

Radiological Survey of Sandside Dunes and Reay Golf Course, October 2000

A report produced for UKAEA
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Executive Summary

AEA Technology was contracted to provide a programme of Groundhog™ surveys, contract No. NS05929. The program required surveys to be undertaken of Sandside Dunes and a 50 metre strip of Reay Golf Course.

This report sets out the methodologies and addresses the findings of the Groundhog™ Sandside Dunes and Reay Golf Course investigations which were carried out during August, September and October 2000.

It concludes that there were no particles detected on Sandside Dunes or Reay Golf Course (50 metre strip) during the duration of the survey.

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1 Introduction

AEA Technology was contracted to provide a Groundhog™ survey of Sandside Dunes and a 50 metre strip of Reay Golf Course using the Groundhog™ system.

This report sets out the methodologies and addresses the findings of the Groundhog™ Sandside Dunes and Reay Golf Course investigations carried out during August, September and October 2000.

1.1 OBJECTIVE

The objective of the survey was to find any radioactive particles $\geq 1\text{E}5\text{Bq}$ that may be present and remove and transport any particles encountered during the survey to the UKAEA laboratory at Dounreay for analysis. If no particles were found then to demonstrate so with an auditable method.

The area to be surveyed was defined in the proposal. This consisted of Sandside Dunes and a 50 metre wide strip of Reay Golf Course (section A). The dunes were broken down into three sections, West (section B), Central (section C) and East (section D). No monitoring was undertaken in some areas due to the presence of thick rough grass or steep slopes on some dunes. Additionally, we were requested not to undertake surveys on the golf course greens.

2 Methodology and Instrumentation

Groundhog™ is the unique combination of an extremely sensitive gamma radiation detection system linked to a positioning system. This enables highly accurate gamma radiation contour mapping to demonstrate and validate the extent of potential radiological contamination or map particle finds.

2.1 GROUNDHOGä

The Groundhog™ system provides facilities to automatically record instrumental measurements gathered in the field, in this case from Gamma-radiation detectors, together with high-accuracy location information, in this case from the satellite-based Global Positioning System (GPS).

Once the instrumental and location data have been collected, the data is transferred into a Geographical Information System (GIS) where data management and validation takes place, and final reporting is produced using suitable electronic mapping information.

For the survey of Sandside Dunes, the system was also equipped with alarm facilities customised to detect enhanced levels of gamma-radiation, and also to detect the presence of Caesium-137 particles.

A vehicle with a mounted Groundhog™ system was deployed on the 50 metre strip survey of Reay Golf Course along with a portable Groundhog™ system. A portable Groundhog™ system was deployed on the Sandside Dunes survey.

2.2 LIMIT OF DETECTION

AEA Technology has conducted laboratory experiments, field trials and has developed models on which the sensitivity can be demonstrated. When operating in standard operational conditions the LoD is expressed as; the system is capable of detecting a 1×10^5 Bq of Cs-137 in a particle buried at 10cm.

2.3 INSTRUMENT CONFIGURATION

The Groundhog™ system was configured as described below:

2.3.1 Global Positioning System (GPS)

The Groundhog™ GPS was configured with a local 'Base Station' to provide continual reference information which allowed the Groundhog™ survey units to be operated at sub-metre accuracy. The Base Station was operated continuously.

The Groundhog™ systems were configured for sub-metre accuracy measurements, using 'post processing at the end of each survey session. On completion of survey sessions, the Base Station and survey 'data loggers' were returned to the Data Manager for analysis.

All data transferred from the data loggers was retained for future use.

2.3.2 Portable Detector and Ratemeter

The Groundhog™ system was carried by the operator using a shoulder strap.

The system is capable of at least 8 hours continuous surveying without need to 'down load' the survey data

2.3.3 Survey Vehicle

The Groundhog™ system was mounted onto a Landrover and was used at a very low speed. The detector array was fitted to the front of the vehicle. See figure 11 for a photograph of the detector array mounted onto a vehicle.

2.3.4 Data recording and alarms

The alarm unit used on the portable system comprises of a self-contained alarming unit.

The data transmitted from the detector array was collected on a survey computer set up in the driving cab of the vehicle. This computer recorded all data collected by the array, including daily calibration sessions performed by the operators. The Survey Computer provided alarm and system validation facilities.

2.4 DATA PROCESSING

Data collected on the Base Station and the survey systems was transferred to a local PC system on which the GPS 'post processing' software is installed. This 'Differential Correction' software compares the data streams from the Base Station and the survey units and eliminates systematic errors from the GPS system, thus allowing highly accurate positions to be computed.

At certain times between survey sessions, the post processed data was then 'exported' into a Geographical Information System (GIS) and simple coverage plots produced to check survey coverage.

2.5 DATA INTERPRETATION

All data collected during the survey was loaded into the database in as close to its original form as possible, to allow a wide variety of tests and analyses to be performed.

3 Description of Results

Figures 1,3,5,7 and 9 show the sensor readings taken during the surveys. Figures 2,4,6,8 and 10 show the total gamma-radiation measurements being interpolated to produce clear pictures of the survey results.

3.1 DATA MANAGEMENT

A total of 564,054 sensor measurements were taken during the course of the surveys. Data was reviewed on a regular basis.

3.2 SENSOR COVERAGE

The survey data was continually reviewed during the course of the project, and where survey coverage had fallen to an unacceptable level, areas were re-surveyed. A total of 564,054 validated measurements were taken during the surveys of the Sandside Dunes and Reay Golf Course (50 metre strip). This covered a total area of 141,009 m².

3.2.1 Sandside Dunes

Some 343,883 validated measurements were taken during the survey of Sandside Dunes and a total area of approximately 62,145 m² was surveyed. These figures are broken down in the table below.

| Area Surveyed | Section | Total Area m ² | Sensor Measurements |
|---------------|---------|---------------------------|---------------------|
| West | B | 16,430 | 78,684 |
| Central | C | 14,455 | 60,496 |
| East | D | 31,260 | 204,703 |
| | | | |
| Total | | 62,145 | 343,883 |

It was anticipated that there would be areas on the dunes that would not be accessible for surveying. These areas were estimated prior to the survey starting. The problems encountered were due to the nature of the terrain and to the height and gradient of the slopes associated with the dunes.

On the west section (B) 10% was estimated to be inaccessible. After completion the survey area was measured and it was calculated that the total coverage of the area that was surveyed had been exceeded by 23%.

On the central section (C) 20% was estimated to be inaccessible. After completion it was calculated that 36% had in fact been inaccessible.

On the East section (D) 30% was estimated to be inaccessible. Better than estimated coverage was achieved and only 25% was inaccessible.

3.2.2 Reay Golf Course - 50 metre strip

Some 220,171 validated measurements were taken during the survey of Reay Golf Course (50 metre strip). Excellent survey coverage was achieved. The 50 metre strip included coverage of the tee-off areas and bunkers which were surveyed using the portable GroundhogTM system.

A total area of 70,282 m² was surveyed. Some areas were inaccessible due to the presence of Greens and areas of thick rough grass.

3.3 SURVEY FIGURES

3.3.1 Figure 1

Figure 1 details the individual sensor readings for Reay Golf Course (50 metre strip) survey. Each blue dot represents the individual sensor reading location. Survey coverage can be clearly seen on this plot. Areas where no sensor records are shown are those areas where access was not possible.

3.3.2 Figure 2

Figure 2 shows a surface interpolation for Reay Golf Course (50 metre strip). Survey coverage can be clearly seen on this plot. Areas where no sensor records are shown are those areas where access was not possible.

Some areas show elevated levels. These are believed to be associated with the geological conditions of those particular areas. All alarms were investigated using conventional instrumentation and found to be background levels.

Generally the interpolation shows a gross gamma count interpolation of between 200 and 300cps.

3.3.3 Figure 3

Figure 3 details the individual sensor readings for the Sandside Dunes West Section survey. Each blue dot represents the individual sensor reading location. Survey coverage can be clearly seen on this plot. Areas where no sensor records are shown are those areas where access was not possible.

3.3.4 Figure 4

Figure 4 shows a surface interpolation for the Sandside Dunes West Section survey. Survey coverage can be clearly seen on this plot. Areas where no sensor records are shown are those areas where access was not possible.

Generally the interpolation shows a gross gamma count interpolation of between 100 and 300cps.

Some areas show higher levels. These are associated with the geological conditions of the area.

3.3.5 Figure 5

Figure 5 details the individual sensor readings for the Sandside Dunes Central Section survey. Each blue dot represents the individual sensor reading location. Survey coverage can be clearly seen on this plot. Areas where no sensor records are shown are those areas where access was not possible.

3.3.6 Figure 6

Figure 6 shows a surface interpolation for the Sandside Dunes Central Section survey. Survey coverage can be clearly seen on this plot. Areas where no sensor records are shown are those areas where access was not possible.

Generally the interpolation shows a gross gamma count interpolation of between 100 and 300cps.

3.3.7 Figure 7

Figure 7 details the individual sensor readings for the Sandside Dunes East Section survey. Each blue dot represents the individual sensor reading location. Survey coverage can be clearly seen on this plot. Areas where no sensor records are shown are those areas where access was not possible.

3.3.8 Figure 8

Figure 8 shows a surface interpolation for the Sandside Dunes East Section survey. Survey coverage can be clearly seen on this plot. Areas where no sensor records are shown are those areas where access was not possible.

Generally the interpolation shows a gross gamma count interpolation of between 100 and 300cps.

3.3.9 Figure 9

Figure 9 details the individual sensor readings for the Sandside Dunes and Reay Golf Course (50 metre strip) survey. Each blue dot represents the individual sensor reading location. Survey coverage can be clearly seen on this plot. Areas where no sensor records are shown are those areas where access was not possible.

3.3.10 Figure 10

Figure 10 shows a surface interpolation for the Sandside Dunes and Reay Golf Course (50 metre strip) survey. Survey coverage can be clearly seen on this plot. Areas where no sensor records are shown are those areas where access was not possible.

Generally the interpolation shows a gross gamma count interpolation of between 100 and 300cps.

3.3.11 Figure 11

Figure 11 shows a photograph of the vehicle mounted Groundhog™ system. The detector array can be seen clearly at the front of the vehicle. The photograph shows the system mounted onto the front of a Unimog. For the survey of Reay Golf Course, this system was mounted onto the front of a Landrover.

3.3.12 Figure 12

Figure 12 shows the count rate distribution for the sensor readings taken during the survey of Sandside Dunes West Section. The count rates in cps are plotted against the occurrences.

3.3.13 Figure 13

Figure 13 shows the count rate distribution for the sensor readings taken during the survey of Sandside Dunes Central Section. The count rates in cps are plotted against the occurrences.

3.3.14 Figure 14

Figure 14 shows the count rate distribution for the sensor readings taken during the survey of Sandside Dunes East Section. The count rates in cps are plotted against the occurrences.

3.3.15 Figure 15

Figure 15 shows the count rate distribution for the sensor readings taken during the survey of Reay Golf Course (50 metre strip). The count rates in cps are plotted against the occurrences.

4 Conclusion

The overall area surveyed on Sandside Dunes and Reay Golf Course was approximately 141,009 m².

The survey of Sandside Dunes and Reay Golf Course (50 metre strip) resulted in no particles being detected within the survey area. As detailed in Section 3 above, background levels that have been detected are assessed to be a result of the geological conditions of the area.

Appendices are contained in a separate report to reduce file downloading time - please see menu.