	Remove Smoke and Fumes from Cockpit/Cabin
DESCRIPTION	The provision of systems required to remove smoke and fumes from the cockpit/cabin.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Cockpit/cabin conditioning systems</li> </ul>

FUNCTION	Life Support Following Decompression
DESCRIPTION	The provision of systems required to support life in cockpit/cabin after cockpit/cabin decompression.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Emergency oxygen systems</li> </ul>

FUNCTION	Emergency Egress
DESCRIPTION	The provision of design and systems required to support the rapid egress of personnel from the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Ejection seats</li> <li>• Survival aids</li> <li>• Auto-ejection systems</li> <li>• Parachutes</li> <li>• Emergency chutes</li> <li>• Emergency doors</li> <li>• Inherent cabin design</li> </ul>

FUNCTION	Emergency Jettison of Stores
DESCRIPTION	The provision of systems required to carry out the rapid safe separation of expendable stores.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Stores jettison systems</li> </ul>

FUNCTION	Protection During Accident/Incident
DESCRIPTION	The provision of design and systems required to protect personnel in the event of an accident or incident.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Basic air system design (crash-worthiness, resilience to birds, cable cutters)</li> </ul>

FUNCTION	Contain High Energy Debris
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DESCRIPTION	The provision of design and systems required to contain any high energy debris released within the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Basic air system design (containment of shed rotor blades, turbines, compressors etc)</li> </ul>

FUNCTION	Fire Indication
DESCRIPTION	The provision of systems required to indicate the presence of uncontrolled fire within the Air System to the operator.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Fire warning systems</li> </ul>

FUNCTION	Fire Suppression
DESCRIPTION	The provision of systems required to suppress fire within the Air System.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Fire extinguishers</li> </ul>

FUNCTION	Emergency Cargo Jettison
DESCRIPTION	The provision of systems required to allow the rapid separation of cargo loads.
EXAMPLE RELATED SYSTEMS	<ul style="list-style-type: none"> <li>• Cargo jettison systems</li> <li>• Cable cutting systems</li> </ul>

## GENERAL GUIDANCE

### SPECIFIC RISK DRIVERS

36. It is acknowledged that RtL can be highly sensitive to a range of factors that may apply when at a particular point in time. Therefore, it may be appropriate for hazard analysis to investigate the equipment contribution associated with a particular hazard in a specific circumstances, where the perceived level of risk warrants it. The following guidance is designed to offer users a taxonomy for such risk drivers.

37. Particular attention should be paid to circumstances that might be considered to present an increased likelihood of a top event arising and/or an increase to the severity of outcome related to a top event. Risk drivers can be defined by one or more of a number of characteristics, independently or in combination. The ASPIRE programme has defined the characteristics in Table 6, below:

PHASE OF FLIGHT What is particular about the manner the air system is functioning?	Landing	Take Off	Hover	Transition from the Hover	Maintenance	Ground Running
OPERATING CONDITIONS What is particular about the condition the air system is being operated in?	Night/IMC	Night/VMC	Day/IMC			
AIRSPACE What is particular about the airspace the air system is being operated in?	Class A	Class C	Class D	Class E	Class G	Low Level
OVER FLOWN TERRAIN What is particular about immediate area of ground below the air system?	Densely Populated	Sparsely Populated	SEA			
OPERATOR COMPETENCE LEVEL What is particular about the individual/s controlling the air system?	Standard crew configuration	Individuals undergoing training				
TERMINUS What is particular about the physical location the air system has been launched from or will be recovered to (if different)?	Main operating base	Unprepared surface - Runway	Unprepared surface - HLS	Embarked		
SORTIE TYPE What is particular about the purpose of the air systems flight (or part of flight)?	Air to Air Refueling	Air Display	Passenger carrying			

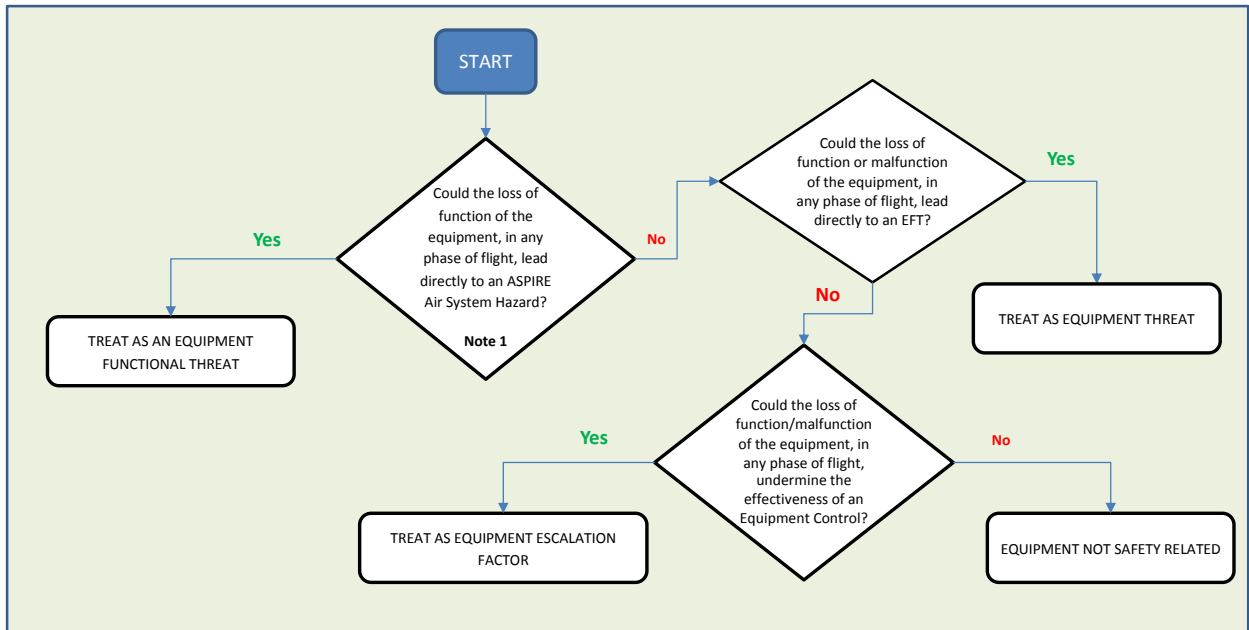
Table 6 – Risk Drivers

38. Given the multi-dimensional nature of factors described above, it is considered impractical to mandate analysis of the equipment contribution to RtL across all combinations as the volume of entities would be considerable. However, it is anticipated that where users wish to investigate specific risk drivers they will do so using these characteristics.

### DISTINGUISHING BETWEEN A THREAT AND A CONTROL

39. As part of the transition to the ASPIRE approach it is expected that there will be a need to decide on a platform specific basis whether certain functions (and their associated failures) are a threat to a hazard or the failure of a control. It is entirely possible that a particular function can be a threat in one set of circumstances but a control in others. Great care should therefore be taken in making allocations to ensure that the function is correctly assessed. Guidance to assist in this attribution process is shown at Figure 4.

This guidance will assist in the structure of Hazard Management architecture when attributing an equipment to being a threat or a control within an accident sequence.



**Notes**

1. Interpretation of 'Directly' – In order to ensure that low level equipment component threats do not artificially drive the examination of the Hazard the equipment in question must be examined at the functional level (e.g. loss of GPWS function, loss of passenger entertainment system function, loss of external lighting etc.)

Figure 4 – Distinguishing Between Threats and Controls

## ANNEX A – STANDARDISATION OF EQUIPMENT THREAT INFORMATION

Table 1 shows the output of an assessment that was carried out by the ASPIRE team in order to establish if a systems approach or a functional approach is the best means to standardise equipment threat information.

CHARACTERISTIC	BEST SUITED – SYSTEMS OR FUNCTIONAL APPROACH	COMMENTS
Academically Robust	Functional/Systems	Both a functional and a systems approach could be viable.
Level of Complexity	Functional	The functional approach will provide a smaller number of entities that can be used to improve reporting clarity.
Longevity	Functional	Functional definitions are not specific to a generation of platforms.
Universality	Functional	Functional failures work well for a broad range of platforms.
Coherence with other tools	Functional	The broader approach of the functional method will afford a better opportunity for alignment with ASPIRE tools as they develop.
Transition burden	Functional	Mapping of systems nodes to functional threats will be easier for DTs as they will not have to rework current system level threats into 'new system level threats'.
Granular enough to be meaningful	Systems	The systems level will be more meaningful to the DT and TAA but the functional level is likely to be more familiar to the ADH community. The TAA will be able to understand relative contribution through a combination of systems and functional information.
Consistent numerical approach	Functional	The use of the functional approach presents an opportunity to align hazard information across different platforms with very different characteristics and still achieving a valid comparison.

Table A1