[Form 2 (to be reported to Committee on Countermeasures for Contaminated Water Treatment and to be disclosed to public)

Technology Information	
Area	5 (Select the number from "Areas of Technologies Requested")
Title	Dounreay Shaft Isolation Project
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1. Overview of Technologies (features, specification, functions, owners, etc.)

Background

Dounreay was Great Britain's nuclear fast reactor centre from 1955 until 1994; and the shaft is one of the highest priorities UKAEA faces in its £4billion project to decommission the 140-acre site.

The shaft was used as a Scottish Office approved disposal facility for solid radioactive waste from 1959. Approximately 750m3 of radioactive waste accumulated in the shaft up to 1977, when disposals ceased following an explosion.

BAM Ritchies' Shaft Isolation scheme, developed with consultant Halcrow, was designed to provide reassurance against leakage, eliminate concerns that the shaft is a source of particles in the marine environment, and create a stable environment for waste retrieval at a later date.

The works are briefly described as follows:-

Ground Investigation

Prior to the main grouting works of the £16M project to hydraulically isolate a shaft partly infilled with nuclear waste at the UK Atomic Energy Authority (UKAEA) Dounreay site, on the north coast of Scotland, BAM Ritchies undertook ground investigation work to add to the knowledge gained from preliminary ground investigation work and assist with the design of the grouting trials and hydrogeological testing.

The ground investigation work comprised:-

- Seven boreholes using Geobore S triple tube coring to depths between 62 and 105.5m; vertical and inclined

- Geophysical Testing (by Robertson Geologging Ltd)

- Optical televiewer
- Acoustic Televiewer
- Borehole geometry(4 arm caliper)

- Spectral Gamma
- Fluid temperature and conductivity
- Resistivity

- Hydrological Testing (by Solexperts)
  - Environmental Head Tests using double packers at 5m spacings
  - Production Tests

- Double 19mm and 50mm standpipes in each hole

- Factual report

Grouting Trials

BAM Ritchies undertook grout penetration trials where the spread of grout was tracked, in real time, through in in-situ rock mass. Three separate trials were carried out, with both cementitous blocker and primary grouts being injected in a total of 50 stages. Three or four component grout was mixed using the full scale plant, tested in the site lab and injected using single packer, ascending stage techniques.

The twin computer controlled grout batching equipment produced colloidally mixed grout in batch volumes of up to 200 litres. This was fed to five pump units, which were controlled and datalogged remotely from a grout control module. The pump capacity ranged from 3-12 litres per minute and from 0 to 100bar. The grout was then delivered to the injection stage through pipework of up to 200m in length, which feed boreholes of 75m depth. Typical pump flow rates were 3-5 litres per minute at 15 to 40 bar.

Around each grout injection borehole were up to six monitoring boreholes. These boreholes were set at radial distances from the injection borehole of 3, 4 and 6m. Within each monitoring borehole, a double packer string was set in the bedrock at the same level as the grout injection packer, at depths of up to 75m. The packer string contained pH, temperature and pressure sensors monitored by data loggers.

In addition to the pH, temperature and pressure sensors contained within the double packers, a further 40No vibrating wire piezometers were installed across the trials site. These recorded ambient, tidal and grout injection induced changes in ground water pressures at depths of up to 80m below ground level.

The tests were successful with grout penetration being recorded in fissures of approximately 50 to 1000microns. It is believed that this trial represents the first time that grout penetration has been measured and tracked in real time through insitu rock fissures.

Main Works

Following the successful completion of site trials and construction of the Raised Working Platform, the main works to hydraulically isolate the Dounreay shaft was successfully completed resulting in a massive reduction in potential water ingress during future radioactive waste removal operations from an estimated 350m^3/day to 12.7m^3/day.

The works commenced with site characterisation & baseline hydrological testing followed by bulk infilling of the Liquid Effluent Discharge Tunnel (LEDT) and then high pressure rock fissure injection grouting. All drilling and grouting equipment operated with datalogged sensors and grouting control included realtime ground movement monitoring at depths of up to 100m with a resolution of 0.03mm.

Drilling was undertaken using wireline methods. Custom grout mixes were developed for both LEDT infill and rock fissure injection with ultrafine cements used extensively. BAM Ritchies drilled more than 300 boreholes up to 80 metres deep, with a combined total of 24km.

The work created a nominal ten metre thick barrier around the shaft by grouting fissures in the Caithness Flagstones reducing rock mass permeability to 5 10^{-9} m/s. The project was complete in 2008 after a year programme.

2. Notes (Please provide following information if possible.)

- Technology readiness level (including cases of application, not limited to nuclear industry, time line for application)

The technology used at Dounreay along with related technologies for non-rock masses is readily available within BAM Ritchies with regard to:-

- Personnel
- Plant
- Equipment

- Design
- Supply Chain
- Management Systems
- HSQE precautions

- Challenges
  - Working in the contaminated site
  - Access/working areas
  - Language
  - Verification
  - Residual water flows
  - Royal BAM Group approval to undertake work
  - Insurances
  - HSQE management

- Others (referential information on patent if any)
  - Requirement of a local partner in Japan?

【Areas of Technologies Requested】

(1) Accumulation of contaminated water (Storage Tanks, etc.)

(2) Treatment of contaminated water (Tritium, etc.)

(3) Removal of radioactive materials from the seawater in the harbor

(4) Management of contaminated water inside the buildings

(5) Management measures to block groundwater from flowing into the site

(6) Understanding the groundwater flow