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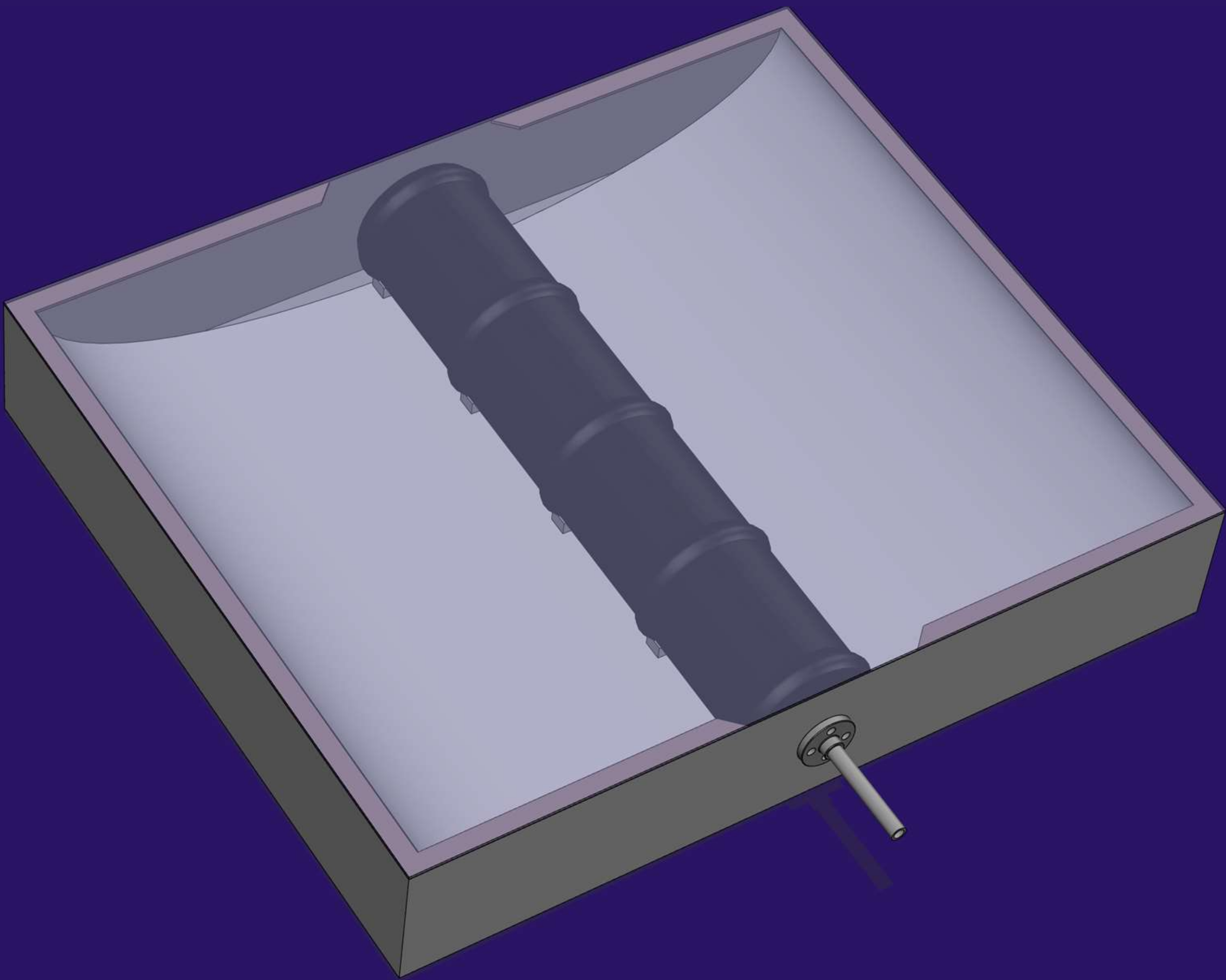
NRI | Natural Resources Institute

Solar heater

Dr Marcelo Precoppe



Construction guide delivered to **INTERMECH ENGINEERING LIMITED**, in fulfilment of the project *Upgrading the flatbed dryer with a solar-powered system for Tanzanian smallholders* funded by GCRF AgriFood Africa Innovation Awards Competition.

January 2021

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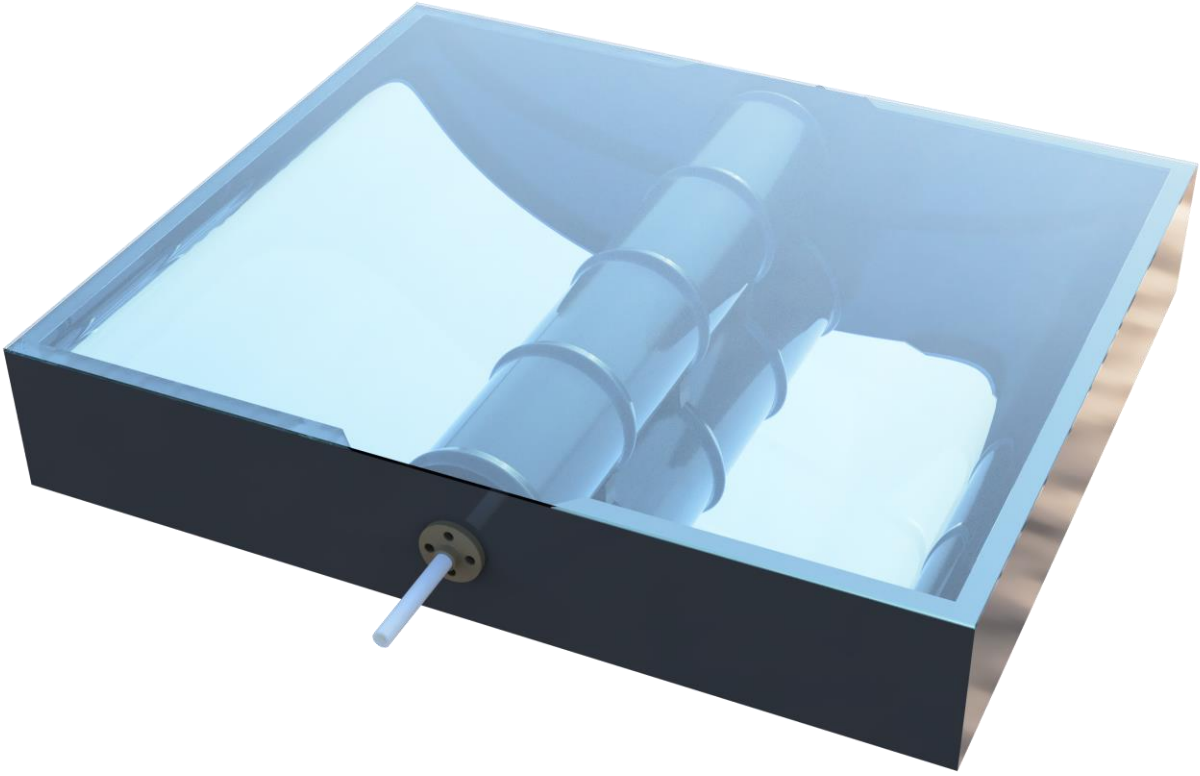

Dr Marcelo Precoppe | Natural Resources Institute | University of Greenwich | Chatham Maritime | United Kingdom

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About the Natural Resources Institute

The Natural Resources Institute (NRI) is a specialist research, development and education organisation of the University of Greenwich, UK, with a focus on food, agriculture, environment, and sustainable livelihoods.

About the author

Dr Marcelo Precoppe is NRI's Crop Postharvest Technologist. He obtained his PhD at the University of Hohenheim in Germany. His research interest lies in developing postharvest technologies for small-sized enterprises.

Disclaimer

The author is safe to assume that the advice and information in this document are believed to be true and accurate at the date of writing. The author gives no warranty, express or implied, concerning the material contained herein or for any errors or omissions that may have been made.

⚠ Warning
High temperature can occur at the solar heater and its components. If handled incorrectly can result in personal injuries.

Introduction

Cassava (*Manihot esculenta*) is a perennial root crop native to the central region of South America but nowadays cultivated throughout the humid tropics. Cassava is the main source of calories for many people living in Africa. However, the root has a short shelf-life, and two days after being harvested becomes unsuitable for human consumption. For this reason, cassava is usually processed into flour, an easy to store dried product which can be used later as the basis for a variety of dishes. During the cassava flour production, the roots are peeled, grated, pressed, pulverized, dried, and milled.

The objective of this guide is to provide the instructions on how to build a solar heater that preheats the drying air, assisting the heating unit and consequently reducing fuel consumption. It is important to notice that this novel solar heater is still experimental, not fully tested nor validated.

Overview of the solar heater

The solar heater is composed of water tanks surrounded by reflectors, each enclosed in a box with a glass cover. A total of 12 tanks are installed in series. Water is induced by a pump, and a radiator, placed at the heating unit air inlet, transfer the heat accumulated by the water to the drying air (Figure 1).

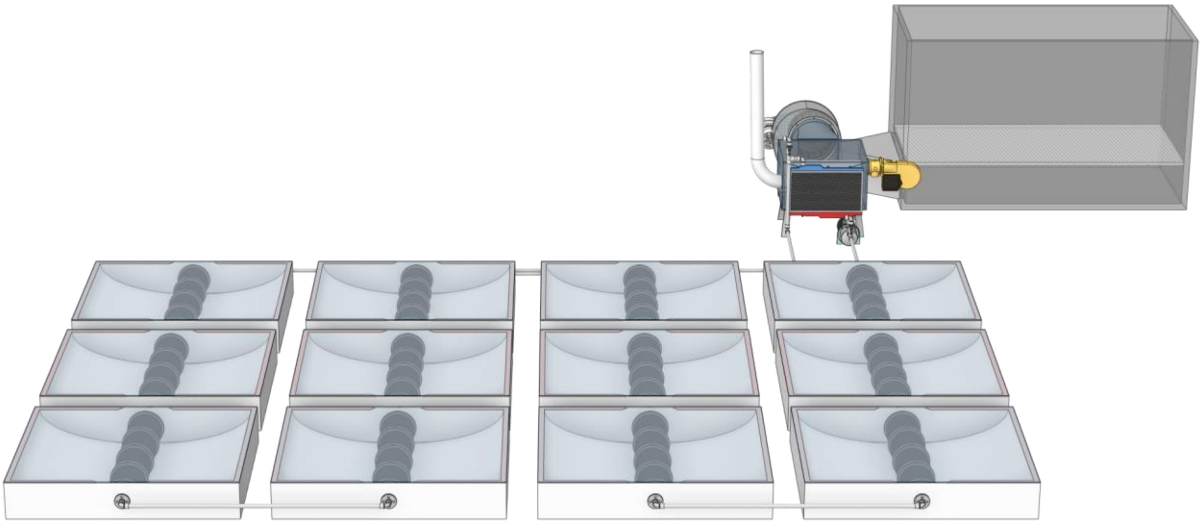


Figure 1 *Solar water heater assist the heating unit by pre-heating the ambient air.*

Solar collector

The solar collector is composed of a water tank, surrounded by a reflector, all enclosed in a case covered by a glass (Figure 2).

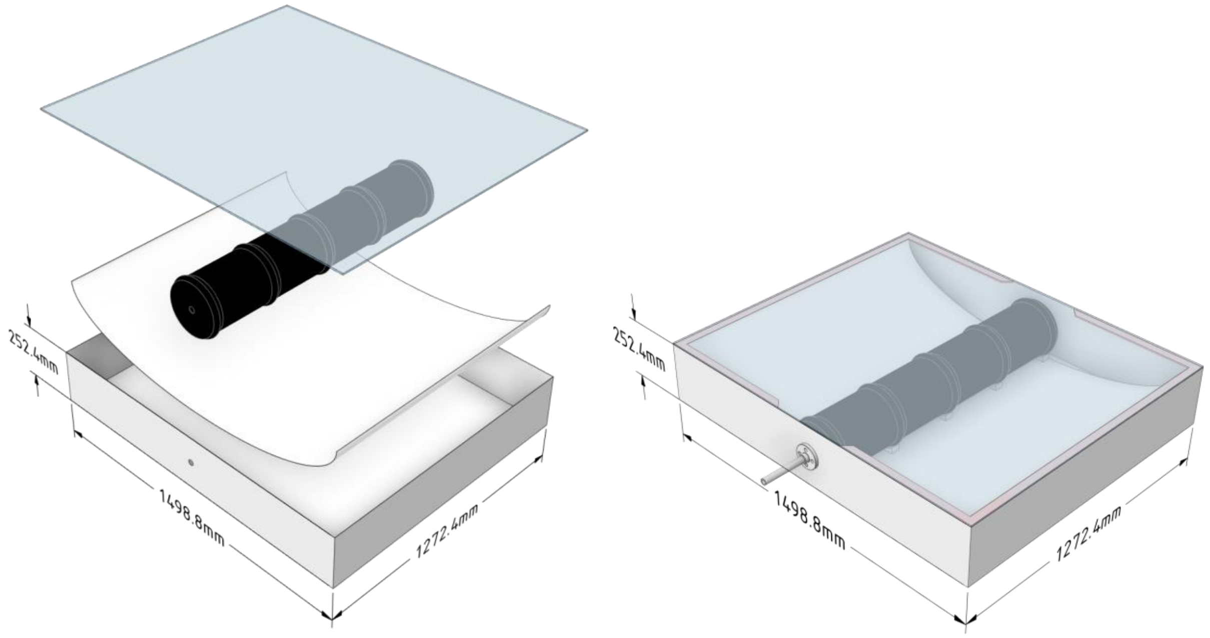


Figure 2 *The solar collector is made of a water tank and reflector, both enclosed in a case covered by a glass.*

Water tank

The water tank can be built with 1.2 mm thick stainless-steel. The tank dimensions are intended to optimize the use of the metal panel and use a third of it, as shown in Figure 3. The size of the tank, as well as the thickness of its wall, can be adjusted according to the dimensions of the locally available stainless-steel panel, using one-third of it.

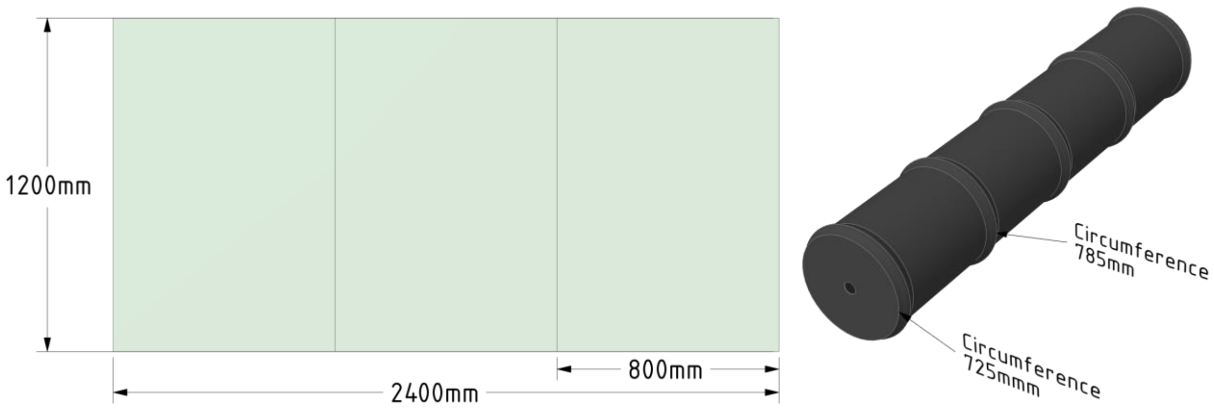


Figure 3 *Water tank can be built using a third of the stainless-steel metal panel.*

To strengthen the sheet metal and avoid the water pressure deforming the tank, structural grooved seams are added to the tank (Figure 4). The tank should be coated with a heat resistant mate-black paint.

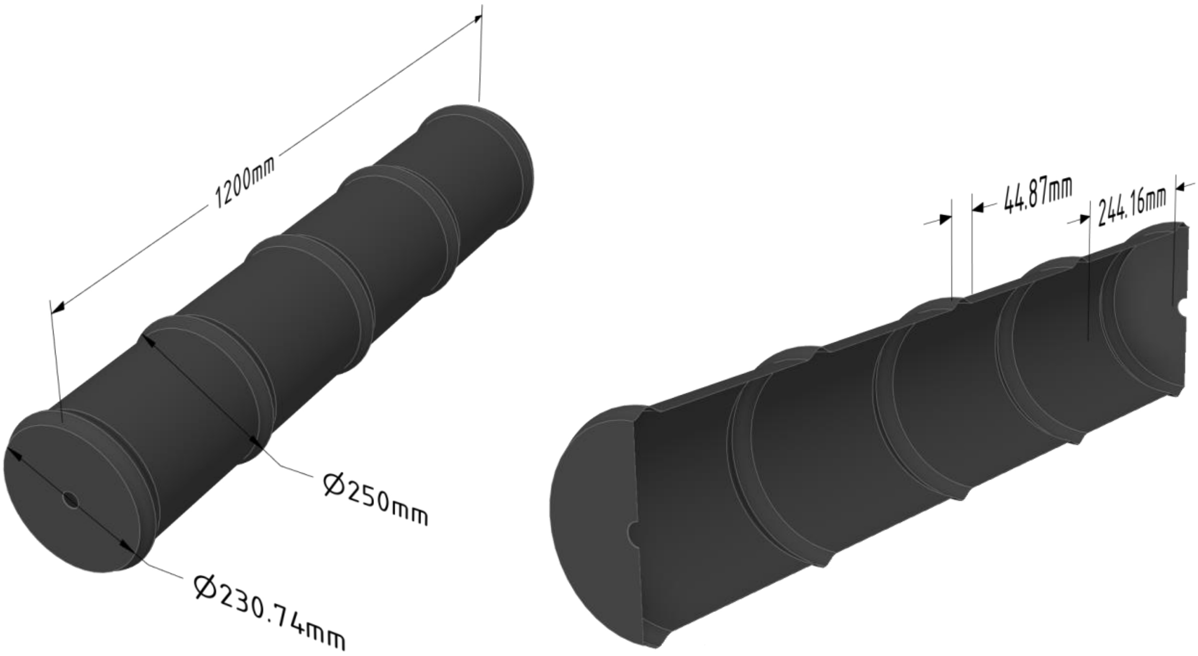


Figure 4 *Structural grooved seams are added to the tank to enhance its strength and rigidity.*

Tank holder

To keep the tank in place, wedges are placed along its length (Figure 5).

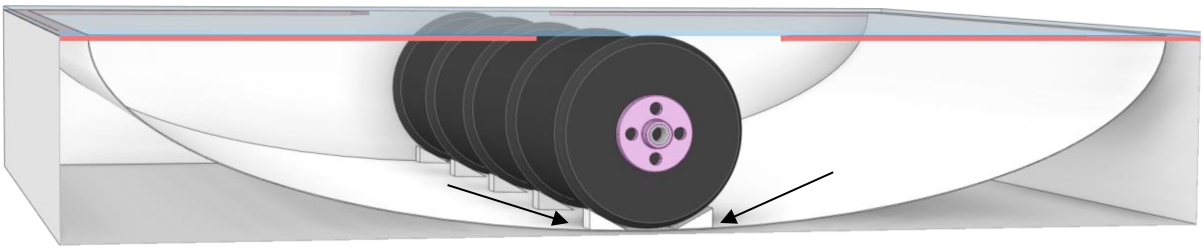


Figure 5 *Wedges are used to hold the tank in place.*

Reflector

The reflector can be build using a flexible mirror, aluminium, stainless-steel, or any other highly reflective material. One option is to use the remaining part of the stainless-steel panel used to build the water tank. The reflector was dimensioned to use two-thirds of a metal panel, as shown in Figure 6.

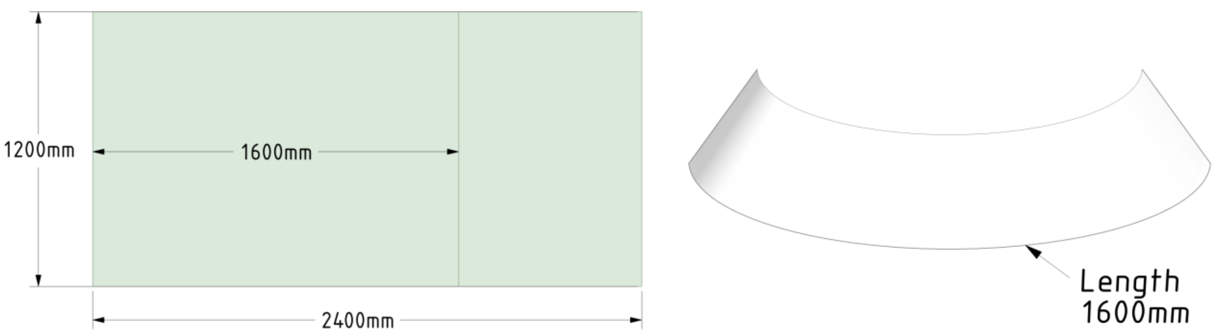


Figure 6 *Reflector can be built using the remaining of the steel panel used to build the tank.*

The reflector should be polished to maximise its reflectance. The shape of the reflector is a parabola with the tank at its focus (Figure 7).

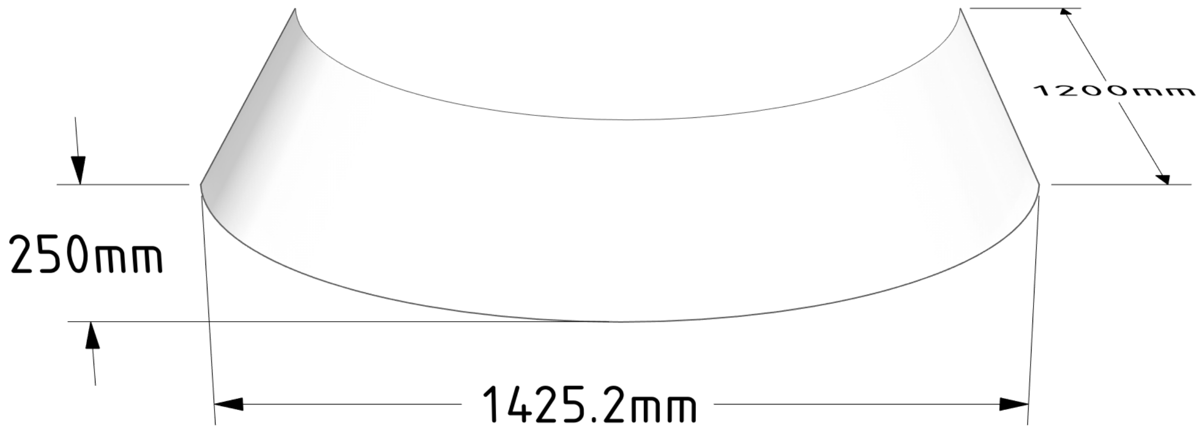


Figure 7 *The reflector has the shape of a parabola (half ellipse) with the tank at its focus.*

Enclosure

The enclosure is a sheet metal folded box. It can be galvanized or coated with corrosion-resistant paint, preferably coloured mate-black. The box has a frame at its edge to facilitate fitting the glass, as shown in Figure 8.

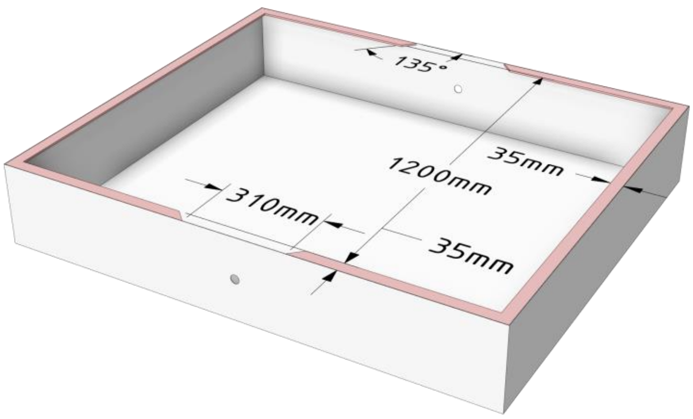


Figure 8 *The box, enclosing the water tank and the reflector, has a frame for fixing the glass.*

Glass cover

The glass is the most fragile part of the solar heater and should be installed in a way that is not subject to the contracting and expanding forces of the enclosure (Figure 9). The type of glass and its thickness can be chosen according to local availability.

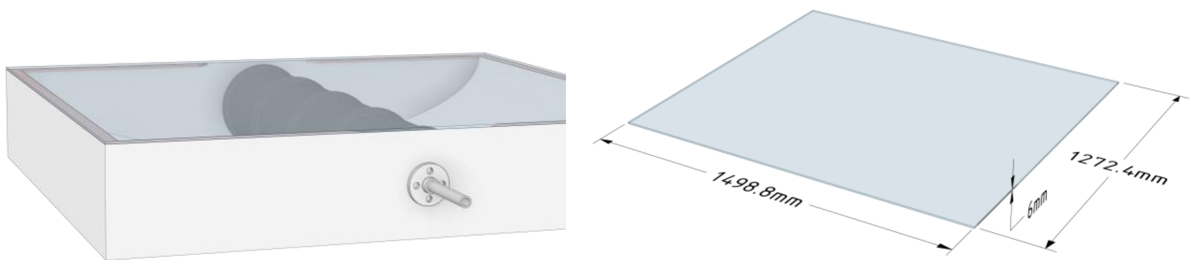


Figure 9 *Discuss with the local glazer about the best choice of glass type and available thickness.*

Radiator

A car radiator is used to transfer the heat accumulated by the water to the air. The model of the radiator depends on the local availability, but its size should match the size of the air inlet of the heating unit (Figure 10).

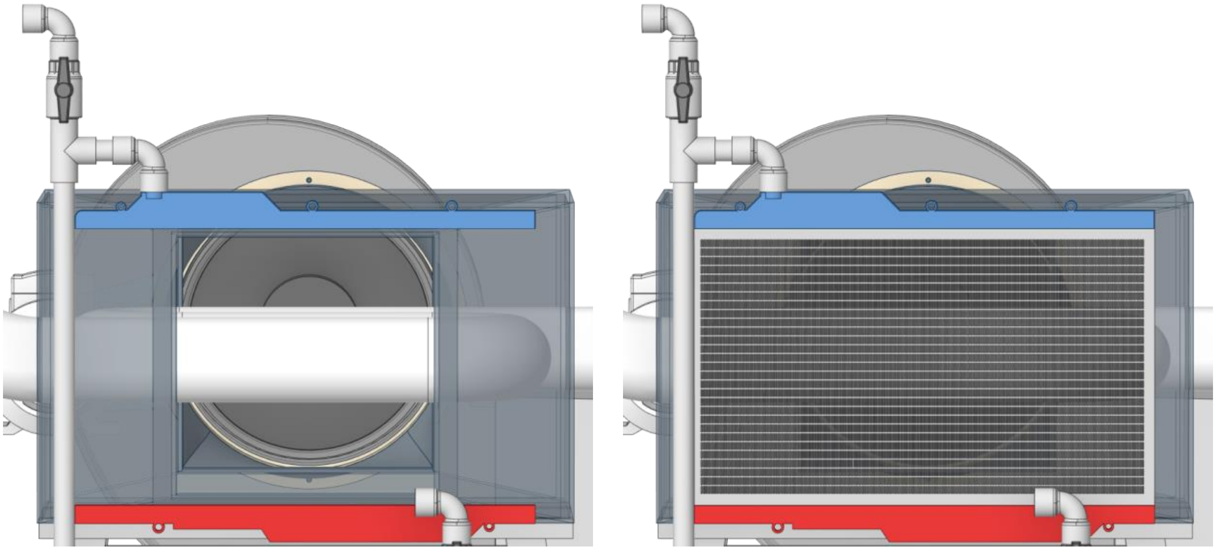


Figure 10 *A car radiator of a size that fits the heating unit air inlet should be used.*

Water pump

Water flow is induced by a water pump (Figure 11). The model of the pump depends on the local availability, but it must be able to withstand water at a temperature up to 85 °C. Preference should be given to a water pump designed to circulate water, instead of a pump designed to raise water. In addition, a pump with a higher head is preferable than a pump with a higher flow rate.

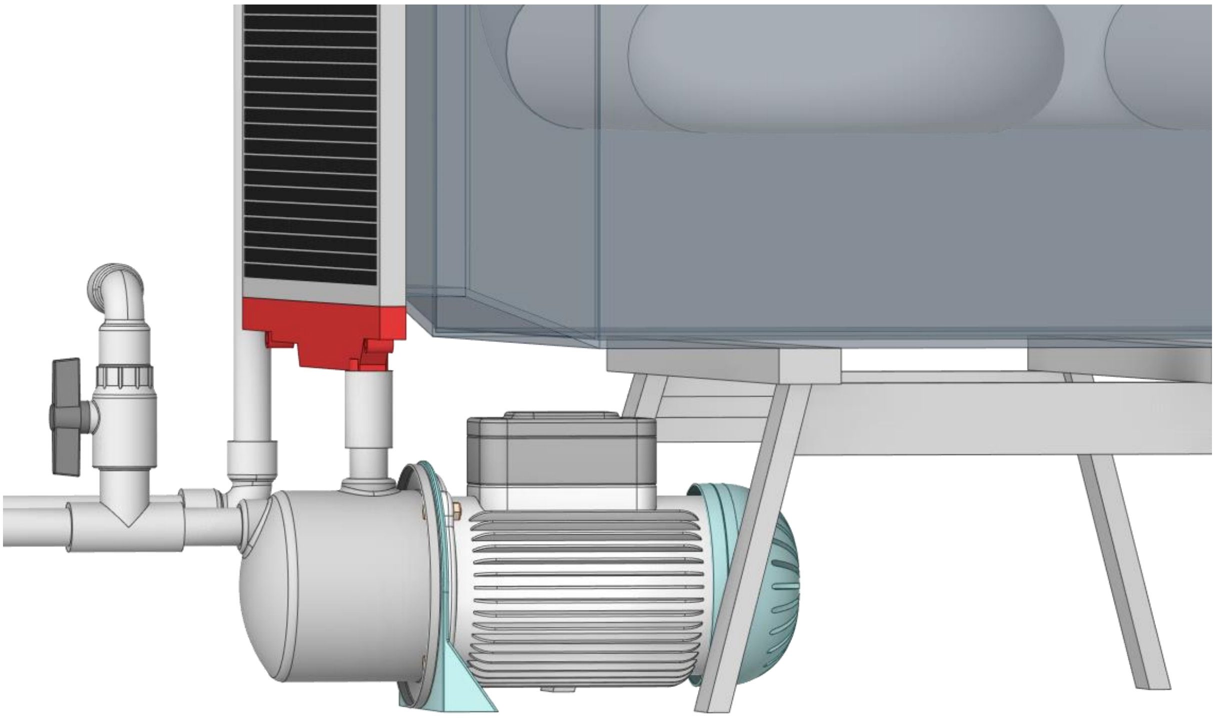


Figure 11 *Pump must be able to withstand water at 85 °C.*

Plumbing

Pipeline layout should be carefully planned to place the solar heater as close as possible to the heating unit and in a way that minimizes the use of elbows and bends, as illustrated in Figure 12.

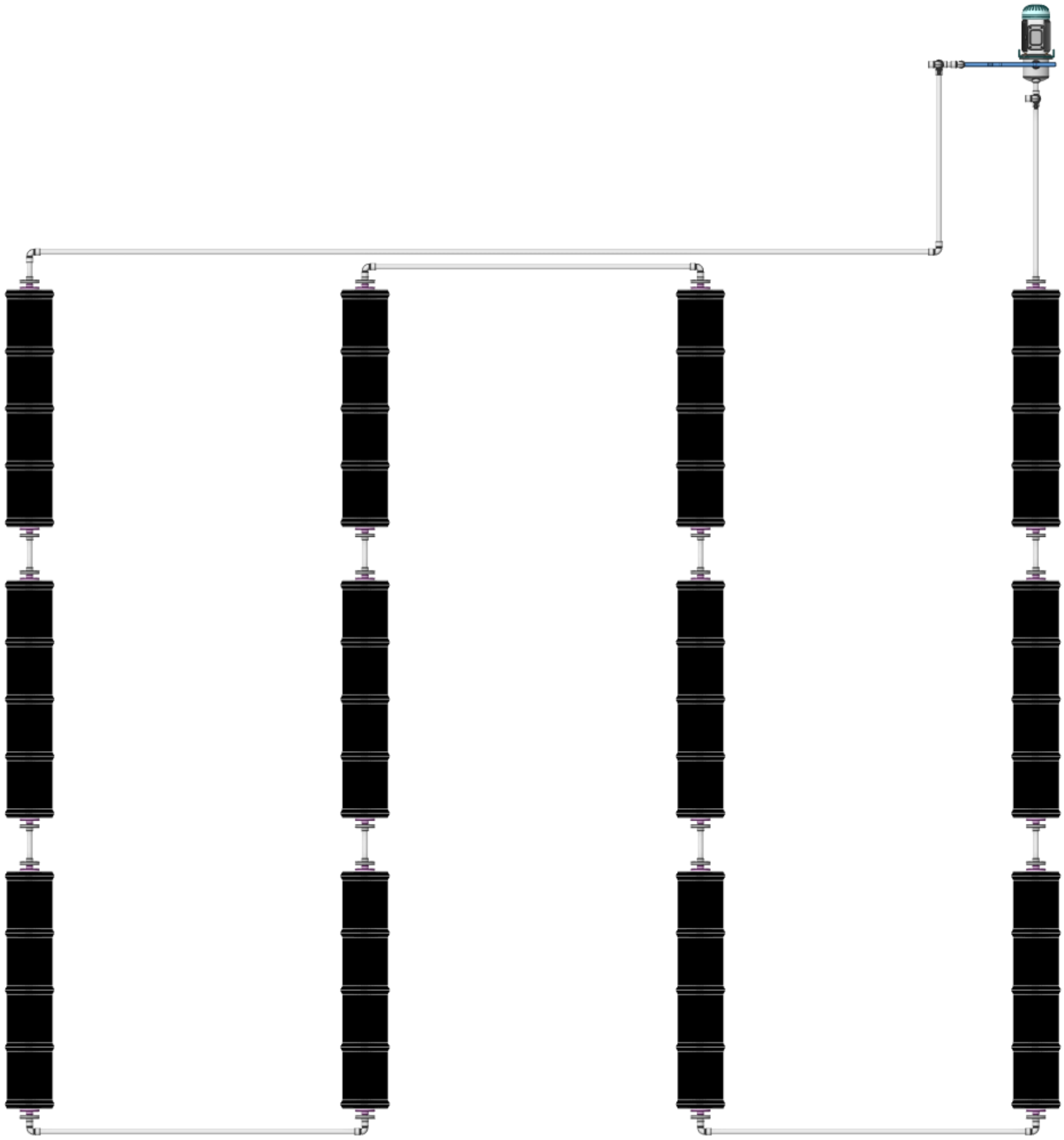


Figure 12 *Pipeline should be planned to minimize the use of bend and elbows.*

Pipe size and connection style can be chosen according to local availability, but they should be able to withstand temperatures up to 85 °C. CPVC pipes for hot water are recommended. All pipes and elbows must be enclosed by pipe insulation (i.e., flexible rubber foam, fibreglass, polyethene foam, etc.)

On/Off valves should be fitted in the pipeline, to facilitate filling the tanks with water, to prime the pump, and to release the pressure built from the water expansion when heated (Figure 13). Anytime the system is not being used the valves should remain open, avoiding pressure build-up and consequent damage to the pipeline and water tanks.

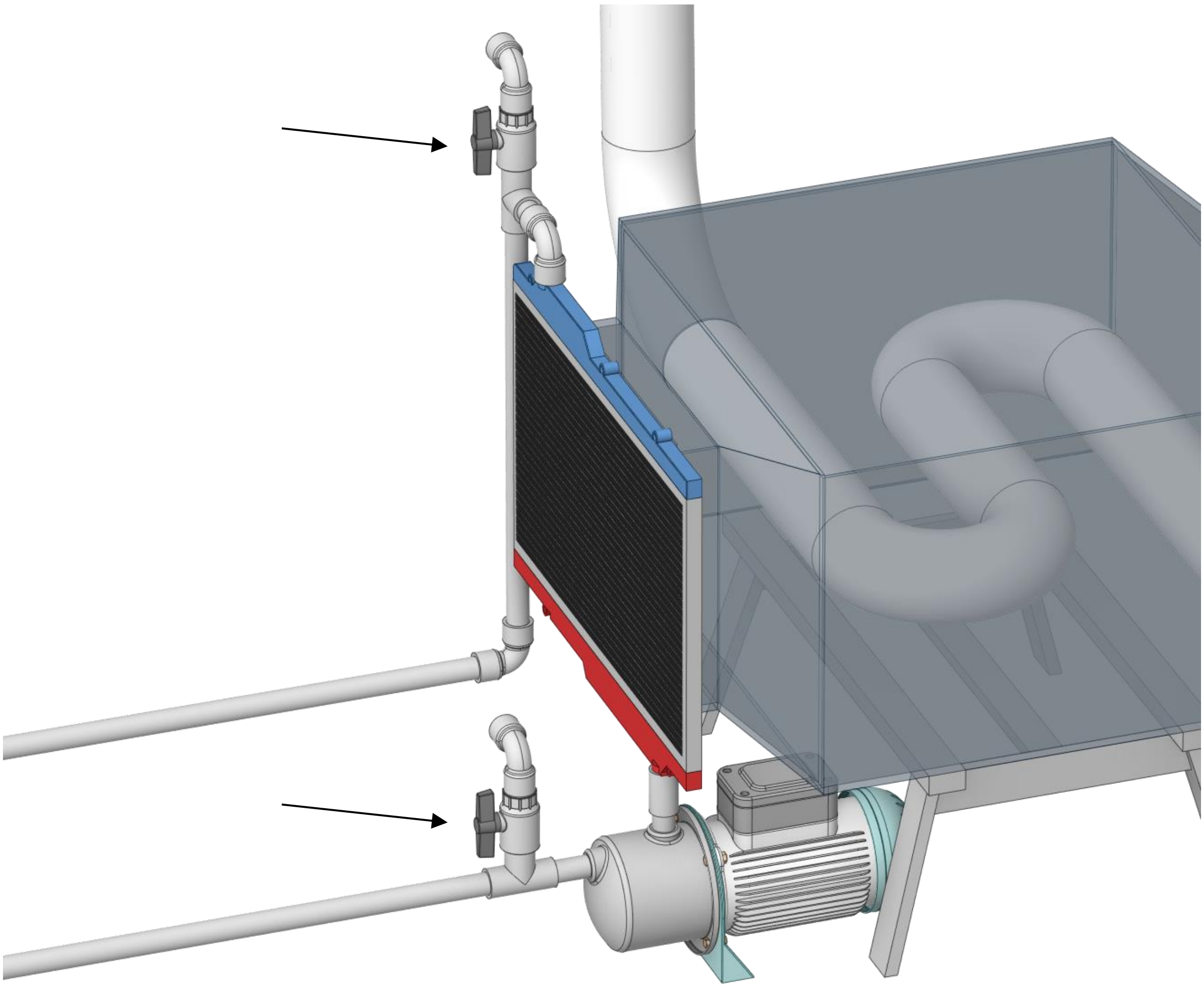


Figure 13 *Valves installed in the pipeline must remain open when the system is not in use.*

Equipment dimensions

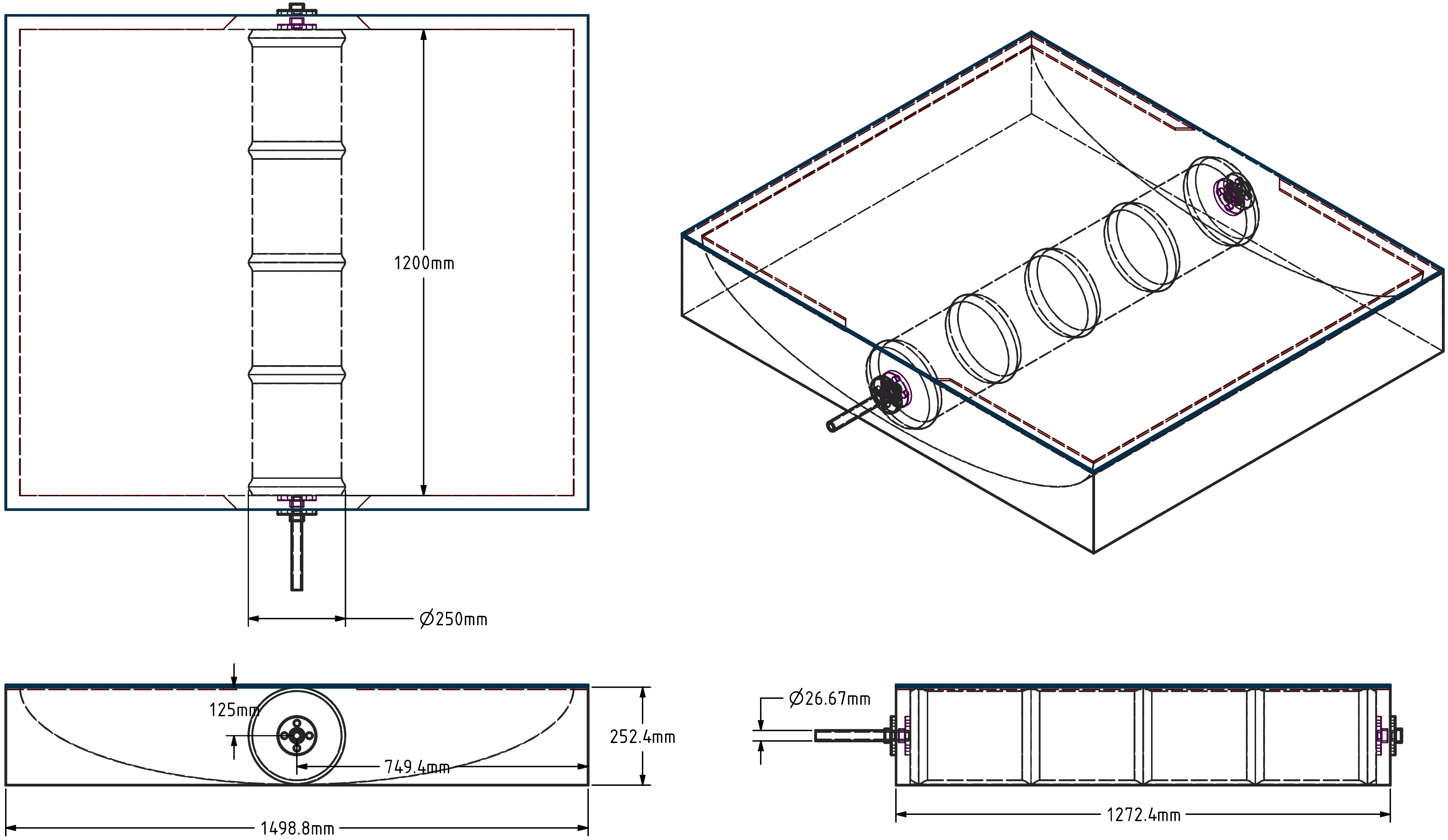
Appendix 1 shows the main dimensions of the solar collector. However, exact sizes should be obtained from the 3D CAD file available at https://a360.co/398AXG0. This link allows visualization and downloading the file in IGES, STEP and other commonly used 3D CAD formats. Please note that at those files, the heating unit, fan, and dryer are mere illustration, and its dimension does not reflect the reality in any way.

Finances

The construction of this equipment will be funded by the *GCRF AgriFood Africa Innovation Awards Competition*. Payments will be made via international bank transfer, in two instalments, one at the start and one at completion. Once authorized, payments might take up to 28 days to be processed.

Follow-up activities

The heating unit must be built and installed at Intermech Engineering facilities processing centre latest by the end of February 2021, so it can be tested and troubleshot with the dryer in March 2021.



Appendix 1

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