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Version: V0	Rue du Pont du Val, 1 4100 Seraing ☎ + 32 (4) 330 47 80 - 🖷 + 32 (4) 338 24 03 pierre.theunissen@edfluminus.be	Contact name: Pierre Theunissen

DOWNSTREAM FISH MIGRATION ALONG THE LOW MEUSE RIVER

Action C1

Installation of a pilot behavioural barrier and downstream fish pass at pilot site 1

Deliverable – On site installation report (electrical barrier HPP Grands Malades)

luminus LIÈGE université profish LIFE4FISH EDF R&D UNIVERSITÉ DE NAMUR Life

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I. Introduction

Based on the extensive experimental findings available in the scientific literature and operational testing in the field and in the lab, the solution chosen for the LIFE4FISH project is an electrical barrier.

The barrier comprises a chain put at the bottom of the water and electrodes that float thanks to buoys. There are two fences, the first one is for the eel and the second one for the salmon. The salmon barrier will be set up next year when the downstream pass will be carried out.

The effectiveness of this technology, if demonstrated at the Meuse pilot site, could be harnessed for diverting fishes from the water intake channels at hydropower plants and any other waterways that have an impact on the migratory movements of the species in question (canals, industrial water intake channels, etc.).

The behavioral barriers will be placed upstream of the power plant at the entrance to the water supply channel in order to divert the fish toward a properly calibrated bypass.

II. SITE PREPARATION

1. Supplier Selection

The supplier selection was done on February 2019 according to several requirements:

- **Biotechnological criteria 45%:** barrier efficiency / barrier location / project compatibility.
- **Price criteria 40%:** purchasing price / purchasing conditions.
- **Technical aspect 5%:** specific design adapted to the site.
- **Project management 5%:** Site preparation and site follow-up.
- **Security aspect 5%:** Risk analysis / Material choice.

The electrical barrier chosen for the pilot site is the technology of Procom System, a polish society based in Wroclaw.

The Procom's barrier consist in two rows of electrodes, one for the anodes and the other one for the cathodes. The electrical field generate by the barrier creates a stress feeling for fish that prefer to go away from the barrier. It could led them to a properly calibrated pass. The barrier works by impulsion, the power is supplied by an electrical cabinet. And Procom can control the barrier from Poland thanks to an internet connection in the electrical cabinet.

The eel barrier has a row of anodes and cathodes and another row of anodes. The salmon barrier will have a row of anodes and a row of cathodes.

Under the biotech criterion, Fish pass was excluded. As regards the Fish guidance system, the price criterion was very unfavorable.

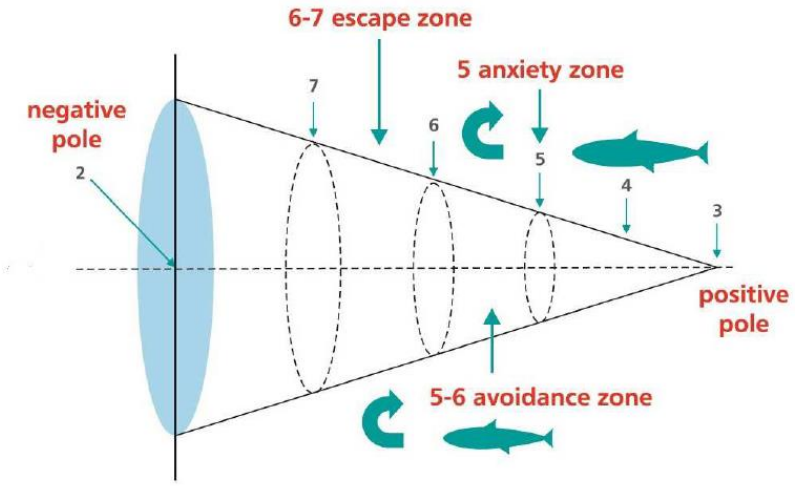


Figure 1 : Blueprint of the stress reaction of the fish near from the barrier.

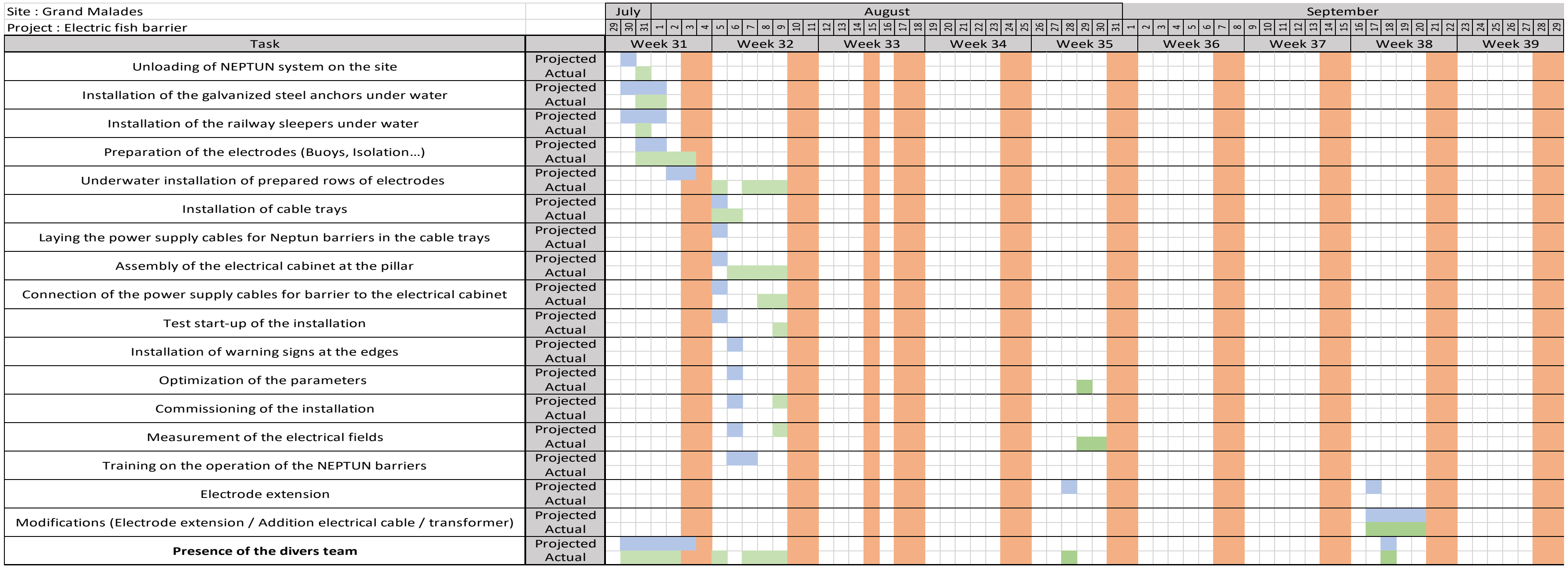
2. Supplier Scope

Three suppliers worked for the electrical barrier project.

- Procom System : In charge of preparation of the electrical barrier, installation of the electrical cabinet.
- Hydroscaph: In charge of underwater work: preparation and installation of anchorages (concrete bloc) – preparation and installation of the electrical barrier.
- NewElec : In charge of the installation of cable from the powerplant to the Procom's electrical cabinet. The RJ45 cable, power supply cable and ground cable.

3. Projected Schedule and Actual Schedule

During the transport from Poland to the Grands Malades powerplant, the car broke up, so we lost 2 days, the work started Wednesday 31th July instead of Monday. With the lot of delay Procom had, the construction finished on Friday 20th September instead of 15th August. One month's delay due to numerous errors on the supplier's side (electrodes too short, electric field too weak).



4. Financial aspect

Total for all the actions	269 834,00€

III. Project Realization

1. Security aspect

At Luminus, security is the most important. The safety rules must be applied by employees, suppliers, subcontractors. To ensure the safety of the site, the worksite manager provided the necessary documentation for the good progress of the works: work permit and risk analysis. The risk analysis is written by the company performing work. This document is approved or completed by the worksite manager, the work permit is written afterwards.

The main risks are related to the fall of a person into the water, a risk increased during the short period when the fence was down to let us put the electrodes in the water. Several solutions were implemented to make the workers as safe as possible. All work areas are marked out. Wearing the lifejacket is mandatory close to the water.

On one step of the work, Procom System had to use a CMR product (Carcinogenic, Mutagenic and Reprotoxic), so before this use, we checked that no one was on the working area, and the user was protected with a mask with cartridge.
Every morning, the site manager gives the safety instruction and signs the work permits. To ensure maximum safety, the Grands-Malades' hydropower plant is shut down during the works.

We will put an aerial fence above the barrier to indicate the presence of electrodes near to the top of the water

2. Power Supply

Electrodes are powered by an electrical cabinet installed by Procom system next to the concrete pills of the bridge. The power cable comes from the power plant and Procom wanted to add a ground cable of 35 mm², but after measurement of the powerplant ground, the initial ground of the power cable appeared to be enough and no additional ground cable was required.

Between the barrier and the electrical cabinet, Procom installed a railway for the cables. The railway is in stainless steel because it is outside and near from the water.

The railway cable was installed on the wall for the eel barrier and the salmon barrier by the divers, but the cables of the salmon barrier are not inside yet. Installation of the salmon barrier is foreseen later (end of 2020, beginning of 2021).

During the tests we observed the presence of fish shocked by the electric field. We decided to reduce the voltage on the transformer.

For the control of the barrier, Procom needs an internet connection in the electrical cabinet. The first option was to plug a RJ45 cable from the powerplant to the electrical cabinet, but this solution was not possible because, the transmission of data was forbidden via this way. So the option chosen is a 4G router from Proximus, implemented in the electrical cabinet, and powered up thanks to an electrical outlet. The IP address is fix to allow Procom to connect through a gateway from Poland.

Figure 2 : The electrical cabinet

Figure 3 : The Railway cable

3. Anchors installation

With the late arrival of the Procom team, Hydroscaph was in charge of the determination of the position of the anchors. We knew that the length of the barrier was 36 meters, so divers used a rope between the two wall and prepared the work for the arrival of the anchors.

When the concrete is not covered by sediments, anchors are fixed with mechanical fixation, 2 on horizontal fixations and 4 when the anchor is vertically on the wall. But when the concrete is covered, the system is belayed by railway sleepers. Railway sleepers were ordered by Procom in Poland and came with the transporter. Thanks to a crane, divers put the concrete block in place under water

Figure 4 : The delivery truck with the concrete blocks

Figure 5 : A concrete block hold by the crane before the submersion

4. Electrodes preparation

Both barriers (smolt and eel) were brought by Procom but the Smolt one will be stocked on the power plant site until it will be installed next year.

The electrodes are made in stainless steel pipe (Figure 5), there are two diameters. The shackles are fixed to the electrodes via a plastic part made for the isolation. The standard length of pipe was 6 meters so where the electrodes needed to be longer, they were extended with a welding, and if needed they were cut. To protect the welding a thermoplastic is put on the welding location.

Procom drilled the lower extremity of each electrode to put the plastic part that isolate and fix the electrode on the chain (Figure 6). Then for the floatability, some buoys are fixed to the electrodes. Two buoys for the larger electrodes, one and a half for the other ones. After a call of their designer, Procom System moved the position of the buoys because it appeared to high.

Thanks to a galvanized shackle electrodes are fixed to the chain. The electrical connection between the cable is a physical connection, the extremity is locked on a threaded shaft with a screw. A metal cover is ad on the connection to protect the system and in addition to the physical protection, the PUH-255 (sealant) is put inside the metal cover.

There is a vertical step in the concrete, it represents a distance of approximately one meter. We saw that the distance between electrodes was the same all along the chain so we asked to Procom how they managed this step for the right position of electrodes. It appeared that they forgot to pay attention to this step. The solution proposed was to move the electrodes which was on the position of the step, the fifth and to put it in first position. So the distance between the electrodes before and after the step was good but we have now a succession of two cathodes and two anodes. Procom system does not consider that as a problem. For the second barrier, the anode one, Procom remove one electrode, so there was a distance of three meters instead of two between electrodes before and after the step.

Figure 6 : The stainless steel pipes of the electrodes

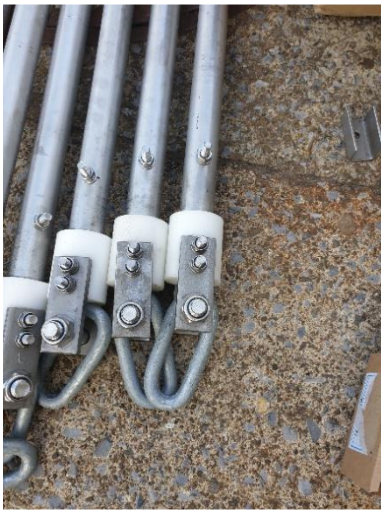


Figure 7 : Electrode fixation and isolation

Figure 8 : The chains and cables

Figure 9 : The cable with the derivations for each electrode

Figure 10 : An electrode on the chain

Figure 11 : Electrical connection between the cable and the electrode

Figure 12 : The connection once the isolating product was put

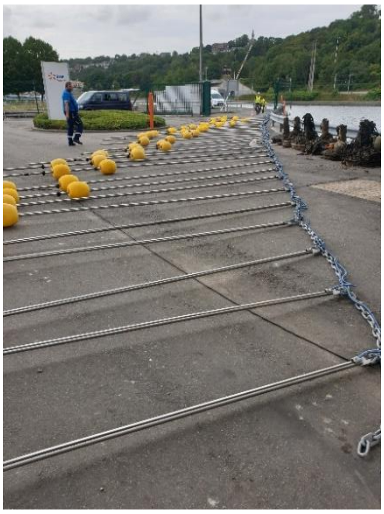


Figure 13 : The first barrier almost ready for the submersion

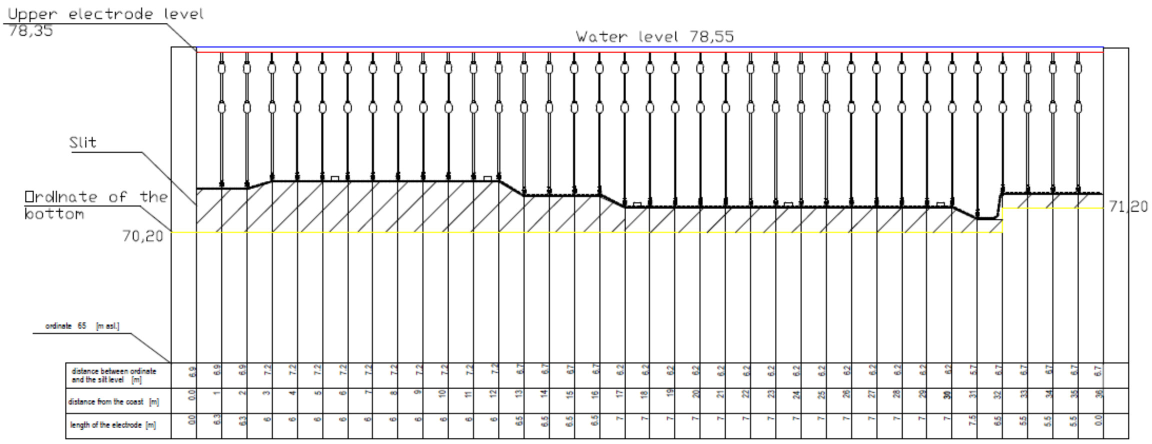


Figure 14 : A sectionnal view of the Anode/Cathode barrier as given by Procom

5. Barrier installation

The fence near the water was removed to put the Neptun System in the water.

Thanks to a water hose fixed in a lot of point on the chain, the whole system was able to float. The water hose is inflated by a small compressor. It make the system easier to move and put in the right position. One extremity was hold with a rope from the otherside of the water. Then electrode after electrode we put the system into the water, paying attention that no one is between electrodes in case of a fall in the water of the whole chain carried away by its weight. Once the barrier is on position, divers cut the rope to make the system drown.

The first barrier, the one with the cathodes was set up without any delay. Divers put shackles to fix the chain to the concrete blocks and the anchors. But then Procom asked to the divers to move the buoys because they were too high. Divers proceeded by two, one maintained the position of the buoys while the second fixed it. This delay represented about half a day.

For the second one there were more problems, at first, the barrier was too long. Two electrodes was against the wall. So the extremity of the barrier had to be put out of the water to cut the electrodes and let the surplus of chain in the water. Some workers hold the chains and electrodes while another one take down the shackles. Then divers fix the chain in the depth. This operation did not take a long time but was a delay. The two barrier were in the water.

Figure 15 : The alignment of the electrodes

Figure 16 : The water hose before fixed on the chain

Figure 17 : The start of the installation of the barrier

Figure 18 : The installation of the barrier

Figure 19 : The barrier and the inflated water hose

Figure 20 : The separation of the barrier from the water hose

Figure 21 : Divers moving the buoys

Figure 22 : The barrier after the first installation

6. Modifications and lack of communication that delayed the project

Once the barrier was installed, the electrode length above the water was very important. Procom asked to the divers to cut the part of the electrode which was not in the water. It was not in the scope of the divers but as polish worker did not want to go on the boat and use the grinder to cut, divers did it. They cut several electrodes some parts was more than one meter and the longest has a length of 1,55 m.

But with the loss of weight due to the electrode part removal, the whole system rose to the surface. The distance between the chain and the bottom varied but the biggest distance was about 85 centimeters. Some ways to make the system to be heavier had to be found. We used some chain residues and fixed it on the chain with shackles and threaded shaft. The barrier was less high but it was another delay on the project.

Procom asked the divers to measure some distance, needed to their files. And one distance was unsatisfying for the homogeneity of the electrical fields. As mentioned before, one electrode of the second barrier was removed so the chain length between the two electrodes passed from 1,5m to 3m, and the distance between them at the surface was 2,2m it was too long for Procom. So Procom asked us to remove the part of the chain where there was the missing electrodes. Divers removed the shackles of the chain, and thanks to a hoist attached on the chain and the parachute of the divers, a half of the barrier is put out of the water. We thought Procom wanted to work on the missing electrode location but they wanted to add an electrode at the extremity. It would be easier for us to just put out the extremity and if Procom told us clearly what they wanted, we would lose less time. Procom added the electrode to the chain from a boat and then divers deflated the parachute, the barrier went down. Because of the time, divers just attached the chain to the bottom at both extremity. And in the next morning totally fixed the fence.

The result of the operation is that one electrode is now fixed in the step at the half of the height. The surplus of chain is below the step. But the distance was still a bit too long. The electrode on the step was not movable so divers moved the electrode on both sides of the step, without touching the electrical connection. So the move was limited by the tense of the electric cable. But with this move, the distance was satisfying enough for Procom.

On the side of the powerplant, the distance between the top of electrodes is too important, up to 1,20 m. So Procom came with some stainless steel pipes and sleeves that the divers fixed to the electrodes to decrease this distance.

The construction of the electric barrier was longer than expected because of a lack of communication. Some delays could have been avoided if Procom prevented us earlier. There were no real problem, but the addition of little delays lead to a lateness of two days on the schedule. And the addition of the comeback of Procom is also an important problem because the deadline for the project was the 15th of August. Thanks to Hydroscaph that helped to deal with the problems, all the needs.

Figure 23 : Divers cutting electrode from the boat

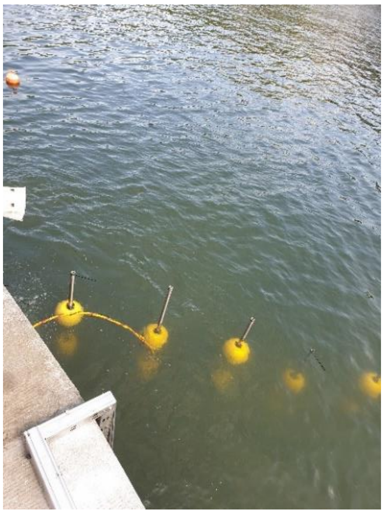


Figure 24 : Electrodes after cut with the marking of the water level before cut (colson)

Figure 25 : The barrier after cutting of the electrodes

Figure 26 : The parachute and the hoist used to pull the chain out of the water

Figure 27 : The addition of one electrode

Figure 28 : The barrier while we put it down

Figure 29 : The barrier before Procom came back to add some part to the shortest electrodes

Figure 30 : Electrodes extensions

Figure 31: Electrodes extensions with buoys

Figure 32 : Fixation of the extensions

7. Procom measurement of the electrical field

The last step was to measure the potential of the electrical field along the barrier. Procom used an oscilloscope to check in the water if all was clear. The first time they came they cannot finish all the measures so they came back to measure again.

Procom did not want to work on the inflate boat lend by Profish so they used another boat from Profish, an aluminum boat. So they tinkered a perch to put the oscilloscope without be in contact with the electricity.

After the second measurement phase, the electric field was weaker downstream than upstream of the barrier.

The Polish company has therefore decided to carry out new tests with this time an additional power supply.

Figure 33 : The tinkered perch for the oscilloscope

Figure 34 : Measurement from the dock

Figure 35 : The tinkered perch

Figure 36 : Measurement from the aluminum boat

After internal discussions at Procom, they decided to supply new power cables downstream of each barrier line. This work was carried out in week 38. They have again taken measurements and confirmed the weakness of the downstream electric field. It was decided to connect three new electrical cables: one on the last electrode of the downstream line, and two on the last two electrodes of the upstream line. The divers of the Hydroscaph company were commissioned to remove the electrodes from the water. To do this, they unhooked the concrete block chain, they attached a sing to the bridge pier and with a hoist attached to the chain, they pulled out the electrodes. Once electrodes out of the water, Procom has fixed the new electrical cables. Wearing a mask and coveralls was mandatory when using the product to seal the connection.

The transformer in the electrical cabinet was changed because the power supply was stronger. After the electrical connection, Procom made new measurements to check the electric field. Everything is detailed in Procom's report on the commissioning of the barrier.

Figure 37 : Take the chain out of the water with a hoist

Figure 38 : Electrodes are out of water

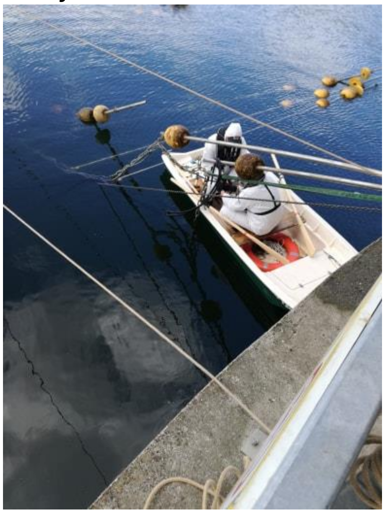


Figure 39 : Electrical connection

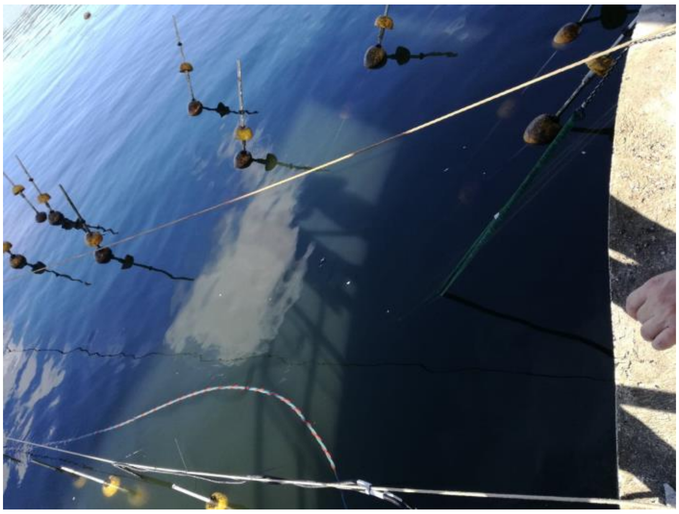


Figure 40 : Replacement of electrodes