RIVER "Roadmap Report" Canal & River Trust

ORIGINAL PLAN / TIMELINE

Was to adapt an existing CRT narrow maintenance craft for the purpose of the project. We investigated this and given the scope and cost of altering and renovating an existing craft for the project purposes was not dissimilar to that of the construction a new craft, concluded that a purpose designed and constructed boat for *RIVER* would be the most cost effective and practicable solution.

WHAT CAUSED THE DELAY?

- Progress was delayed due to the length of time needed to confirm the engine space and associated technology configuration on the fitted-out boat. CRT staff stressed the need to get proposals about what equipment to purchase, the need to get each process agreed, then install the equipment to take the process forward.
- The CRT team and Klaus Bieker of DST invited others in WPT1 to agree the dimensions of the boat being used to trial the RIVER technologies. This proved difficult, but CRT raised the urgent need to agree on the process going forward to start fitting out the boat at the meeting in Rotterdam in December 2018.
- Meetings were subsequently held in the UK with Klaus Bieker of DST and a second workshop took place at Church Minshall, Nantwich in April 2019. CRT led technical discussions during this technical meeting and partners inspected a typical narrowboat engine space and cabin, location of engine control, transmission control, and engine monitoring system. At this meeting partners were first asked to agree a timetable. Final agreement to this CRT / DST proposal was only received at the SG Meeting in Luxembourg in December 2019.
- CRT needed to order equipment and book time slots for physical installation on the boat AFTER the modelling stage, so boat demonstrator activities were delayed until later in 2020. This restricts the length of time the fully fitted out boat can be taken out on the CRT canal network (due to routine autumn/winter closures for maintenance and during periods of bad weather). The extension of the project now enables full trials to collect data but demonstrations to enterprises (Deliverable 1.2) were not possible until boat fitting completed.

WHAT IS THE NEW TIMELINE?

- The revised solution to become a project specific craft designed specifically for the requirements of RIVER was agreed in December 2019.
- Construction started in March 2020, was delayed due to the Covid 19 crisis - but on schedule to be completed by July 2020 ready to accommodate the skid and commence 'on water' trials.

TECHNICAL DEVELOPMENTS AFFECTING PROGRESS / SOLUTIONS PROPOSED

- The oxygen making part of the equipment and all the other equipment had been outlined. However, to accommodate this - it became clear that the quantity of electrical power required would exceed the capabilities of the existing craft engine to provide both electrical power **and** craft transmission power.
- A second concern was that the pressurised gas tanks for the various functions including all the ancillary equipment equated to a pay load in excess of the capabilities of the craft. A decision was therefore made, to use replaceable proprietary bottled compressed oxygen rather than generate the oxygen on board the craft.
- Despite this, the electrical requirements for the craft still far exceeded the power production capabilities of the craft engine and confirmed that a second larger engine would be required to generate the required electrical output.

Initially the intention was for the propulsion engine of the craft to provide both the electrical power and propulsion, but the size engine required to provide the crafts propulsion was not of enough capacity to undertake both functions. The types and characteristics of the individual items of equipment and their starting loads needed factoring into the selection of electrical power generator.

Accommodating this second larger engine (which also require its own fuel tank and system, control equipment, batteries, cooling system, exhaust system) within the confines of a narrow beam work craft, started to impact on and limit the available hold space planned to host the project equipment. So, it was clearly impossible to provide all the electrical and craft transmission power from within the craft - and leave enough space for the other project equipment to be sensibly located within the craft.

EXPECTED OUTCOMES

The proposed solution was:

1. Use an electric 3 phase transmission motor to power the craft.
2. Add a hold mounted self-contained generator to power the electric 3 phase transmission motor AND provide the electrical power required for the project equipment.
3. Mount the project equipment needed within the craft on two pre-constructed removable "skids"

As a result, the oxygen injection and gas recirculation are undertaken as part of operating the generator engine - and it is the exhaust gases from this that would be captured and compressed. This arrangement allows us to tackle the targets of the project whilst still accommodating the systems and equipment that make up the project within the confines of the craft hold.

Powering the craft and the project equipment

A problem identified was that the craft's existing engine compartment could not physically accommodate an arrangement where the weight of the larger engine installation in this location would exceed the safe loading capabilities of the craft. We looked at using two engines at different locations within the craft to distribute the load but this also required a duplication of services and ancillary equipment - a second engine and generator assembly, that was also supported by a battery bank and a few DC to AC inverters (that self-synchronize with the existing AC supply and automatically provide additional power as the generator takes up the electrical loads)

This option allowed us to look at smaller generator that would physically fit in to the craft along with all the other equipment. But we still had two diesel engines and fuel tanks, cooling systems, exhaust system within the relatively small craft. This all used up space that was required for other equipment.

We also considered a hybrid diesel / electric craft propulsion system. This allowed the propulsion engine to perform with electrical generator 1st priority and the propulsion being provided by batteries during periods of high electrical demand. This again was an endeavour to maximize the size of the second generator and its engine.

The chosen power solution was to use a generator that would match the base load but would require the start-up electrical loads of the equipment to be cascaded. This option still having the option to add, or an element of battery and inverter start up load support. To further minimize and manage the issue of generator loading the craft propulsion would be provided by a variable speed 3 phase motor drive unit. Programming of this drive unit will limit and manage the operating parameters of the craft electric propulsion motor. This arrangement keeps all the project equipment together and avoids having to pipe engine exhaust gases through the cabin area of the craft. The heavy and bulky items are positioned more suitably within the craft to distribute the load.

Mounting the project equipment on pre-constructed removable "skids"

This facilitates the skids being built up, off site at the same time as the craft is constructed. It also saves a lot of expense in fitting the craft out. The thinking behind this arrangement is that if the equipment is conventionally mounted within the craft and its hull it will have no future value once it's all stripped out - it just becomes a pile of individual items of little value or use to others (it will have no residual value for CRT). However, if the project equipment is built on the skid, it is the skid dimensions / parameters that define the available void space for the equipment.

At the end of the project, the two skids lift out with all the equipment attached. They can them be transferred between organisations for further adjustments or enhancements and development work - and none of the initial value or functionality of the installation is lost due to its removal from the craft.

Once the project has been completed craft will be reduced in overall length and converted back to be a 130 Class F work boat.

PROGRESS TO DATE

- The skid has been drawn but have not been finalized to date in terms of all the component's to be mounted.

- Aqueduct Marina were commissioned to construct the craft but have been affected by the Covid 19 lockdown and most of their workforce furloughed. The order for the construction of the craft hull has been placed and was progressing very well up until the disruption caused by the lockdown. They now have 3 engineers returned to work - but these will be spread across the various workshops to maintain social distancing. Work will continue again on the *RIVER* craft along with the other craft on going in their workshops as soon as possible but progress will be limited by the availability of raw materials and only tasks that one individual alone can undertake.

ADDITIONAL COMMENTS

CRT technical staff leading delivery of WPI1 have no significant input to or comment on the efficiencies brought about by this aspect of RIVER We are providing the boat as a test bed for the other teams to test and prove their equipment. However, the potential to fund end use and other product lines to introduce the waste materials of combustion as an input for other process is quite exciting. Some of the benefits e.g. developing integration of waste products into other process streams as a new raw material will be the longer-term wins.

TECHNICAL SUMMARY

- The specific required tank capacities (dimensions and weights) were calculated for the different system configurations.
- The results were applied to the integration into a “Class130” vessel that shall be equipped with the developed technology.
- DST generated a 3D-Model of the „Class 130“ to integrate the tanks and to compare the hydrostatic properties with the added weights caused by the limiting deadweight and space capacity of this boat a diesel-electric drive was proposed.
- It was highlighted that only short operation times are possible with this equipment arrangement.
- The cargo hold is used for the modular diesel engine/generator set.
- An electric motor is used for the propulsion.
- Further, the required number of tanks for Oxygen and CO2 were detected and integrated into the vessel
- Hydrostatic and stability analyses were performed to check the ships operability and safety