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House Calls

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Once upon a time, they say, doctors made house calls, arriving, black bag in hand, to take your temperature and dispense needed pills. Today, the visiting doctor is as elusive as Bigfoot or the Loch Ness monster. Sure, we may have seen this creature in a Norman Rockwell painting or on a television show, but no reputable witness claims to have sighted one in the flesh. No, when we are ill, we drag ourselves out of bed and sit in a clinic waiting room.

Fortunately, that is not the case when turbines need a bit of “doctoring.” An expanding array of machining options, including stationary journal machining (SJM), makes it possible to perform repairs on-site. Rather than wasting time pulling the rotor and shipping the unit off to a shop for work, such techniques can be less expensive and just as effective.

“We don’t see a big difference in quality between doing the work on-site and sending it out to a shop,” says Doug Cherwinski, lead senior engineer for Consumers Energy, which used SJM for grinding collector rings on a 265 MW coal-fired unit. “We are still getting the same quality as we would have if we had sent the rotor to an outside shop.”

Less Downtime

SJM evolved from technology first developed in Europe in the early 1950s, though modern equipment bears little resemblance to the early models.

“Previous catastrophic failures provide important lessons upon which to build more advanced and effective machining systems,” says Charles T. Vollmer of Field System Machining Inc. (FSM), a South Elgin, Ill.-based company that specializes in SJM and large portable on-site machining. “Today’s emergencies call for a new generation of stationary journal machining processes.”

With SJM, rather than having to remove the rotor and turn it on a lathe, the equipment attaches to a stationary rotor and rotates around it. This has several advantages. Because absolutely no shaft rotation is required, this method eliminates the risk of journal cogging, oil climb or bearing damage. In addition, the plant crane or rigging assistance is no longer needed to remove the turbine. Since the turbine remains in place, the process doesn’t tie up floor space. The big advantages, however, are in terms of reduced cost and shortened outages.

“Journal and bearing failures will happen,” Vollmer continues. “It is comforting to know that SJM can quickly and efficiently get you back online and running with minimum downtime.”

FSM, which has a large array of on-site machining tools, designed and built its own SJM. It is a portable machining apparatus that enables the company to accurately machine shafts, journals, collector rings and other components by rotating around the part. It can restore straight, round or concentric conditions to within 0.0005 inches (0.5 mil) final machine tolerances from virtually any position. The machine consists of:

- Two outer rings with riding pads that revolve around the shaft
- One tool holder with a lead screw that machines across the shaft with a direct feed mechanism
- One electrical variable speed motor attached to a gear box that drives pulleys that are connected to the outer rings
- One ring with four honing stones that enables surface finishes of 16 rms (root-mean-square) or better.

FSM receives dimensional information from the customer (the fastest option) or it sends a technician on-site to take measurements. The machine is then preassembled so that when the crew arrives on-site, it is preset for the journal size. In most cases, the setup is simulated on a computer-aided drawing program to assure a proficient operation. By performing the setup in the shop before shipping it to the job location, the setup time is reduced and, consequently, so is the downtime for the customer.

Rather than removing the rotor and turning it on a lathe, stationary journal machining allows equipment to be attached to a stationary rotor, so the rotor can be machined on-site.

The machine is easily packed into three small gang boxes weighing less than 500 pounds each, which enables them to be air shipped to any location or transported in the back of a small pickup truck. Once the equipment arrives on-site, the operators can set it up and begin machining within four hours. A journeyman machinist operates the SJM like any metal cutting machine and it takes two qualified people per shift to operate.

Costly Shipping

Southern Illinois Power Cooperative Inc. (SIPC) chose to go with SJM when it needed to machine some collector rings. The cooperative has four coal-fired units and two dual-fuel (natural gas/diesel) General Electric (GE) Frame 7EA turbines at its plant on Lake of Egypt, near Marion, Ill. Three of the coal units have 33 MW Allis Chalmers turbines dating back to 1962, but last year SIPC installed a new circulating fluidized-bed (CFB) boiler to feed them. The fourth unit is a 172 MW GE turbine with a B&W boiler that went online in 1978. Both the CFB and Unit No. 4 burn Southern Illinois coal and carbon.

A few years ago, SIPC noted excessive collector ring wear on its No. 2 and No. 4 units. “When the spiral groove in the collector ring wears down below the specified tolerance or wears unevenly, the ring has to be replaced or remachined,” says plant engineer Clark Madden. “The collector rings can wear unevenly and this makes the rings jump up and down during operation. If they jump too much, you will lose your exciter and it will take the unit offline.”

SIPC evaluated three options:

- Pulling the rotor and machining it on-site using a portable lathe. This would require time to unload and set up the lathe, and time to unload and reinstall the rotor. Cost was estimated at $45,000, not including downtime cost.
- Shipping the rotor to a repair shop. This would result in additional downtime, transportation and insurance costs, as well as the risk of damage to the rotor while in transit. Estimated cost was $50,000.
- Performing SJM. This method would result in a short turnaround and lower cost: $15,000.

SIPC opted for the third option. “We decided to machine the rotor on-site because it was possible to set up an SJM orbital top cutter and an SJM orbital mill so we wouldn’t have to turn it on a lathe,” says Madden.

When the units came down for maintenance, the FSM machinists removed the pedestal at the exciter end and installed the SJM. The work took 36 elapsed hours, compared to 110 had the rotor been pulled.

“Machining in place saves downtime because it is a big job to uncouple a rotor from the generator and then remove it,” says Madden. “Plus there is no time wasted in shipping.”

Saving a Million

Consumers Energy (CE), an electric and gas utility serving six million residents of Michigan’s lower peninsula, took a similar approach to repairing its worn collector rings. The principal subsidiary of CMS Energy Corp., Jackson, Mich., CE operates 14 fossil-fueled steam plants, 13 hydroelectric facilities, several combustion turbine peaking plants, as well as a pumped storage and a nuclear plant.

The utility used stationary journal machining on two of the units at its 2,100 MW D.E. Karn/J.C. Weadock Generating Complex in Essexville, Mich. The first job consisted of machining the Unit No. 2 collector rings that exhibited excessive wear.

“It was just normal brush wear on the collector rings and hadn’t caused any problems yet, but we decided to do the work in a scheduled outage, rather than waiting until they were causing problems,” says Cherwinski.

CE also had three options. One was to pull the brushes aside and hone the collector ring while the unit was operating. This had the advantage of being able to account for the natural vibration of the rotor under operating conditions, but also had the potential downside of getting particles in the system. Another option was to ship the rotor out and have the work done in a machine shop, but that would have been a costly option, especially taking into account schedule impact and risks involved in shipping large components off-site.

“If there is another option, we prefer not to ship large rotors around the country,” Cherwinski explains. “The technology is available to do this work in place, so that is what we opted to do.”

After a competitive bidding process, the company selected FSM to do the work. The 265 MW unit has dual generators, and FSM machined both sets of collector rings, and turned, polished and machined the spirals. The job was done during a scheduled outage with the turbine in place. Each collector ring took 42 hours, and the work was completed in seven 12-hour shifts. CE paid considerable less to have the work done on-site than the estimated $127,000 it would have cost for other methods.

Later, CE used FSM for repairs on another one of its D.E Karn units. The second job consisted of machining a 6.25-inch journal on the 638 MW Unit No. 3's main boiler feed pump. In this case, because of the size of the unit, disassembling the unit and shipping the shaft to a machine shop would have resulted in 10 days of downtime. Instead, the job was completed in 36 hours at a sharply reduced cost.

Running the Numbers

ROI Calucation Example: Conventional Turbine Repair Versus SJM Repair				
	213 MW Turbine		650 MW Turbine	
Downtime Costs*	$4,294,080 (14 days @ $306,720/day)	$920,160 (3 days @ $306,720/day)	$19,656,000 (12 days @ $936,000 day)	$2,808,000 (3 days @ $936,000/day)
	Conventional Repair	SJM Repair	Conventional Repair	SJM Repair
Labor/Repair Cost	$500,000	$50,000	$750,000	$70,000
Total Costs	$4,794,080	$970,160	$20,406,000	$2,878,000
Savings	$3,823,920		$17,528,000	
*Downtime based on peak pricing/lost revenue of $60/MWh.				

Staggering costs and crippling delays often occur with conventional disassembly, off-site repair and reassembly of a steam turbine. When emergencies occur or normal outages cause power failures, lost production hours must be kept to a minimum. SJM produces major cost savings by eliminating unnecessary downtime. The table shows the cost savings for two sizes of turbines.

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