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REPORT No: DERA/CBD/DRPS/38/2000

**RADIOLOGICAL INVESTIGATION OF
DOON HILL, KIRKCUDBRIGHT TRAINING AREA.**

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SUMMARY

A radiological investigation at Doon Hill, Kirkcudbright Training Area was carried out by the DERA Radiation Protection Services (DRPS), on 31 August 2000. Doon Hill firing point is used for trials involving the long range firing of depleted uranium (DU) projectiles. The areas surveyed were in the vicinity of the PCC firing plates and the surrounding area. The investigation identified an area of radioactive contamination in the area of interest but no contamination was detected in the vicinity of the Control Building, which is due for re-development.

INTRODUCTION

1. DERA Radiation Protection Services (DRPS) carried out a radiological investigation of an area of Doon Hill, Kirkcudbright Training Area on 31 August 2000.
2. The purpose of the investigation was to identify any ground radioactive contamination near the protection plates for the photochronic cells (PCCs) and surrounding area; to confirm that the area fenced off should continue to be placed 'out of bounds'; and to confirm that current access controls to the area are sufficient. In addition a survey was carried out to assess the radiological risk to contractors who are due to carry out works on the Control Building.

BACKGROUND INFORMATION

3. The Doon Hill firing point was used between 1983 and 2000 for trials involving depleted uranium (DU) projectiles. There were six recorded malfunctions, during this period, but no debris was recorded as being found in the area surrounding the PCC protection plates.
4. The firing point was last used to fire DU projectiles in August 2000. No malfunctions were reported.
5. A survey of the area, carried out by staff from DERA Eskmeals, reported enhanced gamma radiation in parts of the accessible area, and intrusive sampling found positive traces of uranium oxide, the location of this contamination was recorded but was not remediated, and the surface recovered.

SCOPE OF INVESTIGATION

6. Information collected during previous investigations and information supplied by Assistant Commandant Kirkcudbright Training Area KTA and DERA Eskmeals formed the basis for the scope of the radiological investigation.
7. The agreed scope of the investigation included a walk-over survey of accessible areas around the PCC protection plates and a survey outside the perimeter fence in order to assess the radiation risk to contractors carrying out work in the Control Building.

SURVEY METHOD

8. Portable hand held, radiation monitoring instruments, sensitive to the detection of a range radionuclides were used during the survey. The instruments used were the Mini-Monitor 900 series fitted with a Type 44B probe (serial number: 035926/0510) and the Series 1000 'Mini-Rad' portable dose-rate meter (serial number: 002310).

The 44B probe is sensitive to X and gamma (γ) radiation in the energy ranges 10 kiloelectron volts (keV) to 1 megaelectron volts (MeV) and provides a response in counts per second. The Mini-Rad is a low-level gamma dose rate sensitive to radiation energies between 50 keV and 1.25 MeV and provides a response in $\mu\text{Sv h}^{-1}$. All instruments were calibrated in accordance with UK Health and Safety Executive and UK Accreditation Service (UKAS) requirements. Typical UK background readings for the different types of instruments are provided below:

| Instrument | Survey Use | Typical Background |
|------------------------|---------------------------------------------|---------------------------|
| Mini Monitor Type 44B | β / γ contamination survey meter | 10 – 12 cps |
| Series 1000 'Mini-Rad' | Environmental dose rate meter | 0.1 $\mu\text{Sv.h}^{-1}$ |

9. An action level of 20 cps was adopted as this was the measured background level for the area. This relatively high background was due to the presence of granite in the area. At locations where the action level count rate was exceeded, a soil sample was taken for laboratory analysis.
10. Samples removed were submitted for alpha spectrometry analysis by the DRPS laboratory, the DRPS alpha spectrometry techniques are UKAS accredited. The analysis technique involves the separation of Uranium by extraction chromatography, and then the purified sources are counted on silicon detectors under vacuum. The resulting data are processed by a commercial spectrum analysis package, and the assessed activity concentration (becquerels per kilogram (Bq.kg^{-1})) or limit of detection (LOD) for the nuclide of interest is reported for each sample.

DISCUSSION

11. The area surveyed (Figure 1) illustrates the extent of the walkover survey of the area surrounding the PCC protection plates. The results of the survey are discussed below.

PCC protection plates and surrounding area

12. A 70% coverage walkover survey was undertaken in this area. A 100% coverage survey could not be achieved due to dense undergrowth and the presence of the PCC protection plates. The walkover survey was also hindered by adverse weather conditions (gale force winds and driving rain).
13. An area where the count rate was 30 cps was identified, this area is shown as hotspot on Fig. 1. The dose rate measurement at this point was $0.1 \mu\text{Sv.h}^{-1}$ at 1 metre from the ground and $0.15 \mu\text{Sv.h}^{-1}$ at contact. A soil sample was collected for alpha spectrometry analysis. The results, enclosed, show the presence of uranium.

Building Contractors

14. The Control Building outside the perimeter fence, which surrounds the firing point, is shown in Figure 1. A radiation survey at the perimeter fence by the control building was carried out at 1m intervals gave readings of less than $0.1 \mu\text{Sv.h}^{-1}$ at all points and therefore there is no risk of external radiation exposure to the contractors carrying out redevelopment work on the Control Building.
15. The firing point area is fenced off and "No Entry" radiation warning signs are displayed. There is no access to any persons who are not involved with firing range duties.

CONCLUSIONS

16. Radiological monitoring of the area of interest and the area around the Control Building showed that there is no risk of significant exposure to radiation to contractors carrying out redevelopment work.

RECOMMENDATIONS

17. It is recommended that a more detailed investigation be carried out in the area of interest if there is likely to be any further development. The protection plates for the photochronic cells would need to be removed and the undergrowth cut down so that a comprehensive walkover survey could be carried out.

18. DRPS liaison with site personnel indicated that it is unlikely that contamination in the area of interest would be found at any significant depth. Consequently, intrusive investigations within the area of interest would be of limited value in identifying areas of ground contamination that may have occurred as a result of earlier trials, especially around the areas of the protection plates for the photochronic cells. However, intrusive investigations would be considered prudent at such time that the site is subject to radiological investigations for the purpose of clearance of the site.

19. DRPS carry out an annual environmental survey of the Kirkcudbright ranges, during May, this would be a suitable time of year to carry out a comprehensive survey.

| Sample Descriptor | Fresh Weight (g) | Dry Weight (g) | Ashed Weight (g) | Measured Activity of Dry Sample (mBq/g) | | | | Total U | 238/234 RATIO |
|-------------------|------------------|----------------|------------------|-----------------------------------------|-------|--------|--------|---------|---------------|
| | | | | U-238 | U-235 | U-234 | | | |
| Doon Hill | 377.00 | 206.16 | 58.80 | 439.5 ± | 6.8 ± | 78.7 ± | 83.9 ± | 5.6 ± | 1.7 |

| Sample Descriptor | Soil Bulk Density (Dry weight/Fresh volume) (g/cm ³) | Mass of Soil per m ² in Each Horizon (kg/m ²) | Total Uranium Activity per unit Area to Specified Depth (Bq/m ²) | Total Uranium Content of Dry Soil (µg/g) | Total Uranium per Unit Area to Horizon Depth (mg/m ²) |
|-------------------|------------------------------------------------------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------|-------------------------------------------------------------------|
| Doon Hill | 9.09 | 181.80 | ##### ± ##### | 37.5 ± | 6814.5 ± |

Limit of Detection

- U-238 0.3 mBq/g dry wt
- U-235 0.3 mBq/g dry wt
- U-234 0.3 mBq/g dry wt

Activity results have been rounded to one decimal place

A specific activity for DU of 14.0 MBq/kg has been used

All uncertainties are stated at a 95.4% confidence level

Figure 1. Doon Hill

