Engineering Failure Analysis 18 (2011) 492–498

Contents lists available at ScienceDirect

Engineering Failure Analysis

journal homepage: www.elsevier.com/locate/engfailanal

Short communication

Thermal fatigue failure of fuel spray bars of a jet engine afterburner

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ARTICLE INFO

Article history:
Received 4 March 2010
Received in revised form 5 August 2010
Accepted 5 August 2010
Available online 10 August 2010

Keywords:
Superalloy
Alloy-718
Weld zones
Stress raisers
Thermal fatigue

1. Introduction

Afterburning or reheating is one the methods to periodically augment the basic thrust of the turbojet engines. It increases the thrust by adding fuel to the exhaust gases after they have passed through the turbine section. At this point there is still much uncombined oxygen in the exhaust. The resultant increase in the temperature raises the velocity of the exiting gases and therefore boosts engine thrust. Most afterburners will produce an approximate 50% thrust increase, but with a corresponding threefold increase in fuel flow. Since the specific and actual fuel consumption is considerably higher during the time the engine is in afterburning or "hot" operation, as compared to the non-afterburning or "cold" mode of operation, reheating is used only for the time-limited operation of takeoff, climb, and maximum bursts of speed [1]. Fig. 1 shows a simple afterburner schematic [1]. It consists of the following components: (i) engine or turbine-driven afterburner fuel pump, (ii) afterburner fuel control, (iii) pressurizing valve—if multistage operation is possible, (iv) spray bars, (v) torch igniter and or ignition system, (vi) flame holders, (vii) variable-area exhaust nozzle, (viii) connections (mechanical and pressure) from main fuel control.

Fig. 2 shows a failed afterburner. It comprised of a manifold of elliptical cross-section extending circumferentially therein and a series of fuel spray bars spaced around the manifold circumference.

During general overhaul inspection of the A/B manifolds, hairline-cracks were found in the weld zones of the fuel spray bars. These hairline-cracks were occurring frequently causing excessive rejection of A/B manifold assemblies. The A/B manifold assemblies were tested at a hydraulic pressure of 100 kg/cm^2 during manufacturing; while in service manifolds observe 40 kg/cm^2 pressure of fuel. Five failed/rejected A/B manifold assemblies were analyzed during failure investigation.

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1350-6307/$ - see front matter
doi:10.1016/j.engfailanal.2010.08.003