MENASHA LOCK ELECTRIC FISH BARRIER

DRAFT OPERATION MANUAL

FOX RIVER NAVIGATIONAL SYSTEM AUTHORITY

MARCH 15, 2019

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1. OVERVIEW

This draft operations manual was developed to accompany permit applications for the construction of an electrical deterrent system at the downstream (north) side of Menasha Lock in Menasha, Wisconsin. The purpose of the electrical deterrent system is to prevent upstream migration of invasive Round Goby (*Neogobius melanostomus*) from the Fox River into Lake Winnebago via the Menasha Lock.

The intent of the final form of this document is to stand alone as an operational manual for the electric deterrent system. A physical copy of this document would be kept in the control building at the Menasha Lock for use as reference by authorized personnel. In some cases, other documents are referenced, such as the Operations & Maintenance Manual for the electric deterrent system and the rotenone application protocol set forth by Wisconsin Department of Natural Resources (DNR). These documents would also be kept as references on location.

At times, this Operations manual directs onsite staff to contact a management representative of the Fox River Navigation System Authority (FRNSA) for a decision. The designated FRNSA representative will have special knowledge of appropriate actions to take in these particular situations. A secondary intent is to have explicit management approval in the case of complex or consequential decisions.

This document was developed based on 60% design documents and expectations of lock and electric deterrent system operations as of March 2019. This draft document is not a final document, and is not intended to be used for lock or electric deterrent system operations. Only a final document, approved by FRNSA and DNR, is intended for use for lock and electric deterrent system operations.

2. ANNUAL OPERATIONS SCHEDULE

a. Boat operations

i. In general, the Menasha Lock is open for boat transits starting second weekend of May and ending the first Sunday in October. Variations from this lock operation schedule will be publicly posted on the FRNSA website and official Facebook and/or Twitter account.

ii. The Electric Deterrent System will be turned off after the first Sunday in October. Any lock usage during the period in which the Electric Deterrent System is off will require a DNR-approved rotenone treatment[1] in advance of lock opening (see Section 2b).

iii. Procedure to be conducted the week prior to scheduled lock opening (typically lock will open the weekend before Memorial Day; in 2020 this is Friday, May 22)

1. Barrier test (see "Spring opening procedure" protocol) must precede the rotenone treatment.
2. Rotenone treatment must be done before daily operation begins per DNR requirements.

b. Barge operations

i. Barge lockages during the summer period when the Electric Deterrent System is operational should follow the protocols presented in Section 4.

ii. Wisconsin DNR allows a finite number of lockages during lock shutdown season. A DNR-approved rotenone treatment must be administered prior to opening the lock gates.

c. Winter shutdown

i. Winter shutdown period is defined as the end of the first Sunday in October until the weekend before Memorial Day.

ii. The rotenone treatment should be scheduled for the spring opening with input from Wisconsin DNR. Rotenone treatment must be completed prior to the commencement of daily lock operation per DNR requirements.

[1] Details of rotenone treatment of the Menasha Lock is outside the scope of this document.

3. DAILY OPERATIONS SCHEDULE

a. Menasha Lock operations

i. May, September and October
   a. Monday-Thursday, lock is operated 10 AM to 7 PM
   b. Friday-Sunday and holidays, lock is operated 9 AM to 7 PM

ii. June, July and August
   a. Monday-Thursday, lock is operated 10 AM to 8 PM
   b. Friday-Sunday and holidays, lock is operated 9 AM to 8 PM

iii. Variations from this lock operation schedule will be publicly posted on the FRNSA website and official Facebook and/or Twitter account.

b. Barrier operations

i. The Electric Deterrent System shall be operational around-the-clock *at all times* during the operations period (see Section 2a). At no time during the operations period should the Electric Deterrent System be disabled.

ii. The Electric Deterrent System features a backup power system (standby generator and Uninterruptible Power Supply for gap protection) that assures system operations even when line power to the barrier is stopped or curtailed (blackout or brownout conditions). However, if the Electric Deterrent System is disabled during the operations period, the FRNSA designated liaison should be contacted immediately to determine the impact of the barrier outage, and to determine if lock operations should be impacted by the outage. See Section 4j for protocol in the event of a barrier outage.

c. Daily "Flush"

i. During the operations period (See Section 2a), a lock "flush" procedure shall be followed before any lockages can occur.
   1. Monday-Thursday, flush occurs at 9:30 AM
   2. Friday-Sunday and holidays, flush occurs at 8:30 AM

ii. See Section 4c for the protocol of the daily "flush."

4. PROTOCOLS

a. Spring opening procedure

i. Perform visual inspection of barrier control building, barrier structure (above water), and lock grounds.

ii. Conduct barrier startup procedure as specified in Electric Barrier Operations & Maintenance Manual; verify all components are in normal working order.

iii. Disconnect power to the Uninterruptible Power Supply (UPS) unit(s) connected to the pulser(s) by unplugging the unit from the outlet. The indicator status should change to show output power source is the UPS battery. Return power to the UPS unit(s) by replacing the plug into the outlet. If a fault indicator light is shown when the power is disconnected to the UPS, contact the FRNSA designated liaison for further instructions.

iv. Turn on the electric barrier and verify the following items on the FBTCS screen (see Figure X1 for an example):

1. The "LOCK" symbol is shown (means the barrier is OFF):
2. Network status is connected.
3. Line power is active and generator power is inactive (the opposite will be the case when the barrier is under generator power or during weekly generator exercises).
4. No alarms. If alarms are shown on the screen, take measures as described in Electric Barrier Operations & Maintenance Manual to verify the alarm issue is rectified and the alarm is cleared.
5. Relevant digital outputs are selected or select if necessary. This includes:
    a. Warning lights
    b. Navigation lights
6. Relevant digital inputs are selected or select if necessary. This includes:
    a. Smoke alarm
7. Incoming voltage is between 230-250 V.
8. Building temperature is between 50°F and 95°F.
9. Building relative humidity is between 5% and 95% (water vapor must not be condensing).
10. Water temperature is measuring within reasonable range: 40-70°F
11. Water conductivity is measuring within reasonable range: 300-700 µS/cm.
12. Water depth is measuring within reasonable range: 4-13 feet
13. Power output readings for two pulsers are shown on the screen – "Pulser 1" and "Pulser 2". One pulser is labeled "MASTER" and the other is labeled "SLAVE."
14. Waveform reading for each pulser matches the designated waveform registered in the Electric Barrier Operations & Maintenance Manual.

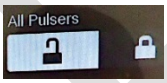
The reading will include pulse duration and frequency (for example, “2 ms 5 Hz”). Each pulser should have identical waveforms.

15. Voltage reading (VOLTS) for each pulser should be within the ranges designated in the Electric Barrier Operations & Maintenance Manual.
16. Power reading (KILOWATTS) should read “0.00”
17. If all the above items are verified as positive, proceed to the next step. If any item is not within range, contact the designated liaison with FRNSA for further instructions (the designated liaison is indicated in the Electric Barrier Operations & Maintenance Manual).

v. Contact the FRNSA designated liaison to report the barrier is ready to operate. Wait for approval from liaison before proceeding to the next step.

vi. Warn all boats in vicinity of the barrier to not enter the barrier.

vii. Visually confirm all humans and animals larger than a rodent are not present in the barrier or approaching the barrier.

viii. On FBTCS screen, turn on the barrier by clicking on the “UNLOCK” symbol (this will turn the barrier ON): 

ix. Visually inspect barrier for two minutes. If unusual activity is noted, contact the FRNSA designated liaison for further instructions.

x. Visually verify the following features (digital outputs as shown on the FBTCS) are operational:

1. Warning lights
2. Navigational lights

xi. On FBTCS screen, verify the following:

1. The “LOCK” symbol is shown on the screen.
2. Network status is connected.
3. Line power is active and generator power is inactive (the opposite will be the case when the barrier is under generator power or during weekly generator exercises).
4. No alarms. If alarms are shown on the screen, take measures as described in Electric Barrier Operations & Maintenance Manual to verify the alarm issue is rectified and the alarm is cleared. If the issue(s) is not rectified and the alarm(s) is not cleared, contact the FRNSA designated liaison for further instructions.
5. Relevant digital outputs are selected. This includes:
    a. Warning lights
    b. Navigation lights
6. Relevant digital inputs are selected. This includes:
    a. Smoke alarm
7. Incoming voltage is between 230-250 V.

8. Waveform reading for each pulser matches the designated waveform registered in the Electric Barrier Operations & Maintenance Manual. The reading will include pulse duration and frequency (for example, “2 ms 5 Hz”). Each pulser should have identical waveforms.
9. Voltage reading (VOLTS) for each pulser should be within the ranges designated in the Electric Barrier Operations & Maintenance Manual.
10. Current reading (AMPS) should be within the ranges designated in the Electric Barrier Operations & Maintenance Manual.
11. Power reading (KILOWATTS) should be within the ranges designated in the Electric Barrier Operations & Maintenance Manual.
12. If all the above items are verified as positive, proceed to the next step. If any item is not within range, contact the FRNSA designated liaison for further instructions.

xii. Use Electric Field Probe to verify expected voltage gradients at multiple pre-designated locations on both sides of the barrier, and record these values in the worksheet in Attachment 1.

xiii. Close and lock the barrier control building upon leaving.

xiv. Before the lock gates can be opened, the water inside the lock must be treated with a Wisconsin DNR approved dose of rotenone. Conduct the rotenone treatment per DNR protocol prior to opening the lock gates.

b. Fall closing procedure

i. The fall closing procedure shall be performed following the final lockage of the season. No lockages may occur following the fall closing procedure unless a DNR-approved rotenone treatment is applied.
ii. Perform visual inspection of barrier control building, barrier structure (above water), and lock grounds.
iii. Move mouse to “wake up” computer monitor
iv. Select the “LOCK” symbol to turn off power from the pulsers to the electrodes:
v. Turn power switches off on pulsers
vi. On FBTCS, acknowledge loss of communication alarm (may take a few minutes for the alarm to show on the screen) and other alarms.
vii. At least five minutes after pulsers are turned off, and after all alarms have been acknowledged, turn off the FBTCS.
viii. Turn off the monitor
ix. Turn off the star concentrator
x. Turn off the UPS using the button on the front panel of the UPS.
xi. DO NOT trip the circuit breaker for the UPS or unplug the UPS. This will turn off the charge to the UPS batteries, allowing them to self-discharge.
xii. Turn air conditioner to “HEAT” mode and set for minimum temperature of 50°F.
xiii. If required, follow FRNSA-specified Lockout/Tagout procedures.

c. Daily "flush" procedure

i. During the period that Menasha Lock is open for lockages, a daily "flush" of water by opening the lower lock gate is required prior to allowing boat traffic in Menasha Lock and the electric deterrent system.

ii. The following procedure should be followed at least 30 minutes prior to the scheduled opening of the Menasha Lock.

1. Visually confirm all humans and animals larger than a rodent are not present in the barrier or approaching the barrier.
2. Warn all boats in vicinity of the barrier to not enter the barrier.
3. Ensure the lock is at full pool elevation (i.e. same level as Lake Winnebago/Government Canal). If the lock is not at full pool, follow normal procedure for filling lock to full pool.
4. Ensure upper lock gates are in the fully closed position.
5. Rapidly open the right (east) lower lock door to fully open position.
6. After water level within lock matches low pool elevation (i.e. same level as Little Lake Butte Des Morts), return right (east) lower lock door to fully closed position.
7. Note start and end times of daily flush on Daily Flush Log (Attachment 2).

d. Daily operation procedure

i. Move mouse to “wake up” monitor; verify the following items:

1. The “UNLOCK” symbol is shown on the screen (“unlock” = ON)
2. Network status is connected.
3. Line power is active and generator power is inactive (the opposite will be the case when the barrier is under generator power or during weekly generator exercises).
4. Acknowledge and resolve any alarms are shown on the screen. Take measures as described in Electric Barrier Operations & Maintenance Manual to verify the alarm issue is rectified and the alarm is cleared.
5. Relevant digital outputs are selected or select if necessary. This includes:
    a. Warning lights
    b. Navigation lights
6. Relevant digital inputs are selected or select if necessary. This includes:
    a. Smoke alarm
7. Incoming voltage is between 230-250 V.
8. Building temperature is between 50°F and 95°F.
9. Building relative humidity is between 5% and 95% (water vapor must not be condensing).
10. Water temperature is measuring within reasonable range: 40-70°F
11. Water conductivity is measuring within reasonable range: 300-700 µS/cm.
12. Water depth is measuring within reasonable range: 4-13 feet
13. Power output readings for two pulsers are shown on the screen; these are labeled “Pulser 1” and “Pulser 2.”
14. One pulser reads “MASTER;” the other reads “SLAVE.”
15. Waveform reading for each pulser matches the designated waveform registered in the Electric Barrier Operations & Maintenance Manual. The reading will include pulse duration and frequency (for example, “2 ms 5 Hz”). Each pulser should have identical waveforms.
16. Voltage reading (VOLTS) for each pulser should be within the ranges designated in the Electric Barrier Operations & Maintenance Manual.
17. Power reading (KILOWATTS) should read a number higher than 0.
18. If all the above items are verified as positive, proceed to the next step. If any item is not within range, contact the designated liaison with FRNSA for further instructions (the designated liaison is indicated in the Electric Barrier Operations & Maintenance Manual).

ii. If configured, activate operator timer and make periodic entries.

e. Alarm response

i. The following alarms can be received from the barrier FBTCS:

1. Daily status report not received
    a. Description. FBTCS not sending alarms or daily status reports.
    b. Cause.
        i. FBTCS power is off.
        ii. Modem/router power is off or connections are loose.
        iii. External antenna is broken (if applicable).
        iv. FBTCS internal error.
    c. Procedure to resolve. A physical inspection is required to diagnose the source of the problem. Inspect the following:
        i. Check that the FBTCS is powered on.
        ii. Check for loose connections between the FBTCS, modem/router, and external antenna.
        iii. Check the FBTCS monitor screen for other alarms that may indicate a cause (e.g. Loss of communication error message), and follow protocol for those alarms.
        iv. Cycle FBTCS off/on one time (i.e. "reboot;" this will not affect the pulser output to the electrodes).
        v. If issue is not resolved, contact designated liaison with FRNSA.
2. Loss of communication
    a. Description. Internal communication between FBTCS/Star Concentrator/Pulser is not occurring.
    b. Cause.
        i. A physical connection (e.g. loose wire)
        ii. Circuit breaker tripped.
        iii. Pulser is turned off.
        iv. Communication error.
    c. Procedure to resolve. A physical inspection is required to diagnose the source of the fault. Inspect:
        i. Power to pulsers
        ii. Pulsers operational?
        iii. Fiber connections between pulsers and star concentrator
        iv. Power to star concentrator
        v. Star concentrator operational?
        vi. Fiber connections between star concentrator and converter box
        vii. Connection between USB to Fiber converter box and USB port on FBTCS

vi. If these inspections do not resolve the issue, cycle FBTCS off/on one time (i.e. “reboot;” this will not affect the pulser output to the electrodes).

3. Pulser fault
    a. Description. The pulser is not outputting. FBTCS attempts to restart the pulser up to 6 times over 25 seconds; if all of these attempts are not successful, an alarm is sent.
    b. Cause.
        i. Pulser circuit breaker tripped.
        ii. Internal circuit breaker tripped (also causes a loss of communication warning)
        iii. Power surge.
        iv. High current spike in the barrier.
    c. Procedure to resolve.
        i. Check circuit breaker on wall panel. If the breaker is tripped, try to determine the reason the breaker tripped. Check for signs of electrical arcing or a burning odor – if these conditions exist, a licensed electrician is needed to evaluate the circuit and circuit panel; contact the FRNSA designated liaison for further instructions. If no obvious reasons for the breaker being tripped are evident, reset the circuit breaker one time. If the breaker will not reset or if it trips off again, a licensed electrician is needed to evaluate the circuit; contact the FRNSA designated liaison for further instructions.
        ii. Check the pulser is plugged into the wall.
        iii. Check that the power light is on.
        iv. Check that the fiber connection to the star concentrator is secure.
        v. Turn the pulser off, turn back on in 10 seconds.
        vi. If these steps do not resolve the problem, replace the pulser with the spare. Contact Smith-Root to return the pulser for troubleshooting.
4. High current warning
    a. Description. Not an error, but a warning that output current has exceeded a user-specified upper set point.
    b. Cause.
        i. High water conductivity.
        ii. Something very conductive is in the barrier or crossed the electrodes; for example, a dragged steel cable or a barge.

c. Procedure to resolve.
    i. Check the conductivity reading on FBTCS screen to determine if water conductivity is abnormally high.
    ii. Check the output on the FBTCS screen to determine if the problem is ongoing.
    iii. Visually inspect the barrier to determine if there is debris in the barrier.
    iv. If the output does not show ongoing high current output, and no debris is in the barrier, no further adjustments are needed.
    v. If the high current output is ongoing and no debris is seen the barrier, there may be a submerged object across the electrodes. Contact designated liaison with FRNSA.

5. Low current warning
    a. Description. Not an error, but a warning that output current has exceeded a user-specified lower set point.
    b. Cause.
        i. Low water conductivity.
        ii. An indication of a loose/broken wire or connection between the pulser and electrodes.
    c. Procedure to resolve.
        i. Check the conductivity reading on FBTCS screen to determine if water conductivity is abnormally low. If this is the case, no further action is required.
        ii. Check the pulser output connections are not loose.
        iii. Contact designated liaison with FRNSA. An electrician or Smith-Root representative should conduct a loop test for each electrode.
6. High temperature warning – pulser high temperature[2]
    a. Description. Internal pulser temperature exceeds 105°F. If temperature continues to increase, the pulser may cease to operate.
    b. Cause.
        i. Typically caused by high ambient temperature in the equipment building.
        ii. Pulser fan failure.
    c. Procedure to resolve.
        i. Reduce ambient temperature inside equipment building.

[2] Not included in current FBTCS software version 3.6.21.6; will be included in future versions.

ii. Observe if the pulser fan is not running. If the fan is not running even though building temperature exceeds 90°F, contact designated liaison with FRNSA and replace the pulser with the spare. The pulser should be returned to Smith-Root for troubleshooting. (Pulser fan does not automatically run until ambient temperature exceeds 90°F).

7. Building high temperature
    a. Description. Not an error, but a warning that equipment building ambient temperature has exceeded a user-specified upper set point, typically about 100°F.
    b. Cause.
        i. Circuit breaker for air conditioner is tripped.
        ii. Air conditioner is turned off.
        iii. Air conditioner failed.
    c. Procedure to resolve.
        i. Check circuit breaker for air conditioner. If the breaker is tripped, reset the circuit.
        ii. Check air conditioner power. If it is turned off, turn it on.
        iii. If the air conditioner won't power on, contact designated liaison with FRNSA. A technician may be needed to repair the air conditioner.
8. Building low temperature
    a. Description. Not an error, but a warning that equipment building ambient temperature has exceeded a user-specified lower set point, typically about 50°F.
    b. Cause.
        i. Circuit breaker for air conditioner (heater) is tripped.
        ii. Thermostat is set too low.
        iii. Air conditioner (heater) is turned off.
        iv. Air conditioner (heater) failed.
    c. Procedure to resolve.
        i. Check circuit breaker for air conditioner. If the breaker is tripped, reset the circuit.
        ii. Check thermostat is set for recommended temperature (ideally between 50-95°F).
        iii. Check air conditioner (heater) power. If it is turned off, turn it on.
        iv. If the air conditioner (heater) won't power on, contact designated liaison with FRNSA. A technician may be needed to repair the air conditioner.

9. Security warning
    a. Description. Not an error, but a warning that a sensor dedicated to barrier security has entered a user-specified alarm state.
    b. Cause. Depends on security sensor. For example, a door sensor detected the equipment building door has been opened.
    c. Procedure to resolve.
        i. Depends on security sensor.
        ii. In some cases, no action is needed.
        iii. If an unexpected alarm state is detected, contact designated liaison with FRNSA or local law enforcement as needed.
10. Generator fault
    a. Description. Typically, this fault status is delivered to the FBTCS from the generator control board. Smith-Root recommends the minimum fault notice from generator is failure to start.
    b. Cause. Variable, can include:
        i. Generator failure.
        ii. Generator startup battery failure.
        iii. Generator is out of fuel.
        iv. Automatic Transfer Switch fails to communicate with generator.
        v. Automatic Transfer Switch fails to transfer load.
    c. Procedure to resolve.
        i. If line power is still on, and the generator fault occurred during weekly exercise, a maintenance technician should inspect the generator and Automatic Transfer Switch to determine the cause of the fault.
        ii. If line power is out, the barrier is only operational for the period in which the pulsers still operate on UPS battery power. No lockages should occur until power has been restored. Contact designated liaison with FRNSA.
11. Low fuel (if applicable)
    a. Description. Not an error, but a warning that backup generator fuel tank level has exceeded a user-specified lower set point, typically 20-25% of capacity.
    b. Cause. Fuel has been consumed, removed, or there is a leak.
    c. Procedure to resolve.
        i. Physically inspect tank to identify potential leaks.
        ii. Contact designated liaison with FRNSA to order a fuel refill.

f. Boat lockage procedure (for motorized boats, drift boats and rowboats longer than 8-ft; does not pertain to other human-powered boats and personal watercraft)

i. Boat passage is only possible during lock operation hours (see Section 3a).

ii. For boats moving in an upstream direction (from Little Lake Butte Des Morts to Lake Winnebago/Government Canal), the lower lock doors shall be opened prior to boats entering the electrical deterrent system.

iii. All lines, cables and ropes attached to the boat must be removed from the water before entering the electrical deterrent system.

iv. For motorized vessels, all oars and paddles must be removed from the water before entering the electrical deterrent system.

v. For human-powered boats (drift boats and rowboats only), only oars/paddles made of non-conductive materials may be used within the electrical deterrent system. Non-conductive oars/paddles must have a fully dry length of at least 12 inches between the paddle and the handle. If non-conductive oars/paddles are not available, all passengers must exit the boat at the designated boat dock, and the boat will be towed through the electrical deterrent system and lock using the procedure described for personal watercraft (Section 4g).

vi. Barge poles/quant poles may not be used in the electrical deterrent system.

vii. Maximum speed limit in the electrical deterrent system is 5 knots.

viii. All boats must follow the following lockage procedure:

1. Approach lock and sound 3 long blasts on horn to notify Lock Tender.
2. Upon approaching lock at a safe and slow speed, Lock Tender will direct timing and placement of all vessels into and out of the lock chamber. Generally, larger vessels enter and exit first.
3. Personal Flotation Devices (PFD) are recommended for all passengers. Children 13 years old and younger are required by Federal Law to wear a PFD while aboard recreational vessels.
4. Passengers must keep arms and legs inside the vessel when within the electrical deterrent system.
5. A bow and stern safety line provided by Lock Tender is required for all vessels. Safety lines must be attended at all times and are never to be tied to any vessel.
6. Turn engine off while in lock.
7. No smoking or cooking while in electric deterrent system or lock.
8. Passengers of recreational vessels must remain in their vessels at all times during the lockage procedure. For safety, pets should be on a leash.
9. Operators should have vessel information and fee readily available for the Lock Tender. Seasonal permits must be permanently displayed in a location easily seen by Lock Tender.
10. All operators must be able to control their vessel in a safe and sober manner.

11. Failure to adhere to the above guidelines may result in a refusal of lockage and/or notification of law enforcement authorities. Lock Tender will complete Incident Report record.
12. Public docks are provided for recreational use and may be used at your own risk.

g. Procedure for human powered boats except drift boats and row boats longer than 8-ft (kayaks, canoes, paddleboards, etc.)

i. At this time, FRNSA does not allow small human powered vessels (not to include drift boats and rowboats longer than 8-ft in length) in Menasha Lock and the electrical deterrent system.

ii. Human-powered boats and vessels wishing to cross between Little Lake Butte Des Morts and Lake Winnebago/Government Canal shall utilize the provided boat ramp and portage path on the east side of the lock.

h. Lockage procedure for personal watercraft (wave runners, jet skis, etc.)

i. Only one operator and no passengers per personal watercraft is allowed in the electrical deterrent system. Passengers must disembark using the provided public docks.

ii. Personal watercraft that does not allow the operator to safely maneuver the watercraft with no part of his/her body submerged in the water is not allowed in the electrical deterrent system and thus may not use Menasha Lock.

iii. The operator is required to correctly and securely wear a Type III Personal Flotation Device (PFD) when operating the watercraft within the electrical deterrent system. Personal watercraft operators without securely fastened Type III PDF are not allowed to use Menasha Lock.

iv. In addition to items (i-iii) of this procedure, personal watercraft operators shall follow the procedures set forth for motorized boat passage (Section 4f).

i. Lockage procedure for barges

i. Barges wishing to cross between Little Lake Butte Des Morts and Lake Winnebago/Government Canal shall contact FRNSA to schedule the lockage at least one business day in advance.

ii. In addition to item (i) of this procedure, barge operators shall follow the procedures set forth for motorized boat passage (Section 4f).

j. Outage procedure

i. The electric deterrent system has two backup systems in the event of line power failure – a backup generator, and an Uninterruptible Power Supply for gap protection (the period between when line power is lost and generator power is delivered).

ii. The system is designed so that the deterrent electrical field is delivered to the electrodes (and thus the water column) until the control system sends a specific "OFF" signal to the pulsers, the power switch on the pulsers are manually turned off, or power is no longer supplied to the pulsers.

iii. The electrodes for the electrical deterrent system receive the pulsed DC electric current at their ends on both the near and far sides of the barrier. This redundancy allows the system to be functional in the case of a break in the electrode and if one of the delivery conductors fails.

iv. Despite the redundancies and backup power systems, an outage procedure is required in the event the electric deterrent system is not functional for any period of time during the lock operations period. Upon discovery or suspicion that the electric deterrent system is not functional, the following procedures shall be followed:

1. If the discovery is made by someone other than the Lock Tender, the Lock Tender should be informed immediately.
2. Any lockages in progress are to be immediately suspended. Any boats in the lock are allowed to leave the lock only into Little Lake Butte Des Morts via the lower lock gates upon approval of the FRNSA liaison. The upper lock gates shall not be opened under any circumstances.
3. The FRNSA designated liaison shall be contacted immediately.
4. Boats waiting for lockage shall be informed that lock operations have been suspended indefinitely.
5. The FRNSA designated liaison shall conduct an initial forensic investigation to determine when and for how long the electric barrier was off line. The details of this investigation will depend on the circumstances of the outage. The following items shall be checked:
    a. Indication of power outage in the area or to the control building
    b. Running status of the generator
    c. System alarm notices that were delivered by email/SMS
    d. Circuit breaker panel, noting tripped breakers
    e. Pulser power indicator lights, and position of ON/OFF switches
    f. Indicator lights and position of ON/OFF switches for the power strips on the equipment racks (if applicable)
    g. Indicator lights and position of ON/OFF switches for the UPS units
    h. Star concentrator power indicator light and position of ON/OFF switch

i. FBTCS power indicator light and position of ON/OFF switch
j. FBTCS monitor, particularly the alarm status area
k. Backup generator fuel tank level (if applicable)

6. Immediately following the conclusion of the preliminary investigation, the FRNSA designated liaison shall contact the DNR designated liaison to discuss the risks of upstream passage of invasive fish during the outage. FRNSA and DNR will work to determine the appropriate course of action, which may include a more detailed investigation.
7. As soon as possible, FRNSA should notify the public of the expected length of the lock closure on the FRNSA website and official Facebook and/or Twitter account.

5. SAFETY FEATURES

a. Intrinsic safety features of BP-1.5 POW pulse generator

i. Chassis has safety ground wire through plug
ii. Electrically isolated output
iii. Inherent safer qualities of pulsed DC compared to AC for a number of reasons

b. Intrinsic safety features of electric barriers (not including POW pulse generator)

i. Electric field limited to lower part of water column creates extremely low electric field at water surface.
ii. Specification of Insulcrete™ with superior resistivity to electrical current
iii. Use of FRP rebar within barrier walls and slab
iv. Ground wire on lock gate gear assemblies
v. Ground wire on fencing and handrails
vi. Restricted access
vii. Option for parasitic electrodes at upstream and downstream ends
viii. Narrow electrode spacing limits the vertical distribution of electric field
ix. Burial of conductors in non-conductive conduits reduces interaction and trip hazards
x. Operating at relatively lower voltage limits the maximum current potential and current distribution vertically and horizontally in the water column.

c. Extrinsic safety features (all are optional items that may be selected by FRNSA)

i. Warning light (amber light illuminated when barrier is active)
ii. Emergency shutoff switch on outside of barrier equipment building or closer to the barrier (switch/switches would control a double pole contactor that physically disconnects power to the electrodes) – potentially one on each side of the lock.
    1. Physical switch (i.e. “big red button”)
    2. Radio-controlled switch
iii. Additional grounding will be applied at select metal appurtenances as needed
iv. Signage
v. Fence
vi. Lock Tender on site
vii. Video camera for off-hours
viii. Security guard for off-hours
ix. Throw rope (on both sides of barrier)
x. Life ring (on both sides of barrier)
xi. Non-conductive ladder (on both sides of barrier)

6. NAVIGATIONAL AIDS AND SIGNAGE

Note: Draft details of signage and navigational aids intended to notify water users of the electric deterrent system are included within the 60% Draft Design drawings for the Menasha Lock Electric Fish Barrier. This section will be updated in the final draft of this document.

7. MAINTENANCE

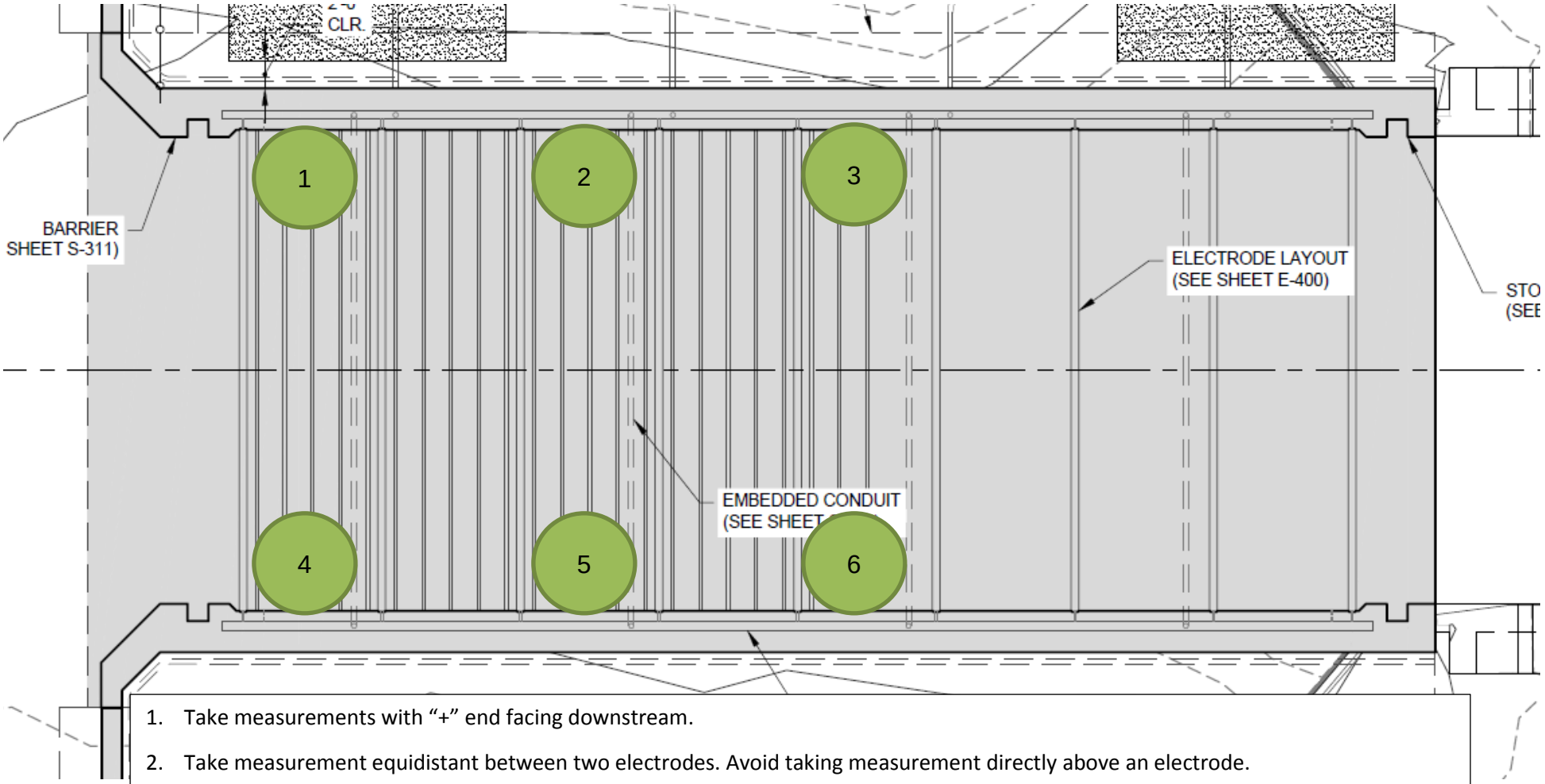
a. Weekly maintenance inspection and procedures

i. Sweep floor.
ii. Dust barrier equipment and remove cobwebs or other debris.
iii. Check external and internal lights.
iv. Inspect building for signs of insect nests or rodent/reptile presence. Remove and control pests inside the building.
v. Check for evidence of roof leaks.
vi. Check and change or clean air conditioner filter.
vii. Verify air conditioner and building thermostat are operational.
viii. Generator maintenance
    1. Check oil level. Change oil per manufacturer's recommendation.
    2. Check fuel level, and inspect lines for leaks.
    3. Check air filter.
    4. Check startup battery (crank test).
    5. Check startup battery water level (if applicable).
    6. Check water level (for liquid-cooled generators only).
    7. Check for evidence of water leaks inside generator.
    8. Check for dirt/dust/debris buildup and clean if necessary.
    9. Inspect for signs of insect/rodent/reptile/bird presence. Remove and control pests as necessary.

b. Annual maintenance inspection

i. FRNSA shall enter into an agreement with Smith-Root for an annual maintenance inspection of all components of the electrical deterrent system.
ii. The Annual Maintenance Inspection shall be conducted annually no more than four (4) weeks and no less than one (1) week prior to the spring opening of Menasha Lock.

ATTACHMENT 1. Electric Field Probe Measurements Worksheet



1. Take measurements with "+" end facing downstream.
2. Take measurement equidistant between two electrodes. Avoid taking measurement directly above an electrode.
3. Slowly lower probe until the probe makes contact with the barrier floor. Raise the instrument one foot and begin measurement.

#1: Right margin downstream between E02-E03: _____

#2: Right margin center between E12-E13: _____

#3: Right margin upstream between E22-E23: _____

#4: Left margin downstream between E02-E03: _____

#5: Left margin center between E12-E13: _____

#6: Left margin upstream between E22-E23: _____

ATTACHMENT 1. Electric Field Probe Measurements Worksheet

ATTACHMENT 2. DAILY FLUSH LOG

Date	Begin time	End time	Date	Begin time	End time