Mike Griew, 19TH July 2017

I wish to comment on points concerning helicopter safety raised in reports submitted by Graham Liddy and DBS Consultation/Jensen Marks Aviation Consultants pertaining to submissions made to An Bord Pleanála by the Department of Defence/Irish Air Corps. Having read these reports, and after consulting with expert colleagues and drawing on personal knowledge of twin-engine helicopter operations gained from 21 years and approximately 7200 hours experience operating medium-sized helicopters in the offshore oil and gas industry:

1) I disagree with Liddy's key finding that there are no circumstances which would require a landing or departing helicopter to fly through the dangerous section of the Indaver plume incinerator's plume (4.3), and with the DBS/JM report author's conclusion that introduction of a Waste to Energy plant at Ringaskiddy does not pose any additional threat to the safety of Air Corps helicopters from Haulbowline Naval Base (2.1).

2) I wish to draw the Bord's attention to misleading information that has been discovered in the reports, and to erroneous misinterpretations of Dr Porter's report (Document 07 of Further Information) that leads both sets of authors to grossly underestimate the vertical extent of the Indaver plume and consequently bases their analyses of the site on an erroneous assumption.

Flight through dangerous sections of the Indaver plume

1) The Horizontal Plume

I will concern myself with just one scenario: failure of a single engine during departure from the Main Square, this being the only helipad site currently available at Haulbowline since closure of the soccer pitch some years ago for health and safety reasons. The DOD/IAC did not refer to the soccer pitch for this reason, therefore comments referring to it (e.g. Liddy 6.4.2 and DBS/JM 8.4) are irrelevant.

I will not consider an implausible theoretical flight path passing overhead the Indaver site, rather I will examine choices faced by the pilot, seen from the pilot's seat, when faced with engine failure at the moment he/she commits to continuing departure, the worst-case scenario upon which suitability of a helipad is based and is the basis for requirements such as the six degree cone referred to by Liddy in sections 6.4, 16.2 and Appendix O. I will show 1) the DOD's assertion that a 1-2km clear run is needed for departure, to be correct, 2) that Liddy's claim in section 8.5 that 'the area of the proposed plant is totally unsuitable for use as a low angle departure route' is incorrect, and 3) that the Indaver plume, in combination with the DePuy wind turbine, would create an additional threat to safety.

The aerial photograph on page 29 of the DBS/JM report, shown below with noteworthy captions (the UCC Beaufort Building, Electricity Pylons, Crematorium Island) added, sets the scene.

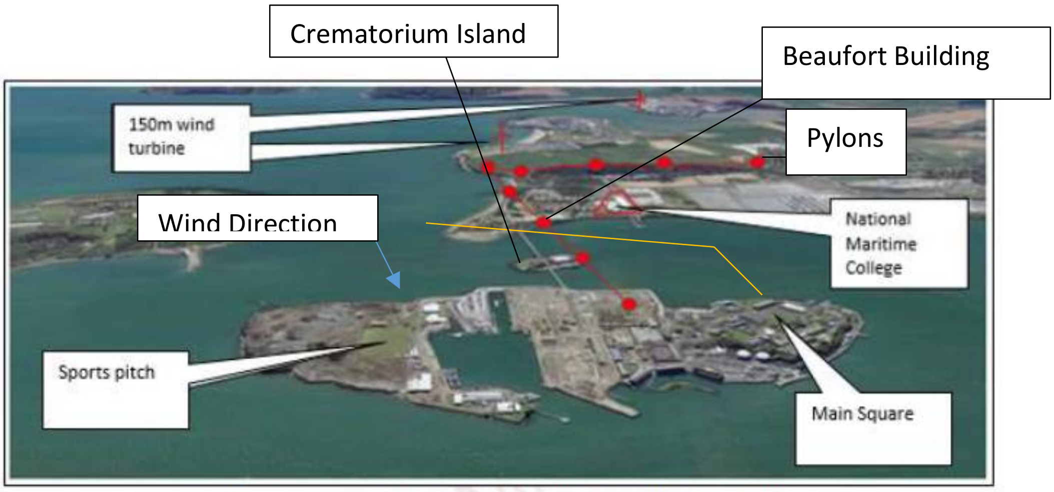

Figure 8 – other obstacles in the vicinity of Haulbowline

Fig. 1

The following conditions are assumed:

- A fully laden AW139.
- Wind speed 10kts, consistent with the sea state indicated in Figure 6, blowing from a southerly direction.
- A distance of 1.2km (rounded up to 0.7nm for convenience) from the main square to the Indaver site.
- Engine failure occurring just after take-off decision point (TDP) as depicted in Appendix H of the Liddy report, at a height of 180ft above ground level (from Liddy's description of a Cat. A helipad take-off profile in 7.2.2.2).

The standard Cat. A helipad departure profile, which the pilot of the AW139 would follow, comprises:

1) Initial acceleration phase to 'Takeoff Safety Speed' (VTOSS), which is 40kts according to Appendix H in the Liddy report. Loss of height occurs during this phase, I have assumed the AW139 will be at 150ft agl. when it starts to climb.
2) A climbing phase during which VTOSS is maintained. This continues until the helicopter reaches 200ft agl.
3) A second acceleration phase, during which the helicopter's rate of climb temporarily reduces or even arrests, until the best rate of climb airspeed (VY) is achieved. VY for the AW139 is 70kts according to Fig. 14 in the DBS/MA report.
4) Further climb to at least 1000ft agl.

This sequence is accompanied by power adjustments, for the first 2.5 minutes of the procedure the engine will be set to 'Intercontingency Power' which gives temporary boost above normal take-off power. The One Engine Inoperative rate-of-climb graph (Fig. 14) on page 43 of the DBS/JM report shows take-off power, therefore Liddy's estimate that height gain over a distance of 1.175 will be

870ft, a value I assume was extracted from relevant performance graphs (ROC at maximum continuous power, at 15C/1013hPa, can be seen to be just over 750ft/min, a height gain of only about 600ft if one assumes ground speed of Vy-10kt headwind, or 60kts, over a distance of 0.7nm).

The nearest upwind shoreline to Main Square is about 1000m from TDP, therefore half way across the channel separating Haulbowline from the NMCI/Beaufort foreshore, when passing abeam the crematorium island, the helicopter will be about 375ft agl.

Up to this moment I would expect the pilot to have flown straight ahead, facing directly into wind, firstly as he/she would be preoccupied with accurately controlling airspeed, the essential requirement of the take-off profile, and secondly because the pilot would know any deviation from rotors-level flight would reduce rate of climb, so would be reluctant to sacrifice performance until safe height has been gained and speed has stabilised at VY.

Half way across the channel, however, I conjecture that dealing with approaching obstructions would override any other considerations, and the pilot would face three choices:

1) Fly straight ahead, attempting to climb over the NMCI buildings or the Hammond plant, on a path taking him/her initially towards rising ground and the DePuy wind turbine, then towards factories and another wind turbine in the distance;
2) Deviate right, turning towards Ringaskiddy villiage, rising ground and factories in the distance, or the Port of Cork dockyeards;
3) Deviate left, turning towards Spike Island and open water, a path that would take him/her over pylons and pass close to the Beaufort building, but expedite flight to a clear, unobstructed area beyond.

The following Google Earth Images simulate the pilot's view. These are marred by lack of the elevation detail needed to recreate realistic scenes, however they are instructive.

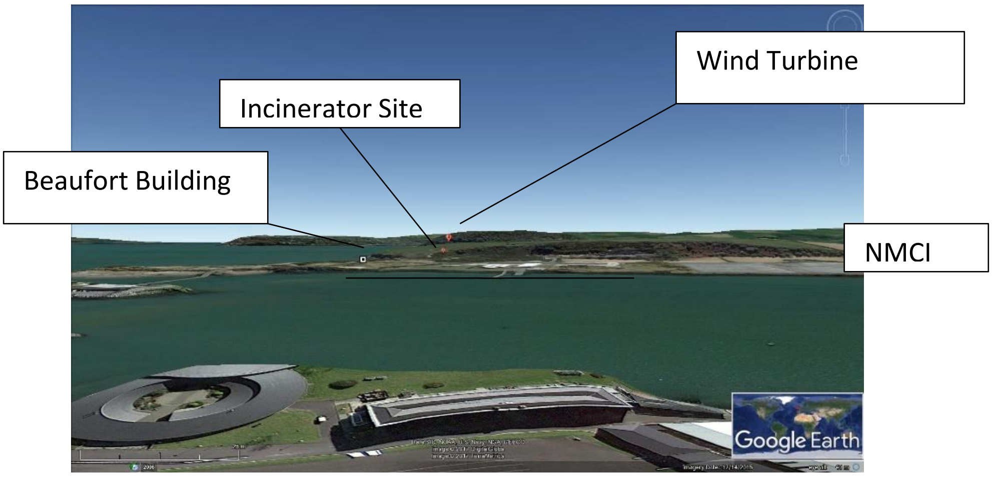

Fig 2. Viewpoint from TDP (Approx. 150ft agl.)

Fig. 3. Viewpoint from mid-channel, almost abeam Crematorium island, at 110m (350ft) agl.

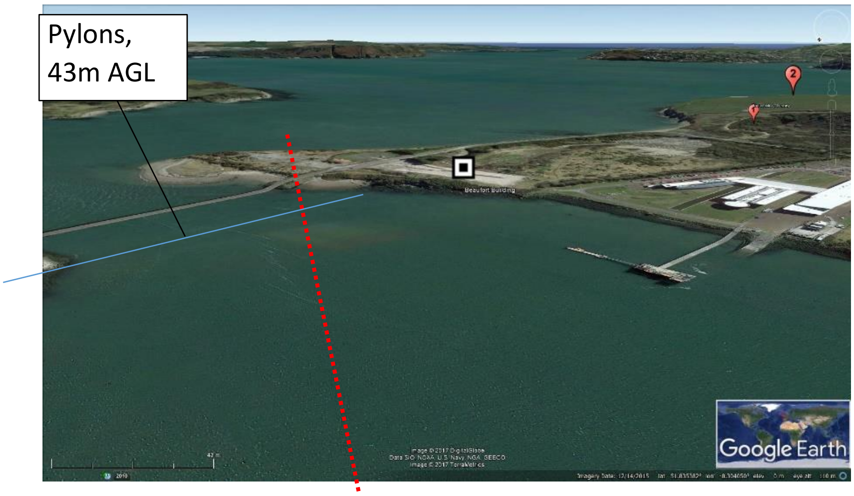

Fig. 4. Viewpoint looking left towards the harbour, from 110m agl.

Fig 5. View looking right towards Ringaskiddy, 110m agl.

Neither scene presents an obstacle-free view, however in my opinion both tracks are viable, given that the helicopter will be climbing strongly, and both comply with the six degree safety cone described by Liddy and shown graphically in Appendix P. The easterly option would be the natural choice to take, however, if the pilot felt compelled to avoid overflying buildings, factories or the dockyard, for example when carrying an external load. In this case, proximity to the Beaufort building and overflight of the pylons, which would be cleared by at least 250ft, would be a reasonable price to pay for an expeditious path to an open area.

However, if the proposed incinerator chimney is introduced into this scenario, because of its proximity to the DePuy wind turbine located 389m upwind (Liddy, 5.9.1) and the likelihood that emissions from the incinerator would be drawn into, and trapped within, the vortex-like stream of air generated by the turbine, the helicopter would be flying towards an invisible and potentially critical threat.

The above photograph shows the turbulence field behind the Horns Rev 1 offshore wind turbines. *http://www.windturbinesyndrome.com/2011/wind-turbine-turbulence-what-are-the-micro-climate-effects/*

Fig. 6

As vividly depicted in fig.6, the wind-driven air mass impinging on wind turbine blades is redirected into a swirling, cone-shaped stream when it interacts with spinning blade disc.

Evidence given by Dr. Paul Leahy, first introduced at the Oral hearing, then re-iterated in his comments to the Liddy and DBS/JM reports and reproduced in figure 7 below, graphically depicts this dynamic airflow and shows how emissions from a chimney are caught up in, and remain trapped by, the turbine vortex.

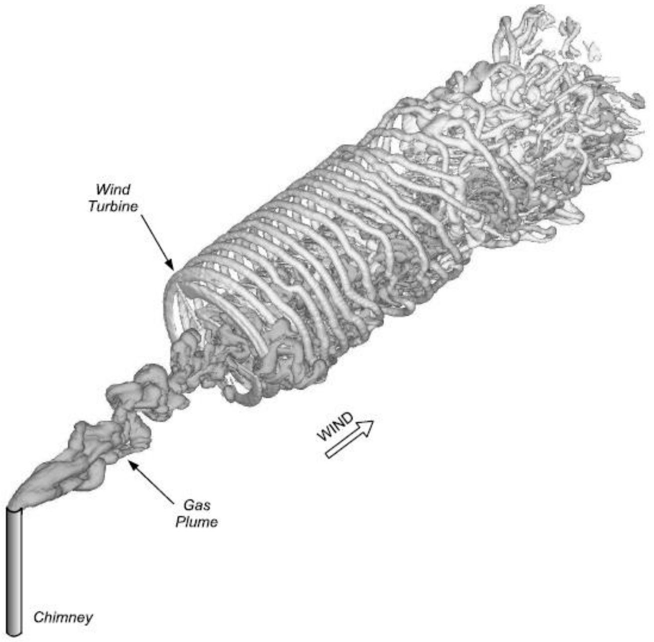

Figure 3. Interaction between the pollutant gas plume exhausted from a flue stack and a wind turbine located downwind; turbine tip speed ratio = 6.

Fig. 7

Although the DePuy wind turbine would be upwind of the incinerator chimney in the scenario being described, the converse of the arrangement shown in figure 7, I find it equally plausible that emissions from a chimney downwind of the turbine would be sucked into the stream, given that the top of the chimney, which is 265ft above sea level would inject the plume directly into the path of the vortex which would extend from 240ft to 570ft amsl. (according to DBS/CM in section 9.11, the turbine blade tip height is 173m, the blade radius is 50m according to Liddy in section 5.9.1., and in this section the chimney height is given as 80m amsl.)

In this scenario, the helicopter will be climbing through 400ft when it enters the vortex stream at a shallow angle, getting ever close to the source of emissions and being exposed to ever-increasing concentrations of whatever gas mixture lies with, as it flies through the stream.

How potent the gas/air mixture within the vortex will be, in terms of whether or not it could influence engine performance, is not known at this time. As Dr. Leahy told us at the Oral hearing, this is not a well-researched field therefore these questions remain open. Before forming an opinion as to the potential risk, however, I would urge the Bord to study findings in the next section, since these indicate both Liddy and DBS/JM underestimated the extent of the dangerous section of the plume. In this respect, the reader should refer to Dr Porter's original findings, not those of Liddy and DBS/JM.

In regards to the dangers posed to gas turbine engines by oxygen deprivation in general, Liddy's states report of the Poolbeg incident in section 5.4.1 in which he states: 'smaller gas turbines are more susceptible to engine stoppage at high moisture intake and depleted oxygen levels'. Without qualifying information this statement is of little relevance. On the one hand, whilst the 1500hp engine in the AW139 can be thought of as large compared to the 420hp engine that flamed-out, it is proportionally small compared to the 4700hp engines in a C-47 helicopter. On the other hand, the fully automated digital control system fitted to the AW139's engines is far more sophisticated than the mechanical regulator of the JetRanger engine that flamed-out. As a person with considerable experience working with embedded computer systems, I would not be surprised if this degree of complexity, relying on computer system fed by data from a network of sensitive temperature, pressure, and combustion monitoring instruments, might actually increase the engine's susceptibility to power fluctuations in ambient conditions that its designers did not foresee and therefore did not program the system to respond to appropriately. Furthermore, in the aforementioned single engine departure scenario the engine will be operating at its absolute maximum power setting, which might also have a bearing on its susceptibility to power fluctuations. The question of AW139 engine reliability is one, I suggest, that can only be properly answered after detailed analysis of relevant test data.

2) The Vertical Plume*

In the report from Graham Liddy (document 09 of the Further Information), there are frequent references to the extent of the "danger area" of the plume from the incinerator. In every case this is stated or interpreted as 3.5 metres *both in horizontal and vertical directions*, and we are told explicitly that the plume temperature reduces "very quickly" above the stack (see 6.28.1 below).

For example:

"4.3. ... The dangerous section of the plume from the proposed stack is of very limited extend, being only 3.5 meters both horizontally and vertically, and would not be entered into by a helicopter using normal obstacle clearance precautions."

"6.4.16.8. When a plume safety distance of 3.5 meters (as per Para 6.27) from the top of the stack is considered, it is obvious that the plume effect makes no significant addition to the size of the obstacle formed by the stack."

"6.4.16.9. Because of the very small danger area of the plume extending, at a maximum, 3.5 meters vertically and horizontally from the stack, a helicopter would have to be so close to the stack that the rotor blade tips would be in imminent danger of striking the actual stack. No extensive plume, that would be a danger to a helicopter, would be produced from this stack. Therefore, regardless of wind direction and helicopter flight path, a helicopter would not be at risk from the plume unless it was in imminent danger of physically colliding with the stack."

"6.27.3. These latest figures from Dr Porter make the DOD calculations that a clearance height of 1,075 ft above ground would be required to clear the stack, 230 ft above ground, obsolete and no longer applicable."

"6.28.1. ...As already discussed in Para 6.27, vertical velocity and temperature of the Ringaskiddy plume reduced very quickly above the top of the stack. Therefore, the risk area is confined to a small area both above and laterally from the stack, and it will not pose a threat to helicopters operating from the NS base."

"7.2.3.5. ... Dr Porter has determined (Para 6.27) that the extent to the plume, based on "five years of meteorological data covering all meteorological conditions including pressure / temperature inversions" will not exceed 3.5 metres, in either a horizontal or vertical direction."

The report from DBS Consulting (document 08 of the Further Information) makes a similar statement:

"9.5 The findings of AWN in their site specific modelling have determined that the effects of any plume would have completely dissipated within 3.5m both laterally and vertically."

These statements are misinterpretations of Dr Porter's report (document 07 of the Further Information). As can be seen in Figure 1 of that report, Dr Porter used a *horizontal* grid in his modelling (at an unstated height) and thus the information given in his report concerns only the *lateral* spread of the plume. Dr Porter's report submitted with the Further Information gives absolutely no indication of the *vertical* extent of the plume.

Dr Porter's statement in section 2.1, that 'The current study has built on the work previously undertaken and has replaced these conservative risk heights with risk heights based on detailed site-specific information...the site-specific risk heights have been found to be limited to a distance of 3.5m from the stack top' paints a different picture, might explain why Liddy and DBS Consulting used this value their analyses, but we find it astonishing that such experienced pilots and air safety specialists could have understood from the report that it would be safe to fly directly *over* the stack, 3.5 metres above its top, while hot flue gas is exiting it at 13.5 m/s (30.1mph) at a temperature of 145 °C. As rational people, one would have expected them to call into question the validity of data that differed so dramatically from previous information and leads to such a radical new conclusion. It doesn't take computer simulation to predict that the temperature 3.5m above the stack will be only slightly below the stack exit temperature, in fact our AERMOD modelling predicts a temperature of around 130 °C at 3-4 metres above the stack.

In his report Dr Porter cites a report from the MITRE Corporation

(http://www.ctcombustion.com/oxc/20130730-FAA-FOIA-Response/MITRE/September%20Plume%20Report%20Final[1].pdf)

as the basis for his methodology. Fig. 1 is derived from this report, and shows the vertical extent of the plume as being much greater than its horizontal extent in calm conditions. It is unfortunate that Dr Porter's report in the Indaver further information, which cites the MITRE report extensively, does not make this fact clear and is in fact silent on the matter of the vertical extent of the plume or its associated danger zone (the relevant diagram from that report is shown below).

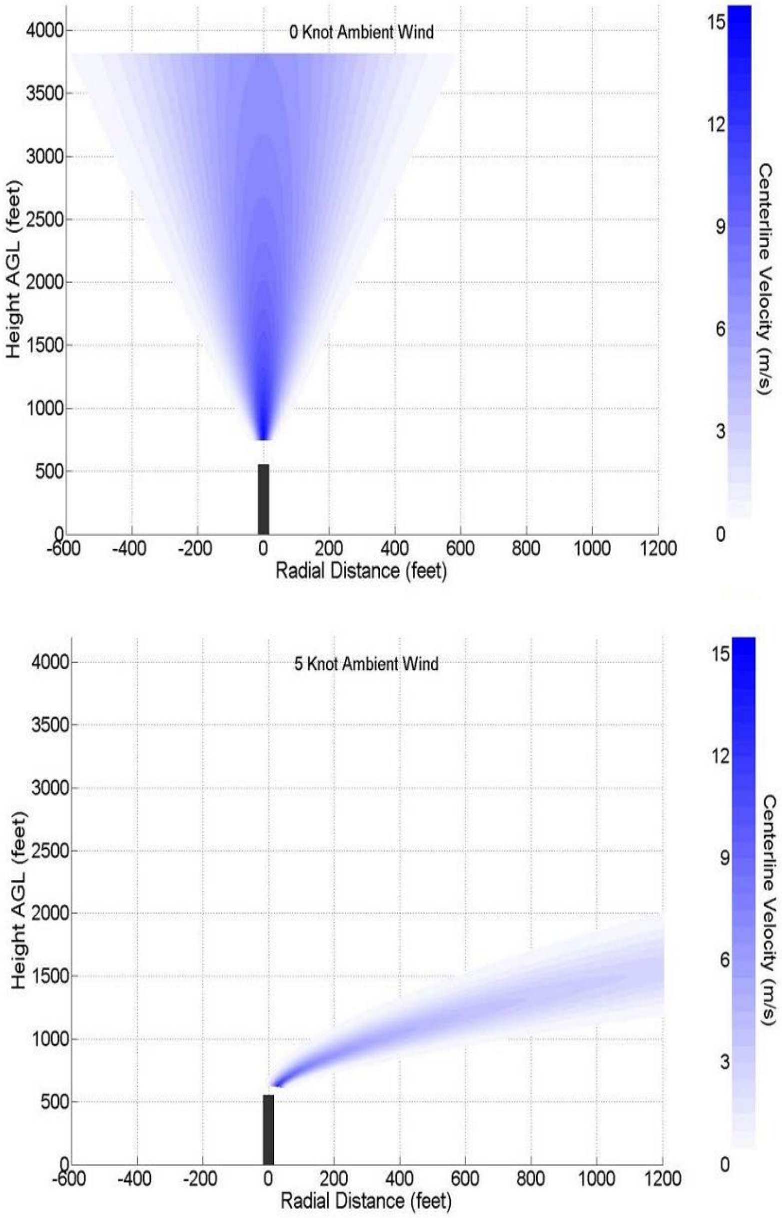

Fig. 8 Plume vertical extent under calm conditions and with wind (From MITRE Corporation report “Expanded model for determining the effects of vertical plumes on aviation safety”, MP120461, Sept 2012)

Site-specific modelling

The covering letter accompanying the Indaver further information (Document 01) states that "By the time of the second submission (i.e. 11th May 2016), it had been calculated that a plume from a larger facility than the proposed development could have a worst-case effect on helicopters up to 100 metres from the stack top. The Department of Defence based its second submission on this plume analysis. Indaver has taken on board the Department of Defence's submissions and the Board's queries and has commissioned the relevant expert, Dr Porter of AWN, to undertake a site-specific analysis of the potential effect of the plume from the proposed development on helicopters".

This gives a very clear impression that (a) during the oral hearing, no site-specific analysis had been done; (b) the Department od Defence's submission of 11th May, to which the Board has asked Indaver to respond, was not based on site-specific analysis. This would be misleading in both respects. It is therefore important to clarify.

The report from Dr Porter, which formed the basis for the Department of Defence's submission of 11th May, was submitted to the oral hearing on 4th May (http://ringaskiddyrrc.ie/wp-content/uploads/RRRC-Stack-Plume-Dr-Edward-Porter-AWN-Assessment_Final.pdf). In Figure 1 of that report, a graph of recommended height limit against initial plume velocity is presented (based on high temperature and low oxygen risk), and Dr Porter's text below that figure states: "The result shows that for an exit velocity of 13.5 m/s (as per the RRRC stack), the maximum height above the stack where the temperature exceeds the threshold level is 310 feet (95 metres). After 95 metres, the plume temperature will be lower than the risk temperature and will pose no risk to helicopters. Therefore the temperature of the plume will not be a risk for helicopters that are flying more than 95 metres (310 feet) from the top of the stack." (The "threshold level" of temperature referred to is 50 °C).

This was based on the stack exit velocity from the proposed Ringaskiddy incinerator, but other aspects of the plume were not necessarily comparable. Dr Porter therefore carried out site-specific modelling in the same 4th May report, using the AERMOD simulation program. It is important to emphasise this: the site-specific modelling presented in the Further Information is *not* the first time that Dr Porter has done the site-specific analysis.

In the 4th May report, pages 4 and 5 (headed "Modelling Plume Dilution Using AERMOD", Dr Porter uses a simple plume dilution approach (a linear relationship between concentration of plume components and temperature, falling from 145 °C on exit from the stack to a worst-case ambient temperature of 30 °C). He applies this to the Ringaskiddy plume to find the "decrease in temperature of the exhaust plume with distance downwind".

It is also regrettable that he did not calculate the height above the stack at which the threshold temperature of 50 °C is reached, which would have been easy to do, as he presents the necessary equation in the 4th May report. (Based on the conclusions of the MITRE report, and as shown in the figure above, this analysis needs to be done in calm conditions which maximise the vertical extent of the plume danger area.)

The general form of the equation is this:

Temperature = Ta + (Ts-Ta)/d

- where Ta is ambient temperature, Ts is stack exit temperature, and d is a dilution factor which can be obtained from the concentration of any of the plume components. Dr Porter expresses the relevant temperatures in Kelvin and we will do the same.

It would have been simple for Dr Porter to derive the site-specific risk height using the site-specific modelling he presents in the 4th May report. It would also have been simple for him to present the site-specific risk height in the report now submitted with the Indaver further information (document 07). But he does not do this. Instead he uses what appears to be a horizontal grid, at unspecified height (see figure 1 of document 07 of the further information) to calculate the *horizontal* distance from the stack where a helicopter would be endangered.

Modelling the site-specific risk height in calm conditions

Since Dr Porter does not report the vertical extent of the danger area, it will be derived in the following calculation.

At an ambient temperature of 30 °C (303.15 K) as used by Dr Porter, with stack temperature of 145 °C (418.15 K), his equation gives the dilution factor for 50 °C plume temperature as 5.75:

303.15 K + (418.15 K - 303.15 K)/5.75 = 323.15 K (50 °C)

At a stack NOx concentration of 200 mg/m^3, this dilution factor corresponds to a NOx concentration of 34.8 mg/m^3. The risk height for elevated temperature is thus the height at which the plume concentration of NOx has fallen to 34.8 mg/m^3.

In calm conditions (wind velocity 0.1 m/s), calculation with AERMOD shows that this concentration is reached 131 metres above ground level (430 feet, 61 metres above the stack top).

A 3-dimensional plot of the Ringaskiddy plume has been created, using one year of recorded weather from the site. It can be viewed at this link:

http://plumeplotter.com/news/ringaskiddy/plume.html

We are grateful to PlumePlotter for the AERMOD modelling and the 3-dimensional plot.

The following screenshot, which shows the Indaver chimney and buildings to scale, gives an example of the output of this modelling. An animation of this model can be found at:

https://youtu.be/38Mn7J6AHlc

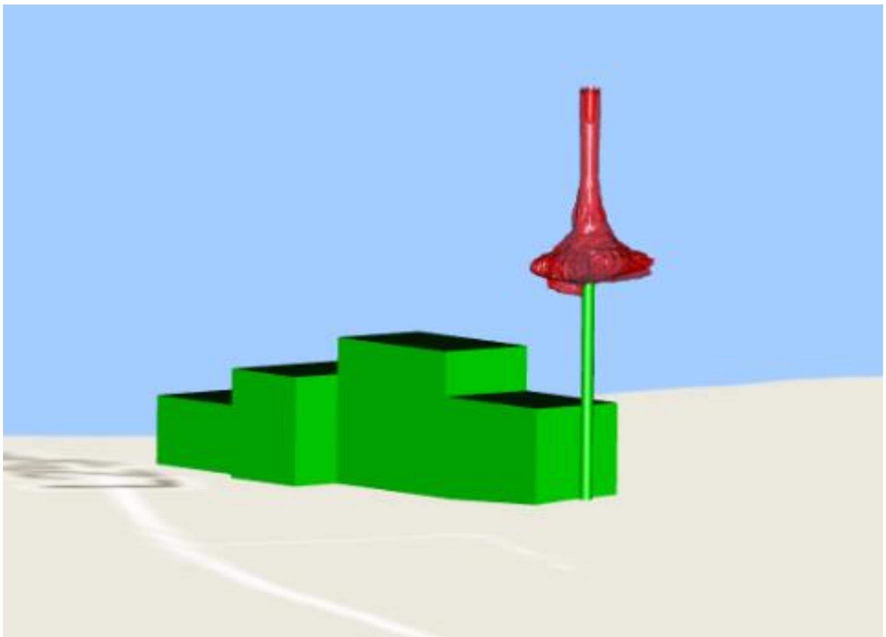

Fig. 8

The Department of Defence's submission of 11th May 2016 (section 5) argued as follows: "...if the high-risk zone of the plume rises to 100 m above the stack (as estimated by Indaver), it would be reckless to operate an aircraft anywhere close to that high-risk zone, and therefore a safety margin is applied. This safety margin or safety buffer is applied from the top of the high-risk zone, i.e. it is treated as if it were a solid obstacle. ...the standard obstacle clearance height of 500 feet may be applied to the top of the plume high-risk height...Therefore it is the opinion of the Department of Defence that the avoidance zone of 1000 ft as originally submitted is in fact very necessary."

Based on the above calculation of the site-specific risk height for elevated temperature (430 feet), when added to the standard obstacle clearance height of 500 feet, gives a minimum safe height above the stack of 930 feet. The Department of Defence's conclusion mentioned above (1000 ft avoidance zone) thus appears entirely reasonable.

The misunderstanding in both the Liddy and DBS reports, both of which based their analysis on a risk height of 3.5 metres above the stack top, is thus an extremely serious one, which undermines the conclusions of their reports. A section like the following, in the Liddy report, could not have been written if the properties of the plume had been properly understood:

"6.4.16.6. If a helicopter continues at a 6° climb to a point 1,175 meters (the distance from the Main Square in Haulbowline to the proposed stack) from a take-off point, it will achieve an altitude of 405 ft, plus the TDP altitude of 180 ft, giving a total of 585 ft, over the stack. As the stack is only 246 ft high, it will clear the physical obstacle of the stack by 339 ft. When it reaches the wind turbine (which is 1,528 meters from the Main Square) on the same climb out angle, it will be at an altitude of 526 ft plus 180 ft for TDP giving a total of 706 ft, giving a clearance over the blades of 214 ft. This is only 63% of the clearance achieved over the stack. While operation outside the 500-meter point is not part of these departure requirements, the point does clearly demonstrate that the wind turbine is the critical physical obstacle, not the proposed stack."

Clearing the *physical* obstacle of the stack is not enough.

Examples of misdirection and misleading information

1) Examples cited in both reports imply the DOD acted duplicitously by objecting to dangers posed by the incinerator whilst ignoring or accepting other hazards of a similar nature. The following passages put those risks into proper contexts.

Shipboard helicopter operations

The DBS/CM authors, in section 15.11, refer to winching or load lifting and state that 'Such flight, hovering over the stern of the ship, will place the aircraft, which will often be very heavy, in very close proximity to the funnels of the vessel and within the exhaust gases and where oxygen depletion can be expected to be significant'; and in 15.12 'these are the very condition which the DOD/IAC submission claim will have such an effect on their operations from Haulbowline as a result of the plume from the proposed stack'.

Liddy goes further, in Appendix C, by directly comparing ship engine power to Indaver incinerator power output, implying a direct relationship between hazards created by exhaust emissions from ships stacks and risks from incinerator chimney gases.

Even to a layperson, this standpoint seems naïve, if not downright absurd. The diesel combustion process which is common to INS ships and HMS Ocean, pictured in Liddy's report, takes place within a sealed cylinder and exhaust gases are created by plunging pistons, a totally different arrangement to the flow of gasses rising from a furnace; moreover exhaust from the diesel engine will cool and slow as it passes through turbochargers and (in most modern vessels) particle scrubbers. Therefore gas volumes, flow rates, temperatures and residual oxygen levels cannot possibly be comparable. Moreover, it would be surprising if naval ships did not take measures to moderate the heat from their exhaust systems to avoid becoming easy targets for heat-seeking missiles. I am reliably informed this is certainly the case for modern steam-turbine powered warships that emit almost no heat from their exhausts for that reason.

It should be added that Liddy uses a value for power output of the Indaver incinerator in his comparisons to other exhaust emission that is actually *electrical* power, for example in 5.3.1 'the proposed stack is of relatively power low output (18.5MW). As a result the amount of exhaust gases…is relatively low' (presumably the sentence should read '…relatively low power output…'). Discussions of the R1 formula at the oral hearing revealed the thermodynamic efficiency of the incinerator would be about 25% or less, therefore if power outputs were to be used for comparisons a figure of 74MW would be more appropriate and ratios of ship power to incinerator power stated in Appendix C are greatly exaggerated.

The authors' claim, unsupported by any facts regarding diesel ship exhaust emission oxygen levels, which attempt to lead the reader to believe that because ships engines produce exhaust plumes near which helicopters are regularly to be seen operating, in the same conditions that would be found near incinerator chimney plumes, therefore helicopters are not at risk flying near incinerator chimneys, should be seen for the misdirection that it is.

However, although I object to the manner in which the authors portray risks associated with ship stack emissions, I would not disagree that hazards exist. But these hazards are never ignored, standard operational procedures for deck landings eliminate the need to fly through the exhaust plume (the normal approach to a deck is from one side, not from directly astern, so when the helicopter crosses the deck edge it is below the plume), and usually mitigated by the fact that wind blows past the exhaust stacks when the engine is producing significant power, as the ship will be moving, cooling and dispersing gasses even in the short distance from the stack to the helideck (and when the ship is at rest, the plume either rises vertically or is carried by the wind). In regards to deck approaches, media evidence leads me to believe military helicopters operate in the same manner described previously, which is a civilian procedure.

In the case of underslung load lifting and winching operations, ship engines (again, referring to civilian helicopter operations) are unlikely to be running at full power: in order to steady the helideck the ship will be maintaining a course and sailing at a speed that minimises motion, and will be turned out of wind if necessary to ensure exhaust plumes, if they do impinge on the operation, pass to one side of the deck.

In regards to turbulence, operating to helidecks that lie in the lee of superstructure in strong winds is demanding, but rotor blades cut through the air at much higher speed than the magnitude of variations in wind speed that cause this kind of turbulence, so the jolting and buffeting it generates is generally more of a challenge to piloting skill than a threat to the machine. In rare instances where a deck lies in the lee of a very large windbreak, for example a tall shrouded drilling Derek atop a massive superstructure, extreme turbulence can develop so standard operating procedures are put in place to restrict aircraft weight ensuring sufficient power margins are available to arrest higher than normal rates of descent and cope with radical control inputs.

Water Bombing

In section 8.11 of his report, Liddy presents a striking image of an Air Corps AW139 fighting a gorse-fire, claiming the helicopter is 'surrounded by exhaust gasses and high temperature plumes from the fire, and being buffeted by rising hot gasses generated by the fire, even when carrying a very heavy underslung load'. Taken out of context this alarming comment inevitably leads the reader to suppose that, if the helicopter can cope with this risk comfortably, it should be able to handle risk posed by incinerator plumes equally effortlessly.

In a quest for context, a leading pilot's forum (http://www.pprune.org/rotorheads/111399-helicopter-fire-fighting-merged-threads.html) was searched for anecdotal evidence of dangers associated with helicopter fire-fighting, specifically engine failures attributed to oxygen deprivation above vegetation fires. This revealed no instances of engine failures, neither did a review of 'Federal Aerial Firefighting: Assessing Safety and Effectiveness', Blue Ribbon Panel Report to the Chief, USDA Forest Service and Director, USDI Bureau of Land Management, December 2002. (https://www.nifc.gov/aviation/av_documents/av_blueribbon/brp_120202.pdf).

The panel reports: 'However, in reviewing a document that summarized 36 aviation accidents related to fire service helicopters during the past 10 years, many accidents had similar features. Almost one-third of the reviewed accidents related to mechanical failure, approximately one-quarter were associated with operating at the edge of or outside the approved flight envelope, and clusters of accidents involved entanglements with loads or long-lines. Several wire-strike incidents also were noted. The high accident rate appears to be associated with deficiencies in operational control, maintenance, and training.'

I read of no accidents that were directly attributed to high temperature plumes, buffeting or hot rising gasses.

If the hazards alluded to by Liddy were systemic, one would expect to find evidence of concern even in this snapshot. I am led to believe, somewhat surprisingly, that despite the provocative image shown in the Liddy report, risks have been overstated and also that, in the absence of qualifying data, this example bears no relevance to the issue under consideration.

2) In the section entitled 'Other matters that may assist An Bord Pleanála, Liddy found it difficult to explain why the DOD did not object to erection of the DePuy wind turbine, suggesting they should have done 'if aviation safety was an utmost concern'. Quite apart from the defamatory nature of this remark, which appears to suggest the DOD may have chosen to treat dangers posed by the wind turbine, which is a highly visible obstacle that poses well-documented and predictable risks that can easily be integrated into standard operating procedures, differently to those invisible and fickle hazards posed by a chimney plume.

In section 8.2 Liddy lists a number of Defence Forces groups who did not raise objections to the application of the grounds of aviation safety. It is inappropriate to conclude (as Liddy is suggesting here) that the lack of a separate objection implies that these groups had no concerns. There are plausible explanations why objections were not voiced, for example a feeling amongst those groups that a single, expert voice, representing the DOD as a whole, would carry more weight than a number of less focussed submissions.

Furthermore, Liddy shares, in Section 8.7, his opinions about the level of commitment to development of aviation facilities at the Navy base. Since he does not lay claim to knowledge of the DOD's long-term pans, as with his previous comments, Liddy's interpretation is but one possible explanation of circumstances.

I find it objectionable that the author of a supposedly objective report should feel the need to bolster his arguments with conjecture and opinion, presumably in an attempt to adopt a dismissive mind-set regarding the DOD's submission. What seems to me to be a blatant attempt to bolster his paymaster's interests is most unwelcome in a report that forms part of a strategic planning application, which the Bord can be expected to take at face value.

3) Questionable facts surrounding the Devonport example*

Both the Liddy report (section 8.10) and the DBS/JM report (Annexe A) cite the example of Devonport as being evidence that helicopter activity and incinerator operations are compatible. The following research sheds a new and damaging light on the significance of this example.

Devonport Naval Dockyard: the incinerator safety study did not consider the incinerator plume

The Indaver further information includes (in Appendix 2) a safety statement prepared by the Ministry of Defence concerning the effect of a proposed incinerator (which has since been built) on helicopter operations at the base (http://ringaskiddyrrc.ie/wp-content/uploads/EfW-Safety-Statement-Issue-1_2.pdf). There is a full risk analysis, not provided by Indaver, which can be downloaded from this link:

http://www.mvv.de/media/media/downloads/mvv_energie_gruppe_1/geschaeftsfelder_1/umwelt_1/environment_2/environment_1/plymouth/dateienneu111111/20111111_EfW_Safety_Statement_Issue_1_2.pdf.

It shows (item 31, page 24) that the plume from the stack was not even considered in the safety assessment carried out by the MoD. The stack was treated as a tall structure only, and the only risk assessed was that of collision. So to use the Devonport safety statement to answer Department of Defence concerns about the Ringaskiddy plume is irrelevant - the MoD at Devonport did not even consider their own plume.

Devonport Naval Dockyard: Indaver provides a considerable quantity of information about a helicopter landing site that closed long before the Devonport incinerator opened, but gives no indication that it is closed

The safety statement mentioned above gives detailed information about the safety considerations affecting the Weston Mill Lake helicopter landing site within the Devonport base. Full details of its location are given, along with flight paths to and from the landing area, and an entry from the Helicopter Landing Site Handbook giving full details of use of the site.

The safety statement states (section 1): “The helicopter landing site at Weston Mill Lake is classed as a Domestic Helicopter Landing Site, a site available for the regular movement of passengers and stores in peacetime in day light. The site is principally used by the Flag Officer Training Flight for staff transfers to and from vessels at sea and for military helicopter movements to and from the Naval Base. Flag Officer Training Air Ops is the approving and control authority. Figure 1 provides further information on the Helo Site.”

It goes on to detail technical and safety considerations affecting the interaction between the then-proposed incinerator and helicopter flight operations that were at that time being carried out.

The safety statement is dated 2010. The helicopter landing site closed in 2012. The incinerator opened in 2015. The safety statement predicted no adverse effect of the incinerator on helicopter operations from Weston Mill Lake. It is indeed true that there have been no such adverse effects, for the simple reason that the helicopter landing site closed before the incinerator was built.

Appendix 2 also contains details of a site visit carried out earlier this year by members of the Indaver board along with Dr Edward Porter of AWN, who carried out the plume modelling discussed above (http://ringaskiddyrrc.ie/wp-content/uploads/Appendix-2-visit-to-Devonport.pdf). The site visit took place in April 2017.

The site visit report contains these words: "In advance of the development of the EfW CHP facility at Devonport naval base, a study was undertaken to assess the interaction between helicopter operations at the base and the proposed facility. The study found that the proposed facility would not affect helicopter operations at the base, and its findings have been borne out. The waste to energy plant has been operating since 2015 without interfering with the operations of the Naval base in any way as we believe would be the case for Haulbowline."

To report that "its findings have been borne out" is inappropriate; the safety study was based on the scenario of the Weston Mill Lake helicopter landing site operating simultaneously with the proposed incinerator, but this situation has never existed in reality, so the findings of the safety study could not be borne out.

Neither of the documents in appendix 2 of the Indaver further information makes clear that the helicopter landing site at Weston Mill Lake is no longer operating. On the contrary, the safety statement describes helicopter operations from the now-closed landing site in the present tense, and the site visit report reassures us that its predictions (of no adverse effects of the incinerator) have been borne out. This is a seriously misleading impression, and it is hard to see how Indaver could not have been aware that a reader would be misled in this way.

Helicopter operations at Weston Mill Lake were carried out by a Royal Naval section called FOST (Flag Officer Sea Training). FOST instructors were moved from the Devonport base to ships at sea for training purposes. After the closure of the Weston Mill Lake site, helicopter transfers are reportedly now made via HMS Raleigh, in Cornwall, a considerable distance from Devonport (http://www.plymouthherald.co.uk/navy-plan-helipad-airport-shut/story-22965650-detail/story.html).

In view of the cessation of the routine flying from the Devonport helicopter landing site by FOST, we are left with no information as to the extent of the remaining helicopter operations, if any, at Devonport - there is no defined landing site for helicopters on the ground. The flight deck of a carrier or helicopter pad of another ship is the only remaining possibility for helicopter operations within the base, but the unanimous verdict of several former naval officers with whom we consulted, who have held responsibility for helicopter operations to and from ships, is that operations to a vessel alongside a quay, or even in the confines of the port, would be highly unusual. Helicopters land on and take off from ships at sea, not normally in port. This is fully consistent with the decision by FOST to transfer their training officers via a distant shore base in Cornwall, rather than via a ship conveniently docked at Devonport itself.

4) Claims in the Liddy report of a 'no-fly zone' around the Indaver site*.

The Liddy report already cited (Document 09 of Further Information) states this: "7.2.2.7. In my expert opinion, take-off or landing would never be conducted towards the area of the proposed plant approaching anywhere near the plant site. Discussions with a number of ex Air Corps pilots who had extensive experience of operations at the NS base have confirmed this opinion. The current obstacles and terrain dictate that flight safety could not be maintained in this area and consequently the only option was to avoid it. One pilot considered this to be a no-go area before Wind Turbine A was erected and that he had never flown within 300 meters of the proposed plant location. He considered the wind turbine to be a major new hazard, which renders this area even more unsafe. Given the existing tall structures and obstacles in the area, the proposed plant does not add any further hazard implications for operations or flight safety."

The claim that this is a "no-go" area is not supported by the experience of a number of us who live or work near the site, or visit it regularly. Helicopter flights do happen, directly over the site of the proposed incinerator, and at low altitude. One member of the group maintaining the historic right of way from Gobby Beach to the Martello Tower, which crosses the proposed incinerator site, filmed a helicopter that spent a considerable time over and around the site (https://drive.google.com/file/d/0B0ayex59OPowTlRjQ0ZmOGpzV3pPY01zREtBeENLc3BNQ0U4/view). In the film clip, taken from approximately the position of the proposed stack and looking south-south-east, the observers on the ground judged the helicopter to be below the altitude of the top of the adjacent wind turbine blades, and it was between them and the turbine, i.e. over the Indaver site. (We understand the gas pipeline is surveyed periodically by helicopter; plausibly this is what the helicopter was doing on that occasion.)

In conclusion I urge the Bord to:

1) Commission an independent study into the combined effects of chimney plumes and wind turbine outflow, if necessary re-modelling the plume itself, in order to:
    - Eliminate further conjecture about the content of the resultant airstream in relation to DOD concerns about helicopter safety at Haulbowline.
    - Reassure communities around the harbour that have been abused in the past by industrial pollution and must carry a burden of worry because of this legacy, particularly families living on elevated ground who would be directly in line with the combined stream and would be subjected to far greater levels of stack emissions than those predicted by current dispersive modelling, for examples those living in Cobh, that every possible precaution has been taken to safeguard their future health.
2) Demand that only site-specific meteorological data be used to feed future modelling, and to allow only high-resolution modelling fed with data obtained from measurement equipment properly sited in accordance with recommended best practices for the software used, bearing in mind sloping terrain in the immediate vicinity of the site and the site's proximity to tidal water, factors that at the micro-climate level, can be expected to significantly alter the site's characteristics compared to the previous source of meteorological data which is situated well inland on the ridge of a five-hundred foot high hill.
3) Demand that meteorological data gathered for the purpose of modelling the site should be recorded for at least three years, as Cork airport yearly averages over a five year period show significant deviations from the thirty year mean, implying short-term data cannot be relied on for this site.
4) Before forming an opinion about the significance of the Devonport incinerator in relation this matter, conduct its own investigation into the location's history and the true extent of regular ongoing helicopter operations at the base.

My concern over a need for independent research at this stage of Indaver's planning application cannot be overstressed. Even after two rounds of clarifications the applicant seems unable to provide objective, incontrovertible information, and this clearly indicates that a core tenet of the Strategic Infrastructure application system, that the Bord should be able place its trust entirely in the findings of reports furnished by the applicant, is unviable.

* These sections were prepared with the help of Dr Gordon Reid.