

MWG

Midwest Generation, LLC
Waukegan Generating Station

2021 Safety Factor Assessment for East Ash Pond & West Ash Pond



Revision 0

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TABLE OF CONTENTS

Table of Contentsi

1.0 Purpose & Scope.....1

 1.1 Purpose..... 1

 1.2 Scope..... 1

2.0 Inputs.....2

3.0 Assumptions.....3

4.0 Methodology3

5.0 Assessment4

 5.1 Summary of Initial Safety Factor Assessment..... 4

 5.2 Changes in Bases for Initial Factors of Safety..... 4

6.0 2021 Safety Factor Assessment Conclusions6

7.0 Certification7

8.0 References8

Appendix A: 2016 East & West Ash Ponds Safety Factor Assessment

1.0 PURPOSE & SCOPE

1.1 PURPOSE

The East and West Ash Ponds (the Ponds) at Midwest Generation, LLC's (MWG) Waukegan Generating Station ("Waukegan" or the "Station") are existing coal combustion residual (CCR) surface impoundments that are regulated by the Illinois Pollution Control Board's "Standards for the Disposal of Coal Combustion Residuals in CCR Surface Impoundments." These regulations are codified in Part 845 to Title 35 of the Illinois Administrative Code (35 Ill. Adm. Code 845, Ref. 1) and are also referred to herein as the "Illinois CCR Rule." Pursuant to 35 Ill. Adm. Code 845.460(a), MWG must conduct and complete a safety factor assessment that documents whether the critical cross section at each of the Ponds achieves the minimum safety factors specified in 35 Ill. Adm. Code 845.460(a).

The Ponds at Waukegan are also regulated by the U.S. Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," 40 CFR Part 257 Subpart D (Ref. 2), also referred to herein as the "Federal CCR Rule." Pursuant to 40 CFR 257.73(f)(3), the Federal CCR Rule requires MWG to conduct and complete a safety factor assessment in accordance with 40 CFR 257.73(e) for the Ponds every five years.

This report documents the 2021 safety factor assessment conducted and completed in accordance with the Illinois and Federal CCR Rules by Sargent & Lundy (S&L) on behalf of MWG for the East and West Ash Ponds at the Waukegan Generating Station. This report:

- Lists the inputs and assumptions used in the 2021 safety factor assessment,
- Discusses the methodology used to conduct the 2021 safety factor assessment,
- Lists and compares the safety factor acceptance criteria for CCR surface impoundments promulgated by the Illinois and Federal CCR Rules,
- Summarizes the results from the initial safety factor assessment completed for the Ponds that was conducted in accordance with the Federal CCR Rule,
- Evaluates potential changes to the inputs used in the initial safety factor assessment to determine whether new or updated liquefaction and/or structural stability analyses are warranted, and
- Provides the 2021 factors of safety for the East and West Ash Ponds in accordance with 35 Ill. Adm. Code 845.460(a) and 40 CFR 257.73(e).

1.2 SCOPE

Per the 2016 Water Infrastructure Improvements for the Nation (WIIN) Act, the East and West Ash Ponds will continue to be subject to both the Illinois and Federal CCR Rules until the U.S. EPA approves the Illinois EPA's CCR permit program. The Illinois EPA has yet to publish a timeline for submitting its proposed CCR

permit program to the U.S. EPA for approval, and so MWG must conduct safety factor assessments pursuant to both sets of regulations at this time.

2.0 INPUTS

Safety Factor Acceptance Criteria for CCR Surface Impoundments

The Illinois CCR Rule (Ref. 1, § 845.460) requires each existing CCR surface impoundment to achieve four minimum safety factors at the impoundment’s critical cross section, which is defined by the Illinois CCR Rule as “the cross section anticipated to be the most susceptible of all cross-sections to structural failure based on appropriate engineering considerations, including loading conditions.” The Federal CCR Rule (Ref. 2, § 257.73(e)) has the same safety factor acceptance criteria as the Illinois CCR Rule. Table 2-1 presents the safety factor acceptance criteria promulgated by both sets of regulations for existing CCR surface impoundments.

Table 2-1 – Safety Factor Acceptance Criteria for Existing CCR Surface Impoundments

| Loading Condition | Minimum Allowable Factor of Safety | Illinois CCR Rule Reference | Federal CCR Rule Reference |
|---------------------------------|---|------------------------------------|-----------------------------------|
| Long-Term, Maximum Storage Pool | 1.50 | § 845.460(a)(2) | § 257.73(e)(1)(i) |
| Maximum Surcharge Pool | 1.40 | § 845.460(a)(3) | § 257.73(e)(1)(ii) |
| Seismic | 1.00 | § 845.460(a)(4) | § 257.73(e)(1)(iii) |
| Liquefaction | 1.20 | § 845.460(a)(5) | § 257.73(e)(1)(iv) |

Initial Safety Factor Assessment

Appendix A provides the initial safety factor assessment conducted by Geosyntec Consultants in 2016 for the Ponds (Ref. 3). The inputs, assumptions, and methodology utilized in these initial safety factor assessments were evaluated to determine whether any updates to this analysis were warranted.

Site Topography & Aerial Images

Topographic data for the Ponds and the adjacent areas was obtained from an aerial survey flown at the site in December 2015 (Ref. 4). Historical and recent aerial images of the Ponds and adjacent areas were obtained from Google Earth Pro (Ref. 5).

Groundwater

Groundwater data for the Ponds and surrounding areas was obtained from annual groundwater monitoring reports prepared by KPRG and Associates, Inc. for the CCR surface impoundments in accordance with 40 CFR 257.90(e) (Refs. 12 through 15).

Ash Pond Conditions

The operating and physical conditions for the Ponds were based on discussions with MWG personnel and on the annual inspection reports prepared for the CCR surface impoundments in accordance with 40 CFR 257.83(b) (Refs. 6 through 10).

Horizontal Seismic Coefficient

Pursuant to 35 Ill. Adm. Code 845.460(a)(4) and 40 CFR 257.73(e)(1)(iii), the Ponds must have a minimum factor of safety of 1.00 when analyzed under a seismic loading condition. This loading condition is represented by a horizontal seismic coefficient that is based on a peak ground acceleration (PGA) with a 2 percent probability of exceedance in 50 years in accordance with the definition of “[m]aximum horizontal acceleration in lithified earth material” promulgated by 35 Ill. Adm. Code 845.120 and 40 CFR 257.53. The design horizontal seismic coefficient is also based on the mapped spectral response acceleration at a period of 1 second (S_1) and on a site correction factor (F_v) that accounts for the impacts of site-specific soil conditions on the mapped PGA and spectral response acceleration. Table 2-2 presents the seismic response parameters obtained from ASCE 7-16 (Ref. 15) on which the Ponds’ seismic loading condition was based.

Table 2-2 – Horizontal Seismic Coefficient Inputs

| Parameter | Symbol | Value |
|--|--------|-------|
| Peak Ground Acceleration | PGA | 0.077 |
| Mapped Spectral Response, 1-Second Period | S_1 | 0.056 |
| Site Correction Factor for 1-Second Period | F_v | 2.4 |

3.0 ASSUMPTIONS

There are no assumptions in this document that require verification.

4.0 METHODOLOGY

The inputs for the Ponds’ initial safety factor assessment were reviewed to determine if any changes have occurred since the initial assessment was completed. Identified changes were then evaluated to determine if updates to the ponds’ previous structural stability and/or liquefaction analyses were warranted. Where no

changes were noted for a given input, or where identified changes were determined to have no impact to the results and conclusions of the initial safety factor assessment, the previous evaluation of that input was considered to still be valid.

5.0 ASSESSMENT

5.1 SUMMARY OF INITIAL SAFETY FACTOR ASSESSMENT

The initial safety factor assessment for the East and West Ash Ponds was completed in October 2016 and is included in its entirety in Appendix A. The results of this assessment indicated that the Ponds' critical cross-sections are stable and meet the factor of safety requirements presented in 40 CFR 257.73(e)(1)(i) through 257.73(e)(1)(iv). Because the Illinois and Federal CCR Rules have the same safety factor acceptance criteria, it is noted that the factors of safety calculated in the initial safety factor assessment also comply with the factor of safety requirements promulgated under 35 Ill. Adm. Code 845.460(a)(2) through 845.460(a)(5).

In addition to evaluating the pond's earthen dikes, the initial safety factor assessment also evaluated a metal bin retaining wall located along a portion of the East and West Ash Ponds' northern dikes. This wall section was analyzed to confirm it meets or exceeds the minimum factors of safety for bearing capacity, overturning, and sliding that are generally accepted industry standards.

5.2 CHANGES IN BASES FOR INITIAL FACTORS OF SAFETY

The following subsections summarize the evaluation conducted to determine if changes to the design inputs used in East and West Ash Ponds' initial safety factor assessment have occurred since the assessment was completed, and to determine whether the initial structural stability and liquefaction analyses can be accepted as-is for this 2021 assessment or if further analysis is required.

5.2.1 CHANGES IN GEOTECHNICAL DATA

Based on reviews of the annual inspection reports (Refs. 6 through 10) and Google Earth aerial images (Ref. 5), there have been no significant changes to the embankments or underlying soils that would require updating the geotechnical parameters used in the 2016 analysis (Ref. 3).

5.2.2 CHANGES IN TOPOGRAPHY ADJACENT TO ASH PONDS

Based on reviews of the annual inspection reports (Refs. 6 through 10) and Google Earth aerial images (Ref. 5), there have been no significant modifications to the ground surfaces adjacent to the Ponds (mass excavations, mass fill placement, etc.) since the initial safety factor assessment was completed. Therefore, the topographic data collected for the site in 2015 (Ref. 4) remains valid for use in this 2021 assessment.

5.2.3 CHANGES IN GROUNDWATER TABLE

Based on reviews of the annual groundwater monitoring and corrective action reports for the Ponds (Refs. 12 through 15), no significant variations in the groundwater were noted. Because the East and West Ash Ponds are lined with a geomembrane, the embankments are not hydraulically connected to the water levels within the Ponds, and a typical phreatic surface normally associated with seepage through an earthen embankment is not applicable. The reported static groundwater elevation is valid for this analysis and there have been no significant changes in the surface water conditions near the site that would impact the site's groundwater levels.

5.2.4 CHANGES IN EMBANKMENT GEOMETRY

Based on reviews of the annual inspection reports (Refs. 6 through 10), Google Earth aerial images (Ref. 5), and visual observations made in September 2021, there have been no significant modifications to the embankments for the Ponds since the initial safety factor assessment was completed. Therefore, there is no basis to reevaluate the embankment geometry of the Ponds for this 2021 assessment.

5.2.5 CHANGES IN EARTHQUAKE DESIGN BASIS

The design horizontal seismic coefficient utilized in the existing technical analysis (Ref. 3) is based on published data in ASCE 7-10 (Ref. 17). Since developing the technical analysis, an updated publication of the reference material has been produced (ASCE 7-16 (Ref. 16)), which provides updated values for the parameters used to determine the design horizontal seismic coefficient (see Tables 2-2 and 5-1). Based on the changes in the site seismic loading parameters from ASCE 7-10 to ASCE 7-16, the horizontal seismic coefficient for the Ponds' seismic loading condition will be less than the value used in the initial safety factor assessment. Therefore, the horizontal seismic coefficient used for the 2016 analysis is conservative. Thus, it is not necessary to change the earthquake design basis used to conduct the initial safety factor assessment for the Ponds.

Table 5-1 – Seismic Loading Parameters Comparison

| Parameter | Symbol | 2016 Values per ASCE 7-10 | 2021 Values per ASCE 7-16 |
|--|--------|---------------------------|---------------------------|
| Peak Ground Acceleration | PGA | 0.086 | 0.077 |
| Mapped Spectral Response, 1-Second Period | S_1 | 0.054 | 0.056 |
| Site Correction Factor for 1-Second Period | F_v | 2.4 | 2.4 |

5.2.6 CHANGES IN ASH POND OPERATIONS

In June 2020, Waukegan took the West Ash Pond out of service for routine cleaning. During a site visit in September 2021, it was noted that most of the CCR previously stored in the West Ash Pond had been removed and minimal surface water remained. In April 2021, MWG filed a notice of intent to close the West Ash Pond in accordance with the Federal CCR Rule's closure criteria (Ref. 2, § 257.102). Closure construction activities will commence at the pond upon receipt of a closure construction permit from the Illinois EPA in accordance with Subpart B of the Illinois CCR Rule. Meanwhile, Waukegan continues to operate the East Ash Pond to manage CCR wastestreams and various non-CCR wastestreams from the Station in accordance with 40 CFR 257.103(f)(1). Operating conditions at this pond have not changed since the pond's initial safety factor assessment was conducted in 2016.

The decrease in surface water elevation in the West Ash Pond decreases the driving forces in the embankment; therefore, the surface water elevation used for the 2016 analysis is conservative for the pond's current operation condition. Because the operating conditions at the East Ash Pond have not changed since the initial safety factor assessment was completed, the 2016 structural stability analysis for the pond remains valid. Therefore, there is no basis to reevaluate the surface water elevations used to conduct the initial safety factor assessment for the Ponds.

6.0 2021 SAFETY FACTOR ASSESSMENT CONCLUSIONS

The initial safety factor analyses for the East and West Ash Ponds (Ref. 3) were reviewed and validated for compliance with the Illinois and Federal CCR Rules' safety factor acceptance criteria for existing CCR surface impoundments. No changes that would invalidate the conclusions of the initial safety factor assessment were identified in reviews of available information and reports completed for the CCR surface impoundments since the initial assessment was completed in 2016. Therefore, the results reported in the initial safety factor assessment for the East and West Ash Ponds' earthen dikes and retaining wall remain valid for this 2021 assessment.

Table 6-1 presents the 2021 factors of safety for the East and West Ash Ponds' earthen dikes at Waukegan as determined in accordance with 35 Ill. Adm. Code 845.460(a) and 40 CFR 257.73(e).

Table 6-1 – 2021 Illinois & Federal CCR Rule Factors of Safety for the East and West Ash Ponds at the Waukegan Generating Station

| Loading Condition | East Ash Pond | West Ash Pond | Min. Allowable Factor of Safety |
|---------------------------------|---------------|---------------|---------------------------------|
| Long-Term, Maximum Storage Pool | ≥ 1.50 | ≥ 1.50 | 1.50 |
| Maximum Surcharge Pool | ≥ 1.40 | ≥ 1.40 | 1.40 |
| Seismic | ≥ 1.00 | ≥ 1.00 | 1.00 |
| Liquefaction | Note 1 | Note 1 | 1.20 |

Notes: 1) The embankment soils for the Ponds are not considered susceptible to liquefaction because saturation of the embankment soils is unlikely based on the installed geomembrane liner system. A limited portion of the bottom of the embankments may become saturated with groundwater based on the design phreatic surface. Liquefaction triggering analyses of these saturated soils show that liquefaction and associated post-liquefaction shear strength loss is unlikely for the design seismic event (Ref. 3). Thus, liquefaction safety factors are not reported.

7.0 CERTIFICATION

I certify that:

- This safety factor assessment was prepared by me or under my direct supervision.
- The work was conducted in accordance with the requirements of 35 Ill. Adm. Code 845.460 and with the requirements of 40 CFR 257.73(e).
- I am a registered professional engineer under the laws of the State of Illinois.

Certified By: Thomas J. Dehlin Date: October 15, 2021

Seal:



Th. Dehlin
10/15/2021
Exp. 11/30/2021

8.0 REFERENCES

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**APPENDIX A: 2016 EAST & WEST ASH PONDS SAFETY
FACTOR ASSESSMENT**

