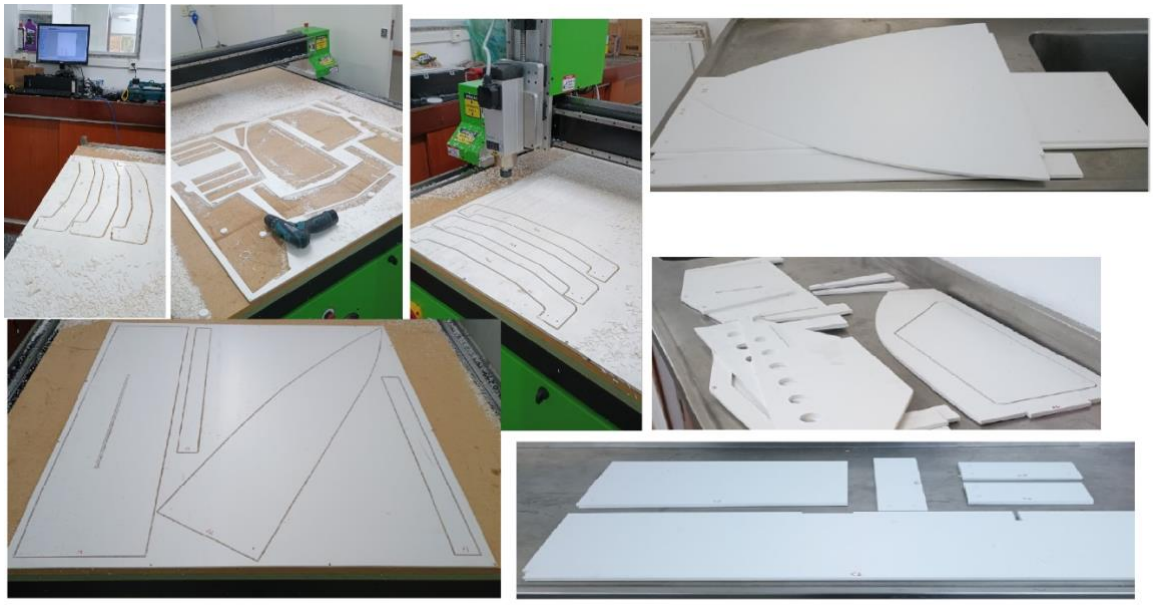
Laboratório de Ondas e Correntes COPPE|UFRJ	Cutting Plan Description	**Issued by:** Felipe da Silva Lopes
		Approved by: Joel Sena Sales Jr & Antonio Carlos Fernandes
	ASV01 - CPR.A	**Issued:** 10/22/2025

PROJECT	**Code:**	**ASV01**
	Title:	DH-200 ASV – Cutting Plan Report
	Client:	Laboratory of Waves and Currents
	Effective date:	October 2025
	Manager:	Emerson Andrade
	Coordination:	Joel Sena Sales Jr & Antonio Carlos Fernandes



REPORT	**Code:**	CPR
	Title:	DH-200 – Cutting Plan Report
	Author:	Felipe da Silva Lopes
	Type:	Cutting Plan Description
	Revision:	A
	Issued:	10/22/2025

DOCUMENT HISTORY

Revision	Date	Issued by	Reviewed by	Approved by	Comments
A	10/22/2025	FSL	EA	EA	First version.
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Notes:

FSL = Felipe da Silva Lopes

EA = Emerson Andrade

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1. Introduction

This document aims to provide step-by-step guidance on cutting parts for the Autonomous Surface Vessel (ASV) hull. The cutting process began with the receipt of the 3D file in Rhinoceros format (.3dm) with the parts properly identified. The parts were then flattened, their respective cut lines, holes, roughing, and other details to be machined were extracted, and the files were saved in .dxf format. Aspire-Vectric CAD/CAM software was used to program the machining tools for each cutting stage and plan the cutting sequence according to the assembly sequence. The CNC router was activated and configured for the origin (zero points), to receive the files saved in Mach 2/3 Arcs (mm) (*.txt) format, and loaded into the Mach 3 CNC software, where the commands and cutting coordinates for the parts were executed (see Figure 1).

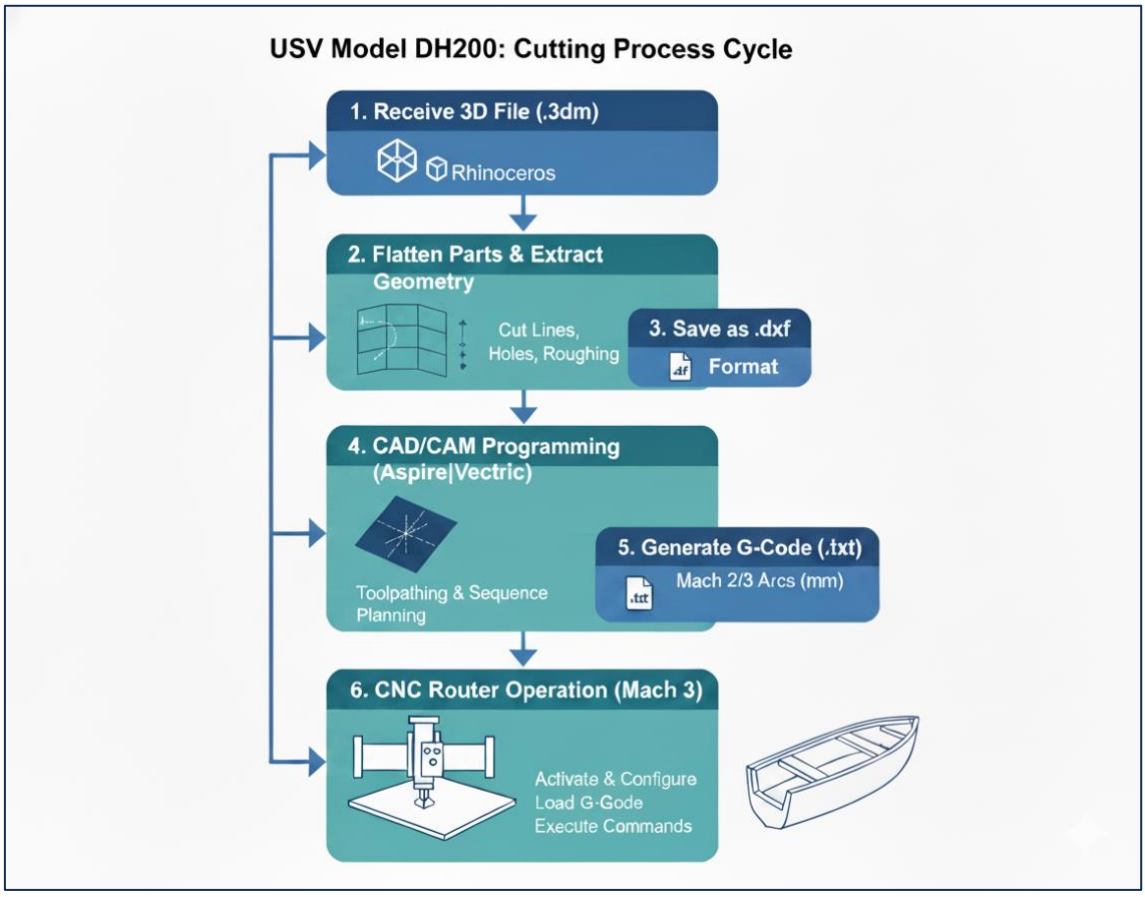

Figure 1 - Cutting Process Cycle.

2. Plate development

In this process, Rhinoceros software was used to create a separated file for manipulating the hull plates. These parts were separated by thickness so they could be pre-arranged. The development was done using the *unrollsurface* command, which essentially consists of flattening each hull plate into 2D. At the end of this process, it was necessary to convert the file from meters to millimeters, as the CAD/CAM software uses this unit of measurement (Figure 2).

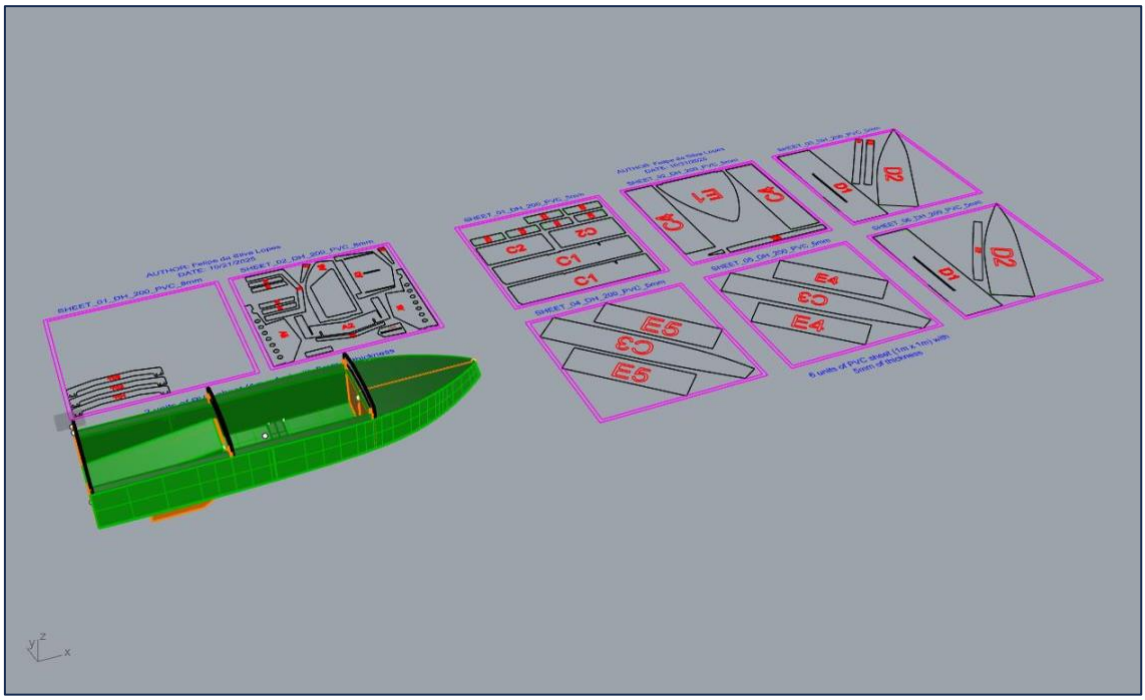

Figure 2 – Development of the DH_200.

3. Nesting

The 5mm and 8mm thick sheet layers were created with the cutting, text, and engraving needs. The 1000mm x 1000mm (1m x 1m) sheets were designed with a 20mm cutting margin for fixing the sheet in the CNC by using screws. The spacing between pieces of 12mm was also assumed. Thus, it was possible to organize and align, optimizing each piece on the sheets as much as possible, in order to avoid material waste. In this case, the 5mm and 8mm thick white PVC sheet material was used (Figure 3). The original files for this step were saved as: *DH_200__CUT_PLAN_PVC_SHEET_5mm.dxf* and *DH_200__CUT_PLAN_PVC_SHEET_8mm.dxf*.

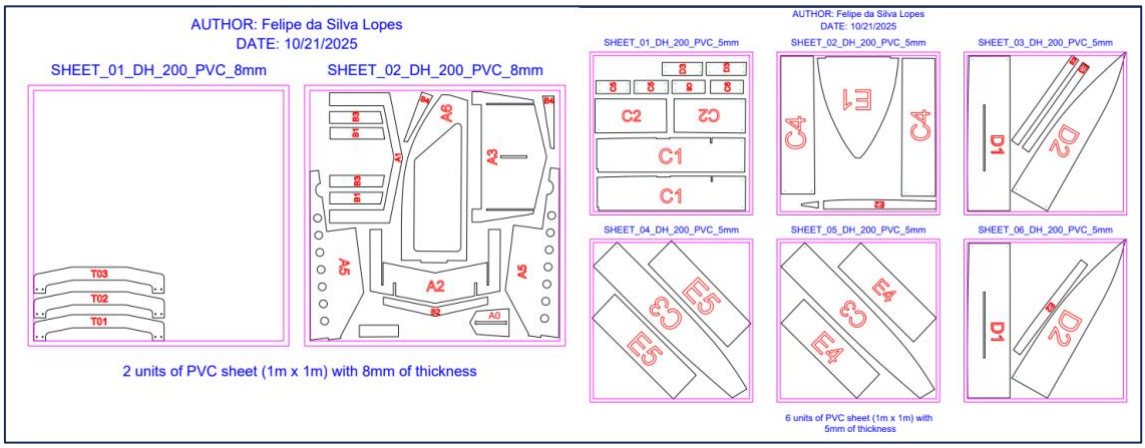

Figure 3 – Nesting parts organized by sheet.

4. CAD/CAM Programming

In this step, Aspire version 8 software was used, and the *.dxf* files previously prepared for cutting were loaded. Initially, a cutting area of 1000mm wide (x axis) x 1000mm high (y axis) was determined, with a thickness of 5mm or 8mm depending on the sheet (Figure 4 and 5). Then, the *.dxf* file was imported, and the cutting were marked in the toolpath tab, where the cutting settings were configured, such as: Cutting Depth, Machining Tool, Machining Direction, and Cutting Ramp. A single-flute milling cutter with a 4mm diameter and a 2mm cutting depth, spindle speed of 18.000 rpm, feed rate of 1.620 mm/s, and plunge rate of 810 mm/s was used.

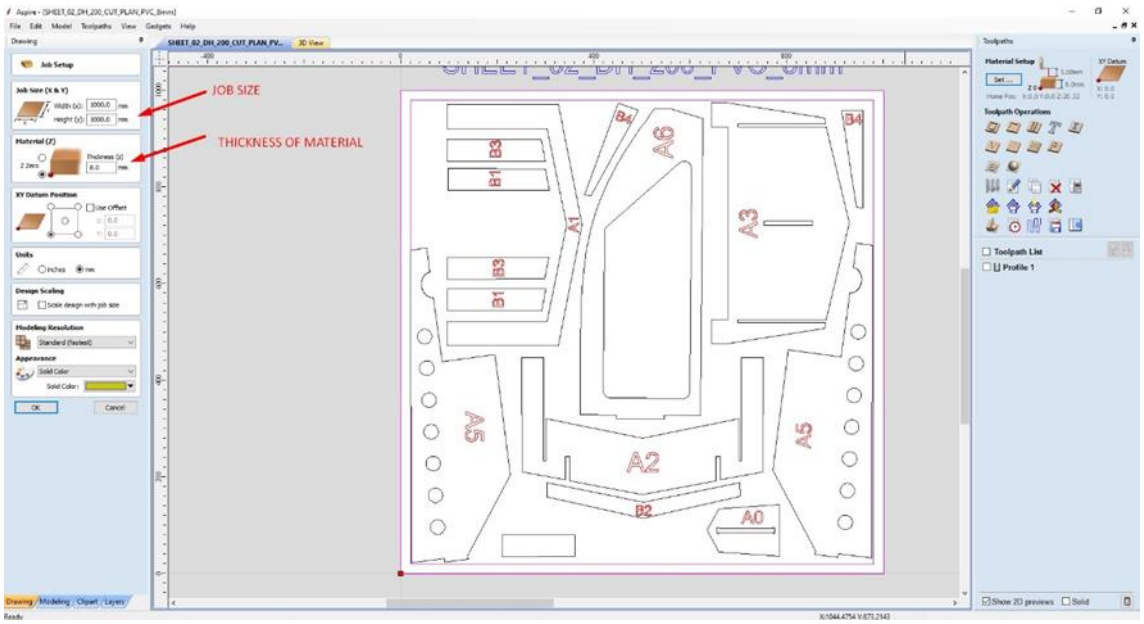

Figure 4 – Pre-set Job Setup.

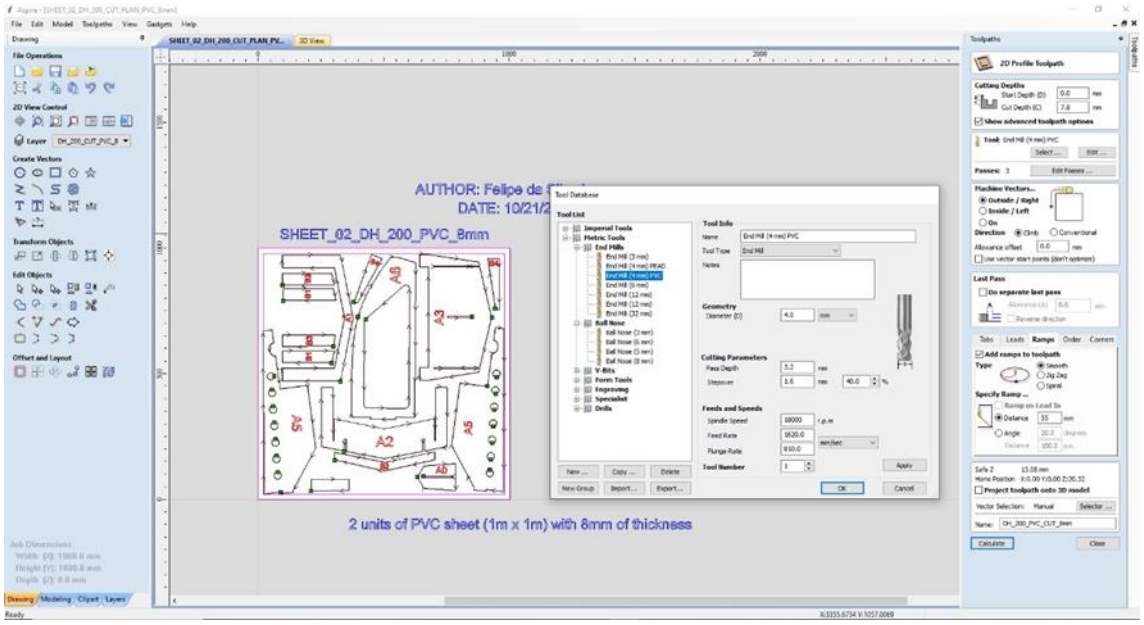

Figure 5 – 2D Profile Toolpath.

5. CNC Cutting Process

The CNC router used was a 3-axis (x, y, z) with a 1.2m x 2.5m cutting area (Figure 6), controlled by the *Mach 3* software, which is widely used in this type of machine. It works using G-Code programming language, widely used in Computer Numerical Control (CNC) machines. Before operating the machine, Personal Protective Equipment (PPE) such as safety glasses, ear protection, and gloves must be worn. Extreme caution should be exercised when operating this machinery, as it can cause serious injury. Once these precautions are taken, the following steps should be taken:

- Fix the sheet metal to the table with screws
- Turn on the machine
- Recognize the machine's zeros
- Set the cutting zeros for the x and y axes at the corner of the sheet metal and the z axis at the cutting table
- Load the cutting files
- Start cutting

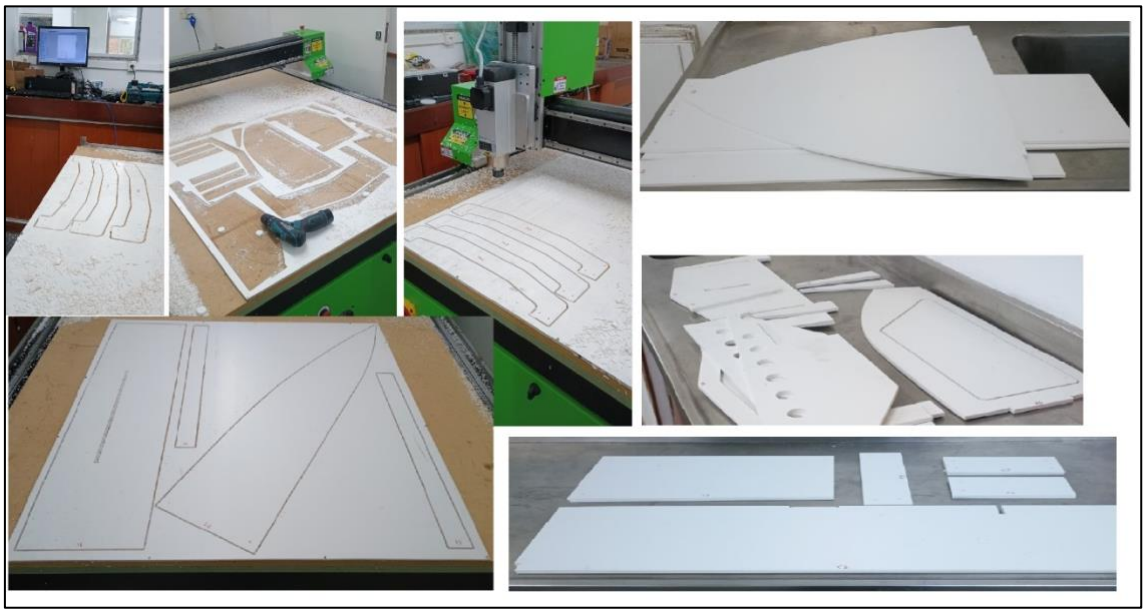

Figure 6 – CNC Cutting Process Overview.

6. References

- Robert McNeel & Associates. Rhinoceros 8 [software]. Available at: https://www.rhino3d.com/. Accessed on: October 22, 2025.
- VECTRIC Ltd. Aspire [software]. Available at: https://www.vectric.com/products/aspire/. Accessed on: October 22, 2025.
- ARTSOFT USA / MachSupport. Mach3 [software]. Available at: https://www.machsupport.com/software/mach3/. Accessed on: October 22, 2025.