



# Chief Nuclear Inspector's Technical Advisory Panel on Accidental Aircraft crash risk evaluation

## Response to Consultation

In July 2012, ONR's Chief Nuclear Inspector (CNI) took a decision to convene a Technical Advisory Panel (TAP) to review the current state of the art in accidental aircraft crash risk evaluation. A series of five meetings has been held and a comprehensive research project undertaken. In July 2014, ONR consulted TAP members to seek their views on how the TAP was progressing against its objectives and to identify any knowledge gaps that needed to be addressed before a final report is made to the Chief Nuclear Inspector. This paper reports the consultation outcome.

## The consultation exercise

The consultation document sets out the TAP's stated aims and objectives, provides a summary of the meetings held to date and gives ONR's view on the current position with regards to progress against objectives. A series of consultation questions were posed for TAP members to respond to. These were:

1. To what extent has the TAP met the Chief Nuclear inspector's aims? If there are shortfalls, how do you think these could be addressed?
2. To what extent has the TAP met its objectives? If there are shortfalls, how do you think these could be addressed?
3. To what extent has the TAP addressed the technical areas it set out to address? If there are shortfalls, how do you think these could be addressed?
4. What other technical areas do you consider should be investigated?
5. To what extent has the LU/HSL research report met your expectations and the project specification?
6. To what extent do you support the report's conclusions and recommendations?
7. Do you believe there is a need for further research or deliberations? If so, in what areas?

The response rate was good with six of the seven TAP members responding. The level of detail provided in the responses was variable but all members responded to all questions<sup>1</sup>.

## Summary of responses

In response to questions 1 and 2, relating to the TAP having met the Chief Nuclear Inspector's objectives, and its own objectives, the response was consistent. Members felt the objectives in both cases had been met. However, there were some comments provided. Some members felt the panel's deliberations could have been enhanced with representation from the military and earlier involvement of end-users. A lack of consideration of military aircraft flying patterns was cited as a potential shortfall.

Members generally agreed in response to that the TAP had addressed the technical areas that it set out to address (Question 3), and some members identified additional technical areas that could be explored (Question 4). However, this was accompanied by a warning that any additional work should be considered in the context of ALARP, and that any additional work should be proportionate to any potential improvements in risk evaluation methodology. The additional technical areas identified were:

- Look ahead to future aviation trends rather than focus on historical data
- Greater consideration of local factors
- Formal definitions of aircraft and airspace categories.

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<sup>1</sup> One respondent declined to answer question 6 on the basis that he was involved in undertaking the work referenced.

- Analysis of military aircraft data
- Data screening methods/ decision making

All members agreed that the LU and HSL research reports met their expectations and the project specifications (Question 5). The TAP found it particularly helpful to include a measure of confidence in calculated risk values.

The TAP generally supported the report's conclusions and recommendations (Question 6). However, there was again caution that a decision on taking up the recommendations should be considered in the context of ALARP, and that any additional work should be proportionate to any potential improvements in risk evaluation methodology.

One member commented that the report focused primarily on aircraft reliability and airfield crashes, and consequently there was little focus on the applicability to nuclear sites.

Some members identified potential areas of further work (Question 7), with the previously stated caution relating to ALARP and proportionality. These included:

- Consideration of local factors, including meteorological effects
- Flight density around nuclear sites
- Lateral distribution of crashes

## Identification of potential further work

From the consultation responses ONR has identified the following areas for potential further consideration:

- Consideration of military aviation training activity and crash data
- Effect of local factors, including meteorology, on crash data
- Selection of data sources and development of screening methods to ensure the most appropriate data is used in risk calculations
- The LU/HSL research report recommendations (See Annex A)

An overwhelming message from the TAP membership is that any future work, including taking up recommendations from the research report, should be considered in the context of ALARP, and that any additional work should be proportionate to potential improvements in risk evaluation methodology.

## Conclusions

The consultation exercise is considered by ONR to have been a success. ONR has confidence that the TAP has achieved what it set out to achieve. The TAP has collectively identified that there remains some uncertainty associated with quantifying accidental aircraft crash risk but has questioned whether any significant improvements can be brought about in a proportionate manner. This should be considered in light of the research findings that the Byrne methodology is conservative when compared to other methodologies.

ONR will host a meeting of the Technical Advisory Panel on 29 October 2014. The objective of this meeting will be to seek consensus on any future actions. The TAP will be asked to:

- i) Agree that the summary provided in this report accurately reflects their views
- ii) Discuss the possible future actions
- iii) Express their views on what would be considered ALARP/proportionate with regards to future work

## Recommendations

The project team suggested the following recommendations for consideration by the TAP:

1. All operators of licensed nuclear sites should undertake a site-specific hazard identification exercise in relation to the aviation-specific external threats to ensure that their safety arguments were complete and had not omitted any hazardous scenarios from consideration.
2. The geographic spread and time space of aircraft accident data should be expanded because of the sparse nature of accident data for crashes onto Great Britain.
3. The operators of licensed nuclear sites, and other government agencies, should consider special measures to protect against "beyond design case" events from aviation-related activities.
4. The operators of licensed nuclear sites should be responsible for conducting local flight surveys to ensure that the number and type of flights operating in the vicinity of the licensed nuclear site is compatible with the assumptions used in the calculation of aircraft accident frequency.
5. The operators of licensed nuclear sites should ensure that local operating conditions that may modify the probability of a flight suffering an accident significantly are taken into account.
6. The significant number of general aviation accidents away from the aerodrome of departure and intended arrival may allow for a more site-specific model to be derived rather than the current generalised Byrne distribution.
7. The significant number of general aviation accidents in the vicinity of the aerodrome of departure or intended arrival may allow for a more site-specific model to be derived rather than the Philips model in current use. The use of the DOE standard as an improved method prior to the development of a new model should be considered.
8. The Byrne model should be improved for the calculation of crash frequency distributions in the vicinity of an aerodrome. The use of a third generation model, such as NLR, should be considered as a short term replacement until a model that includes normalisation, use of normal operations data, consideration of aerodrome design factors and consideration of aircraft performance factors.
9. The cross-track lateral accident location for all phases of flight would benefit from additional research to validate, or otherwise, the current assumptions within crash location models.
10. The grouping of aircraft into different mass and kinetic energy groups should be reconsidered with the objective of removing the inconsistencies present within the Byrne model. Operations by ex-military aircraft could be considered for grouping with current military aircraft. Operation of civilian aircraft but on military and state activities could be considered for grouping with current military aircraft.
11. The modelling of military aircraft accidents could be improved and associated with actual flight paths intended to be flown as well as forecast loss rates for new aircraft types.
12. The Byrne model could be improved through the local application of a hazard analysis to consider the licensed nuclear site acting as an obstacle to an otherwise safe flight.
13. The Byrne model could be improved through updating the assumptions relating to aircraft impact models, skidding friction factors projectile bounce factors and projectiles dropping from aircraft.
14. The Byrne model should be extended, if required to comply with consequence analyses implications, to include the hovering phase of helicopter operations, the operation of gyrocopters, gliders, airship, gas-lifting balloons and hot-air balloons. The use of the DOE standard as a substitute would be an acceptable intermediate step until a more specific Great Britain model could be developed.
15. The operations by unmanned aerial vehicles should be considered in greater detail in time.
16. Any future model developed for use in the vicinity of an aerodrome should consider the correlation between lateral and longitudinal crash distances; the use of a Gamma distribution; the normalisation of the data including aircraft performance factors and flight performance factors; and the use of normal operations data. The significance of the variation in weather conditions experienced across Great Britain could be tested in a sample analysis in order to determine if such factors had to be considered at all locations of licensed nuclear sites.

17. If any model is to be developed beyond the Byrne model for use in Great Britain then the usability could be improved by changing to look-up tables such as published in the DOE standard model or through a risk map being published for the whole of Great Britain.
18. Any modelling of aircraft accident frequencies at a specific location should include the consideration of confidence intervals and the 95% confidence interval upper bound should be used in safety arguments to demonstrate that a licensed nuclear site does not suffer from excessive risk associated with aviation-related hazards.