

 Eskom	Guideline	Technology
---	-----------	------------

Title: **Guideline for the Design of Ash Disposal Facilities for Coal Fired Power Stations**

Unique Identifier: **240-125171334**

Alternative Reference Number: **N/A**

Area of Applicability: **Engineering**

Documentation Type: **Guideline**

Revision: **1**

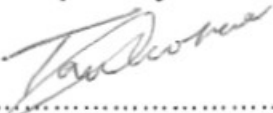
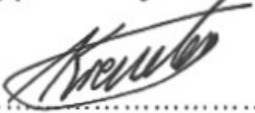
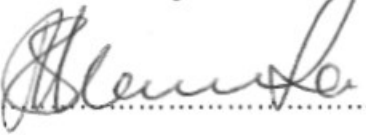
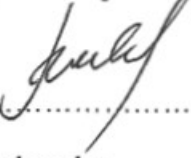
Total Pages: **11**

APPROVED FOR AUTHORISATION

☒ TECHNOLOGY ENGINEERING
DOCUMENT CENTRE ☎ X4962

Next Review Date: **April 2022**

Disclosure Classification: **CONTROLLED DISCLOSURE**

Compiled by  T. Chokoe Engineer Geotechnical Engineering CoE Date: <u>29/03/2017</u>	Approved by  A. Kreuter Chief Engineer Geotechnical Engineering CoE Date: <u>30/03/2017</u>	Authorised by  T. Mavunda CoE Manager Geotechnical Engineering CoE Date: <u>30/3/2017</u>
		Supported by TC  G. Dudenska Civil TC Chairperson Date: <u>30/03/2017</u>

PCM Reference: **240-53573079 - Perform Geotechnical Engineering**

SCOT Study Committee Number/Name: **SC10-02-WG-03: Guideline on Ash Dump/Dam Design**

CONTENTS

	Page
1. INTRODUCTION	3
2. SUPPORTING CLAUSES	3
2.1 SCOPE	3
2.1.1 Purpose	3
2.1.2 Applicability	3
2.2 NORMATIVE/INFORMATIVE REFERENCES	3
2.3 NORMATIVE	4
2.3.1 Informative	4
2.4 DEFINITIONS	4
2.4.1 Disclosure Classification	5
2.5 ABBREVIATIONS	5
2.6 ROLES AND RESPONSIBILITIES	6
2.6.1 Engineering Design Work Lead (EDWL)	6
2.6.2 Specialist or Review Engineer	6
2.6.3 Lead Discipline Engineer (LDE)	6
2.7 PROCESS FOR MONITORING	6
2.8 RELATED/SUPPORTING DOCUMENTS	7
3. GUIDELINES FOR ASH DUMP DESIGN	7
3.1 COMPLIANCE TO LEGISLATION & REGULATIONS	7
3.1.1 Environmental Impact Assessment	7
3.1.2 Waste Management License/Environmental Authorisation	7
3.1.3 Integrated Water Use License (IWUL)	7
3.1.4 Waste Classification	7
3.1.5 Eskom Water Management Policy & ZLED Philosophy	8
3.2 ASH DISPOSAL FACILITY:	8
3.2.1 Basic/Conceptual Design/Feasibility Studies	8
3.2.2 Site Investigations	9
3.2.3 Geohydrological Studies	9
3.2.4 Service Life Requirements	9
3.2.5 Barrier Design	9
3.2.6 Leachate Management System	9
3.2.7 Storm Water Management	9
3.2.8 Pollution Control Dams	10
3.2.9 Silt/Sediment Management	10
3.2.10 Erosion Control	10
3.2.11 Stability Analysis	10
3.2.12 Rehabilitation	10
3.2.13 Ground water Monitoring	10
3.3 SAFETY CONSIDERATIONS	11
4. AUTHORISATION	11
5. REVISIONS	11
6. DEVELOPMENT TEAM	11
7. ACKNOWLEDGEMENTS	11

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

1. INTRODUCTION

Ash is produced as a combustion waste product through burning coal to generate electricity. In the electricity generation industry ash is commonly produced in two states, namely coarse ash and fly ash. Different ashing systems are adopted in the design philosophy for power stations depending on, among other things, the site location, environmental compliance requirements and technology used. Eskom utilizes two types of ashing systems namely wet ashing system and dry ash system. The wet ash system (with wet ash dam) is mainly common to the older fleet of power station. While the dry ashing system is more common to newer fleet.

Power station ash comprises of dissolved salts and constituents that can potentially have a negative impact on the environment and groundwater resources. Section 21(g) of the National Water Act, 1998 (Act No. 36 of 1998) requires listed water use activities, which have potential to negatively impact on the environment, to be licensed. To promote the safeguarding of the environment against the potential negative impacts of waste facilities, Government promulgated regulations in 2013 (Government Notices Regulations No. 634, 635, 636 of 2013) that prescribe the minimum requirements for the classification, design, disposal and management of waste to landfills.

Power station fly ash has also been successfully used as a resource in the engineering industry to enhance the properties of concrete. For this reason some coal fired power stations supply the cement industry with fly ash. Ash that is not supplied to the industry needs to be accordingly disposed of at an appropriate waste disposal facility in a manner that will not negatively impact the environment and groundwater resources.

Site specific conditions and plant design requirements typically vary depending on, amongst others things, the site location and performance requirements for the ash disposal facility. However some minimum design requirements and aspects are common and require consideration in the civil design of ash disposal facilities within Eskom. The following provides general guidelines for consideration in the design of ash disposal facilities within Eskom.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document outlines general requirements for consideration in the civil design of an ash dam/dump, pollution control dams and their components within Eskom. Specific design requirements and considerations with respect to the civil design will be defined in the project specific Stakeholder Requirements Definition (SRD) and relevant technical documents.

2.1.1 Purpose

This document does not prescribe the design requirements but rather is intended to provide a framework of general requirements and minimum design aspects to consider in the civil design of ash disposal facilities within Eskom. The designer is not limited to this document and is encouraged to use applicable documents consistent with national and international [where applicable] standards and industry best practices for the design of ash disposal facilities.

2.1.2 Applicability

The document shall apply to relevant projects within Eskom Holdings Limited Generation Division.

2.2 NORMATIVE/INFORMATIVE REFERENCES

The latest edition of the publications referred to below shall apply.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

2.3 NORMATIVE

- [1] National Environmental Management Act: Waste Act (Act No. 59, 2008)
- [2] National Environmental Management Act (No. 107 of 1998)
- [3] National Water Act (No. 36, 1998)
- [4] Government Notice Regulation (GNR) 704, Regulations on use of water for mining and related activities aimed at protection of water resources
- [5] Government Notice Regulation (GNR) 634, Waste Classification and Management Regulations (2013)
- [6] GNR 635, Norms & Standards for the Assessment of Waste for Landfill Disposal (2013)
- [7] GNR 636, Norms & Standards for Disposal of Waste to Landfill (2013)
- [8] GNR 921, List of Waste Management Activities that have, or are likely to have, a Detrimental Effect on the Environment.
- [9] Eskom Water Management Standard, 32-245.

2.3.1 Informative

- [10] Eskom Water Management Policy, 32-183.
- [11] Medupi Power Station Ash Stack Facility Operations Manual, JW057/10/B754
- [12] Department of Water affairs and Forestry, Best Practice Guidelines A4: Pollution Control Dams, 2007.
- [13] Progressive Interaction In Engineering Review of License Application as at January 2014, DWA
- [14] Eskom Standard for the Execution of Site Investigations, 240-57127951
- [15] Eskom Execution of site Preparation and Earthworks Standard, 240-57127953
- [16] Eskom Geotechnical and Foundation Engineering Standard, 240-57127955
- [17] Eskom Geotechnical Standard for Coal Stockyard and Ash Dam/Dump Site Investigations, 240-92460850
- [18] Geohydrological interpretation, modeling and impact risk assessment for Medupi Power Station 2008, Report number 2008/28/PDV
- [19] Eskom Guidelines for the integrated water and waste management process, February 2006. Eskom GGM 0970.
- [20] Eskom Position Paper, Prevention of Groundwater Pollution: A Case of Lining new Ash Dumps, June 2010.

2.4 DEFINITIONS

The following definitions, abbreviations and references are used in this document

Definition	Description
Ash Dam	Wet Ash Dam. Ash Tailings Dam site designated for disposal of ash slurry. Interchangeably Ash storage facility, ash disposal facility.
Ash Dump	Dry Ash Dump. Landfill site designated for disposal of conditioned ash. Interchangeably Ash storage facility, ash disposal facility.
Groundwater	Water sources located subsurface below the water table.
Waste	Undesirable by-products that is collected, stored or discarded and can potentially

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Definition	Description
	pollute the environment and ecosystems.
Effluent	Liquid and/or water that percolates through waste carrying contaminants.
Consultant/Designer	Appointed design engineer or consultant responsible for the design of the ADF.
Waste generator	Any industry whose actions, productions or activities results in the generation of waste in accordance with Government Notice 634. In this instance Eskom is a waste generator with respect to the production of ash during the process of power generation.
Eskom	Applies to Eskom Holdings Limited Division
Water Resource	Includes a watercourse, surface water, estuary, aquifer/ground water and the sea
Waste facility	Facility for the management of waste from source to end use by avoiding, minimising, reusing, recycling or disposal of waste.

2.4.1 Disclosure Classification

Controlled Disclosure: Controlled Disclosure to external parties (either enforced by law, or discretionary).

2.5 ABBREVIATIONS

Abbreviation	Description
ADF	Ash Disposal Facility
CoE	Centre of Engineering Excellence
DEA	National Department of Environmental affairs
DWS	National Department of Water & Sanitation
EIA	Environmental Impact Assessment
GN	Government Notice
GN/GNR	Government Notice, Government Notice Regulation
IWUL	Integrated Water Use License
NEM:WA	National Environmental Management Act: Waste Act (Act No. 59 of 2008)
NEMA	National Environmental Management Act (Act No. 107 of 1998)
PCD	Pollution Control Dam
ROC	Required Operational Capability
SR	System Requirements
SRD	Stakeholder Requirements Definition
URS	User Specific Requirements
ZLED	Zero Liquid Effluent Discharge

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

2.6 ROLES AND RESPONSIBILITIES

The following have responsibilities in terms of this document:

2.6.1 Engineering Design Work Lead (EDWL)

The Engineering Design Work Lead is responsible for delivering the scope of work, and for:

- Coordinating, integrating and interfacing all design-related activities and deliverables.
- Design Strategy.
- Design Team Structure.
- Coordination of Lead Discipline Engineer's work.
- Performing basic management functions such as planning; organizing; leading and controlling; decision-making; and communication.
- Ensuring that the relevant design standards and guidelines are adopted.
- Managing requirements of design reviews.
- Integrity of the engineering design.
- Design meets the agreed user requirements.

2.6.2 Specialist or Review Engineer

The Specialist or Review Engineer has a single area of speciality in the design and is responsible for:

- Maintaining a support role during the design period.
- Reviewing all outputs.
- All design approvals.
- Providing support and advice to all engineers in the design team.
- The technical assurance of technology application.
- Acting as custodian of design guidelines and specifications.

2.6.3 Lead Discipline Engineer (LDE)

The Lead Discipline Engineers are discipline specific and have working experience in the design of the relevant equipment/components and are responsible for:

- The technical integrity of the design within their specific engineering domain.
- Management of interfaces within their specific engineering domain.
- The input, and deciding on the design criteria.
- Ensuring the outputs are as per the specifications.
- Ensuring the prescribed legislation, regulations, governance, standards and guidelines are adopted in the design.

2.7 PROCESS FOR MONITORING

None

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

2.8 RELATED/SUPPORTING DOCUMENTS

None

3. GUIDELINES FOR ASH DUMP DESIGN

3.1 COMPLIANCE TO LEGISLATION & REGULATIONS

South African legislation requires a waste generator intending to construct and operate a waste disposal facility to comply with prevailing legislative and regulatory requirements in respect to the design, construction, disposal and management of the waste disposal facility. These compliance requirements are prescribed in the National Environmental Management Act: Waste Act (Act No. 59 of 2008) and other relevant Acts and Regulations. Below are some of the compliance requirements that need to be considered in the design of an ash facility within Eskom.

3.1.1 Environmental Impact Assessment

As a precursor to obtaining authorisation for an ash disposal facility, the National Environmental Management Act, 1998 (Act No. 107 of 1998) and Environmental Impact Assessment Regulations (of 2010) require an environmental impact assessment (EIA) study to be conducted in order to identify the potential environmental impacts associated with the proposed ash disposal facility. The site selection and geohydrological studies reports, amongst others, are generally required as supporting documentation to the EIA report for submission to the relevant licensing authorities. The findings of the EIA study together with the recommendations are key elements that need to be considered in the design of the ash disposal facility for appropriate impact mitigation measures.

3.1.2 Waste Management License/Environmental Authorisation

In terms of NEM:WA (No. 59 of 2008) and sub regulation Government Notice No. 921, “*no waste generator may commence, undertake or conduct a waste management activity listed unless a waste management license is issued in respect of the waste management activity*”. A waste management permit for the proposed ash dump/dam is hence required in order to authorise the construction of the facility, disposal of the permitted waste, treatment, operations and management of the produced ash.

Depending on the information required for the waste management license application preliminary studies and investigations (such as preliminary site investigations, preliminary geohydrological studies, feasibility studies, concept design, etc.) may be required as prescribed in the waste license application or in consultation with the relevant authorities to ensure that the Department is provided with the necessary information for consideration in respect to awarding of the license applied for.

3.1.3 Integrated Water Use License (IWUL)

Activities listed as having potential to negatively impact on the environment in terms of surface and ground water pollution, need to be licensed in terms of Section 21 (g) of the National Water Act, 1998 (Act No. 36 of 1998), “disposing of waste in a manner which may detrimentally impact on a water resource”. The IWUL application typically takes into consideration the overall storm water management philosophy of the proposed ash disposal facility. Depending on the stage of the project information such as, amongst others, preliminary capacity estimates of the pollution control dams, water balance models and estimated expected waste tonnage etc., may be required.

3.1.4 Waste Classification

Ash and other waste [where applicable] intended for disposal at the proposed facility shall be classified in accordance with current and prevailing legislation and regulations for waste classification and applicable national standards in order to determine the waste type and the required appropriate liner design.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Where applicable, plant specific aspects such as operations, waste co-disposal and ash conditioning methods which can potentially alter the composition of the ash/waste stream need to be discussed with the relevant Authorities for guidance and clarity on the applicable waste stream(s) to subject to classification.

3.1.5 Eskom Water Management Policy & ZLED Philosophy

Eskom has adopted a zero liquid effluent discharge (ZLED) philosophy aimed at encouraging practices that promote water resource pollution prevention. One of Eskom's water management policy directives (as outlined in Eskom Water Management Policy document number 32/1163) is to "*ensure that new infrastructure is designed, maintained and operated in a manner that water will be utilised effectively and efficiently and to ensure environmental duty of care*"¹. In general these principles are in line with Government's objectives for water and environmental resource conservation. Adopting Eskom's ZLED philosophy and Water Management Policy principles in the design of the ash disposal facility and its components is encouraged and recommended in order to ensure "*effective and efficient use of water and conservation and protection of water resources*".

3.2 ASH DISPOSAL FACILITY:

Ash disposal facilities (ADF) generally comprises of the following systems: ash handling/conveyance systems, ash dump and pollution control systems. The ADF and its components shall be designed to meet the service life requirements and performance requirements as specified in the SRD document. The following provides general aspects to be considered in the civil design of ash facilities:

3.2.1 Basic/Conceptual Design/Feasibility Studies

The basic/conceptual design for the proposed ash dump is normally based on (but not limited to) the following aspects:

- Type of ashing system required (wet/dry)
- Mechanical arrangement of boiler ash extraction plant
- Operational configuration
- Conveyance system (pipes/conveyors)
- Estimated capacity requirements
- Geometry
- Footprint
- Topography of terrain
- Possible other uses (i.e. dual storage purpose)
- Water balance
- Pollution control
- Rate of deposition

The capacity of the ash stack is mainly dependent on among other things the foot print, achievable safe maximum stacking height, side slopes, geometry, topography of the area. The design of the ash stack and consideration for the above mentioned aspects is expected to provide the required capacity on the

¹ Eskom Water Management Policy, 32/1163

identified foot print area. The stability of the stack at the design height shall be accordingly assessed to ensure safety against a slope failure. See also section 3.2.11.

3.2.2 Site Investigations

Geotechnical site investigations are required as a minimum in order to investigate the existing geological and geotechnical conditions, geological constraints and to estimate the engineering & physical properties of underlying geology for the footprint area which affect the design and construction of the proposed ash disposal facility.

The type, objectives and scope of the investigations required shall be defined by the appointed designer for the project. Refer to Eskom Standard for the Execution of Site Investigations (document no. 240-57127951) and Geotechnical Standards for Coal Stockyard and Ash Dam/Dump Site Investigation (Eskom document no. 240-92460850) which provide guidelines and minimum requirements for general investigations activities for Eskom projects. Specific and specialist requirements for testing and investigations in line with the objectives of the site investigations shall be at the discretion of the designer.

Due to relatively high capital costs required for large projects such as ash dumps, where possible, site investigations shall assess site specific material for potential use as construction material (i.e. general fill, engineered barrier layer works etc.) to make the project more economically viable.

3.2.3 Geohydrological Studies

Geohydrological investigations as part of the site investigations are required in order to investigate the existing groundwater systems/regime; and to assess the potential impacts of the proposed ash disposal facility to the groundwater regime. The findings and recommendations of the studies provide elements that need to be considered in design in order to provide reasonable measures to mitigate, control and manage the identified potential impacts.

3.2.4 Service Life Requirements

The long term performance of the ash dump design, designed components and specified material (i.e. geomembranes, geotextiles, layer works etc.) shall meet the service life requirements of the facility as defined in the ROC.

3.2.5 Barrier Design

The appropriate barrier design and associated design components for the ash facility is based on the classification of the waste streams in terms of Government Notice No. 634 & 636. The barrier design shall comply with the relevant prevailing regulations, prescribed minimum engineering design requirements, applicable standards and engineering codes of practice for the design of waste disposal facilities.

3.2.6 Leachate Management System

The buildup of leachate above the barrier system can potentially lead to the development of hydraulic head and potentially risk of instabilities associated with such. A leachate collection systems is designed amongst others to take this potential effect into consideration. Appropriate leachate management systems (collection and/or detection systems) shall be designed according to the industry best practices and applicable standard. The leachate management system shall be designed to effectively collect and convey leachate without failure to the designed collection impoundments.

3.2.7 Storm Water Management

The expected clean and dirty storm water runoff from the considered catchment shall be collected and conveyed in appropriately designed storm water management infrastructure. The storm water

CONTROLLED DISCLOSURE

management infrastructure shall be accordingly sized to suit the expected runoff. The design of the drainage infrastructure shall comply with prevailing regulatory & legislative requirements, industry codes of practice and applicable standards for the design of storm water management infrastructure for both effluent containment and erosion protection aspects.

The provision for specific maintenance requirements (i.e. cleaning, monitoring) shall be accordingly considered in the designed systems as defined in the project specific Stakeholder Requirements Definition.

3.2.8 Pollution Control Dams

The design of pollution control dams shall comply with prevailing regulatory requirements for water management (i.e. National Water Act and Government Notice No. 704), applicable standards and relevant design best practice guidelines in respect to, amongst others things: sizing, stability requirements, spillways, freeboard requirements, safety evaluation, environmental compliance and other relevant design considerations.

Refer to Eskom standards for the design of dams.

3.2.9 Silt/Sediment Management

Storm water flow and dirty runoff from ash facilities normally tends to entrain sediments. Excessive build-up of sediments over time, if left unattended, can potentially reduce the conveyance capacity of channels and storage capacity of pollution control dams. Suitable silt management systems shall be designed in accordance with best practices to manage and control sediment deposition.

3.2.10 Erosion Control

Steep gradients, angles, slopes for drainage trenches and embankments in general contribute to high runoff velocities and risk of erosion. The geometry of ash stacks typically has steep gradients which can lead to risk of erosion. The design of the ash dump and its components shall accordingly consider appropriate erosion mitigation, control and protection measures [where deemed necessary].

3.2.11 Stability Analysis

The relevant national and international [where applicable] standards and codes of practice shall be accordingly considered in the stability analyses of the ash disposal facility in order to ensure acceptable global and local systems stability and safety against shear failure of, amongst others: the ash dump, ash dump base, barrier system interface layers, embankments, capping systems and pollution control dam walls and others.

The assessments of the achievable and safe rate of rise for ash shall take into consideration the overall stability of the ash stack.

3.2.12 Rehabilitation

Ash dumps generally remain in existence post the decommissioning of power stations. They form a permanent feature of the landscape and environment. Continuous rehabilitation of ash dumps is a common practice in the industry to generally promote the following: reduce erosion of the slopes, reduce ash dust blow-off and negative visual impacts, integration and restoration of the surrounding environment. The design of the ash dump shall consider suitable rehabilitation measures.

3.2.13 Ground water Monitoring

Ground water monitoring is required as part of the Environmental Management Plan and operations of the Ash Dump/Dam. The requirements for ground water monitoring, ash dump monitoring and frequency

of surveillance are prescribed in the conditions of the Waste Management License and relevant regulations. Where required, monitoring systems shall be accordingly considered in the design.

3.3 SAFETY CONSIDERATIONS

The design shall consider reasonable measures to ensure the safety of personnel during construction and operations. The designer is referred to OHS requirements.

4. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
Andre Kreuter	Chief Engineer: Geotechnical Engineering CoE
Terrance Mavunda	CoE Manager: Geotechnical Engineering CoE
Galia Dudenska	Senior Manager: Civil & Structural Engineering
Andre Kreuter	Chief Engineer: Geotechnical Engineering CoE

5. REVISIONS

Date	Rev.	Compiler	Remarks
March 2017	0.1	T. Chokoe	Draft Document for review created
March 2017	0.2	T. Chokoe	Final Draft Document for Comments Review
March 2017	1	T. Chokoe	Final Document for Authorisation and Publication

6. DEVELOPMENT TEAM

- Tau Chokoe

7. ACKNOWLEDGEMENTS

- Andre Kreuter
- Terrance Mavunda
- Geotechnical Engineering Study Committee

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.