Selecting Targets for OSI Drilling to Obtain Radioactive Samples: Based on Test Site Observations

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“Drilling to obtain radioactive samples”

- Target must be identified
- Drilling operator is engaged
- Permits and agreements
- Procedures have been defined

Executive Council approval is required.
Approval will depend on many issues

- OSI evidence (visual, geophysical, radionuclide) indicates a sampling target
- Operational activities can be accomplished
- Inspection Team proposal to Executive Council through Director General to conduct drilling
- Requires majority decision

*Must be a reasonable opportunity for success.*
What constitutes “a reasonable opportunity for success”

1) Remote Event Detection
   - IMS/IDC
   - Other

2) Wide area search
   - Overflight/Visual Orientation
   - Visual Field Checks
   - SAMS
   - RN Monitoring

3) Location Investigations
   - Visual surveys
   - SAMS
   - CPT (?)
   - RN Surveys

4) Detailed site examination
   - Focused Visual investigation
   - CPT
   - RN Sampling
   - Drilling?

A convincing sampling target.
Potential Sampling Target

Target Diameter: Puddle = 1/6 Cavity
10 kt = 6 m
50 kt = 10 m
100 kt = 14 m

1 - Prompt injection
2 - Melt puddle
3 - Fractionated volatiles
4 - Atmospheric pumping
5 - Groundwater movement

Not to Scale
Chemical Species

- **Non-volatile** (refractory) species condense as soon as the melt is formed.
- **Semi-volatile** species which are absorbed or adsorbed on particles as the temperature approaches ambient.
- **Volatile** species which condense only below ambient temperatures. Extreme examples are the noble gases.
Timing and Location

- Non-volatile radionuclides are concentrated in the cavity melt puddle
- Volatile radionuclides can migrate into chimney and damage zone
- Volatile radionuclides have short half-lives and provide isotopic ratios best for timing
- Longer half-life radionuclides affected by fractionation and dilution
“Drilling to obtain radioactive samples.”

Concept of Operations

- **What?**
  - Collect adequate and controlled samples.

- **How?**
  - Safely (personnel and environment)
  - Rapidly (existing licenses, etc.)
  - Efficiently (compact; self contained, minimal support, etc.)
  - Confidentially (protect information)

- **Who?**
  - Contract drilling company (pre-approved by PTS?)
Typical Vertical UGT Post-Shot Drill Back

1. Drill Rig
2. Cellar
3. Chimney & Puddle Glass
4. Side Track Hole
5. Primary Hole

Vertical Test
Post-Test Drilling
Gamma Logging to Select Sampling Points

Gamma Logs

Higher Sensitivity

Lower Sensitivity

Sample Activity

RN 1

RN 2

RN 3

RN 4

~Cavity Bottom
Radionuclide Migration in groundwater from Cheshire Test

Heat from the explosion moved radionuclides upward toward transmissive zones.

The radionuclides were discovered in a hole drilled 300m down gradient 11 years later.

Sawyer, Thompson and Smith, 1999
Sample Handling

- Safety Mandatory
- Sample Security Issue
- Packaging
- Sealing and Tagging
- Chain of Custody
Summary

• Target definition depends on:
  – Explosive yield
  – Geology
  – Hydrology
  – Timing
  – Equipment

• Historically, drilling for diagnostic radionuclides was difficult
  – Need continuous gamma logging
  – Blow-out prevention critical
  – Drill-string collar important for slant/directional drilling
  – Puddle materials difficult to texturally distinguish

• Optimized chance of success by understanding the potential distribution and fate of radionuclides.
Summary

• Drilling for OSI samples is similar to historical post-shot operations but not exactly the same

• Drilling to intersect chimney has higher success probability than that of finding the puddle

• Need to specify equipment such that all OSI situations can be addressed.

• Drilling capabilities and experience of contractors vary—special capabilities will be required