

| WASTE STREAM | 7D41 | ILW Submarine Ion Exchange Resin |
|--------------|------|----------------------------------|
|--------------|------|----------------------------------|

**SITE** HMNB Devonport

**SITE OWNER** Ministry of Defence (MOD)

**WASTE CUSTODIAN** Babcock International Group

**WASTE TYPE** ILW

#### WASTE VOLUMES

|                        | Reported (m <sup>3</sup> ) | OR     | Conditioned (m <sup>3</sup> ) | Packaged (m <sup>3</sup> ) |
|------------------------|----------------------------|--------|-------------------------------|----------------------------|
| Stocks:                | At 1.4.2025                | = 3.3  |                               |                            |
| Future arisings:       | 1.4.2025 - 31.3.2028       | ~ -0.9 |                               |                            |
|                        | 1.4.2028 - 31.3.2031       | ~ -0.8 |                               |                            |
|                        | 1.4.2031 - 31.3.2034       | ~ 0.1  |                               |                            |
|                        | 1.4.2034 - 31.3.2037       | ~ -0.2 |                               |                            |
| Total future arisings: |                            | -1.7   |                               |                            |
| Total waste volume:    |                            | 1.5    |                               |                            |

Number of waste packages in stock: At 1.4.2025..... - packages

Comment on arising rates: Generation rate is dependent upon the submarine refit/maintenance plan, which is variable. 'Current Stocks' declared are for waste stored in raw form awaiting treatment. Waste disposal due to commence c. 2025/26 which will follow a conditioning/treatment campaign as part of a MoD driven Resin Disposal Project (RDP) to significantly reduce C14 & remove chelates. Reported volumes in 'future arisings' represent a balance of newly generated waste versus a program of work in which this wastestream will be reduced and converted into conditioned wastestream: 7D26/C.

Additional information on quantities: The volume quoted above is the total volume of the ion exchange resin and water within the Resin Storage Vessel (RSV)

Uncertainty factors on volumes:

|                |        |                   |        |
|----------------|--------|-------------------|--------|
| Stock (upper): | x 1.10 | Arisings (upper): | x 1.50 |
| Stock (lower): | x 0.90 | Arisings (lower): | x 0.50 |

**WASTE SOURCE** During operation of the submarine reactor system primary coolant is passed through an onboard ion exchange resin which removes soluble activation products and also acts as a very coarse filter.

#### PHYSICAL CHARACTERISTICS

General description: The waste consists of resin beads which are uniform spheroids of approximately 0.6 - 1.0 mm size. The ion exchange resin is organic mixed cation and anion hydrogen-hydroxide (H-OH) type where the active groups are quaternary amines and sulphonic groups. These are manufactured from polystyrene divinylbenzene copolymer. The ion exchange resin is mixed to ensure an even number of anion / cation active sites. When resin is shown to be exhausted it is discharged into a Resin Storage Vessel (RSV). Resin is headed by an amount of water and remains wet during its storage period. Resin is held within a Resin Storage Vessel (RSV). There are no large items present. The waste will be mixed with a standard cement mixture (see below) before an inactive capping grout is applied to the drum to seal the active surface.

Changes since waste generated: The waste will be stored in the raw state until it has decayed to LLW levels and/or has been treated/conditioned to remove chelates and remove/reduce C-14 and is able to be managed in accordance with 7D26/C.

Bulk density (t/m<sup>3</sup>): ~ 1.1

Comment on density: The density will be in the region of 1-1.1 t/m<sup>3</sup>. Once conditioned for disposal the density will increase as the waste will be encapsulated into an appropriate concrete matrix (~ 1.9 t/m<sup>3</sup>).

#### CHEMICAL COMPOSITION

General description and components (%wt): The waste consists of polystyrene bead mixed cation/anion resin. The main elements removed are metallic activation products. Other anions are also held by the resin. Ion exchange resin (75%), water (25%)

Chemical state: Acid

Sheet metal proportion / thickness: -

Metals and alloys (%wt):

|                           | (%wt) | Type(s) / Grades(s) with proportions | % of total C14 activity                                                                                                                 |
|---------------------------|-------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Stainless steel.....      | = 0   | -                                    | Not applicable apart from the metal activation products that may have adhered to the resin. This would be in very small concentrations. |
| Other ferrous metals..... | = 0   | -                                    |                                                                                                                                         |
| Iron.....                 | = 0   | -                                    |                                                                                                                                         |
| Aluminium.....            | = 0   | -                                    |                                                                                                                                         |
| Beryllium.....            | = 0   | -                                    |                                                                                                                                         |
| Cobalt.....               | = 0   | -                                    |                                                                                                                                         |
| Copper.....               | = 0   | -                                    |                                                                                                                                         |
| Lead.....                 | = 0   | -                                    |                                                                                                                                         |
| Magnox/Magnesium.....     | = 0   | -                                    |                                                                                                                                         |
| Nickel.....               | = 0   | -                                    |                                                                                                                                         |
| Titanium.....             | = 0   | -                                    |                                                                                                                                         |
| Uranium.....              | = 0   | -                                    |                                                                                                                                         |
| Zinc.....                 | = 0   | -                                    |                                                                                                                                         |
| Zircaloy/Zirconium.....   | = 0   | -                                    |                                                                                                                                         |
| Other metals.....         | = 0   | -                                    |                                                                                                                                         |

Organics (%wt):

|                                     | (%wt)  | Type(s) and comment | % of total C14 activity                                                                                                                               |
|-------------------------------------|--------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Total cellulotics.....              | = 0    | -                   | ion exchange resin of organic mixed cation and anion hydrogen-hydroxide (H-OH) type. These are manufactured from polystyrene divinylbenzene copolymer |
| Paper, cotton.....                  | = 0    | -                   |                                                                                                                                                       |
| Wood.....                           | = 0    | -                   |                                                                                                                                                       |
| Halogenated plastics.....           | = 0    | -                   |                                                                                                                                                       |
| Total non-halogenated plastics..... | = 0    | -                   |                                                                                                                                                       |
| Condensation polymers.....          | = 0    | -                   |                                                                                                                                                       |
| Others.....                         | = 0    | -                   |                                                                                                                                                       |
| Organic ion exchange materials..... | = 75.0 | -                   |                                                                                                                                                       |
| Total rubber.....                   | = 0    | -                   |                                                                                                                                                       |
| Halogenated rubber.....             | = 0    | -                   |                                                                                                                                                       |
| Non-halogenated rubber.....         | = 0    | -                   |                                                                                                                                                       |
| Hydrocarbons.....                   | = 0    | -                   |                                                                                                                                                       |
| Oil or grease.....                  | = 0    | -                   |                                                                                                                                                       |
| Fuel.....                           | = 0    | -                   |                                                                                                                                                       |
| Asphalt/Tarmac (cont.coal tar)..... | = 0    | -                   |                                                                                                                                                       |
| Asphalt/Tarmac (no coal tar).....   | = 0    | -                   |                                                                                                                                                       |
| Bitumen.....                        | = 0    | -                   |                                                                                                                                                       |
| Others.....                         | = 0    | -                   |                                                                                                                                                       |
| Other organics.....                 | = 0    | -                   |                                                                                                                                                       |

Other materials (%wt):

|                                       | (%wt)  | Type(s) and comment | % of total C14 activity                                        |
|---------------------------------------|--------|---------------------|----------------------------------------------------------------|
| Inorganic ion exchange materials..... | = 0    | -                   | Resin remains wet when stored with overstanding head of water. |
| Inorganic sludges and flocs.....      | = 0    | -                   |                                                                |
| Soil.....                             | = 0    | -                   |                                                                |
| Brick/Stone/Rubble.....               | = 0    | -                   |                                                                |
| Cementitious material.....            | = 0    | -                   |                                                                |
| Sand.....                             | = 0    | -                   |                                                                |
| Glass/Ceramics.....                   | = 0    | -                   |                                                                |
| Graphite.....                         | = 0    | -                   |                                                                |
| Desiccants/Catalysts.....             | = 0    | -                   |                                                                |
| Asbestos.....                         | = 0    | -                   |                                                                |
| Non/low friable.....                  | = 0    | -                   |                                                                |
| Moderately friable.....               | = 0    | -                   |                                                                |
| Highly friable.....                   | = 0    | -                   |                                                                |
| Free aqueous liquids.....             | = 25.0 | -                   |                                                                |
| Free non-aqueous liquids.....         | = 0    | -                   |                                                                |
| Powder/Ash.....                       | = 0    | -                   |                                                                |

#### COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

|                | (%wt) | Type(s) and comment |
|----------------|-------|---------------------|
| Fluoride.....  | = 0   | -                   |
| Chloride.....  | = 0   | -                   |
| Iodide.....    | = 0   | -                   |
| Cyanide.....   | = 0   | -                   |
| Carbonate..... | = 0   | -                   |
| Nitrate.....   | = 0   | -                   |
| Nitrite.....   | = 0   | -                   |
| Phosphate..... | = 0   | -                   |
| Sulphate.....  | = 0   | -                   |
| Sulphide.....  | = 0   | -                   |

Materials of interest for waste acceptance criteria:

|                                                | (%wt) | Type(s) and comment |
|------------------------------------------------|-------|---------------------|
| Combustible metals.....                        | = 0   | -                   |
| Low flash point liquids.....                   | = 0   | -                   |
| Explosive materials.....                       | = 0   | -                   |
| Phosphorus.....                                | = 0   | -                   |
| Hydrides.....                                  | = 0   | -                   |
| Biological etc. materials.....                 | = 0   | -                   |
| Biodegradable materials.....                   | = 0   | -                   |
| Putrescible wastes.....                        | = 0   | -                   |
| Non-putrescible wastes.....                    | = 0   | -                   |
| Corrosive materials.....                       | = 0   | -                   |
| Pyrophoric materials.....                      | = 0   | -                   |
| Generating toxic gases.....                    | = 0   | -                   |
| Reacting with water.....                       | = 0   | -                   |
| Higher activity particles.....                 | = 0   | -                   |
| Soluble solids as bulk chemical compounds..... | = 0   | -                   |

Hazardous substances / non hazardous pollutants:

|                             | (%wt) | Type(s) and comment                                                                                                                                                                                                                                                     |
|-----------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Acrylamide.....             | -     | -                                                                                                                                                                                                                                                                       |
| Benzene.....                | = 0   | -                                                                                                                                                                                                                                                                       |
| Chlorinated solvents.....   | -     | -                                                                                                                                                                                                                                                                       |
| Formaldehyde.....           | -     | -                                                                                                                                                                                                                                                                       |
| Organometallics.....        | -     | -                                                                                                                                                                                                                                                                       |
| Phenol.....                 | = 0   | -                                                                                                                                                                                                                                                                       |
| Styrene.....                | -     | -                                                                                                                                                                                                                                                                       |
| Tri-butyl phosphate.....    | = 0   | -                                                                                                                                                                                                                                                                       |
| Other organophosphates..... | -     | -                                                                                                                                                                                                                                                                       |
| Vinyl chloride.....         | = 0   | -                                                                                                                                                                                                                                                                       |
| Arsenic.....                | = 0   | -                                                                                                                                                                                                                                                                       |
| Barium.....                 | -     | -                                                                                                                                                                                                                                                                       |
| Boron.....                  | P     | Not present in current inventory but may contain Boron in future holdings dependant on submarine processes i.e potential for on-board boronation of primary effluent. This would equate to an average boron concentration comparable to 7D26/C waste stream (~ 22 mg/l) |
| Boron (in Boral).....       | = 0   | -                                                                                                                                                                                                                                                                       |
| Boron (non-Boral).....      | = 0   | -                                                                                                                                                                                                                                                                       |
| Cadmium.....                | = 0   | -                                                                                                                                                                                                                                                                       |
| Caesium.....                | -     | -                                                                                                                                                                                                                                                                       |
| Selenium.....               | = 0   | -                                                                                                                                                                                                                                                                       |
| Chromium.....               | = 0   | -                                                                                                                                                                                                                                                                       |
| Molybdenum.....             | = 0   | -                                                                                                                                                                                                                                                                       |
| Thallium.....               | -     | -                                                                                                                                                                                                                                                                       |
| Tin.....                    | = 0   | -                                                                                                                                                                                                                                                                       |
| Vanadium.....               | = 0   | -                                                                                                                                                                                                                                                                       |
| Mercury compounds.....      | -     | -                                                                                                                                                                                                                                                                       |
| Others.....                 | = 0   | -                                                                                                                                                                                                                                                                       |

Complexing agents (%wt):

| Yes                            |         |                                                                                                                                                                                                                                                                                                            |
|--------------------------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                | (%wt)   | Type(s) and comment                                                                                                                                                                                                                                                                                        |
| EDTA.....                      | -       | -                                                                                                                                                                                                                                                                                                          |
| DPTA.....                      | -       | -                                                                                                                                                                                                                                                                                                          |
| NTA.....                       | -       | -                                                                                                                                                                                                                                                                                                          |
| Polycarboxylic acids.....      | -       | -                                                                                                                                                                                                                                                                                                          |
| Other organic complexants..... | << 0.01 | Sampling includes analysis for complexing agents. Only resins with results below detection thresholds will be disposed under this wastestream. However, although not expected, it is possible there may be very small trace quantities of undetected organic complexing agents present (i.e. << 0.01 %wt). |
| Total complexing agents.....   | << 0.01 | -                                                                                                                                                                                                                                                                                                          |

Physical components:

|                                         | Number | Type(s) and comment |
|-----------------------------------------|--------|---------------------|
| Sources.....                            | = 0    | -                   |
| Electronic & Electrical Equipment (EEE) | -      | -                   |
| EEE Type 1.....                         | = 0    | -                   |
| EEE Type 2.....                         | = 0    | -                   |
| EEE Type 3.....                         | = 0    | -                   |
| EEE Type 4.....                         | = 0    | -                   |
| EEE Type 5.....                         | = 0    | -                   |

## TREATMENT, PACKAGING AND DISPOSAL

Planned on-site / off-site treatment(s):

| Treatment                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | On-site / Off-site | Stream volume % |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-----------------|
| Size reduction<br>Decay storage<br>Low force compaction<br>Supercompaction (HFC)<br>Incineration<br>Drying/dewatering/liquid separation<br>Tie down/fixatives/strippable coating/painting application<br>Decontamination<br>Metal treatment<br>Recycling / reuse<br>Thermal treatment, including vitrification<br>Encapsulation<br>Polymer encapsulation<br>Other physical treatment<br>Other chemical treatment<br>Containerisation<br>Treatment not yet determined<br>None | On-site            | = 100.0         |

Comments on planned treatments:

It is planned that most of the existing stock waste will be treated/conditioned to reduce the C-14 before the resulting product will be encapsulated for disposal. New arisings will be managed/decayed stored until disposal route is agreed.

Conditioning method:

Following decay/treatment/processing the resin will be assessed for suitability to move into the 7D26/C resin waste-stream. In this case the resin will be immobilised in a cement matrix using an in-drum mixing technique in order for NWS/LLW Repository wasteform requirements to be met. The wastestream will be conditioned in the Tradebe Inutec LLW Cementation Plant at Winfrith and the final product consists of an uncompactable waste matrix. The encapsulation process will be carefully controlled to ensure that each container and its contents meet all aspects of the NWS WAC, including Discrete Item limits where applicable. The wastestream is conditioned by mixing the wet resin with a blend of cement powders so that the resultant grout sets to a dry, solid monolith. An IX/cement resin formulation has been developed which is based on 120 litres of fully water-saturated and flooded resin mixed with 170kg blended cement powder. The blended cement powder consists of a standard mixture of ground-granulated blast furnace slag (ggBFS) and ordinary Portland cement (OPC) in the mass ratio 9:1 respectively for non-borated resin and 100 % OPC for borated resin. The waste loading of the final cement wasteform for 7D26/C is typically 25% by mass

Conditioning plants:

| Plant Name | Location |
|------------|----------|
|            |          |

Likely conditioning matrix:

Non-standard

Further information on the conditioning matrix:

When stored, the waste is held in its raw state. If treated/processed into the 7D26/c waste stream, a IX/cement resin formulation has been developed which is based on 120 litres of fully water-saturated and flooded resin mixed with 170kg blended cement powder. The blended cement powder consists of a standard mixture of ground-granulated blast furnace slag (ggBFS) and ordinary Portland cement (OPC) in the mass ratio 9:1 respectively for non-borated resin and 100 % OPC for borated resin. However, this will only occur following treatment when the waste is diverted into 7D26/C waste stream.

### Waste Packaging:

Likely container type:

| Container          | Waste packaged (vol%) | Waste loading (m³) | Payload (m³) | Number of packages | Estimated start date for packaging |
|--------------------|-----------------------|--------------------|--------------|--------------------|------------------------------------|
| Not yet determined | 100.0                 | -                  | -            | -                  | -                                  |

Range in container waste loading:

If conditioned/treated, this waste will be disposed under 7D26/C waste stream. The following comments are based on the assumption that waste is diverted into 7D26/C

Other information on packaging and conditioning:

The method of preparation, using an in-drum mixing technique, ensures a homogeneous product. The fully-filled 200 litre drums will then be placed in a half height 2910 ISO freight container of the approved design for transport to the LLW Repository. As an alternative packaging process, the conditioned waste may be used to fill interstitial space between 200 litre drums of waste within a disposal container (e.g. 1/2 height ISO) to increase the packing efficiency of the final disposal container although this option has not yet been used.

Conditioned density (t/m³):

~ 1.9

Conditioned density comment:

Unconditioned 'Raw' wet ion exchange resin waste has an average density of around 1100 kgm-3 as stored. The cement conditioned product in mild steel drums has an average density of around 1900 kgm-3. The wastestream (if diverted to 7D26/C) is conditioned by mixing the wet resin with a blend of cement powders so that the resultant grout sets to a dry, solid monolith. The waste loading of the final cement wasteform is typically 25% by mass

**Management Routes:**

| Disposal Route                                                                     | Stream volume % | Raw density t/m <sup>3</sup> | Start date |
|------------------------------------------------------------------------------------|-----------------|------------------------------|------------|
| Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland) | = 100.0         | ~ 1.9                        |            |
| Expected to be Non-NSD HAW managed under Scottish Government's policy              |                 |                              |            |
| Expected to be disposed to LLW Vaults NRS Dounreay                                 |                 |                              |            |
| Expected to be consigned to the Geological Disposal Facility                       |                 |                              |            |
| Expected to be consigned to a Near Surface Disposal Facility                       |                 |                              |            |
| Expected to be consigned to the LLW Repository                                     |                 |                              |            |
| Expected to be consigned to a Landfill Facility                                    |                 |                              |            |
| Expected to be disposed On-Site                                                    |                 |                              |            |
| Expected to be managed by In-Situ Disposal                                         |                 |                              |            |
| Expected to be consigned to an Incineration Facility                               |                 |                              |            |
| Expected to be consigned to a Metal Treatment Facility                             |                 |                              |            |
| Expected to be Out of Scope                                                        |                 |                              |            |
| Expected to be recycled / reused                                                   |                 |                              |            |
| Disposal route not known                                                           |                 |                              |            |

Classification codes for waste expected to be consigned to a landfill facility:

**Opportunities for alternative disposal routing:** Not yet determined

| Baseline Management Route | Opportunity Management Route | Stream volume (%) | Opportunity Confidence | Comment |
|---------------------------|------------------------------|-------------------|------------------------|---------|
| -                         | -                            | -                 | -                      | -       |

**RADIOACTIVITY**

**Source:** The main source of activity held on the ion exchange resin are activation products from operation of PWR reactor. The main contaminants are cobalt-60, iron-55, carbon-14, nickel-63 and tritium. The waste is generated by the processing of radioactive liquid by submarine coolant treatment systems.

**Uncertainty:** The raw resin within each container is representatively sampled using a full core sampling technique. The resin is then analysed for a range of beta/gamma nuclides e.g. Co-60, Fe-55, Ni-63, C-14, Cl-36 and H-3 & gamma spectroscopy. There are triggers in the sampling and analysis routine that carries out additional analysis for other nuclides should certain key nuclides be detected. Other nuclides detected below limit of detection may have generic resin fingerprint values applied. Errors associated with the measurements are within the tolerances of a UKAS accredited laboratory. Future treatment of the waste may significantly reduce C-14 content.

**Measurement of radioactivities:** Core samples are taken from each resin container. The sample is prepared and analysed to determine the major nuclides by gamma spectroscopy and other selective chemical techniques for other beta/gamma nuclides. Gross alpha and gross beta measurements are also taken. If certain trigger nuclides (e.g. Cs-137) are detected then additional analysis will be undertaken for other nuclides (e.g. I-129).

**Chemical form of radionuclides:** H-3: Present as HTO in the overstanding water. Not expected as organically bound tritium on resin. Total activity of tritium not significant  
C-14: On resin in various chemical forms, mainly adhered to the resin.  
Cl-36: -  
Se-79: -  
Tc-99: -  
I-129: -  
Ra: -  
Th: -  
U: -  
Np: -  
Pu: -

| WASTE STREAM |                            | 7D41              |                 | ILW Submarine Ion Exchange Resin |          |                            |                   |                 |                                 |
|--------------|----------------------------|-------------------|-----------------|----------------------------------|----------|----------------------------|-------------------|-----------------|---------------------------------|
| Nuclide      | Mean radioactivity, TBq/m³ |                   |                 |                                  | Nuclide  | Mean radioactivity, TBq/m³ |                   |                 |                                 |
|              | Waste at<br>1.4.2025       | Bands and<br>Code | Future Arisings | Bands and<br>Code                |          | Waste at<br>1.4.2025       | Bands and<br>Code | Future Arisings | Bands and<br>Code               |
| H 3          | =                          | 1.36E-03          | A A 1           | ~                                | 1.36E-03 | B B 2                      | Gd 153            |                 |                                 |
| Be 10        |                            |                   |                 |                                  |          |                            | Ho 163            |                 |                                 |
| C 14         | =                          | 3.05E-02          | A A 1           | ~                                | 3.05E-02 | B B 2                      | Ho 166m           |                 |                                 |
| Na 22        |                            |                   |                 |                                  |          |                            | Tm 170            |                 |                                 |
| Al 26        |                            |                   |                 |                                  |          |                            | Tm 171            |                 |                                 |
| Cl 36        |                            |                   |                 |                                  |          |                            | Lu 174            |                 |                                 |
| Ar 39        |                            |                   |                 |                                  |          |                            | Lu 176            |                 |                                 |
| Ar 42        |                            |                   |                 |                                  |          |                            | Hf 178n           |                 |                                 |
| K 40         |                            |                   |                 |                                  |          |                            | Hf 182            |                 |                                 |
| Ca 41        |                            |                   |                 |                                  |          |                            | Pt 193            |                 |                                 |
| Mn 53        |                            |                   |                 |                                  |          |                            | Tl 204            |                 |                                 |
| Mn 54        | =                          | 3.43E-07          | A A 1           | ~                                | 3.43E-07 | B B 2                      | Pb 205            |                 |                                 |
| Fe 55        | =                          | 1.10E-03          | A A 1           | ~                                | 1.10E-03 | B B 2                      | Pb 210            |                 |                                 |
| Co 60        | =                          | 4.79E-03          | A A 1           | ~                                | 4.79E-03 | B B 2                      | Bi 208            |                 |                                 |
| Ni 59        |                            |                   |                 |                                  |          |                            | Bi 210m           |                 |                                 |
| Ni 63        | =                          | 2.53E-03          | A A 1           | ~                                | 2.53E-03 | B B 2                      | Po 210            |                 |                                 |
| Zn 65        |                            |                   |                 |                                  |          |                            | Ra 223            |                 |                                 |
| Se 79        |                            |                   |                 |                                  |          |                            | Ra 225            |                 |                                 |
| Kr 81        |                            |                   |                 |                                  |          |                            | Ra 226            |                 |                                 |
| Kr 85        |                            |                   |                 |                                  |          |                            | Ra 228            |                 |                                 |
| Rb 87        |                            |                   |                 |                                  |          |                            | Ac 227            |                 |                                 |
| Sr 90        |                            |                   |                 |                                  |          |                            | Th 227            |                 |                                 |
| Zr 93        |                            |                   |                 |                                  |          |                            | Th 228            |                 |                                 |
| Nb 91        |                            |                   |                 |                                  |          |                            | Th 229            |                 |                                 |
| Nb 92        |                            |                   |                 |                                  |          |                            | Th 230            |                 |                                 |
| Nb 93m       |                            |                   |                 |                                  |          |                            | Th 232            |                 |                                 |
| Nb 94        |                            |                   |                 |                                  |          |                            | Th 234            |                 |                                 |
| Mo 93        |                            |                   |                 |                                  |          |                            | Pa 231            |                 |                                 |
| Tc 97        |                            |                   |                 |                                  |          |                            | Pa 233            |                 |                                 |
| Tc 99        |                            |                   |                 |                                  |          |                            | U 232             |                 |                                 |
| Ru 106       |                            |                   |                 |                                  |          |                            | U 233             |                 |                                 |
| Pd 107       |                            |                   |                 |                                  |          |                            | U 234             |                 |                                 |
| Ag 108m      | =                          | 9.01E-07          | A A 1           |                                  | 9.01E-07 | B B 2                      | U 235             |                 |                                 |
| Ag 110m      | =                          | 1.34E-12          | A A 1           | ~                                | 1.34E-12 | B B 2                      | U 236             |                 |                                 |
| Cd 109       |                            |                   |                 |                                  |          |                            | U 238             |                 |                                 |
| Cd 113m      |                            |                   |                 |                                  |          |                            | Np 237            |                 |                                 |
| Sn 119m      |                            |                   |                 |                                  |          |                            | Pu 236            |                 |                                 |
| Sn 121m      |                            |                   |                 |                                  |          |                            | Pu 238            |                 |                                 |
| Sn 123       |                            |                   |                 |                                  |          |                            | Pu 239            |                 |                                 |
| Sn 126       |                            |                   |                 |                                  |          |                            | Pu 240            |                 |                                 |
| Sb 125       | =                          | 4.68E-07          | A A 1           | ~                                | 4.68E-07 | B B 2                      | Pu 241            |                 |                                 |
| Sb 126       |                            |                   |                 |                                  |          |                            | Pu 242            |                 |                                 |
| Te 125m      |                            |                   |                 |                                  |          |                            | Am 241            | =               | 1.14E-06 B B 2 ~ 1.14E-06 B B 2 |
| Te 127m      |                            |                   |                 |                                  |          |                            | Am 242m           |                 |                                 |
| I 129        | =                          | 2.14E-06          | A A 1           | ~                                | 2.14E-06 | B B 2                      | Am 243            |                 |                                 |
| Cs 134       |                            |                   |                 |                                  |          |                            | Cm 242            |                 |                                 |
| Cs 135       |                            |                   |                 |                                  |          |                            | Cm 243            |                 |                                 |
| Cs 137       | =                          | 2.78E-05          | A A 1           | ~                                | 2.78E-05 | B B 2                      | Cm 244            |                 |                                 |
| Ba 133       |                            |                   |                 |                                  |          |                            | Cm 245            |                 |                                 |
| La 137       |                            |                   |                 |                                  |          |                            | Cm 246            |                 |                                 |
| La 138       |                            |                   |                 |                                  |          |                            | Cm 248            |                 |                                 |
| Ce 144       |                            |                   |                 |                                  |          |                            | Cf 249            |                 |                                 |
| Pm 145       |                            |                   |                 |                                  |          |                            | Cf 250            |                 |                                 |
| Pm 147       |                            |                   |                 |                                  |          |                            | Cf 251            |                 |                                 |
| Sm 147       |                            |                   |                 |                                  |          |                            | Cf 252            |                 |                                 |
| Sm 151       |                            |                   |                 |                                  |          |                            | Unsp a            |                 |                                 |
| Eu 152       |                            |                   |                 |                                  |          |                            | Unsp b/g          |                 |                                 |
| Eu 154       |                            |                   |                 |                                  |          |                            | Total a           | 1.14E-06        | *                               |
| Eu 155       |                            |                   |                 |                                  |          |                            | Total b/g         | 4.03E-02        | *                               |

#### Bands (Upper and Lower)

A a factor of 1.5  
B a factor of 3  
C a factor of 10  
D a factor of 100  
E a factor of 1000

Note: Bands quantify uncertainty in the mean radioactivity.

#### Code

1 Measured activity  
2 Derived activity (best estimate)  
3 Derived activity (upper limit)  
4 Not present  
5 Present but not significant  
6 Likely to be present but not assessed  
7 Present in significant quantities but not determined  
8 Not expected to be present in significant quantity  
\* Total calculated from the 114 declared radionuclides