BURNS McDONNELL

Initial Structural Stability Assessment of Louisa Surface Impoundment

MidAmerican Energy

MidAmerican Energy Company
Louisa Generating Station

Final
October 10, 2016

Initial Structural Stability Assessment of Louisa Surface Impoundment

Prepared for

MidAmerican Energy Company
Louisa Generating Station
Muscatine, Iowa

Final
October 10, 2016

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INDEX AND CERTIFICATION

MidAmerican Energy Company
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Report Index

Certification

I hereby certify, as a Professional Engineer in the State of Iowa, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the MidAmerican Energy Company Louisa Generating Station or others without specific verification or adaptation by the Engineer.

Nathan Textor, P.E.

Date: 10/10/16

Nathan Textor
License Number 23013

My license renewal date is December 31, 2016

Sections covered by this seal: Sections 3.1, 3.2, 3.3 and 3.7.

10-10-16

10/10/16

Richard E. Besancon
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Date: October 10, 2016

My license renewal date is December 31, 2016

Sections covered by this seal: Sections 3.3, 3.4, 3.5 and 3.6.

TABLE OF CONTENTS

Page No.

LIST OF FIGURES

LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
BMcD	Burns & McDonnell
CFR	Code of Federal Regulations
CCR	Coal Combustion Residual
EPA	Environmental Protection Agency
FS	Factor of Safety
Impoundment	Surface Impoundment
LGS	Louisa Generating Station
MEC	MidAmerican Energy Company
NPDES	National Pollution Discharge Elimination System
RCRA	Resource Conservation and Recovery Act
U.S.C.	United States Code

1.0 SUMMARY OF OBJECTIVES

On April 17, 2015, the Environmental Protection Agency (EPA) issued the final version of the Federal Coal Combustion Residual (CCR) Rule to regulate the disposal of coal combustion residual materials generated at coal-fired units. The rule is administered as part of the Resource Conservation and Recovery Act [RCRA, 42 United States Code (U.S.C.) §6901 et seq.], using the Subtitle D approach. MidAmerican Energy Company (MEC) is subject to the CCR Rule.

Per the requirements of 40 CFR Section 257.73(d), the Initial Structural Stability Assessment of all Active CCR Impoundments must be completed. A qualified professional engineer must determine that the result of the assessment meets the requirements of 257.73(d). On behalf of MEC, Burns & McDonnell (BMcD) has completed the Initial Structural Stability Assessment of the Louisa Generating Station (LGS) Surface Impoundment. An excerpt from the CCR Rule describing the requirements that are addressed in this report is included in Appendix A.

This report contains a description of the site, subsurface information obtained to support the evaluation and the results of the structural stability assessment performed. The seals on this document certify that the Surface Impoundments meets the requirements of 40 CFR Section 257.73(d).

2.0 IMPOUNDMENT DESCRIPTION

The Surface Impoundment (referred to herein as Impoundment) is located to the east of the main plant area at LGS, as shown in Figure 1. The Impoundment contains CCR and process water. The western side and west half of the north side of the Impoundment are incised. The remaining portions of the Impoundment have a perimeter embankment system. The Impoundment is broken up into two sections (Main Pond and Reclaim Pond) that are separated by an inner embankment. However, these two sections are hydraulically connected.

The outer embankment was originally designed by Black & Veatch Consulting Engineers in 1981 to have slopes of 3.5H:1V and a crest elevation of 568 feet. The Black & Veatch design drawing indicates the Impoundment was to be lined with a 12-inch thick natural clay layer. The Mississippi River lies to the east of the Impoundment. The U.S. Army Corps of Engineers' Mississippi River levee is directly adjacent to the Impoundment east embankment. The levee crest elevation is below the Impoundment embankment crest elevation. Water within the Impoundment is pumped from the pump house in the northeast portion of the Impoundment into Outfall 002 to the Mississippi River under the National Pollution Discharge Elimination System (NPDES) Permit No. # 58-00-1-05 or recirculated back to the plant for reuse.

Figure 1: General Location of Surface Impoundment

3.0 STRUCTURAL STABILITY ASSESSMENT

The primary object of the structural stability assessment in Section 257.73(d) of the CCR Rule is to "document whether the design, construction, operation and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein." Existing documents, site investigations, site visits and hydraulic design were all reviewed/performed to assess different aspects of the Impoundment as discussed within the CCR Rule. A discussion for each of these aspects is provided below.

3.1 Stable Foundations and Abutments

Section 257.73(d)(i) of the CCR Rule requires that the foundations and abutments be stable. As part of work done at the site, a geotechnical investigation was performed by Braun Intertec in April and May of 2016. BMcD used information from this investigation to perform the Initial Safety Factor Assessment of the Impoundment. General subsurface conditions indicate that the foundation materials are medium dense to dense sands over bedrock. These soils are not susceptible to settlement. Given this fact and the age of the Impoundment, additional settlement is not anticipated.

Results of the Initial Safety Factor Assessment indicated that appropriate slope stability factors of safety are met for the existing embankments. Based on the stability evaluation and minimal expected future settlement, the foundations are considered stable.

No cracking or seepage was observed at the Impoundment abutments. Thus, the abutments are considered stable.

3.2 Adequate Slope Protection

Section 257.73(d)(ii) of the CCR Rule requires that there be adequate slope protection to protect against surface erosion, wave action and adverse effects of sudden drawdown.

Along the outer slope of the embankments, there was minor erosion observed in places, typically associated with recent construction activities that had not been reseeded based on growing season. The majority of the outer slope was observed to have adequate vegetation to prevent erosion. The interior face of the embankments are lined with rip rap within the zone of wave action. No erosion was observed within the Impoundment embankment. Based on the observed conditions, there is adequate slope protection.

3.3 Dikes Mechanically Compacted

Section 257.73(d)(iii) of the CCR Rule requires that the dikes, or embankments, be mechanically compacted to a density sufficient to withstand the range of load conditions in the CCR unit. During design of the Impoundment, Black & Veatch prepared an earthwork specification that required the embankment fill be placed in 8-inch lifts and compacted to 95 percent of Standard Proctor Density. Compaction testing was done during construction by Soil Testing Services, Inc. to confirm these specifications were met. Based on this information, the embankments are adequately compacted.

3.4 Slope Vegetation Height

Section 257.73(d)(iv) of the CCR Rule requires that the vegetated slopes of the dikes and surrounding areas not exceed a height of six (6) inches above the slope of the dike. However, based on the following discussion, this is no longer a requirement of the CCR Rule.

On June 14, 2016, the U.S. Court of Appeals for District of Columbia Circuit (D.C. Circuit) granted the unopposed motion in the CCR litigation to remand and remand/vacate certain elements of the CCR Rule as a result of the settlement between industry and environmental petitioners. See the below text from the oral argument (USCA Case #15-1219, Document #1619358):

> "Upon consideration of the unopposed motion for voluntary remand of specific regulatory provisions, it is ORDERED that the motion be granted. The following provisions are hereby remanded with vacatur to the agency for further proceedings: 1) the phrase "not to exceed a height of 6 inches above the slope of the dike" within 40 C.F.R. §§ 257.73(a)(4), 257.73(d)(1)(iv), 257.74(a)(4), and 257.74(d)(1)(iv)."

3.5 Spillway

Section 257.73(d)(v) of the CCR Rule requires that the spillway be constructed of non-erodible material, designed to carry sustained flows and must have a capacity with the ability to adequately manage a design flood event which is based on the surface impoundment hazard classification.

The Impoundment does not have a spillway but instead operates Outfall 002 to the Mississippi River. Outfall 002 is a 6-inch diameter steel pipe that discharges wastewater pumped from the Reclaim Pond.

Based on previous work, the Impoundment hazard classification has been determined to be low; therefore the spillway must adequately manage a 100-year flood event. BMcD performed a study to evaluate the watershed, runoff, discharge, and impounded depth during a 100-year flood event. The results indicate

that there is adequate storage within the Impoundment and that overtopping the embankment is not a concern using the existing operation and infrastructure.

3.6 Hydraulic Structure Integrity

Section 257.73(d)(vi) of the CCR Rule requires that any hydraulic structures underlying the base of the CCR unit or passing through the embankment of the CCR unit maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation and debris which may negatively affect the operation of the hydraulic structure. Hydraulic structures and conduits known to run under or through the embankment for the Impoundment are as follows:

- Steel discharge line associated with Outfall 002,
- Two 8-inch steel lines,
- Two 12-inch steel lines,
- One 6-inch steel line and
- One concrete electrical duct bank.

All of these structures and conduits run under or through the north embankment to the pump house. According to Page 21394 of the preamble to the CCR Rule, "abnormal discharges from hydraulic structures are often an indication of potential issues with the sub-surface or internal integrity of the structure". MEC personnel have noted no turbidity, color change, or other indication in the discharge water that the lines are corroded or failing. There has been no observed settlement or change in grade above the structures and conduits that would imply structural compromise.

3.7 Downstream Slope Stability

Section 257.73(d)(vii) of the CCR Rule requires that any downstream slopes adjacent to a water body should maintain structural stability during low pool of the adjacent water body or after sudden drawdown of the adjacent water body. The east embankment of the Impoundment is directly adjacent to the Mississippi River levee and thus is susceptible to long-term flooding events. Because of this, sudden drawdown slope stability must be considered.

Sudden drawdown slope stability evaluations were performed for the east embankment for a design flood event for the Mississippi River. The factors of safety (FS) calculated were 2.00. No minimum required FS value was provided in the CCR Rule. As a comparison value, the calculated FS was compared to the

minimum FS for sudden drawdown for levees put forth by the U.S. Army Corps of Engineers. The minimum sudden drawdown FS for levee and dam design is between 1.0 and 1.2. The east embankment FS is well above these minimum values and thus is considered stable under sudden drawdown conditions.

4.0 REPORT LIMITATIONS

Discussions regarding site conditions that apply to adequate slope protection, hydraulic structure integrity and slope stability were made based on observations made at the time of this Initial Structural Stability Assessment by BMcD and MEC personnel. Any changes to embankment geometry, cracking, settling or observed indications of possible issue with the underground culvert, such as turbidity in the outfall water or settlement at the ground surface, should be communicated to BMcD.

APPENDIX A – EXCERPT FROM CCR RULE (§257.73)

paragraphs (c)(1)(i) through (xi) of this section.

(i) The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

(ii) The location of the CCR unit identified on the most recent U.S. Geological Survey (USGS) 7½ minute or 15 minute topographic quadrangle map, or a topographic map of equivalent scale if a USGS map is not available.

(iii) A statement of the purpose for which the CCR unit is being used.

(iv) The name and size in acres of the watershed within which the CCR unit is located.

(v) A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is constructed.

(vi) A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; the method of site preparation and construction of each zone of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.

(vii) At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely affect operation of the CCR unit due to malfunction or mis-operation.

(viii) A description of the type, purpose, and location of existing instrumentation.

(ix) Area-capacity curves for the CCR unit.

(x) A description of each spillway and diversion design features and capacities and calculations used in their determination.

(xi) The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.

(xii) Any record or knowledge of structural instability of the CCR unit.

(2) *Changes to the history of construction.* If there is a significant change to any information compiled under paragraph (c)(1) of this section, the owner or operator of the CCR unit must update the relevant information and place it in the facility's operating record as required by § 257.105(f)(9).

(d) *Periodic structural stability assessments.* (1) The owner or operator of the CCR unit must conduct initial and periodic structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein. The assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained with:

(i) Stable foundations and abutments;

(ii) Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown;

(iii) Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit;

(iv) Vegetated slopes of dikes and surrounding areas not to exceed a height of six inches above the slope of the dike, except for slopes which have an alternate form or forms of slope protection;

(v) A single spillway or a combination of spillways configured as specified in paragraph (d)(1)(v)(A) of this section. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in paragraph (d)(1)(v)(B) of this section.

(A) All spillways must be either:

(*1*) Of non-erodible construction and designed to carry sustained flows; or

(*2*) Earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.

(B) The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a:

(*1*) Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or

(*2*) 1000-year flood for a significant hazard potential CCR surface impoundment; or

(*3*) 100-year flood for a low hazard potential CCR surface impoundment.

(vi) Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure; and

(vii) For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.

(2) The periodic assessment described in paragraph (d)(1) of this section must identify any structural stability deficiencies associated with the CCR unit in addition to recommending corrective measures. If a deficiency or a release is identified during the periodic assessment, the owner or operator unit must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken.

(3) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial assessment and each subsequent periodic assessment was conducted in accordance with the requirements of this section.

(e) *Periodic safety factor assessments.* (1) The owner or operator must conduct an initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in paragraphs (e)(1)(i) through (iv) of this section for the critical cross section of the embankment. The critical cross section is 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 safety factor assessments must be supported by appropriate engineering calculations.

(i) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.

(ii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.

(iii) The calculated seismic factor of safety must equal or exceed 1.00.

(iv) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

(2) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating

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