



**University  
of Manitoba**



## **CF34-10A Fan Frame Etching Immersion Fixture**

Final Design Report

**MECH 4860 – Engineering Design**

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## Executive Summary

Magellan Aerospace Winnipeg has recently obtained a contract which includes completing an in-house etching immersion process for the CF34-10A jet engine fan frame. A fixture is required to secure, lift and rotate the fan frame to complete this process. The fan frame is the main structural component in the jet engine and provides support to the engine booster assembly through bearings and structurally supports the rotor. The frame also provides ducting for primary and secondary air flows through the engine.

The etching immersion process removes an alpha case surface layer that is formed on the titanium from oxidation during the casting process. This layer creates a brittle surface and results in micro-cracks that contribute to a reduction in fatigue properties in the titanium. A nitric-hydrofluoric acid bath is used to remove the alpha case layer. While Magellan Aerospace has the acid bath, they require a fixture that can be used to secure, lift, submerge and rotate the fan frame in the acid.

Initially, a set of design criteria and metrics were created by meeting with the client resulting in defining the main functions of the design and its process requirements. Concepts were generated and filtered through a concept screening and weighted decision matrix selection process. The top concept was then further analyzed both analytically and numerically to ensure safety standards and all criteria were met. Lastly, engineering drawings, a bill of materials, a standard operating procedure, an assembly procedure and a failure modes and effects analysis were completed. A design proposal that meets all functional requirements was achieved during the four-month project. Primary needs met include:

- Total cost of \$17,913.33 achieving under an allocated budget of \$28,000.
- Weight of 312 lbs achieving under an 800 lbs weight limit excluding the fan frame.
- Minimal maintenance for a 4-year design life while etching one fan frame per week.
- Consistent rotation at 1 RPM for 20-minutes using current pneumatic shop resources.
- Meets all Manitoba Safe Work and ASME safety standards and regulations.
- A modular design which can simply attach and detach from the fan frames allowing them to be stored on a future portable stand.

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[1] Magellan Aerospace Logo – used with permission

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# 1 Introduction

Magellan Aerospace is a manufacturing and design company that produces various components for use in aerospace applications. Magellan has multiple facilities worldwide, but their largest operation exists in Winnipeg, Manitoba. The Winnipeg facilities have recently secured a contract that requires them to implement an etching immersion process and has partnered with the University of Manitoba MECH 4860 design course to design the concept for an etching immersion fixture. The fan frame of the CF34-10A jet engine assembly requires a lifting and rotating immersion fixture to perform etching as part of the required processing.

This document consists of information on the project and preliminary design concepts. It provides an overview of the design problem, including the problem statement, design constraints, limitations, client needs and specifications. Additionally, the report details the methodology used to generate, screen and select potential design concepts. A final design concept was selected and analyzed both analytically and using Finite Element Analysis (FEA). Moreover, the report includes a detailed Failure Modes and Effects Analysis (FMEA) alongside a Safe Standard Operating Procedure (SSOP) to help identify and prevent any design failures and safety hazards. Lastly, the report is concluded with a cost analysis, engineering drawings and recommendations made to the client.

## 1.1 Background and Problem Statement

The CF34-10A fan frame is the main structural support of the jet engine and serves multiple purposes. It provides support to the engine booster assembly through bearings, and structurally supports the rotor. The frame also provides ducting for primary and secondary air flows through the engine. The CF34-10A jet engine is shown in Figure 1. The component of interest for this project is the front mounting frame, as shown in Figure 2.





























































































































































































































































































































































