MAINTENANCE & CALIBRATION: SWOFFER 2100 CURRENT METER

(Last revised 12/18/18)

These procedures may be performed by Streamkeeper volunteers after proper training.

Calibration of the rotor/prop units:

Equipment needed:

- "Flow Calibration Protocol & Data Sheets" Notebook
- All current meters and wands
- All rotor/prop units
- Box of Swoffer replacement parts
- Measuring tape
- Tape to mark starting and end points
- Stopwatch
- Calculator or computer with Streamkeepers' flow-cal spreadsheet
- Clipboard, paper, pencil
- 1/16" Allen wrench
- Replacement parts for rotor/prop assemblies
- (Alcohol to clean fiber optics)

PROP SIZES:

We normally use the 3" props because they perform well in our normal range of velocities (0-4 ft/sec), even if the prop can't be submerged completely. However, the 2" props perform best at higher velocities (1-8 ft/sec), and adequately (underreporting by ~5%) down to 0.6 ft/sec, and are therefore a better choice for some high-flow (e.g., storm) situations. (Fulford 2001)

WHEN TO CALIBRATE:

1) Each Swoffer meter should have two rotor/prop units to accompany it into the field: a primary and a spare. Each of these rotor/prop units should preferably be calibrated at the same time, on the wand it's assigned to. Do not mix and match.
2) New rotor/prop units should be calibrated before going out in the field, but if that is not possible, they should be assigned a calibration number of 184 for 2" props, or 134 for 3" props (per Streamkeepers empirical testing).
3) Rotor/prop units should be replaced or recalibrated when any of the below are true:
   a) A unit is first put into service.
   b) Some kind of blow deforms a prop in a minor way—a slight chip or bending.
   c) A unit fails the blow-spin test (see below). In this case, unscrew the thrust bearing nut and clean the inside of the nut, the rotor shaft, and the bore of the rotor unit with water or alcohol—but do not lube. If the unit then passes the test, it should be recalibrated. (If the shaft shows visible signs of wear, replace it.)
   d) Two monitoring seasons have elapsed since the last calibration.

WHERE TO CALIBRATE:

You need a body of calm water (turn off pool pumps if possible) at least 6" deep and 16' (preferably 26') long, with a straight stretch that you can walk alongside. Some places we have used:

- Jim and Robbie Mantooth, 360-457-5415
- Elwha Hatchery, 360-565-7270
- Dungeness Hatchery, 360-683-4255
- Sequim YMCA, 360-477-4381
- William Shore Pool, 360-417-WSMP
- Red Lion Hotel, 360-452-9215,summer only
- Holiday Inn Express Sequim, 360-681-8756

MAINTENANCE OF FIBER OPTICS:

Check the four fiber-optic "eyes" in the bottom of the rotor and the two photo-optic "eyes" at the end of the sensor boom on the wand. If necessary, clean with soap and water and a soft toothbrush.

CALIBRATION PROCEDURE:

1) When ready to calibrate, all rotor/prop units should be collected within a compartmented box, in bags with unique numbers, assigned to a particular wand and meter. These numbers should match notations made in the most recent worksheets in the calibration notebook.
2) If staff or volunteers have problems they want to bring to the attention of the calibrators, they should leave prominent notes inside the compartmented box.
3) Before calibrating each rotor/prop unit, perform the following two tests:
   a) Before attaching the rotor to the boom, perform a hand-spin test: Hold the rotor unit vertically by the steel rotor shaft with the prop facing up, and give a super-fast spin to the nut on top of the prop by "snapping" your fingers. If you hear a buzz, the rotor needs replacement (but see below).
   b) After hooking up the entire unit, perform a blow-spin test: Turn the meter to "Count," then hold the wand so that the prop is facing up, and blow long and hard straight down on the prop. Just as your blow ends, hit the "RESET" button on the meter and allow the rotor to coast to a stop. If the count is consistently less than 300, it's a sign that the rotor may be failing, though the true test is in the water.

   If the rotor unit fails either test, it still needs to be tested in the water to determine its "sensor-drift," before repair/replacement (see the "Troubleshooting" section below). Then **the new or repaired unit needs to be tested again for calibration. Record both tests.**
4) Two people can best perform these tests. The "prop runner" should practice walking the sensor through the course at the desired speed:
   a) For the 3" props, 1.5 ft/sec. This speed was chosen because the Swoffer meter with a 3" prop performs fairly consistently at velocities between 0.5-3 ft/sec, and below that velocity it is difficult to accurately track the drop-off in performance efficiency; see Fulford 2001 & Thibodeaux 2007.
   b) For the 2" props, assuming they'll be used in high-velocity situations only, a speed of ≥ 4 ft/sec is desirable.

   One good way to count time and keep walking speeds consistent is for the prop-runner to hold a stopwatch in the hand that holds the wand, starting the stopwatch when crossing the starting line. (The actual time is irrelevant except for getting the speed right; calibration of the rotor/prop units is based solely upon the number of prop-turns per foot.) Good songs to sing to set the pace are Carole King's "You've Got a Friend" for the slower speed and the Bee Gees' "Stayin' Alive" for the fast speed.

5) The "prop runner" will place the sensor in the water a few feet before the start of the course, 6-12" below the surface, and begin walking toward the start point. During this pre-trial time, the other sampler, the "meter operator," will hit the Start/Stop button until the numbers don't change as the prop turns, then hit Reset if necessary to re-zero the meter. Then, using the wand rather than the sensor as a guide, press and release the Start/Stop button at the instant the wand enters the course. The indicator will begin counting the number of sensor pulses generated as the prop turns.

6) At the instant the wand leaves the course, the meter operator will press and release the Start/Stop button again. The display now shows (and will hold) the number of pulses generated through the course length. Record this number, then hit Reset to re-zero the meter. Repeat back and forth until you have performed four passes (two in each direction) which are in close agreement. Any "outlier" readings should be ignored.

Outlier readings can be caused by sunlight directly behind the rod causing reflections into the fiber optic unit. You may need to provide a shadow on the back of the rotor/prop unit during the calibration run.

7) If there is any kind of current in the water, it will hopefully be compensated for by the fact that your trials are going back and forth. However, currents may not be consistent, and if so, the paired data will reflect the inconsistency. To check for such inconsistencies, compare the first and second pairs from your four runs; if the averages of these two pairs differ by more than 1.5%, run additional pairs until a clear pair pattern emerges, and then use the pairs that fit the pattern to calculate the calibration numbers.

8) Once you have four consistent readings, calculate average counts per foot with either a calculator or the SK spreadsheet. Any unit with an average of <12.7 counts per foot for a 3" prop or <17.5 counts per foot for a 2" prop should be repaired or replaced as necessary (see the "Troubleshooting" section below) and then recalibrated. Record both tests.

9) We try to always have on hand one or two already-calibrated, unused rotor/prop units that aren't connected to a specific meter. If there are none, build and calibrate one or two of these. You can use any wand.

10) For every 10 rotor/prop units tested (or fewer), perform a replicate set of trials with one unit. If the replicate set differs by more than 1% from its original set, redo the entire calibration set.

11) When you are finished with your pool checks, calculate calibration numbers for each unit (average counts per 10') using the Streamkeepers calibration spreadsheet workbook, following the instructions on the "Template" worksheet that's farthest to the left, to create a new worksheet for both the 3" & 2" props.

12) The spreadsheet will assign the unit in each kit with the highest calibration number as the primary unit, and the other as the spare.

13) Each rotor/prop unit should go into a bag labeled with its kit and unit numbers, calibration number and date, and whether it is a Primary or Spare.

SAMPLE NOTATIONS FOR 3" PROPS:

SK 1.2 – PRIMARY– cal #132 – 11/17/14

SK 1.1 – SPARE – cal #127 – 11/17/14

SAMPLE NOTATIONS FOR 2" PROPS:

SK 1B – PRIMARY– cal #186 – 11/17/14

SK 1A – SPARE – cal #178 – 11/17/14

14) Make sure each bag has a 1/16" Allen wrench, needed to mount the unit.

15) Set the calibration number for each field kit's meter to match the calibration number of its 3" Primary rotor/prop unit:

a) With a flat-bladed screwdriver, remove the black plastic screw on the base of the meter beneath the label "FT cal adjust" on the front.

b) Switch meter to CALIBRATE position.

c) Use a small flat-bladed screwdriver to turn the screw inside and adjust the calibration number.

d) Turn meter off.

16) Make sure that the four screws on the back of the meter are tight and that the two screws at the bottom are snug (not tight because you'll break them—they're plastic).

17) Replace all meters and rotor-prop units in their appropriate field kits, and put meter wands back inside their tubes in the rack. Print out the SK calibration worksheets, staple each worksheet to the front of the corresponding data sheet you worked from, three-hole punch them, and put them in the proper place in the Flow Calibration binder. Return the Flow Calibration notebook to the shelf.

18) Log your team's hours into the Office Volunteer notebook.

FIELD CHECK OF ROTOR/PROP UNITS:

Each time the unit is used in the field, it should be tested for snugness of the shaft and freedom of spin. See the hand-spin and blow-spin tests described in the Flow field protocol.

TROUBLESHOOTING THE ROTOR/PROP UNIT:

If you need to replace parts as described below, you may need to recalibrate the rotor/prop unit, depending on the nature of the problem requiring replacement:

1) If the prop has suffered significant damage, replace it.

2) If you start getting readings that don't make sense, try turning the meter off and back on again, and starting over. Sometimes this will reset the circuits.

3) If the rotor/prop unit fails the hand- or blow-spin test or the number of counts per foot is too low (see above), here are some procedures you can perform:

a) Remove the Thrust-Bearing Nut at the front of the prop. Check the inside bottom of this nut; if a pronounced cup has formed where the rotor shaft spins against it, the nut should be replaced.

b) Remove the steel shaft. If it is dirty, clean it as described above. If it is

very scored or doesn't roll smoothly on a flat surface (with the little o-ring hanging off the edge), it should probably be replaced.

c) The rotor itself is virtually impossible to inspect, but you can try to clean it as described above.

d) If you've performed the above and the unit still fails the spin tests or continues to calibrate below 175 for a 2" prop or 127 for a 3" prop, you probably need to replace just the rotor piece, which is probably scratched up inside. (All parts described here should be in the "Extra Parts" box.) By switching in replacement pieces, you can tell which pieces need to be replaced. Replaced pieces should be assigned the same number as the old pieces, with a note on the calibration form about the replacement, and then re-calibrated.

MAINTAINING THE SWOFFER ADJUSTABLE WAND:

1) Each time a kit returns from the field, take out the wand, extend it fully, and allow it to dry before storage, if time permits.

2) Repair or replace the tell-tail if necessary (see Flow field protocol for description).

3) If the wand becomes difficult to slide up and down, it probably has dirt or an oxide buildup. In either case, clean the shaft with 00 or 000 steel wool. The inside of the outer shaft can be cleaned with a gun-cleaning rod and a brass brush of .375 caliber. If movement is still difficult, try mineral oil or butcher's wax.

REFERENCES:

Fulford, J.M., 2001. Accuracy and consistency of water-current meters. *Journal of the American Water Resources Association* 37:5, pp. 1215-1224.

Thibodeaux, Kirk. 2007. Testing and evaluation of inexpensive horizontal-axis mechanical current meters. In: The Role of Irrigation and Drainage in a Sustainable Future. *Proceedings, 2007 USCID Fourth International Conference on Irrigation and Drainage*, Sacramento, CA, Oct. 3-6, 2007. Ed. A.J. Clemmens and S.S. Anderson. Denver: U.S. Committee on Irrigation and Drainage.