



7. Aircraft Hazards and Risks

This chapter investigates the hazards and potential risks of planned Super Hornet flying operations at RAAF Base Amberley.

Assessment and analysis of Super Hornet flying operations and associated aircraft accident risks, including potential bird strike hazards and aircraft accident risks in the vicinity of RAAF Base Amberley, were conducted. The chapter includes a review and assessment of command and control procedure adequacy and provides recommendations regarding current and planned mitigation measures of each summarized risk.

Details regarding the aviation hazard and risk assessment are provided in the Technical Report – Aviation Hazard and Risk attached as **Appendix K**.

7.1. Methodology

The risk assessment methodology was based on the risk analysis model of *AS/NZS 4360:2004 Risk Management*. The *AS/NZS 4360:2004 Risk Management* is an industry Standard and the general principles outlined in the guideline comprise the following steps:

- Establish the context with relevance to aviation risk;
- Identify the risks;
- Analyse risks, in terms of consequences and likelihood;
- Evaluate the risks – by comparison with predetermined criteria; and
- Prepare and implement a risk treatment plan.

The risk assessment and analysis was based on both current and planned operations as well as existing and planned airfield conditions. Due to the complexities associated with evaluating operations and conditions, the assessment and analysis are generally more qualitative than quantitative. Existing conditions and current or historical data provide information more supportive of quantitative results.

The effect of flight paths and frequency of aircraft movements were analysed as potential contributors to the risk of accidents involving residential and industrial areas.

7.1.1. Aircraft Risk Assessment

A probability analysis of military aircraft accidents within Australia and Super Hornet worldwide provided a baseline for determining potential impacts associated with Super Hornet flying operations at RAAF Base Amberley. The following potential impacts were evaluated and to the extent practicable are presented in a quantitative manner.



These include the consequences of aircraft accidents:

- Occurring on RAAF Base Amberley;
- Occurring in adjacent residential areas;
- Occurring in adjacent industrial areas;
- Involving other aircraft;
- Into or over water catchments or reservoirs;
- Involving fuel spills or igniting bushfires; and
- All other known potential risks.

Consideration of the phase of flight and location relative to RAAF Base Amberley assisted in the estimation of aircraft accident probability in comparison with the frequency of operations. Land use management strategies and consequences were given consideration in the estimation.

7.1.2. Bird Strike Analysis

A site visit to RAAF Base Amberley was undertaken to identify sites on or near the airport that attract birds or bats and the routes of flight used including any seasonal variations. The relative risk of bird strikes was determined with a semi-quantitative and qualitative discussion of the following points:

- The difference in risk between present and proposed flying operations;
- The anticipated magnitude of the risk under proposed flying operations;
- Bird strike risk management with regard for current and proposed procedures;
- Projected success of planned mitigation measures; and
- The expected consequences of each level of risk.

7.1.3. Hazards and Risks to People and Property

Potential hazards and risks to people and property were investigated for future Super Hornet operations at RAAF Base Amberley and included:

- Death or personal injury resulting from aircraft accidents and incidents;
- Damage to or total loss of aircraft;
- Damage to buildings and structures; and
- Damage to or total loss of vehicles.



7.1.4. Hazards and Risks to Waterways, Livestock, Flora and Fauna

Potential hazards and risks to environmental values were investigated for future Super Hornet operations at RAAF Base Amberley and included:

- Contamination of nearby waterways by fuel or hazardous materials;
- Death or injury to livestock as a result of aircraft accidents or incidents;
- Damage to flora caused by fuel spillage, fire or hazardous materials; and
- Injury or death to fauna (i.e. birds and animals) as a result of aircraft accidents or incidents including those caused by animal or bird strikes.

7.1.5. Command and Control Procedures

A high level review of emergency response procedures provided the basis for a discussion of the following additional aircraft hazard and risk issues:

- Fire safety controls, including bushfire ignition, and hazardous materials spill response;
- A description of relationships with disaster control organisations including command and control; and
- Measures to reduce the risk of hazardous incidents affecting the public and environment.

7.2. Review of Existing Data

7.2.1. Accident Risk Assessment

An extensive review of literature and data was conducted for the aircraft accident assessment regarding aviation risks, accident data, the Super Hornet operational data and policies and procedures relating to aircraft operations and risk mitigation. Aircraft accident data from Defence is provided in **Appendix K**.

7.2.2. Bird Strike Analysis

The bird strike analysis and associated risk of bird and bat strikes at RAAF Base Amberley was conducted through an extensive review of literature and data. Data on reported bird strikes occurring at RAAF Base Amberley was obtained through the Defence Aviation Hazard Reporting and Tracking System (DAHRTS) database. Information extracted from a review of related Defence documents provided insight into Defence environmental policy and procedures at RAAF Base Amberley including specific procedural guidelines associated with the deployment of the Super Hornet at the Base.



7.2.3. Command and Control

The RAAF Base Amberley Airfield Emergency Plan (AEP) outlines the specific response procedures for aircraft incidents or accidents including procedures for command and control operations. The AEP is comprised of several supporting plans that address all known emergencies that may affect the safety, security, environmental health and operation of RAAF Base Amberley.

A separate plan has been developed in accordance with Defence’s Manual of Fire Protection and Engineering (MFPE), concerning bushfire monitoring and response procedures. This plan promotes a pro-active approach regarding management of bushfire risks and encourages cooperative involvement with local Council to continually improve bushfire protection of adjoining RAAF Base Amberley land uses and associated land development.

7.3. Risk Criteria and Structure

The environmental and community issues criteria against which the identified risks are to be evaluated are outlined in Table 7-1 (scale of consequences), Table 7-2 (likelihood scale) and Table 7-3 (risk level). The likely severity of consequences of an incident combined with the likelihood of the incident occurring informs the risk level.

■ **Table 7-1 Scale of Consequences**

Severity Level	Health & Safety	Property	Natural Environment
Severe	Multiple fatalities or significant irreversible effects to >50 persons.	Damage beyond repair	Very serious, long-term environmental impairment of ecosystem functions.
Major	Single fatality and/or severe irreversible disability (>30%) to one or more persons.	Major repairable damage rendering property temporarily inhabitable	
Moderate	Moderate irreversible disability or impairment (<30%) to one or more persons	Major repairable damage but property remains habitable	Serious medium term environmental effects
Minor	Objective but reversible disability requiring hospitalization	Moderate repairable damage but property remains habitable	Moderate, short-term effects but not affecting ecosystem functions
Negligible	No medical treatment required	Superficial damage	Minor effect on biology of physical environment



■ **Table 7-2 Likelihood Scale**

Category	Probability	
	Quantitative	Qualitative
Probable	< 1 x 10 ⁻³ per year	High
Possible	< 1 x 10 ⁻⁵ per year	Medium
Improbable	< 1 x 10 ⁻⁷ per year	Low

■ **Table 7-3 Risk Level Matrix**

Likelihood	Severity				
	Negligible	Minor	Moderate	Major	Severe
Improbable	Acceptable	Acceptable	Acceptable	Review	Reject
Possible	Acceptable	Review	Review	Review	Reject
Probable	Acceptable	Review	Reject	Reject	Reject

The level of risk informs the need for the consideration of mitigation measures and the ongoing monitoring of the risk.

Queensland Government SPP 1/02 has defined Public Safety Zones at the end of runways. The dimensions of these zones incorporate the area where the risk per year resulting from an aircraft crash to an individual is somewhere between 1 in 10,000 (10⁻⁴) and 1 in 100,000 (10⁻⁵).

7.4. Areas of Risk Management

The areas of risk concerning planned flying operations of the Super Hornet at RAAF Base Amberley have been identified in Table 7-4.

■ **Table 7-4 Areas of Risk**

Area of Risk Management	Assessment and Analysis
Current risk compared with proposed flying operations of the Super Hornet	Probability analysis of military aircraft accidents in Australia and to the extent relevant Super Hornet world-wide
Consequences of aircraft accidents	Crashes on Base, in residential and industrial areas, involving other aircraft, into or over water catchments and storage reservoirs, aircraft fuel spills, bushfire ignition, hazmat, etc
The effect of flight paths and frequency of aircraft movements	Accidents involving residential and industrial areas
Identification of sites and the relative risk of bird or bat strikes	Attractants, routes of flight, and seasonal variations of birds and bats; differences in present and proposed flying operations, magnitude of risk, current and proposed risk management, likelihood of planned measure success, and consequences of each level of expected risk
Command and control procedures and relationship with disaster control	Fire control and management proposals, fire safety details and hazmat spill measures, and mitigation measures to reduce the risk of hazardous effects on the public and environment



7.5. Aircraft Accident and Wildlife Hazard Overview

Military aircraft incidents and accidents were reviewed with regard for the F-111 and the Super Hornet. Australian military aircraft other than the F/A-18A were not considered to be relevant because of their relative age and time of service, the lack of substantial data available and characteristics dissimilar to the Super Hornet.

7.5.1. Military Accidents and Incidents in Australia

Eight F-111 aircraft have been lost in accidents from all causes and all phases of flight since the aircraft was introduced to RAAF service in 1973. The F-111 had flown a total of 132,418 hours in 36 years of Australian service to 30 June 2008, resulting in a Category 5 (resulting in loss of life) accident rate of 6.04 per 100,000 hours. This rate was slightly lower than the rate of 6.13 per 100,000 flying hours experienced by the United States Air Force for the F-111.

No Category 5 F-111 accidents have occurred at RAAF Base Amberley. Most of the RAAF F-111 accidents occurred in locations remote from airfields. The fact that most of the RAAF F-111 accidents occurred away from airfields is noteworthy because the majority of aircraft accidents would generally occur during the most critical phases of flight, i.e. take-off and landing.

Four F/A-18A aircraft have been lost since the aircraft entered RAAF service in 1985. These accidents also occurred away from airfields. The F/A-18A had flown a total of 241,807 hours in RAAF service to 30 June 2008, resulting in a Category 5 accident rate of 1.7 per 100,000 hours. This compares favourably with the rate of 3.44 per 100,000 hours for F/A-18A/B/C/D models in service with the United States Navy.

The PER guidelines refer to comparison with military aircraft accidents within Australia. The most recent F-111 and F/A-18A Category 5 accidents occurred in 1999 and 1992 respectively. In recent years, F-111 and F/A-18A safety records have a downward trend and the safety of both aircraft compared favourably with others in the Defence inventory.

7.5.2. Super Hornet Operation Worldwide

A report by the United States General Accounting Office (GAO) identified the number and rate of serious accidents for US military accidents, including related fatalities, destroyed aircraft, and the value of lost aircraft (GAO, 1998). A Class A mishap is defined as an incident resulting in more than US\$1M damage, or a fatality or permanent total disability.



The GAO report (GAO, 1998) indicated that between 1975 and 1995, the annual number of Class A mishaps to U.S. military aircraft decreased from 309 to 76, while the number of fatalities decreased from 285 to 85. During this period, Class A mishaps per 100,000 flying hours, referred to as the mishap rate, also decreased from about 4.3 to 1.5.

The report also indicated that the mishap rate for US Navy and Marine Corps aircraft dropped significantly from 7.3 mishaps per 100,000 flying hours in 1975 to 1.9 in 1997. This rate applied to all aircraft then in service in the U.S. Navy and Marine Corps including the F/A-18A/B/C/D Hornet.

Data available from the U.S. Navy indicates that after 12 years of flying, the Super Hornet fleet has experienced a Class A mishap rate of less than 1.0 per 100,000 flying hours. This is a significant improvement over earlier aircraft types and supports the general downward trend in Class A mishaps.

7.5.3. Estimated Accident Rate for Super Hornet

Indications from U.S. Navy experience are that Australia may expect an improvement in safety and a corresponding reduction in accident rates from the introduction of the Super Hornet. Regardless, the analysis below will conservatively estimate the Category 5 accident rate for the Super Hornet to be 1.7 per 100,000 flying hours. This is the current accident rate for the F/A-18A Hornet in Australian service.

7.5.4. Potential Bird Strike and Wildlife Hazards

A bird strike is a collision between an aircraft and a bird or bat. A bird strike is considered to have occurred when a pilot reports a strike or whenever evidence such as remains are found on or in the aircraft; a responsible person directly observes a strike, or remains are found on, or beside a runway and no other reason can be determined for the deceased animal.

Determining the risk of bird strikes in aviation is an exercise supported by numerous industry groups, government and military organizations. In Australia, a collective approach to address wildlife and bird strike hazards emanated from the release of an Australian Transport Safety Bureau (ATSB) research paper *The Hazard Posed to Aircraft by Birds*, in 2003. The paper reported on bird strikes in Australia from the decade ending 2001. From this effort the Australian Aviation Ground Safety Council initiated a bird and animal hazard forum which led to the formation of the Australian Animal Wildlife Hazard Group (AAWHG). The AAWHG examines bird strike research to detect trends, develop risk assessment models and establish priorities in the mitigation of bird and animal hazards.



In 2008 a study titled *An Analysis of Australian Birdstrike Occurrences 2002 to 2006* (AR-2008-027) was prepared by the ATSB. The study suggested the degree to which bird strike and wildlife hazard risks can be measured in Australia is often hampered by ineffective or infrequent reporting. The ATSB identified that many strikes are reported more than once causing uncertainty in the numerical accuracy of the data collected. It is important to note that whilst data reflects a general improvement in Australia's bird strike reporting culture, only 20% of all bird strikes are commonly believed to be reported.

Bird strike data in Australia has been systematically collected since the mid-1940s and subsequently utilised in the management of hazards posing risk to aircraft at airfields. Along with worldwide research and practice, this data has provided the basis for wildlife hazard perspectives in Australia.

Also active in bird strike hazard studies, the Department of Defence is at the forefront of wildlife hazard management. Defence published a comprehensive report on bird strikes in 1975 and later provided substantial data through the Directorate of Defence Aviation and Air Force Safety (DDAAFS) concerning phase of flight statistics used in the preparation of the 2003 ATSB research paper.

The report indicates that in Australia the rate of bird strikes per 10,000 movements on regular passenger transport aircraft increased from 4.7 in 2002 to 6.7 by 2006. In other countries where similar data is recorded (Canada, Europe, UK and USA), this same period has shown an increasing trend of bird strikes along with evidence suggesting migratory bird patterns may have recently altered. Foraging and roosting movements are likely to occur around and in RAAF Base Amberley as birds and bats are drawn to flowering, fruiting and seeding habitat blooming in annual rotation throughout all seasons.

Sharing knowledge regarding the effect of bird strikes will remain critical for military and civil aviation however differences in aircraft types and flight profiles tend to preclude any direct comparisons especially considering the more stringent bird strike certification standards faced by civilian aircraft and airfields. Whilst wildlife management programs at military and civilian airfields employ the same techniques and generally the same equipment, military aviation has greater flexibility in flight scheduling and route selection making it possible to avoid known bird activity areas. Commercial aviation is relatively inflexible and bound to schedules, flight routes and altitudes dictated by factors other than bird movements.

7.6. Aircraft Accident Consequences and Likelihood

This section presents information and analysis relating to the potential likelihood of aircraft accidents occurring in the RAAF Base Amberley area.



7.6.1. Likelihood of Aircraft Accidents

The likelihood of a Super Hornet crash affecting the area around RAAF Amberley can be estimated by reference to the historical data for RAAF F/A-18A aircraft (a crash rate of 1.7 per 100,000 flying hours) in conjunction with the planned flying operations of the Super Hornet in the vicinity of RAAF Base Amberley.

Accordingly, the estimated likelihood of a Super Hornet crash occurring in the vicinity of RAAF Base Amberley, per year, can be expressed as:

Planned Super Hornet flight hours per year	X	Estimated likelihood of a Super Hornet accident per flight hour
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Flight hours in the RAAF Base Amberley area are assumed to include those spent by Super Hornet in the departure, approach or circuit training phases of flight. Annual Super Hornet operations at Amberley are planned to include approximately 4,648 total aircraft movements. This total equates to 1,724 departures and 1,724 arrivals and around 600 practice circuit take-off and landings.

A single departing Super Hornet or a pair of Super Hornets using the normal departure profile will leave the Amberley Military Control Zone 1.25 minutes after take-off and will reach an altitude of 17,000 feet (5,150m) after a four minute climb, approximately 18.5 km from the start of take-off. The cumulative annual time for 1,724 Super Hornet departures from Amberley is:

$$\text{Departures} - 1,724 \times 1.25 \text{ minutes} = 2,156 \text{ minutes or about } 36 \text{ hours per year.}$$

The approximate breakdown of movements by the type of approach is: 86 arrivals will involve a straight-in visual approach, 258 will involve an instrument approach, and 1,379 arrivals will involve the standard initial and pitch procedure for rejoining the circuit and landing. One additional approach is accounted for in the rounding of approach percentages providing a total of 1,724.

A single Super Hornet or a pair arriving at Amberley will normally use the standard initial and pitch method of rejoining the circuit for landing. The entire rejoin procedure takes 3.5 minutes, 2 minutes of which are within RAAF Base Amberley airspace (surface to 4,500 feet). A straight-in visual approach will generally take less time than the standard procedure, so for a conservative estimate these operations can be considered together. The cumulative time for standard Super Hornet arrivals at RAAF Base Amberley is calculated as:

$$\text{Arrivals (standard)} - (1,379 + 86) \text{ arrivals} \times 2 \text{ minutes} = 2,930 \text{ minutes or around } 49 \text{ hours per year.}$$

The instrument approach procedure involves a final approach taking 4.5 minutes during which the aircraft descends from an altitude of 2,500 feet (750 m) and 10 NM (19 km) from the runway to the touchdown point. The final approach is flown at 130 knots (250 km/hr). Planned Super Hornet operations at RAAF Base Amberley include a total of 258 instrument approaches per year. The cumulative time for Super Hornet instrument approaches to RAAF Base Amberley is:



Arrivals (instrument) – 258 arrivals x 4.5 minutes = 1,161 minutes or approximately 19 hours per year.

The number of Super Hornet training circuits flown at Amberley is planned to be 600 per year. Each take-off, circuit and landing is assumed to take 3.4 minutes. Total time planned to be spent on circuit training for the Super Hornet is:

Training circuits - 600 x 3.4 minutes = 34 hours per year.

The total Super Hornet flying hours expected to take place in the vicinity of RAAF Base Amberley is:

Total flying hours - 36 hrs + 49 hrs + 19 hrs + 34 hrs = 138 hours per year.

The likelihood of a Super Hornet accident occurring in the vicinity of RAAF Amberley is therefore:

(138 hrs/8,760(one year)) x (1.7/100,000) = 2.68 x 10⁻⁷.

This puts the likelihood of an aircraft accident in the 'Possible' category within the likelihood scale.

The level of risk to an individual property or person is considerably lower than the probability of an aircraft crash occurring, due to the fact that the area occupied by a single building or person is considerably less than the total area in which a potential aircraft accident could occur. Although difficult to estimate precisely, it is reasonable to conclude that due to the relative areas occupied by individuals (buildings or persons) the likelihood of individual exposure to the consequences of an aircraft accident would be reduced to less than 1 x 10⁻⁷ (or into the 'Improbable' category).

7.6.2. Accidents Occurring on RAAF Base Amberley

7.6.2.1. Departures and Arrivals

Super Hornet arrival and departure flight paths at RAAF Base Amberley avoid populous areas. F-111 arrivals and departures at RAAF Base Amberley have also followed this practice. The likelihood of an F-111 aircraft accident during arrivals and departures is also assessed as being in the 'Possible' category on the basis of the available accident data and operational information.

Aircraft accidents occurring on RAAF Base Amberley would almost certainly be close to the ends of the runway and close to the extended runway centreline e.g. runway overruns or undershoots.



7.6.2.2. Runway Overruns or Undershoots

There is a possibility that a person or persons could be struck by an F-111 or Super Hornet overrunning or undershooting the runway at RAAF Base Amberley during take-off or landing (departure or arrival), resulting in a fatality or severe irreversible disability. The severity of this occurrence is 'Major.'

Runway 15/33 is the only runway at Amberley that will be used for Super Hornet operations. The runway length of 3,047 metres is more than adequate for F-111 and Super Hornet operations at maximum weight.

The likelihood of an overrun during take-off is very low. F-111 and Super Hornet can accelerate to the scheduled take-off speed and stop in the remaining runway length using only the aircraft brakes following a rejected take-off. The F-111 and the Super Hornet are equipped with an arrestor hook which can be extended to engage the arrestor cables that are permanently installed on Runway 15/33 at Amberley, 500 metres from each end of the runway pavement. The cables provide a means of stopping these aircraft in the event of a brake system failure or in other circumstances which may cause the aircraft to run off the end of the runway.

Undershooting or landing short of the runway surface is a rare occurrence usually brought on by an aircraft experiencing abnormal hydraulic system operation or flight control problems. These difficulties are usually known well in advance of arrival and the emergency response procedures at RAAF Base Amberley would prepare for arrival of an aircraft in distress with emergency equipment at the ready and the public safety areas clear.

The likelihood of an overrun or undershoot of the runway at RAAF Base Amberley has been accounted for in estimating the likelihood of an aircraft accident.

7.6.3. Accidents Occurring in Residential Areas

The area surrounding RAAF Base Amberley is predominantly rural, with rural residential, low density residential, commercial and industrial centres as well. The orientation of Runway 15/33 is north-west to south-east.

7.6.3.1. Death or Personal Injury from Flying Debris or Fire

Flying debris or fire as the result of a catastrophic aircraft accident has the potential to cause death or severe irreversible disability or impairment to one or more persons. This translates to 'Major' on the Scale of Consequences.

Approximately half of all aviation accidents occur during the take-off and landing phases of flight. In calculating the probability of a person being exposed to flying debris from an F-111 or Super Hornet accident at RAAF Base Amberley, it is assumed that such an accident is more likely to occur while the aircraft is conducting repetitive take-offs and landings. However, no F-111 Category 5 accidents have occurred at RAAF Base Amberley during 36 years of service with the RAAF.



Planned annual hours to be flown by the Super Hornet are 4,500. For an assumed accident rate of 1.7 per 100,000 hours, similar to the F/A-18A, this results in an accident probability of:

$$0.000017 \times 34/4500 = 1.28 \times 10^{-7}.$$

Within the likelihood scale, the likelihood of exposure of a person to a Super Hornet accident during circuit training at Amberley falls within the 'Improbable' category. The same likelihood applies to F-111 operations.

The probability of such an accident arising from engine failure is remote because the F-111 and the Super Hornet are both twin engine aircraft. Advice from CASA Airworthiness Certification Standards indicates that the likelihood of a catastrophic engine failure on take-off in a modern jet civil transport aircraft is no more than 1 in 100,000 hours of operation, or 1.0×10^{-5} . It can be assumed that the engines in the Super Hornet have similar reliability to those in a modern jet civil transport aircraft because of their recent origin and modern turbofan design. The probability of an F-111 or Super Hornet accident arising from a double engine failure due to independent causes is:

$$1 \times 10^{-5} \times 1 \times 10^{-5} \text{ or } 1.0 \times 10^{-10},$$

This is in the 'Improbable' category.

The Super Hornet, like the F/A-18A and the F-111, is able to fly on the remaining engine in the event of a failure or malfunction which requires an engine to be shut down in flight. The aircraft also has the ability to continue take-off in the event of an engine failure occurring on the runway after the aircraft has reached the speed at which the take-off can be safely aborted.

7.6.3.2. Jettisoned or Inadvertently Released Aircraft Stores

A person could be struck by aircraft stores that have been jettisoned intentionally or released inadvertently. Injuries sustained from the effects of falling aircraft stores have the potential to cause death or severe irreversible disability or impairment to the affected person(s). This translates to 'Major' on the Scale of Consequences.

External fuel tanks and stores carried on the Super Hornet will not be deliberately jettisoned except in an emergency, for example where there is a risk of the landing gear collapsing during landing. If jettison becomes necessary, this action is usually performed over a safe area designated for the purpose. There have been no recorded instances of deliberate jettison of stores from the F-111 or the F/A-18A while arriving at or departing from an airfield.



There are two recorded instances of aircraft stores falling uncommanded from F/A-18A aircraft. Hours flown by the F-111 and the F/A-18A have been combined to 374,225 because both aircraft routinely carry external stores, although no inadvertent release incidents have occurred with the F-111. This equates to a rate of one in 187,112 hours or 0.0000053 per hour of flight. Two events in (36 + 24) years of RAAF operation of the F-111 and the F/A-18A equates to (2/60) or 0.0333 per year.

It is assumed that inadvertent release of aircraft stores can occur anywhere within 10 kilometres of Amberley, i.e. an area of 214,280,000 square metres, and that the Super Hornet will experience a similar incident rate to the F-111 and the F/A-18A. The probability of an F-111 or Super Hornet inadvertent release incident injuring a person at Amberley or in the surrounding area is therefore:

$$2 \times 0.0338 \times (1/214,280,000) = 3.15 \times 10^{-10} \text{ per year}$$

This is in the 'Improbable' category.

7.6.3.3. Falling Aircraft Components or Equipment

A person could be struck by falling aircraft components or equipment lost during flight. These items are generally small lightweight removable access panels, covers, fairings or vanes, the loss of which is often not discovered until the aircraft is inspected after landing. Injuries sustained from the effects of falling components or equipment could conceivably range from 'Minor' to 'Major' on the Scale of Consequences. In most cases, though, the small lightweight nature of the items possesses the potential to cause objective but reversible disability requiring hospitalization. This translates to 'Minor'. However, in recognition that in some cases more severe injuries may occur, the consequences have been assessed as 'Moderate'.

Records of these losses for the F-111 are incomplete but 52 items of this type were lost from F-111 aircraft since 1980, resulting in an average loss rate of approximately 1.85 components per year.

Records for the F/A-18A cover the whole period of service for the aircraft and show that 36 components were lost in flight over a period of 23 years during which the aircraft flew 241,807 hours. This equates to a loss rate of 1 in 6,716 hours or 0.000148 per hour of flight or 0.638 per year. The Super Hornet can be expected to perform at least as well as the F/A-18A and better than the F-111 in this respect. There have been no recorded injuries attributed to falling components or equipment from the F-111 or the F/A-18A.

In calculating the probability of this occurring at RAAF Base Amberley, it is assumed that a component may fall from an Super Hornet anywhere within 10 kilometres of Amberley, that only 5% of these components are lost outside military training areas or weapons ranges, and that a person must be present in the precise location and at the same moment as the component reaches the ground. The area within a 10 kilometre radius of Amberley is 214,280,000 square metres. A person is assumed to occupy a ground area of one square metre.



The probability of an individual person being injured by a Super Hornet component falling from the aircraft within 10 kilometres of RAAF Base Amberley is:

$$1/214,280,000 \times 0.638 \times 0.05 = 1.48 \times 10^{-10} \text{ per year}$$

This is in the 'Improbable' category.

7.6.3.4. Damage to Buildings, Structures and Vehicles

Buildings, structures and vehicles at a Super Hornet accident site in a residential area may be exposed to impact forces that exceed the applicable design standards, and fire. The severity of impact and fire damage may range from 'Negligible' to 'Moderate' on the Scale of Consequences.

No damage to buildings or structures has or injuries to persons have been attributed to falling components or equipment. Even though buildings and structures are not by nature transient, the probability of exposure to these hazards is assessed as 'Improbable'.

7.6.4. Accidents Occurring in Industrial Areas

Industrial or commercial areas in the vicinity of RAAF Base Amberley have been identified as small scale facilities in Walloon and Pine Mountain north of the Base and south-east of the Base in Yamanto. Runway 15 departures would be to the south-east while Runway 33 departures would be to the north-west. Runway 15 is projected to accommodate 80% of Super Hornet movements.

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7.6.4.1. Personal Injury

In industrial areas, the severity of injuries to persons arising from a catastrophic aircraft accident or other hazards is similar to that identified for residential areas. This translates to 'Major' on the Scale of Consequences. The likelihood of a member of the public being killed or injured in an industrial area as a result of a Super Hornet accident is similar to that for residential areas and is in the 'Improbable' category.

7.6.4.2. Damage to Property

The severity of possible damage to buildings, structures and vehicles present at a Super Hornet accident site in an industrial area is similar to that for residential areas, and ranges from 'Negligible' to 'Moderate' on the Scale of Consequences. The number and size of industrial areas within the vicinity of RAAF Base Amberley is relatively small further resulting in the exposure of buildings, structures and vehicles to damage from a Super Hornet accident as 'Improbable.'



7.6.5. Accidents Involving Other Aircraft

One accident occurred in 1990 as a result of a collision between two F/A-18A aircraft during air combat manoeuvring. Air combat manoeuvring is conducted in Flying Training Areas well away from RAAF Base Amberley and populated areas. All other aircraft operations are highly controlled in accordance with air traffic control procedures so it is reasonable to assume there is negligible possibility of an accident of this kind involving the Super Hornet and any other aircraft occurring at RAAF Base Amberley.

The probability of a collision between two Super Hornets flying as a pair in formation is similar to that for other catastrophic accidents and falls within the 'Improbable' category. There is no reason to believe the probability of accidents involving other aircraft occurring is greater than currently exists for aircraft operations at RAAF Base Amberley.

7.6.6. Accidents Into or Over Water Catchments and Storage Reservoirs

The Amberley Military CTR comprises an area of about 2,057 square kilometres. Water catchments and storage reservoirs occupy up to 25% of the area within the Amberley Military CTR. Contamination of waterways is possible from fuel spillage associated with aircraft accidents, but in catastrophic accidents which often involve intense fire, spilled fuel is usually burned before it can enter waterways in quantity or soak into the ground.

The amount of fuel carried on board the aircraft will significantly affect the extent of this hazard. Aircraft used in short and medium haul civil air transport operations such as the B-737-800 may carry up to 21 tonnes of fuel. In contrast, fuel carried by the Super Hornet with a full internal load and three external tanks is 11 tonnes. This relatively small amount will generally be limited to the immediate site of a Super Hornet accident.

A Super Hornet accident site is likely to be small if the aircraft trajectory is near the vertical when the aircraft strikes the ground. This is most likely to occur during uncontrolled flight after the crew has ejected from the aircraft. The distribution of spilled fuel and hazardous material is therefore likely to remain within the accident site, assisting site cleanup and remediation.

If not contained and removed, jet fuel spillage may contaminate water catchment areas and storage reservoirs. Water contaminated with jet fuel has the potential to cause objective but reversible disability requiring hospitalisation. This equates to 'Minor' on the Scale of Consequences.

Hazardous materials such as carbon fibre have the potential to cause severe irreversible disability or impairment to human health. This translates to 'Major' on the Scale of Consequences.

Unburnt spilled fuel that may enter waterways and storage reservoirs is readily detectable by appearance and smell, and can be treated before it enters the public water supply system. Hazard to human health and safety is therefore minimised so the likelihood of a person suffering disability from this hazard is 'Negligible.'



In the event of an aircraft accident, control measures are generally implemented immediately to prevent public access to the accident site. These measures are intended to facilitate accident investigation by preserving evidence at the site, and to protect members of the public from inadvertent exposure to health and safety hazards until the relevant environmental response plan has been implemented and the accident site has been sanitised.

Emergency response teams are aware of hazardous materials that may be present at a military aircraft accident site and will take the necessary precautions to safeguard the health and safety of team members during removal and disposal of hazardous material and site remediation.

The Base is bound by the Bremer River and Warrill Creek and the groundwater table lies approximately 15 m below the surface and flows to the Bremer River. Fuel spills occurring on RAAF Base Amberley are required to be contained and removed through approved practices contained in the RAAF AEP in accordance with EPBC Regulations. Every effort to prevent fuel spills from entering water catchments or impacting stormwater runoff is made as part of these procedures.

The severity of damage to water catchments and water storage reservoirs resulting from a Super Hornet accident is therefore 'Minor.' The likelihood of public exposure to hazards arising from a Super Hornet accident into or over a water catchment area or a water storage reservoir is categorised as 'Improbable.'

7.6.7. Analysis of Risks Involving Bushfires

7.6.7.1. Damage to Flora

The severity of damage to plant life within an accident site could range from superficial to irreversible damage from fire and consequent plant death. This would be considered to have only a transient effect on the biology of the surrounding physical environment due to the relatively small area that a Super Hornet accident site can be expected to occupy, and site sanitation and rehabilitation by environmental response teams. The severity of damage to plant life is therefore 'Moderate,' on the Scale of Consequences.

Although vegetation is not transient in nature, the likelihood of flora exposure to the effects of fuel spillage and fire within the affected area must be considered as 'Improbable' due to the remote probability of a Super Hornet accident.

7.6.7.2. Death or Injury to Fauna

Fauna in the Amberley area could be potentially at risk of injury or death as a result of fuel spillage and fire resulting from a Super Hornet accident. This would be considered to have a moderate short-term effect on the biology of the surrounding physical environment as a whole but would not affect ecosystem functions. The severity of risk to local fauna present at a Super Hornet accident site is 'Minor.'



Without detailed assessment of the population and behaviour of all types of fauna found within natural areas inside the Amberley Military CTR, it is not possible to quantify the likelihood of exposure to this hazard. However, given that fauna is transient in nature, and widely distributed throughout areas of natural vegetation, it is reasonable to conclude that the likelihood is 'Improbable' on the Scale of Consequences.

7.6.7.3. Bushfires Occurring in Rural Areas

Bushfires represent the most significant ecological risk from an aircraft crash apart from the danger to people, structures and equipment on the ground. The possibility of bushfires that may be attributed to F-111 or Super Hornet operations is 'Improbable' however and the risk minor given the low rate of aircraft crashes and the predominance of RAAF aircraft activity occurring in close proximity to airbases where bushfire response services are readily available.

Additionally, RAAF employs standard procedures for the management and control of aircraft crash sites addressing personnel and public safety as well as accident investigation, liaison with civil authorities, crash site clean-up procedures and recovery actions necessary for return to normal operations.

While crash response procedures sometimes develop on-scene with regard to coordination and communications with civil environmental authorities, response and remediation efforts are always prioritized below rescue, human safety and immediate suppression of fire.

Any response to a RAAF aircraft accident or incident should be coordinated with local Defence environmental staff. The RAAF Base Amberley Defence Support Group (DSG) should be notified as soon as practicable following an aircraft accident or incident. Crashes occurring off Base or over water will require DSG staff advice to appropriate civil environmental authorities regarding potential pollution risks and possible remediation procedures. This practice is also followed should a crash event on Base involve the possibility of off-site contamination of resources as a result of fluids entering surface or underground water supplies that pass through Defence property.



7.7. Summary of Impacts

Evaluation of the risk level of each hazard is summarised in Table 7-5.

■ **Table 7-5 Aircraft Accident Risk Evaluation Summary**

Category	Hazard	Level of Severity	Likelihood	Risk level
Health & Safety (People)	Death or Personal Injury From Aircraft Accidents (General Public)	Major	Improbable	Review
	Personal Injury From Falling Aircraft Components or Equipment (General Public)	Moderate	Improbable	Acceptable
	Death or Personal Injury From Jettisoned or Unintentionally Released Stores (General Public)	Major	Improbable	Review
Property	Damage to Buildings or Structures	Moderate	Improbable	Acceptable
	Damage to Vehicles	Moderate	Improbable	Acceptable
Natural Environment (Waterways, Flora & Fauna)	Damage to Water Catchments and Water Storage Reservoirs	Minor	Improbable	Acceptable
	Injury or Death to Flora as a Result of Fire	Moderate	Improbable	Acceptable
	Injury or Death to Fauna as a Result of Fire	Minor	Improbable	Acceptable
	Bushfires in Rural Areas	Minor	Improbable	Acceptable

With the exception of the risk of death or personal injury from aircraft accidents and from jettisoned or unintentionally released stores, all of the risks in Table 7-5 have been assessed as 'Acceptable'. Both of the 'Review' risk levels identified are a result of the potential consequences of an incident occurring being high rather than the likelihood being high. The probabilities in relation to both hazards are extraordinarily low. For the risk in relation to jettisoned or unintentionally released stores, for example, the likelihood that an individual would be struck is less than 1 in a billion, per year. This is much lower than the requirement for Public Safety Zones as outlined in Queensland Government SPP 1/02.

7.8. Mitigation Measures

Civil Aviation Safety Regulations (CASR) requires certain airfield operators in Australia to have procedural controls to address wildlife and bird strike hazards on and in the vicinity of the airfield. These procedures and practices correspond to the adoption of recommendations made by the International Civil Aviation Organisation (ICAO) in 1990.



These practices define the responsibility of airfield operators to:

- Assess the likelihood and consequences of risks posed by birds on and in the vicinity of the airfield;
- Implement actions necessary to reduce or otherwise mitigate bird populations on and in the vicinity of the airfield; and
- To the extent possible, eliminate or prevent the establishment of any site in the vicinity of the airfield that attracts birds or otherwise presents a danger to aviation.

The *National Framework for Bird and Animal Management at Airports* (Australian Airports Association, 2006), offers guidance in the preparation of a wildlife hazard assessment which leads to subsequent development of wildlife and bird hazard management plans. The assessment model used is semi-quantitative using bird population data, size, flocking characteristics, and strike frequency to determine risk probability.

7.8.1. Bird Strike Risk Management for Current and Planned Operations

Defence is conducting further wildlife and bird strike hazard assessment at RAAF Base Amberley in preparation of developing risk management and bird hazard mitigation strategies. The monitoring of bird and bat strike incidence and frequency will provide information relative to mitigation implementation effectively reducing the risk of bird strike hazards to as low as reasonably practical.

7.9. Command and Control Procedures

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Defence emergency response procedures including command and control procedures in response to aircraft accidents and incidents are a multi-layered, highly disciplined and specialised process. Advance planning to assess and address potential risks through the preparation of emergency response procedures helps minimise the impacts of emergencies occurring on or near an airfield. Minimisation of emergency impacts, especially those involving life-saving measures and the maintenance of aircraft operations is the principle aim of response procedures and planning. The following legislative bodies and regulations comprise the requirements for airfield emergency planning:

- Australian international obligations as a Contracting State to the International Civil Aviation Organisation (ICAO) Annex 13;
- Australian Civil Aviation Safety Authority (CASA) Civil Aviation Regulation (CAR) 89.1(1) (b); and
- Defence Aviation Safety Manual.

7.9.1. Airfield Emergency Plan

The process for responding to a number of known emergencies is outlined in the RAAF Base Amberley AEP. Established control and coordination procedures are contained in the AEP including guidance for RAAF interaction with civil agencies involved in emergency response. The AEP also establishes RAAF Base Amberley's role in community emergencies that range from aircraft accidents to industrial or natural disasters.



The facilities and community importance of RAAF Base Amberley potentially make the Base a central resource for responding to any local emergency.

The AEP contains procedures for coordinating response to emergencies by on-Base agencies and units as well as entities within the surrounding community that commonly assist in emergency response. These civil entities include law enforcement, medical and fire fighting services. To ensure seamless integration with civil resources, the AEP is constructed in a manner consistent with existing emergency and disaster plans currently in place in the surrounding community.

Base entities such as Air Wings and Aircraft Squadrons are required to have supporting emergency response plans and to coordinate these with the Base Aviation Safety Officer (BASO).

The BASO maintains the Base Emergency Response Kit, monitors the currency of the AEP and ensures training for all Base units to assist in AEP functions. The BASO conducts a variety of periodic training in support of aircraft emergency response on a monthly, semi-annual and annual basis. Training exercises are also conducted with civil emergency response agencies.

7.9.2. Command and Control Interface with Civil Authorities

If an aircraft accident occurs off Defence property, the senior state police officer assumes command jurisdiction. Civil police are authorised to exercise limited control over any incident occurring on Defence property that involves serious injury or fatality. It is normal for civil police to control emergency response to a remote aircraft accident with the responding RAAF personnel subject to civil jurisdiction.

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RAAF Base Amberley coordinates emergency response activities as necessary, with the following civil resources:

- State Emergency Services (SES);
- Queensland Ambulance Service;
- Queensland Police;
- Queensland Fire Fighting Services; and
- Ipswich and Brisbane General Hospitals Staff.

Civil authorities undertake emergency response as part of normal operations when lives or property are affected by an off-base emergency involving military aircraft. When the magnitude of an emergency is beyond that of normal base resources, civil assistance will be requested. Coordination and partnering with civil entities is but one demonstration of Defence and RAAF Base Amberley commitment to working cooperatively with the community.



7.9.3. Bushfire Response and Control Procedures

The command and control of fire events is required to apply the Australasian Interagency Incident Management System (AIIMS). This is the Incident Control System (ICS) used by civilian fire services. A manual describing the ICS is held at the Air Base Command Post.

Although the Queensland Fire and Rescue Service (QFRS) may undertake fire suppression on RAAF Base Amberley, the *Queensland Fire and Rescue Service Act 1990* does not give QFRS authority to act independently on military lands. The QFRS therefore must be invited by Air Base Command Post onto RAAF Base Amberley for any purpose including fire suppression. The QFRS will use their command system to manage QFRS resources under the overall control of the appropriate person with authority on the military land. In larger fire events a QFRS Commander may head up the on-site QFRS personnel rather than an Incident Controller.

7.9.4. Summary of Command and Control Procedures

The command and control procedures applied to aircraft incident and accident response at RAAF Base Amberley appear are in line with best practices recognized in Australia and internationally among airfield emergency service organizations. The detailed preparation, implementation and execution of these procedures are indicative of Defence strategy, priority and management of safety involving aircraft, airfields and personnel.

Coordination and interaction with civil authorities on a recurring basis, including integrated training exercises assist in assuring cooperative, capable response to aircraft accidents and incidents whether they occur on or off the Base. Lessons learned from these activities and from documentation of actual emergency response ensure adequacy of procedures whilst assisting RAAF in the formulation of future emergency response procedures in relation to projected operations, hazards and risks.

7.10. Summary and Conclusions

In RAAF service the F/A-18A generally has a much better safety record than the F-111. This is due to a number of factors which include the adoption of a proactive approach to military aviation safety by Defence through the introduction of safety management systems. These systems represent a set of checks and balances and are aimed at achieving continuous safety improvements and corresponding reductions in accident and incident rates. The Super Hornet is also substantially a new aircraft, which shares only limited structural commonality with the F/A-18A-D family of fighters.

The risk level (refer to Table 7-5) presented by a number of hazards (risks relating to aircraft accidents and jettisoned stores) is sufficient to warrant further review and application of appropriate additional control measures. The sections below outline Defence's review of these risks.



Risks to the natural environment, property and health and safety of people (from falling aircraft equipment) were considered to have risk levels of 'acceptable'.

7.10.1. Risks to People and Property

The risk to the public from flying debris and fire following a catastrophic accident, jettisoned or unintentionally released stores and debris from falling equipment or components are all examples of potential hazards that may occur outside of the airfield boundary. These hazards are managed by state and local planning controls. Permissible development in the public safety areas (at the end of runways) required by the Queensland State Planning Policy 1/02 excludes:

- Significant increases in people living, working or congregating in those areas; and
- The use or storage of hazardous materials.

The continued application of these controls by ICC will ensure that the risk to the public in those areas is as low as reasonably practicable. Existing low density rural zoning adjacent to the runway safety areas at RAAF Base Amberley should be retained under the *Ipswich Planning Scheme, Division 4 — Amberley Air Base and Aviation Zone* as this will assist in limiting public exposure to the identified risks of Super Hornet operations at Amberley.

In regard to the risk of jettisoned or inadvertently released stores, there are no recorded incidents of deliberate jettison of stores by F-111 or F/A-18A aircraft while arriving at or departing from an airfield. Standard operating procedures preclude deliberate jettison of external stores other than in appropriate areas and following receipt of clearance. The risk of further inadvertent release of external stores carried by the Super Hornet is mitigated by the following controls that have similarly been in place for the F-111 aircraft:

- The use of arrival and departure tracks at Amberley that avoid F-111 and Super Hornet overflight of populous areas;
- Rigorous application of pre-flight checks and tests to ensure that all airframe components, access panels and external stores are securely mounted;
- Strict observance of operating rules and procedures that preclude unintentional release of external stores; and
- Super Hornet deployment to other locations such as Townsville, Tindal and Darwin for release of external stores on designated air weapons ranges.

These procedures have been developed to effectively mitigate the risk to people and property arising from Super Hornet operations at RAAF Base Amberley. Applying these procedures fulfils the requirements of 'REVIEW' within the risk assessment process further reducing the risk to as low as reasonably practical.



7.10.2. Risks to Buildings and Structures

This assessment indicates that the risks to buildings and structures should be reviewed. Existing land use planning takes account of RAAF aircraft operations at Amberley and minimises the risk of damage to buildings and structures by controlling development in the area surrounding the Base. The risk of damage to buildings and property is as low as reasonably practical and therefore 'ACCEPTABLE' provided the controls are applied.

Considering the low likelihood of an aircraft crash incident at Amberley, based on historical data, and the routine application of accepted best practice in terms of extensive controls placed on aircraft operations, the risk arising from an aircraft crash incident can be considered to be as low as reasonably practical for the current airfield configuration.

7.10.3. Measures to Review and Update Command and Control

The risk assessment has highlighted to Defence that the AEP for RAAF Base Amberley should be reviewed and updated annually. All training and practice exercises should be completed in a timely fashion and the resulting lessons learned incorporated into emergency procedures and command and control communications.

Whilst training is not a substitute for an actual occurrence, realistic scenarios, professionally conducted by dedicated personnel often provide the best preparation for managing the real thing. The obstacles encountered and overcome through exercise of the AEP contribute to revision of plans and effective application of procedures in the event of an actual occurrence.

7.10.4. Monitoring and Reporting of Environmental Impacts

Defence monitors the aviation hazards and risks through the Defence Aviation Hazard and Risk Tracking System as part of the Defence Aviation Safety Management System. Incidents with an environmental impact are also recorded through the Defence Environmental Management System.



7.10.5. Summary of Mitigation Measures

Measures to mitigate or reduce the likelihood of risk occurring at RAAF Base Amberley include:

- Practices and procedures that place a priority on operational safety for:
 - Aircraft ground and aircraft-in-flight manoeuvres; and
 - Bird and wildlife hazard assessment, management strategy development and implementation.
- Placing priority on people, property and environmental health and safety through:
 - Increased awareness of hazards that incorporates base maintenance, development and housekeeping considerations; and
 - Exercising proper vigilance in the communication, coordination, and application of hazard mitigation.
- Ensuring regular training, practice, documentation and evaluation of all aspects of:
 - Aviation and aircraft flight safety;
 - Environmental hazard management; and
 - Emergency response command and control procedures.