ACCURATE BRAZING
And Thermal Processing

CASE STUDY 1.08

2020 INDEPENDENT HIP STUDY

HIP Rejuvenation Extends the Life of Fr7E 1st Stage Buckets.

BY WARREN MIGLIETTI, PH.D., FALL 2020

These buckets operated for 3 service intervals and were repaired twice in their history. Removing specimens from the pressure side, suction side and root of these engine run components and then stress rupture testing at 1550°F/50ksi showed that the airfoil material had a 2.58X—2.94X reduction in life; whereas the root material had 1.14X—1.24X reduction if life, as clearly evident in Table 1.

However, for the HIP Rejuvenated material, there was an 1.35X – 1.39X increase in life for the airfoil material and a 1.38X – 1.40X increase in life for the root material, respectively, when compared to virgin- like as-cast and heat treated material, as clearly evident in Table 1.

This case study shows how the proper use of HIP Technology can be used to extend the life of these Fr7E, Stage 1 buckets. When the End User saw this data, they decided to repair these components and operate a 4th service interval. *Figures 1 and 2 show 2 views of a Fr7E, 1st stage bucket that is cast from IN738LC material.*

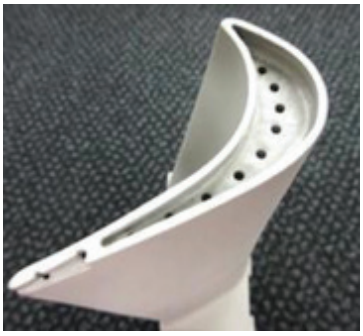

FIGURE 1: Top view of Fr7E, 1st Stage bucket

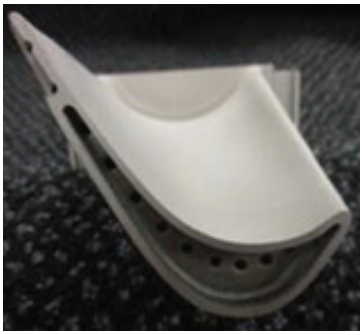

FIGURE 2: Longitudinal view of Fr7E, 1st Stage bucket

TABLE 2: Stress rupture results of Fr 7E engine run material compared to HIP rejuvenated material

Material Type and location where specimen was removed from	Stress in ksi	Temp in °F	Life in hours	Improvement / Reduction in Life	Elongation %	Reduction in Area (RA) %
As received-engine run- 3 hot gas path (HGP) service intervals. Pressure side	50	1550	33.9	2.94X reduction in life	Was not measured	Was not measured
As received-engine run- 3 hot gas path (HGP) service intervals. Suction side	50	1550	38.7	2.58X reduction in life	Was not measured	Was not measured
As received-engine run- 3 hot gas path (HGP) service intervals. Root 1 specimen	50	1550	80.4	1.24X reduction in life	Was not measured	Was not measured
As received-engine run- 3 hot gas path (HGP) service intervals. Root 2 specimen	50	1550	87.4	1.14X reduction in life	Was not measured	Was not measured
HIP Rejuvenated material Airfoil 1	50	1550	139	1.39X improvement	5.8	5.5
HIP Rejuvenated material Airfoil 2	50	1550	135	1.35X improvement	5.7	5.3
HIP Rejuvenated material Root 1	50	1550	138	1.38X improvement	5.3	5.9
HIP Rejuvenated material Root 2	50	1550	140	1.4X improvement	5.2	5.7
Virgin Like / Original Casting Material not exposed to engine operation. Baseline	50	1550	100	1.0	5.0	5.0

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About the Author

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Dr. Miglietti is currently the President and Principal Metallurgical Consultant of Miglietti and Associates, LLC, a consultancy company based in Kansas City, Missouri. Prior to this he was Director of Repair Technology at ProEnergy and worked for 7 years at PSM-An Alstom Company. In addition he worked for 5 years at GE's Repair Development Center and 5 years for Sermatech International as a process repair engineer and as a component repair engineer respectively. His principal responsibility was the development of novel repair techniques and processes for components, operating in advanced land-based gas turbine engines, such as the Frame 7FA.03, GT24/26 and W501F/M501F engines. He has over 30 years of experience and expertise in the Welding (GTAW and Laser), Brazing (Narrow and Wide Gap Diffusion), FIC, Acid Stripping and Heat Treatment of Ni and Co-base superalloys. Dr. Miglietti is the outgoing chairman of the Commission XVII – "Brazing and Diffusion Bonding" of the International Institute of Welding (IIW) and was past chairman of the Manufacturing, Materials and Metallurgy Committee of IGTI, an affiliate of ASME. He has authored or co-authored 47 technical papers and has 13 repair technology patents. Today, he has a strong focus on assisting clients with materials characterization and mechanical property evaluation of Additive Manufactured/3D printed components, as well as providing heat treatment information for these components.

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