LM6000 Upgrade Solutions

Repower Outcomes

Model	Output (MW)	Heat Rate (BTU/kW hr)	HS Interval (hrs)	MOH Interval (hrs)	Start Time (min)	Exhaust Flow (lb/s)	Exhaust Temp. (°F)
PA	40	9,065	16,000	48,000	10	279	824
PC	45	8,549	16,000	48,000	10	284	829
PC-SPRINT	51	8,526	16,000	48,000	10	295	857
PD	43	8,240	25,000	50,000	10	275	863
PD-SPRINT	47	8,245	25,000	50,000	10	288	853
PF	43	8,240	25,000	50,000	10	275	863
PF-SPRINT	47	8,245	25,000	50,000	10	288	853
PCU	53	8,702	25,000	50,000	10	293	931
PCU-SPRINT	54	8,732	25,000	50,000	10	296	929
PG	55	8,625	25,000	50,000	5	316	880
PG-SPRINT	57	8,673	25,000	50,000	5	318	897
PDU	48	8,210	25,000	50,000	10	281	933
PDU-SPRINT	51	8,294	25,000	50,000	10	289	929
PH	48	8,398	25,000	50,000	5	300	890
PH-SPRINT	50	8,376	25,000	50,000	5	303	883

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Product Offering	Description	SC Output Change(%)	CC Output Change(%)	SC Heat Rate Change(%)	CC Heat Rate Change(%)	Availability	Flexibility	Reliability	HS/MOH Life (khrs)	Emissions	Safety	Regulatory
F2F Repower – LM5000 to LM6000	Uprate a LM5000 to a LM6000 gas turbine for more power, better efficiency and better reliability.	✔	✔	✔	✔	✔		✔				
F2F Repower – PA to PC (PAU)	Uprate a PA to a PC gas turbine for more power, better efficiency, better reliability and increased life.	Up to 12% higher	Up to 12% higher	Up to 6% lower	Up to 6% lower	✔		✔	✔			
F2F Repower – PC to PD/PF	Convert PC engines with water injection for NO_x control to the Dry Low Emissions (DLE) technology to eliminate water use.								✔	PD – 25 ppm NO_x PF – 15 ppm NO_x		✔
F2F Repower – PD to PF	Convert a PD to a PF to reduce NO_x from 25 to 15 ppm.									PF – 15 ppm NO_x		✔
F2F Repower – PG at 3600 RPM (PCU)	Uprate a PC to a PG and operate the gas turbine at 3600 RPM for more power, better combined cycle efficiency, better reliability and increased life.	Up to 8% higher	Up to 8% higher + bottoming cycle		Up to 1.0–2.5% lower	✔	✔	✔	PC limits – 32.5/65 PG limits – 25/50			
F2F Repower – PG at 3930 RPM (PCU)	Uprate a PC to a PG and operate the gas turbine at 3930 RPM for more power than at 3600 RPM, better combined cycle efficiency, better reliability and increased life.	Up to 10% higher	Up to 10% higher + bottoming cycle		Up to 1.0–2.5% lower	✔	✔	✔	✔			

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F2F Repower – PH at 3600 RPM (PDU)	Uprate a PD/PF to a PH and operate the gas turbine at 3600 RPM for more power, better combined cycle efficiency and lower emissions.	**Up to 8% higher**	**Up to 8% higher + bottoming cycle**		**Up to 1.0–2.5% lower**	✔		✔		✔		✔
F2F Repower – PH at 3930 RPM (PDU)	Uprate a PD/PF to a PH and operate the gas turbine at 3930 RPM for more power than at 3600 RPM, better combined cycle efficiency and lower emissions.	**Up to 10% higher**	**Up to 10% higher + bottoming cycle**		**Up to 1.0–2.5% lower**	✔		✔		✔		✔
Cross Fleet Repower – Non-LM to LM6000	Repower existing Non-LM units units with LM6000 technology to reduce emissions and add flexibility.	**Up to 30% higher**	**Up to 35% higher + bottoming cycle**	**Up to 22% lower**	**Up to 25% lower**	✔	✔	✔	✔	✔		
Peak Performance – PC	Increase SPRINT water flow to suppress T3 to ensure operation in T48 control, increase T48 max, and increase water injection for NO_x to provide approximately 5% more power with a life penalty.	**Up to 5% higher**	**Up to 5% higher**	**Up to 1.5% lower**	**Up to 1.5% lower**							
Peak Performance – PD-PF	Increase SPRINT water flow to suppress T3 to ensure operation in T48 control, and increase T48 max to provide approximately 5% more power with a life penalty.	**Up to 5% higher**	**Up to 5% higher**	**Up to 1.5% lower**	**Up to 1.5% lower**							
PC Rad-Rad Combustor Conversion	Convert Single Annular Combustors (SAC) with jet-rad swirlers to rad-rad swirlers to increase combustor and stage 1 High Pressure Turbine (HPT) life.					✔		✔	**25/50**			
Full and Part Load Efficiency	Upgrades to improve full and part load efficiency.			✔	✔							
Hybrid Electric Gas Turbine (EGT)	Enables spinning reserves without operating at sync idle using batteries. Also, improves grid stability by providing VARs to the grid.						✔	✔	✔	✔		✔
Steam Injection for NO_x	Addition of steam through the fuel nozzles for emissions control.	**Up to 4% higher**	**Up to 4% higher**	**Up to 7% lower**	**Up to 7% lower**					✔		
Steam Injection for Power	Addtion of steam injection into the Compressor Discharge Port (CDP) for an increase in power output.	**Up to 7% higher**	**Up to 7% higher**	**Up to 11% lower**	**Up to 11% lower**							
4-Hour Lockout Avoidance	Prevent or reduce 4 hour lockout events by: • Slow Roll–Slow roll engine to prevent rotor lock. • Soft Start–Bump engine with rotor locked until it is freed.					✔		✔			✔	
Alternative Fuel Retrofit	Provide hardware that enables the use of alternative fuels.						✔					
Fast Start	From 0 to base load in 5 min.						**5 min start**					✔
Fuel Variability Monitoring System	Adjusts fuel control to accommodate large fuel property swings by timing the change in gas and using a Modified Wobbe Index Meter (WIM).						✔			✔		
Auto NO_x Biasing	Upgrade control logic to to closed loop control NO_x						✔			✔		✔
Automatic Voltage Regulator (AVR)	Upgrade any AVR to an EX2100e.						✔					✔
Controls – Mark VIe Controls	Upgrade any control system to a GE Mark VIe with the latest fuel control software.					✔	✔	✔				
Controls – MicroNet* Plus	Upgrade any control system to a Woodward Micronet Plus with the latest fuel control software.					✔	✔	✔				
Controls – Software Core	Upgrade software only to the latest version assuming controls are already a GE Mark VIe or a Woodward Micronet Plus.					✔	✔	✔				
Direct Drive Ventilation Fans	Replace belt drive fans with direct drive fans to reduce maintenance costs. Eliminates noisy belts and pillow block bearing failures by eliminating the belts and bearings.					✔		✔				
Fire Protection System	Replace existing fire system with a NFPA-compliant fire protection system.					✔					✔	✔
Fixed to Variable Inlet Guide Vanes (FIGV to VIGV)	Replace the FIGV with VIGV to provide better part load efficiency.			✔	✔		✔					

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Fuel System Gas to Dual Fuel	Convert fuel system to operate on both liquid and gas fuel.						✔					
Fuel System Liquid to Dual Fuel	Convert fuel system to operate on both liquid and gas fuel.						✔					
High Flow On-Line Water Wash	Improve performance in dirty environments: • Reduce or eliminate power losses due to compressor fouling. • Reduce or eliminate off-line water washes.	**Maintain output**	**Maintain output**	**Maintain HR**	**Maintain HR**	✔	✔					
Human Machine Interface (HMI)	Allows the user to control the gas turbine more effectively during operation, as well as to monitor live and historical turbine operating data.						✔					
IGV Schedule Optimization for Degraded Engines	Adjust VIGV schedules to provide more air flow into the LPC when engine has degraded, providing increased power and efficiency under certain operating conditions.	**Up to 2% higher**	**Up to 2% higher**	**Up to 1% lower**	**Up to 1% lower**							
Inlet – Anti-Icing	Provide heating system to the air inlet system to eliminate icing in the filterhouse.					✔	✔	✔				
Inlet – Chilling – Air	Add inlet coils to lower combustion air inlet temperature to increase power in hot environments.	✔	✔	✔	✔							
Inlet – Chilling – Water	Add inlet coils to lower combustion air inlet temperature to increase power in hot environments.	✔	✔	✔	✔		✔					
Inlet – Evaporative Cooling	Add evaporative coolers to lower combustion air inlet temperature to increase power in dry environments.	✔	✔	✔	✔							
Low Pressure (LP) and High Pressure (HP) SPRINT	Add both LP and HP SPRINT to increase power output.	✔	✔				✔					
Low Pressure (LP) SPRINT	Add LP SPRINT to increase power output.	✔	✔				✔					
MetalScan	System used to better monitor bearing life and predict bearing issues. Tracks metal chip count in each turbine lube oil sumps during operation.					✔		✔				
Primary Frequency Control (PFC)	Add primary frequency control capabilities to any genrator control system.						✔					✔
Sump Evacuation System (SES)	Addition of a suction fan to evacuate all turbine bearing sumps to remove lube oil vapors and eliminate potential coking in any drain sumps. Mainly intended for the DE sumps.					✔		✔				
Super Polish High Pressure Compressor Blades	All stages of the High Pressure Compressor (HPC) are replaced with super polished ones to increase surface tension on blades and vanes to reduce fouling and improve performance during operation.	**Maintain output**	**Maintain output**	✔	✔							
Thrust Balance Valve Removal	Replace the hydraulically actuated thrust balance valve that can fail and has to be maintained with an orifice.					✔		✔				
Variable Frequency Drive (VFD) for Ventilation Fans	Regulates ventilation fan speeds to maintain the proper temperature and eliminate freezing in the generator or turbine enclosures. Also, enables soft starting to eliminate fan noise and bearing stress on fan startup.					✔	✔	✔				
Vibration System	Upgrade any vibration system to latest Bently Nevada vibration monitoring system.					✔		✔			✔	
Water Injection	Add water injection for NO_x control to any Single Annular Combustor (SAC).									**25 ppm NO_x**		✔
Asset Performance Management (APM)	Identify the impact of each critical failure mode on total plant reliability, mitigate each with digital solutions, to the extent possible, and measure the effect of the solution as reliability improvement.					✔		✔			✔	
Operations Optimization (OO)	Provide flexibility to tune set points and achieve overall improvement in Heart Rate (HR).			**Up to 0.2% lower**	**Up to 0.5% lower**		✔					

For more information, please contact your GE Power account manager, or visit: www.gepower.com

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