TOWN AND COUNTRY PLANNING ACT 1990 (AS AMENDED)

RE-DETERMINATION APPEAL BY T A Fisher & Sons Ltd

Against the refusal of Full Planning Permission

by

West Berkshire Council

ON

LAND TO THE REAR OF THE HOLLIES, READING ROAD, BURGHFIELD COMMON

For

The erection of 32 dwellings including affordable housing, parking and landscaping. Access via Regis Manor Road.

Application Reference no. 22/00244/FULEXT
Appeal Reference no. APP/W0340/W/22/3312261

PROOF OF EVIDENCE

by Dr Michael Charles Thorne BSc PhD FInstP FSRP CradP

August 2024

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1. Scope of Proof

1. My name is Michael Charles Thorne. My qualifications include a BSc (Hons) degree and a PhD in physics. I am a Fellow of the Institute of Physics, an Honorary Fellow of the Society for Radiological Protection and a Chartered Radiation Protection Professional. I am also Editor-in-Chief of the Journal of Radiological Protection. The evidence which I have prepared and provide for this appeal is true and has been prepared cognisant of my responsibilities as an expert witness. The opinions expressed are my true and professional opinions.

2. I have approximately 49 years of experience in operational and environmental radiological protection. For the last 18 years, I have advised SKB, Sweden on site characterisation activities relating to geological disposal of radioactive wastes. I also provide advice on radioactive waste disposal to organisations in the UK, Finland, France, Spain and the United States. In addition, I have extensive experience in the remediation of former uranium mining and milling sites, having led or participated in projects in Bulgaria, Slovakia, Albania and Romania. I have participated in various studies for the International Atomic Energy Agency (IAEA) and was chairman of the group of experts that has recently published a Technical Report on uranium in the environment. In the non-nuclear field, I have provided advice to the Channel Tunnel Safety Authority and on the safety of developments near chemically hazardous installations. I have also appeared as an expert witness in various public inquiries, hearings and civil trials in the UK and the USA and was a member of the WHO expert group that evaluated US liabilities for compensation in relation to residents of the Rongelap Atoll in the Marshall Islands. I have published several books (comprising six volumes on radionuclides in the environment and two volumes on the pharmacodynamics of toxic metals, semi-metals, organic compounds and asbestos) and book chapters, as well as more than 100 peer-reviewed journal articles, mainly on the environmental transport of radioactivity, but also including papers on biokinetics (including the biokinetics of plutonium) and the medical management of incidents and accidents involving exposure to radioactive substances.

3. I have reviewed the evidence provided by Dr Keith Pearce to this Inquiry. Based on my review, I agree with the assessment and conclusions set out by Dr Pearce in his evidence.

4. My Proof of Evidence relates solely to issues concerning the potential for monitoring individuals and the environment during and subsequent to a potential radiation emergency at AWE Burghfield in which plutonium is released to air and is dispersed downwind. I show that monitoring of potentially exposed members of the public is likely to be of limited usefulness, but that monitoring of the environment could be useful in characterising the downwind area within which radiation doses might be sufficiently large to justify sheltering during passage of the atmospheric plume of radioactive material.

2. Techniques for Monitoring Plutonium in Humans and the Environment

5. The relevant radioisotopes of plutonium (mainly Pu-239 and Pu-240) are difficult to monitor. They are both primarily alpha-emitting radionuclides. If the need is to detect low concentrations in environmental materials, it is usual to collect samples, dissolve them, separate the plutonium from them, plate it out to make a thin source and then determine the activity using alpha spectroscopy. Because alpha spectroscopy has good energy resolution, this approach means that specific isotopes can be identified ensuring that a distinction can be made between contamination resulting from a radiation emergency and alpha-emitters, such as U-238, that are naturally present in the environment. Other techniques of analysis are available, e.g. through the application of mass spectroscopy to count the numbers of atoms of these radionuclides present in a sample, but these also involve similar, complex radiochemical procedures.

6. Because the analysis of samples by alpha spectroscopy is complex, it is usually undertaken in a laboratory environment remote from the site of sampling. I would expect such facilities to be available on both the AWE sites at Burghfield and Aldermaston. At the sampling site, activities are largely non-intrusive, comprising removal of samples of environmental media (e.g. soil) or wipe tests on impervious surfaces (e.g. glass or polished stonework or car roofs). Therefore, the only potential disruption to residents would be in granting access for sample taking at those few locations on their property selected for sampling. Even this disruption might be avoidable because samples could be taken from locations with public access. The proposed development would not increase the number of samples required because the aim would not be to provide a detailed map of contamination. Rather, results from samples would be used to confirm or calibrate estimates of the pattern of dispersion of the plume based on meteorological modelling and on knowledge of the time course of release from the source location to the atmosphere (see also paragraph 8).

7. As a consequence of the complexity of alpha spectrometric assays, sample throughput is likely to be limited and timescales for obtaining results from individual samples could be about 24 hours or longer. Some improvements in throughput could be obtained by parallel processing of radiochemical analyses and by using alpha spectroscopy equipment in which multiple thin samples can be counted simultaneously. However, this would not reduce the time interval before the results from the first samples became available, which would be

after the plume had become dispersed well beyond the DEPZ. Therefore, monitoring should be considered as complementary to mathematical modelling of the dispersion and deposition of radionuclides released in a radiation emergency. This can be done using the Met. Office NAME model (https://www.metoffice.gov.uk/research/approach/modelling-systems/dispersion-model).

8. The Met. Office provides a national service for retrodictive and prospective modelling of dispersion using NAME together with its knowledge of historic, current and forecast weather conditions within the PACRAM service (https://www.metoffice.gov.uk/services/government/environmental-hazard-resilience/cbrn-incident-management). The Off-site Emergency Plan (page 224 [CD5.42]) anticipates reliance on support from the Met. Office in plume tracking following a radiation emergency at AWE Burghfield.

9. The NAME model can be used either with forecast or archived meteorological data. In this context, it would be used with retrospective time-course estimates of the release and archived meteorological data to provide estimates of the spatial pattern of deposition resulting from the radiation emergency. These results would provide a basis for focusing actual monitoring. In my view, this monitoring should be directed to confirming and refining the dispersion calculations, rather than attempting to provide a detailed map of the spatial pattern of contamination. Thus, there is a need to prioritise the throughput of a limited number of samples from sites selected to optimally inform refinement of the dispersion calculations – this may be achievable within about 24 hours and can/should be part of advance emergency planning.

10. For the magnitudes of accidents considered in relation to AWE Burghfield, contamination levels in the environment are projected to be very low. Therefore, for areas in the outer part of the DEPZ and for all distances within the DEPZ upwind of the accidental release, the outcome of such monitoring should be that levels of contamination are either very low or undetectable. Therefore, the main role of such monitoring is to exclude areas from further investigation or decontamination, so focusing resources on those areas where radioactive contamination is of radiological significance.

11. The committed effective dose per unit intake for Pu-239 or Pu-240 is 0.05 mSv per Bq (Table G.1 of ICRP Publication 119, Annals of the ICRP, Volume 41, Supplement 1, 2012 [CD27.21]). Therefore, to incur a dose of 1 mSv an individual would have to inhale 20 Bq of Pu-239 or Pu-

240. For a mix of rest and light exercise, a typical breathing rate is 1.2 cubic metres per hour (about 0.4 cubic metres per hour sitting awake and 1.25 to 1.5 cubic metres per hour for light exercise, Table 8 of ICRP Publication 66, Annals of the ICRP, Volume 24, Numbers 2 to 4, 1994 [CD27.22]). Therefore, the time-integrated concentration required for an intake of 20 Bq (and a dose of 1 mSv) is 20/1.2 = 16.7 Bq-h per cubic metre (60,000 Bq-s per cubic metre).

12. For dry deposition, aerosols and reactive gases typically have a deposition velocity of 0.001 to 0.01 m per second, with aerosols more typically being toward the lower end on this range (page 407 of Cooper, J R, Randle, K and Sokhi, R S, Radioactive Releases in the Environment: Impact and Assessment, Wiley, 2003 [CD27.23]). Therefore, for a time-integrated air concentration of 60,000 Bq-s per cubic metre, the total deposition would be 60,000 × (0.001 to 0.01) = 60 to 600 Bq per square metre, with a value of around 60 Bq per square metre more characteristic of an aerosol of plutonium oxide.

13. Thus, if for example the annual dose limit for members of the public of 1 mSv is taken as a boundary for distinguishing individuals who should be subject to quantitative dose assessment, then the corresponding individual body burden is around 10 Bq (bearing in mind that some of the inhaled activity will be immediately exhaled). For an individual located on the proposed development who failed to shelter, the effective dose that could be received might be as large as 11.3 mSv, corresponding to a body burden of about 113 Bq.

14. Presence during passage of the plume in areas where deposited environmental concentrations of 60 Bq per square metre or more resulted would also be an appropriate criterion.

15. Monitoring of individuals having a body burden of 10 to 113 Bq of Pu-239 or Pu-240 is not feasible. Their only emissions that could be monitored outside the body are low energy x rays and these arise in only a few percent of emissions. Furthermore, these x rays are strongly attenuated by body tissues.[1] The best that could probably be done is to take nose blow or nasal swab samples and analyse them for alpha activity. However, this is only a semi-quantitative procedure, would be relevant for only a few hours following the release, would be limited in the number of samples that could be analysed and would not deliver results for about 24 hours or longer (depending on the prioritization given to these samples).

16. For environmental contamination, impervious surfaces (e.g. car roofs) could be used for wipe tests (porous materials are less useful because of dispersion of the deposition within the sample and associated attenuation of the short-range alpha emissions by self-absorption effects). The wipes could then be digested, and the plutonium precipitated for alpha spectrometry. Wipe testing is a semi-quantitative procedure. Typically, the area wiped is around 0.01 m^2 with 0.05 to 0.5 of the activity that is present transferred to the wipe (de Souza, D C B and Vicente, R, Wipe sampling – review of the literature, 2011 International Nuclear Atlantic Conference, ISBN 978-85-99141-04-05,

(https://inis.iaea.org/collection/NCLCollectionStore/_Public/43/046/43046431.pdf [CD27.20]).

17. Thus, if the level of contamination present is 60 Bq m^{-2}, the activity transferred to the wipe is likely to be in the range 60×0.01×(0.05 to 0.5) = 0.03 to 0.3 Bq. For comparison, 1 g of soil typically contains about 0.035 Bq of the alpha emitter U-238 (Table 4.3 of IAEA Technical Reports Series No. 488, The Environmental Behaviour of Uranium, International Atomic Energy Agency, Vienna, Austria [CD27.27]), so even small amounts of environmental material picked up in a wipe test would result in alpha contamination of the sample at or above the concentrations of interest. Although alpha-spectroscopy could be used to discriminate between different alpha-emitting radionuclides, this would require careful

[1] Youngman (Youngman, M J, Transportable System for Monitoring Internal Radioactive Contamination in People, Public Health England, PHE-CRCE-000, October 2017 [CD27.19]) has set out detection limits for Am-241 in the lung. For a ten-minute count, these detection limits vary from 58 to 250 Bq, depending upon the chest wall thickness. Am-241 is considerably easier to detect than Pu-239 or Pu-240 because it emits 60 keV gamma rays that are more energetic than the predominant 17 keV x rays emitted by these isotopes of plutonium. Additionally, these gamma rays are emitted in about 36% of decays of Am-241 compared with x ray emissions in no more than 10% of decays for mixtures of Pu-239 and Pu-240.Thus, the limit of detection for plutonium would be at least several hundred Bq and would be strongly dependent on the thickness of the chest wall of the measured individual.

sample preparation to deliver useful results. This indicates that the collection of environmental samples following a radiation emergency, while useful, may not be adequate to fully define the areas of interest. Note that even ignoring the effects of background, count times would be relatively long. With a counting efficiency of 0.5 (the maximum that can be achieved when counting a thin plated-out sample), an activity of 0.03 Bq would give only 0.015 counts per second or 54 counts per hour. Therefore, counting times of around one hour would likely be required to distinguish between significantly and non-significantly contaminated samples.

18. An alternative approach would be to have provision in place to undertake high volume air sampling at selected sites on and beyond the boundary of AWE Burghfield. High volume air samplers have intake rates of around 1 m^3 $minute^{-1}$ (60 m^3 h^{-1}). If these were triggered in the event of a radiation emergency and the time-integrated air concentration was 16.7 Bq h m^{-3} [equivalent to a dose of 1 mSv – see paragraph 14 above] the total alpha activity deposited on the filter (assuming 100% efficiency of capture) would be 60×16.7 = 1000 Bq. This would be readily detectable without further processing because the background concentration of alpha emitters on unused filters would be very low, and the radiation-emergency-related concentration would be relatively high because of the large volume of air sampled. Measurements made at the time of a radiation emergency would provide rapid reassurance that atmospheric concentrations over much of the DEPZ would not justify continuing sheltering and subsequent measurements would help to confirm that resuspension of deposited activity was not a significant concern in the more contaminated areas proximate to the accident location. Such large volume air samplers (which would also be useful for routine monitoring) are standard technology and could be adapted for rapid initiation and sample recovery in the event of a radiation emergency. It is noted that the most recent version of the off-site emergency plan at the time of writing confirms that both AWE sites have the capacity to undertake initial monitoring and will share their results with the Strategic Control Centre; and describes receipt of "initial radiation monitoring results at site perimeter / near site (AWE)" and the use of such initial monitoring results alongside dispersion modelling: [CD 5.42 at pages 72, 34 and 84 respectively].

19. Passive detectors might also be used, e.g. ‘tacky shades’ have been used at Magnox commercial power-production reactor sites in the past. However, such detectors would need to be in place continuously and would be subject to the potential for background from naturally occurring radioactive materials. This problem would be exacerbated by the much smaller volume of air sampled per unit time by such detectors relative to high-volume air samplers and by their lower (and uncertain) efficiency of capture of aerosols.

3. Conclusions

20. In summary, in the area around the proposed development, requirements for environmental monitoring should be limited to the taking of a small number of well-chosen environmental samples. Details of the extent of such sampling and the locations sampled would be determined at the time of the radiation emergency by the distribution of contamination in the environment as calculated by atmospheric dispersion modelling, supplemented by results from any high-volume air sampling as described at paragraph 18. It is likely that results from the dispersion modelling and limited monitoring would mean that no further monitoring would be required during the initial (up to two-day) emergency phase. At the location of the proposed development, it is projected that dose rates that would arise after the passage of the initial plume would be so low that decontamination of the environment would not be required. Thus, disruption of residents of the development in the period following the initial phase of a radiation emergency at AWE Burghfield should be minimal.

21. In respect of determining on-going requirements for sheltering, the primary information on the dispersion of radioactivity will come from retrodictive atmospheric dispersion modelling coupled with information on the time course of release of radioactivity from the source. This information could be available within one hour, and certainly should be available within a few hours of the incident. With high volume air sampling at and beyond the AWE Burghfield site boundary involving rapid total alpha counting, the results obtained over the first few hours could be used to confirm, calibrate and refine the estimates made using meteorological monitoring. Thus, within a few hours, reasonably accurate estimates of the environmental distribution of contamination should be available, sufficient to allow determination that substantial parts of the DEPZ can be released from protective actions and allowing focus on the contaminated sector(s). Additionally, time-series analyses of both meteorological projections and air-filter sample data would ensure that robust evaluations could be given of when airborne levels of radioactivity will decrease below specified thresholds of concern (or whether they are already below those thresholds). Subsequently, results obtained from alpha spectroscopy of wipe-test samples might be useful in further constraining the areas where significant deposition from the plume had occurred, recognising that only semi-quantitative results can be expected from wipe tests, and that the deposited activity would only be retained on impervious surfaces for a limited period.

22. In respect of monitoring of individuals, their external contamination could be estimated by alpha spectroscopy of samples of clothing or hair. However, such monitoring would give

little information on their internal contamination and results would not be available for about 24 hours, even if the samples were processed as rapidly as possible. Therefore, such measurements would be of no use in initial triage of exposed individuals. At the low levels of contamination of interest, gross alpha counting of the samples would provide no useful information because of problems of self-absorption in the samples and due to the natural background of other alpha-emitting radionuclides that would be present. Estimating the internal plutonium content of individuals by external counting would not be practical at the low levels of contamination of relevance. Overall, triage of individuals in the hours to days following an accident should be based mainly on reported details of their locations and activities during the period of plume dispersion. Only a limited number of the potentially most exposed individuals might be selected for personal monitoring. These would be expected to be individuals located downwind of the accident and close to the AWE Burghfield site boundary over the period of release and would not be expected to involve residents of the appeal site. Indeed, it seems likely that the only individuals who should be prioritised for personal monitoring might be those present on the AWE Burghfield site at the time of the radiation emergency. It is emphasised that even in the most highly exposed individuals present off-site, radiation doses would be far too low for them to manifest any clinical symptoms of exposure to radioactivity. Such clinical symptoms might become manifest in some, more susceptible individuals at effective doses in excess of 100 mSv, a threshold above which the REPPIR-19 Approved Code of Practice recommends that medical surveillance should be instituted for emergency workers (see paragraphs 529 and 530 of The Radiation (Emergency Preparedness and Public Information) Regulations 2019: Approved Code of Practice and guidance, 2nd Edition, HSE, 2020) [CD 5.39]. Furthermore, even the most exposed individuals off-site would not require any immediate medical treatment, as their exposures would be too low to justify applying any decorporation procedure, such as the administration of a chelating agent (see Thorne, M C, Responding to radiation accidents: what more do we need to know?, Journal of Radiological Protection, Volume 42, (2022). 031003 [CD27.4]). Thus, any actual monitoring results would be primarily for reassurance and would not be a significant factor in decision making.