GE Rapid Response 207FA Plant Operation

The GE 207FA Rapid Response (RR) plant is designed to break the links normally existing between the gas turbine(s) (GT) and the steam cycle startup. Thus freed, the GT can load at it's own maximum rate. This has emissions and economic benefits as well as providing fast energy supply to the grid to support renewable regulation without sacrificing the high efficiency of new combined cycle gas turbine (CCGT) plants.

Startup

The RR plant starts from a previously established "ready to start" (RTS) condition. RTS consists primarily of electrical systems energized, steam process vessels filled to prestart level, manual valves in run position, and controls in auto.

Upon start command, the GT starting process is initiated to roll the GT. If purge credit is not established, a heat recovery steam generator (HRSG) purge is performed with an unfired GT time of about 15 minutes. With purge credit, the GT fires on the fly1 or 2 minutes after roll. After fire, the GT accelerates to full speed no load (FSNL) with driving power provided by the load commutated inverter (LCI), a variable speed drive, motoring the generator. At about 95% speed, the LCI disengages and the GT settles at FSNL. The GTs may be started simultaneously or sequentially.

On hot and warm starts, the GT synchronizes and loads directly to any desired load including base load. This is the portion of the plant startup sequence, for a non-RR design, where the GT is normally held at a low load for steam temperature matching to steam turbine (ST) metal. The RR plant has terminal attemperators which allow it to control steam temperature independent of GT exhaust temperature so it can avoid holds on these starts.

On a cold start, greater than 72 hours of shutdown, a short GT hold is still employed to mitigate HRSG startup thermal stress.

As the GT loads, the HRSG warms up and steam production begins. Warmup rate and steam flow, pressure, and temperature rise are a function of HRSG initial temperature. Cold HRSGs warmup slower than hot HRSGs. The first steam flow is through steam bypass valves and eventually to the condenser. The bypass valves operate in automatic pressure control to stabilize the steam cycle.

A hybrid high pressure (HP) steam bypass system is used to lower the reheat pressure to the ST startup requirement. The hybrid system consists of a bypass line from each HRSG HP steam line to the cold reheat (CRH) steam line and a second bypass line from the HP steam line to the condenser. This system allows as much steam as needed to be cascaded from HP to CRH for cooling the HRSG reheater section and starting the ST while the balance of HP steam can be directed to the condenser. When steam conditions are correct, admission to the ST is initiated.

Depending upon it's initial temperature, the ST is accelerated and loaded at varying rates. An online continuous stress controller allows maximum ST loading rates without overstressing the ST. The ST is accelerated to FSNL, synchronized and partially loaded by steam admission to the intermediate pressure (IP) section only. At about 20% ST load the ST high pressure (HP) control valve is opened and steam flows through the entire ST.

Flow admission to the ST continues until all of the steam bypass valves are shut and all steam is flowing to the ST. At least 95% plant output is achieved at this point in the start sequence.

If the terminal attemperators were operating to lower steam temperature on a warm or cold start, at this time the attemperating water flow is ramped down to bring steam temperature up to rated level. The rate of steam temperature increase is limited by the ST stress controller.

With the terminal attemperators off and the bypass valves shut baseload operation of the RR plant is identical to that of the conventional combined cycle plant.

Shutdown

Due to the use of shutdown purge, or "purge credit", a modification to the normal shutdown procedure is included. This consists of a GT hold at about 10% load for 10 minutes to cool down the HRSG superheater headers. This lowers the header metal temperature and reduces the damage due to quenching of the header as steam in the superheater condenses and collects in the lower headers during shutdown purge.

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