AIRCRAFT HAZARDS TO NUCLEAR POWER STATIONS: IMPLICATIONS OF THE TORNADO CRASH 17 NOV 99

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1. Introduction

This briefing reviews the safety implications of the crash of an RAF Tornado fighter aircraft in the vicinity of the British Energy Advanced Gas-cooled Reactor nuclear power station at Torness, East Lothian, on 17 November 1999.

2. Circumstances of the accident

The accident involved a Tornado F.3 interceptor aircraft belonging to No.5 Squadron Royal Air Force, based at RAF Coningsby in Lincolnshire. The aircraft was one of three aircraft from the squadron carrying out night low level flying training over NE England/SE Scotland on the evening of 17 November. The aircraft was training for a future overseas deployment. The training involved flying with navigation lights switched off and with the crew navigating visually using night vision goggles (NVGs). These devices amplify small amounts of ambient light in order to create conditions for the wearer similar to daylight, enabling them to fly visually at night.

Preliminary reports suggest that the aircraft suffered a major fire, possibly accompanied by double engine failure, while flying over East Lothian at low level. The two crew ejected successfully and landed near the village of Birnieknowes, some 2.5km south of the Torness plant. They were later airlifted by helicopter to hospital in Edinburgh. The aircraft continued out to sea and crashed at a location approximately 13.5km east of the power station and 4.5km from the nearest land at Fast Castle Head.

Initial MoD reports say that the crew were aware of the location of the Torness power station and its low flying avoidance zone (see below), and ensured that the aircraft was pointing away from the power station and out to sea before ejecting. The relative locations of the aircrew's landing area and the crash site of the aircraft lend support to that statement since the aircraft clearly travelled some distance in an easterly direction before crashing into the sea.

The crew landed at a location some 700 metres outside the power station's low flying avoidance zone. There was a strong west to north-westerly airflow over eastern Scotland at the time of the accident. This suggests that the location of their ejection from the aircraft is likely to have been some distance to the west or north west of their landing point. If the aircraft then flew east from that point to its crash location, it is possible that it may have infringed the avoidance zone by flying inside its southern boundary. However precise evidence on this point is unlikely ever to be available, and if any such infringement resulted from the pilot's efforts to point the aircraft out to sea and away from the power station then it would be insignificant in safety terms.

3. Low flying avoidance areas around nuclear power stations

All nuclear power stations in the UK have designated zones around them which prohibit entry by any military aircraft. These apply to all commercial nuclear power facilities. In Scotland this covers Hunterston and Torness power stations. The zones are of one nautical mile (1852 metres) radius and extend from ground level to 2000 feet above the ground or the highest object on it. In Torness's case the zone extends to 2400 feet above sea level because the highest point of the building at Torness is approximately 400 feet above sea level.

These prohibited zones are known officially as Provost Marshal Prohibited Areas (PMPs). The Provost Marshal is the head of the RAF Police. PMPs have a rather stronger disciplinary authority than most low flying avoidance areas, which are established and managed by a group in Whitehall with only indirect reference to the RAF Police.

Commercial production nuclear power stations such as Torness have no exclusion zones around them for civilian aircraft. Under the terms of the *Air Navigation Order*, it is legal for any civilian aircraft to fly within 500 feet of any part of the structure of Torness power station. Other nuclear facilities, principally those with some connection to military nuclear materials research and/or production, do have civilian air traffic prohibited or restricted zones. These have a radius of 2 nautical miles and extend to 2000 feet. Examples of these in Scotland are Coulport/Faslane, Dounreay and Chapelcross. In addition there is a smaller zone, of half a nautical mile radius, around the submarine reactor nuclear waste storage facility at Rosyth Dockyard. These zones are established under the terms of the *Air Navigation Order* and apply to both civil and military aircraft.

4. The basis for avoidance areas

Modern nuclear power station design standards take account of the possibility of an aircraft crashing directly on the reactor building. This is the reason why there are no general air traffic avoidance areas around any commercial nuclear power facilities in the UK. Protection of these facilities against aircraft crash hazards is provided by engineering standards in the buildings themselves. The existence of avoidance areas for military low flying is based purely on concern by the Ministry of Defence and the nuclear industry to ally public fears about the safety of military flying training adjacent to nuclear power stations. It has no basis in probabilistic risk assessments of aircraft accident hazards.

It is less clear what provision is made for protection against aircraft crashes in the design of nuclear power station peripheral facilities such as waste storage and emergency power supply generation and distribution. This area would require further research.

The existence of the 2 nautical mile prohibited zones around facilities such as Coulport/Faslane and Chapelcross is partly due to security considerations (the desire to prevent low level photography) and partly because these facilities are built to different design standards and their operational activities may include, for example, movement of nuclear materials outside buildings on the site.

In considering the degree of protection afforded by the existing avoidance areas, it should be noted that no protection against aircraft crash is provided in the case of aircraft flying at altitudes greater than 2000 feet. This has no logical basis, since the higher an aircraft is flying, the further it can travel in the event, for example, of the crew abandoning it. Logically, if protection is to be provided against the unlikely event of any aircraft crashing on a nuclear plant, the avoidance zone should not be cylindrical in shape, stopping at 2000 feet, but should be an inverted conical shape, with the apex at the power station, getting progressively wider with altitude. The principal difficulty with this is that it would be impossible to portray on a two-dimensional aeronautical chart and extremely difficult for aircrew to assess the boundaries of when flying in its vicinity.

The Ministry of Defence would also be expected to point out that since there is no risk-assessment basis for the Provost Marshal Prohibited areas around nuclear power stations, there is no need to take account of hazards from aircraft at higher altitudes. If the *raison d'etre* of these PMPs is to allay public fears, there is no need to address higher flying aircraft since these are for the most part invisible to the public and therefore not seen as a threat.

Other hazardous industrial sites also have avoidance areas, some of which are larger than those round nuclear power stations. The Grangemouth petro-chemical complex, for example, has a 1.5nm avoidance for military low flying around it. Most other hazardous industrial plants have low flying avoidances with a much smaller radius, typically 500 metres. If it was found that ancillary facilities at Torness were vulnerable to aircraft crash impact, the resulting military low flying avoidance would be likely to be accommodated within the existing 1nm radius zone and would therefore mean no change on the current provisions.

5. Variation of risk with type of aerial activity

Notwithstanding the fact that nuclear power station buildings are designed to survive an aircraft impact, the probability of an aircraft crash on a nuclear power station in a particular location will vary depending on the types of aerial activity typically conducted in the vicinity of the power station, and the density or frequency of air traffic.

Torness is situated in Low Flying Area 16, which covers the whole of southern Scotland. In 1998 the density of military low flying in LFA 16 was 10% higher than the UK national average although it has in previous years been closer to

the national average. In addition a large area between Dunbar and Newcastle, up to 5000 feet, is designated as a Low-level Operational Training Area (LOTA) within which air defence aircraft (primarily RAF Tornado F.3s) fly practice interceptions against aircraft operating at low level. The LOTA was established in 1992 and has resulted in more frequent and intensive interaction between military aircraft in the area than was previously the case. this will include air combat between opposing fighters, fighters descending into the low flying system to intercept low flying aircraft, and the aircraft under attack performing evasive manoeuvres when intercepted.

The existence of the LOTA and its associated activities are likely to have caused some increase in the probability of aircraft accidents, both because traffic volume will have increased, and because the interactions between aircraft increase the risk of mid-air collisions, loss of control accidents, and controlled flight into the terrain (where, for example, pilots focusing their attention on evading interceptors fail to maintain sufficient altitude). These factors are unlikely to be quantifiable.

6. Conclusions

The available evidence suggests that the crew of the Tornado which crashed on 17 November made some attempt to direct the abandoned aircraft away from the power station. Notwithstanding the unpredictable behaviour of an abandoned aircraft with a serious technical problem, there does not appear to have been a major risk of the aircraft crashing on Torness power station.

UK production nuclear power stations are built to design standards such that the integrity of nuclear materials would not be threatened by a direct aircraft impact on the power station. Thus even if the aircraft had crashed on the power station it is highly unlikely to have resulted in any radiological consequences. However the vulnerability of radioactive waste storage areas and of emergency power supplies to an aircraft crash is not known.

Because nuclear power stations are designed to withstand aircraft impact, the low flying avoidance areas around them are not there for safety reasons but simply to allay public fears. Vulnerability of ancillary facilities might justify establishing a risk-based exclusion zone, but current practice would be likely to mean the zone was smaller than the existing Provost Marshal Prohibited area around Torness.

The risk of an aircraft crash on any particular facility will depend on the frequency of flights in the area and the nature of the aerial activity in the vicinity. Torness is situated in a low flying area which currently receives higher than the national average amount of low flying, and is also within a fighter training area which results in greater interactions between aircraft. These are likely to raise the probability of accidents, though the extent of the increased risk is unknown.
