



***INTERNATIONAL WORKSHOP ON
SUSTAINABLE MANAGEMENT OF DISUSED SEALED
RADIOACTIVE SOURCES***

RADIOACTIVE WASTE IN JORDAN

***LISBON, PORTUGAL
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JORDAN ATOMIC ENERGY COMMISSION***



JORDAN OVERVIEW



- **Total area: 89 213 sq. Km**
- **Sea Port : Aqaba**
- **Coastline: 26 Km**
- **Population: 5.723 million**
- **31% (15- 29) 38% (below 15)**
- **Climate: Mediterranean & Arid Desert**



INTRODUCTION 1 / 2

- ***At present Jordan has no nuclear power plant or operational research reactors.***
- ***Jordan does not produce any radioactive material.***
- ***The radioactive materials are widely used in the peaceful nuclear applications in Jordan in the field of medicine, industry, agriculture and training & teaching. And so the amount of radioactive waste in Jordan is relatively small.***



INTRODUCTION 2 / 2

- ***Only low and intermediate waste has to be treated, conditioned and stored in Jordan.***
- ***The radioactive waste activities are carried out at Jordan Atomic Energy Commission (JAEC).***



ORIGIN AND VOLUME OF RADIOACTIVE WASTE (RW)

- ***RW in Jordan is generated from:-***
 - a. medical, industrial , agriculture and research and education applications.***
 - b. Scrap metals , entering Jordan through the custom crossing borders.***
 - c. Natural Origin Radioactive Material (NORM), and Technically Enhanced Natural Origin Radioactive Material (TENORM)***

- ***The number of decommissioned radioactive instruments to be declared as waste is expected to increase significantly in the future.***



NO. OF RADIATION PRACTICES AND IONIZING RADIATION IN JORDAN

<i>Radiation Practices</i>	<i>No. of Institutions</i>	<i>No. of Radiation Sources</i>	<i>No. of Radiation Workers</i>	<i>Inspection Frequency</i>	<i>Percentage of each practice to the total volume</i>	<i>Inspectors required</i>	<i>Comments</i>
<i>Diagnostic Radiology</i>	300	1000	2200	1	70.75%	4	<i>Dental radiology is not included</i>
<i>Nuclear Medicine</i>	15	--	35	2	3.54%	1	-
<i>Radiotherapy</i>	4	15	60	2	0.94%	1	-
<i>Importing firms</i>	30	--	50	1	7.08%	1	-
<i>Industrial Applications</i>	75	800	600	1	17.69%	2	<i>NDT, Irradiators, Accelerators, SSD Lab.</i>
							<i>Another Researches and Industrial Applications.</i>
<i>Total</i>	424	1815	2945	--	100%	9	



INVENTORY OF RADIOACTIVE WASTES IN SEWAQA (DISPOSAL RADIOACTIVE WASTE SITE)

<i>Radionuclides</i>	<i>No. of Sources</i>	<i>Total Activity (mCi) / Year</i>	<i>Comments</i>	<i>Applications</i>
<i>Cs-137</i>	<i>33</i>	<i>3500(2007) 15 (Unknown)</i>	<i>Conditioned in 25 steel drums of 200 L</i>	<i>Industrial Nuclear Gauges</i>
<i>Co-60</i>	<i>43</i>	<i>3500 (2007)</i>	<i>Conditioned in three steel drums of 200 L</i>	<i>Industrial Nuclear Gauges</i>
<i>Sr-90</i>	<i>6</i>	<i>50 (2007)</i>	<i>Conditioned in one steel drum of 200 L</i>	<i>Industrial Nuclear Gauges</i>
<i>Cs-137 Tubes</i>	<i>30</i>	<i>560 (1999)</i>	<i>Conditioned in one steel drum of 200 L</i>	<i>Medical Brachytherapy</i>
<i>Cs-137 Needles</i>	<i>54</i>	<i>100 (1999)</i>		<i>Medical Brachytherapy</i>
<i>Am-241</i>	<i>5</i>	<i>225</i>	<i>Conditioned in two steel drums of 200 L</i>	<i>Industrial Nuclear Gauges</i>
<i>No. of radioactive sources = (171)</i>			<i>No. of drums = (32)</i>	



INVENTORY OF RADIOACTIVE WASTE AT THE TEMPORARY INTERIM STORAGE FACILITY IN JAEC.

<i>Radionuclides</i>	<i>No. of Sources</i>	<i>Total Activity (mCi) / Year</i>	<i>Comments</i>	<i>Applications</i>
<i>Cs-137</i>	<i>24 10</i>	<i>1800(2007) Unknown</i>	<i>23 Sources Conditioned in three steel drums of 200 L and the others are still waiting conditioning.</i>	<i>Industrial Nuclear Gauges</i>
<i>Co-60</i>	<i>37 4</i>	<i>3400 (2007) Unknown</i>	<i>20 Sources Conditioned in Two steel drums of 200 L and the others are still waiting conditioning.</i>	<i>Industrial Nuclear Gauges</i>
<i>EU-152</i>	<i>4</i>	<i>Unknown</i>	<i>Stored in shielded container.</i>	<i>Industrial Nuclear Gauges</i>
<i>AmBe-241</i>	<i>2</i>	<i>5</i>	<i>Stored in its original shielded container as Moisture nuclear gauges.</i>	<i>Industrial Nuclear Gauges</i>
<i>Ni-63</i>	<i>2</i>	<i>20 (1995)</i>	<i>Stored within the electron capture detector.</i>	<i>Industrial</i>
<i>Am-241</i>	<i>1</i>	<i>45(1990)</i>	<i>Stored within the alloy analyzer.</i>	<i>Industrial</i>
<i>Cd-109</i>	<i>3</i>	<i>50(1993)</i>	<i>Stored within the alloy analyzer.</i>	<i>Industrial</i>
<i>Fe-55</i>	<i>3</i>	<i>50(1990)</i>	<i>Stored within the alloy analyzer.</i>	<i>Industrial</i>
<i>Co-60</i>	<i>4</i>	<i>Unknown</i>	<i>Scrap Metals</i>	<i>Industrial Irradiators</i>
<i>Unknown RW</i>	<i>10</i>	<i>Unknown</i>	<i>Scrap Metals/Crossings Border</i>	<i>Industrial applications</i>

No. Of total sources = (104)



INVENTORY OF RADIOACTIVE WASTES STORED AT THE USER'S PREMISES, DECLARED AS RW AND REQUESTED JAEC FOR RW TREATMENT AND DISPOSAL.

Radionuclides	No. of Sources	Total Activity (mCi) /Year	Comments	Applications
Co-60	Unit	400 000 (at present)	Stored at the Hospital.	Medical Radiotherapy
I-125	3 m3	Tubes ,Bottles and Syringes	Stored at the University	Bovine Regency tests
Ra-226	Number of Solution	in mCi	Stored in plastic containers in shielded cabinet	Water Studies
Ra-226	Scintillation Vials	>200	Stored at the laboratory	Water analysis
Tritium	Scintillation Vials	>200	Stored at the laboratory	Water analysis
Uranium	Scintillation Vials	>200	Stored at the laboratory	Water analysis
Co-60	5	1.25	Stored at the Hospital	Brachytherapy
Cs-137	20	8 000	Stored at the user's premises	Density, Level Nuclear Gauges
Co-60	15	5000	Stored at the user's premises	Density, Level Nuclear Gauges
Technetium Generators	Many	٢.٧ each	Stored at the user's premises	Nuclear Medicine



LEGISLATION OF RWM 1/2

Jordan has now two Nuclear commissions:

- ***Jordan Nuclear Regulatory Commission (JNRC) acts as the Regulatory Authority to implement the Law No. (43), 2007, on Radiation Protection , Nuclear safety and Security (safeguards).***
- ***Under the Law No.(43) ,the JNRC is authorized to regulate, control and to provide Regulations and Guidance on rules and procedures on the safe use of nuclear energy and the safety and security of radiation sources, management and treatment of RW and spent fuel and transport of radioactive materials.***



LEGISLATIONS OF RWM 2/2

- ***Jordan Atomic Energy Commission (JAEC) to transfer the applications of the Nuclear energy and radiation technology to the country and to implement the Law No. (42), 2007.***
- ***Under the Law No.(42), JAEC shall undertake the duties to Process, fabricate and manage nuclear materials in all the stages of nuclear fuel cycle and to manage and dispose of radioactive waste.***



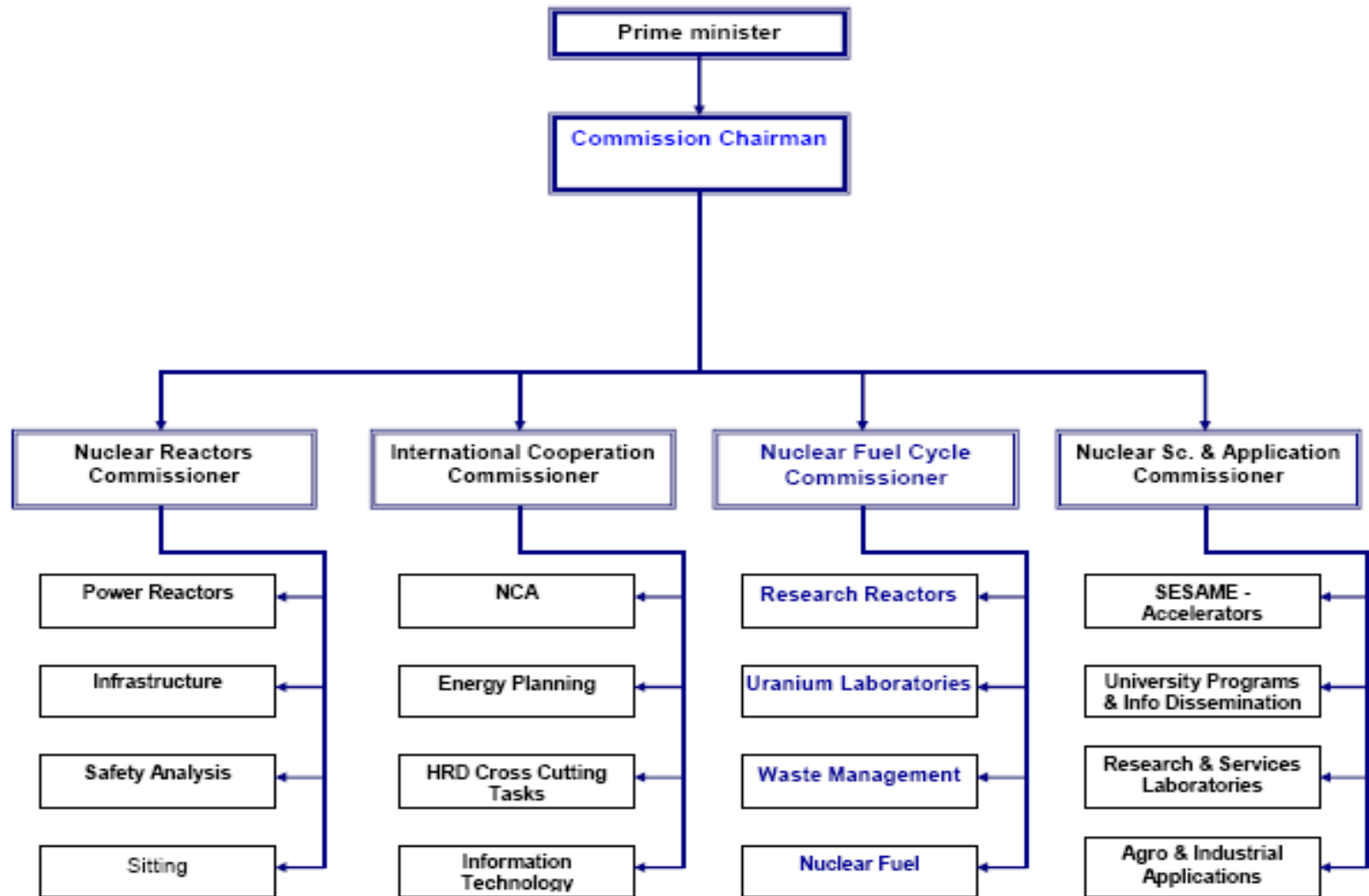
EXPORT/ IMPORT OF RW

Article No.(17) of the Law No.(43) states that :-

- a. Disposal of radioactive waste resulting from the use of radiation sources in different applications in the Kingdom or burial in its land unless with the consent of the board and under the supervision of the Commission in the sites licensed by the Commission and allocated for by the Ministry of Environment.***
- b. It is prohibited for any person to introduce any radioactive materials classified as radioactive waste to the territory of the Kingdom, or use, handle, transport, store, dispose or bury in the territory of the Kingdom, including the sites mentioned in paragraph (b) of this article.***

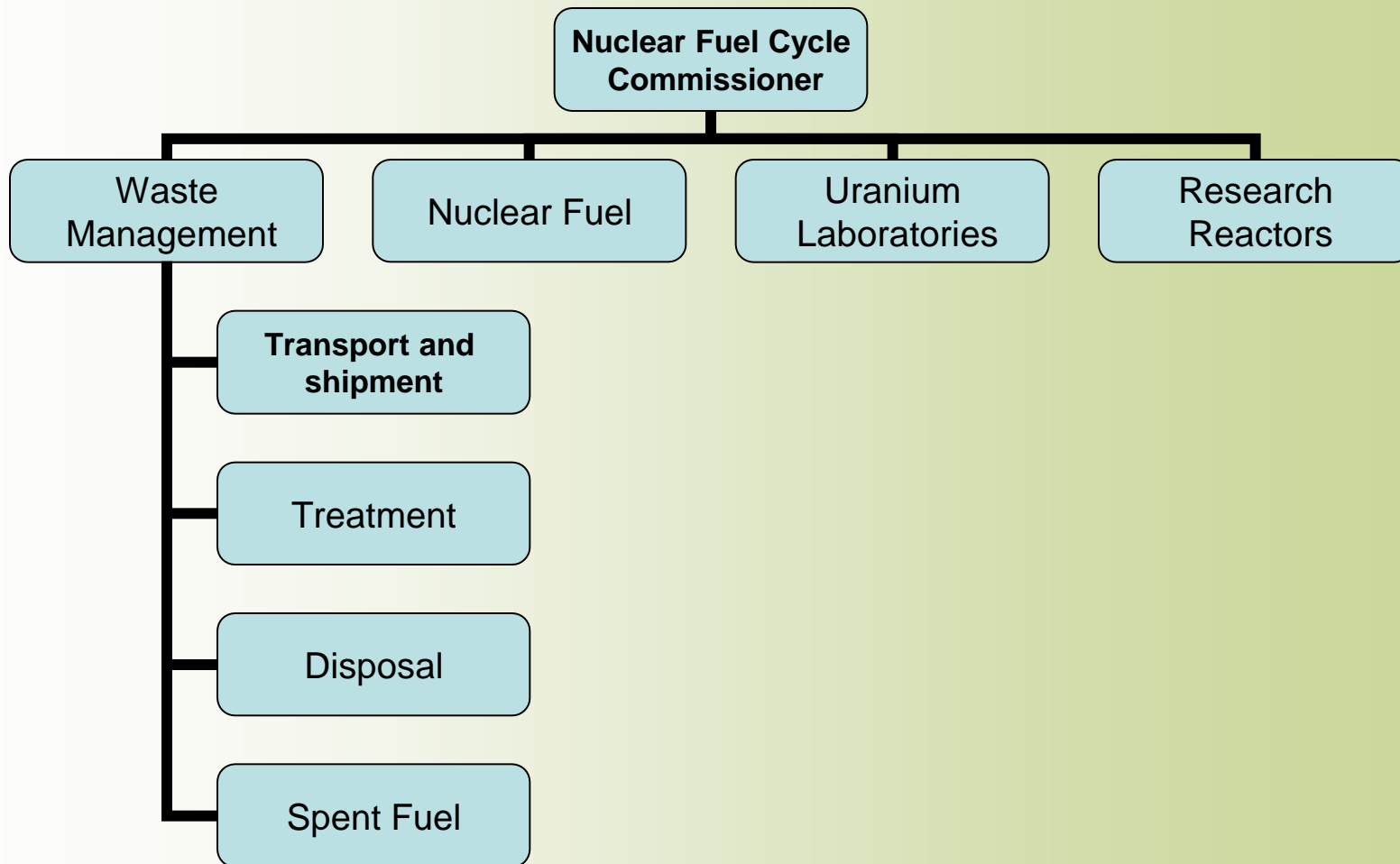


JAEAC ORGANIZATION CHART





NUCLEAR FUEL CYCLE COMMISSION STRUCTURAL CHART





NATIONAL POLICY / STRATEGY OF RWM

- ***The radioactive waste generated in Jordan is mostly low level waste (LLW) including short-lived and long-lived radionuclides.***
- ***The primary management of short- lived LLW is the responsibility of the generators . However, JAEC has been conducted the collection, storage as well as processing of spent radiation sources of LLW.***
- ***The user of Radioactive material remains responsible for his waste until it's collect by the JAEC or discharge with authorization. He is also responsible for the characterization, segregation and decay storage according to the safety and radiation protection conditions defined by regulatory body and wastes acceptance criteria defined by JAEC.***



HAZARDOUS RADIOACTIVE WASTE DISPOSAL SITE

- ***The most significant near-term risk faced by Jordan is an accident due to inconsistent controls currently applied to spent sources and decommissioned equipment at a multiple independent facilities.***
- ***Therefore, the JAEC with the help of the Ministry of Environment constructed and operated a permanent disposal site for a radioactive waste among the Hazardous Waste Disposal Site at the South of Jordan .***



THE NATIONAL CENTRALIZED RADIOACTIVE WASTE DISPOSAL SITE (NCRWDS)

- ***The conditioned /managed Disused sealed radioactive sources (DSRS) is stored within the National Hazardous Waste Disposal Site at Sewaqa at allocated site for RW .***
- ***Currently, no final radioactive waste disposal facility exists in Jordan and this site should be licensed by JNRC and allocated for by the Ministry of Environment.***



THE NATIONAL CENTRALIZED RADIOACTIVE WASTE DISPOSAL SITE (NCRWDS)

The National Centralized Radioactive Waste Disposal Site (NCRWDS) has an area of (4) Hectares and located at 150 Km South of the capital (Amman) and it is in operations since 1998. The NCRWDS has well- engineered underground pit of an area 3.6 mX3.6 m X3.6 m with 0.6 mm iron sheet cover of two layer and a basement of reinforced concrete (50 cm), water insulation layer of (0.4 cm), concrete (10 cm) and stone- block paving (15 cm) with three layers, and each layer can accommodate 25 steel drums of 200 L. Up to this moment, nearly 1.5 layer is full of conditioned RW. Another reinforced concrete pit of diameter 1.25m and depth of 3.5 m in the NCRWDS is constructed but not yet used.



THE NATIONAL CENTRALIZED RADIOACTIVE WASTE DISPOSAL SITE (NCRWDS)



The gateway to the Disposal Site At Sewaqa



The RW Disposal Site at Sewaqa



Partially Constructed processing building at Sewaqa



RW Disposal Hole at Sewaqa



NATIONAL PLAN FOR DSRS

- ***Conditioning- to produce waste package suitable for transport, long term storage and for final disposal.***
- ***Method used- Conditioning of waste in 200L steel drum by cementation.***
- ***Planning- consideration of source characterization , number of sources, size , volume, dimension, suitable personnel and resources.***
- ***Inventories of all DSRS are available but not yet categorized .***
- ***We will use IAEA RWMR for waste tracking system.***



NATIONAL CENTRALIZED INTERIM STORAGE AND TREATMENT FACILITY(NCISTF)

- ***Unconditioned radioactive waste is stored in the National Temporary Interim Storage Facility at JAEC.***
- ***A National Centralized Interim Storage and treatment Facility(NCISTF) has been established at JAEC in March 2010. It is planned to collect , store and manage all the LILW generated from hospitals, clinics, industry, agriculture , research and training applications in this NCISTF.***



NATIONAL CENTRALIZED RW STORAGE AND TREATMENT FACILITY

- ***JAEC has built a CSF with the best international standards for protecting our human health and the environment from the long term effects of radioactive waste and to prevent the accidents associated with the spent radiation sources.***

(Total cost of the Building > 400,000 JD).

- ***Implemented Security system (> 150,000 JD).***
- ***The construction and security system funded by GTRI/DOE/USA.***



NATIONAL CENTRALIZED RW STORAGE FACILITY

The national centralized RW storage facility consists of two separate buildings (adjacent to each other):-

- ***The main building (Dirty area) is designed to have several stores: receipt/dispatch store, operational store for sources to be conditioned, underground stainless steel drum wells store, decay store and stores for high, intermediate and low activity sources.***
- ***The second building (Clean area) houses support facilities (change room, shower (bathroom)/ and wash room, sanitary room, radiation equipment and health physics room, office room, documentation and security monitoring room.***



CONDITIONING OF SPENT SEALED SOURCES 1/2

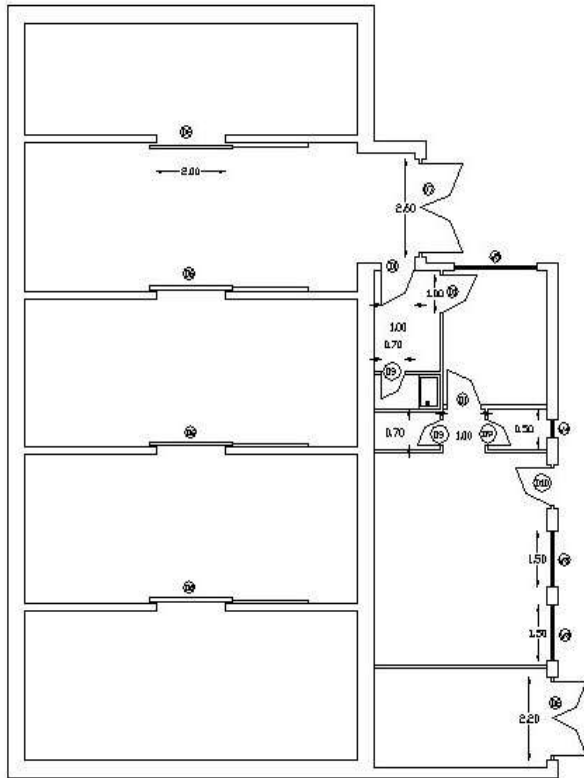
- ***Radioactive wastes which contain radioisotopes of long half-life or intermediate level activity will be solidified by cementation for final disposal.***
- ***This preferred option is to reduce the safety risks for accidents associated with the spent radiation sources by conditioning or immobilization of spent sealed sources in cement matrix. The product package (drum) is stable for long time under interim storage conditions. Using additional shielding inside the drum is always possible to reduce the surface dose rate. By proper conditioning a spent source in concrete, the source is transformed into a form which can not cause any large exposure even if the waste package is handled without special precautions.***



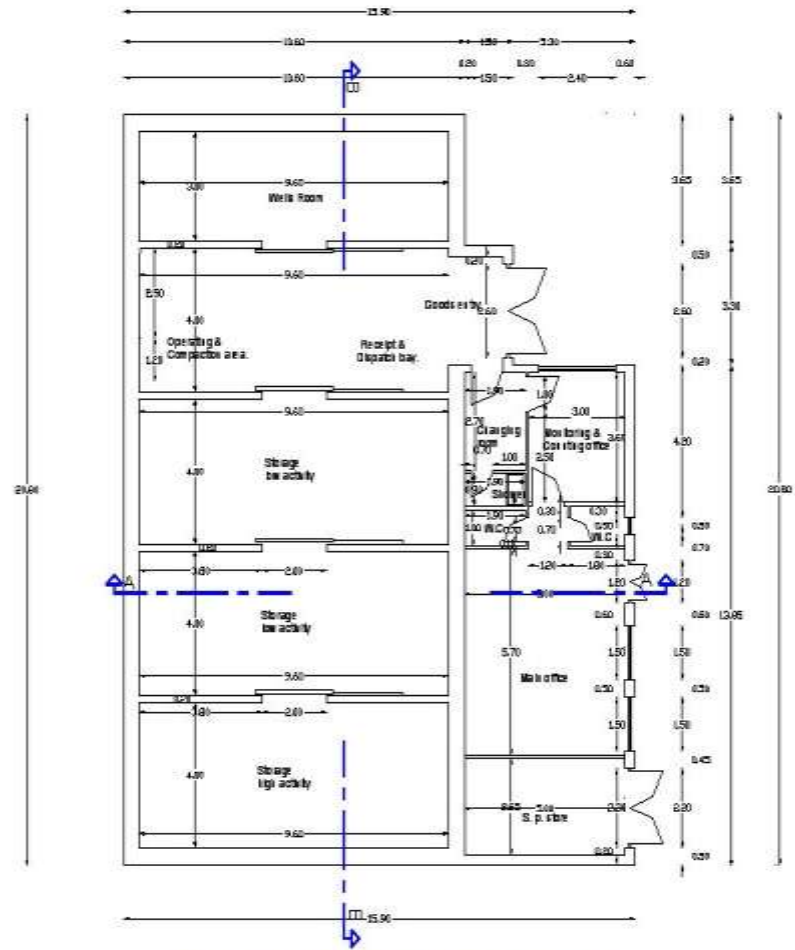
CONDITIONING OF SPENT SEALED SOURCES 2/2

- ***It is required that the drum should be fixed in its position after the waste has been immobilized for a few days for solidification and coherence of cement mixture and then the drum is allowed to be transported to the interim storage facility of the conditioned low level wastes.***
- ***Cementing is carried out by in drum 200 L (steel drums), the radioactive wastes are centered the steel drums and surrounded with mortar. The non burnable and compactable solid radioactive waste will be treated and conditioned in analogue method.***

CSF SCHEMATIC (PLAN)



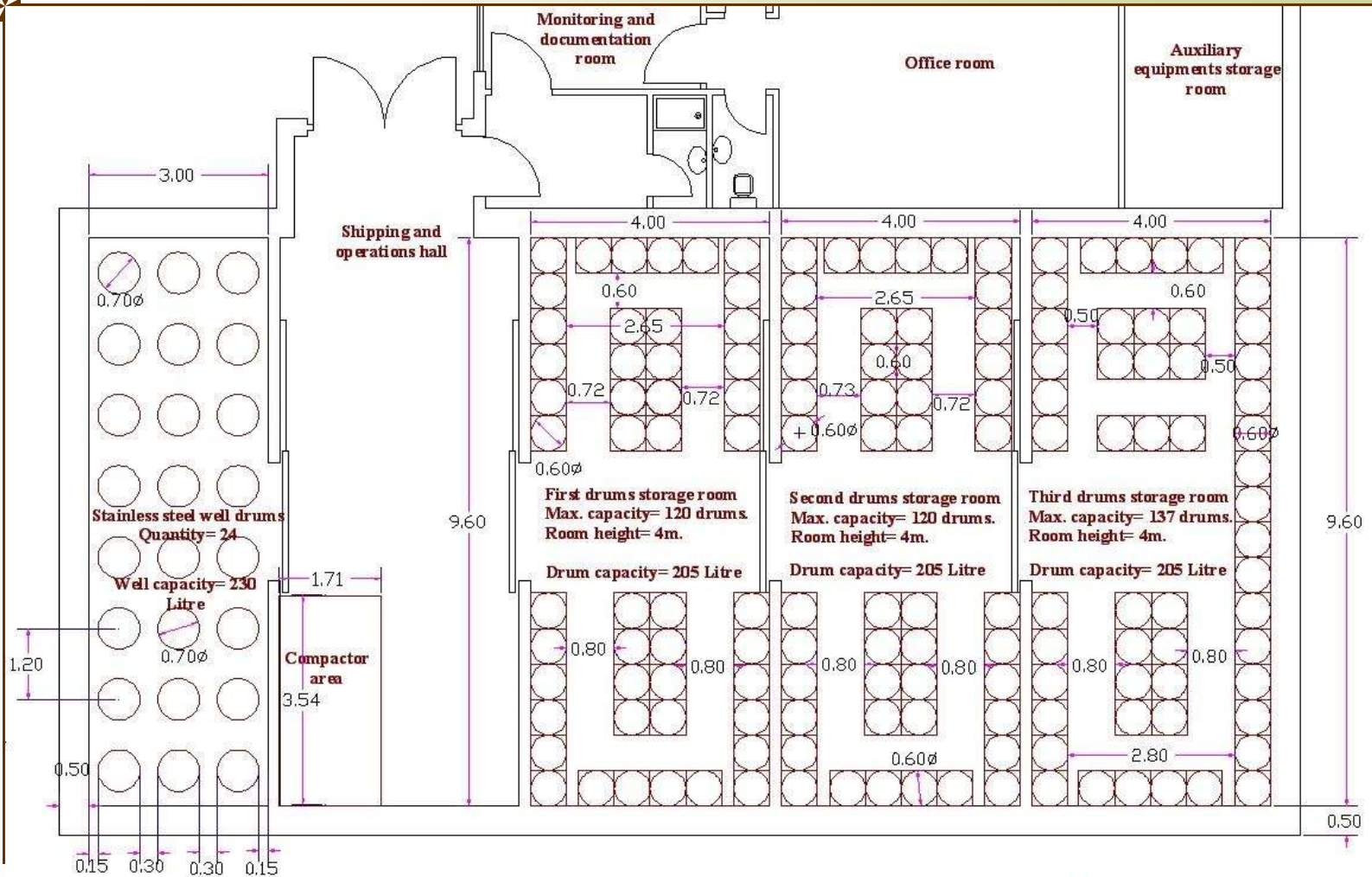
**CENTRALIZED WASTE PROCESSING
AND STORAGE FACILITY PLAN
SCALE 1-100**



**CENTRALIZED WASTE PROCESSING
AND STORAGE FACILITY PLAN
SCALE 1-100**



CSF SCHEMATIC



*Dimensions are in metre (m)



NATIONAL CENTRALIZED RW STORAGE FACILITY





LIQUID STORAGE TANK NEARBY THE CENTRAL STORAGE FACILITY





STAINLESS STEEL DRUMS IN THE WELL ROOM





PLANNED ARRANGEMENT OF THE CONDITIONED RW STEEL DRUMS IN THE CSF





INTRODUCING THE CSF TO PUBLIC POLICE AND TESTING THEIR RESPONSE IN CASE OF EMERGENCY





TRANSPORTATION OF MEDICAL RADIOACTIVE WASTE TO THE CSF





THANK YOU