January

Using Pareto Analysis to Focus Reliability Improvements

Kathy | January 1, 2005

This approach helps uncover reliability problems obscured by the volume of plant work requests.

Progress Energy's Harris nuclear power plant in New Hill, NC, is taking a proactive approach to identify and improve equipment performance. Power plants such as Harris have more than 100,000 components. Personnel perform thousands of maintenance activities annually.

With large organizations and personnel turnover, many equipment reliability

over many years with different people involved.

All plant components require some level of maintenance over time. Some contribute more than others to the maintenance workload. To minimize operation and maintenance costs, plant equipment needs to operate at a maximum maintenance interval. Harris's Component Engineering group is employing a simple statistical method known as a Pareto analysis that, when applied to maintenance work requests, can identify the equipment that contributes the most to the plant maintenance work load.

Conducting Pareto analysis

A Pareto analysis is conducted by adding the number of work requests for each component type over the time frame of interest. When ordered by the count of work requests for each component, the analysis identifies the "vital few" components that contribute the most to plant maintenance and distinguishes them from the "trivial many" that have a small contribution. The objective is to then take action to reduce the vital few into the trivial many.

Work requests from 2001-2003 were reviewed at Harris and sorted by equipment type. The counts for equipment that comprised 40 percent of all maintenance performed at the plant over the 3-year period are shown in Fig. 1.

There are several hundred equipment types in use at the plant. The benefit of this systematic breakdown is a focused review of a limited number of components. In this case, nine equipment types were involved: Isolation valve, panel, pump, door, fan, motor, pneumatic operator, relief valve, and breaker.

Break down by manufacturer, model

The work requests for a specific equipment type are reviewed then by manufacturer and model. The information for one equipment type, fans, is illustrated in Fig. 2.

Of the 58 fan models at Harris, eight models required nearly 50 percent of the fan maintenance work during the 2001-2003 period. Again this systematic breakdown permits a focused review of a manageable number of fan applications.

Of the 14 work requests on the model SZ-3024 fans (a centrifugal belt driven fan), 36 percent were triggered by vibration and 64 percent by loose belts (Fig.

The cam-lock style roller element bearings were failing on an average of every 2-3 years compared to their L10 design life of 12-15 years. A thorough review was conducted of the maintenance practices for belt and bearing replacements, the preventive maintenance strategy employed on the fan, and the design of the fan.

Discussions with the bearing manufacturer identified a problem with the site maintenance practice which did not require relocking the collar of the bearing after the run-in of fan belts. Additionally, a more reliable bearing was identified for the application that is expected to improve the overall reliability of the fan. The result of these improvements will reduce fan maintenance at the Harris plant by $21,900.

Do same for isolation valves

The same systematic approach was used for isolation valves. Since initial plant operation in 1987, Harris has experienced repeated position indication (i.e., dual indication or loss of indication) with a particular manufacturer's solenoid valves. The solenoid valves use a reed switch assembly and a magnet mounted on the valve stem to actuate open or closed lights on the main control room panels.

Over the years various root cause analyses focused on the switch assembly and maintenance practices for adjusting the reed switches. Modifications to the reed switch bracket and enhancements to the maintenance procedures did improve reliability. However, a significant number of these position indication problems were still occurring.

A Pareto analysis (Fig. 4) of position indication failures by valve model number was conducted over a 10-year period from 1994-2003. Three models were responsible for 75 percent of the problems. Recognizing this permitted a focused comparison that identified the same three models had a relay in the position indication electrical circuit. The other models did not have the relay.

Mock-up testing verified the relay was causing excessive voltage spikes across the reed switch contacts that resulted in electrical arcing. Over time, the condition would result in micro-welding the reed-switch contacts together thus producing a malfunction of the position indication. The solution was to install a low cost varistor for voltage suppression that will eliminate the electrical arcing. The expected savings in maintenance is $68,000.

In both of these examples the Pareto analysis provided a systematic breakdown of work requests to focus on the vital few components that have the highest contribution to plant maintenance. The further breakdown of this data by equipment model number and the cause of the equipment degradation focused available resources on a limited number of applications that required investigation. The investigation of the corrective maintenance procedures, preventive maintenance strategies, and equipment design revealed equipment that was not operating at the optimum maintenance interval.

The Pareto analysis was effective at uncovering the equipment reliability problems. Once the problem is recognized, a solution can be formulated. The systematic application of a Pareto analysis resulted in improved equipment reliability and reduced equipment maintenance.

Daryl R. Gruver is supervisor, component engineering, at the Harris plant of Progress Energy, 5413 Shearon Harris Rd., New Hill, NC 27562; (919)-362-2820

FAN RELIABILITY 2001-2003

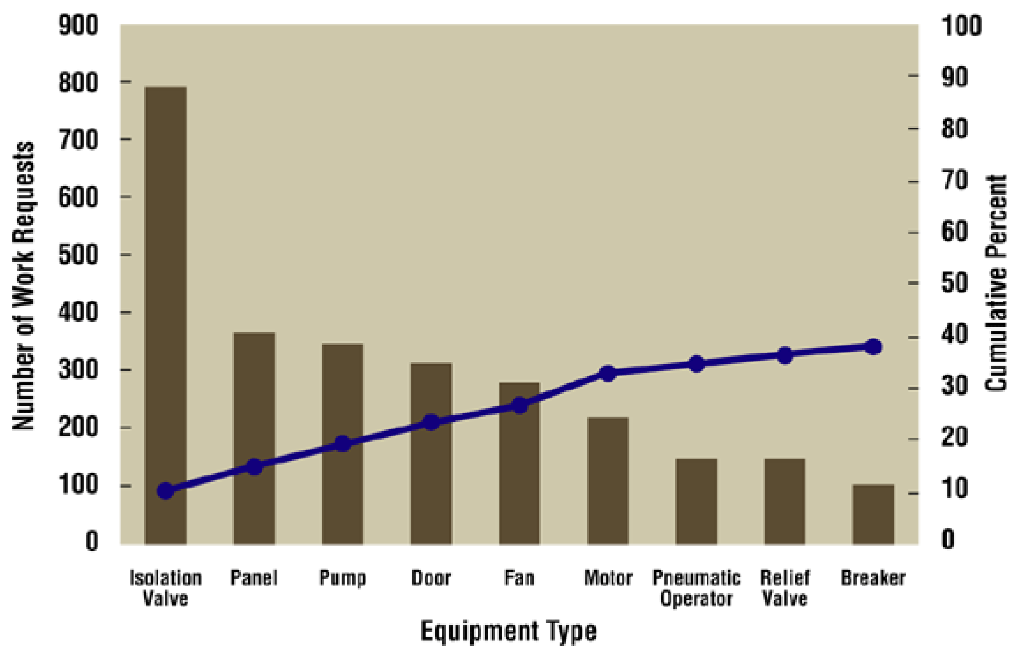

Fig. 1. Breakdown of work requests by equipment type.

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FAN RELIABILITY 2001-2003

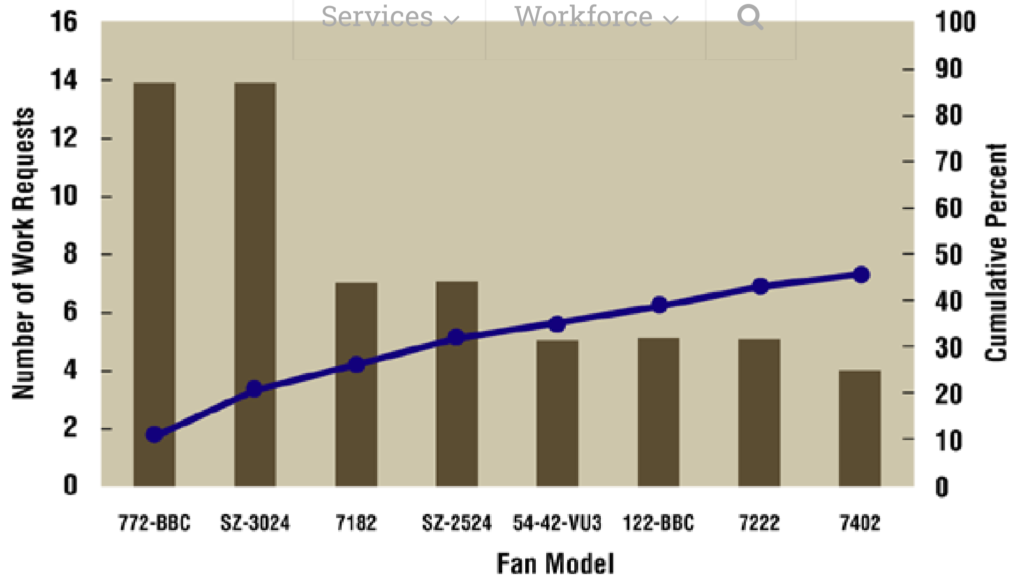

Fig. 2. Breakdown of fan work requests by model number.

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MODEL SZ-3024 WORK REQUEST TRIGGERS

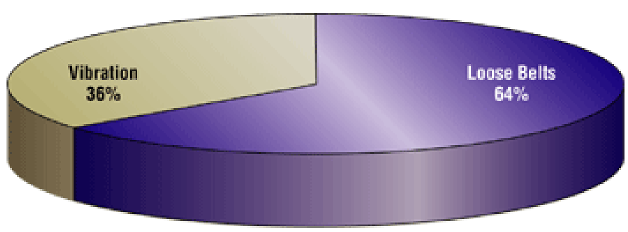

Fig. 3. Breakdown of fan work request triggers for model SZ-3024.

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SOLENOID VALVE RELIABILITY 1994-2003

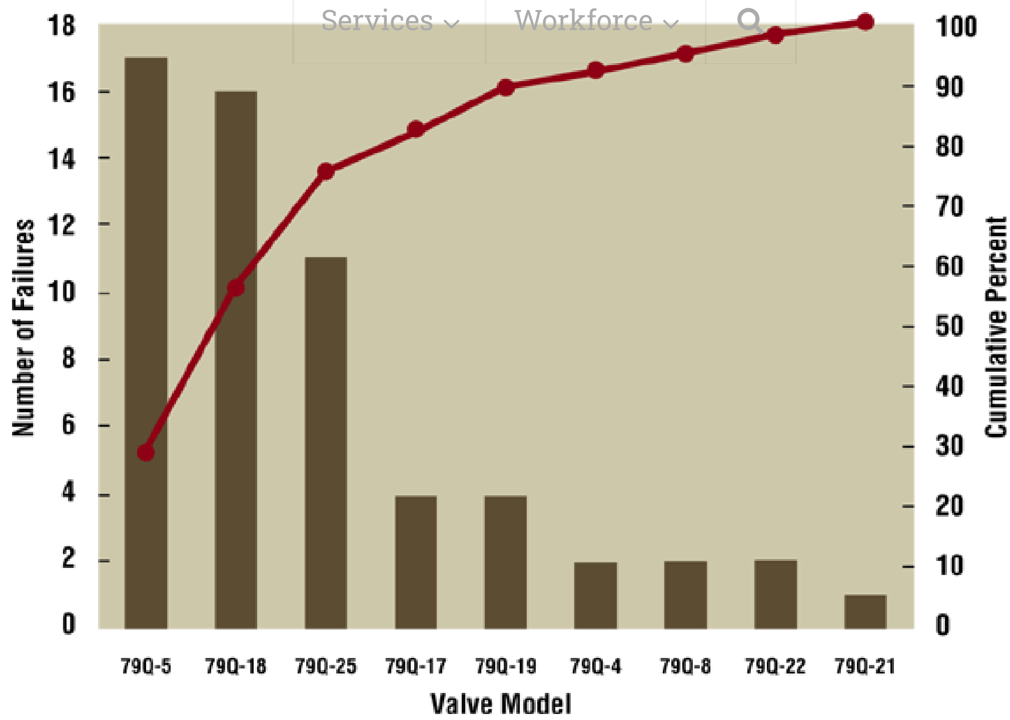

Fig. 4. Breakdown of solenoid valve position indication failures 1994-2003 by model number.

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