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Partnering in Engineering Excellence

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It's in Refiners' Interest to Train New Blending Engineers Fast

By Ara Barsamian

Introduction

With crude oil priced at over $75/Bbl and gasoline selling at over $3 a gallon in the US, refiners are running at breakneck rates to take advantage of the current high profit margins. This stress has an impact on reliability and availability of gasoline blending production facilities and the process units that supply the blend components rundowns.

On the other hand, current refinery personnel rotation practices move people in and out about every two years; just about the time people get proficient, they get rotated to another job. This leads to costly mistakes, particularly in blending. How do you minimize the impact of typical blending mistakes such as bad recipes, poor knowledge of blend component properties, and temperamental blending equipment? By providing a reasonable, realistic, fast-track training program. Described below is a fast-track training program for a blending engineer. But the same approach can be applied to training blending operators and all other areas that are involved in blending, either directly or indirectly (e.g., planning and economics, lab, process control, analyzers, I & E, maintenance, etc.).

Example Fast-Track Training Program for a Blending Engineer

The purpose of this training program is to make a new blending engineer productive in the shortest amount of time. The program can be scheduled to be completed in approximately four weeks.

At the end of the training program, the new blending engineer will be able to:

- Calculate blend recipes
- Prepare blend schedules
- Create blending work orders
- Correct off-spec blends
- Assess blend performance to reduce giveaway, re-blends, and other problems
- Do blend audits (e.g., plan vs. actual, root-cause analysis)
- Assess and incorporate new blend components

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- Assess and incorporate new specifications
- Provide input to refinery planning LP teams for improved planning
- Assess blending equipment suitability and reliability

A typical training program consists of six components as described below.

1. **Overview of Blending: approximately three days of classroom training provided by current blending engineer**

Explanation of what blending is, component and finished product tank allocations, calculations of blend recipes, product specifications (including ethanol blending), preparation of blend schedules and blend work orders, steps in starting, monitoring, and ending a blend, and taking samples to the lab for "certifying" a tank.

2. **Blending Operations: approximately one week on-the-job training by offsites blending operator**

Work side by side with field blending operators to do tank lineups, open/close valves, start and stop pumps, pump components according to the blend engineer's recipe, use of tank gauging to measure component volumes transferred, use of mixers or pumps to circulate a tank, settling a tank, injecting dyes and additives, pumping product to the jetty, taking line samples to the lab, taking blend tank samples to the lab, getting results from the lab, write blending operator logs and reports.

3. **Lab Testing of Blend Samples: approximately one week on-the-job training by a lab technician handling blend samples**

Work side by side with lab personnel. Learn about ASTM test methods for gasoline samples, the accuracy/precision of the measurements, participate in the reception of blend line or tank samples, participate in the measurement of octanes with CFR knock engines – from engine warm-up to actual measurement, measurement of RVP/DVPE and precautions in avoiding loss of light ends, measurements of D86 distillations, measurements of aromatics, benzene, olefins, oxygenates, density, recording of the information, entering data into LIMS, reporting back to blending people.

4. **Refinery LP Planning: approximately two days on-the-job training by a refinery planner**

Use latest refinery planning LP report to illustrate the following:

- Annual business plan, including monthly production of blend components and finished gasoline, by grade
- Purchased components, schedules, and pricing
- Expected additional blend components from new process units
- Blend component (shadow) prices and product selling prices
- Specification blending recipes (average monthly recipes, by grade)
- Expected new product grades and specifications

5. **Instrumentation Department: approximately three days**

Learn about DCS control system, field blending equipment [e.g., flowmeters, control valves, inline mixers, booster pumps, on-line analyzers, fast sample loop, sample conditioning system, protofuels system, remote controlled motor operated valves (MOV) and pumps].

6. **Blending Console Inside Control Room: approximately two days by Offsites Supervisor**

Learn about the use of tank gauging system to determine tank inventory, the amount of component or product transfers, communications with field operators doing field equipment lineups, starting/stopping pumps, opening/closing valves, handling of blends and logging information, communications with blending engineer about blend problems and corrections, and communications with jetty about marine loading/unloading.

Closing Comments

Considering that a refinery may blend 50,000 to 150,000 Bbls/day of gasoline, and that current margins are in the $10 to $25 range (depending on the region and location), we are talking about billions of dollars per year in cash flow. Reasonable training is a small price to pay for capturing these margins while they last (which might be quite a while, considering that oil consumption far outweighs new oil discoveries). But regardless of the generally quoted margins, having properly trained blending engineers will maximize each refinery's individual margin.

Ara Barsamian has over 31 years of experience in blending (crude, mogas, distillate, fuel oil, lubes), oil movements & storage (OM&S), crude handling logistics, refinery tank farm sizing studies, refinery supply chain management, NIR analyzers, and master plan/automation benefits studies for major process plants and hydrocarbon storage facilities. Please contact Jerry Lacatena if you'd like more information on Carmagen's expertise in this area.

OSHA Announces Increased Emphasis on Petroleum Refineries

By Vincent A. Carucci

On June 12, 2007, the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) announced a directive implementing a National Emphasis Program to help eliminate workplace hazards associated with the release of highly hazardous chemicals at petroleum refineries. This directive (CPL 03-00-004) was prompted by the "large number of fatal or catastrophic incidents in the refining industry" in the US. Based on OSHA statistics compiled since 1992, "no other industry sector has had as many fatal or catastrophic incidents related to the release of highly hazardous chemicals as the petroleum refining industry." Based on the announcement, over the next two years, OSHA will conduct approximately 81 refinery inspections. These are in addition to other regional and state enforcement projects already underway. The news release and details of this new emphasis program are on the OSHA web site at www.osha.gov/Osh Doc/Directive_pdf/CPL_03-00-004.pdf.

The following highlights items covered in this directive:

- Site Selection
- Site- Specific Targeting and Unprogrammed Inspections
- Inspection Resources (i.e., an OSHA inspection "team")
- Inspection Process
  - Document review
  - Employee interviews
  - Verification that documented procedures are actually implemented.
- Inspection Procedures
  - Opening conference
  - Document requests
  - PSM review
  - Use of personal protective equipment and camera/video
  - Initial walkaround inspection
  - Selection of unit(s) for more detailed reviews
- Inspection of Contractors
- Compliance Guidelines
- Citations

The directive lists the required documentation, areas that will be reviewed, and the types of information requested. Reviewing this well in advance of the inspections would be a good idea to help avoid possible difficulties later. While this directive only applies to refineries in the U.S., the information contained in it provides excellent guidance for refineries located anywhere.

Vincent Carucci, President of Carmagen Engineering, Inc. also provides mechanical engineering expertise in the areas of pressure vessels, heat exchangers, piping systems, and storage tanks to the process and power industries, insurance companies, and attorneys.

Article 1: Reduce Your Maintenance Costs With Fitness-For-Service (FFS) Assessments

By Stephen J. Gliebe, P.E.

What Is An FFS Assessment?

FFS assessments are quantitative engineering evaluations that are performed to demonstrate the structural integrity of in-service equipment that contain flaws or are otherwise damaged. They may be used in conjunction with a plant's Risk Based Inspection (RBI) and Risk Based Maintenance Programs to enhance their effectiveness.

FFS assessment techniques have been around for a long time. The procedures used to perform FFS assessments were formalized in the First Edition of API Recommended Practice 579, *Fitness-For-Service,* released in January 2000. API RP 579 provides a common general approach that uses the assessment levels described below. It also provides specific component assessment procedures that are appropriate for particular degradation or damage mechanisms (e.g., general or local metal loss, brittle fracture, pitting, fire damage, deformation and cracks).

Since each of these mechanisms requires a different assessment methodology, I have decided to write a series of articles on how FFS techniques may be applied for several of the most commonly seen mechanisms. The articles will focus on Level 1 and Level 2 assessments since they are sufficient to establish that the equipment is suitable for continued service in most cases.

Assessment Levels

Each damage mechanism included in API RP 579 may be evaluated using three possible assessment levels.

- Level 1 is the most conservative level. It can generally be performed by plant inspectors and engineers.
- Level 2 is more detailed and precise than Level 1. It is typically conducted by plant engineers or engineering specialists with FFS experience.
- Level 3 is the most detailed level. It often employs finite element methods and is primarily intended for use by engineering specialists knowledgeable in FFS. Note that a Level 3 assessment is not required in most situations, and it requires more data and more time to conduct.

Can FFS Assessments Reduce Your Maintenance Costs?

Did a recent inspection find general, local or pitting corrosion in excess of the corrosion allowance on a vessel component? Will the component thickness be less than the minimum required thickness before the next scheduled maintenance opportunity? Are the flaws found unacceptable for continued service according to API 510, *Pressure Vessel Inspection Code*, guidelines? If you answered yes to any of these questions, a FFS assessment should be considered since it may justify continued service without a costly shutdown or repair.

General Metal Loss

This first in a series of FFS articles will focus on general metal loss. General metal loss (GML) is defined as relatively uniform thinning over a significant area of the equipment, or an area of metal loss that greatly exceeds its depth. An FFS assessment for GML would typically be considered when the remaining thickness is below the minimum required thickness. Since the minimum required thickness is not always known for all equipment components, some plants use metal loss in excess of the corrosion allowance to trigger a discussion on applying FFS techniques. Or sometimes, repairs may be recommended whenever there is metal loss in excess of the corrosion allowance. This second approach may be overly conservative. Section 4 of API RP 579 provides additional guidance for performing Level 1 FFS assessments for GML.

GML Level 1 Limitations

GML Level 1 assessments are permitted only if certain conditions are satisfied. The complete list of limitations in Section 4 of API RP 579 should be reviewed before proceeding with a GML Level 1 FFS assessment. Some of the limitations are:

- The original design criteria must be in accordance with a recognized code or standard (e.g., ASME Code Section VIII or ASME B31.3).

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- The component must have a design equation that specifically relates pressure (or liquid fill height for tanks) and/or other loads, as applicable, to a required wall thickness (e.g., pressure vessel cylinder or storage tank).
- The component must be subjected to internal or external pressure loads only. Supplemental loads that would affect the component's minimum required thickness are negligible.

GML Level 1 Methodology

A Level 1 GML assessment may be performed using individual point thickness readings or thickness profiles. Point thickness readings would be used if there are no significant differences among the values obtained at the inspection monitoring locations. Thickness profiles (i.e., thickness readings on a prescribed grid) are required if there is too much variation in the point thickness readings. Guidance on grid spacing is provided in API RP 579.

The accuracy of the FFS assessment is a function of the inspection data quality. Any uncertainties in the measurement data should be considered when performing an assessment. Below is a summary of a Level 1 GML assessment methodology using individual point thickness readings.

Point Thickness GML Level 1 Assessment Summary:

- Review the inspection history of the equipment.
- Calculate the required minimum thickness.
- Obtain point thickness readings in the thin areas.
- Calculate the coefficient of variation (COV). If the COV ≤ 10%, the use of point thickness data is acceptable. Section 4 of API RP 579 provides a template for the calculation of the COV.
- Determine the minimum measured metal thickness.
- Specify the Future Corrosion Allowance (FCA). The FCA is the amount of metal loss anticipated before the next scheduled inspection.
- Compute the remaining thickness ratio. The remaining thickness ratio, R_t, is based on the minimum measured thickness, the FCA, and the minimum required thickness as noted below. It is one of the inputs needed to establish the length over which the thickness data may be averaged.

$$R_t = \frac{t_{min\_measured} - FCA}{t_{min\_required}}$$

- Compute the maximum length that may be used for thickness averaging. API RP 579 permits averaging thickness readings in lieu of the more conservative approach that uses the minimum measured thickness in the corroded area when assessing the component's fitness for service. See API RP 579 for additional information.
- Determine the axial and circumferential extent of the flaws using the tables and equations in API RP 579 Section 4.
- Measure the distance from a major structural discontinuity to the thinned area (e.g., nozzle, skirt).
- Compare the calculations for the remaining thickness ratio, minimum measured thickness minus the FCA, circumferential extent of the flaw, and the distance from a major structural discontinuity, to the API RP 579 acceptance criteria.
- If the flaw is acceptable, develop an inspection strategy for the equipment.
- If the flaw is unacceptable:
  - Repair the flaw, rerate or replace the component, or
  - Lower the FCA (e.g., by reducing the inspection interval or mitigating the corrosion), or
  - Conduct a Level 2 FFS assessment

Article 2:

Article 2 in this series will cover API RP 579 General Metal Loss Level 2 assessments.

Steve Gliebe is a Professional Engineer with 30 years experience in the refining and chemical industries. He is well-versed in both engineering and supervision including hands-on experience managing maintenance and capital projects, training union and management colleagues, supervising maintenance/inspection organizations, developing programs for preventative maintenance of fixed equipment and piping per industry standards, and performing root-cause analyses to improve equipment reliability. Please contact Vince Carucci if you'd like more information on Carmagen's expertise in this area.

- Presented a one-day, piping system design training course for a major, US refining company. This course provided an overview of both the mechanical and hydraulic design aspects of refinery piping systems and is a key part of this company's corporate training program. Also presented a one-day heat exchanger design course for the same company.
- Continued to provide significant project management and cost engineering consulting support for multiple clients in the US and overseas.
- Continued to provide welding, materials, and process engineering litigation consulting support for multiple major cases.
- Conducted a reliability and maintenance audit at a European plant location for a major international pharmaceutical company. A number of improvement opportunities were identified that will enhance system reliability.
- Conducted a one-week, scope review of a refinery-wide turnaround (T/A) to be conducted in Spring 2008 at a major refinery in Europe. Based on a review 130 of 840 work list items having an estimated cost of 6.7 M Euros, potential savings of 1.5 M Euros were identified. Also identified were significant T/A scheduling and organizational issues that should be addressed in order to achieve the desired objectives in a cost-effective manner.
- Issued a report that provides recommendations to help determine appropriate criteria for determining the type of repair or replacement strategy to be used for the bottoms of aboveground atmospheric storage tanks [e.g., nothing, partial repair, replace in-kind, or upgrade (such as internal lining, cathodic protection system, double-bottom, etc.)]. This report was part of a two-year program to make significant improvements in the maintenance and reliability of aboveground atmospheric storage tanks at a major refinery in Europe.
- Carried out FCC as well as Coker CO Boiler reliability and performance assessments including material evaluation, that resulted in a series of recommendations for an East Coast refiner.
- After review of four (4) critical heater designs and operations, the scope of work for this West-European client was expanded to cover design and operations review of seven (7) more heaters. Based on the evaluation of the current operating conditions, certain areas of operation were identified as not being consistent with safe or reliable operation. In addition, the client had requested general comments related to the coil metallurgy used in each of the seven (7) heaters included in this phase of study.
- Significant refractory failures in a Claus type Sulfur Plant reactor forced a unit shutdown and corresponding reduction in the refinery throughput at a Caribbean refinery. Onsite refractory engineering assistance was provided on an emergency basis to develop refractory repair recommendations to enable bringing the unit back on-stream as soon as possible. The refinery anticipated similar problems in other parallel trains and will plan to take corrective measures in a timely fashion based on lessons learned during this activity.
- Numerous FCC unit refractory problems were attended to for a major domestic refiner with multiple refineries throughout this summer. These activities had to do with attending to emergency shutdowns caused by refractory problems as well as turnaround planning for FCC units after a busy summer.
- Positive Material Identification (PMI) Manuals were developed for a West Coast refiner. The PMI Manual describes the procedures and methods to be employed for positive identification of the material supplied by the manufacturer (of the pressure vessel, for example) for consistency with what was specified in the purchase order. Also, corrosion mitigation manuals were developed for key process units at the same location.
- Provided long term resident engineering support (on a long term assignment basis) in the areas of cost estimation, procurement and construction management to a major grassroots petrochemical undertaking in the Far East.
- Concluded Phase 2 of a major Risk Based Inspection (RBI) assessment activity for a major chemical plant that resulted in significant manpower and cost savings for the client. The work on Phase 3 kicked off simultaneously.
- The Materials Requisitions documents prepared by multiple EPC contractors for machinery and air cooler equipment were reviewed for comments on potential omissions of significant requirements from the specifications for a European refiner's major upgrading project. Related to the same project, a separate Fitness for Service (FFS) evaluation project kicked off.

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- Assisted a major European refiner with a performance test of the crude heater in the atmospheric distillation unit. The test and subsequent evaluation saved significant potential investment in heater upgrade work that was deemed necessary for the expanded operating range.
- The Construction Site Crane Safety course material was updated for a major oil company. For the same client, a separate project to update the corresponding safety manuals was kicked off simultaneously.
- For a Canadian refiner, confronted with the evaluation of the local research council's newly developed NOx regulations, an assessment of the current applicable US regulations and requirements for equipment the client is planning to install was provided. This helped the refiner to keep the research council's expectations within reasonable limits.
- Providing plot layout support for domestic and international refiners.
- Performing strategic reliability initiatives for an international refiner, including the vacuum units, visbreaker, hydrocrackers and hydrotreaters, and H_2 management system.
- Providing on-going fractionation specialist support to a major refiner.
- Developing LOPA standards for a domestic refiner.
- Performing expanded scope of an Energy Management Study for two Crude Distillation units for a major Gulf Coast refiner.
- Providing process design support in a major technology provider's offices.
- Provided extended lube hydrotreating pilot plant support services.
- Providing technical support to a major domestic client for Biomass process development for ethanol production, and CO_2 removal technology evaluation.
- Completed Encon optimization support for a first commercial plant of a novel polymer technology.
- Providing global training course development support covering safety, offsites, and storage tank design areas for a major refiner.
- Providing technical litigation support in analytical chemistry, process and metallurgical areas to defend major refiner in class action suit.
- Providing technical support to provide design packages at two major refineries to design multi-hole orifice and slide valve specs in the FCC flue gas system, and improve mechanical reliability. Also, reviewed CFD and FEA models.
- Completed refinery and offsite tankage planning assistance to a contractor relocating refinery units overseas.
- Performing PIMS modeling and refinery planning support.
- Providing technical litigation support associated with safety issues related to a refinery explosion.
- Providing technical Mogas blending consultation to seven domestic refineries regarding optimization, equipment and controls assessment, and certification.
- Providing process and mechanical technical support to refiner and contractor for selected FCC regenerator internals, J-bends, and standpipes in detail design phase.
- Completed work on assessment of risk and recommended procedures for processing mustard ton containers, which contain (or could contain) hydrogen in the vapor space.
- Providing process support for evaluation of various aspects of "oil sands" processing scheme feasibility and review of vacuum heater performance/transfer line pressure profile.
- Performing noise consultation and prep of front end design of jet line noise reduction package.
- Performing HAZOP support at multiple locations for a domestic refiner.