The CARMAGEN ENGINEERING INC. Report©

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Happy Holidays!

The Carmagen Engineering Report© is published periodically by our staff and presents information and viewpoints on engineering topics relevant to the hydrocarbon processing industry. While the contents of The Carmagen Engineering Report© have been carefully reviewed, Carmagen Engineering, Inc. does not warrant it to be free of errors or omissions. Some back issues are available and may be requested while supplies last.

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We welcome your comments and suggestions for future editions. Please send them to bmesa@carmagen.com.

Unit Integrity Audit - the "Carmagen Engineering" Way

By Sam Zaczepinski

If you are a typical refiner, your process units have likely been modified and/or expanded more than once. In addition, your units are likely operated to different product specifications using much different feedstocks and utilizing newer and more active catalysts. Hopefully, over time, these changes have resulted in significantly improved unit profitability.

You may wonder what else is left to do to squeeze the next increment of profit from your strained facilities. One inexpensive step you can take is to carry out an independent, experience-based, unit audit using industry experts who have participated in such reviews for much of their lengthy careers. Carmagen Engineering offers such experts who have performed similar audits at many locations worldwide.

A typical audit is normally carried out as a joint Carmagen Engineering/refinery team activity. Lasting anywhere from 2-5 weeks (elapsed time) and deploying 1-3 consultants, such audits yield recommendations in the areas of yield and product quality improvements, capacity expansion opportunities, operating cost reductions, and reliability improvements. More specific benefits may be associated with recommendations for catalyst selection and/or replacement, steps to mitigate catalyst contacting deficiencies, process monitoring suggestions, energy conservation opportunities, catalyst/equipment fouling mitigation techniques, and the like.

While the above example targets catalytic process units, the same methodology is applicable to all refinery units. The key to a successful audit is the ability to effectively channel the specialists' know-how into a refinery-specific situation. We believe that, based on their experience, the Carmagen Engineering specialists are uniquely qualified to deliver such service to any refiner interested in extracting added profitability from their plant facilities.

To learn more about this service, please contact Carmagen Engineering or visit our website at http://www.carmagen.com.

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Screening Piping Vibration Problems

By Vincent A. Carucci

To screen vibration problems, answer the following questions: How long has it lasted? How fast is it moving? How loud is it? How much is it moving? The following are some screening guidelines that may be used.

If a component lasts to its endurance limit without failure, it is unlikely to ever fail by fatigue unless conditions change. For example, consider an endurance limit of 10 x 10^6 cycles. At a frequency of 5 Hz, it takes 24 days to reach the endurance limit, at 100 Hz it takes 1.2 days. For equipment that sees only a few cycles a day, the endurance limit will never be reached within the useful life of the equipment.

A useful screening limit for maximum vibration velocity is 2 in./sec. Stress is proportional to velocity for frequencies at or above the first natural frequency.

In some cases the noise level is an indication of a vibration problem. The sound power level inside the pipe can be calculated from a measured level outside the pipe and the calculated pipe transmission loss.

The displacement of the pipe can be checked to determine if the level is dangerous. The stress can then be calculated and compared to fatigue data or the endurance limit (about 3000 psi for steel considering a stress concentration factor of 5). Figure 1 provides general screening criteria for allowable peak-to-peak vibration amplitude as a function of frequency.

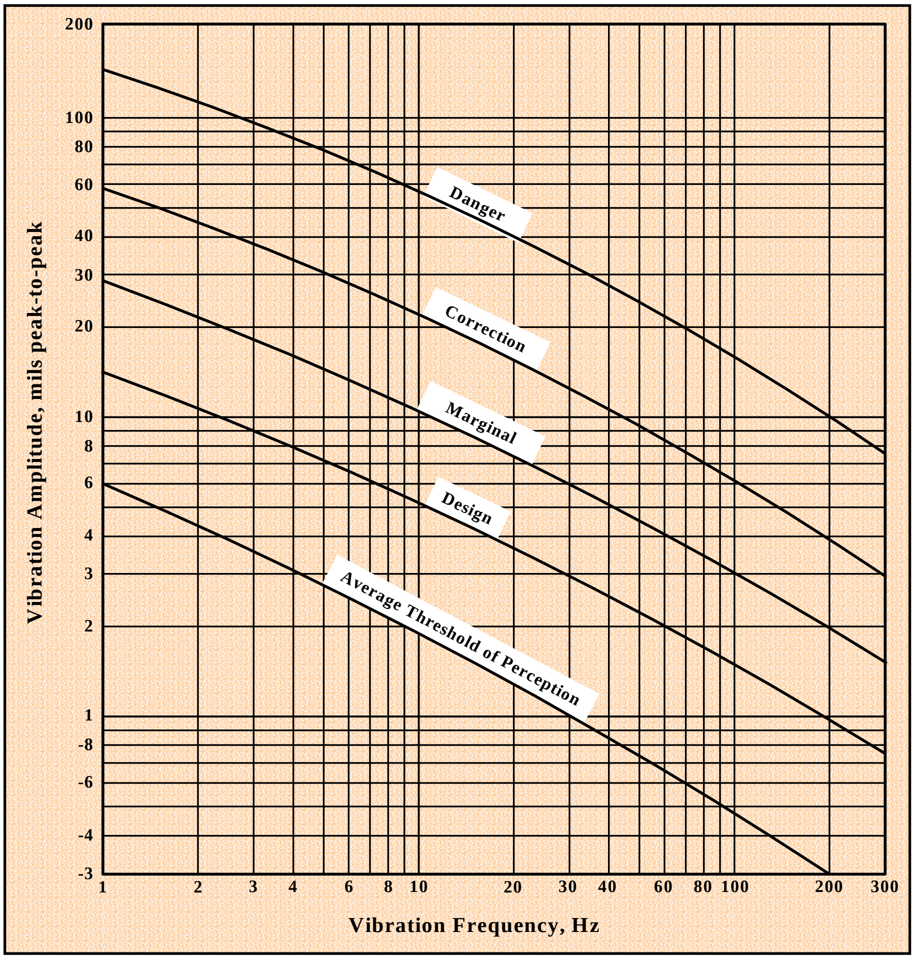


Figure 1 - Allowable Piping Vibration Levels

Carmagen Engineering Broadens Range of Activities

Over the past year, Carmagen Engineering engaged in a number of new or expanded initiatives. Two such activities involve:

- Third Party Technology Developments - support of technical readiness assessments
- Litigation Support - expert witnesses and/or consultants in support of an international arbitration

In all cases, our clients had a number of alternatives available to them. Selection of Carmagen Engineering for those tasks reflects well on our professional staff whose qualifications and industry recognition have tipped the scales in our favor.

More Energy Efficiency Improvement Tips

By Edward Wolfe

The October ***CARMAGEN REPORT*** article "How Much Cash is Going Up In Smoke" gave a few examples of how to improve energy efficiency in a plant. Here are several more.

ELIMINATE USE OF LIVE STEAM FOR DEAERATOR OPERATION

Deaeration is a two step process to remove dissolved oxygen from boiler feedwater. The first step is mechanical deaeration, where live steam heats the boiler makeup water in a pressure vessel to a temperature of 250°F and then strips the oxygen to the atmosphere.

The second treatment step is chemical deaeration of the boiler feedwater by the addition of oxygen scavenging chemicals in the deaerator storage vessel. The chemical treatment assures that there will be no free oxygen in contact with carbon steel. If present, oxygen will form corrosion pits throughout the steam system, causing serious damage.

Several plants have reversed these steps by having the cold boiler makeup water first treated with a vacuum deaerator, then adding an oxygen scavenger chemical, before flowing through heat exchangers where process waste heat is picked up. The potential amount of steam saved is as much as twenty percent of the makeup water flow rate.

REDUCE MAKEUP WATER TREATMENT COSTS

The storage vessel is the terminal collecting point for the boiler feedwater. Knowing all the flows of water and steam to the deaerator is the key to calculating the boiler makeup water requirements. Boiler feedwater consists of the following three flows which are combined in the deaerator storage vessel and then pumped as feedwater to the boiler:

- Returned Steam Condensate From The Plant
- Heating Steam Condensate For The Deaerator
- Boiler Makeup Water

The impurities in the makeup water are diluted by the blending of returned plant steam condensate and the deaerator heating steam condensate.

Doing a heat and material balance around the deaerator storage vessel is the key to determining the amount and quality of the boiler makeup water required for a specific steam system to calculate the amount of heating and stripping steam required to operate the deaerator. The steam tables published by ASME are used. Knowing the amount of the steam condensed for heating the cold water in the operation of the deaerator, plus the amount of returned condensate, will provide the dilution factor for the impurities in the boiler makeup water. This is the result of the blending of both the returned condensate and the deaerator condensate with the makeup water. Knowing the limits of each impurity in the boiler makeup water allows plant operations to control the treatment steps in the most cost effective manner.

Can You Afford Not to Apply R&M Principles On Your Next Capital Project?

By Robert J. Motylenski

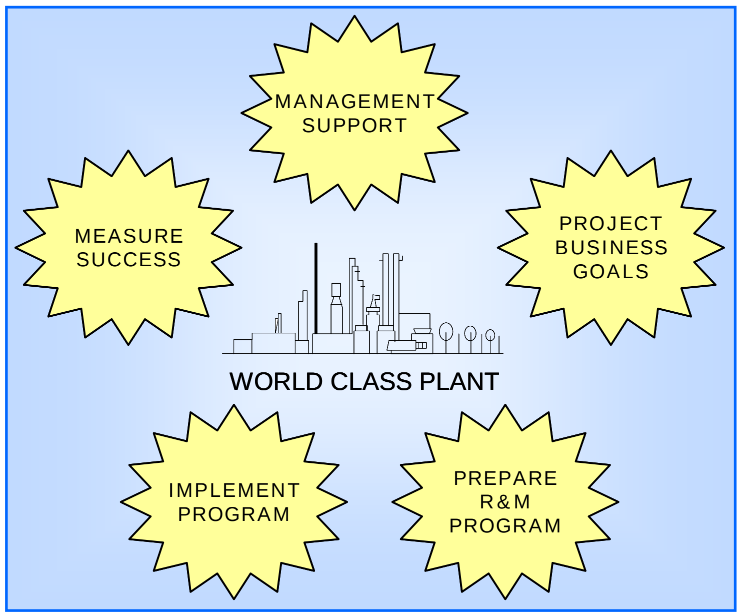
During the past few years, most refineries and chemical plants have concentrated on improving profitability by reining in operating cost, and moving from reactive maintenance to proactive maintenance to equipment management programs, while either sustaining or improving plant availability. With the potential for new investments to meet the increased demand for petroleum products and environmental regulations, companies need to utilize a work process for ensuring that reliability and maintenance (R&M) are considered during project development. This will assure that the new facilities do not jeopardize the profitability gains already achieved and that they will operate reliably and with low maintenance costs. If reliability and maintenance are not considered, the past efforts to better control operating expenses will be jeopardized and plants will have to undertake new initiatives in the future to curb unacceptable operating costs and poor reliability.

A proven work process is available whose prime objective is to ensure that the inherent reliability imparted to the design is compatible with that needed to achieve the required operational availability, meet business objectives, and achieve the planned return on investment. This needs to be accomplished at minimum investment cost and without jeopardizing future plant availability. A second objective is to ensure that the plant will remain competitive with regard to maintenance cost and resource requirements by including equipment maintainability in the work process.

To maximize the benefits from the work process, involvement needs to begin as soon as project screening and early planning are underway. This reduces the potential for cost and schedule impacts from changes made later in project development, since the cost of design changes geometrically increases as a project moves from one phase to the next. Another reason for implementing the work process during screening is that about 95% of the life cycle cost of a project is established upon completion of detailed engineering, and any changes that are required after the design is finalized will impact schedule and cost.

The key aspects of the work process are:

- Secure **Management Support** to implement the process (i.e., adequate resources and funding).
- Define the **Project R&M goals** compatible with the project business goals.
- Define an **R&M Program** that defines the activities that occur during the screening, planning, and engineering phases to ensure R&M is considered during project development.



- **Implement** the planned activities. To ensure consistent implementation, use checklists for various reviews.
- **Measure Success** to ascertain that the project has achieved the overall R&M goals.

Many people believe that by focusing on reliability, project cost will escalate. That is not necessarily true. Additional engineering effort will be required in most cases, but the overall life cycle cost will be reduced, resulting in improved profitability. As an example of success, a grassroots refinery consciously made an additional capital investment of 5 to 10% for improved reliability and

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better maintainability. The results over a 15-year period were an average reduction of 36% in maintenance cost and a 29% reduction in unplanned downtime. Other examples available show that additional upfront engineering effort results in higher plant reliability and lower maintenance cost. The project front-end loading (FEL) process being implemented by many companies also necessitates the need to work R&M early in a project.

If you are interested, here is how Carmagen Engineering can help:

- Review and explain the work process and help the R&M stakeholders prepare an implementation plan.
- Assist in developing the Project R&M Goals based on defined project business objectives.
- Work with R&M stakeholders in preparing an R&M Program for the project that supports the Project R&M Goals.
- Assist in identifying critical equipment and systems that need individual R&M objectives.
- Participate in key reliability and maintainability reviews.
- Help develop a plan for preparing equipment management plans.
- Assist in developing a program for ensuring the R&M objectives are achieved.

Hot Bolting for Flange Leakage Control

By Vincent A. Carucci

Hot bolting refers to tightening a flange while it is in service. It is used to stop small stable leaks or as a preventive measure in high temperature or cyclic services. "High temperature" in this case may be defined as over 800°F (427°C). A cyclic service is one where the operating temperature changes by more than 300°F (149°C) in less than 30 minutes.

Most flanges that are assembled and bolted using appropriate procedures should never need to be hot bolted. Most locations do not routinely hot bolt flanges that are not leaking. However, scheduled hot bolting can be used to improve the reliability of certain troublesome joints if experience has shown that leaks occur with time or process upsets.

On many occasions, the writer has recommended and successfully used hot bolting as a preventive measure during the startup and initial operation of new process units. In these cases, construction scaffolding was installed before startup in order to provide ready access to the flanges of interest (i.e., the ones in high temperature or cyclic services).

Hot bolting should only be considered if it can be done safely. Each case must be reviewed by local safety and engineering personnel before attempting to retighten a flange on-line. The following are some considerations that must be addressed:

- Stability of the leak
- Effect of tightening on leak stability
- Personnel exposure to leaking material
- Personnel access and egress
- Need for process operating changes or additional process controls
- Suitability of tools
- Contingency plans, including considering the possibility of a fire
- Qualification of the boltup crew

Ideally, hot bolting should be done using the same method as was used for the initial flange boltup (i.e., hammer and wrench, torque wrench, stud tensioner, etc.). However, in the case of tensioning, this cannot be done above 250°F (121°C) due to the typical temperature limits of the seal materials used in the tensioning head construction. Since most hot bolting is required on flanges that operate at well over that temperature, it will normally be done with torque wrenches.

CEI Work Highlights

- Working with a major European refiner to develop Reliability and Maintenance programs and procedures that will help them achieve 1st Quartile performance.
- Completed an operations reliability and maintenance audit for another major European refiner. The goal of this audit was to identify the most promising areas where changes will have the most impact.
- Provided Mechanical Engineering support, including finite element analysis, pressure vessel, piping and tankage design review/analysis, to supplement the staff of a major engineering organization.
- Carried out a study for replacing or restoring a furnace air pre-heater for a large refinery in the United States.
- Provided Electric Power Engineering consulting to a client that had damage that occurred during the installation of a 66 KV power cable at a methanol plant in the Caribbean.
- Carried out a technical bid review for the supply of a new boiler system for a client in the Middle East.
- Reviewed the requirements for secondary containment and cathodic protection systems to be included in an engineering standard for a domestic client.
- Conducted a review of the causes for an oil transfer pump failure at a terminal in the United States.
- Completed an evaluation of a prototype piece of equipment from a materials and equipment operational point of view for a Canadian client.
- Witnessed the acceptance tests for a fired heater burner to be installed at a Canadian refinery to assure that the burner complied with the conditions of the project specification.
- Facilitating the work of a bid review team assessing a major refinery maintenance contract for a client in the Far East.
- Carrying out a Cold Eyes Review (CER) of a gap/ risk assessment recently conducted for the electric utility portion of a large domestic refinery.
- Assisted a European client in a technology selection decision involving the FCC Naphtha Desulfurization process technology.
- Provided client assistance in a technology selection for a Tail Gas Treating unit. Both technology attributes and revamp implications were considered.
- Participated in a number of HAZOP reviews for US and European-based refiners.
- Performed a number of equipment-layout oriented consulting services for refiners in the USA, Europe, and Far East.
- In support of another consulting company, provided an assessment of soil remediation costs for a port facility in Africa.
- Assisted a US-based client in an evaluation of a specific Wet Gas Scrubbing technology.
- Continued to provide long-term onsite support for a major European refiner. The support ranges from operations support through troubleshooting to individual project responsibilities.
- Assisting a client in an independent proprietary technology assessment.
- Continuing to provide expert witness support (process and metallurgy) in an ongoing formal arbitration in India.
- Continuing to support a third-party development of a novel fluid solids process.
- Providing fractionation and gas treating support for a major upstream project in the Middle East.
- Providing expert environmental expertise in support of ongoing formal legal proceedings involving a major refiner.