AEROSPACE
MANUFACTURING and DESIGN

No Coolant Needed

by Matt Grasson - Senior Editor at GIE Media, Inc.

With nearly 3,500 F-35s still scheduled for production during the life of the Joint Strike Fighter program, it is imperative to look at every aspect of the manufacturing process to reduce costs while ensuring a high level of quality. That is exactly why a team from Lockheed Martin Aeronautics, the Enterprise Drilling Center of Excellence contacted Amamco Tool's product development team.

According to Lynn Jenkins, Enterprise Drilling Center of Excellence technical lead and senior manufacturing engineer, the need for enhanced cooling comes from the materials and structural configurations used on Lockheed Martin's 5th generation F-35 Lightning II Joint Strike Fighter program.

"Overheating during drilling can damage the composite, aluminum, or titanium structural materials. Traditional cooling methods have been employed for many of our drilling applications; however, we also want to ensure that any cooling enhancements employed would address our green initiatives," Jenkins says.

Lockheed Martin implemented the use of double margin cutting tools, which was not new to Jenkins. In fact, Lockheed Martin was using them in many of their production applications with traditional liquid coolant applied through the motor nosepiece bushing. This method technically provides an acceptable solution for the application. However, with the advent of some of the newer material stack configurations, Jenkins identified the need to improve the cooling and chip evacuation characteristics.

The old axiom, if it ain't broke, don't fix it, haunts custom tool makers because they think every job is one that they can do – even better. Manufacturers think the same. In the case of an air-cooled tool solution, savings of not only the cost of unnecessary technologies but clean up, is seen at Lockheed Martin.

In the early days of tool development for Lockheed's F-35 project, engineers established an astounding cost savings. Just consider these facts:

- A 450% increase in the number of holes drilled by a tool resulting in a lower cost per hole, and lower per unit cost
- In some instances, more than 1,200 holes compared to 275 produced by the previous tool.
- Up to 75% faster cycle times (the time a tool touches the part)
- Up to 97% reduction in tool cost.

Working with Lockheed during the years has kept us focused on being competitive. Focusing our attention to – lowering the cost of the job.

Andrew Gilpin,
Product Development Manager,
AMAMCO Tool

Noting this need, Jenkins and the team collaborated on testing several cooling strategies that included liquid, paste, and chilled air. However, each of these methods provided some form of setback.

"With liquid coolants you have to consider the equipment necessary to present the coolant, extra air, or power lines in the work area, and the increased time and cost of setting up that equipment and maintaining it. Coolants and lubricants that are in paste form do not require any extra equipment. However, they do create additional issues for the process because the cutting tools need to be cleaned after drilling, which requires labor, approved solvents, and waste disposal," Jenkins explains.

"Clogging of the cutting tool flutes with the materials we use prove to be very costly due to the extra cleaning time between cycles to remove excess paste and swarf from the cutter flutes. Chilled air actually proves to be less beneficial than forced air at ambient temperature. Like liquid coolants, chilled air requires additional equipment which adds cost to the process."

During the testing process, the team reviewed several aspects of each process. They looked at the required setup time, the effects of each type of coolant on cutting times, the cost of each type of coolant, and which type of coolant would be most effective.

According to Jenkins, any process requiring additional equipment beyond the actual machining or drilling equipment, drives cost up and eventually increases the amount of time needed for setup, operation, and maintenance.

So he suggested looking at forced air at ambient temperature as an option.

“Any time you have requirements for additional equipment and associated ancillary costs, your bottom line will be impacted. We strive to create products that not only meet, but also exceed customer expectations. One of the methods we use to achieve this is focusing on the cost per hole associated with our drilling processes. Any time we can meet or exceed quality expectations and achieve the lowest cost per hole with minimal equipment, we will pursue that avenue,” Jenkins says.

This is exactly what forced air at ambient temperature does. During the testing process, development of a MOD (modification kit) for use with the existing drilling equipment by Lockheed Martin engineers, integrated a cutter air supply, with no special equipment required, and resulting in minimal additional costs. Another big impact is the reduction and near-complete elimination of multiple washes to remove contamination and debris left over from the traditional liquid cooling methods, which is a large cost- and time-savings. With forced air, there is no contamination or oily residue left to clean up.

After approximately two years of testing and production evaluations, the decision was not difficult to implement forced air at ambient temperature for the majority of the portable drilling applications. However, Lockheed Martin will continue to use liquid coolant on a small percentage of very specialized applications.

When asked about the amount of cost savings, Jenkins says, “It would be very difficult to determine at this time. We will not be able to attribute actual cost savings until sufficient production use of this new cooling process has been recorded. However, the reduction in defects due to overheating, the decreased drilling time per hole, use of an environmentally-friendly coolant, and the elimination of coolant clean-up and associated waste disposal will certainly result in substantial cost savings.”

The Enterprise Drilling Center of Excellence works very closely with our cutting tool and portable equipment manufacturers and providers during our process/tool development efforts. This level of cooperation makes the entire development process progress quicker and smoother than other options.