

**WASTE CERTIFICATION, ACCEPTANCE AND DISPOSAL FOR LLW/ILW/MW/HW
MANAGEMENT OF RADIOACTIVE WASTE IN GERMANY:
QUALITY ASSURANCE OF WASTE PACKAGES WITH RESPECT TO IAEA
RECOMMENDATIONS**

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ABSTRACT

In Germany the management of low and intermediate level waste (LILW) is based on the preliminary waste acceptance requirements for disposal at the planned repository at former iron ore mine Konrad, recommendations of the Reactor Safety Commission and federal laws and regulations. These requirements also contain regulations for quality assurance and quality control programs. Two mainly used processes for assuring quality of radioactive waste products are shown. The IAEA has published regulations for quality assurance of radioactive waste packages as well as recommendations for inspection and verification of waste packages containing LILW. Based on examples of actual waste conditioning campaigns for LILW it is discussed how the international standards are adopted by the German regulations for quality assurance and quality control.

INTRODUCTION

Quality assurance in radioactive waste management is of significant importance. Handling, conditioning, interim storage and disposal of radioactive waste should be performed with the objective of achieving adequate safety and protection of human health and the environment. For attaining this goal quality assurance and quality control programs perform an important role in radioactive waste management. The management of low and intermediate level waste (LILW) is required within a network of national regulations providing a clear allocation of responsibilities. These national statutes are required to meet international laws, guidelines and recommendations.

International standards were published by the IAEA /1, 2/. According to these publications national regulations for quality assurance programs need to be established and implemented in the waste treatment process in accordance with the international requirements and recommendations for quality assurance and as demanded by the regulatory body for the predisposal management of LILW. A sufficient documentation for each generated waste package is of importance as well as a system for self-assessment and independent assessment (audits) for the treatment and conditioning procedure. Such assessments should be made to determine whether the treatment and conditioning processes of LILW meet the applicable requirements for disposal. Process audits should be conducted for verifying that waste management processes are being conducted within specified parameters. Self- assessment and audits should be focused on the treatment and conditioning process and on product relevant properties /1/.

In 1995 the bases for the application of quality assurance to the conditioning and packaging of radioactive wastes were formulated /2/. An overview of influences of regulations and quality assurance programs on waste management processes is given in Fig. 1. Rules for inspection and verification of waste packages for near surface disposal were developed by the IAEA for the management of LILW. Performance

criteria for the achievement of waste package quality are described as necessary for waste management process design /2/. Systems, processes and structures must be adequately controlled. This procedure includes the whole treatment and conditioning process as well as the waste containers for storage and disposal. Assessment in this process is the act of checking conditioning processes, inspections, documenting waste product properties on the basis of detailed description of waste treatment processes, e. g. by a process control quality plan. Process control quality plans should identify the procedures of treatment, packaging, handling and storage of waste, inspections and tests to be carried out, and associated responsibilities. Additionally the IAEA articulated requirements for the documentation of waste properties /3/.

WASTE ACCEPTANCE REQUIREMENTS AND CONTROL OF WASTE PACKAGES IN GERMANY

In most countries the operation of a radioactive waste repository is a task for the waste generators. In Germany the disposal is a public task and so the responsibilities for the quality assurance and control programs concerning waste management differ from those in other countries. Waste treatment and conditioning processes for disposal have to be approved by the federal authority, the federal office for radiation protection (BfS). Also state specific regulations for interim storage have to be taken into account. The licensing and regulatory oversight in Germany includes the acceptance requirements for storage and disposal including aspects of quality assurance – e. g. regulations for self- and independent assessment - as well as regulations for transport (Fig. 1).

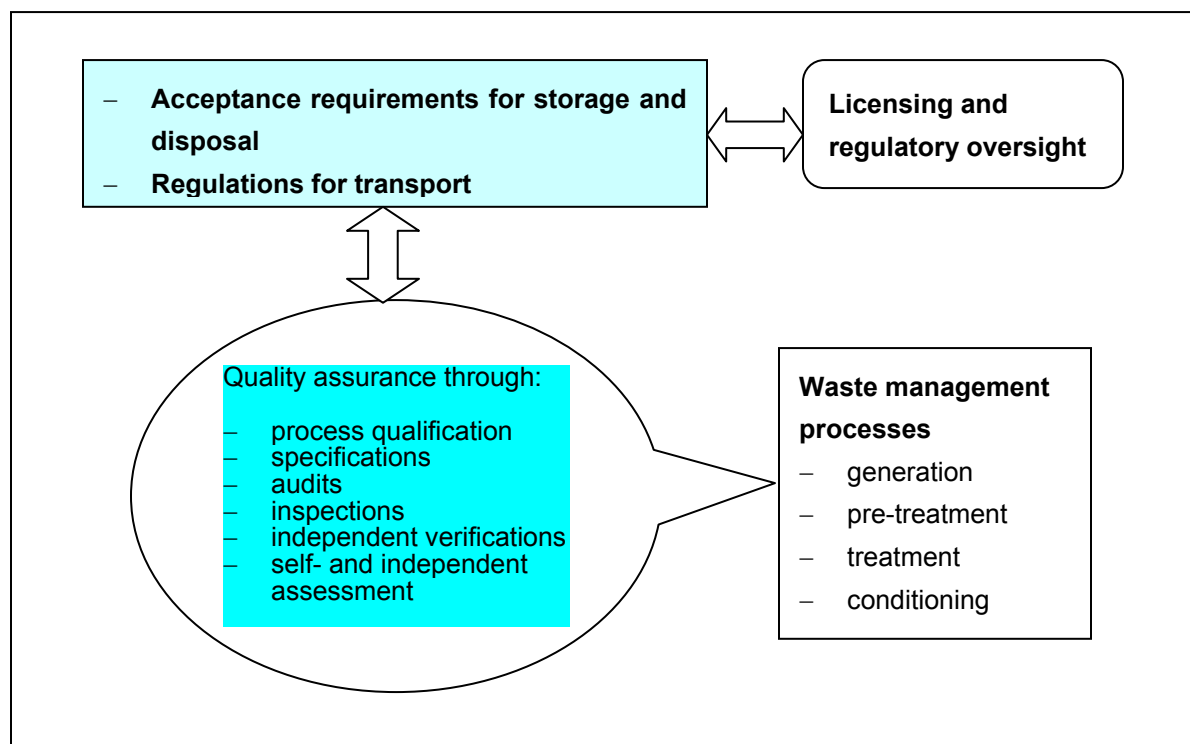


Fig. 1 Waste management processes and quality assurance /2/, licensing and regulatory oversight in Germany

The treatment of low and intermediate level waste is based on the waste acceptance requirements for disposal which were published by the BfS as the authority for disposal of radioactive waste /4, 5/. In the waste acceptance requirements for the planned disposal at the former iron ore mine Konrad, regulations

for conditioning of radioactive waste, quality assurance and quality control as well as the documentation of all relevant data for the waste packages are described. Acceptance requirements for interim storage facilities are based on the acceptance requirements for disposal, so waste must be treated in a way that the waste products and the waste packages can fulfil the requirements for disposal without major additional conditioning steps.

According to the German radiation protection ordinance any treatment and conditioning process leading to waste packages to be disposed of must be assessed by the BfS. The preliminary waste acceptance requirements for the Konrad mine describe two possibilities for the qualification of waste treatment processes.

The first possibility is the campaign specific qualification of the waste treatment using a process control quality plan. In this plan each conditioning and documentation step is listed as well as the necessary inspections by independent experts. The plan is assessed by the authority for disposal and only valid for a special category of raw waste and a limited amount of waste with specified origin. The procedure for a campaign specific qualification is as follows:

- Notification to the experts working on behalf of the BfS about a planned treatment and conditioning campaign by the waste owner or his service company. This notification must include a description of the amount and properties of the raw waste, a detailed description of the treatment and conditioning process and the casks. The conditioning and treatment process as well as the self-assessment and independent assessment steps are listed in the mentioned process control quality plan.
- The process control quality plan is assessed by technical experts on behalf of the BfS. The results are documented in an assessment report. With this, additional inspections might be required in the process quality control plan which is finally approved by the BfS.

After the process of conditioning the properties of the waste package and the results of the inspections are documented. Technical experts check the documentation and the BfS approves the compliance with the waste acceptance requirements for disposal. Fig. 2 shows an example of a campaign specific process control quality plan signed by the conditioner, assessed by expert and approved by the BfS and the state authorities.

Ablaufplan									
ALP-Nr.: 44R16.03		Datum: 28.03.2002		Kampagne: Konditionierung von metallischen Abfällen des KKW Rheinsberg mit nachfolgender Zwischenlagerung im ZLN				Blatt: 1	von: 10
Abfallart: Metalle			Herkunft: KKW Rheinsberg			Bundesendlager			
Kampagnen-Nr.: KKR02.01									
Arbeits-schritt	Prüf-schritt	Beschreibung der Arbeits- und Prüfschritte	Anweisung	Prüfer		Prüfung durchgeführt		Nachweis:	
				W ₁	W ₂	W ₁	T		
A1		Anmeldung einer Kampagne bei den zuständigen Aufsichtsbehörden/BfS		x				Kampagnenanmeldung	
A2		Informationen über den Rohabfall und die vorgesehenen Behälter (Behälterbestätigung, Behältertyp mit Innenbehälter) an den zuständigen Sachverständigen		x					
P1		Kampagnenabhängige Prüfung auf Anwendbarkeit des ALP auf den angemeldeten Rohabfall durch den beauftragten Sachverständigen des BfS und Übergabe der Stellungnahme an das BfS				x			
P2		Anlagenbezogene Beurteilung der Kampagne durch den beauftragten Sachverständigen des MLUR und Übergabe der Stellungnahme an das MLUR				x			
P3		Anlagenbezogene Beurteilung der Kampagne durch den beauftragten Sachverständigen der Aufsichtsbehörde des ZLN und Übergabe der Stellungnahme an das UM M-V				x			
A3		Freigabe des ALP durch das BfS und der Kampagne durch die Aufsichtsbehörden						Freigabe	
P4		Eingangskontrolle der Abfallbehälter/Verpackungen		x		x*			


Datum/Prüfvermerk		Datum: Ablaufplanfreigabe/Kampagnenfreigabe		W ₁ = KKR W ₂ = ZLN T = Gutachter bzw. beauftragter Sachverständiger * = Stichprobeweise	
W ₁ : 28. März 2002 <i>Brenner</i>	KKR 01	BIS: 12.07.2002 <i>Steger</i>	UM M-V: 11. Juli 2003 <i>B. Richter</i>	 Das Original ist an dieser Stelle rot gestempelt	
W ₂ :					
T: 15. April 2002 <i>F. Velt</i>					
T: 28.01.03 <i>B. Kramer</i>					

Fig. 2 Process control quality plan

After approval of the campaign specific process control quality plan the waste owner or the conditioner can begin with the treatment. During the treatment and conditioning process a sufficient documentation of all relevant process parameters has to be done. Additionally self-assessment and independent assessment by experts are carried out with respect to the process control quality plan.

Most waste products in Germany are produced under conditions of a campaign specific qualification using detailed process control quality plans. During the campaign, specific qualified conditioning assessment by independent experts is done for

- collection of raw waste
- conditioning with respect to the process control quality plan
- determination of waste product properties
- inspection of waste containers
- measurements determining radiological and chemical properties
- documentation of waste packages
- approval of waste packages for storage acceptance

In Table I an overview of the steps for quality assurance during conditioning campaigns which are approved within a campaign specific qualification is given in comparison to the IAEA-Standards.

Table I Quality assurance processes for waste packages, comparison between acceptance requirements for disposal at Konrad mine /4,5/ and IAEA- Standards /1-3/

Quality assurance program	Preliminary Konrad requirements		IAEA-Standards
	Campaign specific qualification	Treatment process qualification	
Management	Quality assurance program - requirements for raw waste - approved detailed description of conditioning process including radiological and chemical measurement steps and waste containers - documentation of waste packages	Quality assurance program - detailed requirements for all possible kinds of raw waste - approved detailed description of conditioning process including radiological and chemical measurement steps and waste containers - documentation of waste packages	Approach to all activities concerning quality assurance programs - pre-operational activities (raw waste characterization, container design, conditioning process) - operational activities (waste pre-treatment, treatment, conditioning, container manufacture, interim storage) - records and document control
Performance	Quality assurance during - work process - documentation for storage acceptance	Quality assurance during - design and description of conditioning process - work process - documentation for storage acceptance	Quality assurance is needed during each step of waste treatment procedures: - design control - procurement control - work process control - inspection and testing for acceptance
Assessment	Independent assessment is done during - collection of raw waste - conditioning with respect to the process control quality plan - determination of waste product properties - inspection of waste containers - measurements determining radiological and chemical properties - documentation of waste packages - approval of waste packages for storage acceptance Self-assessment during all steps effecting waste package properties	Assessment during the conditioning process of - raw waste - each step of conditioning affecting waste product properties - each measurement step determining waste product properties Assessment is done in form of - self-assessment according to requirements of the approved conditioning process manual - periodical independent assessment	Assessment should be done when specified requirements have to be met: - self-assessment - product verification - independent assessment <ul style="list-style-type: none"> o waste management process as a whole o specific activities within the process under control of a single organization o quality of waste products for interim storage and consignment for disposal - frequencies for audits <ul style="list-style-type: none"> o all aspects of QA should be audited within a period of less than three years o immediately after changes in treatment processes o whenever waste products do not meet the requirements o after corrective actions are taken, to verify the adequacy of their implementation

TREATMENT PROCESSES OF LOW LEVEL AND INTERMEDIATE LEVEL WASTE IN GERMANY

During the last ten years around 850 campaign specific qualifications of nearly 40 waste owners were worked out covering a wide variety of raw waste and waste products. The waste mainly originates from light-water reactors but also from research institutes, nuclear industry, decommissioning projects or state collecting depots. The stock of conditioned waste at the end of 1999 and the production in 1999 as reported by the waste producer /6/ is shown in Table II.

Table II Stock of conditioned waste and production in 1999 in m³ /6/

Waste producers	Stock on End of 1999	Production in 1999
Research institutes	30634	1198
Nuclear industry	2684	160
Light water reactors	11792	1199
Decommissioned reactors	4206	804
Federal state collecting depots	2165	124
Other waste producers	212	212
Reprocessing	11839	206
Total	63712	3903

Waste originating from light-water reactors mainly consists of mixed wastes (e. g. contaminated working material, preventive clothing, tools, foils, filter papers, cleaning or isolation material), ashes as a residue from burned mixed wastes, debris, filters, metals like fittings, tubes and wires, liquid wastes solidified by drying or cementation and contaminated soil.

One example of qualified waste specific conditioning campaigns is the super-compaction of mixed wastes originating from maintenance inspections. These are mixed wastes with a specific activity of β -/ γ -nuclides up to 1E06 Bq per gram. Fig. 3 shows raw waste, the process of super-compaction and the final product in a container for interim storage.

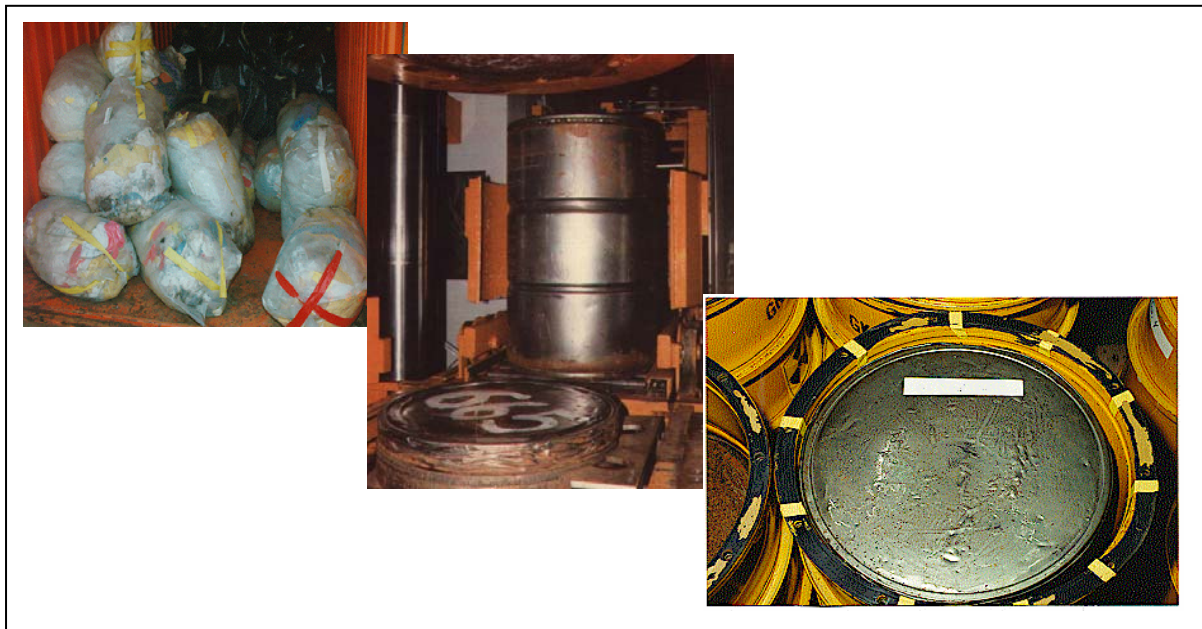


Fig. 3 Raw waste, super-compaction and waste product

In most cases these waste products do not have to fulfil more than the basic requirements to chemical and physical properties and therefore only a minimum of independent inspections is required. The amount of independent inspections is described in the assessment report and fixed with the approval by the BFS respectively the authority for interim storage. In the case of higher activities, waste products have to satisfy further requirements, e. g. restriction of burnable substances by complete metallic coating.

Examples for campaign specific qualification for conditioning of radioactive waste with respect to the information about the raw waste, the treatment process, the self-assessment, the independent assessment and the documentation are listed in Table III.

Table III Overview of two waste conditioning campaigns for mixed waste, both using a process quality control plan for quality assurance

Information	Campaign A	Campaign B
Raw waste	Mixed waste, not suitable for burning, e. g. isolation material, plastics like PVC, cotton, small impacts of metals, sometimes high amount of water	Like campaign A, additional filters, small amount of resins in filters or metals
Specific activity	1E02 Bq/g	1,5 E03 Bq/g
Treatment process	Super-compaction, thermal drying, characterisation by several measurements (e. g. γ -scanning, gas analysis of the inner atmosphere of the package)	Like campaign A, additional characterisation by several measurements (e. g. nuclide-specific analysis for special raw wastes)
Container for storage and disposal	Basic requirements for containers	In some cases further requirements, e. g. fixing of waste products by cementation
Self-assessment	Control of raw waste description, parameters of waste treatment process, properties of waste products (no own measurements), sampling procedures, measurement equipment of conditioning facility	Like campaign A
Independent assessment	Control of raw waste description, parameters of waste treatment process, properties of waste products (no own measurements), sampling procedures, measurement equipment of conditioning facility Amount of independent assessment: 3 percent of the raw waste and the following waste products, at least once per campaign/treatment period	Like campaign A, but higher amount of samples Amount of independent assessment: At least 3 percent of the raw waste and the following waste products, at least once per campaign/treatment period
Documentation	Documentation according to the storage and disposal requirements, assessment by independent experts on behalf of the authorities	Like campaign A

The examples show that based on the known amount of waste, the known raw waste properties and the description of the planned treatment process the process quality control plan with the assessment report and the approval by the authorities offers a flexible instrument in radioactive waste treatment. As the assessment and approval only covers a limited amount of waste the time period from the application of a campaign to the final approval is relatively short; 75 % of the campaigns in the last 3 years were approved within 3 month.

The second possibility for qualification of radioactive waste products is the assessment of the treatment process, e. g. super-compaction of mixed waste or drying of liquid waste. The assessment of a conditioning process is not limited to a special amount of waste or period of time; in general it ensures the conditioning of a wide variety of wastes without any restriction to the amount and origin of the raw waste. The assessment of such a treatment process is based on a detailed description of the process including the description of the planned quality assurance and control program with respect to the strategy and quality assurance methods used to verify compliance with repository waste acceptance criteria. This assessment and approval is based on:

- The detailed treatment process is fixed in a treatment process manual by the conditioner.
- The specific manual is checked by experts.
- Testing of the treatment and conditioning process.
- Approval of the treatment process specific manual by experts and by the BfS. With the approval of the treatment process the manual is binding for the conditioner.

In addition to the treatment manual the BfS establishes all necessary inspections by independent experts in an inspection manual. During the last years this kind of qualification was used just a few times, e. g. for the solidification of liquid waste in an on-site power-plant conditioning facility. The assessment and approval of this treatment specific process took approximately three years.

The aspects of quality assurance for the assessment of campaign specific qualification and treatment processes are summarized in Table I showing that IAEA-standards /1-3/ are fulfilled.

SUMMARY

In Germany the management of low and intermediate level waste (LILW) is based on the preliminary waste acceptance requirements for disposal at the planned repository at the former iron ore mine Konrad, recommendations of the Reactor Safety Commission and federal laws and regulations. These requirements also contain regulations for quality assurance and quality control programs. The IAEA has published regulations for quality assurance of radioactive waste packages as well as recommendations for inspection and verification of waste packages containing LILW. Mainly there are two ways for quality assurance processes in radioactive waste conditioning, a campaign specific qualification process and a treatment qualification process. The first mentioned is the one used most often because of its flexibility and because of the short required time for approval of such campaigns. The examples of conditioning campaigns show that German regulations are in accordance with the international recommendations.

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