ACCURATE BRAZING
And Thermal Processing

CASE STUDY 1.06

2020 INDEPENDENT HIP STUDY

Extend the Life of Fr7B, 2nd Stage Buckets with HIP'ing.

BY WARREN MIGLIETTI, PH.D., FALL 2020

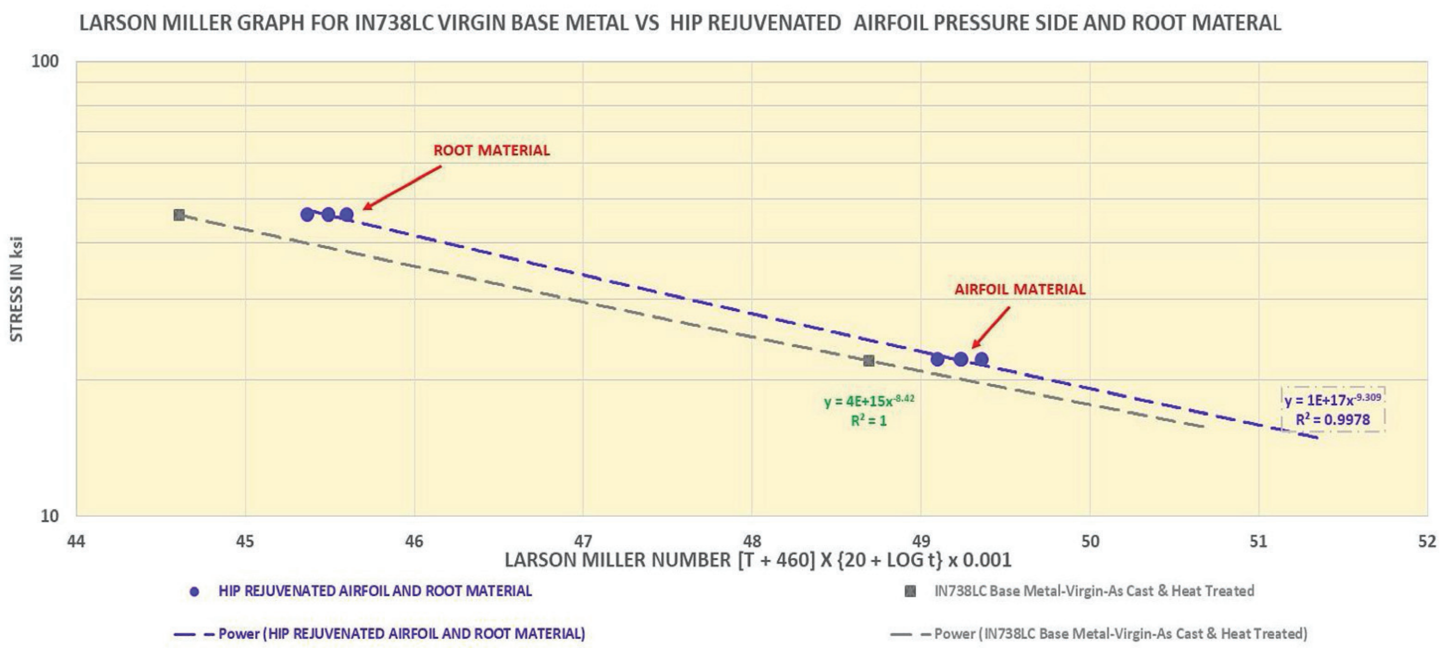
These buckets operated for 3 service intervals and were repaired twice in their history. No engine run material was tested, but the material from the HIP Rejuvenated bucket revealed the stress rupture data shown in Table 1. The same tabular data is shown in Figure 2. The conclusion reached from this Case Study was that there was an average 1.75X increase in life for the airfoil material, which was tested at 1800°F/22ksi, and an average 2.71X increase in life for the root material, which was tested at 1600°F/46ksi, when compared to virgin like as-cast material. Figure 2 clearly shows that the HIP Rejuvenated material has superior properties to that of the virgin base metal.

When the End User saw this data, they decided to repair these buckets and operate for a 4th service interval.

FIGURE 1: Fr7B, 2nd stage bucket that operated for 3 service intervals.

TABLE 1: Stress rupture results of Fr7B engine run material compared to HIP rejuvenated material

Stress Rupture test condition 1800oF/22ksi	Hours to failure	Elongation %	Reduction in Area %
Specification minimum at 1800°F/22ksi	35.0	5.0	5
HIP Rejuvenated Airfoil specimen #1	69.5	9.0	7.7
HIP Rejuvenated Airfoil specimen #2	53.4	5.8	7.7
HIP Rejuvenated Airfoil specimen #3	61.3	8.7	8.7
Average of Rejuvenated specimens	61.4	7.8	8.0
Stress Rupture test condition 1600oF/46ksi	**Hours to failure**	**Elongation %**	**Reduction in Area %**
Specification minimum at 1800°F/22ksi	45.0	5.0	5
HIP Rejuvenated Root specimen #1	122	7.1	9.9
HIP Rejuvenated Root specimen #2	138	8.0	10.9
HIP Rejuvenated Root specimen #3	106	7.3	10.8
Average of Rejuvenated specimens	122.0	7.5	10.5



FUGURE 2: Larson Miller graph for IN738LC Virgin Base Metal vs HIP Rejuvenated Airfoil Pressure Side and Root Material.

Now Introducing HIP'ing Services in our South Carolina Location

Accurate Brazing is a full-service vacuum brazing and heat treating enterprise with over 30 years in the business. Over that time, we've become adept at heat treating materials that include stainless steel, super alloys, copper, and refractory materials. Unlike competitors, Accurate Brazing has the unique expertise, capacity, and equipment to take new programs and get them into production quickly.

Due to an increasing need for perfect parts for demanding industries such as aerospace, medical, and casting, Accurate Brazing has recently invested Quintus in Hot Isostatic Pressing (HIP) Technology in our Nadcap certified facility in South Carolina. This will assist our customers with the need to get their components quicker and cheaper.

Quintus
TECHNOLOGIES

The One-Stop Shop for Brazing, Heat Treating, and Now, Hot Isostatic Pressing.

Accurate Brazing Benefits

RAPID COOL

Our HIP furnace quenches (fast cools) after holding at elevated temperature, resulting in a good microstructure; whereas other suppliers of HIP services cannot quench, requiring an additional post HIP heat treatment to achieve the desired microstructure costing you additional time and money.

HIP AND HEAT TREATMENT CAPABILITIES

- *Max Pressure: 30,000 psi*
- *Max Temperature: 2,282°F*
- *Max Cooling Rate: 390°F*
- *Gas Chromatograph*
- *Load capacity 26"dia x 69"*

About the Author

Warren Miglietti, Ph.D. - President and Principal Metallurgical Consultant of Miglietti and Associates, LLC

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.

SOUTH CAROLINA
Brent Davis
Vice President
299 B Garlington Road
Greenville, SC 29615

W (864) 213-9310
C (864) 423-6625
brent.davis@accuratebrazing.com

NEW HAMPSHIRE - HQ
Hazen Earle
Northeast Regional Manager
36 Cote Avenue
Goffstown, NH 03045

W (603) 945-3761
C (603) 235-4502
hazen.earle@accuratebrazing.com

CONNECTICUT
Bob Sartori
General/Operations Manager
4 Progress Drive
Manchester, CT 06042

W (860) 432-1840
C (860) 306-3628
bob.sartori@accuratebrazing.com

aalberts

aalberts.com