FINAL

LIFE ASSESSMENT REPORT

J.B. Sims Generating Station Unit 3

B&V PROJECT NO. 198962
B&V FILE NO. 40.0000

PREPARED FOR

Grand Haven Board of Light and Power

13 JUNE 2018

BLACK & VEATCH

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Business Confidential 13 June 2018

Board of Directors
Grand Haven Board of Light & Power
1700 Eaton Drive
Grand Haven, MI 49417

Subject: J.B. Sims Generating Station, Unit 3 Life Assessment Report

Dear Board of Directors:

We are pleased to submit this life cycle assessment report for J.B. Sims Unit 3. In April of 2018, Black & Veatch was retained by the Board of Directors to conduct an independent condition assessment on Sims Unit 3. Black & Veatch was the original design engineer of record for this unit when it was installed in 1983. For over the past 35 years, Black & Veatch has routinely provided support for the Grand Haven Board of Light and Power as requested.

The findings of this independent life condition assessment are included in the attached report. An itemized list along with an action schedule and forecasted expenses have been provided for continued operation of Sims Unit 3. Since the costs exceed the benefit of life extension on Sims Unit 3, Black & Veatch has also provided alternate generation strategies and steps that should be taken by the Grand Haven Board of Light & Power to provide electric service that is safe, reliable, and affordable into the future.

It has been a pleasure serving the Grand Haven Board of Light and Power over the past 35 years and we look forward to continue supporting you for the foreseeable future and beyond. Please feel free to contact Bradley Saad (Tel: 734-458-4677, email: SaadBR@bv.com) or myself (Tel: 269-352-4230, email: ChandrapalM@bv.com) if you would like any clarification, additional information or if you have any questions regarding the findings and our recommendations,

Very truly yours,
BLACK & VEATCH LTD. OF MICHIGAN

Marcus Chandrapal
Business Development

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1.0 Executive Summary

The J.B. Sims Generating Station's Unit 3 has been operating for 35 years, with many of the plant equipment and equipment components not being replaced during this time. Black & Veatch was the original design engineer of record for this unit when it was installed in 1983. Additionally, Black & Veatch continuously monitors the operation of the facility through the Monitoring and Diagnostic (M&D) services program which was initiated in 2016. Black & Veatch also recently provided on site heat rate testing, evaluation, and improvement recommendations to optimize the operation of the unit. In April 2018, the Grand Haven Board of Light and Power (GHBLP) selected Black & Veatch to assess the condition of the Unit, the results of which are covered in this report.

After review of historical plant operation and maintenance data, on-site walkdown and meetings with plant Maintenance & Operations staff, Black & Veatch confirms that many of the critical plant equipment and sub-components have become obsolete and worn to the point of needing replacement and condition assessments which, in addition inspection and test reports are old and may not be representative of the equipment's current condition.

Based on operating data, previous test results, historical studies and evidence available, Black & Veatch estimates an investment of $35.0 million will be required for continued safe and reliable operation. Continued operation in the current condition without taking corrective action will increase the risk of possible equipment and/or catastrophic failure, which could cause serious injury or death to personnel and long-term loss of generation. Increased operating hours will increase reactive repair work, requiring increased overtime and maintenance expenses. Additionally, a coal fired power plant requires a significant fuel inventory. If a failure occurs in which the utility is not willing to fix due to costs of repairs, then there will be stranded costs due to the coal that needs to be either sold or disposed resulting in potentially significant lost revenues.

Black & Veatch's assessment did not find conditions which would prevent Unit 3 from returning to service in June 2018. There are important issues which need to be addressed as soon as possible, however, to mitigate risk and identify equipment and sub-components with a high risk of failure. Black & Veatch has developed a listing of recommended actions which need to be addressed within the next five years. Table 1-1 shows progressive expenditure levels for the next five years.

Table 1-1 Progressive Expenditure for Sims Unit 3

ACTION SCHEDULE	FORECASTED EXPENSE, $M
< 6 Months	1.9
< 12 Months	2.5
> 24 Months < 5yrs	8.8
Next Major Outage	7.9
5+ Year Plan	13.9
TOTAL	**35.0**

Based on findings of the condition assessment and estimated financial commitment, Black & Veatch recommends GHBLP shutting down Unit 3 by June 1, 2020 for the following reasons:

- Unit 3 has reached the end of useful life, requiring significant investment to continue safe and reliable operation.
- Necessary expenditures of approximately $35.0 million dollars will be required for life extensions. These costs will have exceeded any benefits of life extension since this unit is more expensive to operate than other alternatives currently available.
- Other more economical power supply options exist that would drastically improve future electric prices for utility rate payers and increase electrical reliability. Grid reliability will become even greater when the GHBLP's ongoing multi-year phased 69 kV capital improvements are completed in 2019 and Network Integration Transmission Service (NITS) is obtained from the Midcontinent Independent System Operator (MISO). Options include both market purchases and internal generation if Grand Haven chooses to retain some locally owned and locally controlled assets.
- GHBLP will be able to take advantage of lower staffing levels through attrition which will significantly minimize any adverse effects to steam plant employees.
- Significant environmental costs can be avoided due to compliance with the Coal Combustion Residuals Rule and the upcoming Effluent Limitations Guidelines.
- The next turbine overhaul which is scheduled for 2020 can be avoided, along with both the replacement of 480V and 4160V electrical equipment, which will take approximately 2 years to purchase and install, and the boiler and scrubber controls, which need replacement but will also require long lead times and a long unit outage.

If the decision is made to cease operations of the steam plant, Black & Veatch has the following recommendations to implement over the next two years:

- Implementation of safe operating and maintenance practices for High Risk electrical equipment will be needed to help mitigate the possibility of personal injury during the next two years.
- Inspection and testing of high risk equipment needs to be performed within 6 months to learn current equipment conditions and plan safe work area strategies.
- GHBLP should plan on safety and reliability improvement expenditures of 4.4 Million until plant shut down on June 1, 2020.

2.0 Scope of Assessment

The Grand Haven Board of Light and Power requested Black & Veatch to review the J.B. Sims Plant's internal assessment and perform an independent condition assessment. Black & Veatch has had extensive experience performing condition assessments on both coal and natural gas fired generators for other large power providers. There are many systems and components which comprise a coal fired power plant such as GHBLP's. Black & Veatch reviewed design information, drawings, and interviewed plant personnel to understand historical operation & maintenance practices leading to the current plant condition. This information coupled with Black & Veatch's experience with power plant design and operations and maintenance processes helped develop the context of this assessment report. Being the original engineer of record for Sims Unit 3, Black & Veatch was uniquely qualified to perform this assessment.

Black & Veatch was retained under this scope of work to provide an opinion on the continued safe operation and condition of Unit 3. Appendix A lists recommendations and cost estimates which have a bearing on the continued safe operation of J.B. Sims Unit 3. Black & Veatch's opinion is based on the availability of relevant information. Qualified engineers licensed in Mechanical Engineering, Electrical Engineering, and Structural Engineering and Metallurgists have reviewed the condition of this Unit and were used to develop the recommendations contained in this report.

The study includes a review of the internal condition assessment completed in February 2018 and review of any other equipment which will impact safe and reliable operation, including the following systems:

- Turbine
- Boiler
- Air Pollution Control Equipment
- Electrical
- Auxiliary Equipment / Balance of Plant
- Environmental (Does not include permits review)
- Fuel Handling (Visual Inspection)

Deliverables from this assessment will support the financial analysis for ongoing unit operation or alternative generation solutions.

Black & Veatch performed a high level present value cost benefit of the recommended actions. In addition, Black & Veatch has provided alternative generation scenarios which can be considered to replace Sims Unit 3 capacity.

The following four high impact categories are the basis for the assessment:

- Safety
- Environmental
- Reliability
- Infra-Structure

3.0 Infra Structure Assessment Findings

Black & Veatch conducted a plant site visit for 2 days with one (1) experienced Black & Veatch professional for reviewing, requesting and collecting available information from the Data Room, conducting a walkdown of the facility, taking pictures and conducting interviews with the plant operation and maintenance staff. While at the plant site, the Black & Veatch professional assessed the plant systems in terms of design, history, current condition, and future needs.

Black & Veatch structured the assessment to focus on High Impact categories, recognizing them as the key components to safety and reliability. Black & Veatch did not itemize every deficiency identified during the assessment; therefore, Appendix A is not a comprehensive action and cost list. Items contained in Appendix A are items with significant impact to the short- and long-term safety and reliability of the plant. This list does not include routine maintenance required or costs of replacement equipment currently being replaced or scheduled for replacement within the next few months.

Black & Veatch Mechanical Engineers, Electrical Engineers, Estimators, Construction and Project Management, an Operations and Maintenance consultant, and Material Science persons were used to review vendor reports, testing and inspection data and to provide input to the report.

3.1 SAFETY IMPACTS

Safety issues are the first concern and must be the first to address, having an immediate to short term impact to human and equipment safety. Black & Veatch's timing for addressing safety issues is shown in the column labeled "Action Schedule" in Appendix A. Action items with the designation of "less than" (<) should be considered as maximum periods of time to be completed, which will help reduce the potential of failure and injury to GHBLP personnel.

3.1.1 Electrical Equipment

3.1.1.1 Motor Control Centers and Medium Voltage Switchgear

Black & Veatch reviewed available 480V Motor Control Center (MCC) and 4160V switchgear data and the most recent 2016 inspection reports available. All the MCC's and switchgear have reached the end of their useful life and are obsolete; in some cases, switchgear is classified as dangerous. MCC and switchgear replacement parts are not available. Repair and/or replacement is performed by plant electricians and/or fabricated by outside local machine shops. The existing cabinets are worn and would require extensive rewiring to receive new MCC and Switchgear breakers.

Figure 3-1 Photo of 4160V Breaker Cubical Deterioration

Replacement of this equipment requires a long lead time and is not a practical short-term solution to protect plant personnel. Estimated lead time to engineer, purchase and install this electrical equipment is 36 - 48 months. Installation of the equipment will require an extended outage of 4 – 6 weeks where demolition and installation will need close coordination with other outage activities because of the impact to other outage work during loss of major electrical circuits during this time. Black & Veatch does not recommend replacement of the MCC and 4160V switchgear if Unit 3 operation is ceased by June 2020. If it is the intention of the utility to operate beyond 24 months, then Black & Veatch recommends beginning the replacement process immediately. Black & Veatch agrees with the electrical inspection and testing report recommendations dated 2016, in which the inspection team recommended replacement of the equipment. Precautionary maintenance and operation safety procedures should only be used to protect against personnel injury for a short period of time.

Figure 3-2 Photo of MCC Panel with Do Not Use Tags (Orange)

Black & Veatch recommends GHBLP exercise due diligence in electric equipment safety and procedure compliance. Immediate training by a qualified certified instructor in Arc-Flash safety should be given to all operations and maintenance personnel in accordance with NFPA 70E. The purpose of NFPA 70E®, Standard for Electrical Safety in the Workplace®, is to provide a working area for employees that is safe from unacceptable risk associated with the use of electricity in the workplace. NFPA 70E establishes safety processes that use policies, procedures, and program controls to reduce the risk associated with the use of electricity to an acceptable level. It is imperative that everyone in the plant knows and understands the cause and effect of an arc flash. Specific arc flash training should be conducted to include preventative measures and proper personal protective equipment necessary for each hazard level. GHBLP should have their Operation and Maintenance procedures pertaining to MCC's and switchgear reviewed and modified by a qualified and certified consultant who is familiar with the equipment and its current condition and NFPA 70E standards.

Black & Veatch recommends no maintenance be performed on 480 V MCC and 4160V switchgear buckets and breakers while on line. Switching On/Off the equipment should be done by remote control switching. If the equipment is not equipped with remote switching capabilities, then all safety precautions must be implemented for personnel protection in accordance with NFPA 70E.

Black & Veatch recommends that non-essential personnel access be restricted near or entering MCC & Switchgear rooms or enclosures during online operation. Areas which are designated as general access locations, such as the Unit 3 scrubber control room, electrical equipment rooms and walkways between 408V and 4160V equipment, should be restricted, allowing only essential O&M personnel during electrical maintenance functions. If electrical work is being performed in the area, O&M personnel should wear properly rated flash protection PPE in accordance to NFPA 70E for the distance working from the electrical equipment.

The costs for arc flash training and O&M procedure updates are included in Appendix A.

GHBLP' s seasonal cycling operating mode of the Unit imposes additional startup stress on the MCC's and switchgear, which will increase the degradation and potential catastrophic failure during startup and operation.

Estimated lead time for all 480V and 4160V equipment is 36 - 48 months. This includes engineering, purchase, and installation. Installation of the equipment will require an extended outage of 4 - 6 weeks where demolition and installation will need to be closely coordinated with other outage activities because of the impact to other outage work during loss of major electrical circuits during this time.

Unit 3's Generator Potential Transformer (PT) cubicle is in poor condition. Original cabinet safety switches are obsolete and unavailable. There are no keys to the safety locks on the cubicles; therefore, there is no restricted access. A cabinet could be accidently opened while on line, causing an explosion due to a ground fault injuring personnel. GHBLP should immediately find an acceptable locking system for the cabinets.

If it is decided to run the plant over 24 months, work should begin immediately for replacement of the potential transformers and locking cabinets to ensure proper time for engineering, procurement, and coordination with the next major outage scheduled for 2020. Appendix A includes replacement costs.

Figure 3-3 Photo of Generator PT Cabinet

3.1.1.2 Underground Electric Cables

Unit 3 has a duct bank between the main building and ESP and Scrubber buildings. The duct bank carries low and medium voltage electrical cables in addition to control cabling for the backend processes. If one of the 4160V cables were to fail in the duct bank, it would take a portion of the duct bank out of service for an extended period. Cables typically do not fail, but in the case of the GHBLP plant, operational incidents have compromised the medium voltage cable jacket insulation, therefore increasing its risk of failure. Non-destructive methods are available, but still impose a possibility of failing the cable during testing. If the cable failed during testing, immediate replacement of the cable would be needed. Successful testing of the cable will indicate the health of the insulation, which will provide direction on the next step action to be taken.

Black & Veatch does not recommend electrical non-destructive testing of the insulation be done in the short term. If it is decided to run Unit 3 past 24 months, cable testing should be done at the next major outage. Testing and replacement cost of the 4160V conductor cable and terminations should be considered after receiving test results. Appendix A includes estimated replacement costs for 4160V cables, assuming the existing duct bank conduits will be cleaned and reused.

3.1.1.3 Low Voltage Electric Panels and Wiring

Low voltage wiring and electrical panels in the scrubber building have deteriorated from years of exposure to the corrosive conditions shown in Figure 3-4. As the equipment continues to deteriorate, additional maintenance is required to keep electric equipment, switches and receptacles operable. Performing maintenance on these systems is becoming increasingly dangerous. In some cases, light switches and wall outlets are restricted from use because they are not safe to use.

Figure 3-4 Photo of Corroded Receptacles

Replacement of the low voltage system in the scrubber building should be considered for personnel safety. Black & Veatch recommends performing an assessment of the low voltage system within 6 months to identify immediate safety issues and mitigation. The assessment can be used for determining the work scope for replacement if Unit 3 runs longer that 24 months. An assessment cost estimate for the low voltage system is included in Appendix A.

3.1.2 Boiler Pressure Parts

GHBLP received from Babcock & Wilcox (B&W), the plant boiler manufacturer, a Plant Service Bulletin - Safety Alert Warning issued in 2017 regarding findings on recent failure analysis dealing with carbon-molybdenum steel. These grades of carbon steel and carbon-molybdenum steels may fail when graphitization occurs in the steel grain structure. Conditions described in B&W's Plant Service Bulletin could expose plant personnel to unpredictable and catastrophic boiler failure "RESULTING IN PERSONAL INJURY AND DEATH." This type of material has been used in GHBLP's

Unit 3 boiler. GHBLP has not experienced failures of this material type to date. Headers and piping material found to have advanced graphitization should be immediately replaced.

B&W recommended that operators of steam generating plants immediately begin sampling and testing this material during each outage. GHBLP has not started a sample and testing program. Black & Veatch will address this service bulletin in the following sections.

3.1.2.1 Boiler Header and Pipes

Headers and piping containing materials referenced in the Service bulletin were last Non-destructive Tested (NDT) in 2004. The report found the material tested had no evidence of creep void formations but did have evidence of spheroidized carbides. Spheroidization is the failure mechanism which the B&W service bulletin addresses. Long term exposure to high temperatures will cause the spheroidized carbides to align themselves along the material grain structure, creating a weak zone which could accelerate the crack forming process to the point of failure. Testing result conclusions about the material condition were noted, "appears to be typical of those expected in low carbon steel pipe after a twenty-year service life". The material has now been in service for 35 years old with no follow up testing. Boiler maintenance programs typically begin performing routine header and pipe inspection and testing 10 years after the start of commercial operation with follow up inspections every 5 years thereafter. Based on the lapse of testing Black & Veatch recommends conducting inspection and testing of the high temperature secondary and reheater superheater headers within 6 months.

3.1.2.2 Boiler Tubes

The most recent boiler tube testing and analysis was conducted in 2008. Boiler tube thickness testing should be routinely scheduled during annual outages to keep track of erosion patterns and tube thinning. Past analysis reports concluded the tubes' material was approaching its useful life. With continued operation these tubes will fail, causing forced outages, collateral damage to surrounding tubes, and risk of injury to personnel.

Figure 3-5 Photo of Boiler Tubes with Weld Overlay to Extend Life

Failure of a boiler tube can potentially impact personnel working around the boiler. Tube failures typically fail in the direction of the fire side (inside) of the boiler, directing the energy into other tubes and space within the boiler with little effect to the outside area. There is the possibility of a cold side failure, however; inspection and testing is required to map potential failure areas and subsequently set up restricted boiler zones for personnel protection. Black & Veatch recommends implementing a sampling and testing program for boiler tubes within the next 6 months.

3.1.3 High Energy Piping

In fossil and combined cycle plants, high-energy piping (HEP) systems, including main steam, hot reheat and cold reheat piping, are critical in terms of personnel safety and overall plant longevity. Because of the potential for long-term degradation of piping system materials, and the undesirable consequences of piping system failures, these systems require a dedicated and periodic inspection, testing and analysis program. Information available shows the last high energy piping (HEP) piping inspection and stress analysis was done in 2004. These pipes and attachments are long overdue for analysis and inspection for metallurgical degradation and proper hanger support. As a part of the HEP inspection and testing, hanger inspection and pipe stress analysis should be performed. Black & Veatch's unit walkdown did not identify any immediate concerns in the condition of the support system. The pipe and attachments are not visible and must have insulation and lagging removed to inspect and test.

Cost estimates for HEP analysis, testing, and hanger inspection of the HEP piping is included in Appendix A. Pipe stress analysis will require a pipe system walkdown in both the hot and cold positions; therefore, this work should be done within 12 months.

3.1.4 Feedwater Piping

Flow Accelerated Corrosion (FAC) is a phenomenon which occurs in high pressure boiler feed water piping systems. FAC causes severe corrosion erosion on the internal surfaces of feedwater piping and valves. FAC occurs mostly on carbon steel, which has little resistance to this corrosion mechanism. GHBLP has replaced piping which appeared to be affected by FAC. FAC can cause catastrophic failure of the pipe or valves, resulting in personal injury and death. FAC analysis of the high-pressure feedwater piping will identify high risk locations in the piping system; testing for FAC will be done at these locations. Cost estimates for FAC analysis and testing of the high-pressure piping is included in Appendix A; replacement costs are not included. Black & Veatch recommends a FAC program be implemented within 6 months.

3.1.5 Deaerator and Deaerator Storage Tank

Cracking in deaerator welds is a serious safety concern. In some instances, shell cracking has resulted in small leaks; in others, complete failure has occurred. In response to the life-taking and life-threatening failures reported in 1982 and 1983, technical advisories and guidelines were prepared outlining the necessity of internal weld inspection and recommending methods for inspection and repair. Advisory statements of this type have been issued by Technical Association of the Pulp and Paper Industry (TAPPI), the National Association of Corrosion Engineers (NACE), and The National Board of Boiler and Pressure Vessel Inspectors.

Information available shows the last deaerator NDT inspection was done in 2004. A cost estimate for deaerator inspection and testing is included in Appendix A. Black & Veatch recommends a deaerator inspection be performed within 6 months.

3.2 ENVIRONMENTAL IMPACT

3.2.1 Coal Combustion Residual (CCR) Rule

The coal combustion residual ponds need to be replaced with compliant ponds in accordance with the Environmental Protection Agency's (EPA's) Title 40 of the Code of Federal Regulations Part 257. To comply with regulations, GHBLP is required to install at least one new CCR compliant retention tank by the end of October 2018. For continued normal operations, a second pond will need to be installed the following year. Due to the size of the ponds being less than 40 acres in total, GHBLP may avoid the costs of compliance using the alternative closure provisions of Part 257. GHBLP staff is currently seeking clarification with the agency to determine if these provisions apply. For the alternate closure provisions to become applicable, the owner must certify that the facility will cease operations, has no alternative disposal capacity currently available, and will have the impoundments completely mitigated by October 2023. The EPA preliminarily agreed that certification of closure in June 2020 will allow the utility to use the alternative closure requirements. EPA staff is currently seeking a final opinion through their legal department. Designs have been completed by a qualified engineering firm and the project to install one new pond meeting the requirements is ready to be issued for bids. Estimated time to bid, award, and construct is approximately four months. If a decision is not made on the facility, then GHBLP staff should bid this out for construction in July 2018. A cost estimate for installation of a new CCR tank is included in Appendix A.

3.2.2 Scrubber Blowdown Effluent

The Environmental Protection Agency (EPA)published the Final 2016 Effluent Guidelines Program Plan in April 2018. The EPA is estimating that a draft rule will be proposed in December 2018, with a final rule published in the Federal Register in December 2019. Typically, applicable facilities have three years to meet compliance with new standards. The rule currently includes meeting Best Available Technology (BAT) effluent limits for Arsenic, Mercury, Selenium, and Total Dissolved Solids. While selenium is a difficult pollutant to limit for coal fired power plants that use wet Flue Gas Desulphurization, mercury may also present a significant challenge for compliance. The proposed rule currently will require a maximum daily limit of 39 nanograms per liter (ng/L). Historical test results for the scrubber wastewater at the Sims facility has indicated mercury levels as high as 20,000 ng/L. This will require that the Sims facility either construct a wastewater treatment plant capable of reducing pollutant concentrations below the standard or consider converting the wet scrubbers to dry scrubbers. The cost of a waste water treatment plant is included in Appendix A.

3.2.3 Underground Piping

Underground piping systems which convey suction supply water from the CCR pond to the High Pressure (HP)/Low Pressure (LP) ash water pumps, HP ash water pumps to the Fly Ash Exhauster and piping from the Ash Pond Makeup, Scrubber drains and Waste Neutralization tank to the CCR Pond have been partially repaired or replaced because of leaks. When these underground pipes

leak into the ground, it becomes an environmental and operational problem. These pipes should be replaced for continued operation of the plant. Another underground pipe is the bottom ash sluice piping, which carries bottom ash to the CCR ponds. If this pipe is shut down for repair or replacement while the unit is on line, eventually the unit will be forced off line due to the inability to remove ash from inside the boiler. The cost of these underground pipes is included in Appendix A.

3.2.4 New Source Review and Prevention of Significant Deterioration

Given the magnitude of items identified in this condition assessment it would be necessary for the GHBLP to review if the items identified in this report would trigger any New Source Review and Prevention of Significant Deterioration requirements. Prevention of Significant Deterioration (PSD) requirements can be trigger for major sources making major modifications to their combustion units.

3.3 RELIABILITY IMPACTS

3.3.1 Boiler

3.3.1.1 Boiler Tubes

Boiler tube failures typically have the largest impact on Unit reliability. Preventative measures of inspection and testing, repair and replacement and repair of deteriorated materials will improve reliability, but not eliminate tube failures. The Unit 3 boiler tubes have various degrees of degradation, but all materials have reached their end of life. Inspection and repair will identify some of the potential failure locations, but not all. With continued operation, the material will continue to deteriorate and fail. For continuing long term operation, a replacement program should be considered. Typical tube section delivery is 12 to 18 weeks, with installation taking 3 to 6 weeks. The boiler tube inspection and testing recommended earlier in the report will provide information to develop a replacement strategy.

Review of 2008 inspection data, frequency of leaks, and visual inspection during the recent site visit shows that the boiler north and south waterwalls have numerous repairs and tube replacements due to excessive tube thinning. The east wall, which contains the burners, is in reasonable shape. The west waterwall has recently been replaced and appears to be in good shape. Based on the 2008 report, secondary and reheater superheater outlet pendants are thinning. To make an accurate evaluation of the superheaters, NDT inspection needs to be done. Along with NDT testing, several superheater tube samples should be removed to analyze their metallurgical condition. Results of the evaluation will help determine a strategy for repair and replacement options. With the available information, no conclusion can be made as to the condition of the primary and reheater superheaters and economizer; additional NDT testing is required.

Appendix A includes estimated costs for inspection, testing and replacement of the north and south waterwall tubes panels, secondary and reheater superheaters and economizer sections. Black & Veatch assumes these boiler tubes sections will be replaced in the +5-year category with the caveat that the replacement schedule may need to be changed after receipt of testing and analysis of the tubes.

3.3.1.2 Burners

The current burner manufacturer is no longer in business; therefore, burner parts must be specially fabricated. Boiler bottom ash unburned carbon residuals known as LOI (Loss of Ignition) are high and should be reduced to improve boiler efficiency. Combustion optimization has been done to improve LOI levels yet remain higher than desired. Current LOI levels are not affecting the disposal and are therefore not a concern in regard to waste removal. Burner design may be an issue; therefore, a new burner could improve the LOI. Operationally the burners have no issues. Maintenance costs will continue to rise as the heat-affected materials deteriorate and new special-order components are needed. Black & Veatch has included estimated costs for replacement burner components in Appendix A.

3.3.1.3 Burner Coal Transport Piping

Pulverized coal transport pipes from the coal mills to burners have experienced leaks in the past by erosion thinning. Small sections have been replaced to maintain operation. Leaking coal pipes create an air quality and fire hazard condition inside the main turbine and equipment building. A pipe thickness testing and replacement plan should be in place to replace worn pipes before a leak occurs. A coal pipe maintenance program has not been established and thickness testing of the pipes has not been done. Black & Veatch recommends performing thickness inspection on the coal pipes within 6 months to determine their condition and develop a replacement plan, no matter whether or not the plant is to be shut down. Appendix A includes an estimated cost for performing thickness testing.

3.3.2 Turbine

During the 2015 outage the turbine OEM performed a turbine and valves inspection. The OEM recommends performing the next turbine inspection in 2019. The OEM has routinely recommended inspections every 3 - 5 years. Black & Veatch has reviewed the OEM's recommendations for work to be done during the outage and based on the data available it appears to be prudent for the GHBLP to follow the schedule of performing the next turbine and valve inspection in 2020. Black & Veatch agrees with the OEM repair and replacement recommendations. Black & Veatch provides the following opinion on the OEM recommendations:

1) **Turbine Vibration** the OEM recommends performing a full train (generator LP and HP/IP turbine) alignment. Current vibration levels are moderately higher than one would expect during normal operation, but vibration is not in alarm. Vigilant monitoring of turbine vibration, oil temperatures and operating parameters should be maintained by operations.

   Unless vibration levels rise, vibration should not be a motivation to be fixed on a 2019 outage.

2) **Turbine HP Stationary and Moving Blades (1st to 3rd Stages)** - Damages to these blades appear to be from foreign object damage (FOD). Damage of this type and location typically comes from loose foreign objects from upstream. To help protect the turbine from this type of damage while on line, there are strainers (filters) in the main steam piping upstream of the turbine. The OEM inspection report identified one of the strainers being damaged. The report does not detail the extent of damage and does not suggest the strainer damage could have created the blade damage. The strainer may have been damaged by foreign material left in the superheaters after a repair or modification. The damage repair was well done and should

provide adequate service until the blades and vanes are replaced. Turbine efficiency can be expected from the repairs made.

Unless there is a noticeable change in turbine operation and/or performance, turbine blade and vane replacement should not be a motivation to be set on the 2019 outage.

OEM replacement and repair recommendation costs are included in Appendix A and are scheduled to be performed in 2020 if it is decided to continue operating Unit 3 past 24 months.

3.3.3 Generator

During the 2015 outage the generator rotor was removed, inspected and tested. The generator stator was inspected while the rotor was out. No issues were identified.

Generator protection relays are used to protect the generator from on-line electrical disturbances which could critically affect the health of the generator. The protection relays are obsolete, with parts and support service not available. Black & Veatch reviewed available inspection reports and agrees with the reports that generator protection relays should be replaced within 12 months for continued safe and reliable operation. Replacement costs are included in Appendix A.

3.3.4 Boiler – Turbine – Scrubber Controls

The OEM for the boiler, turbine and scrubber controls has recommended replacement of these systems because they are obsolete; parts and service are not supported. Control system problems are a constant issue for operations and maintenance. In some instances, some control circuits must be jumped for continued operation.

Figure 3-6 Photo of Relays with Jumpers

Black & Veatch did not find where critical system protection has been jumped. GHBLP Maintenance has a supply of extra control modules and replacement parts, but will soon run out and not be able to buy replacements. Some parts have been purchased on eBay due to no OEM parts being available.

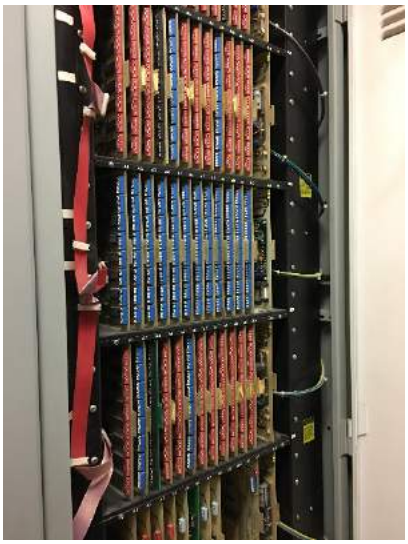

Figure 3-7 Photo of Obsolete Control Module Cards

The control systems are becoming an increasing factor in Unit reliability. Replacement of these control systems will be required for continued operation in the future. A cost estimate has been included for the replacement of the Boiler, Turbine and Scrubber control systems. The replacement of the controls will take an extended downtime period and should be conducted in coordination with the next major outage. GHBLP staff has been in discussions with ABB to provide emergency support in case of boiler or scrubber control failures. Although these programs are no longer supported, ABB will provide whatever assistance they can until the controls have been replaced. Until that time, the plant's reliability is in question with the current controls. Replacement costs are included in Appendix A.

3.3.5 Balance of Plant

3.3.5.1 Feedwater Heaters

From reviewing plant information and performing interviews with plant operation and maintenance, no feedwater heater mechanical issues were identified. Using Black & Veatch's 2017 site heat rate study, some degradation in feedwater heater performance in the HP heaters was noted as compared to the 1985 performance test. Both Heaters 34 and 35 had a temperature rise (TR) value approximately 9° F below the 1985 performance test data. Additionally, HP Heater 34's terminal temperature difference (TTD) has increased 20.4° F and HP Heater 35's TTD has increased 4.8° F relative to the 1985 performance test data. A decrease in TR and an increase in TTD indicate reduced heat transfer in the heater, which may be because of fouling, plugged tubes, or air blanketing tubes within the heater. The drain cooler approach (DCA) temperatures on these heaters show little change since 1985, indicating little change in performance of the drain cooler sections. Black & Veatch recommends internal cleaning, inspection, and eddy current testing be done during the 2020 outage. Outage costs associated with inspection and testing are included in Appendix A.

3.3.5.2 Electrostatic Precipitator

Inspection of the Electrostatic Precipitator (ESP) by the OEM identified numerous repairs and replacement work which should be performed for reliable near-term operation. Black & Veatch

reviewed this list and agrees the scope of work should be executed within 12 months. Cost estimates for performing this work are included in Appendix A.

3.3.6 Scrubber

3.3.6.1 Scrubber Reheater Coils

Scrubber reheater coils are located inside the outlet hood duct of the scrubber vessel and are used for reheating the exhaust flue gas following the wet SO2 removal process. According to the original design specifications, the flue gas temperatures prior to the reheat section should be approximately 124° Fahrenheit (F). The reheat coils using steam supplied by the deaerator should increase the flue gas temperature by 50° to 174° F. A review of historical operating records indicates that the flue gas is not being reheated properly, which will increase the corrosion of the downstream flue gas ductwork. The aggressive operating environment around the reheater coils is exacerbated by leaking reheater tubes which in turn continue to deteriorate reheater tubes, causing frequent leaks and impacting the scrubber outlet flue gas duct. Plugging failed tubes is becoming an increasing maintenance burden and adds operational costs. Replacement of the reheater coils will need to be performed to stop the continued maintenance and operational impacts. Replacement of reheater coils has been included in Appendix A.

3.3.6.2 Scrubber Flue Gas Ducts

The Scrubber Flue gas duct system components consist of Inlet and Outlet Ducts, Expansion Joints and Dampers. Failure of any one of these components will severely impact Unit reliability and possibly create an unsafe condition.

Vendor recommendations and visual inspection confirm expansion joints, ducts and dampers are seriously degraded and need replacing and repair.

Figure 3-8 Photo of Degraded Coating and Flue Gas Deflector

Leaking expansion joints affect system process stability, work area safety and duct structural movement. Dampers are required for proper air flow distribution between scrubber vessels and for safe isolation of a scrubber vessel for maintenance. Ducts which are the conduit for the flue gas to be conveyed between the boiler and chimney must be free from leaks and have sufficient structural strength to support themselves. Flue gas duct leaks directly impact Net Unit Heat Rate.

Costs for replacement of the expansion joints and dampers within the scrubber duct system are included in Appendix A.

Black & Veatch recommends a comprehensive duct survey comprised of visual inspection and NDT testing be initiated to identify leaking and thinning ducts. A duct repair and replacement strategy should be developed after completion of the duct survey. Duct replacement costs have been included in Appendix A.

3.3.6.3 Scrubber Vessel

GHBLP's internal condition assessment raised concerns with the structural integrity of the scrubber vessels A & B. Therefore, in May 2018, a structural engineering firm was contracted to perform assessment on both vessels. The structural evaluation conducted by Sidock Engineering in May 2018 showed signs of overstress on Module B. Lime slurry material accumulated around the area of the scoop resulted in overstress of the shell, indicated by deformation of vessel in a 72" wide by 96" tall area. The report recommended removal of accumulated material immediately (which staff has confirmed was completed on May 24, 2018) and reinforce the area of deformation using 0.375" A36 steel plate at the earliest opportunity. The report also recommended repairing areas of rubber liner for all cracks exposing the carbon steel. Appendix A does not include repair costs.

3.3.6.4 Scrubber Vessel Internal Piping and Appurtenances

Scrubber vessels contain many different components used in the process of scrubbing SO2 from exiting boiler flue gas. The piping and appurtenances are engulfed with the flue gas and scrubber reagent as it passes through the scrubber vessel. The atmosphere is very corrosive, which in time deteriorates all the piping, appurtenances and internal support structure.

Figure 3-9 Photo of Degraded Internal Scrubber Piping

Failure of these components can cause a forced shutdown of the scrubber tower, leaving the redundant scrubber vessel to do all the flue gas scrubbing. Each Scrubber tower is designed for 100% capacity in case this situation occurs. Both scrubbers are in varying levels of degradation, requiring replacement of components to restore reliability and capacity. Currently neither scrubber tower can be isolated because upstream and downstream dampers do not work, as previously discussed in the Scrubber Vessel Ducts section. Appendix A includes costs for piping, support structures and appurtenances in both scrubber vessels.

3.3.6.5 Scrubber Vessel External Recirculation Piping and Equipment

Scrubber reagent is an abrasive fluid which is recirculated from the bottom of the scrubber vessel, processed, and returned into the scrubber vessel interior piping and spray nozzles. The exterior piping is old and worn, causing frequent leaks, and in some cases the lining has separated from the pipe wall, blocking flow in the pipe.

Figure 3-10 Photo of Scrubber Recirculation Pipe Liner Separation

GHBLP has recently replaced the scrubber recirculation pumps. The large diameter piping needs to be replaced within the next 12 months to mitigate major leakage and system shutdowns. Piping and other system-related equipment replacement costs are included in Appendix A.

3.3.7 Fuel Handling

During Black & Veatch's site visit, a walkdown of the coal yard and coal handling equipment was conducted. Coal yard structures and equipment appear to be in good working order. A visual inspection of the conveyor control building and several of the coal conveyors found no issues to report. Waterfront unloading facility walkdown was not done due to limited time on site. GHBLP reported the coal barn located between the plant and coal yard is in need of structural repairs on the supports to foundations and the roof to the building is in need of replacement. Estimated costs are not included in Appendix A.

3.4 INFRA STRUCTURE IMPACTS

3.4.1 Scrubber Control Room

The scrubber control room and electrical switchgear room enclose the scrubber DCS control system and 4160V and 480V switchgear and MCC's respectively. The roof over this area leaks and has been temporarily repaired. An observation made when walking through the Scrubber control room and electrical equipment room was that heavy accumulations of dirt and limestone dust on the equipment and floor can be seen. Dust and dirt gets into electrical equipment connections and causes arcing and overheating, which can lead to premature failure. Dust enters the rooms through doors and other crevices. The air conditioning system is not providing adequate air pressurization to properly seal the room. The air conditioning and air handler equipment is located on the control room roof. Black & Veatch recommends the scrubber control room cracks and crevasses get sealed and the air conditioning system be checked for adequate air flow and control room pressurization within the next 6 months. If sealing the control room does not help, then the air conditioning system should be resized and replaced. If it is decided to continue to run Unit 3 past 24 months,

replacement of the AC system should be done at the same time as the roof. Roof and air conditioning system replacement costs are included in Appendix A.

Figure 3-11 Photo of Scrubber Control Room Roof with Two Handler Units

This roof should be replaced if it is decided for Unit 3 to continue to run after 24 months.

3.4.2 Facility Roofs and Drains

There are numerous areas of the facility where the roofs are leaking and the storm water drains are corrupted and leaking in the plant. The age of the facility indicates that the roofs and drains are at the end of their expected life and a replacement plan should be developed and implemented. If the plant ceases operation within the next 24 months, and no electrical safety issues are present, temporary diversion measures or temporary roof/drain repairs should be made. The costs for roof replacements are not included in Appendix A. Costs would have to be obtained through bid estimates.

3.5 COST ANALYSIS

Black & Veatch has estimated the forecasted capital improvements expenditures required for continued safe and reliable operation of Unit 3 to be $35.0 Million Dollars. Table 3-1 summarized the progressive expenditure commitment for Sims Unit 3.

Figure 3-12 shows the increase in operating costs assuming using the past two-year average Capacity Factor of 43% as the basis for the next five-year period. Average annual generation for the next five-year period is estimated to range between 275,000 – 300,000 MWH. Using current coal pricing forecasts Black & Veatch has used Energy Information Agency (EIA) annual cost escalation estimate of 2% for Northern Appalachia Coal for the next five years.

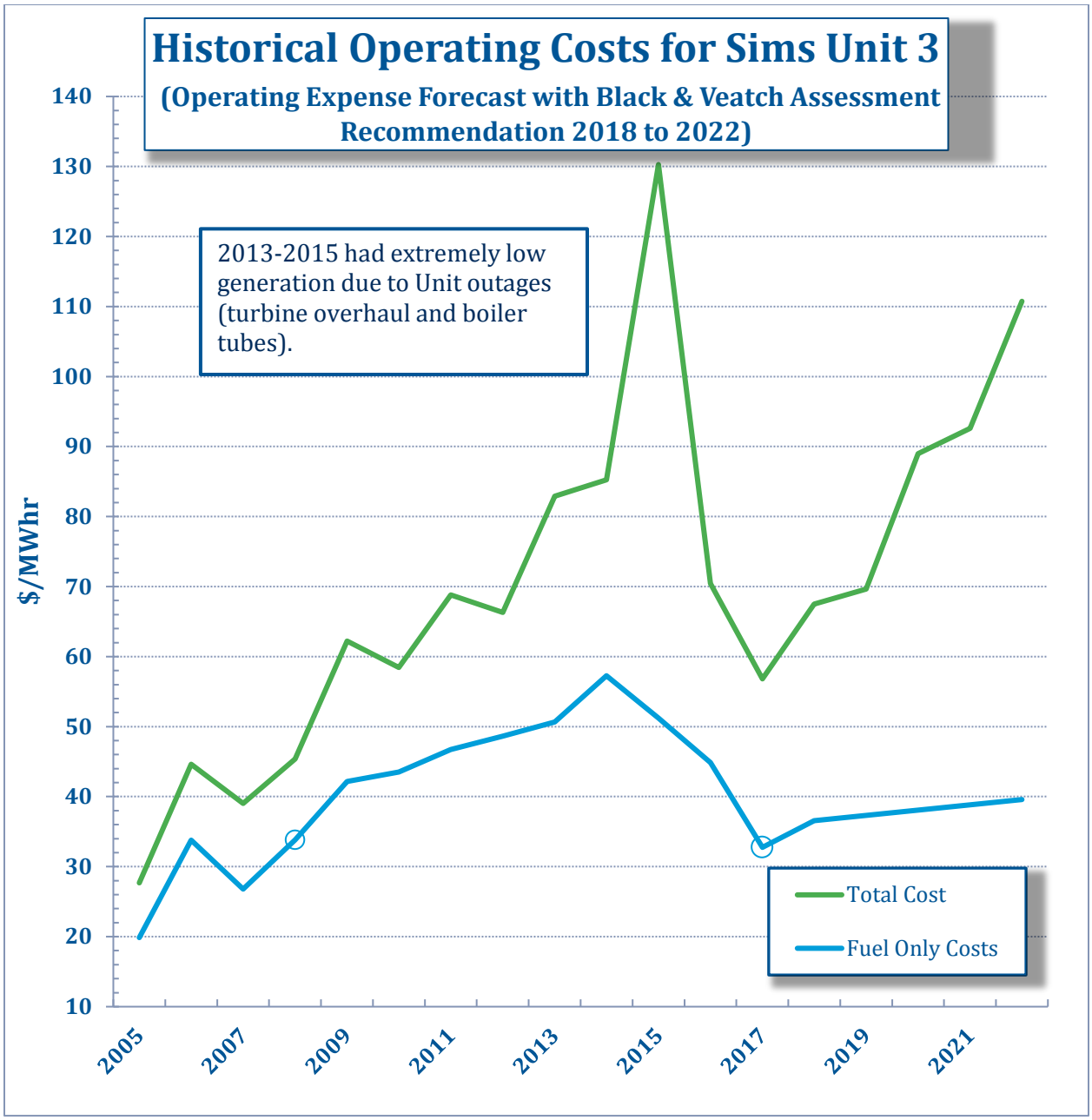

Figure 3-12 Operating Expense Forecast 2018 - 2020

Black & Veatch recommends the following list of action items totaling $4.4 Million dollars which should be done within the timeframe before Unit shut down in June 1, 2020 to sustain safe and reliable operation with minimal investment in the plant.

Table 3-1 Action Item List: To Perform Before Unit Shutdown in June 1, 2020

ACTION ITEM LIST - TO PERFORM BEFORE UNIT SHUTDOWN IN JUNE 1, 2020		
IMPACT CATEGORY	**ITEM DESCRIPTION**	**ESTIMATED COST**
Safety	Plant safety training on arc flash and arc flash prevention	$6,000
Safety	Review and update O&M procedures on 480V and 4160V switchgear	$65,000
Safety	Perform low voltage assessment to determine immediate safety hazards and future scope of replacement	$62,000
Safety	Full scale boiler inspection for base line condition assessment	$250,000
Safety	Perform hanger inspection and analysis to determine high stress pipe sections of main steam and hot reheat piping from boiler outlet to turbine inlet. Perform NDT and analyze for creep life and hanger lug inspection	$345,000
Safety	Perform FAC analysis to identify high risk FAC point in piping runs. Perform NDT inspection to identify thinning pipe sections	$323,000
Safety	Perform TAPPI inspection and testing	$125,000
Environmental	Replace TUF pump suction lines	$30,000
Environmental	Active ash ponds (dependent on EPA confirmation)	$625,000
Reliability	Replacement of A module 5th floor internal piping and appurtenances	$372,000
Safety	Perform internal Inlet/Outlet duct visual and NDT inspection to identify leaks and thinning areas. Remove internal coating, install new coating anchors and reinstall coatings.	$211,000
Safety	Unit 1 & 2 Stack Duct	$64,000

ACTION ITEM LIST - TO PERFORM BEFORE UNIT SHUTDOWN IN JUNE 1, 2020		
IMPACT CATEGORY	**ITEM DESCRIPTION**	**ESTIMATED COST**
Infra Structure	Test silos as indicated in 2012 Report.	$35,000
Reliability	Replacement of generator relays	$210,000
Reliability	Coal barrel, nozzle end tips replacement	$75,000
Reliability	NDT inspection of coal pipes to identify thinning for coal pipe repairs	$25,000
Reliability	Air Heater Basket Replacement and LCS to Encoder System	$247,000
Reliability	Repair and replacement - Both A and B Modules inlet and outlet duct expansion joints	$312,000
Reliability	Replace A Module mixers	$84,000
Environmental	ESP Cell 1 thru 4 replacement components	$276,000
Reliability	Awning replacement	$49,000
Reliability	Replace absorption trays for fluidizing bed	$155,000
Reliability	Replace external scrubber recirculation piping	$378,000
Safety	Remove accumulation of hard ash material from under funnel inside vessel	$25,000

The following series of tables show item details for each Action Schedule category if the decision is to continue operations of Unit 3. Additional information for each item can be found in Appendix A.

Table 3-2 Action Item List Required to be Done in Less than 6 Months

ACTION ITEM LIST - LESS THAN 6 MONTHS		
IMPACT CATEGORY	ITEM DESCRIPTION	ESTIMATED COST
Safety	Plant safety training on arc flash and arc flash prevention	$6,000
Safety	Review and update O&M procedures on 480V and 4160V switchgear	$65,000
Safety	Perform low voltage assessment to determine immediate safety hazards and future scope of replacement	$62,000
Safety	Full scale boiler inspection for base line condition assessment	$250,000
Safety	Perform FAC analysis to identify high risk FAC point in piping runs. Perform NDT inspection to identify thinning pipe sections	$323,000
Safety	Perform TAPPI inspection and testing	$125,000
Environmental	Replace TUF pump suction lines	$30,000
Environmental	Active ash ponds (dependent on EPA confirmation)	$625,000
Reliability	Replacement of A module 5th floor internal piping and appurtenances	$372,000
Safety	Remove accumulation of hard ash material from under funnel inside vessel	$25,000

Table 3-3 Action Item List Required to be Done in Less than 12 Months

ACTION ITEM LIST - LESS THAN 12 MONTHS		
IMPACT CATEGORY	**ITEM DESCRIPTION**	**ESTIMATED COST**
Safety	Perform hanger inspection and analysis to determine high stress pipe sections of main steam and hot reheat piping from boiler outlet to turbine inlet. Perform NDT and analyze for creep life and hanger lug inspection	$345,000
Safety	Perform internal Inlet/Outlet duct visual and NDT inspection to identify leaks and thinning areas. Remove internal coating, install new coating anchors and reinstall coatings	$211,000
Safety	Unit 1 & 2 stack duct	$64,000
Infra Structure	Testing of silos as indicated in 2012 Report	$35,000
Reliability	Replacement of generator relays	$210,000
Reliability	Coal barrel, nozzle end tips replacement	$75,000
Reliability	NDT inspection of coal pipes to identify thinning for coal pipe repairs	$25,000
Reliability	Air Heater Basket Replacement and LCS to Encoder System	$247,000
Reliability	Repair and replacement - Both A and B Modules' inlet and outlet duct expansion joints	$312,000
Reliability	Replace A Module mixers	$84,000
Environmental	ESP Cell 1 thru 4 replacement components	$276,000
Reliability	Awning replacement	$49,000
Reliability	Replace absorption trays for fluidizing bed	$155,000
Reliability	Replace external scrubber recirculation piping	$378,000

Table 3-4 Action Item List Required to be Done at Next Major Outage

ACTION ITEM LIST – NEXT MAJOR OUTAGE		
IMPACT CATEGORY	**ITEM DESCRIPTION**	**ESTIMATED COST**
Infra Structure	Unit 3 Chimney Inspection	$15,000
Reliability	120-volt AC and Feeds mills, FD fans, ID fans, all 4160 Volt out to scrubber. Soot blowing, all instrumentation cables from scrubber and precipitator. Low voltage power cables	$178,000
Reliability	Swirler Blade Assemblies replacement	$25,000
Reliability	Replace vacuum filters	$500,000
Reliability	Replace inlet and outlet ID fan dampers transition damper	$376,000
Reliability	Replace ESP inlet transition expansion joint	$188,000
Infra Structure	Thickener Tank liner replacement	$400,000
Reliability	Major Turbine Outage work recommended by OEM (Fuji)	$1,828,000
Reliability	Inlet & outlet dampers I.D. fans	$342,000
Reliability	Replace reheat coils	$1,575,000
Reliability	Flue Gas Duct Expansion Joint Replacement	$720,000
Reliability	Automatic Turbine Startup Controls	$55,000
Reliability	Boiler and Scrubber Controls Replacement	$972,000
Reliability	Boiler and Scrubber Alarm Panel Replacement	$350,000
Reliability	Replace Coal Feeder Control Stations for 3A, B, C Mills	$150,000
Reliability	Air Heater Controls	$168,000
Reliability	Open feedwater heaters, clean tubes and inspect using eddy current testing.	$125,000

Table 3-5 Action Item List Required to be Done in >24 Months <5 Years

ACTION ITEM LIST - >24 MONTHS <5 YEARS		
IMPACT CATEGORY	ITEM DESCRIPTION	ESTIMATED COST
Safety	NDT testing all 4160V cable feeds from main building to scrubber building. Cable feeds to mills, FD fans, ID fans, all 4160 Volt out to scrubber.	$15,000
Safety	Replacement of generator PT Cubicle	$347,000
Safety	4160V breakers, cubicles and structure and buss for 4 breaker banks	$2,391,000
Safety	480V breakers, cubicles and cabinets	$2,133,000
Environmental	Replace piping that has had multiple failures	$573,000
Infra Structure	Replace Scrubber Control Room Roof	$80,000
Reliability	Replace North and South Waterwalls	$2,086,000
Reliability	Remove both old air handlers and replace with one proper capacity Unit	$219,000
Reliability	Scrubber controls replacement	$676,000
Reliability	4160 Volt protection relay replacement	$194,000
Reliability	Generator relays replacement	$125,000

Table 3-6 Action Item List Required to be Included in 5+ Year Plan

ACTION ITEM LIST – INCLUDED IN 5+ YEAR PLAN		
IMPACT CATEGORY	**ITEM DESCRIPTION**	**ESTIMATED COST**
Environmental	Emission monitoring equipment used to analyze gas exiting the chimney after pollution controls	$350,000
Environmental	Waste Water Treat Facility	$3,000,000
Infra Structure	Internal module interior coating rubber liner replacement	$1,000,000
Reliability	Secondary superheat section in boiler	$1,054,000
Reliability	Replace primary superheat	$571,000
Reliability	Replace reheat superheater	$1,529,000
Reliability	Replace Economizer Section	$1,486,000
Reliability	Inlet and Outlet Ductwork Replacement	$2,337,000
	Inactive Ash Ponds	$650,000
Reliability	Replace underground steam, fire, and service water piping	$1,000,000
Infra Structure	Replacement of 24C loader	$900,000
Environmental	Groundwater	NA

4.0 Conclusions

The legacy of Sims Unit 3 can be appreciated by its long and proud service to provide livelihood to its employees and reliable and affordable power to the customers of GHBLP. The Grand Haven Sims Unit 3 critical systems are reaching their end of life, so that significant financial expense will be required to replace aged equipment for continued safe and reliable operation. Plant maintenance and operation has done a commendable job maintaining and operating the original equipment to maximize its useful life.

Continued operation of Unit 3 will require continued effort navigating the constantly changing coal plant environmental regulation policies. The Grand Haven Power Plant site is responsible for costs associated with regulatory and consent order compliance before 2023. GHBLP may defer or eliminate costs if a commitment to closing the plant by the end of 2020 is made. Continuing operation of Unit 3 will expose GHBLP to future regulation and unforeseen environmental and site remediation costs.

GHBLP has arrived at a fork in the plants' life where a decision must be made on the future of the plant. One fork requires an investment in excess of $35.0M to bring a coal fired power plant with old technology, uncompetitive heat rates, and increasing environmental regulations back to a safe and reliable status. The second fork requires an investment which will bring Grand Haven customers new high efficiency, reliable and renewable generation technologies. Black & Veatch's recommendations are a compilation of our independent assessment and our review of GHBLP plant staff recommendations. Appendix A lists these recommendations in the order of precedence of Safety, Environmental, Reliability and Infra-Structure considerations respectively for continued operations. Black & Veatch believes the most important element of the assessment is making sure personnel in the plant stay safe while continuing to operate and maintain plant equipment. Black & Veatch always recommends a diligent and comprehensive safety program in the workplace. Special emphasis must be made to ensure personnel are aware of equipment conditions and making sure proper personnel protection is practiced when working around this equipment. Special precautions must be made for 480V and 4160V MCCs and switchgear until replacement is made. Maintenance and operating procedures should be reviewed and modified to accommodate the equipment conditions and potential safety hazards. Where possible, nonessential personnel should stay clear of designated equipment when in operation.

Black & Veatch found that critical equipment which contains high energy media such as steam, water and electricity needs inspections and testing to determine its current condition and need for replacement. Inspection and testing of this identified equipment and sub-components will help develop a safe, logical and cost-effective strategy plan for continued operation of Sims Unit 3.

Black & Veatch discussed year-round plant operation at lower loads with GHBLP, which would help reduce cyclic and startup stress on both mechanical and electrical equipment. However, unit heat rate while operating at low load during low demand periods is expensive, creating an unacceptable high energy cost per megawatt and therefore is not recommended because it would not provide the cost benefit intended. Black & Veatch agrees that a seasonal operation strategy is the best operating mode alternative to get the plant out to 2020.

5.0 Recommendations

Based on findings of the condition assessment and estimated financial commitment, Black & Veatch recommends that GHBLP minimize any future investments in the steam plant and shut down Unit 3 by 2020 for the following reasons:

- Unit 3 has reached the end of its useful life, requiring significant investment to continue safe and reliable operation.
- Necessary expenditures of approximately $35.0 million dollars will be required for life extensions. These costs will have exceeded any benefits of life extension since this unit is more expensive to operate than other alternatives currently available.
- Given the magnitude of items identified in this condition assessment it would be necessary for GHBLP to review if the items identified in this report would trigger any New Source Review and Prevention of Significant Deterioration requirements.
- Other more economical power supply options exist that would drastically improve future electric prices for utility rate payers and increase electrical reliability. These options include both market purchases and internal generation if Grand Haven chooses to retain some locally owned and locally controlled assets.
- GHBLP will be able to take advantage of lower staffing levels through attrition which will significantly minimize any adverse effects to steam plant employees.
- Significant environmental costs can be avoided due to compliance with the Coal Combustion Residuals Rule and the upcoming Effluent Limitations Guidelines.
- The next turbine overhaul which is scheduled for 2020 can be avoided, along with both the replacement of 480V and 4160V electrical equipment, which will take approximately 36 - 48 months to purchase and install, and the boiler and scrubber controls which need replacement but will also require long lead times and a long unit outage.

If the decision is made to cease operations of the steam plant, Black & Veatch has the following recommendations to implement over the next two years:

- Implement safe operating and maintenance practices for High Risk electrical equipment to help mitigate possibility of personal injury during the next two years.
- Perform inspection and testing to high risk equipment within 6 months to learn current equipment conditions to planning safe work area strategies.
- Continue operating Unit 3 on a seasonal basis.
- Continue transmission accessibility for full demand service by 2020.
- Should GHBLP choose to shut down Unit 3 by 2020, consider the following additional recommendations for the next steps to plan for future capacity and generation:

5.1 COST VERSUS BENEFIT

Based on the projected investments necessary to allow for continued safe and reliable operation of the unit, combined with projections for other operating and maintenance expenses, including fuel,

the average cost of generation for Sims Unit 3 is expected to be $85/MWh over the next five years (2018-2021, see Figure 3-12). Historical weighted average day ahead Local Marginal Pricing (LMP) for the Grand Haven electrical node is presented in Table 5-1.

Table 5-1 Cost of Power at Grand Haven Node

Calendar Year	Average Day Ahead LMP $/MW-hr
2017	$31.14
2016	$28.96
2015	$30.32
2014	$48.60
2013	$35.19
2012	$34.01
2011	$37.05

* Cost per MW-hr adjusted for load

A comparison of the projected average cost of generation for Sims Unit 3 (average of $85/MWh over the next five years) compared to historical day ahead LMP pricing (average of $35/MWh over the previous five years) suggests that continued operations of Sims Unit 3 does not make economic sense.

5.2 ALTERNATIVE GENERATION OPTIONS

Sims Unit 3 is a baseload dispatchable generation asset with a net capacity of about 70 MW. It is Black & Veatch's understanding that the size of the asset was based on significant electrical market sales prior to 2010. As Figure 5-1 indicates, demand rarely exceeds 55 MWs.

If GHBLP desires to own and control some of its own power generation, Black & Veatch recommends GHBLP consider smaller, flexible generation technologies such as aeroderivative gas turbines or reciprocating internal combustion engines (RICE). These technologies would give GHBLP the flexibility to quickly come online and match load as required to meet demand while minimizing reliance on external sources.

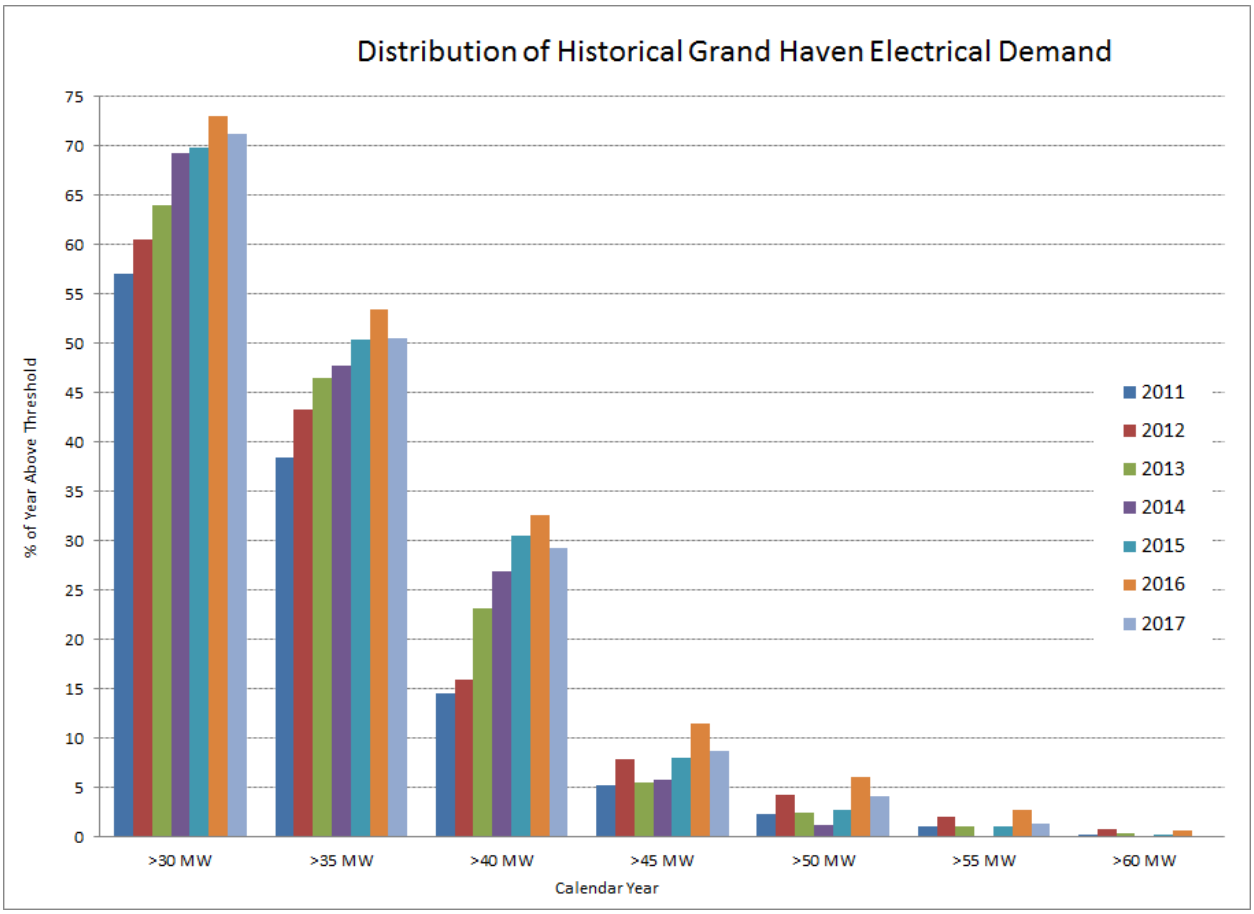

Figure 5-1 Distribution of Historical Grand Haven Electrical Demand

Black & Veatch has prepared basic performance and cost estimates for natural gas fueled generation assets with full load capabilities in the range of approximately 30-60 MW. Suggested technologies are as follows:

- **Simple Cycle Aeroderivative Gas Turbines** – one or two aeroderivative gas turbines with fast start (less than 10 minute) startup capabilities. The representative prime mover technology used is the General Electric (GE) LM2500+G4 aeroderivative gas turbine.
- **Reciprocating Engines** – three to six medium-speed reciprocating engines with fast start (as fast as 2 minutes) startup capabilities. The representative prime mover technology used is the Wärtsilä 20V34SG medium-speed reciprocating engine.

A summary of technology characteristic estimates is presented in Table 5-2 below. All numbers presented are generic, top-down order-of-magnitude estimates reflective of current market conditions. No guarantees apply. Estimates presented are for generic "greenfield" installations. Costs can be reduced with a favorably sited project. For example, constructing at the Sims Plant could reduce the cost of major equipment foundations as the site is located on top of a significant number of concrete pilings. Reusing these pilings to support a new power station could reduce the construction costs. Another example is in the potential to reduce the transmission interconnect costs by reusing a portion of the infrastructure already in place for Sims.

Table 5-2 Alternative Generation Characteristics

DESCRIPTION	UNIT	AERODERIVATIVE GAS TURBINES	RECIPROCATING ENGINES
Representative Make		GE	Wärtsilä
Representative Model		LM2500+G4	20V34SG
Number of Units		1 – 2	3 – 6
Thermal Performance - Hot Day Conditions (Note 2)			
Baseload Output	MW	30 – 61	27 – 55
Baseload Heat Rate	Btu/kWh-HHV	10,000	8,500
Minimum Load Output	MW	15	1
Minimum Load Heat Rate	Btu/kWh-HHV	14,100	17,900
Non-Fuel O&M Cost Estimates (Note 3)			
Fixed Costs (FOM)	$/kW-year	40 – 23	44 – 25
Variable Costs (VOM)	$/MWh	8	10
Capital Cost Estimates (Note 4)			
Overnight EPC Capital Cost	$/kW	1,100 – 1,000	1,200 – 1,050
Total Investment Cost	**$/kW**	**1,375 1,250**	**1,500 1,313**

Notes:

1. GENERAL - All options considered are natural gas fueled with SCR and oxidation catalyst. Makes and models presented are representative of competitive technologies only and do not reflect a decision of technology selection.
2. Nominal hot day performance estimates based on local conditions. HHV – Higher Heating Value.
3. Non-fuel operating and maintenance (O&M) cost estimates are generic and "greenfield" in nature, assuming no shared staffing with other facilities.
4. Overnight Engineering, Procurement & Construction (EPC) capital cost estimate includes all Inside the Battery Limits (ISBL) project costs to the high-side of the GSU transformer. An "Owner's costs" allowance of 25% of the Overnight EPC cost has been included to arrive at the "Total Investment Cost". Owner's costs include costs for project development (studies, rights-of-way, road upgrades, demolition, permitting, public relations), initial plant spares outside the gas turbine or engine Long Term Service Agreement (LTSA) (in VOM estimates), plant furnishings, rolling stock, startup/construction support (Owner's site mob, staff training, initial consumables, construction power, construction all-risk insurance), Owner's contingency, Owner's project management, taxes/advisory fees, utility interconnect agreements, and legal fees. Capital cost estimates represent a "greenfield" installation.

5.3 RECOMMENDATIONS FOR NEXT STEPS

As loads, asset mixes, and surrounding market conditions change, Black & Veatch recommends GHBLP continue with the current resource plan and conduct modeling to determine the most economic power supply portfolio to replace Sims Unit 3 in 2020. Below is a roadmap for such a unified planning process:

- **Production Cost Modeling** - Integrating load forecasts with production cost inputs is recommended to understand least-cost plans for serving load to GHBLP stakeholders. Initially, 10-20 least-cost plans are chosen and then more rigorously modeled and tested stochastically using Monte Carlo simulation techniques. Factors beyond simple system economics are also considered. This stage of the process involves the following components:
  - Forecasting
    - Customer demand and future economic activities
    - Climate and weather conditions
    - Environmental regulations and incentives
    - Fuels (as applicable)
    - General inflationary and escalation impacts
    - Energy, capacity, and ancillary service markets
    - Opportunities for purchase/sales agreements
  - Estimates of supply-side generation alternatives
    - If the GHBLP decides to own and control its own power generation, modeling will assist in determining the most appropriate economical size of the generation facility.
  - An understanding of risk mitigation and contingencies necessary for serving load.
  - It is Black & Veatch's understanding that GHBLP belongs to a municipal joint action agency that can perform this function.
- **Project Development** – If GHBLP identifies a project to pursue internally, the project begins to be transformed from concept to reality during project development. Major steps would include determining where to site the plant, establishing utility supply agreements, performing preliminary engineering work to better define plant design requirements and estimate plant costs, obtaining plant permits, and identifying project execution, major equipment procurement, and contracting approaches.
- **Abatement, Demolition, and Mitigation of existing site and facilities** – Conduct a decommissioning and demolition study evaluating the requirements and costs associated with the retirement of Unit 3 and supporting infrastructure. This study will include environmental remediation, permitting, facilities decommissioning and demolition requirements. Estimated costs will be generated which are associated with each aspect of the decommissioning, demolition, salvage and resale of equipment. Decommissioning refers to the formal process to removing an electric generating unit and other associated equipment from active service, such that GHBLP no longer uses the equipment for generating electricity. Demolition is defined as the tearing down and removal of equipment, buildings, and structures while potentially preserving valuable components and materials for reuse. Salvage is the process or actions taken to remove a piece of equipment for scrap or resale and reuse.

Appendix A. Unit 3 Life Assessment Recommended Action List

SECTION	LOCATION	ACTION SCHEDULE	IMPACT CATEGORY	ITEM DESCRIPTION	FINDINGS	ESTIMATED COST
Electrical	Training	< 6 months	Safety	Plant Safety Training on Arc Flash and Arc Flash prevention	Inadequate safety program and process for operation and maintenance of aged equipment	$6,000
Electrical	Training	< 6 months	Safety	Review and Update O&M procedures on 480V and 4160V Switchgear	Procedures and Drawings are not updated with age specific procedures and drawings	$65,000
Electrical	Scrubber 4160V Cables	> 24 months < 5 yrs	Safety	NDT testing all 4160V cable feeds from main building to scrubber building. Cable feeds to mills, FD fans, ID fans, all 4160 Volt out to scrubber	Evidence that wires are corroded due to pit filling with corrosive fluids from historical scrubber operation malfunctions. Emergency lighting in the scrubber has been affected and power system has failed in fly ash silo due to faulty wiring. Replacement is likely necessary for 4160V cables and terminations. Testing should be conducted however caution should be exercised as testing may be destructive and replacement of power cables may be necessary after test. This could result in a long outage.	$15,000
Scrubber Low Voltage Electrical	Scrubber Building	< 6 months	Safety	Perform Low voltage assessment to determine immediate safety hazards and future scope of replacement	Low voltage wiring and electrical panels have deteriorated from years of exposure to corrosive conditions in scrubber building.	$62,000
Boiler	Boiler Inspection all areas including HT Headers	< 6 months	Safety	Full scale boiler inspection for base line condition assessment	Secondary Superheat Outlet header has reached expected useful life. Header requires condition assessment to determine metallurgical condition.	$250,000
High Energy Piping	HEP stress analysis and Hangers and Hanger Attachments inspection & testing	< 12 months	Safety	Perform hanger inspection and analysis to determine high stress pipe sections of main steam and hot reheat piping from boiler outlet to turbine inlet. Perform NDT and analyze for creep life and hanger lug inspection	Full scale high energy piping (HEP) nondestructive and creep analysis should be conducted. This has not been conducted in the past and given the age of the system it should be performed. Additional analysis should be conducted on hangers and hanger attachments.	$345,000
Feedwater	Feedwater piping from BFP to Economizer	< 6 months	Safety	Perform FAC analysis to identify high risk FAC point in piping runs. Perform NDT inspection to identify thinning pipe sections	Flow assisted corrosion (FAC) and nondestructive tests should be conducted. GHBLP has replaced several elbows at deaerator with FAC damage.	$323,000
Feedwater	Deaerator and Storage Tank	< 6 months	Safety	Perform TAPPI inspection and testing	Last deaerator NDT testing was conduct in 2004 and should be updated.	$125,000
Scrubber	Thickener	< 6 months	Environmental	Replace TUF pump suction lines	Lines are leaking externally causing slurry to discharge onsite. Lines need to be removed and replaced for continued Sims operation or a temporary fix should be conducted to seal or reroute discharge if Sims is going to cease operations in the near future. Staff informed B&V that a temporary patch has been installed and seems to be holding but is not a long-term solution.	$30,000

SECTION	LOCATION	ACTION SCHEDULE	IMPACT CATEGORY	ITEM DESCRIPTION	FINDINGS	ESTIMATED COST
Environmental	Outside	< 6 months	Environmental	Active ash ponds (dependent on EPA confirmation)	Ash ponds need to be replaced with Coal Combustion Residual Rule (CCR) compliant ponds per Title 40 of the Code of Federal Regulations Part 257. Due to the size of the ponds being less than 40 acres, Sims may avoid costs of compliance using the alternative closure requirements of Part 257 with acceptance from the Environmental Protection Agency. To qualify, the owner must certify that the facility will cease operations, have no alternative disposal capacity, and have impoundments mitigated in accordance with the rule by October 2023.	$625,000
Structural	Outside	Next Major Outage	Infra Structure	Unit 3 Chimney Inspection	Chimney needs periodic inspection. Last Class II inspection was conducted in 2015. According to the American Society of Civil Engineers a Class I inspection which is visual surveillance using binoculars or spotted scope should be conducted every 6-24 months. Class II Chimney Inspection involves full height interior and exterior inspection should be conducted every 2-5 years.	$15,000
Electrical	Scrubber	Next Major Outage	Reliability	120-volt AC and Feeds mills, FD fans, ID fans, all 4160 Volt out to scrubber. Soot blowing, all instrumentation cables from scrubber and precipitator. Low voltage power cables	Evidence that wires are corroded due to pit filling with corrosive fluids from historical scrubber operation malfunctions. Emergency lighting in the scrubber has been affected and power system has failed in fly ash silo due to faulty wiring. Replacement is likely necessary for 4160V cables and terminations. Testing should be conducted however caution should be exercised as testing may be destructive and replacement of power cables may be necessary after test. This could result in a long outage.	$178,000
Scrubber	A Module	< 6 months	Reliability	Replacement of A module 5th floor internal piping and appurtenances	A module headers have been repaired with wire and fiberglass material. Nozzles have been failing and falling off of headers. Headers and nozzles need to be replaced for continued operation of A module.	$372,000
Electrical	CEMS	5+ Year Plan	Environmental	Emission monitoring equipment used to analyze gas exiting the chimney after pollution controls.	The instruments used to monitor emissions from Unit 3 are nearing the end of useful life. Additionally, the umbilical used to bring flue and calibration gases from the probe to the instruments is original and has exceeded useful life. Due to turnaround times, certification requirements, and monitor availability requirements in Title 40 of the Code of Federal Regulations Part 75 the facility should prepare to replace prior to instrument failure.	$350,000
Environmental	Process Water Discharges	5+ Year Plan	Environmental	Waste Water Treat Facility	The Environmental Protection Agency published the Final 2016 Effluent Guidelines Program Plan in April, 2018.EPA has stated that the rule will be proposed in December 2018 with final rule published in the Federal Register in December 2019. This rule will require that Best Available Technology limits for various pollutants are met (e.g. Mercury max day limit is 39 ng/L vs current FGD effluent of 20,000 ng/L). Compliance will likely be required by 2023. If compliance cannot be met with effluent limits, then facility may need to evaluate installation of a dry flue gas desulphurization system.	$3,000,000
Scrubber	A & B Modules	5+ Year Plan	Infra Structure	Internal module interior coating rubber liner replacement	Replace and repair interior rubber lining of module vessels.	$1,000,000

SECTION	LOCATION	ACTION SCHEDULE	IMPACT CATEGORY	ITEM DESCRIPTION	FINDINGS	ESTIMATED COST
Boiler	Secondary Superheater	5+ Year Plan	Reliability	Secondary superheat section in boiler	Based on historical nondestructive testing the secondary superheat section of the boiler has exceeded its useful life.	$1,054,000
Boiler	Primary Superheater Tubes	5+ Year Plan	Reliability	Replace Primary superheat	Identified in the past as needing replacement. Costs are for materials only and not installation.	$571,000
Boiler	Reheater Superheater Tubes	5+ Year Plan	Reliability	Replace Reheat superheater	Identified in the past as needing replacement.	$1,529,000
Boiler	Economizer Tubes	5+ Year Plan	Reliability	Replace Economizer Section	Some tubes from the economizer section of the boiler where sent out for testing and the findings determined the tubes segment had experienced significant corrosion and erosion of the outside diameter surface. The findings stated the likely cause was corrosion and erosion from fly ash which is produced by burner coal in the boiler. The steel tubes are ASME SA-178, grade C carbon steel.	$1,486,000
Scrubber	Ductwork	5+ Year Plan	Reliability	Inlet and Outlet Ductwork Replacement	Insulation needs to be removed to determine extent of repairs or replacements. Multiple failures have occurred and internal coating is missing in over 50 % of the ductwork. These failures cause emission exhaust to leak into the scrubber house. While this currently is a reliability issue, if it progressively gets worse, it could turn into a safety concern if not properly addressed.	$2,337,000
Scrubber	Ductwork	< 12 months	Safety	Perform internal Inlet/Outlet duct visual and NDT inspection to identify leaks and thinning areas. Remove internal coating, install new coating anchors and reinstall coatings	Perform internal Inlet/Outlet duct visual and NDT inspection to identify leaks and thinning areas. Remove internal coating, install new coating anchors and reinstall coatings. Multiple failures have occurred and internal coating is missing in over 50 % of the ductwork. These failures cause emission exhaust to leak into the scrubber house. While this currently is a reliability issue, if it progressively gets worse, it could turn into a safety concern if not properly addressed.	$211,000
Site Remediation	Outside	5+ Year Plan		Inactive Ash Ponds	Ash ponds need to be closed as required by the Coal Combustion Residual Rule (CCR) per Title 40 of the Code of Federal Regulations Part 257.	$650,000
Electrical	Generator	> 24 months < 5 yrs	Safety	Replacement of generator PT Cubicle	Explosion may occur if cabinet doors are open while on line	$347,000
Structural	Outside	< 12 months	Safety	Unit 1 & 2 Stack Duct	Stack Duct and structure between old Unit 1 & 2 Boilers to Unit 3 stack has not been inspected since installation (1983). Safety concern is due to structure being located overhead. Another consideration could be to consider removing the ductwork from Units 1 and 2 since they are no longer functional.	$64,000
Boiler	Coal Silos	< 12 months	Infra Structure	2012 Report indicated that Silos should be tested	Original thickness of metal is 0.25" thick. Nondestructive testing should be conducted to determine material thickness. Testing has not been conducted in the past.	$35,000
Electrical	Generator	< 12 months	Reliability	Replacement of generator relays	Should be upgraded to Schweitzer relays.	$210,000

SECTION	LOCATION	ACTION SCHEDULE	IMPACT CATEGORY	ITEM DESCRIPTION	FINDINGS	ESTIMATED COST
Boiler	Burners	< 12 months	Reliability	Coal barrel, nozzle end tips replacement	Cracking occurring on end tips which should be either repaired or replaced. Inspection conducted in fall 2017 recommended repair or replacement of nozzles on B1 and B2 at next outage. Staff is currently monitoring cracks for signs of further degradation.	$75,000
Boiler	Burners	Next Major Outage	Reliability	Swirler Blade Assemblies replacement	Overheating was observed, but no visible distortion. Should survive over next 3-5 years however repairs may be needed if operation will exceed 5 years.	$25,000
Boiler	Burner Coal Pipes	< 12 months	Reliability	Coal pipes require NDT inspection to identify thinning for coal pipe repairs.	Due to the age of piping the burner lines should be replaced. A small section of A1 burner line was replaced in spring outage 2017. Inspection should be done to identify thin spots to plan repairs. Inspection will help develop replacement strategy if unit runs longer than 24 months.	$25,000
Boiler	Air Heater	< 12 months	Reliability	Air Heater Basket Replacement and LCS to Encoder System	Basket and controls have exceeded useful life.	$247,000
Scrubber	Inlet and outlet duct	< 12 months	Reliability	Repair and replacement - Both A and B Modules inlet and outlet duct expansion joints	Expansion joints should be replaced. Module A expansion joint is currently leaking and limiting the boiler to 40 MWs to keep safe operating levels of SO2 in the scrubber house.	$312,000
Scrubber	A Module	< 12 months	Reliability	Replace A Module mixers	Two module mixers need replaced on A module.	$84,000
Air Pollution Control	ESP	< 12 months	Environmental	ESP Cell 1 thru 4 replacement components	Precipitator inspection conducted by B & W 28 March 2017 - See expanded descriptions	$276,000
Scrubber	B Module	< 12 months	Reliability	Awning replacement	B module awning is deteriorating and needs replaced.	$49,000
Scrubber	B Module	< 12 months	Reliability	Replace absorption trays for fluidizing bed.	Trays are starting to fall apart. Upper levels on Module A are in the worst shape and have started to fall to the next tray level. Some are starting to show signs of deterioration in B module.	$155,000
Scrubber	A&B Modules	< 12 months	Reliability	Replace external scrubber recirculation piping	Piping from recirc pumps to modules is failing.	$378,000
Scrubber	Vacuum filters	Next Major Outage	Reliability	Replace Vacuum filters	Replacements will be needed on vacuum filters.	$500,000
Electrical	4160V Breakers	> 24 months < 5 yrs	Safety	4160V Breakers, cubicles and structure and buss for 4 breaker banks	Obsolete and need replacement.	$2,391,000
Electrical	U3 Mezz Floor	> 24 months < 5 yrs	Safety	Motor Control Center - **A**	Condenser exhauster, bottom ash crusher, flue gas reheat, low pressure ash pump, overflow ash pump, nuet basin pump, air dryer.	$141,000
Electrical	U3 Mezz Floor	> 24 months < 5 yrs	Safety	Motor Control Center - B	Condenser exhauster, bottom ash crusher, flue gas reheat, low pressure ash pump, overflow ash pump, nuet basin pump, air dryer.	$141,000

SECTION	LOCATION	ACTION SCHEDULE	IMPACT CATEGORY	ITEM DESCRIPTION	FINDINGS	ESTIMATED COST
Electrical	U3 Mezz Floor	> 24 months < 5 yrs	Safety	Motor Control Center - C	Turbine valves, drip legs, governor control breaker, classifier, gland steam condenser exhauster.	$141,000
Electrical	5th Floor	> 24 months < 5 yrs	Safety	Motor Control Center - D	All coal handling and fire systems.	$141,000
Electrical	Scrubber Control Room	> 24 months < 5 yrs	Safety	Motor Control Center - E	3B scrubber auxiliaries.	$184,000
Electrical	Scrubber Control Room	> 24 months < 5 yrs	Safety	Motor Control Center - F	3A scrubber auxiliaries.	$184,000
Electrical	Basement of Unit 3 & 2nd Floor of Scrubber	> 24 months < 5 yrs	Safety	480 Volt Secondary Unit Substation Breakers	Mechanical parts have worn out and need replacing.	$970,000
Auxiliary	Underground Systems	5+ Year Plan	Reliability	Replace Underground Steam, Fire, and Service water piping	Piping for all three systems have had multiple failures. Underground piping is repaired at points of failure but need to be properly addressed and replaced.	$1,000,000
Auxiliary	Underground Systems	> 24 months < 5 yrs	Environmental	Piping has had multiple failures - requires replacement	Suction piping from the CCR to the HP/LP ash water pumps and HP ash water pumps to the Fly Ash Exhauster and piping from the Ash Pond Makeup, Scrubber drains and Waste Neutralization tank to the CCR	$573,000
Structural	Outside	> 24 months < 5 yrs	Infra Structure	Replace Scrubber Control Room Roof	Roof has been patched multiple times which indicates that replacement is soon to be required.	$80,000
Boiler	Waterwall Tubes	> 24 months < 5 yrs	Reliability	Replace North and South Waterwalls	Identified in the past as needing replacement. Testing will provide an estimate when replacement is required.	$2,086,000
Scrubber	Control Room Air Conditioning	> 24 months < 5 yrs	Reliability	Remove old both old air handlers and replace with one proper capacity Unit	Original air handler is abandoned. Current Air Handler is undersized	$219,000
Electrical	Controls	> 24 months < 5 yrs	Reliability	Scrubber Controls replacement	Controls are original installation from 1983 and have been identified by manufacture as being obsolete and requiring replacement. Technical support is no longer available. 2012 ABB Report indicated that controls for scrubber (Net90) and Boiler Controls (lnfi90) are obsolete and will not be supported. This will require a long outage and should be conducted in coordination with next overhaul if controls remain functional for that long.	$676,000
Electrical	Mezz Floor and Second Floor in Scrubber	> 24 months < 5 yrs	Reliability	4160 Volt Protection Relay replacement	Mezz Floor Unit 3 and second floor scrubber.	$194,000
Electrical	Generator	> 24 months < 5 yrs	Reliability	Generator relays replacement	Should be upgraded *to* schweitzer relays.	$125,000

SECTION	LOCATION	ACTION SCHEDULE	IMPACT CATEGORY	ITEM DESCRIPTION	FINDINGS	ESTIMATED COST
Scrubber	ESP	Next Major Outage	Reliability	Replace Inlet & Outlet ID Fan Dampers Transition damper	Repair/ Replace the nonfunctional outlet ID dampers.	$376,000
Air Pollution Control	ESP	Next Major Outage	Reliability	Replace ESP Inlet Transition Expansion Joint	Replace expansion joints as needed.	$188,000
Scrubber	Thickener	Next Major Outage	Infra Structure	Thickener Tank liner replacement	Relining thickener tank.	$400,000
Turbine	HP/IP/LP Section	Next Major Outage	Reliability	Major Turbine Outage work recommended by OEM (Fuji)	Multiple scope of work lines - see details	$1,828,000
Turbine	Blades	Next Major Outage	Reliability	High Pressure moving & stationary Blades of Hot Isostatic Pressed (HIP) Rotor.	1st-3rd stage blades have damage estimated to be from foreign debris found in turbine. Replace moving blades of 1st and 2nd stages.	$245,000
Turbine	Inspection	Next Major Outage	Reliability	Turbine Open clean close inspection	FUJI recommendation.	$1,040,000
Turbine	Bolts	Next Major Outage	Reliability	Distance bolts of the HIP inner casing	4 pieces of the distance bolts were found damaged during disassembly.	$5,000
Turbine	Taper Pins	Next Major Outage	Reliability	Taper Pin of HIP outer casing horizontal flange	Pins recommended to be exchanged with new pins of a larger size. The new pins should be 1mm.	$85,000
Turbine	Center of HIP Rotor	Next Major Outage	Reliability	Turbine/Generator alignment	New spare liner should be prepared for next overhaul adjustment. Over tolerance of casing height position was observed during final assembly	$61,000
Turbine	Seal Fin of LP Rotor	Next Major Outage	Reliability	Seal fins were found missing and/or bent	Replace with new seal fins of proper height with new size wire.	$25,000
Turbine	LP Gland Packing	Next Major Outage	Reliability	Taper Pins LP gland packing	New spare taper pins should be installed.	$81,000
Turbine	Main Oil Pump	Next Major Outage	Reliability	Main shaft surface	Main oil pump shaft should be reconditioned.	$30,000
Turbine	Main Steam Control	Next Major Outage	Reliability	Main Steam Control Valve	Valve stand needs to be machined.	$50,000
Turbine	Main Steam Strainer	Next Major Outage	Reliability	Main steam strainer at MSV	Strainer needs to be replaced.	$85,000
Turbine	Special Tools	Next Major Outage	Reliability	Turbine Tools	Many special tools for the turbine are missing or broken and need to be replaced.	$85,000
Turbine	Bearings	Next Major Outage	Reliability	Spare Bearings	Turbine Bearing #1, Generator Bearings #1 & 2, and Exciter Bearing need to be re-Babbitt and machine to OEM specifications.	$39,000

SECTION	LOCATION	ACTION SCHEDULE	IMPACT CATEGORY	ITEM DESCRIPTION	FINDINGS	ESTIMATED COST
Gas	Inlet duct Scrubbers	Next Major Outage	Reliability	Inlet & outlet dampers I.D. fans	Inlet dampener have been removed and outlet dampeners are seized and controller are rotted.	$342,000
Scrubber	A & B Modules	Next Major Outage	Reliability	Replace Reheat coils	Both module reheat coils are in need of replacement. The tubes are leaking and are approximately 22 percent inoperative at this point due to deterioration .	$1,575,000
Boiler	Flue Gas	Next Major Outage	Reliability	Flue Gas Duct Expansion Joint Replacement	Expansion joints should be inspected and replace by priority according to the inspection	$720,000
Electrical	ATS	Next Major Outage	Reliability	Automatic Turbine Startup Controls	Unit will not start on "Very Hot Mode." Fuji should be called in to correct automatic turbine start sequence.	$55,000
Electrical	DCS	Next Major Outage	Reliability	Boiler and Scrubber Controls Replacement	2012 ABB Report indicated that controls for scrubber (Net90) and Boiler Controls (lnfi90) are obsolete and will not be supported. This will require a long outage and should be conducted in coordination with next overhaul if controls remain functional for that long.	$972,000
Electrical	DCS	Next Major Outage	Reliability	Boiler and Scrubber Alarm Panel Replacement	Experiencing issues with failures. Circuit boards are failing routinely. Using existing inventory to replace failed boards.	$350,000
Electrical	PLC	Next Major Outage	Reliability	Replace Coal Feeder Control Stations for 3A, B, C mills	PLC is obsolete. Experiencing issues with failures.	$150,000
Electrical	Air Heater	Next Major Outage	Reliability	Air Heater Controls	Alarms have indicated controls are near failure.	$168,000
Auxiliary	Fuel Handling	5+ Year Plan	Infra Structure	Replacement of24C Loader.	Current loader was built in 1984 and has reached the end of its service life.	$900,000
Scrubber	A&B Modules	< 6 months	Safety	Remove accumulation of hard ash material from under funnel inside vessel	Structural evaluation conducted by Sidock Engineering in May 2018 showed signs of overstress on Module B. Lime slurry material accumulated around area of scoop resulted in overstress of the shell indicated by deformation of vessel in a 72" wide by 96" tall area. Recommendation is to remove accumulated material immediately (which staff has confirmed was completed on May 24, 2018) and reinforce area of deformation using 0.375" A36 steel plate at the earliest opportunity. Report also recommended repairing areas of rubber liner for all cracks exposing the carbon steel. Removal of accumulation should	$25,000
Environmental	Outside	5+ Year Plan	Environmental	Groundwater	Groundwater monitoring program in 2017 indicated contamination above regulatory limits. Additionally, monitoring wells were installed in May 2018 and sampling program will be conducted. Site mitigation will be required based on groundwater results.	NA
Feedwater	Feedwater heater internal cleaning and inspection	Next Major Outage	Reliability	Open feedwater heaters, clean tubes and inspect using eddy current testing.	Black & Veatch site heat rate study identified slight decrease in FWH performance.	$125,000