Objectives and Activities of the Technical Committee  
“Landfill Technology”

Hans-Günter Ramke, Höxter

Introduction to the Workshops

Design and Construction of Bottom Liner and Leachate Collection Systems –  
Appropriate Solutions for Developing Countries

Landfill Restoration, Capping and Monitoring –  
Useful Experience for Developing Countries

organized by of the Technical Committee Landfill Technology  
of the German Geotechnical Society (DGGT)

in the Frame of

Sardinia 2009: Twelfth International Waste Management  
and Landfill Symposium

organized by IWWG, International Waste Working Group

Symposium in S. Margherita di Pula – Cagliari, Sardinia, Italy  
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Address of the Author

Professor Dr.-Ing. Hans-Günter Ramke  
University of Applied Sciences Ostwestfalen-Lippe, Campus Hoexter  
An der Wilhelmshöhe 44, D-37671 Hoexter  
Phone ++49/5271/687-130, e-mail hans-guenter.ramke@hs-owl.de
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Objectives and Activities of the Technical Committee “Landfill Technology”

Professor Dr.-Ing. Hans-Günter Ramke
University of Applied Sciences Ostwestfalen-Lippe, Campus Hoexter
Professorship of Waste Management and Sanitary Landfilling

Technical Committee Landfill Technology Overview

- Introduction
- Problems of Present Practice
- Objectives and Scope
- Members of the Technical Committee
- Contents and Approaches
- Invitation for Participation
Introduction
Present Situation - Part 1

- Waste Management in Theory
  - source reduction
  - reuse and recycling
  - pre-treatment before disposal

- Waste Management in Practice
  - get the waste off the streets
  - dispose of the waste as good as possible ("landfilling")
  - develop an integrated waste management (perhaps)

Introduction
Present Situation - Part 2

- Future Developments
  - growing population
  - increasing living standards
  - growth of waste quantity
  - growth of waste toxicity

- Problems of Waste Disposal
  - hundreds of thousand of dangerous dumps
  - landfilling is mid-term the most important practice
  - in future more than 10,000 landfills all over the world
Introduction
Present Situation - Part 3

- Consequences for Landfill Technology
  - landfill technology becomes globally important just now
  - landfill technology with local resources

- Contribution of Germany
  - comprehensive theoretical and practical experience
  - willingness of international know-how-transfer

Introduction
Technical Committee Landfill Technology

- Objectives of the Technical Committee
  - preparation of a „Toolkit Landfill Technology“ for experts in Developing and Newly Industrialised Countries
  - publication via the internet in English language

- Participating Technical Committees
  - „Committee on Geotechnics of Landfill Engineering“
    German Geotechnical Society - DGGT
  - “Committee Sanitary Landfills”
    German Association for Water, Wastewater and Waste - DWA
    Association of Municipal Waste Management & City Cleaning - VKS
Problems of Present Practice
Insufficient Landfill Practice - Part 1

- Typical Problems
  - life threats for „waste pickers“ and their families
  - health risks for people in the neighbourhood
  - air pollution caused by burning waste
  - greenhouse effects of landfill gas
  - soil contamination
  - pollution of surfacewater and groundwater
  - rapid reproduction and spreading of vermin

Problems of Present Practice
Insufficient Landfill Practice - Part 2

Landfill in Latin America - waste pickers on a landfill

Photo: P. Schnittger, Hamburg, Germany
Problems of Present Practice
Insufficient Landfill Practice - Part 3

Landfill near Bandung, Indonesia, - Extensive landslide

Photo: F. Költsch, Braunschweig, Germany

Problems of Present Practice
Insufficient Landfill Practice - Part 4

Landfill in the Middle East - Operation with high tipping edge
Problems of Present Practice
Insufficient Landfill Practice - Part 5

Landfill in the Middle East
- Burning waste at landfill bottom

Problems of Present Practice
Insufficient Landfill Practice - Part 6

Landfill in the Maghreb
- Large urban landfill
Problems of Present Practice
Insufficient Landfill Practice - Part 7

Landfill in Latin America
- Pollution of Surface and Groundwater

Problems of Present Practice
Insufficient Landfill Practice - Part 8

Landfill in the Middle East
- Leachate Pond at Landfill Bottom
Problems of Present Practice
Insufficient Landfill Practice - Part 9

Landfill in the Maghreb
- Untrapped Leachate discharge at landfill slope

Problems of Present Practice
Insufficient Landfill Practice - Part 10

Landfill in the Maghreb
- Leachate discharge in open trenches
Problems of Present Practice
Insufficient Landfill Practice - Part 11

Landfill in the Maghreb - Leachate discharge into a river

Problems of Present Practice
Insufficient Landfill Practice - Part 12

Dump in Latin America - Flock of birds

Photo: P. Schnittger, Hamburg, Germany
Problems of Present Practice
Reasons for Insufficient Practices of Landfilling

- Socio-Economical Conditions
  - poor public awareness
  - limited financial resources
  - no availability of construction materials and products

- Knowledge-based Reasons
  - no legal requirements
  - lack of local knowledge and experience

Problems of Present Practice
Missing Technical Guidelines and Recommendations

- International Guidelines
  - existing in industrialised countries
  - not always applicable in Developing Countries

- International Technical Literature
  - for experts in Industrialised Countries on a high level
  - for decision makers in Developing Countries
  - for beginners as an introduction in landfill technology
  → no technical handbooks for skilled engineers in DCs
Objectives and Scope
Objectives of the Toolkit - Part 1

- Basic Idea
  - transfer of engineering know-how
  - for preparation of local solutions

- Considerations for Appropriate Solutions
  - hydrological and climatic conditions
  - ecological requirements and effectiveness
  - economic resources
  - availability of construction material and technology
  - regional experience in construction

Objectives and Scope
Objectives of the Toolkit - Part 1

- Content of the Toolkits
  - landfill design
  - landfill construction
  - landfill operation
  - landfill monitoring

- Parts of the Toolkits
  - Fundamentals
  - Regional Experience
  - Collection of Examples
Objectives and Scope
Objectives of the Toolkit - Part 2

- Users of Toolkit
  - landfill designers
  - manager of landfill operators
  - engineers in construction companies
  - employees in public authorities

- Method of Publication
  - toolkit at the level of GDA-Recommendations
  - publication at an own website
  - publication in English

Objectives and Scope
Scope of the Toolkit - Part 1

- Part I: Fundamentals
  - comprehensive overview of landfill technology
  - prepared by members of the Technical Committee

- Part II: Regional Experience
  - regional practice, standards, pilot projects
  - prepared by international co-operation partners
Objectives and Scope
Scope of the Toolkit - Part 2

- Part III: Examples
  - presentation of case studies and constructional solutions
  - cost effective and sustainable
  - compiled by interested professionals

- Tools
  - bibliography
  - design tools for calculation (EXCEL)
  - internet links
Members of the Technical Committee
Part 1

- Members (June 2009)
  - consulting companies  6
  - landfill operators  3
  - public authorities  3
  - institutions of international co-operation  2
  - universities and scientific institutions  6
  total  20

Members of the Technical Committee
Part 2

- International Partners (June 2009)
  - Europe  Poland, Romania, Hungary
  - Asia  China, India, Indonesia, Pakistan
  - Africa  Morocco, Tunisia
  - Middle East  Jordan, Iran, Syria, Turkey
  - South America  Brazil
Contents and Approaches
Principles of Sanitary Landfilling - Overview

- Introduction
- Municipal Waste Management
- Health and Environmental Risks of Dumps & Landfills
- Concepts of Landfilling
- Economic Aspects
- Legal Framework and Standards
- Principles of Landfill Design
- Principles of Quality Management

Contents and Approaches
Development of Standards - Part 1

- Criteria for Suitable Standards
  - ecological effectiveness
  - economical resources
  - regional experience in construction
  - availability of construction materials
  - hydrological and climatic conditions
Contents and Approaches
Development of Standards - Part 2

- Typical Mistakes in Development of Standards
  - requirements economically not realisable
  - requirements technically not realisable
  - requirements organisationally not realisable

- Necessary Regional Differentiation
  - hydrological and climatic conditions
  - conditions of waste management
  - economical conditions

Contents and Approaches
Development of Standards - Part 3

Map of Morocco
- Marking of different regions

Quelle: Spiegel Online, Länderlexikon, 27.02.07
Contents and Approaches
Site Selection and Bottom Lining - Overview

- Site Selection
- Principles of Bottom Lining
- Mineral Liners
- Geosynthetic Barriers
- Asphalt Liners
- Construction of Liner Systems
- Site Infrastructure
- Site Development

Contents and Approaches
Bottom Liner Systems - Technical Assessment

<table>
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<th>Hydraulic Permeability</th>
<th>Long-Term Behavior</th>
<th>Complexity of Construction</th>
<th>Availability of Raw Material</th>
<th>Local Experience in Construction</th>
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<td>++</td>
<td>+</td>
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</tbody>
</table>
Contents and Approaches
Bottom Liner Systems – Quality Assurance

- Necessity for Quality Assurance
  - to check the fulfilment of all requirements
  - e.g. mineral liners: permeability, density
  - e.g. geomembranes: installation without damages

- Type and Quantity of Tests
  - depending on the type of liner which is chosen

Contents and Approaches
Collection and Treatment of Emissions - Overview

- Degradation Processes in Landfills
- Leachate Quantity and Quality
  - Leachate Collection
  - Leachate Management
- Landfill Gas Quantity and Quality
  - Gas Collection
  - Gas Treatment
Contents and Approaches
Leachate Collection Systems - Part 1

- Standard Leachate Collection System
  - 30 cm drainage layer
  - coarse drainage material, 16 – 32 mm gravel

- Particular Problems in Developing Countries
  - drainage material very often not available
  - alternative: secondary drains made of very coarse stones

Contents and Approaches
Leachate Collection Systems - Part 2

- Necessity
  - coarse drainage material not available
  - improvement of efficiency and life span of leachate collection system by secondary drains made of coarse stone

- Parameters
  - secondary stone drains of very coarse material (32 – 150 mm)
  - dams with a width 2.5 m, height > 1 m, k > 1·10⁻² m/s
  - angle to the pipes according the slope line
Contents and Approaches
Leachate Collection Systems - Part 1

Leachate collection system with secondary drains

Contents and Approaches
Leachate Collection Systems - Part 4

Leachate collection system with secondary drains - Landfill of Hannover (overview)
Contents and Approaches
Leachate Collection Systems - Part 5

Leachate collection system with secondary drains - Landfill of Hannover (details)

Contents and Approaches
Leachate Treatment - Leachate Generation

- General Experience
  - even in arid or semi-arid climates leachate generation
  - only little leachate generation caused by precipitation
  - but comparative much "primary leachate generation (wet waste)"
  - high organic load of leachate
    - fast development of landfill height
    - high content of organics

- Consequences
  - leachate recirculation is no solution
  - accumulation of leachate must be avoided
- Methods of Leachate Management
  - recirculation
    (low leachate quantity and dry waste)
  - evaporation
    (only under arid climates, pre-treatment useful)
  - vaporisation
    (in case of no surface water in the neighbourhood)
  - off-site treatment
    (together with municipal sewage, pre-treatment useful)
  - on-site treatment
    (2 - 3 treatment stages necessary for high discharge quality)

- Simple Solution of Leachate Treatment
  - aerated lagooning
  - at the lower end of the landfill
  - three ponds with a sealed bottom
  - first pond: settling pond
  - second pond: pond with artificial aeration (if possible)
  - third pond: final settling pond with natural aeration
  - partial leachate pre-treatment
  - reduction of organic constituents

(Source: Oeltzschner, 1996)
Contents and Approaches
Leachate Treatment - Recommendations (2)

- Leachate Management in Arid Climates
  - leachate recirculation is not successful when organic content and moisture of waste are high
  - evaporation should be used for leachate removal as far as possible where it is possible
  - pre-treatment seems necessary to avoid handling and odour problems
  - anaerobic ponds are useful in summer (temperature > 15 °C)
  - in addition and as basic treatment option aerated lagoons are to be installed (floating aerators)

(Source: Ramke, 2005)

Contents and Approaches
Leachate Treatment - Recommendations (3)

Scheme for leachate management in arid climates

(Source: Ramke, 2005)
Contents and Approaches
Leachate Storage – Part 1

- General Recommendations
  - If there is a leakage in the leachate storage the whole lining system of the landfill is vain!
  - The lining system for the landfill is very expensive and the leachate storage pond or basin is comparably cheap.
  - Please, take special care about the liner of the leachate pond/basin.

Contents and Approaches
Leachate Storage – Part 2

- Dimensioning of Leachate Storage Basin/Ponds
  - The minimum requirements of Germany might be helpful.
  - $V \geq 20 \cdot Q_{\text{average,d}}$ (capacity to store the average leachate quantity of 20 days)
  - $V \geq 5 \cdot Q_{\text{max,d}}$ (capacity to store the maximum daily leachate quantity for days off)
  - The bigger volume is to be chosen.
Contents and Approaches
Landfill Operation - Overview

- Organisation of Landfill Operation
- Pre-Treatment of Waste
- Waste Placement and Compaction
- Settlements of Landfill Body
- Landfill Stability
- Monitoring
- Improvement of Existing Sites
- Complex of Problems of Waste Pickers

Contents and Approaches
Pre-Treatment of Waste - Introduction

- Objectives of Pre-Treatment
  - reduction of waste quantity
    (and improving of waste quality)
  - prolongation of landfill life-span
    (less waste volume, increasing of compaction density)
  - decreasing of emissions of landfills
    (less leachate and landfill gas emissions)

- Technical Possibilities
  - waste incineration (WI)
  - mechanical-biological waste pre-treatment (MBW-T)
Contents and Approaches
Pre-Treatment of Waste - Requirements of the EU

- Requirements for Landfill Classes II
  - acceptance criteria for “non-municipal” waste
  - reduction of the content of organics of MSW before disposal
  - allowed amount related to the amount in 1995

- Required Reduction of Organics in MSW
  - until 2006: 75 %
  - until 2009: 50 %
  - until 2016: 35 %

Contents and Approaches
Pre-Treatment of Waste - MBW-Advantages (1)

- Effects of Mechanical-Biological Pre-Treatment
  - significantly reduction of the biodegradable content of the waste
  - decisive diminishing of the biological decomposition processes taking place in a landfill
  - decreasing of moisture content and the mean particle size, the treated material becomes considerably more homogeneous
Contents and Approaches
Pre-Treatment of Waste - MBW-Advantages (2)

- Results of Mechanical-Biological Pre-Treatment
  - higher compaction density at same compaction energy
  - reduction of the waste quantity to be disposed of
  - extension of the life-span of the landfill
  - significant lower concentration of organics in the leachate
  - significant reduction of landfill gas generation

Contents and Approaches
Pre-Treatment of Waste - Rottening Windrows (1)

Schematic cross section of a passively aerated rottening heap
(Source: GTZ, 2000)
Contents and Approaches
Pre-Treatment of Waste - Rottening Windrows (2)

- Handling of Rottening Windrows (1)
  - rottening windrows are very suitable for an on-site pre-treatment of waste
  - the height of windrows is ~ 2m, the width 30 - 60 m
  - the space of the ventilation pipes is ~ 2 - 3 m
  - the windrows are covered with sieved composted waste

Contents and Approaches
Pre-Treatment of Waste - Rottening Windrows (3)

- Handling of Rottening Windrows (2)
  - during the rotting process the windrow must not become dry
  - in arid areas or during dry summer periods irrigation is recommended, for this purpose sewage and leachate can be used
  - in humid climates protection against rainfall might be useful
  - after 6 - 9 month of “composting” the windrow is spread into 20 cm high layers and has to be well compacted
  - details of the rottening process depend on the waste properties, the local situation, and the climatic conditions
Contents and Approaches
Pre-Treatment of Waste - Rottening Windrows (4)

Landfill in Iran –
Front of some
Rottening
Windrows

Contents and Approaches
Pre-Treatment of Waste - Rottening Windrows (5)

Landfill in Iran –
Lateral Surface
of a Rottening
Windrow
Contents and Approaches
Landfill Closure and Restoration - Overview

- Landfill Capping
- Water Balance of Capping Systems
- Soil Cover and Vegetation
- Drainage of Landfill Capping Systems
- Barrier and Liner Systems
- Rehabilitation of Existing Sites
- Rehabilitation of Sludge Deposits

Contents and Approaches
Landfill Capping - Overview

- Tasks of a Surface Cover System
  - isolation of the wastes from environment at the surface
  - provision of long-term minimisation of leachate production
  - control of venting of landfill gas

- Components of a Surface Cover System
  - bearing layer and/or gas drainage layer
  - sealing layer (mineral liner and/or geomembrane)
  - drainage layer
  - top soil cover (vegetation layer) and vegetation
Contents and Approaches
Landfill Capping - Local Characteristics

- Criteria for System Selection
  - risk potential of the landfill
  - availability of liner and drainage soils
  - local experience in construction

- Important Local Characteristics
  - general climatic conditions - arid or humid
  - distribution of precipitation - dry weather periods
  - risk of surface runoff, local vegetation

Contents and Approaches
Landfill Capping - Questions

- What cover design is used in your country and why?
  (restrictions or potential due to climate, material availability, law, costs)

- What long-term experience exist with these covers?

- Are there measurement results?
  (e.g. from digging, lysimeters)
Contents and Approaches
Landfill Capping - Alternatives

Surface Cover and Liner Systems (Cross Section)

Contents and Approaches
Water Balances - Questions

- Are water balance calculations performed?
- What models are used?
- What experience exist in model application?
  (applicability, data availability, cvalidity of results, comparison of models)
- Should precipitation data be corrected?
  (systematic measurement errors)
- How is climate change to be considered?
Contents and Approaches
Soil Cover and Vegetation - Part 1

- Problems in Arid Areas
  - partly long drought
  - periodically short heavy rainfalls
  - erosion sensitive soils

- potential solutions
  - selection of autochthon vegetation
  - short lengths of slopes
  - simple fixing of slope surfaces

Contents and Approaches
Soil Cover and Vegetation - Part 2

Erosion Channels at a Landfill Site in the Middle East
Local Vegetation at an Arid Landfill Site

Different Stages of Restoration of a Landfill in Germany
### Contents and Approaches

#### Landfill Aftercare - Overview

- Long-term Behaviour of Landfills
- Operational Tasks of Aftercare
- Long-term Monitoring

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#### Economic Calculations and Finance - Overview

- Investment and Operation Costs
- Calculation of Dynamic Unit Costs
- Finance of Investments
- Carbon Trade
Invitation for Participation
Part 1

- Invited Experts
  - all landfill professionals (designers, operators, scientists)
  - in particular from developing countries
    and newly industrialised countries

- Topics of Contributions
  - data of landfill behaviour (leachate, gas, barrier systems)
  - design of treatment plants and barrier systems
  - cost effective treatment of leachate and landfill gas
  - landfill operation under different climatic conditions

Invitation for Participation
Part 2

- International Workshop in Germany
  - presentation of the toolkit – part fundamentals
  - exchange of experience with international partners

- International Conference in Southern Europe
  - international announcement of the results

- Internet-Addresses and Contact
  - www.landfill-technology.de
  - hans-guenter.ramke@hs-owl.de
Addresses

Professor Dr.-Ing. Hans-Günter Ramke
Chairman of the Technical Committee Landfill Technology
University of Applied Sciences Ostwestfalen-Lippe
Campus Hoexter
Department of Environmental Engineering and Applied Informatics
Professorship of Waste Management and Sanitary Landfilling
An der Wilhelmshoehe 44, 37671 Hoexter, Germany
Phone: ++49/5271/687-130; Fax: ++49/5271/687-130
E-mail: hans-guenther.ramke@hs-owl.de