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Among the Additive Manufacturing processes for metal, the Electron Beam Powder Bed Fusion process (EB-PBF) is an edge technology. This is particularly true for sectors like aerospace, automotive, and medical, since it allows the production of complex near-net-shaped parts using titanium, nickel, and cobalt-chromium alloys. However, a drawback of the process is that the produced components suffer from poor surface quality. Hence, products can necessitate further precision machining operations to meet the design requirements. This study investigates the machinability of Ti6Al4V ELI alloy components produced by EB-PBF. This alloy is selected for its industrial interest since it combines high mechanical performance, low density, resistance to corrosion, and biocompatibility. In order to examine that, semi-finishing and finishing milling operations were conducted on a CNC machining center using a flat end-mill. The CNC machine was equipped with an acquisition system to measure the cutting force components developed during machining. A design of experiments was set up to study how the EB-PBF building orientation will affect the machining forces by varying cutting parameters, namely feed for tooth, cutting speed, and depth of cut. The obtained data were analyzed to identify force curves and specific energy. The semi-finishing and finishing processes gave comparable force values regardless of the orientation used in the construction phase. Additionally, this investigation has revealed that during the machining operations vibrations can occur, especially for higher cutting speeds. An observation of the chips showed an almost discontinuous chip that could have contributed to the onset of vibrations. The outcomes of this study increase the knowledge on the machining of EB-PBF parts and suggest that machining parameters should be adapted for this specific application since the microstructure and the thermal history of the EB-PBF part highly affect the machining behavior.