
# Technical Paper

## Major Overhaul and Repair of an F-Class Turbine

**In late 2006 an F-class end user surveyed the capabilities of the OEM and several independent gas turbine repair shops to rebuild a Frame 7F unit. No one but the OEM had ever rebuilt an F-class rotor. Sulzer Hickham demonstrated the greatest rotor repair experience among non-OEM shops, and expressed a strong desire to work with the client to perform this repair. The client was particularly impressed by the amount of effort Sulzer Hickham had already put into the development of repair procedures and tooling for the 7F. The client was also willing to proceed with the rebuild, making the best use of material already in client's inventory.**

Sulzer Hickham was awarded the turnkey contract for complete field and shop repairs of the unit. The field work consisted of removal of the rotor and all hot section components, compressor stator vane inspection and shimming, casing alignment and the complete reassembly of the unit. In addition to the compressor rotor rebuild, the shop work included NDE of the turbine rotor and refurbishment of combustion system and hot gas path components.

Sulzer Hickham mobilized on site less than a week after signing the contract. Within a matter of weeks, the rotor was in the Sulzer Hickham large rotor bay for major inspection, marriage joint separation, compressor disassembly, and repairs to all non-conforming components.

*Compressor rotor restack.*

The F-rotor has unique disassembly/reassembly criteria, and is much larger than the Frame 7EA (3 bearing style) rotors. The F-class rotor is a 2 bearing design, with compressor and turbine combined thus requiring special tooling and fixtures to lift and/or maneuver the rotor.

Sulzer Hickham had anticipated the opportunity to service F-class rotors and had invested in special tooling and handling equipment to make the task efficient and safe.

Inspection procedures had been developed, documented and were already in place. Inspection forms for received items, detailed parts lists and inspection documents for the sub assemblies were also ready. When the rotor arrived, photos were taken to document the as-received condition of the rotor, including the shipping stands and how they and the assembly were secured to the trailer. The inspection and documentation process began using the developed procedures. Additional inspection documents were put in place so as to record all critical phases of the process.

A formal report of repair recommendations was generated from incoming findings and the following general repairs were required to bring the assembled rotor to desired specifications:

Compressor rotor blades from rows 2 – 5, and 9 – 17 were removed. New replacement blades for rows 2 – 5, and 9 – 16 were installed. The original row 17 rotor blades were NDT inspected and installed into the replacement 17th stage stub shaft. All turbine bucket locking/sealing hardware was replaced with new parts.

Heavy fretting was found between numerous compressor wheel contact faces and rabbet fits, requiring extensive repairs.

All "indications" (cracks) discovered by NDT in the compressor disc dovetail areas were removed, and then re-NDT'd. Masking and shot peening of all discs concluded this repair phase.

*Fuel nozzle flow test.*

As a result of blade migration, stages 1, 6, 7, and 8, were repositioned to their correct axial location. A Sulzer Hickham coating (HICoat A-08) was applied to the inner and outer web areas of each compressor disc for corrosion protection.

All compressor through bolts were inspected for reuse. Noteworthy was the discovery of pre-existing gall marks which date back to the assembly/disassembly process used in the original manufacture of the compressor section. The bolt "stretch" was also found to be 30% below specification during disassembly. The client had never serviced this compressor section and thus the conclusion of "original" assembly.

Each compressor disc was dynamically balanced, using a state-of-the-art vertical balancing machine designed for compressor disc balancing. The compressor was re-stacked without incident.

Paralleling the compressor rotor work, the turbine spindle was final inspected, and balanced prior the rejoining of the two rotors for final assembly. Once both sections were "married", the final inspections and dynamic balance of the assembly concluded this phase of the repair operation.

In addition to the turbine rotor, Sulzer Hickham received all hot gas components for inspection, repair, heat treatment and coating. All turbine buckets, stationary nozzles and combustion components were inspected utilizing many special fixtures and tooling designed to simulate the turbine frame and insuring that critical fits and dimensions will be maintained.

Using Sulzer Hickham incoming inspection and engineering evaluation processes, the row 1 turbine buckets were found to be life limited and beyond repair due to extensive cracking at the airfoils. The client supplied replacement 1st stage buckets, and they were inspected and qualified by Sulzer Hickham. The 2nd and 3rd stage buckets posed different challenges. Utilizing Sulzer Hickham Parent Metal Bonding (PMB) techniques (patent pending) accompanied by micro-plasma welding all buckets were restored to serviceable condition. In addition to the blade restoration Sulzer Hickham applied their "in service proven" MCrAlY protective coatings to further enhance the expected life of the buckets. With all repairs and coatings complete, the buckets were moment weighed and prepared for installation into the turbine rotor, after which final dynamic balancing was completed.

The inspection of the stationary nozzles revealed that they required significant weld repairs. As would be expected, the 1st stage nozzle required the most extensive welding for "crack" repairs and major dimensional correction. Through proper fixturing, welding, and specialized reshaping techniques the dimensions were properly restored followed by major weld repair of the inner and outer walls of the gas path. The pressure and suction sides of the airfoils required extensive weld repairs. Once the segments were complete with the welding and blending process then EDM machines were used to re-establish the cooling holes at precise angles and precise sizes. All cooling passages were then verified to be free and clear of any blockage. The segments then went thru final NDE

*Repaired and coated first stage nozzle.*

inspection and were certified ready for TBC coating. With post coating QC checks complete the nozzle was then assembled for final dimensional and visual checks. The second and third stage nozzles required slightly less effort than did the first stage, however, all dimensional restoration, weld repair, heat treatment and coating followed the same regimen. All combustion parts were inspected, repaired, and coated.

*Rotor assembly low-speed balance.*

All parts were shipped to the client's site where Sulzer Hickham technical supervisors and turbine mechanics reassembled the unit. The reassembly progressed without problems and the turbine was started without incident.

The ability to provide turnkey solutions, covering the entire project separates Sulzer Hickham from other "third" party suppliers. Knowledgeable personnel, specialized tooling and fixturing, and innovative processes all in one facility offer owners a true alternative to traditional OEM solutions.

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