THIELSCH ENGINEERING

CYCLING OPERATIONS RESULTS IN STEAM CHEST REPAIR

Recently, Thielsch Engineering was contracted to provide engineering supervision and perform repairs by welding on the main steam control valve chest at a 500 MW facility located in Texas, thus returning it to a level of integrity suitable for continued service under the design operating conditions. The mid 70’s vintage unit had experienced significant thermal fatigue as a result of cycling operations.

The cracking conditions had been identified three years ago and had been monitored for propagation. The repairs to the chest involved over forty-five separate locations of cracking conditions, each over an inch deep, with the deepest being 2-1/2 inches. The repair process utilized on the valve chest consisted of several phases. These included nondestructive examinations, preheating, and welding, and post-weld heat treatment. Each of these processes was carefully monitored and implemented by Thielsch Engineering personnel.

A series of nondestructive examinations were performed throughout the repair process. The nondestructive examinations performed included visual, liquid penetrant, and dry magnetic particle inspections. The final examination included visual and dry magnetic particle inspections.

Although the extent of cracking excavation was significant and thorough removal was required, the more challenging part of this particular repair was the accessibility of many of the cracking locations. Some of these areas required incredibly creative techniques for access involving the use of some “not so specialized” equipment including a standard broomstick handle and a mirror at times. Typical views of the repairs in progress are provided in Fig.’s 1-6 below. The ability of Thielsch’ talented welders was proven by this challenging repair process; using over 300 pounds of welding rod, working two shifts around-the-clock for over four weeks, our group of talented and committed engineers and welders saved this client hundreds of thousands of dollars by refurbishing, rather than replacing, this critical component.

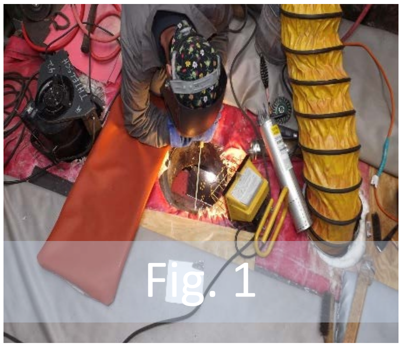
Fig. 1


Fig. 2

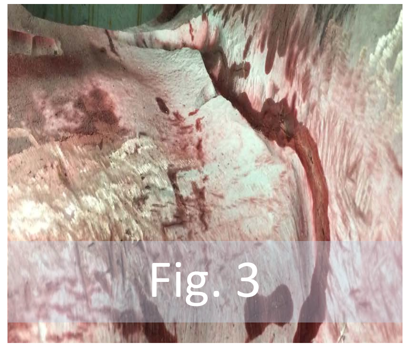
Fig. 3


Fig. 4


Fig. 5

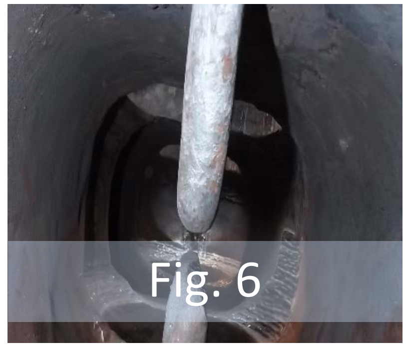
Fig. 6

Because the damage conditions revealed in this steam chest were a result of thermal fatigue caused by the effects of cycling operations, let's take a brief look at how cycling a unit can decrease the life expectancy of your critical components.

Most power generation facilities were designed on the assumption that they would be operated in a baseload mode or infrequently cycled. However, in response to local power market conditions and the terms of their power purchase agreements, many plants are now cycling their units more frequently than designers had intended. Ultimately this can result in greater thermal stresses, more pressure cycles, more cyclic fatigue damage and overall faster wear and degradation to the critical components due to both the mechanical and corrosion processes.

In brief, baseload is the minimum amount of power that a utility or distribution company must make available to its customers, or the amount of power required to meet minimum demands based on reasonable expectations of customer requirements. Baseload plants are devoted to the production of baseload supply. These plants are used to meet some or all of a given region's continuous energy demand. They are to produce energy at a constant rate usually at a low cost relative to other production facilities available to the system. They tend to run at all times with the exception of repairs or scheduled maintenance.

Cycling may be defined as the operation at varying outputs or the switching on and off of electricity generating units. This cyclic operation results in thermal transients and fluctuating pressure levels, which has proved to cause fatigue damage, chemical corrosion and various other forms of impairment to the generator's components. Certain types of units, called peaking units and some combined-cycle units are specifically designed for this mode of operation and do not have as adverse effect as those designed for baseload operations. This is because baseload units are designed for continuous operation, close to their maximum rated output. When operated in a cyclic manner they often suffer great physical damage to the various components of the generating unit.

As a general comment, cycling service has an adverse effect on the life expectancy of a unit. This is due to the fact that cycling results in fatigue loading (alternating cyclic stresses) whereas; baseload operation results in creep (sustained stresses). Depending on the severity of the stresses, and the number of cycles, fatigue loading can result in cracking, particularly at restraint locations. This can be compared to the differences between driving a vehicle on the highway for 100,000 miles or driving a vehicle in town with stop and go traffic for 100,000 miles. The maintenance requirements and life expectancy of the vehicle driven in town are vastly different than that of the highway driven vehicle.

Many utility owners and investors of combined-cycle plants are now rethinking the concept of baseload operation to cycling operation. Since current combustion turbines do not have low turndown while maintaining emissions, the ability to cycle a unit is the alternate solution. Such cycling plants are designed to optimize plant operations by providing rapid startups, partial loading, and short shutdowns. A combined-cycle plant having operating flexibility can definitely provide start, stop, and partial load operation to match changing demand for power. However, these benefits can bring on added costs due to wear and tear on equipment through thermal cycle fatigue.

It is critical for plant owners and operators to understand the impact of cycling. To achieve cycling plant operations, owners must consult with engineering experts to determine cycling flexibility, availability, and reliability. All plants start and stop as a result of planned outages or unexpected trips. For cycling, the plant superintendent and load dispatcher have the daily latitude to call for daily on/off and partial load operation within any given 24-hour period. There are no longer limitations with eight hours, 12 hours, and longer restarts that used to justify or force a unit to stay on line. Whether dealing with an already operating unit or a newly proposed one, plant owners must again work with experienced engineers to consider the severe wear and tear that the unit will be subjected to as a result of frequent starts and stops.

Cycling is more demanding than running a unit at baseload. It subjects the unit to persistent stopping, starting, and load changing that could drastically reduce service life expectancy. To learn more about our experience with baseload and cycling units, please contact Peter Kennefick at pkennefick@thielsch.com.