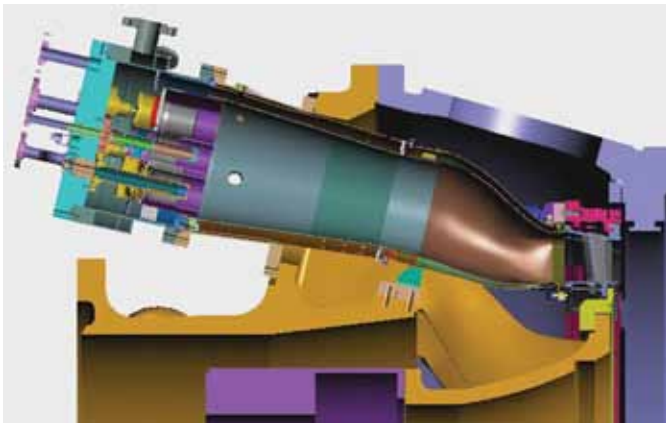
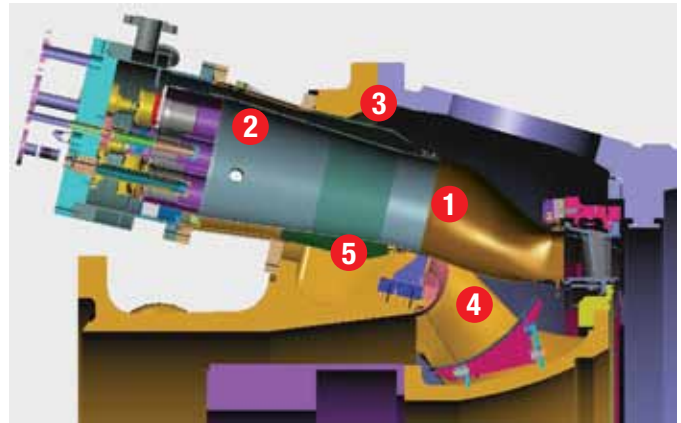


# 7FA-P1 Package for 7FA: Save Up to One Million Dollars per Year in Fuel Cost on Each of Your Units

The 7FA-P1 package from PSM helps 7FA users to substantially reduce fuel cost. Designed to reduce combustor pressure drop and optimize combustor-cooling effectiveness, this package improves the 7FA's heat rate by 1-1.5%. This can result in yearly fuel savings of up to a million dollars for a base load unit, and up to half a million dollars for an engine in cyclic operating mode. Plus, an output increase up to 2.0% can be expected. 7FA-P1 is designed for implementation on all 7FA DLN 2.6 and 2.6+ combustion systems in the framework of a combustor inspection.



**OEM Configuration**



**7FA-P1 Configuration** (1 - effusion-cooled TP, 2- OEM or PSM liner, 3- low-pressure-drop flow sleeve, 4- CDC exit guide vanes, 5- bullhorn mount block and brackets)

## Introduction

Fluctuating fuel prices make it increasingly challenging for operators of gas turbines to remain competitive in the power generation industry. When the yearly fuel bill for a 7FA creeps up to the neighborhood of a hundred million dollars, pressuring the power plant's bottom line profitability to continuously shrink, fuel consumption matters more than ever and engine efficiency becomes a key focus for gas turbine operators.

PSM has recognized this customer need and leveraged its extensive F-class gas turbine expertise and experience to conduct a detailed assessment of the cooling effectiveness on the 7FA combustion system.

In a comprehensive engineering program the cooling concept of the original DLN 2.6 combustor was completely remodeled. A combination of improvements, including effusion-cooled transition pieces and reduced-pressure-drop flow sleeves, has demonstrated engine heat rate improvement well above 1% in numerous field applications. The 7FA-P1 low-pressure-drop package is designed for implementation during a combustor inspection, either as a rework package to the existing combustor parts, or as a complete set of new parts (or a combination of both).

# The 7FA-P1 upgrade achieves tremendous **heat rate improvement** through changes in the way the combustor parts are cooled.

The OEM's impingement-cooled transition piece is replaced with an effusion-cooled single wall design. The OEM impingement sleeve is completely eliminated. This means fewer parts and thus elimination of any risk related to impingement sleeve assembly problems. In addition, absence of the impingement sleeve increases the flow cross-section between two adjacent transition pieces, which results in reduced parasitic pressure drop and thus engine heat rate improvement. The 7FA-P1 transition piece features a modified inlet support ring and reconfigured bullhorn brackets that fit into new mounting blocks. A set of flow guides on the compressor discharge case, on both the inner and outer diameters, is added to more efficiently direct the flow exiting the compressor diffuser. This enhances transition piece cooling on the inner diameter and also reduces diffusion losses into the mid-frame cavity. The new flow sleeves of the 7FA-P1 package are redesigned for reduced pressure loss. Each flow sleeve features an increased annulus area with optimized inlet holes and a set of flow dividers for uniform circumferential flow distribution. Finally, introduction of more effective seals minimizes air leaks, in particular between the flow sleeve and the combustor case.



7FA-P1 Hardware Installation & Instrumentation

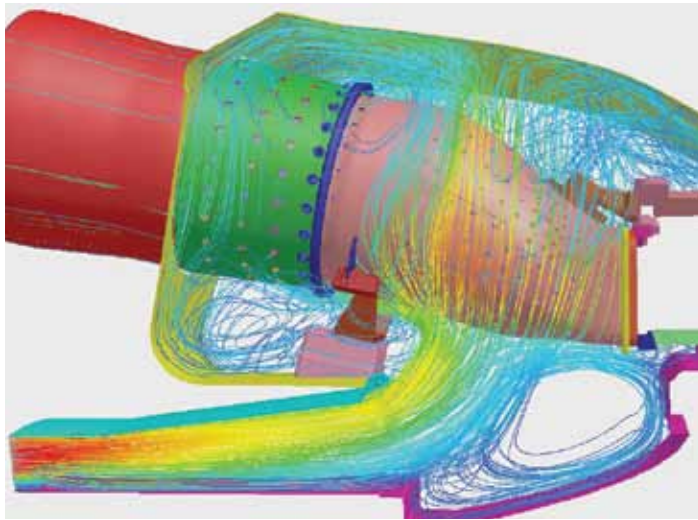


7FA-P1 Guide Vane Support Welding

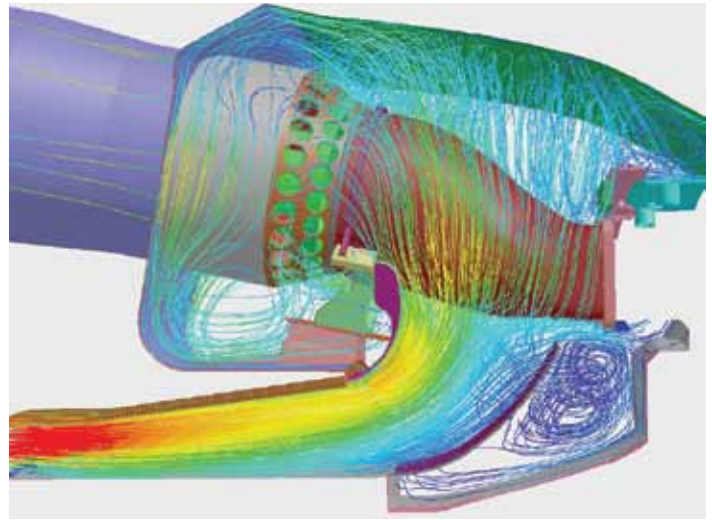
### Installation Scope

The 7FA-P1 low-pressure-drop package includes the following parts:

- + 14 effusion-cooled single-wall transition pieces with modified inlet support ring and reconfigured bullhorn bracket, new or reworked (12K, 12KEL, or 24K design)
- + 14 reduced-pressure-loss flow sleeves with increased annulus area, optimized inlet holes, flow dividers, and improved seals, reworked or new (12K/12KEL/24K)
- + Addition of a set of new compressor discharge case flow guides, both inner and outer diameter
- + New set of bullhorn mount blocks



OEM TP is cooled through impingement sleeve, at 1% to 2.5% pressure drop depending on impingement hole positions



PSM TP is cooled by directing compressor exit flow toward the TP, reducing pressure loss utilized for cooling

### Key Features

- Effusion-cooled single-wall transition pieces with modified inlet support ring and reconfigured bullhorn bracket, for optimized cooling effectiveness and minimized cooling pressure drop (reworked or new, 12K/12K+/24K)
- Reduced-pressure-loss flow sleeve featuring an increased annulus area, optimized inlet holes, flow dividers for uniform flow distribution, and two-ply hula seals for minimum leakage (reworked or new, 12K/12K+/24K)
- Addition of compressor discharge case exit flow guide vanes, both inner and outer diameter, to enhance transition piece cooling and reduce diffusion losses into mid-frame cavity (new)
- New bullhorn mount blocks
- Low-flow 1st stage turbine nozzle for reduced NO<sub>x</sub> (reworked or new, optional)
- Installation within the scope of a combustion inspection

### Major Benefits

- 1-1.5% reduction in gas turbine heat rate
- Gas turbine output increased up to 2%
- Plant heat rate reduction up to 0.5%
- Plant output increased by at least 1.0%
- Fuel savings of up to 1 million dollars per year
- Significant reduction of transition piece failure risk through elimination of the impingement sheets
- Easy reversion to OEM configuration during a C.I. if unmodified OEM parts must be used in an emergency

	OEM Configuration	PSM 7FA-P1 Package	Improvement (Nominal)
Power (MW)	171.7	174.5	1.75%
Heat Rate (BTU/kWh)	9420	9300	1.25%
Base Load Fuel Cost (\$MM/year)	84.1	83.1	1.0
Assumptions	Utilization:	base load, 8000 hours per year	
	Specific fuel cost:	\$6.50 per MMBTU	

PSM 7FA-P1 fuel savings example calculations

## Your Benefits

PSM's 7FA-P1 low-pressure-drop upgrade provides 7FA users with the opportunity to significantly reduce their unit's heat rate. The upgrade demonstrated 1-1.5% improvement in simple cycle engine efficiency in several commercially operating engines. This translates into substantial fuel savings of 1 million dollars per year<sup>1</sup> for a 7FA in base load operation. The associated increase in output was measured up to 2.0%. In combined cycle mode, an improvement of up to 0.5% for plant heat rate can be expected. Fewer parts in the combustion system, in particular absence of the impingement sleeve on the transition piece, reduce the risk of failure and potential forced outages.

The package is designed for quick and easy implementation within the scope of a C.I. without significantly affecting the overall outage duration.

## Additional Options

### *Low-Flow 1st Stage Turbine Nozzle*

For users who are restricted by stringent air permits, PSM offers a low-flow 1st stage turbine nozzle. This nozzle features optimized cooling and consumes less cooling air, which in turn is available to the combustion process, resulting in lower NOx emissions, and further heat rate improvement. The low-flow nozzle design is available as a full, new set or as a rework package for the OEM part.

<sup>1</sup> Calculated using natural gas priced at US\$6.50 per million BTU.

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