CONVENTIONS FOR THE PREPARATION OF THE 2010 UK RADIOACTIVE WASTE INVENTORY

1. Purpose of this note

This note presents the conventions to be used for the preparation of the 2010 Inventory. It is an update of a Nirex Technical Note prepared for the 2007 Inventory exercise (Document Number 496039, Rv.4, 2nd March 2007).

2. Introduction

The Nuclear Decommissioning Authority (NDA) prepares and maintains an inventory of radioactive waste in the United Kingdom in conjunction with the Department for Energy & Climate Change (DECC), i.e. the UK Radioactive Waste Inventory (the Inventory). The Inventory is the most comprehensive and up to date source of information on radioactive waste in the UK in the public domain.

The preparation of the Inventory requires the collation of a very large volume of information. As radioactive wastes arise in a diversity of sources and in a large number of different forms, a number of conventions have been adopted by DECC and NDA in order to assist the Waste Custodians in the preparation of the information that they will provide and to ensure that a clear presentation of the information (individual and collective) can be made.

The current Inventory is based on a stock date of 1 April 2007 (i.e. the 2007 Inventory) and the next update will have a stock date of 1 April 2010 (i.e. the 2010 Inventory). This note presents the conventions to be used for the preparation of the 2010 Inventory.

Generic

1. All information provided by the Waste Custodians for the preparation of the Inventory will be released into the public domain. It is the responsibility of the Waste Custodians to ensure that this information is suitable for such a release.
2. The site owner where the waste is managed has contracts with waste custodian organisations that manage its sites on its behalf.
3. The waste custodian is the licensee of the site where the waste is currently stored or will arise. The custodian has all responsibilities for the safe and environmental compliant management of the waste.
4. For the 2010 Inventory, the following site owner/waste custodian will be used:
   - The Nuclear Decommissioning Authority (NDA) is the owner of sites managed by Sellafield Limited, Magnox South Limited, Magnox North Limited, Dounreay Site Restoration Limited (DSRL), Research Sites Restoration Limited (RSRL), the LLW Repository Limited and Springfields Fuels Limited (SFL).
   - The Ministry of Defence (MoD) is the owner of sites managed by Atomic Weapons Establishment (AWE), Babcock International Group, Qinetiq,

BAE System Marine Ltd (BAESML) and Rolls Royce Marine Power Operations Ltd (RRMPOL).

- United Kingdom Atomic Energy Authority, GE Healthcare, Urenco and British Energy are both site owner and custodian of wastes managed on their respective sites.
- For waste arising from Minor Waste Producers (WMP), the owner is the WMP and the custodian is the organisation that operates the site where the waste is to be managed.

Waste Streams

5. Radioactive waste is defined in terms of waste streams. A waste stream summarises waste materials or a collection of waste items at a particular site, usually in a particular facility and/or from particular processes or operations. It is often distinguishable by its radionuclide content and in many cases also by its physical and chemical characteristics
6. Each waste stream is allocated a unique identifier. This consists of a digit indicating the waste custodian of the waste, followed by a letter indicating the site of storage, followed by a two- or three-digit number. Numbers in the range 01 to 99 identify operational wastes, and a three-digit number identifies decommissioning wastes. For example:

Waste stream 1A01:	1	(Waste Custodian = GE Healthcare Ltd)
	A	(Site = Amersham)
	01	(Waste stream = operational)

7. A waste stream that has been conditioned in a suitable container for long-term management, or is being conditioned as it arises, includes a /C suffix (e.g. 2D02/C).
8. The minimum information that shall be provided to describe a waste stream is:
   (a) a waste stream identifier;
   (b) a waste stream description;
   (c) a waste category;
   (d) volume(s) (for the waste that exists at the stock date, estimated future arising or both).
9. The volume reported for a waste stream must be greater than zero.
10. Radioactive waste that is not fully characterised (e.g. some contaminated land) will not be included in the 2010 Inventory (except if specifically requested by the Waste Custodian). This waste will however be described in a separate document on UK radioactive materials potentially requiring long-term management as waste. Appendix A provides guidance on how to report liabilities from radioactively contaminated land.
11. The Work Breakdown Structure (WBS) code associated with a waste stream is for local use only and will not be published in the public domain.

Waste Categories

12. The Inventory contains information on High Level Waste (HLW), Intermediate Level Waste (ILW), Low Level Waste (LLW), and Very Low Level Waste (VLLW) from nuclear licensed sites. These categories are defined in the UK as follows:

    (a) HLW — Wastes in which the temperature may rise significantly as a result of their radioactivity, so this factor has to be taken into account in the design of storage or disposal facilities.

    (b) ILW — Wastes exceeding the upper boundaries for LLW, but which do not require heating to be taken into account in the design of storage or disposal facilities.

    (c) LLW — Wastes containing radioactivity greater than 0.4 MBq per tonne, but not exceeding 4 GBq per tonne of alpha, or 12 GBq per tonne of beta/gamma activity.

    (d) VLLW — VLLW is a sub category of LLW.

13. If a waste stream has specific activities close to the upper limits for LLW and that the Waste Custodian cannot classify the stream definitively, the stream should be designated ILW.

14. ILW streams that will be decay stored or treated, after the stock date, for disposal as LLW must be reported as ILW. Information on the decay storage, treatment and forecast year when the ILW will become LLW should be provided.

15. Other radioactive wastes are not included in the Inventory, i.e. liquid and gaseous discharges to the environment, VLLW from UK non-nuclear licensed sites and Naturally Occurring Radioactive Materials classified as waste.

Disposed Waste

16. If a radioactive waste that was previously reported in the Inventory has been disposed of at the stock date, detailed information on that waste should no longer be reported in the Inventory (i.e. in individual waste stream data). However, information on such waste should be included in the summary information provided on radioactive waste disposed of in the UK by the stock date.

Time of Arising

17. All radioactive waste that exists at the stock date should be included in the Inventory. Information provided on such waste must reflect its quantity, nature and characteristics at the stock date.

18. All radioactive waste that the Waste Custodians forecast to arise after the stock date should also be included in the Inventory. Information provided on such waste must reflect its quantity, nature and characteristics at the time of its arising. This means:

    (a) for wastes originating from routine operations at nuclear facilities, the year it is produced;

(b) for wastes originating from remediation of contaminated land, the year the land is remediated;

(c) for wastes originating from decommissioning of nuclear facilities, the year it arises from a decommissioning activity.

19. The volume of future waste arisings should be given for financial years April to March. For simplicity, the financial year April 2010 to March 2011, for example, is referred to as '2010'.

Volume

20. For radioactive wastes that exist at the stock date, the volumes reported are those that the wastes occupy in tanks, vaults, drums, etc, in which they are contained at the stock date.

21. For radioactive wastes that the Waste Custodians forecast to arise after the stock date, the volumes reported are those that the wastes will occupy in tanks, vaults, drums, etc, in which they will be contained at the time of their arising.

22. The container should not be included unless it is to be overpacked as part of the waste for long-term management inside another container. For example, for LLW held in ISO container awaiting transport to the LLWR, the volume reported should not include the ISO container.

23. The volume of 200 litre drums containing LLW should be taken as a nominal 200 litres or the assumed volume stated.

24. For waste that has been or will be supercompacted, the waste volume should include the sacrificial containers in which the waste is supercompacted, and any voidage surrounding the resulting pucks where these are packaged in a container for disposal.

25. Volumes of sludges, flocs and other slurry type wastes should include the volume of interstitial fluid, but not the volume of supernate unless this will be part of the conditioned wasteform.

26. For radioactive wastes that are reported in a conditioned form (i.e. waste streams designated with the /C suffix in the stream identifier), the volume reported is the conditioned volume.

27. For an unpackaged waste stream with a corresponding packaged waste stream, negative values can be used to report the annual volumes of the unpackaged waste that are forecast to be packaged (i.e. indicating decreases in the volume of the unpackaged waste). The conditioned waste volume of the resulting packaged waste should be reported for the packaged waste stream. This approach to reporting volumes for wastes that are being retrieved from storage and packaged is encouraged but is not mandatory.

28. Conditioned volume is the volume of the waste form (waste plus immobilising medium) within the container. This should not include any capping material, ullage and disposal container, unless the container is overpacked before disposal, in that case the volume of conditioned waste is the displacement volume of the container.

29. Packaged volume is the displacement volume of the container. It represents a "final" waste volume, whether the waste is stored long-term or disposed.

30. The volumes should be recorded in units of m^3.

Radioactivity

31. The information provided on the radioactivity content of a waste stream is the average specific activity of radionuclides in the waste stream, particularly those radionuclides for which
    - the specific activity is of potential significance for storage, treatment, packaging, transport, disposal or any other reason, whether for normal or accident conditions – see Table 1 for the 112 radionuclides identified as such;
    - the specific activity contributes significantly to the total alpha or total beta/gamma activity of the waste stream.
32. The average specific activity reported should be the average activity per unit volume in waste stocks or arisings based on the reported waste volumes. For waste forecast to arise over several years, the annual specific activities should be averaged over the whole arising period.
33. The activities for Other α and Other β/γ are the total activities of all alpha or beta/gamma emitting radionuclides not included in the list of 112 radionuclides – see Table 1.
34. The total α and total β/γ specific activities are the activities of all listed alpha or beta/gamma emitting radionuclides plus Other α or Other β/γ.
35. The activities of short-lived daughter radionuclides should not be included either individually or with the activities of their parent radionuclides or those for Other α and Other β/γ. For the purpose of the Inventory, short-lived means radionuclides with half-lives of less than three months.
36. However, to derive radionuclide activities in all waste that will be reported in the Main Report, the short-lived daughter radionuclides Y-90, Rh-106, Ba-137m and Pr-144 will be assumed to be present in secular equilibrium with their longer-lived parents. This is because these daughter radionuclides contribute significantly to the total radioactivity in all the waste present at the stock date. The following ratios will be used.

	Ratio
Sr-90/Y-90	1:1
Ru-106/Rh-106	1:1
Cs-137/Ba-137m	1:0.946
Ce-144/Pr-144	1:0.982

37. Uncertainty - A double letter Band (e.g. BC) is used to indicate the uncertainty in the average specific activity value. The first letter indicates the limit on the upper (+) side and the second letter indicates the limit on the lower (-) side. These limiting values represent the 5% and 95% levels on the cumulative distributions of activity (i.e. there is a 5% probability of the specific activity being less than the lower limit, and a 95% probability of the activity being less than the upper limit). The uncertainty bands are:

Band A	within a factor of 50%
Band B	within a factor of 3
Band C	within a factor of 10

Band D within a factor of 100

38. Derivation - A number is used to indicate the derivation of the average specific activity value. The code numbers are as follows:

    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 quantities

    Do not use Code 4 to indicate that radionuclides are not present when the volume of waste (in either stocks or future arisings) is zero.

39. The specific activity should be recorded in units of TBq/m^3. Two-figure precision is sufficient for activity values.

Physical Properties

40. The physical components known or estimated to make up the waste stream should be reported in terms of % of the waste stream volume or mass.
41. The waste stream volume must be the reported volume, and its mass that derived using its reported volume and density.
42. The % breakdown must add up to 100%.

Chemical Properties

43. The materials components known or estimated to be present in the waste stream should be reported in terms of % of the waste stream volume. Trade names and material grades or standard types should be reported if known.
44. Materials present at less than 1% by weight of the total waste stream mass and that are not significant in terms of waste management issues can be grouped together as 'Others'.
45. The waste stream volume must be the reported volume, and its mass that derived using its reported volume and density.
46. The % breakdown must add up to 100%.
47. For combustible metals, only those that are combustible under temperature and pressure conditions likely to be encountered in storage or after disposal should be included.
48. The % breakdown of metals should only include metals present in elemental form, i.e. not metals present as a constituent of alloys.
49. The % breakdown of inorganic anions should be for the anions only, i.e. not the compound of which the anion is a part.
50. The mean bulk density of a waste stream to be reported should be that of the waste in its form at the stock date or time of arising. If the waste is held in sacrificial containers, the container should be included.

51. If no density is reported for a waste stream it will be assumed to be 1.
52. The density of the conditioned waste to be reported should be the density of the waste form itself - waste plus immobilising material, i.e. not that of the resulting waste package. Unless the container is overpacked before disposal, in that case the density will be that of the resulting waste package.
53. If no conditioned density is reported, a value of $2t/m^3$ will be assumed when calculating conditioned weight in the Inventory reports.

Packages

54. The Waste Custodians shall report the number of waste packages that exist at the stock date. This can include complete packages that have or not undergone conditioning. It does not however include containers of LLW awaiting disposal to the LLWR.
55. In addition, the total number of waste packages, conditioned and packaged volumes when all the waste has been packaged will be derived as follows.

$$\text{Package Number} = \frac{\text{Volume reported}}{\text{Loading}}$$

$$\text{Conditioned Volume} = \text{Volume reported} \times \text{Conditioning Factor}$$

with $\text{Conditioning Factor} = \frac{\text{Payload}}{\text{Loading}}$ (see table below)

Packaged Volume = Volume reported x Packaging Factor

with Packaging Factor = $\frac{\text{Container displacement volume}}{\text{Loading}}$ (see table below)

Disposal container	**Payload** volume (m^3)	**Displacement** volume (m^3)
LLW		
1/3 height ISO	9.3	13
1/2 height ISO	15.6	19.5
4m box (no shielding)	18.9	20
2m box (no shielding)	9.5	10.2
Standard NDA ILW		
500l drum	0.47	0.57
500l drum (with pre-cast annulus)	0.4	0.57
500l drum (with basket for waste)	0.47	0.57
$3m^3$ box (round corners)	2.7	3.3
$3m^3$ box (square corners)	2.8	3.6
$3m^3$ drum	2.2	2.6
2m box (no shielding)	9.5	10.2
2m box (with 100mm of concrete shielding)	6.9	10.2
2m box (with 200mm of concrete shielding)	4.9	10.2
2m box (with 300mm of concrete shielding)	3.4	10.2
4m box (no shielding)	18.9	20
4m box (with 100mm of concrete shielding)	14.3	20
4m box (with 200mm of concrete shielding)	10.9	20
4m box (with 300mm of concrete shielding)	8.1	20
Other ILW		
WAGR box	5.76	11.85
MBGWS box	3.5	4.7
Sellafield $3m^3$ box	2.8	3.3
Sellafield enhanced $3m^3$ box	2.28	3.3
HLW		
HLW canister	0.15	0.196

56. If no loading is reported, it will be assumed to be equal to the payload (i.e. equivalent to a conditioning factor of 1.0) when calculating waste package numbers and conditioned or packaged volumes reported in the Inventory reports.
57. If no payload is reported, a representative value will be used when calculating conditioned volumes reported in the Inventory reports (see table above).
58. If no package type is reported for operational ILW streams and Stage 1 decommissioning ILW streams, and if the waste custodian does not advise otherwise, it will be assumed that the waste will be packaged into 500 litres drums. For other decommissioning ILW streams 4m ILW boxes will be used.
59. If no package type is reported for LLW streams, and if the waste custodian does not advise otherwise, it will be assumed that the waste will be packaged into ½ height ISO.

60. For LLW streams that the Waste Custodians forecast to be incinerated in the near future, the packaging and conditioning factors will be assumed to be equal to zero when calculating waste package numbers and conditioned or packaged volumes reported in the Inventory reports, unless otherwise indicated.

Numerical Data

61. The summed waste stream volumes in the Inventory reports will be rounded up to three significant figures.
62. Summed numbers of waste packages will be rounded to three significant figures, except for waste packages at the stock date where the actual numbers being held are reported.
63. Summed waste stream masses and activities will be rounded to two significant figures.
64. All numeric data provided should be given a prefix. The following prefixes are allowed:

Prefix	Interpretation
=	Data supplied by the Data Provider
*	Data provided by the Inventory Contractor and agreed with the Data Provider
**	Data provided by the Inventory Contractor that has been reviewed but not formally endorsed by the Data Provider
<	Less than
<<	Very much less than
>	Greater than
~	Approximately (within a factor of 2)
~~	Very approximately (within a factor of 10)
P	Present but not quantified (in general, this will be >100ppm). For use in physical and chemical description only.
TR	Present at trace levels (in general, this will be in the range 1-100ppm) For use in physical and chemical description only.
NE	Not estimated or data not available

Table 1 – 112 significant radionuclides

Radionuclide	Half-life (years)	Main decay mode
H-3	1.23E+01	βγ
Be-10	1.60E+06	βγ
C-14	5.73E+03	βγ
Cl-36	3.02E+05	βγ
Ar-39	2.69E+02	βγ
Ar-42	3.30E+01	βγ
K-40	1.28E+09	βγ
Ca-41	1.03E+05	βγ
Mn-53	3.70E+06	βγ
Mn-54	8.56E-01	βγ
Fe-55	2.70E+00	βγ
Co-60	5.27E+00	βγ
Ni-59	7.49E+04	βγ
Ni-63	1.00E+02	βγ
Zn-65	6.69E-01	βγ
Se-79	6.50E+04	βγ
Kr-81	2.10E+05	βγ
Kr-85	1.07E+01	βγ
Rb-87	4.80E+10	βγ
Sr-90	2.91E+01	βγ
Zr-93	1.53E+06	βγ
Nb-91	6.80E+02	βγ
Nb-92	3.50E+07	βγ
Nb-93m	1.64E+01	βγ
Nb-94	2.03E+04	βγ
Mo-93	3.50E+03	βγ
Tc-97	2.60E+06	βγ
Tc-99	2.13E+05	βγ
Ru-106	1.01E+00	βγ
Pd-107	6.50E+06	βγ
Ag-108m	4.18E+02	βγ
Ag-110m	6.84E-01	βγ
Cd-109	1.27E+00	βγ
Cd-113m	1.41E+01	βγ
Sn-119m	8.02E-01	βγ
Sn-121m	5.00E+01	βγ
Sn-123	3.54E-01	βγ
Sn-126	1.00E+05	βγ
Sb-125	2.73E+00	βγ
Sb-126	3.39E-02	βγ
Te-125m	1.59E-01	βγ
Te-127m	2.98E-01	βγ
I-129	1.57E+07	βγ
Cs-134	2.06E+00	βγ
Cs-135	2.30E+06	βγ
Cs-137	3.00E+01	βγ
Ba-133	1.05E+01	βγ
La-137	6.00E+04	βγ
La-138	1.05E+11	βγ
Ce-144	7.80E-01	βγ
Pm-145	1.77E+01	βγ
Pm-147	2.62E+00	βγ
Sm-147	1.06E+11	α
Sm-151	8.87E+01	βγ
Eu-152	1.33E+01	βγ
Eu-154	8.60E+00	βγ
Eu-155	4.96E+00	βγ
Gd-153	6.61E-01	βγ
Ho-163	4.57E+03	βγ
Ho-166m	1.20E+03	βγ

Radionuclide	Half-life (years)	Main decay mode
Tm-170	3.52E-01	βγ
Tm-171	1.92E+00	βγ
Lu-174	3.31E+00	βγ
Lu-176	3.61E+10	βγ
Hf-178n	3.10E+01	βγ
Hf-182	8.99E+06	βγ
Pt-193	5.07E+01	βγ
Tl-204	3.78E+00	βγ
Pb-205	1.52E+07	βγ
Pb-210	2.23E+01	βγ
Bi-208	3.68E+05	βγ
Bi-210m	3.00E+06	α
Po-210	3.79E-01	α
Ra-223	3.13E-02	α
Ra-225	4.08E-02	βγ
Ra-226	1.60E+03	α
Ra-228	5.75E+00	βγ
Ac-227	2.18E+01	βγ
Th-227	5.12E-02	α
Th-228	1.91E+00	α
Th-229	7.34E+03	α
Th-230	7.54E+04	α
Th-232	1.41E+10	α
Th-234	6.60E-02	βγ
Pa-231	3.28E+04	α
Pa-233	7.39E-02	βγ
U-232	6.98E+01	α
U-233	1.59E+05	α
U-234	2.46E+05	α
U-235	7.04E+08	α
U-236	2.34E+07	α
U-238	4.47E+09	α
Np-237	2.14E+06	α
Pu-236	2.90E+00	α
Pu-238	8.77E+01	α
Pu-239	2.41E+04	α
Pu-240	6.56E+03	α
Pu-241	1.44E+01	βγ
Pu-242	3.74E+05	α
Am-241	4.33E+02	α
Am242m	1.41E+02	βγ
Am-243	7.36E+03	α
Cm-242	4.46E-01	α
Cm-243	3.00E+01	α
Cm-244	1.81E+01	α
Cm-245	8.50E+03	α
Cm-246	4.73E+03	α
Cm-248	3.40E+05	α
Cf-249	3.51E+02	α
Cf-250	1.31E+01	α
Cf-251	8.98E+02	α
Cf-252	2.65E+00	α

Reference: The identification of radionuclides relevant to long-term waste management in the United Kingdom, Nirex, November 2004, Nirex Report N/105.

APPENDIX A – GUIDANCE FOR REPORTING LIABILITIES FROM RADIOACTIVELY CONTAMINATED LAND

Some licensed sites have identified areas of radioactively contaminated land. Most radioactively contaminated land is of low activity, and can be categorised as either LLW, VLLW, or Substances Of Low Activity (SoLA).

The 2010 Inventory should include information on all radioactively contaminated land at nuclear licensed sites, except for SoLA and liquid or gaseous discharges to the environment that may arise from the remediation of such land, as well as waste that has already arisen from such activities and has been disposed of.

Where areas of radioactively contaminated land are well characterised and there is reasonable certainty on the liability volume, information should be reported in the Radioactive Waste Inventory.

Where there is large uncertainty or characterisation programmes have yet to commence, information on radioactively contaminated land may be reported in the Radioactive Material Inventory.