Ordinance on Underground Waste Stowage and to Amend the Provisions pertaining to the List of Wastes [*])[**]

of 24 July 2002

On the grounds

- of § 7 para. 1 no. 1, § 7 para. 2 in conjunction with § 7 para. 1 no. 4 letter a, § 7 para. 3, § 57 in conjunction with § 59 first sentence of the Closed Substance Cycle and Waste Management Act of 27 September 1994 (*BGBl.* [Federal Law Gazette, *Bundesgesetzblatt*) I p. 2705) after having heard the parties concerned and taking into account t the rights of the *Bundestag*,
- of § 41 para. of § 7 para. 3 no. 1 of the Closed Substance Cycle and Waste Management Act of 27 September 1994 (*BGBl.* I p. 2705) after hearing the parties concerned,
- of § 10 para. 10 first sentence of the Federal Immission Control Act as last amended on 14 May 1990 (*BGBl.* I p. 880), as last amended by Article 2 no. 7 letter b of the Act of 27 July 2001 (*BGBl.* I p. 1950),

the Federal Government decrees as follows:

[*] The purpose of Article 2 of this Ordinance is to implement the Commission Decision 2000/532/EC of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (OJ EC L 226, p. 3), Commission Decision 2001/118/EC of 16 January 2001 and Commission Decision 2001/119/EC of 22 January 2001 (OJ EC L 47, pp. 1 and 32) amending Decision 2000/532/EC and Council Decision 2001/573/EC of 23 July 2001 (OJ L 203, p.18) amending Decision 2000/532/EC.

[**] The obligations arising under Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations (OJ EC L 204, p. 37)amended by Directive 98/48/EC of the European Parliament and of the Council of 20 July 1998 (OJ EC L 217, p. 18), have been complied with.

Article 1

Ordinance on Underground Waste Stowage
(Stowage Ordinance)

§ 1

Scope of application

(1) This ordinance shall apply to the disposal of wastes that are utilised as stowage materials in underground constructions subject to supervision by the mining authorities. This Ordinance does not apply to installations for the underground storage of radioactive wastes.

(2) This Ordinance shall apply to
1. Producers and owners of wastes,
2. Operators of underground constructions subject to supervision by the mining authorities and
3. Operators of facilities producing stowage materials.

§ 2

Definitions

For the purpose of this Ordinance
1. Stowage materials shall mean:
Material that is utilised underground for mining technical or mining safety purposes whereby wastes are utilised, taking advantage of their building physics properties. This also includes unmixed wastes and wastes for direct use.

2. Long-term safety documentation shall mean:
Site-specific safety documentation to prove the geological, geochemical, geotechnical, hydraulic and internal barriers which guarantee that the stowage materials will have no negative effects on the biosphere during operation and in the after-care phase.

3. Metal content shall mean:
Concentration of the metals listed in Appendix 1 in individual unmixed wastes. If metals are chemically bound, the proportion of the metal in the compound shall be considered.

§ 3

Priority of metal reclaiming

Wastes reaching the metal content value listed in Appendix 1 may neither be utilised to produce stowage materials nor for direct use as stowage materials if it is technically possible and economically viable to reclaim these metals from the wastes, and insofar as this is feasible while observing the permissibility requirements of such recycling.

§ 4

Physical Requirements for Wastes

(1) Wastes may only be utilised to produce stowage materials and/or for direct use as stowage materials if the limit values for solids and correlation values as listed in Appendix 2 Table 1 and Table 1a are not exceeded in the respective unmixed waste utilised, and the use of the stowage materials does not lead to harmful pollution of the groundwater or surface waters or any other negative impact on the quality of water bodies. In this context the limit values in eluates as listed in Appendix 2 Table 2 may not be exceeded in the stowage materials.

(2) Divergent to para. (1) it is permissible to exceed the limit values as listed in Appendix 2, insofar as

1. the respective contents do not exceed the contents of the absorbing rock (geogenous basic contents) or
2. only wastes from coal-fired or lignite-fired power stations, thermal power plants and heating stations are utilized for carbon and secondary rock, which

   a) are wastes from coal firing only or
   b) which do not contain higher noxious impurities than provided for under a) in the case of permissible co-incineration of other substances.

(3) Apart from the correlation values as listed in Appendix 2 Table 1a the limit values as listed in Appendix 2 shall not apply to the utilisation of stowage materials in constructions in salt rock if a long-term safety documentation was submitted to the competent authorities. In this context the Guidelines for long-term safety documentation as listed in Appendix 4 shall be observed.

(4) The competent authorities shall see to it that the limit values and correlation values as listed in the Appendices 1 and 2 shall be observed. In this context the provisions relating to sampling and methods of analyses as listed in Appendix 3 shall be observed. The competent authority may oblige the waste producers or owners to carry out the relevant sampling and analyses or have them carried out.

(5) Other requirements arising from legislation on mining or hazardous substances shall remain unaffected.

§ 5
Putting into circulation wastes

Wastes utilised to produce stowage materials and/or for direct use as stowage materials may only be put into circulation in order to convey them to facilities that produce stowage materials or to underground constructions that meet the requirements pursuant to §§ 3 and 4.

§ 6

Transitional provisions

If wastes are utilised to produce stowage materials and/or for direct use as stowage materials on the grounds of licences granted under mining law or disposal contracts entered into prior to 30 October 2002 which are legally valid, the requirements pursuant to §§ 3, 4 and 5 shall be observed on expiry of such licenses or when such contracts are terminated, no later, however, than 1 March 2006.

§ 7

Administrative offences

Pursuant to § 61 para. 1 no. 5 of the Closed Substance Cycle and Waste Management Act an administrative offence shall be deemed to have been committed by anyone who willfully or negligently

1. contravenes § 3 or § 4 para. 1 first sentence by using wastes to produce stowage materials or by using wastes as stowage materials or
2. contravenes § 5 by putting wastes into circulation.

Appendix 1
(to § 2 no. 3, § 3 and § 4 para. 4)

Limit value concentrations (g/kg) for metals in wastes

zinc	$\geq$ 100
lead	$\geq$ 100
copper	$\geq$ 10
tin	$\geq$ 15
chromium	$\geq$ 150
nickel	$\geq$ 25
iron	$\geq$ 500

The concentrations indicated refer to the solids content of the respective waste.

Appendix 2
(to § 4)

Table 1
Limit values for solids (pursuant to § 4 para. 1 first sentence)

Element/compound	Concentration (mg/kg dry matter)
mineral hydrogen carbons	1000
BTEX	5
highly volatile halogenated hydrocarbons	5
PAHs	20
PCB	1
arsenic (As)	150
lead (Pb)	1000
cadmium (Cd)	10
chromium, total (Cr)	600
copper (Cu)	600
nickel(Ni)	600
mercury (Hg)	10
zinc (Zn)	1500
cyanide, total (CN^-)	100

Table 1a
Correlation values for solids (pursuant to § 4 para. 3)

Element/compound	Concentration (mass-%)
Organic proportion of the dry residue of the original substance, determined as TOC loss on ignition	 ≤ 6 ≤ 12

Table 2
Limit values for eluates (pursuant to § 4 para. 1 second sentence)

Inorganic substances	**Concentration (in µg/l)**
arsenic (As)	10
lead (Pb)	25
cadmium (Cd)	5
chromium, total (Cr)	50
hexavalent chromium (Cr VI)	8
copper (Cu)	50
nickel(Ni)	50
mercury (Hg)	1
zinc (Zn)	500
cyanide, total (CN^-)	50
cyanide, readily releasable (CN^-)	10

Organic substances	**Concentration (in µg/l)**
PAHs total [1)] - naphthalene	0,2 2
highly volatile halogenated hydrocarbons, total [2)]	10
PCB, total [3)]	0,05
mineral oil hydrocarbons[4)]	200
BTEX [5)]	20

For salt loads (SO_4^{2-}, Cl^-, F^-) a conductivity of 500 µS/cm shall apply.
The pH shall range between 5.5 and 13. The water soluble fraction (residue from evaporation) shall not exceed 3 mass per cent (%).

1) PAHs, total: sum of the polynuclear aromatic hydrocarbons without naphtalene and methyl naphthalene, as a rule determination using the sum of 15 individual substances in accordance with the list of the US Environmental Protection Agency (EPA) without naphthalene; if appropriate other relevant PAHs (e.g. quinolines) will be considered.
2) Highly volatile halogenated hydrocarbons, total: i.e. sum of the halogenated C1 and C2 hydrocarbons.
3) PCB, total: sum of the polychlorinated biphenyls; as a rule determination by using the 6 congeneres according to Ballschmiter multiplied by the factor 5.
4) n-alkanes (C10 - C39), isoalkanes, cycloalkanes and aromatic hydrocarbons.
5) BTEX aromatic compounds, total: highly volatile aromatic hydrocarbons (benzene, toluene, xylenes, ethylbenzene, styrene, cumen).

Appendix 3
(to § 4 para. 4)

Sampling and methods of analysis

1 General principles

The following instructions stipulate how to conduct the sampling and the analyses to be used and how to assess the results from the analyses. In this context the following two levels are to be differentiated:

- Sampling of wastes to be disposed of at the location of waste production (e.g. industrial plant, recovery plant),

- Sampling in the context of monitoring the wastes transported to the location of disposal.

When carrying out the analyses, the relevant DIN Standards and the following requirements for sampling, sample preparation and analyses shall be observed.

It might not always be possible to produce final results as to the reactions of wastes on the basis of the standardized methods of analysis used, while the in-situ hydrochemical and hydrogeological conditions of the disposal location are being observed for longer periods of time. Therefore, in some cases, it might be necessary to carry out further analyses in order to assess the environmental impacts.

1.1 Sampling

Sampling shall be carried out in such a way that the waste to be assessed is representative. However, the different levels of analysis make it necessary to proceed differently when taking samples. This applies in particular to the number of samples and the sampling method selected.

A minimum quantity of 1 kg is required to prepare the samples. Subject to the structure of the material it might be necessary to use larger quantities.

1.1.1 Sampling devices

When the sampling method and the sampling device are selected, attention shall be paid to the fact that the sample to be taken may not be contaminated by materials of the device with substances to be analysed at a later point in time. Moreover, the material of which the sampling device is made up of, should be inert towards the substances contained in the material destined for analysis.

1.1.2 Sampling protocol

The sampling methods used and the sampling results shall be recorded in a proper way. For this purpose a sampling protocol shall be drawn up, containing at least the data required pursuant to Annex 1. In individual cases it may be necessary to complement these data.

1.2 Sample handling

1.2.1 Preservation, transport and storage

The storage of samples in situ, during transport and in the laboratory is part of the analysis and shall therefore be planned in detail, carried out precisely and recorded properly.

For transport and storage appropriate, tightly closing containers are required. Prior to usage they shall be carefully cleaned. Containers shall be used that are constructed in such a way to rule out that the sample might be affected by substances of the container material. In cases where only inorganic substances shall be analysed, containers made of plastic may be used.

When determining highly volatile components the individual samples shall be directly processed in situ according to the respective method of analysis.

The transformation of parameters that are sensitive to light shall be minimized by using opaque containers for storage. The sample shall be transferred to the provided containers immediately after sampling. During transport to the laboratory the samples shall be refrigerated and kept in darkness.

In the laboratory the samples shall be immediately prepared for analysis, because many components are subject to transformation processes. If it is not possible to immediately analyse the samples, a suitable way shall be selected for the processed sample to be stored, however, depending on the substances to be analysed.

1.2.2 Producing samples for analysis and sample preparation

Sample preparation shall include the mixing, drying, sifting and disintegration of the samples. Similar to sample storage, attention has to be paid to the fact that the chemical structure of such samples is not be modified by external effects.

Methods for sample preparation in relation to the structure (grain size) of the material to be analysed have been included in the LAGA Guideline PN 2/78. The following explanations also include specific requirements for the processing of samples.

As to wastes to be utilised as stowage materials it shall apply as a rule that the material is to be analysed in such grain distribution in which it will be disposed of.

1.2.3 Determining the total contents

Sample processing by dividing, breaking and milling in order to obtain 50 g of homogenous material from 5 to 50 kg.

1.2.3.1 Arsenic and metals

Pursuant to DIN 38414, Part 7 (publication date: January 1983) a part of the sample to be analysed (cf. 1.2.2) shall be dried and finely ground for (minimum 50 g of dry matter < 0.2 mm).

The acid-soluble fractions of arsenic and metals shall be determined in solution by extraction in aqua regia pursuant to DIN 38414, Part 7.

1.2.3.2 Organic components

In order to determine the organic components as a rule the original sample shall be used. Further handling of the samples is carried out pursuant to the provisions listed in the Annexes 2 and 3 for the individual substances and structures.

1.2.4 Determining the fraction to be eluted

The eluate shall be produced pursuant to DIN 38414, Part 4 (publication date October 1984) or to the *Trogverfahren* pursuant to LAGA Guideline EW 98 T (version December 2001), however, such production might differ as follows:

When examining the components for potential leaching, as a rule the material is to be eluted in such state, in which it shall be disposed of. In individual cases the material may only be disintegrated, insofar as it is required to perform the analyses. The water content and the grain size distribution of the sample to be used for leaching are to be determined by using a parallel sample after drying it at 105°C pursuant to DIN 38414, Part 2 (publication date November 1985).

Subject to the largest grain in the original sample to be analysed the sample quantity for elution shall be selected as follows:

Size of largest grain	(more than 5 %)	Sample quantity required
> 0 mm	< 2 mm	approx. 100 g
> 2 mm	≤ 11.2 mm	approx. 200 g
> 11.2 mm	≤ 22.4 mm	approx. 1,000 g
> 22.4 mm		approx. 2,500 g

The water/solid ratio shall be 10 : 1 in any case. It is permissible to produce an elution of several partial samples; the partial eluates are to be combined prior to further processing. For the elution the water/solid mixture is to be stirred for 24 hours. In this context it has to be ensured that the whole sample quantity will be constantly in motion and that grain refinement will be avoided if possible (a vibration frequency ranging from 10 to 100 vibrations per minutes is recommended).

It is not necessary to carry out further elution methods within the framework of the analyses such as the percolation method or the lysimeter tests.

To produce and further process eluates, as a rule the equipment used shall be made of glass. Demineralised water is to be used as elution liquid.

In individual cases it might by necessary to carry out an additional elution under acidic or basic conditions, subject to the hydrochemical conditions prevailing at the location of disposal. In any case an elution has to be carried out by using the pit water occurring at the location of disposal, since it depends on these circumstances how large the fraction of the solid will be that might be dissolved. The pit water may be replaced by a synthetically produced liquid whose chemical structure corresponds to the specific pit water.

The solid must be separated from the eluate immediately after the elution has been completed. In cases where organic and chemical parameters are to be determined, such separation shall be done by centrifuging and not by filtration.

If it is not possible to further process and analyse the eluate directly after the elution was produced, it is possible to store the eluate, provided that the preservation methods stipulated in the DIN methods for the determination of the individual components will be carried out.

1.3 Methods of analysis

The methods to be used are listed in the Annexes 2 and 3.

A n n e x 1

Sampling protocol for taking a solids sample						
Body taking the sample			Purpose of the sampling			
1. Sampling site: ____ (definition, no. on the map)						
2. Location: TK _______________ Right I__I__I__I__I__I__I Above I__I__I__I__I__I__I						
3. Date and time of sampling: ________________________________						
4. Type of sample (soil/sludge/acc. Part II): ________________________________						
5. Sampling device: ____						
6. Type of sampling		Indiv. sample Mixed sample				
6a. For mixed samples: number of individual samples ________________						
7. Sampling information:						
	name of sample/ and/ or number					
	sampling depth					
	colour					
	odour					
	sampling quantity					
	sampling container					
	sample preservation					
8. Remarks/additional information: ____ ____ p. t. o. to continue						
______________________ Place			______________________ Person taking the sample/Driver			

8. Remarks/accompanying information:

Annex 2
Methods of analysis – solids

Analysis parameter	Method	Standard	Publication date
pH	soil quality	DIN ISO 10390	May 1997
dry matter	soil quality determination of dry matter and water content on a mass basis- Gravimetric method	DIN ISO 11465	December 1996
cyanide, total	soil quality	E DIN ISO 11262	June 1995
arsenic	determination of arsenic by atomic absorption spectrometry (AAS) – hydride technique	DIN EN ISO 11969	November 1996
cadmium chromium copper nickel lead zinc	atomic absorption spectrometry (AAS) for all metals inductively coupled plasma atomic emission spectroscopy (ICP-AES) for all metals	DIN ISO 11047 DIN EN ISO 11885	June 1995 April 1998
mercury	water analysis AAS cold vapour technique	DIN EN 1483 DIN EN ISO 12338	August 1997 October 1998
mineral oil hydrocarbons	n-alkanes (in the range of C10 - C39), isoalkanes, cycloalkanes and aromatic hydrocarbons (gas chromatography)	DIN EN 14039	Draft December 2000
highly volatile halogenated hydrocarbons	sum of the halogenated C1 and C2 hydrocarbons gas chromatography with electron capture detector (GC-ECD)	DIN EN ISO 10301	August 1997
benzene and its derivatives (BTEX)	BTEX-highly volatile halogenated hydrocarbons (benzene, toluene, xylene, ethylbenzene, styrene, cumen)	DIN 38407, Part 9	May 1991
polynuclear aromatic hydrocarbons (PAC)	soil quality method using high-performance liquid chromatography (HPLC) HPLC or gas chromatography with mass spectrometer (GC-MS)	DIN ISO 13877 Code of practice no. 1, LUA-NRW *)	January 2000 1994
polychlorinated biphenyls (PCB)	German standard methods for the examination of water, waste water and sludge – Sludge and sediments (group S)	DIN 38414, Part 20	January 1996
TOC	determination of organic and total carbon after dry combustion (elementary analysis). This standard refers to soil and is therefore also applicable to mineral wastes.	DIN ISO 10694	August 1996
loss on ignition		DIN 38414, Part 3	November 1985

The ISO Standards, European Standards and DIN Standards referred to in this Annex are published by the Beuth-Verlag GmbH, Berlin and Cologne, and are filed in the archives of the German Patent and Trademark Office in Munich for safe custody.

*) North Rhine-Westphalia State Environment Agency

Annex 3
Methods of analysis– eluates

Analysis parameter	Method	Standard	Publication date
pH	German standard methods for the examination of water, waste water and sludge; physical and physico-chemical parameters (group C); determination of the pH-value (C5)	DIN 38404, Part 5	January 1984
electrical conductivity	German standard methods for the examination of water, waste water and sludge; water quality; determination of electrical conductivity	DIN EN 27888	November 1993
total solids residue	German standard methods for the examination of water, waste water and sludge; general measures of effects and substances (group H); determination of the total solids residue, the filtrate solids residue and the residue on ignition (H 1)	DIN 38409, Part 1	January 1987
cyanide, total cyanide, readily releasable	German standard methods for the examination of water, waste water and sludge; anions (group D); determination of cyanides (D 13) spectral photometry	DIN 38405, Part 13 E DIN ISO 11262 E DIN ISO 14403 DIN 38405, Part 13 DIN 38405, Part 14	February 1981 June 1995 May 1998 February 1981 December 1988
arsenic	water quality - determination of arsenic with atomic absorption spectrometric method (hydride technique)	DIN EN ISO 11969	November 1996
lead cadmium chromium, total hexavalent chromium (Cr VI) copper nickel zinc	German standard methods for the examination of water, waste water and sludge cations (group D) -determination by atomic absorption spectrometry (AAS) -determination by inductively coupled plasma atomic emission spectrography (ICP-AES)	DIN 34806, Part 6 DIN EN ISO 5961 DIN EN 1233 DIN EN ISO 10304-3 DIN 38406, Part 7 DIN 38406, Part 11 DIN 38406, Part 8 for all elements: DIN EN ISO 11047 DIN EN ISO 11885	July 1998 May 1995 August 1996 November 1997 September 1991 September 1991 October 1980 June 1995 April 1998
mercury	water quality AAS cold vapour technique	DIN EN 1483	August 1997
BTEX	GC-FID	DIN 38407, Part 9	May 1991
PCB, total	GC-ECD GC-ECD or (GC-MS)	DIN EN ISO 6468 DIN 51527, Part 1 DIN 38407, Part 3	February 1997 May 1987 July 1998
PAHs, total		DIN 38407, Part 8	October 1995
naphthalene	GC-FID or GC-MS	DIN 38407, Part 9	May 1991
mineral oil hydrocarbon	extraction by petroleum ether, GC-FID	ISO/TR 11046	June 1994

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Appendix 4
(to § 4 para. 3 second sentence)

Guidelines for long-term safety documentation in the context of site-specific safety assessment of mines in salt rock, were wastes are disposed of

1 General points

1.1 Objective

Long-term safety documentation is to show that the construction (if applicable), the operation and the after-care phase of a mine , where wastes shall be disposed of, will have no negative effects on the biosphere.

The Technical Instructions for Waste Disposal Part 1 of 12 March 1991 (Joint Ministerial Gazette [*Gemeinsames Ministerialblatt, GMBl.*], pp. 139, 469) define under no. 10 the complete and permanent sealing of the wastes from the biosphere as one of the protection target for underground landfills. This protection target also applies to the underground use of stowage materials.

1.2 Storage medium

So far, the complete encapsulation has only been regulated for the storage in underground landfills in salt rock according to the Technical Instructions for Waste Disposal Part 1. In accordance with these provisions, the saline host rock at the same time functions as the only barrier rock. Therefore, the long-term safety documentation in principle has to be provided for the saline rock as barrier rock. Additional geological barriers may provide extra safety, however, they are not mandatory.

Therefore, in the case of underground stowage of wastes in salt rock according to the principle of complete encapsulation, the relevant provisions of the Technical Instructions for Waste Disposal shall be equally applied to stowage activities and their functions, in particular those relating to the long-term safety documentation.

1.3 Permanently safe landfilling

When disposing of wastes in underground landfills according to the Technical Instructions for Waste Disposal Part 1, the declared aim is to completely and permanently seal these wastes from the biosphere. All other requirements on wastes, mining excavations, geotechnical barriers (constructive isolation elements) and all other technical devices and operational measures are geared to that objective. When the host rock is made up of salt rock in conjunction with functional overburden, it must meet the requirements of being impermeable to gas and liquids, of slowly enclosing wastes by virtue of its convergence behaviour and of firmly encapsulating the wastes at the end of the deformation process.

Consequently the convergence behaviour of salt rock does not contradict the requirement that the hollows have to be nonyielding during the operation phase of the underground landfill. The stability requirements are to ensure operational safety on the one hand, and on the other they are to maintain the integrity of geological barriers in order to keep up the protective function with respect to the biosphere. From that point of view a controlled lowering of the overburden is acceptable if it will only cause deformation without shearing and if it will not create any water routing. The possibility of uncontrolled events is to be assessed in relation to their effects on creating new water routings. If water routing can be ruled out in this context, the long-term safety will not be affected.

If wastes are disposed of as stowage materials in a salt mine on the principle of complete encapsulation, the same requirements have to be made and/ or complied with as for the underground storage according to the Technical Instructions for Waste Disposal.

1.4 Barrier rock range and thickness

According to the Technical Instructions for Waste Disposal Part 1 (no. 10.2) the salt rock barrier has to be of sufficient extension at the relevant site and of sufficient thickness in the chosen disposal area. There is no “rule of thumb” on the minimum range and thickness that would acknowledge the site-specific conditions. In principle, the existing thickness of the virgin salt rock has to be big enough as to not impair the barrier function in the long term.

In this context it might be helpful to observe safety pillars (such as warning devices for possible hydraulic routing) in accordance with mining law. If these are not observed, a site-specific justification is required to show that the barrier function is not impaired.

1.5 Damage to barrier rock by mining activities

When the necessary mine shafts are built, the barrier rock gets damaged. Therefore, when the mine is decommissioned, these shafts have to be sealed by means of state-of-the-art barrier constructions in such a way as to ensure that the protection targets are being met. The same applies to the sealing of shafts in mines where stowage material has been disposed of. Reliable documentation has to be recorded for any other intersections of the geological barrier caused by mining activities (exploratory holes, tunnels), and these have to be closed off and sealed. The mine plans pursuant to § 63 of the Federal Mining Act have to be drawn upon as basis for planning and documentation.

2 Long-term safety

2.1 Scope and requirements

When disposing of wastes requiring special supervision in underground landfills in accordance with Technical Instructions for Waste Disposal Part 1, and in the case of underground disposal according to the principle of complete encapsulation, long-term safety documentation is required for the complete system “waste/underground construction/rock mass”, taking into account planned and unplanned (hypothetical) event sequences, while at the same time acknowledging site-specific conditions.

The long-term safety documentation is a comprehensive and all-embracing individual case analysis in the framework of the site-related safety assessment required according to Technical Instructions for Waste Disposal and is essentially based on the results of the other two individual case analyses:
- geotechnical stability analysis
- safety documentation on the operational phase.

In order to assess the long-term effectiveness and integrity of the salt barrier the geotechnical stability analysis is of particular importance.

Once the geotechnical safety analysis proves that the enclosure is complete it is no longer necessary to make model calculations on event sequences that cannot be planned, provided that plausible information is given on whether events that cannot be planned have effects and if so how these will materialize. For this purpose it is usually sufficient to use verbal argumentation. However, this argumentation has to be verified with respect to the specific site. Once the geotechnical safety analysis gives proof of complete enclosure it is also no longer necessary in the long-term safety analysis to make model calculations on the propagation of pollutants in the overburden rock.

The long-term safety documentation for stowage material must include the time-related stabilising effect of the stowage.

2.2 Necessary baseline information

Detailed baseline information on the geological, geotechnical, hydrogeological and geochemical parameters of the site and on the concentration and the mobility behaviour of the pollutants to be disposed of are necessary in order to assess the long-term safety. The baseline information is to be determined on the grounds of the mine plans (§ 63 of the Federal Mining Act).
The necessary baseline information includes:

2.2.1 Geological conditions

- Geological barriers; vertical space between salt hanging zone and nearest top mine structures; horizontal space between hollows and salt rock sides and vertical space to the foot wall; thickness of the whole salt deposit or salt rock mass
- Degree of the development of the deposit
- Surface and underground development drillings
- Stratigraphy in the mining claim (including thickness, facies transitions)
- Substance resources of the salt deposit including the ratio between rock salt and potash salt, clays, anhydrites, carbonate rock
- Structure of the salt deposit/ inner support, structural development including movements of the salt deposit and its surrounding, convergence, strike and dip of the deposit, formation of flanks, transformations at the surface of the deposit, location and formation of the potential leachate reservoirs (e.g. main anhydrite)
- Degree of tectonic strain on the salt structure, prevalent fault direction
- Geological sections of the mining plant
- Geothermal metamorphic grade
- Past and present regional seismic activity
- Subrosion, development of surface dolines
- Halokinesis.

2.2.2 Information on the mining plant

- Cut (depth of the mining plant, excavation volume, roadway cross section, pits, blind pits, spiral shoots and slopes, horizontal expansion of the mining plant, location and depth of all pits within the mining plant, surface area and location of levels and sublevels, distance between levels and sublevels, levels connected to the surface shaft via a bottom landing, location and sites of the planned stowage or tipping grounds)

- Safety
  * Stability of shafts, tunnels, blind pits and extraction spaces
  * If applicable: top inclinations, sideswiping and footwall raises in the mining claim
  • If applicable: solution influxes (location, quantity per time unit, occurrence, temperature/density, saturated/unsaturated, pH value/chemical analysis, effects on mining operations or if applicable individual parts of the mine), cause and origin
  * If applicable: release of gas and risk from gas pockets (location, quantity, composition, cause)
  * If applicable: petroleum and natural gas reserves (in the inner parts or along the salt slope/flanks of salt deposits)
  * Safety pillar with respect to the overburden/ flanks / base / dissolution pockets/ drillings/ pits/ neighbouring mines
  * Existing exploratory drillings underground and from the surface (cf. 2.2.1)
  * Parts of the mining plant (to be) protected by barriers.

2.2.3 Hydrogeological conditions

- Stratigraphy, petrography, thickness and storage conditions of the layers in the overburden and the neighbouring rock

- Data on the structure of hanging aquifers and aquifuges, groundwater stories and groundwater motion

- Permeability and rate of flow

- Mineralisation of groundwater, chemical structure of the ground water, location of the salt water/ fresh water limit

- Use of groundwater, existing or planned drinking water or mineral spring conservation areas and priority areas

- Location, shape and characteristic of surface waters.

2.2.4 Depositing of waste

- Waste types, quantities and qualities

- Disposal concept and technology

- Geomechanical behaviour of wastes

- Reaction behaviour of wastes in case of ingress of water and saline solutions
  * Solubility behaviour
  * Gas generation underground with increased temperature
  * Mutual interactions or with a host rock.

Stock data are to be surveyed and documented as completely as possible (including expert opinions, if appropriate).

2.3 Developing a safety concept

Based on the above mentioned key information or expert opinions, a safety concept is to be developed to begin with. In this process and in the context of a site-specific safety assessment, a first opinion will be developed on whether proof of the complete encapsulation of the disposed wastes containing harmful substances appears feasible in the long term, taking into account the site-specific conditions.

At the same time the results will show whether it will be necessary to carry out additional or complementary reconnaissance work.

2.4 Geotechnical stability analysis

In order to ensure that wastes are permanently sealed from the biosphere the individual hollows must meet the following stability requirements:

a) No deformations are expected while the excavation is made or afterwards - neither in the hollow itself nor on the surface - that could impair the functional of capacity of the mine.

b) The bearing capacity of the surrounding medium is sufficient in order to prevent goaves that could have negative effects on the long-term safety of the mine.

c) The disposed of wastes in the long run add to the stability.

An expert opinion focussing on ground mechanics must be provided to prove the mine's stability during and after the operation period. This expert opinion has to give particular attention to the following tasks:

1. categorizing and assessing the geological/tectonic and hydrological data with respect to their relevance for the existing and predicted ground mechanical situation in the mining plant;

2. analysing the mining situation on the basis of operational experience (if applicable), with a particular view on the dimensioning of the underground mine structure and on the stability assessment;

3. analysing the behaviour of the rock mass based on underground and surface measurements, results of geotechnical laboratory experiments, forward-looking mine surveying and ground mechanical assessments. Existing results and data records of previous mine operations may also be used for this purpose;

4. explaining potential hazards related to ground mechanics that can be derived from the conducted analyses;

5. compiling a safety plant to prove stability and to assess long-term safety (integrity/wholeness) of the geological barriers on the basis of ground mechanics; a description and definition of possible risks and hazardous potential to be observed have to be given in order to be used as a basis for arithmetical proofs;

6. Defining the possible geological and tectonic influencing factors to be taken into account (such as primary stress status, temperature field, earthquakes) or anthropogenic factors to be reconed with (e.g. drivages, waste stowage/ waste disposal);

7. carrying out laboratory experiments to identify ground mechanic properties (strength and strain properties) of the solid salt rock and, if appropriate, of the wastes to be disposed of or to be utilized as stowage material;

8. carrying out measurements in-situ to assess the strain status (stress and strain condition) of the deposit induced by mining activities; on critical sites also permeability measurements in-situ;

9. Developing arithmetical models based on ground mechanics to simulate the strain status of the rock mass and the long-term behaviour of the disposal area and the mining plant, taking into account long-term convergence, stabilising effects of stowage materials/wastes and dynamic effects due to seismicity;

10. assessing conditions relevant to ground mechanics
    - stability (assessment of potential failures regarding strengths or deformations, seismological system stability)
    - convergence of the mining plant and surface lowering
    - long-term effectiveness of geological barriers;

11. Developing measures necessary from the point of view of ground mechanics during deposit operations and afterwards
    - geotechnical measurements accompanying the operational phase
    - fundamental of ground mechanics to be applied to storage and closing barrier construction.

The recommendations by the working group on salt mechanics of the *Deutsche Gesellschaft für Erd- und Grundbau e.V.* on geotechnics of underground landfilling of wastes in salt rock requiring special supervision - storage in mines - can also be resorted to when carrying out geotechnical investigations in mines that are used for complete encapsulation of wastes requiring special supervision.

2.5 Proof of long-term safety

Based on the results of the previous analyses the comprehensive and all-embracing long-term safety analysis of the complete system waste/underground construction/rock mass must look at the following individual systems and evaluate these on the basis of the multiple barrier system:

2.5.1 Assessment of natural barriers

- behaviour of host rock, neighbouring rock and overburden

2.5.2 Assessment of impacts on natural barriers caused by technical intervention

- pits
- other mine structures (e.g. tunnels, blind pits)
- surface drilling
- underground drilling
- bulking induced by mining activities

2.5.3 Assessment of technical barriers

- quality of waste and, if appropriate, conditioning
- type of disposal
- roadside pack
- shaft gate

2.5.4 Assessment of events that jeopardize the complete encapsulation of wastes and might cause the mobilisation of contaminants

- naturally occurring events
  * diapirism and subrosion
  * earthquakes
  * volcanism

- technically induced events and processes
  * development of leakages in exploratory drillings
  * water inrush during the operational phase, for instance via pits
  * ingress of brine during the operational phase
  * failure of shaft gates
  * bulking induced by mining activities
  * drillings or other interventions in the post operational phase

Site-specific conditions determine which other events have to be considered.

2.5.5 Comprehensive evaluation of the complete system, taking into account all safety-relevant aspects

Article 2

Amendment of the Ordinance to Implement the European List of Wastes

The Appendix (to § 2 para. 1) of the Ordinance to Implement the European List of Wastes of 10 December 2001 (*BGBl*. I p. 3379), as amended by Article 4a of the Ordinance of 25 April 2002 (*BGBl*. I p. 1488) shall be amended as follows:

1. In number 3 of the introduction, the comma and the term “zinc” that follow the term “thallium” shall be deleted.
2. The German term for waste specified as “*unverarbeitete Schlacke”* (“unprocessed slag”) under waste code “10 02 02” shall be replaced by the German term “*unbearbeitete slag”* (“unprocessed slag”).

Article 3

Amendment of the Ordinance on Licensing Procedures

§ 21 para. 3 no. 1 of the Ordinance on Licensing Procedures in the version promulgated on 29 May 1992 (*BGBl*. I p. 1001), as last amended by Article 2 of the Ordinance of 24 June 2002 (*BGBl*. I p. 2247), shall be revised as follows:

“1. Type (in particular the waste codes and designations pursuant to the Ordinance to Implement the European List of Wastes) and volume of the wastes destined for incineration”.

Article 4

Entry into force

Article 1 of this Ordinance shall enter into force three month after the day following the promulgation. Articles 2 and 3 of this Ordinance shall enter into force on the day following the promulgation.

Approved by the *Bundesrat*.

Berlin, 24 July 2002

The Federal Chancellor

The Federal Minister for the Environment, Nature Conservation and Nuclear Safety