OVERVIEW REPORT: Consolidated Radioactive Waste Inventory [1]

Currently there is no single, publicly available source of information about worldwide quantities of radioactive waste. The first issue of the new Agency report series entitled "Radioactive Waste Management Status and Trends" [1] indicated that the Agency decided to implement a suite of information systems related to quantities of radioactive waste in its Member States. One of those systems is the Net Enabled Waste Management Database (NEWMDB).

One of the fundamental features of the NEWMDB is that it allows Member States to report their waste inventories according to the waste classification scheme(s) used in their own countries. However, the NEWMDB requires Member States to describe how their waste classification scheme(s) compare with the common classification scheme proposed by the Agency [2]. Member States use the NEWMDB's waste class matrix tool to make this comparison.

Member States participating in submitting information to the NEWMDB were asked to appoint a single point-of-contact, called a Country Co-ordinator, to interact directly with the NEWMDB's Programme Officer. Country Co-ordinators are responsible for completing the waste class matrix on behalf of their country.

The NEWMDB's matrices allow the Agency to transpose Member States' waste inventories according to the Agency's waste classes in order to compile a radioactive waste inventory using a single waste classification scheme.

For a number of years, the Agency has had an objective to compile a ***comprehensive*** radioactive waste inventory in its Member States. However, the results of a May 2002 consultants' meeting at Agency headquarters indicated that the compilation of a comprehensive inventory is, for the foreseeable future, extremely difficult, if not impossible, to achieve. The consultancy reported the following:

1. Currently, there is no single source of radioactive waste inventory data from all countries using radioactive material. The Agency has the broadest membership of these countries, and therefore, it is in the best position to compile an international radioactive waste inventory. A consolidated inventory of radioactive waste in Agency Member States would represent the vast majority of radioactive waste around the world.
2. National infrastructures for radioactive waste management differ between Member States, e.g. some may have very mature regulatory processes, while others are just starting to put an infrastructure in place. Because of these differences, compiling nationally-based information into a common information system is difficult. Therefore the Agency is taking the following approach:
    - Agency staff have concluded that radioactive waste encompasses such a broad area, that it is very difficult to develop a single data source approach,
    - The Agency has developed the NEWMDB to compile **some** of this diverse information from Member States and to translate waste inventory information according to a common waste classification scheme, and
    - Existing information is found in multiple sources both at the Agency and in Member States. Some of these sources of information, and others to be

[1] This NEWMDB Overview report is an update of a report included in the Radioactive Waste Management Profiles No. 4 (2002)

developed, are needed to complement the NEWMDB to report a more complete radioactive waste inventory.

3. The initial implementation of the NEWMDB did not lead to compilation of a comprehensive inventory due to two distinct reasons: (1) limited participation by Member States, and (2) the scope of the NEWMDB's data collection.

   Limited Participation:

   Collecting radioactive waste management data and submitting it to the NEWMDB as requested by the Agency is done on a goodwill basis. A total of 51 out of about 130 Member States nominated Country Coordinators for the NEWMDB's first data collection cycle [2] (about 40% of Agency Member States). Of the 51 Member States with Country Coordinators, 20 made full submissions and 2 made partial submissions (about 15% of Agency Member States).

   During the second data collection cycle [3] ,the number of Country Co-ordinators had increased to 60. However, only 14 new submissions and 3 revisions to submissions from the first data collection cycle were made. In addition, part of the submission from Belarus that was not previously publicly available (Ekores data) was published.

   There was a variety of reasons for the limited participation of Member States with Country Coordinators that included, among others, a lack of technical knowledge, poor Internet access, the priority assigned by the Member State, and other issues preventing submittal. Full and effective cooperation by Member States is required during future data collection cycles to support the compilation of a consolidate inventory.

   Scope of Data Collection

   The intended scope of the NEWMDB was to have Agency Member States report radioactive waste stored or disposed in waste management facilities according to their own national waste classification scheme(s). In recognition of the differences in understanding of definitions for radioactive waste management terms in Member States (e.g., storage, "interim" storage, etc), the following guidance was provided:

   - Waste in the midst of processing or in "interim" storage (as defined in the NEWMDB's glossary) was not to be reported, e.g., typically 1 year or less, because of the added burden on waste reporting this could cause. This waste is likely to represent a small fraction of a country's radioactive waste inventory. The exception was HLW in "interim" storage at reprocessing facilities.
   - Spent nuclear fuel was not to be reported because some Member States do not consider spent nuclear fuel as waste and some Member States do not want to report spent nuclear fuel inventories publicly no matter what its status. However, most, if not all, countries are willing to have their spent fuel inventories reported when consolidated with other fuel in publicly available summary reports.

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2 The first NEWMDB data collection cycle was conducted July 6, 2001 to March 15, 2002.

3 The second NEWMDB data collection cycle was conducted July 1, 2002 to February 14, 2003.

- *In situ* waste was not to be reported, e.g., bulk-contaminated facilities/equipment and abandoned/contaminated sites because of differences in classification (in some countries it is not waste) and difficulties in estimating quantities.
- Exempt/clearance waste was not to be reported because it no longer meets the definition of radioactive waste. In addition, inventories of waste being held in delay/decay storage until they become clearance waste was not to be reported.
- Technology-Enhanced Naturally Occurring Radioactive Material (TE-NORM) was not to be reported because there is no international consensus on whether this material is radioactive waste. This also includes Naturally Occurring Radioactive Material (NORM).
- Uranium mine and mill tailings (UMMT) were not to be reported because the large volume of these low concentration wastes could mask the other radioactive waste and due to difficulties in estimating quantities of UMMT wastes.
- Intentional discharges, e.g., water or air emissions, to the environment were not to be reported because they do not meet the definition of waste in a waste management facility.
- Special fissionable materials, e.g., plutonium, were not to be reported because they may be considered a resource and not waste.

4. Exceptions and variations to the scope of the NEWMDB occurred based on differences in interpretation of NEWMDB guidance for submissions. These differences, noted below, impact upon the compilation of the inventory and need to be addressed in future data collection cycles:
   - At least one Member State did not report the inventory for some of the waste classes defined in its waste matrix, even though the information was available. For example, France has a waste class with very low concentrations (1-100 Bq/g) of radionuclides. France did not want to assimilate this waste into the Agency's LILW-SL category, so the inventory of this waste class was excluded from the data submission (the inventory was, however, included as a comment in NEWMDB submission). The waste results from D&D type activities and will be disposed in a dedicated, "VLLW" disposal facility.
   - Because of the waste classification matrix, at least one Member State did not know how to interpret how a particular waste fit into the Agency waste classification scheme, so it did not report the waste. This highlights the problem with the classification of waste - different countries have different interpretations of how to use the matrix and the Agency waste classification scheme is not complete and not rigorous. This issue needs to be addressed to resolve problems experienced by Member States.
   - France did not report HLW and LILW-LL resulting from reprocessing of foreign spent nuclear fuel in their NEWMDB submittal. The waste is stored in France's reprocessing facility awaiting return to the country of origin. NEWMDB guidance was to report all HLW at processing facilities, not just the domestic portion. This approach is different from the one used by the

EC in its waste inventory survey. The issue needs to be resolved (for both HLW and LILW-LL).

- The NEWMDB requirement was to report spent/disused sealed radioactive sources (SRS) in dedicated SRS management facilities, as dedicated is defined in the NEWMDB's glossary. For the initial submittal, there were different interpretations of the reporting requirements. Ireland interpreted the guidance that a factory or hospital could be the site and a storage area within the site as a facility, and therefore SRS stored there would be reported to the NEWMDB. The USA reported disused sealed sources collected and stored in a government facility pending disposal, and not at factories or hospitals throughout the country. France did not provide information on disused sealed sources pending verification of their inventory and categorization according to the Agency's new categorization scheme. There are differences in understanding and interpretation of guidance by some Member States on how to report SRS in the NEWMDB which needs to be addressed in the future. The NEWMDB Programme Officer reported that this area was the most problematic area and required significant attention.
- For disposal facilities, the NEWMDB contains the following two options for selection:
  Sea dumping (sea bed disposal)
  Sea dumping (deep sea disposal)

  Even though sea disposal is not practiced, Member States were to report waste that had been disposed (however, this guidance was not provided in the NEWMDB on line Help). No submission included information on inventories from sea dumping, which is understandable.
- Countries may not report waste volumes consistently (some countries use actual package volumes, some may use the volume of the waste excluding container or overpack, some may report displacement volume in storage/disposal, etc). This issue should be raised in the inventory report and dealt with over time to ensure consistency in reporting.

5. Based on the current scope of the NEWMDB, the following observations were made:
   - The Agency maintains databases for power and research reactor spent nuclear fuel and publishes summary reports. The Agency should consider adding a "waste flag" for spent nuclear fuel declared as waste. The fuel databases could then be used by the Agency to compile a consolidated inventory of spent nuclear fuel declared as waste to report summary statistics. A separate module added to the NEWMDB for compilation of spent nuclear fuel declared as waste by some Member States is not recommended. Internal experience at the Agency has found that collecting spent nuclear fuel data in a separate NEWMDB module is not likely to be successful.
   - The NEWMDB does not cover UMMT sites or *in situ* "wastes" at radioactively contaminated sites. The Agency has a project called the Directory of Radioactively Contaminated Sites (DRCS) for collecting various data on contaminated sites, with plans to use the same data structure

for UMMT sites. The DRCS is under development and will provide geographical and other information on contaminated sites throughout the world. The DRCS will not contain the type or level of information that would be needed to develop a radioactive waste inventory for contaminated sites or for UMMT sites, since it is extremely difficult to estimate these *in situ* inventories or residues at UMMT sites, whether or not these residues are considered to be wastes. As such, currently there is no consolidated source of information about wastes at UMMT sites or at radioactively contaminated sites.

- The NEWMDB does not cover discharges to the environment, since the scope of the NEWMDB is waste within waste management facilities (confine and contain option and not dilute and disperse option). The Agency has begun a discharge/release data collection initiative within its Safety Programme by asking Member States for country contacts. This programme is the recommended data collection point on discharges and release information. It has the potential to estimate the world wide inventory of radionuclides released into the environment, which would complement the information on confine and contain wastes.
- In the immediate future, the only information source that could supplement NEWMDB data in support of a the consolidated radioactive waste inventory would be spent nuclear fuel databases with a "waste flag".
- In addition to providing the Agency with consolidated information on radioactive waste inventories, there are benefits to Member States from participating in NEWMDB data collection cycles. Developing a national inventory of radioactive waste is a difficult task. This difficulty is not always fully appreciated within a Member State. The NEWMDB project provides an opportunity for Member States, who may or may not have national waste inventory reporting requirements, to share lessons learned, discuss common issues and definitions, and to understand the nuances in developing national inventories.
- While many Agency Member States do not report to international organizations other than the Agency, some Agency Member States, e.g. those that are in the EU or members of the OECD, have additional international radioactive waste reporting requirements. The information in the NEWMDB could be used to satisfy some of the national reporting requirements called for in section II.2(b) of the "Guidelines Regarding the Form and Structure of National Reports" for the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* (Joint Convention). NEWMDB reports could also satisfy other radioactive waste management information requests, e.g. the European Commission, which would avoid duplication of efforts. Country Coordinators for the NEWMDB could be encouraged to interact with those individuals in their own country who are preparing reports for the Joint Convention and other international organizations to inform them of the information and reports available in the NEWMDB.

6. Even with a low participation rate, the results of the first cycle indicated that:
    - The NEWMDB is a suitable tool for the compilation of a international radioactive waste inventory according to a unified waste classification scheme, within the limitations described above, and
    - Many Member States do not have waste classification schemes at all or they have schemes that are not quantitative and/or not disposal based. As a result, many Country Co-ordinators had difficulty specifying how their countries classified their wastes and/or in comparing their waste classification schemes with the Agency's proposed waste classification scheme. This is an issue that needs to be addressed if the Agency is to successfully prepare a consolidated inventory of radioactive waste in its Member States.

Another limitation for preparing a consolidate radioactive waste inventory report is that not all Member States can report waste inventories as of the same reporting date. Please refer to the following from the NEWMDB's on line help:

http://www-newmdb.iaea.org/showhelp.asp?Topic=2-1-4

Reporting Year and Inventory Reporting Date

Reporting Year

Once registered Users login, the NEWMDB's banner will display the following:

(1) indicates the name and the *role* of the User who logged in,

(2) indicates the name of the Member State (this information is linked to Users), and

(3) indicates the Reporting Year.

Reporting Year indicates the various reference years for IAEA requests for submissions to the NEWMDB. For example, the first *data collection cycle* in 2001 used Reporting Year = 2000. As such, Member States were asked to report information about their waste management programmes and activities, excluding waste inventories, as of the end of 2000. In the future, Member States can select a reporting year from a list and can press the Go button **(3)** to display the information that was submitted to the IAEA for the selected reporting year.

Inventory Reporting Date

One of the IAEA goals is to prepare a comprehensive inventory of the radioactive waste in its Member States. To achieve this goal, all Member States would have to report their radioactive waste inventories as of the same reporting date. Currently this is not achievable since not all Member States are currently able to report their radioactive wastes as of the same reporting date. In fact, within some Member States, some groups report inventories as of different reporting dates. As such the NEWMDB allows Member States to define the reference date for reporting their inventories. This can even be done at the Reporting Group level. Please click on the Groups link in the Contents list to the left for additional information about the Inventory Reporting Date.

As such, for initial NEWMDB data collection cycles, the consolidated inventory will not be based on all Member States reporting inventories as of the same date.

In addition, the second data collection cycle was actually an extension of the first cycle, due to low participation in the first cycle. Therefore, the second cycle used the same "latest" reporting date for waste inventories, December 2000. This "latest" date caused a problem for some Member States in the second data collection cycle, such as Japan, since their inventory data were more recent than December 2000. Based on interactions with the NEWMDB Programme Officer, some countries were allowed to report inventories later than the December 2000 date. This anomaly was allowed since, currently, not all countries can report inventories to the same date anyway. This issue will be addressed in future data collection cycles (one option is to allow Member States to specify an inventory date without a "latest" date restriction).

The Agency issued a Note Verbale to its Member State Missions on February 14, 2002 announcing the poor response to the first data collection cycle and requesting that more Member States appoint Country Co-ordinators and complete submissions during the second data collection cycle.

The following presents the *second* consolidated radioactive waste inventory for Agency Member States. The inventory is based on the 36 submissions compiled from both the first and second data collection cycles (see footnotes 2 and 3 on page 2 for the dates of both cycles).

Lastly, the second consolidated inventory is presented subject to all the limitations and caveats discussed previously. As such, it should be interpreted solely as an indicator of what the Agency can prepare for dissemination if it obtains the full and effective co-operation of its Member States and when consistent, traceable radioactive waste information is submitted to the NEWMDB by Agency Member States.

The Second Consolidated Radioactive Waste Inventory

Methodology

1. Agency Member States define the waste classification schemes used in their countries and they compare these schemes with the Agency's proposed common classification scheme. This is accomplished using the NEWMDB's waste class matrix tool; see the example that follows:

Waste Class Matrix ▸ USNRC

Matrix Name	USNRC		
USNRC Class	LILW-SL%	LILW-LL%	HLW%
Class A LLW	100	0	0
Class B LLW	100	0	0
Class C LLW	75	25	0
Greater than Class C LLW	0	100	0
HLW	0	0	100
Description	NRC waste classes defined in Title 10, Code of Federal Regulations, Part 61, Subpart 55. Class C split based on analysis of actual data		

Attachment #134: White paper on USNRC waste classification crosswalk to IAEA classes
File: NRCwastematrix.wpd
File type: WordPerfect Document
Member State's Reference # 2

2. Member States report radioactive waste inventories according to their own waste classes, see the example that follows:

Waste Inventory

Class	Location	Proc.	Volume (m^3)	Distribution in %					
				RO	FF/FE	RP	NA	DF	DC/RE
Class A LLW	Disposal	No	753732	61	0	0	16	23	0
The additional characteristics of the waste: solid (dispersible); solid (non-dispersible)									
Class B LLW	Disposal	Yes	11271	61	0	0	16	23	0
The additional characteristics of the waste: solid (dispersible); solid (non-dispersible)									
Class C LLW	Disposal	Yes	4223	61	0	0	16	23	0
The additional characteristics of the waste: solid (dispersible); solid (non-dispersible)									

Proc.=Is the waste processed (Yes/No)?
RO=Reactor Operations, FF/FE=Fuel Fabrication/Fuel Enrichment, RP=Reprocessing, NA=Nuclear Applications,DF=Defence, DC/RE=Decommissioning/Remediation

3. The Agency transposes the inventories that were reported according to Member State waste classes into inventories reported according to the Agency's common waste classes. The following example is based on the two previous images.

   Class C LLW volume = 4223 m^3
   Class C LLW = 75% LILW-SL and 25% LILW-LL (according to matrix)
   therefore, Class C LLW is "equivalent" to 3167.25 m^3 LILW-SL and 1055.75 m^3 LILW-LL

The above is repeated for all radioactive waste inventories reported to the NEWMDB

NOTE: This conversion should be taken as a *first order approximation* due to ambiguities inherent in the Agency's common classification scheme.

NOTE: With the transposition process, **the Agency will not report individual inventories that have been transposed. Instead, all transposed inventories are "rolled up" into totals.** See Table I.

4. Member States report their inventories of spent/disused sealed radioactive sources (SRS) that are in dedicated SRS management facilities, where dedicated is defined as follows in the NEWMDB's on line glossary:

dedicated: *used in the NEWMDB to indicate a facility for managing sealed radioactive sources (SRS) within the following scope:*

(1) encompasses all SRS, not just disused or spent SRS
(2) the only wastes processed, stored or disposed by the facility are disused and/or spent SRS declared to be waste or the facility has a programme to track the location and characteristics of all SRS in the facility

The intent of the definition is to help ensure that Member States can report the inventory of SRS at waste management sites, which may be difficult or impossible to do for facilities at sites in which not all SRS are tracked individually. See the example that follows:

Spent Sources <=30 years

Nuclide	Number of Sources/Total Activity of Sources (GBq)			cond	uncond	Category	Total Activity for all Groups (GBq)	Decay Date (if all sources are decay corrected to the same date) yyyy.mm
	Group I less than or equal 4GBq	Group II more than 4GBq but less than or equal 4E+4GBq	Group III more than 4E+4GBq					
	num./activity	num./activity	num./activity					
Sr-90	10			No	Yes	3	4.4E+00	2000.12
	4.4E+00							
Cs-137	19	21		No	Yes	3	4.1E+02	2000.12
	4.1E+01	3.7E+02						
Cs-137	140			Yes	No	3	4.7E+02	2000.12
	4.7E+02							
Co-60		2		Yes	No	1	3.8E+03	2000.12
		3.8E+03						
Co-60	79	1		Yes	No	3	2.8E+04	2000.12
	2.2E+02	2.8E+04						
Co-60		5		No	Yes	1	1.1E+05	2000.12
		1.1E+05						
Co-60	2			No	Yes	3	1.1E-02	2000.12
	1.1E-02							
Cd-109	1			No	Yes	3	4.7E-04	2000.12
	4.7E-04							

Categorization: category 1 - higher risk; category 2 - medium risk; category 3 - lower risk.

Spent Sources >30 years

Nuclide	Number of Sources/Total Activity of Sources (GBq)		cond	uncond	Category	Total Activity for all Groups (GBq)	Decay Date (if all sources are decay corrected to the same date) yyyy.mm
	Group Group I less than or equal 2GBq	Group Group II more than 2GBq					
	num./activity	num./activity					
Ra-226	319		Yes	No	2	7.8E+01	2000.12
	7.8E+01						
Am-241	25		Yes	No	3	3.0E+01	2000.12
	3.0E+01						

Categorization: category 1 - higher risk; category 2 - medium risk; category 3 - lower risk.

5. The Agency reports the total of the SRS. See Table II. Please also refer to the "Guide to Reading Member State "Country Waste Profile" Reports", which is included as part of this fifth Radioactive Waste Management Profiles report.

Note: The information in the following tables is subject to all the limitations and caveats discussed previously. As such, it should be interpreted solely as an indicator of what the Agency can prepare for dissemination if it obtains the full and effective co-operation of its Member States and when consistent, traceable radioactive waste information is submitted to the NEWMDB by Agency Member States.

Table I: Second Consolidated Radioactive Waste Inventory (volume of waste in m^3)

	STORAGE		DISPOSAL	
CLASS	**unprocessed**	**processed**	**unprocessed**	**processed**
LILW_SL	1 867 276	185 743	10 094 010	1 329 458
(value in Profiles 4)	(331 428)	(99 526)	(9 609 586)	(1 207 704)
LILW_LL	203 213	54 942	16 052	8 592
(value in Profiles 4)	(186 631)	(46 942)	(11 123)	(8 317)
HLW	356 246	2 325	0	10
(value in Profiles 4)	(360 143)	(2 225)	(0)	(0)

Note: The Member States contributing to the radioactive waste inventory in Table I had, at the time this report was written, 71% of the operating nuclear power plants in the world. If only 6 more Member States (Canada, China, India, the Russian Federation, the Republic of Korea and the United Kingdom) were to make submissions, NEWMDB participants would have 95% of the operating reactors world wide. In this case, the consolidated inventory would represent most of the inventory of radioactive waste world wide (within the limitations cited in this report). See Table III.

The changes to volumes over those reported in "Radioactive Waste Management Profiles No. 4" are mostly due to revisions to the submissions from Spain and the Ukraine (these two Member States had partial submissions in the first data collection cycle) and to the 14 new submissions to the NEWMDB. A decrease in unprocessed HLW stored can be attributed to the revised submission from the Ukraine.

Table II: Second Consolidated SRS Inventory (numbers of sources)

HALF LIFE RANGE	# of category I SRS	# of category II SRS	# of category III SRS
< 30 years	29 176	25 396	1 963
> 30 years	126 953	4 007	

Note: Some Member States provided SRS information to the NEWMDB as part of their submission. However, this information was provided as a database "attachment" – it was not entered into the database via SRS data entry screens. Because of differences in format, the information was not processed for inclusion into Table II. See Table III.

Note: Some Member States did not input SRS information into the NEWMDB because they had not yet categorized their SRS according to the Agency's three categories [3] or they did not want to report their SRS according to the Agency's categories since, at the time, the Agency was revising the categorization scheme. Additionally, some Member States only entered partial SRS information since either it would have been a monumental task to provide complete information or it was impossible to provide complete information (not all sources are tracked within waste management facilities and it was unknown what fraction is tracked). As such, the information in Table II should be taken as incomplete and only partially indicative of the distribution of SRS.

Table III: List of Countries whose Information is Included in Tables I and II

Country	Number of Operating Nuclear Power Plants [4]	SRS Information Included (Yes/No)
Argentina	2	No (see note below)
Belarus	0	Yes
Belgium	7	No
Bulgaria	4	No
Chile	0	Yes
Costa Rica	0	Yes
Cuba	0	Yes
Czech Republic	6	Yes
Ecuador	0	No
Estonia	0	Yes
Finland	4	No
France	59	No
Germany	19	No
Greece	0	No
Hungary	4	Yes
Indonesia	0	Yes
Islamic Republic of Iran	0	Yes
Japan	54	No
Kuwait	0	Yes
Lithuania	2	No
Malaysia	0	No (see note below)
Mexico	2	Yes
Netherlands	1	No
Norway	0	No
Peru	0	Yes
Philippines	0	No (see note below)
Romania	1	No
Slovak Republic	6	No
Spain	9	No
Sweden	11	No
Switzerland	5	No
Thailand	0	No (see note below)
Tunisia	0	Yes
Turkey	0	Yes
Ukraine	13	Yes
United States of America	104	Yes

Note: Some Member States provided SRS information to the NEWMDB as part of their submission. However, this information was provided as a database "attachment" – it was not entered into the database via SRS data entry screens. Because of differences in format, the information was not processed for inclusion into Table II.

4 information taken from the Agency's Power Reactor Information System (PRIS)

References

[1] International Atomic Energy Agency, “Radioactive Waste Management Status and Trends - an overview of international status and trends in radioactive waste management”, report IAEA/WMDB/ST/1 CD ROM, September 2001.

[2] International Atomic Energy Agency, “Classification of Radioactive Wastes”, Safety Guide, Safety Series 111-G-1.1, IAEA, Vienna, 1994.

[3] International Atomic Energy Agency, “Categorization of Radiation Sources”, Technical Document, IAEA-TECDOC-1191, IAEA, Vienna, December 2000 (corrected March 2001).