# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOREWORD</td>
<td>iii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>v</td>
</tr>
<tr>
<td>WASTE MANAGEMENT TOPIC CODES</td>
<td>viii</td>
</tr>
<tr>
<td>ABSTRACTS</td>
<td>1-227</td>
</tr>
<tr>
<td>Belgium</td>
<td>1</td>
</tr>
<tr>
<td>Brazil</td>
<td>20</td>
</tr>
<tr>
<td>European Union</td>
<td>23</td>
</tr>
<tr>
<td>Finland</td>
<td>24</td>
</tr>
<tr>
<td>France</td>
<td>29</td>
</tr>
<tr>
<td>Germany</td>
<td>35</td>
</tr>
<tr>
<td>Hungary</td>
<td>70</td>
</tr>
<tr>
<td>Italy</td>
<td>77</td>
</tr>
<tr>
<td>Romania</td>
<td>80</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>81</td>
</tr>
<tr>
<td>United States of America</td>
<td>82</td>
</tr>
<tr>
<td>INDEX OF PRINCIPAL INVESTIGATORS</td>
<td>Authors I1 - I11</td>
</tr>
<tr>
<td>INDEX OF TITLES</td>
<td>Titles I1 - I7</td>
</tr>
<tr>
<td>INDEX OF DESCRIPTORS</td>
<td>Descriptors I1 - I49</td>
</tr>
<tr>
<td>INDEX OF TOPIC CODES</td>
<td>Topics I1 - I11</td>
</tr>
<tr>
<td>INDEX OF PERFORMING ORGANIZATIONS</td>
<td>Organizations I1 - I13</td>
</tr>
<tr>
<td>INDEX OF COUNTRIES</td>
<td>Country I1</td>
</tr>
</tbody>
</table>
FOREWORD

The research abstracts contained in Volume 25 of the Waste Management Research Abstracts (WMRA 25) were collected between January 1 and June 30, 2000. The abstracts reflect research in progress, or planned, in the field of radioactive waste management. For abstracts of completed research and other published information, the reader is advised to consult one of the many available commercial or non-commercial bibliographic information services, such as the IAEA’s International Nuclear Information System (INIS). Please refer to the following URL for INIS:

http://www.iaea.org/programmes/inis/index.html

Though the information contained in this publication covers a wide range of programmes in many countries, the WMRA should not be interpreted as providing a complete survey of ongoing research in IAEA Member States. Enquiries for further information concerning a particular research abstract should be addressed to the author(s) at his/her institute.

The total number of abstracts published in WMRA 25 is 297. This is comparable to the number of abstracts for each of volumes 23 and 24, which were combined into WMRA 23-24 for a total of 678 abstracts (339 per volume). The slight reduction in the number of abstracts per volume might be attributable to several factors:

• WMRA 22 was published in 1994 and WMRA 23-24 was published in 1999 - the long delay in publishing abstracts for research in progress may have raised concerns about the timeliness of the WMRA information.

• During the compilation of abstracts for WMRA 23-24, the Agency was in the midst of developing and implementing an Internet-based mechanism for abstract submissions and reporting. In addition, it implemented an “in-house” administrative system for abstract review, authorization and publication. WMRA 25 was the first WMRA volume that relied on the Internet-based submission process and the administrative system. As with any new computer application, technical problems were experienced, which may have affected the number of submissions.

• The time frame for collecting abstracts for WMRA 25 was much shorter than for previous volumes, which could also have accounted for the slight reduction in the number of abstracts received for WMRA 25.

While the number of submissions to WMRA 25 is lower than for past volumes, there has been a dramatic change in the accessibility and availability of the abstracts that were submitted. As indicated above, nearly six years transpired between the publication of WMRA 22 and WMRA 23-24. During that time frame, none of the abstracts submitted for WMRA 23-24 were accessible outside of the IAEA. With the implementation of the Internet-based submission for WMRA, and combined with the automated “in-house” administrative system, abstracts in WMRA 25 were accessible via the Internet at the URL listed below as soon as they are authorized for publication by the WMRA Programme Officer.

http://www.iaea.org/cgi-bin/irais.showwmt.pl?wmwmra.wmt
Depending upon Agency workload, some abstracts were authorized and became accessible on the Internet the same day that they are submitted to the IAEA.

Individual abstracts may be viewed via the cited URL. In addition, searches may be carried out to find and view abstracts according to various search criteria, such as by volume, by waste management topic code, by specific database fields (such as title, country, principal investigator), et cetera. As such, for volumes 25 and onward, it will not be necessary to wait until a collection of abstracts is published - abstracts may be viewed interactively via the Internet as soon as they are authorized.

Even though they are directly accessible via the Internet, collections of abstracts in WMRA 25 and future WMRA volumes are or will be published on CD ROM to assist persons that may have difficulty accessing abstracts via the Internet.

WMRA 25 is a collection of Adobe\textsuperscript{tm} Acrobat\textsuperscript{tm} PDF files. In addition to being published on CD ROM, WMRA 25 may be downloaded from the cited URL. After downloading during a brief on-line session, users can work with WMRA 25 off line.

Volume 23-24, also a collection of PDF files, may be ordered on CD ROM or downloaded from the cited URL.

The database that holds the abstracts for WMRA 23-24 and WMRA 25 also contains the abstracts for WMRA 22. It should noted that WMRA 22 data were converted and loaded from a different electronic format. Thus slight differences in content and print format may appear when compared to later WMRA volumes. Although already in printed form, WMRA 22 data were “back loaded” to enable full text search and query functions via the Internet at the cited URL. The collection of abstracts in WMRA 22 is available only in printed form, which may be ordered from the cited URL.

Volumes of Waste Management Research Abstracts are available free of charge, on request, to governmental and private organizations and to researchers. To order additional copies of volumes, please use the electronic request form on the cited URL or mail a request to:

Waste Management Research Abstracts  
Division of Nuclear Fuel Cycle and Waste Technology  
International Atomic Energy Agency  
PO Box 100  
A-1400 Vienna  
Austria

The collection of waste management research abstracts is made possible by the continued participation of researchers who are willing to invest the time and effort necessary to complete abstract forms or to submit information about their research via the Internet. The work of the Resident Missions to the IAEA in Vienna and the other governmental organizations in Member States who co-ordinated the submission of these abstracts is greatly appreciated.

This report was prepared by G.W. Csullog, Division of Nuclear Fuel Cycle and Waste Technology.
INTRODUCTION TO WMRA 25

It is with pleasure that the International Atomic Energy Agency presents the twenty-fifth issue of the Waste Management Research Abstracts (WMRA). This issue contains 297 abstracts that describe research in progress in the field of radioactive waste management. The abstracts present ongoing work in 10 countries and an international organization. Although the abstracts are indexed by country, many programmes are actually the result of co-operation among several countries. Indeed, a primary reason for providing this compilation of programmes, institutions and scientists engaged in research into radioactive waste management is to increase international co-operation and facilitate communications.

Data provided by researchers for publication in WMRA 25 were entered into a research in progress database named IRAIS (International Research Abstracts Information System). The IRAIS database is available via the Internet at the following URL:

http://www.iaea.org/programmes/irais/

This database will continue to be updated as new abstracts are submitted by researchers world-wide.

The format of WMRA 25 is similar to that used for WMRA 23-24. The abstracts are listed by country (full name) in alphabetical order. All abstracts are in English. The volume includes six indexes by: principal investigator, title, performing organization, descriptors (key words), topic codes and country. Figure 1 provides a description of the elements of an abstract.

Internet access to WMRA supports a variety of search functions and allows searching by words or phrases included in the texts of the abstracts. When performing searches, users should take note of the following conventions used in full texts:

- **isotope numbers**: $^{60}$Co, $^{235}$U etc. are represented by Co-60, U-235 etc.
- **chemical formulas**: UO$_2$, H$_2$O, Fe$_2$O$_3$ etc. are represented by UO2, H2O, Fe2O3, etc.
- **m**$^2$ is represented by m$^2$ but m$^3$ is written out in full as ‘cubic metres’
- **ms$^{-1}$** is represented by ‘m per s’ and **Bqm$^{-3}$** by ‘Bq per cubic metre’
- **exponentials** are written out, for example ‘10 to the power of 20’ is used in place of $10^{20}$

A list of waste management topic codes can be found starting on page viii.
# FIGURE 1  Elements of an Abstract

<p>| | |</p>
<table>
<thead>
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<tr>
<td>(1)</td>
<td><strong>CUBI99980901</strong></td>
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<td>(2)</td>
<td><strong>Title:</strong> Conditioning of Cuban spent sealed sources</td>
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<tr>
<td>(3)</td>
<td><strong>Topic Code(s):</strong></td>
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<td></td>
<td>124 - Waste Immobilization; 125 - Waste Packaging;</td>
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<tr>
<td></td>
<td>126 - Waste Storage</td>
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<td>(4)</td>
<td><strong>Title in Original Language:</strong> Acondicionamiento de las Fuentes Selladas Gastadas Almacenadas</td>
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<tr>
<td>(5)</td>
<td><strong>Abstract:</strong> Various types of sealed radiation sources are widely used in Cuba in industry, medicine and research. Once the radiation sources are considered spent, the Center for Radiation Protection and Hygiene (the organization responsible for radioactive waste management in Cuba) makes their centralized collection. All spent radiation sources are stored at present in the Cuban Storage Facility. There are more than 2700 spent sources. A strategic programme to define the procedures for conditioning of existing spent sealed sources began in 1996. The research was developed under the Cuban Nuclear Agency Project. Three prototypes of waste packages (conditioned drums) for different kinds of radiation sources were prepared in 1997. Prefabricated concrete cubes were used for larger spent sources. As most stored sources are industrial Cs sources, four of them were selected to construct a prototype for a conditioned waste package. A 200-litre drum was prepared with concrete filling. The Cs-137 industrial sources were successively placed into the drum (the limit of activity was previously defined). Cement mortar was then poured over the sources. The prepared package with identification number DA-97-01 contains four sources with a total activity of 310 GBq. The dose rate was 184 mSv per hour.</td>
</tr>
<tr>
<td>(6)</td>
<td><strong>WM Descriptor(s):</strong> caesium 137; industrial waste; radiation sources; waste management; waste storage</td>
</tr>
<tr>
<td>(7)</td>
<td><strong>Principal Investigator(s):</strong> BENITEZ, JUAN CARLOS</td>
</tr>
<tr>
<td>(8)</td>
<td><strong>Organization Performing the work:</strong> CENTER FOR RADIATION PROTECTION AND HYGIENE (CUBA)</td>
</tr>
<tr>
<td>(9)</td>
<td><strong>Other Investigators:</strong> Mercedes Salgado; Luis Iova; Alejandro Hernández; Nivaldo García; Oscar Martínez Sandallo Madrano</td>
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<td>(10)</td>
<td><strong>Organization Type:</strong> Other</td>
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<td>(11)</td>
<td><strong>Program Duration:</strong> From: 1996-1-1 To: 1998-12-1</td>
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<tr>
<td>(12)</td>
<td><strong>State of Advancement:</strong> Research in progress</td>
</tr>
<tr>
<td>(13)</td>
<td><strong>Preliminary report(s) available:</strong> Yes</td>
</tr>
<tr>
<td>(14)</td>
<td><strong>Sponsoring Organization(s):</strong> Ministry of Science, Technology</td>
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<tr>
<td>(15)</td>
<td><strong>Associated Organization(s):</strong> None</td>
</tr>
<tr>
<td>Reference Number</td>
<td>A unique identifier for each entry, in bold face, starting with the ISO code for the country followed by the year of update (four digits) and a four-digit number assigned in ascending numerical order.</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Title</td>
<td>English title of the abstract.</td>
</tr>
<tr>
<td>Topic Code(s)</td>
<td>Radioactive waste management subject category codes. A list of these codes can be found starting on page vii-ix.</td>
</tr>
<tr>
<td>Title in Original Language</td>
<td>(optional) For work originally prepared in a language other than English, the title in the original language may be included here. Please note that non-Roman characters are not supported.</td>
</tr>
<tr>
<td>Abstract</td>
<td>All abstracts are printed in English. For the representation of special characters such as chemical formulas, isotope numbers etc. see the information given in the Introduction.</td>
</tr>
<tr>
<td>WM Descriptor(s)</td>
<td>Descriptors or key words taken from the Radioactive waste management Thesaurus. The assigned descriptors are indexed in this volume and represent an additional search possibility.</td>
</tr>
<tr>
<td>Principal Investigator</td>
<td>The name of the primary researcher or author contributing to the document. Corporate/organization authors are also cited where applicable.</td>
</tr>
<tr>
<td>Organization Performing the work</td>
<td>Name and location of the primary author/investigator.</td>
</tr>
<tr>
<td>Other Investigator(s)</td>
<td>Name(s) of other researcher(s) or collaborator(s).</td>
</tr>
<tr>
<td>Organization Type</td>
<td>The type of organization where the research is being performed: an institution of higher education; a foundation or laboratory for research and/or development; private industry; or other.</td>
</tr>
<tr>
<td>Program Duration</td>
<td>The start and finish dates are given in the format YYYY-MM-DD.</td>
</tr>
<tr>
<td>State of Advancement</td>
<td>State of the research: research planned or in progress.</td>
</tr>
<tr>
<td>Preliminary report(s)</td>
<td>Yes or no.</td>
</tr>
<tr>
<td>Sponsoring Organization(s)</td>
<td>The organization providing the funding for the research.</td>
</tr>
<tr>
<td>Associated Organization(s)</td>
<td>Any other organization(s) also performing the research.</td>
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</table>
WASTE MANAGEMENT TOPIC CODES

10 - RADIOACTIVE WASTE
   100 - RADIOACTIVE WASTE - GENERAL
       101 - General policies
       102 - Programme Strategy, Planning and Management
       103 - Effluents and Discharges
       104 - Database & Information Systems, including Technology Transfer Systems.
           Technical Assistance and Costs
       105 - Waste Minimisation
       106 - Quality Assurance Aspects
       108 - Waste Management System Analysis
       109 - Waste Characterisation (Radionuclide Inventory Determination), including
           Computer Codes and Measuring Methods and Techniques

   110 - LOW AND INTERMEDIATE LEVEL WASTE FROM NFC FACILITIES
       111 - Gaseous Waste Treatment
       112 - Liquid Waste Treatment
       113 - Solid Waste Treatment
       114 - Waste Immobilization (Bituminization, Cementation, Including Tests of
           Properties, Leaching Studies)
       115 - Waste Packaging
       116 - Waste Storage
       117 - Waste Disposal
       118 - Waste Transportation (Methods, Containers, Transportation Means)

   120 - RADIOACTIVE WASTE FROM NON-NFC SOURCES
       121 - Gaseous Waste Treatment
       122 - Liquid Waste Treatment
       123 - Solid Waste Treatment
       124 - Waste Immobilization
       125 - Waste Packaging
       126 - Waste Storage
       127 - Waste Disposal

   130 - HIGH LEVEL WASTE
       131 - Gaseous Waste Treatment
       132 - Liquid Waste Treatment
       133 - Solid Waste Treatment
       134 - Waste Immobilization/Vitrification (including Heat Transfer, Leaching
           and Other Studies)
       135 - Waste Packaging (Canister Types, Materials, Corrosion Studies)
       136 - Waste Storage
       137 - Waste Disposal (including Spent Fuel)
       138 - Waste Transportation (Methods, Containers, etc.)
140 - SPENT FUEL
  141 - Spent Fuel Immobilization/Conditioning
  142 - Spent Fuel Packaging (Canisters, Materials, etc.)
  143 - Spent Fuel Storage
  144 - Spent Fuel Immobilization/Conditioning
  145 - Spent Fuel Packaging (Canisters, Materials, etc.)
  146 - Spent Fuel Storage
  148 - Spent Fuel Transportation (Methods, Casks, etc.)

150 - ALPHA BEARING/TRU WASTE
  151 - Gaseous Waste Treatment
  152 - Liquid Waste Treatment
  153 - Solid Waste Treatment
  154 - Waste Immobilization
  155 - Waste Packaging
  156 - Waste Storage
  157 - Waste Disposal
  158 - Waste Transportation (Methods, Containers, etc.)
  159 - Recovery of Radionuclides from the Waste

160 - HAZARDOUS/MIXED WASTE
  161 - Biodegradation/Biotreatment
  162 - Liquid Waste Treatment
  163 - Solid Waste Treatment
  164 - Waste Immobilization
  165 - Waste Packaging
  166 - Waste Storage
  167 - Waste Disposal
  168 - Waste Transportation (Methods, Containers, etc.)
  169 - Removal/Recycling of Organics
  171 - Technologies and Methodologies
  174 - Rehabilitation of Mill Tailings

180 - WASTE CHARACTERIZATION
  181 - Methodologies, Analytical Methods, Measurements Instrumentation
  182 - Waste from form characterization
  183 - Waste packages characterization
  184 - Mixed waste characterization
  185 - Radionuclide characterization in storage tanks
  186 - Radionuclide characterization in drums
  187 - Radionuclide characterization in-situ
  188 - Radionuclide scanning
  191 - ROHE in waste management facilities
  192 - ROHE in laboratories
  193 - ROHE in site characterization
  194 - ROHE in D&D
  195 - ROHE in drums characterization and retrieval
  196 - ROHE in characterization and retrieval of buried waste
  197 - ROHE in characterization and retrieval of liquid waste served in underground
20 - ENVIRONMENTAL IMPACT/ASSESSMENT STUDIES
   200 - ENVIRONMENTAL IMPACT/ASSESSMENT
      201 - Dispersion and Migration of Radionuclides
      202 - Dispersion and Migration Models
      203 - Gas Diffusion Studies
      204 - Impacts from Landfill Sites
   210 - BIOLOGICAL UPTAKE AND TRANSFER
      211 - Biological Uptake Mechanisms and Models
   220 - ENVIRONMENTAL TRANSFER
      221 - Environmental Transfer Models
      222 - Microbial Effects
      223 - Effects of Gaseous Releases
   230 - RADIOLOGICAL ASSESSMENT
      231 - Radiological Assessment Models
      232 - Environmental Risk Assessment
      233 - Long Term Environmental Impact
   240 - ENVIRONMENTAL MONITORING
      241 - Monitoring Programmes
      242 - Monitoring Techniques
30 - FACILITY AND/OR SITE SPECIFIC STUDIES
   300 - FACILITY/SITE - GENERAL
      301 - General Planning and Management
      302 - Site Survey and Characterization
      303 - Earth Science Models and Studies
      304 - Safety Assessment and Performance Studies
      305 - Design, Construction, Commissioning
      306 - Barrier Studies and Tests
   310 - STUDIES FOR NEAR SURFACE DISPOSAL FACILITIES
      312 - Site Survey and Characterization
      313 - Earth Science Studies and Models
      314 - Safety Assessment and Performance Studies
      315 - Design, Construction, Commissioning
      316 - Barrier Studies/Tests/Impacts
   320 - STUDIES FOR GEOLOGICAL REPOSITORIES
      321 - General Planning and Management
      322 - Site Survey and Characterization
      323 - Earth Science Studies and Models
      324 - Safety Assessment and Performance Studies
      325 - Design, Construction, Commissioning
      326 - Barrier Studies/Tests/Impacts including Near Field Effects
      327 - Waste Emplacement
      328 - Natural Analogue Studies
330 - STUDIES FOR LANDFILL SITES
   331 - General Planning, Regulatory Concern, Limits
   332 - Site Characterization, Disposal Technologies
   333 - Landfill site remedial actions

40 - DECONAMINATION AND DECOMMISIONING (D & D)
   400 - D&D - GENERAL
      401 - D&D Programme Strategy, Planning and Management
      402 - Nuclear Power Reactor Decommissioning
      403 - Research Reactor Decommissioning
      404 - Non-Reactor Facility Decommissioning

410 - DECONTAMINATION TECHNOLOGIES
   411 - Mechanical Decontamination Methods
   412 - Chemical Decontamination Methods
   413 - Electrochemical Decontamination Methods
   414 - Ultrasonic/Microwave Decontamination Methods
   415 - Decontamination by Melting
   416 - Other Methods and Techniques

420 - DECOMMISSIONING TECHNOLOGIES
   421 - Dismantling Techniques
   422 - Use of Explosives
   423 - Robotics, Remote Operations

430 - MANAGEMENT OF DECOMMISSIONING WASTE

50 - ENVIRONMENTAL RESTORATION
   501 - Project Planning and Management
   502 - Feasibility Studies
   503 - Environmental Risk Evaluation including models
   504 - Economic Studies
   505 - Criteria
   511 - Site Characterization
   512 - Unknown
   521 - Decontamination of Soils
   522 - Decontamination of Groundwaters
   523 - Waste Retrieval, Emplacement of Barriers
   524 - Management of Restoration Waste

60 - LEGAL, REGULATORY AND GOVERNMENTAL ISSUES
   601 - Criteria for Exempt Levels
   602 - Facility/Site Licensing Process
   601 - Waste Policy Acts
70 - PUBLIC INFORMATION/INTERACTION
   701 - Public Information Programmes, Public Participation
   702 - Information Centres
   703 - Education and Training
   704 - Socioeconomic Aspects

80 - ACTINIDE & TRANSMUTATION
   800 - Actinide & Transmutation Studies