# Utilizing Vibration Monitoring as a Planning Tool for a Predictive Maintenance Program

*By Scott Furgerson, Supervisor, Operations Service Department • San Diego Gas & Electric Company*

When San Diego Gas & Electric (SDG&E) company decided to utilize its vibration monitoring program as a planning tool for its predictive maintenance program, we knew three elements would be the key to success:

1. Skilled vibration analysts and engineers
2. Easy to use automated vibration instrumentation
3. Supportive plant managers and maintenance personnel

We have established a vibration monitoring program to trend machine condition. The program was successful in preventing catastrophic failures and reducing our forced outage rate.

We expanded our efforts by starting a predictive maintenance (PM) program. Vibration monitoring is used as a planning tool to determine when machinery should be overhauled, and to ascertain whether equipment can be operated beyond regularly scheduled maintenance shutdowns. When needless machine overhauls can be avoided, there is a significant financial impact from reduced maintenance cost for parts and labor, as well as increased machine availability.

***Fig. 1. The SKF Microlog portable data collector.***

The PM program employs several different techniques for determining machine condition, including lube oil analysis, borescopy, thermography and analysis of maintenance and operating history. But vibration monitoring was considered the single most important tool because it is the most accurate technique for analyzing the condition of rotating machinery. The PM program is utilized at SDG&E's two fossil fuel power plants on turbine generating units and major auxiliary equipment. The Encina Power Plant has five generating units, and the South Bay Power Plant has four generating units. These generating units range from 100 to 320 megawatts.

Auxiliary equipment includes forced draft fans, induced draft fans, gas recirculation fans, boiler feed pumps, condensate pumps, circulating water pumps, service water pumps, water treatment pumps and fuel oil pumps.

These pumps range from 25 HP up to 5 000 HP. Also included in the program are 18 gas turbines (located throughout SDG&E's service territory), reciprocating compressors and gas turbine compressors at two gas transmission stations.

Even though technological advancements in software and hardware make it possible to expand the role of vibration monitoring, we considered personnel to be the most important resource for the PM program. Two vibration analysts and one vibration engineer are employed full-time in the vibration monitoring program. Two other vibration analysts perform vibration monitoring part time in addition to non-destructive testing.

The vibration analysts and engineer brought to the program self motivation and experience in using electronic instrumentation. The vibration analysts had previous experience as electronics technicians in the U.S. Navy. The vibration engineer holds a degree in electrical engineering. These employees have received additional training at SDG&E through in-plant and outside seminars on the use of vibration information for analyzing the mechanical condition of rotating machinery.

Portability, ease of use, reliability and service were the primary criteria in selecting vibration monitoring instrumentation for the program. Based on these criteria, SKF's computer-aided portable monitoring system, consisting of an SKF Microlog portable data collector and software, were selected. The system is IBM compatible.

Previous experience had shown that when instrumentation and software are difficult to learn how to use, the analysts often will not use the equipment, even though it may be a very powerful tool.

The computer-aided portable monitoring system employed by SDG&E was very easy to learn and operate. The software, with pulldown menus and help windows, is practically self explanatory. Even though a manual is supplied with the system, it is not necessary to operate the software.

The portable data collector is used to measure casing vibration and shaft motion in displacement, velocity and acceleration. On a boiler feed pump, for instance, the measurements are taken in three directions, horizontal, vertical and axial at each bearing location throughout the entire equipment train. A typical equipment train consists of a motor, fluid drive (hydraulic coupling) and the pump or fan. Each machine is surveyed every four to five weeks.

The data is then reduced for analysis at SDG&E's vibration laboratory. The formats used for analysis include vibration trends, vibration spectra, Bode plots, polar plots, waterfall and cascade plots, and vector plots. The monitoring system software also prints reports of points in alarm, points overdue for measurement and points missed during a survey.


*Fig. 2. SKF Microlog portable data collector.*

When analysis reveals a potential problem with a machine, the plant maintenance supervisor is notified and the vibration analyst returns to the machine site within a few days to recheck the vibration condition. For example, during a routine survey conducted recently at the South Bay station, the vibration measurements indicated an increase in vibration on a gas recirculation fan.

The software for the computer-aided monitoring system permits the analysts to preset alarm vibration values. When the vibration value is exceeded, the software flags the information. In this case, the vibration amplitude had increases from 1.5 mils to 5 mils over a three week period.

When the fan was rechecked three days later, the vibration had increased to 10 mils. The maintenance supervisor was notified that the machine was operating with relatively high vibration, and it was recommended that the fan be shut down for maintenance.

The support of the plant managers, maintenance supervisors and maintenance personnel has been the key to the program's success. Resistance to recommendations by "corporate" people, who do not have day-to-day involvement with the machinery, is not uncommon in other utilities.

When SDG&E first started the PM program and recommended certain action on a piece of machinery, only some of the recommendations were followed. Now, more than three years later, every recommendation for the last maintenance overhaul was followed. The confidence and support of the plant personnel was gained by providing reliable information that they could trust.

Our vibration analysts and engineer also conduct one-day basic vibration courses for the plant mechanics. Through these courses, mechanics gain a better understanding of how their work can affect the vibration condition, life and operation of the plant's rotating machinery.

The equivalent availability for our generating units has averaged 87.1% over the past five years, due primarily to the cooperative efforts of the plant managers and personnel, the skills of SDG&E's vibration analysts and engineer, and ease in operating the vibration instrumentation (the national average for that same period in the power industry was 77.9%).

Since expanding our efforts by starting the Predictive Maintenance program two years ago, we have saved USD $750 000 in maintenance costs through our ability to continue to safely operate rotating equipment beyond regularly scheduled maintenance overhaul. At the same time, the labor force was reduced 30%, mostly through attrition, without sacrificing equipment availability.

Please contact:

**SKF USA Inc.**
**Condition Monitoring Center – San Diego**
5271 Viewridge Court · San Diego, California 92123 USA
Tel: +1 858-496-3400 · Fax: +1 858 496-3531

**Web: www.skf.com/cm**



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