PROJECT TO OPERATION – CHALLENGES TO INSTITUTING A SUCCESSFUL INTEGRITY MANAGEMENT PLAN

A.I. (Sandy) Williamson, P.Eng.
Ammonite Corrosion Eng. Inc.
Calgary, Alberta, Canada

PROJECT TO OPERATION – CHALLENGES TO INSTITUTING A SUCCESSFUL INTEGRITY MANAGEMENT PLAN

A.I. (Sandy) Williamson, P.Eng.
Ammonite Corrosion Eng. Inc.
234, 5149 Country Hills Blvd. NW,
Calgary, Alberta, Canada T3A 5K8
e-mail: ammonite.corrosion@telusplanet.net

ABSTRACT

Any successful Integrity Management Plan (IMP) has its roots formed during the project phase. Quality assurance through diligent and professional inspection during engineering project construction is required in order to provide accuracy of the necessary records and drawings that will be used by the IMP. Support for the IMP by senior project management and owner company management must be evident throughout design and construction in order to gain commitments from the different disciplines within the project team. As the project progresses to the operations phase, a clear understanding of the roles of Operations, Maintenance, and Engineering must be outlined and agreed upon. Failure to achieve the cooperation of these teams inevitably leads to costly mistakes. This paper uses examples from various oil and gas projects, both onshore and offshore to illustrate the above points.

INTRODUCTION

As a project moves through the various phases of design, construction, start-up, and finally to full-time operation, there are several factors that define the ultimate success of the project. The economic benefits of the project are the first to be examined, followed by impact to the environment, safety of workers and the community, and finally the integrity of the equipment and operation. While it is necessary for a project to be profitable in order for it to proceed, it should also be necessary for the project's profitability to include a thorough assessment of safety, environmental, and integrity factors. Nowadays, safety and environmental impact studies are conducted during the conceptual phase of the project, however a critical assessment of the integrity issues and their subsequent impact on cost, safety and environment is not always completed until the later stages of a project. Giving integrity issues a low priority can have costly consequences down the road.

Integrity Management Program

A typical IMP for an oil and gas facility is shown in Figure 1. An effective IMP must take all potential threats (failure modes) into account.[1] This information is gained through industry experience. Specific project information such as quality assurance/quality control records, operating guidelines, and process flow drawings are also used to provide input into a corrosion manual for the facility. The process is then divided into corrosion circuits, which are areas of like failure mode(s). Within these corrosion circuits, the consequence of failure is assessed and used in conjunction with the probability of failure to arrive at a criticality rating. The criticality rating is used to determine the frequency of inspection (onstream and offstream). Corrosion monitoring and inspection programs are also defined within each corrosion circuit. Inspection information gathered from the onstream inspection program and turnarounds is used in conjunction with corrosion monitoring information to continually improve the corrosion manual and hence the overall IMP.

This paper examines many of the problems and challenges encountered during the design, construction, start-up, and operation phases that need to be addressed in order not to jeopardize the IMP and ultimately the economic success of the project.

DESIGN PHASE

As the design team is assembled for a project, it is important to identify the resources required for properly identifying the materials, corrosion, and inspection issues that arise. The project's management team should then be prepared to budget for these resources early in the project design. A seasoned corrosion engineer, preferably with operations background can properly assess the impact of alternate materials on the integrity of the equipment throughout its operational life.

It is also important early on in the design phase to gain the project management's and in turn the owner company management's commitment to the method to which alternate project designs will be evaluated. It is commonplace during the design phase to debate the economics of the project design on a lowest capital cost basis vs. lowest life-cycle cost basis. While most project management will say that they are using a life-cycle cost approach rather than capital cost approach, the real issue is whether the project costs are low enough to gain approval or sanction from the owner company. With the large budgets associated with some projects, it is often easier to explain cost overruns after the project has been sanctioned.

The corrosion engineer is therefore constantly challenged with building a piece of equipment from lower cost materials in order to save capital cost (e.g. carbon steel vs. corrosion-resistant alloy), yet ensuring that the lower cost material can survive the operational lifetime of the project. It is easy for a design engineer to appear to save money for the project by choosing a cheaper material, however, the corrosion engineer can identify the associated inspection/maintenance/replacement costs with the alternate material design i.e. life-cycle cost. By looking at the life-cycle cost picture, project management and the owner companies can make a more informed decision as to whether or not the project has economic benefit. NACE International provides a number of these economic guidelines and approaches in "Economics of Corrosion". [2]

It is sometimes necessary during project design to test different materials, coatings, or chemical treatment programs for their application to the design. The corrosion engineer can help to identify testing requirements, oversee the actual test program, and verify the results. Again, there should be adequate money in the budget to conduct these test programs.

It is important to consider the corrosion monitoring program as well as the onstream/offstream inspection program during the design phase. Allowances such as access fittings, instrumentation and computer requirements, and clerical support for these programs need to be included. There is often reluctance on the project's side to allow a lot of money to be spent on these items, however, they end up being a critical part of the IMP during operation and must be functional at the start of operation.

Once the materials of construction have been identified, the task of specification writing begins. The corrosion engineer plays an important role in ensuring that not only the right materials are identified on various drawings, but also that suitable quality control procedures are written for the various components of the design. This aspect is particularly important in the area of coatings, where surface preparation and correct application are critical to the successful performance of the coating system.

During the latter stages of the design phase, there is usually a project challenge exercise often called "value engineering". This is a critical step in the project as the design gets scrutinized for potential cost savings. Key specialist personnel, such as the corrosion/materials engineer who came up with the original design concept and rationale must be retained during this exercise to ensure that the integrity of the facility is not compromised.

CONSTRUCTION PHASE

Having good design specifications and quality control procedures are important for facilitating the construction phase of the project. In addition, there are a number of areas that can affect the IMP during the construction phase.

The most prominent area that affects the integrity of the facilities is the reluctance of project management to adequately budget quality assurance inspectors and clerical support staff. In this day, one can take some comfort in the progress that programs such as API Q1 and ISO 9001 have made in qualifying fabrication shops, however, there are still a number of issues surrounding these programs.

The best way to ensure that equipment meets project specifications is to use project or third-party inspection. Inspectors should have appropriate industry recognized credentials such as NACE, ISO, API, etc. At the beginning of fabrication, a kick-off meeting is held with representatives present from the fabrication shop, project, and project or third-party inspection. The schedule is reviewed and any specification clarifications are discussed. Once fabrication begins, the inspector needs to gain assurance that the fabrication shop is following proper procedures. The inspector stays at the shop as long as there are issues to be resolved. Ideally, the inspector should make one visit for the kick-off meeting and one for the factory acceptance test.

Again, one of the areas that often gets overlooked is coating. Whether the piece of equipment is large or small, the coating specification needs to be enforced. Problems with poor coating application often take some time to show up, usually after the warranty period has run out. The results, however can be very expensive. Using a qualified coating inspector will help to ensure that surface preparation is carried out properly, environmental conditions for painting are proper, and that the application specification is met.

The other issue with coating is that it often takes place during the last part of the fabrication schedule. When delivery schedules become tight, shortcuts are often taken. The onus is on project management to allow for sufficient time in the project schedule in order to avoid this. Using a qualified coating inspector from the start of the job will often help to expedite the job.

The various fabrication shops and facilities should take baseline inspection readings and observations as this is the easiest time to take these readings. The readings should be supplied to the project in electronic format to allow for easy downloading into the inspection database. Ideally project inspection personnel should witness these readings. Once the project enters the start-up phase, manpower restrictions, particularly for offshore projects where there are accommodation restrictions, will severely hamper gathering of this information.

Finally, documentation requirements must not be overlooked. A successful IMP relies heavily on accurate, as-built drawings with attention to material and coating specifications used. The project should have enough draftspeople and clerical support to organize these drawings and the various vendor specifications into a system that can be readily accessed. The inspection database program then needs to be populated with the baseline inspection readings.

START-UP PHASE

The start-up phase of the project should be a relatively “quiet” phase from an integrity management standpoint, provided that the integrity issues have been addressed during the design and construction phases. Experience in a lot of cases unfortunately reveals the start-up phase as a catch-up time for the items that were missed during construction. There’s not a lot that can be done about poor construction practices such as poor coating application, however attention to commissioning of corrosion monitoring equipment, chemical treatment pumps, cathodic protection programs is important. It is particularly important for offshore projects that this equipment is functioning properly prior to start-up. There are usually too many other start-up activities with higher priority that will be carried out first.

Once again, the onus is on the owner company's management and the project's management to consider the implications of deferring these programs.

The corrosion engineer and support personnel from the various chemical treatment companies, corrosion monitoring companies, and cathodic protection companies play an important role during start-up to troubleshoot any problems with their respective programs.

OPERATIONS PHASE

Once the project is up and running, it is time to ensure that the various project documents have been organized and are readily accessible for reference. In an ideal world, the inspection database would already be populated with baseline readings, corrosion monitoring equipment would be functioning properly, and the various chemical treatment and cathodic protection programs would also be functioning properly. For most projects, it takes one or two years to have these programs working properly. For this reason it is important to have service contracts and adequate warranty periods worked out when equipment is bought during the construction phase.

An additional challenge during this time is the changeover in personnel. Project personnel leave and operations personnel take over. The experience gained during the project phase is often lost in this step. Some projects have recognized this problem by building up the levels of operations personnel during the design, construction, and start-up phases. It is also important that the owner company's contract with the project team or company stipulates that the facilities are operating to the owner company's satisfaction before project personnel are allowed to leave.

Finally, it is important that the right lines of communication are set up between operations, maintenance, and engineering personnel.[3] It is incumbent on the owner company's management that this happens in a cooperative manner. As equipment problems occur, it must be clear who has direct responsibility for fixing the problems, and who is in a support role. With the loss of experienced personnel from the project team, it is important that the owner company maintains or even builds their staff levels, particularly during the first one to two years of operation.

EXAMPLES OF CHALLENGES

In the following examples, challenges during the early phases of a project are seen to result in costly rework during the operations phase of the project.

Pipeline Construction

One of the last construction activities that occurs before a pipeline is installed in the trench is to apply a protective coating to the girth weld area. There is usually a dedicated crew that has been trained to apply the coating, whether it is a heat-shrinkable sleeve, or a brush or spray-applied liquid coating. Once the coating has been applied and cured the pipeline is lowered into the ditch and backfilled. In most cases, this activity is schedule driven and there is a lot of pressure on the coating crew to complete as many joints as possible during the shift. Rather than focus on the quality of the job, the focus is predominantly on quantity.

During a recent pipeline inspection in northern Alberta, it was discovered at a number of joint areas that a large percentage of the girth weld coating area was not bonded to the steel substrate. Although initially thought to be coating delamination, it was evident that the pipe had not been adequately preheated. Lack of preheat did not allow the underlying mastic to fuse properly with the sleeve material. The joint areas were obviously not checked properly for this potential problem, with the result that groundwater seeped underneath the coating causing corrosion.

Whether this problem was a result of cold weather and inadequate heating equipment or simply a schedule-driven problem, a simple quality control check would have detected the problem. Instead the problem was buried.

Offshore Coating

Coating of offshore structures and the various package facilities to be installed on these structures is often subject to schedule driven problems as well. In a lot of cases fabrication of the facilities falls behind schedule leading to extreme pressure on the coating applicator(s) to complete their activities under schedule. This can manifest itself in the form of poor surface preparation leaving a contaminated surface or inadequate surface profile or sharp edges on structural members, lack of environmental control during the coating application, lack of cure time between coats, or simply not enough paint to meet the specification thickness requirements.

In most cases, the coated surface initially looks good from a visual perspective, however within a few months of exposure to the offshore environment, a poorly coated surface will become evident. The cost of recoating the facilities in an offshore environment is enormous, which stresses the importance of doing it right the first time.

Offshore Corrosion Monitoring

Corrosion monitoring is a necessary component of a proactive IMP. Properly designed and located, corrosion probes, erosion probes, links to relevant process information on the process computer, and lab analyses help the corrosion engineer to assess metal deterioration rates in the facility. It is important to have this monitoring equipment commissioned and running at start-up in order to provide baseline information about the corrosion processes. While land-based facilities are readily accessible for maintenance and troubleshooting the equipment, offshore facilities are not. As previously mentioned, there is a constant challenge to get maintenance people offshore due to accommodation restrictions.

Corrosion monitoring is considered a low priority in most operations and therefore may be neglected for a considerable amount of time before being fixed or maintained. Without this valuable information, the integrity of the facility can be jeopardized. Furthermore, a lack of information reporting from the corrosion monitoring system, can dictate higher inspection costs. For example, the use of corrosion probes at the beginning and end of a pipeline when used in conjunction with fluid analyses allows the corrosion engineer to put together a fairly accurate story of whether or not the pipeline is suffering from corrosion. When none of these systems are working properly, it may dictate the use of a more costly inspection such as an intelligent pig survey, sooner than later.

Refinery Crude Unit Overhead Corrosion/Fouling

The overhead piping and equipment of a crude distillation tower is often subject to corrosion and fouling issues. Over the years this has been fought with various materials options, and chemical treatment programs. In one particular refinery that was 40 years old, the issue of corrosion and fouling had become bad enough to cause several unscheduled shutdowns. Senior management recognized the cost impact of these shutdowns and a task force was assigned to prevent future occurrences.

The task force made up with representatives from operations, maintenance, and engineering was given sufficient time and resources to solve the problem, which turned out to be the practice of reprocessing slop oil. Over the years the slop oil tanks had become severely contaminated with a thick emulsion, which reduced the residence time and subsequent separation of water from the oil to a minimum. When the slop oil (mostly water) was reintroduced into the crude distillation train, an upset would occur sending suspended solids up the tower where they fouled the trays. The decision was made to spend the money to remove the contaminated slop oil from the refinery. Furthermore, online corrosion monitoring was implemented in the overhead piping, daily checks of the online pH system and chloride levels in the water phase was instituted, and finally a training program was carried out by the task force for all the operations staff. There has not been a recurrence of fouling in this system and corrosion levels are under control

RECOMMENDATIONS

Based on the challenges faced during the various phases of a project, the following recommendations are made in order to avoid high maintenance/replacement costs during the operations phase:

1. Commitment by senior management from the owner company and project to support the IMP. This takes the form of money in the project budget and time in the project schedule to allow for appropriate inspection, and staff levels, etc.
2. Specialist personnel such as a corrosion/inspection specialist who has had experience in the operations phase of a project need to be placed in the project team during the design phase of a project and retained through any "value engineering" exercises to ensure that the integrity of the facility is maintained.
3. In addition to economic, safety, and environmental goals, quality goals/targets should be used to define project success.
4. Lessons learned from similar projects should be used to identify potential pitfalls in the design phase. In addition, the costs associated with various designs should be closely examined from a life-cycle perspective.
5. If maintaining the IMP during the operations phase is foreseen as being difficult, such as in an offshore facility, a more corrosion-resistant design should be used that will allow less frequent inspection intervals.
6. Clear, effective communication between the operations, maintenance, and engineering departments should be made during the operations phase of the project.

References

1. M.J.J. Simon Thomas et al, “Deterministic Pipeline Integrity Assessment to Optimize Corrosion Control and Reduce Cost”, CORROSION 2002, paper 02075, (Houston, TX: NACE International, 2002)

2. NACE Publication 3C194, “Economics of Corrosion”, September, 1994, (Houston, TX: NACE International, 1994)

3. B. Hurst, “How to Implement an Effective Integrity Management Program that Satisfies the Requirements of the Safety Codes Act”, NACE International Calgary Section Seminar, June 2002.

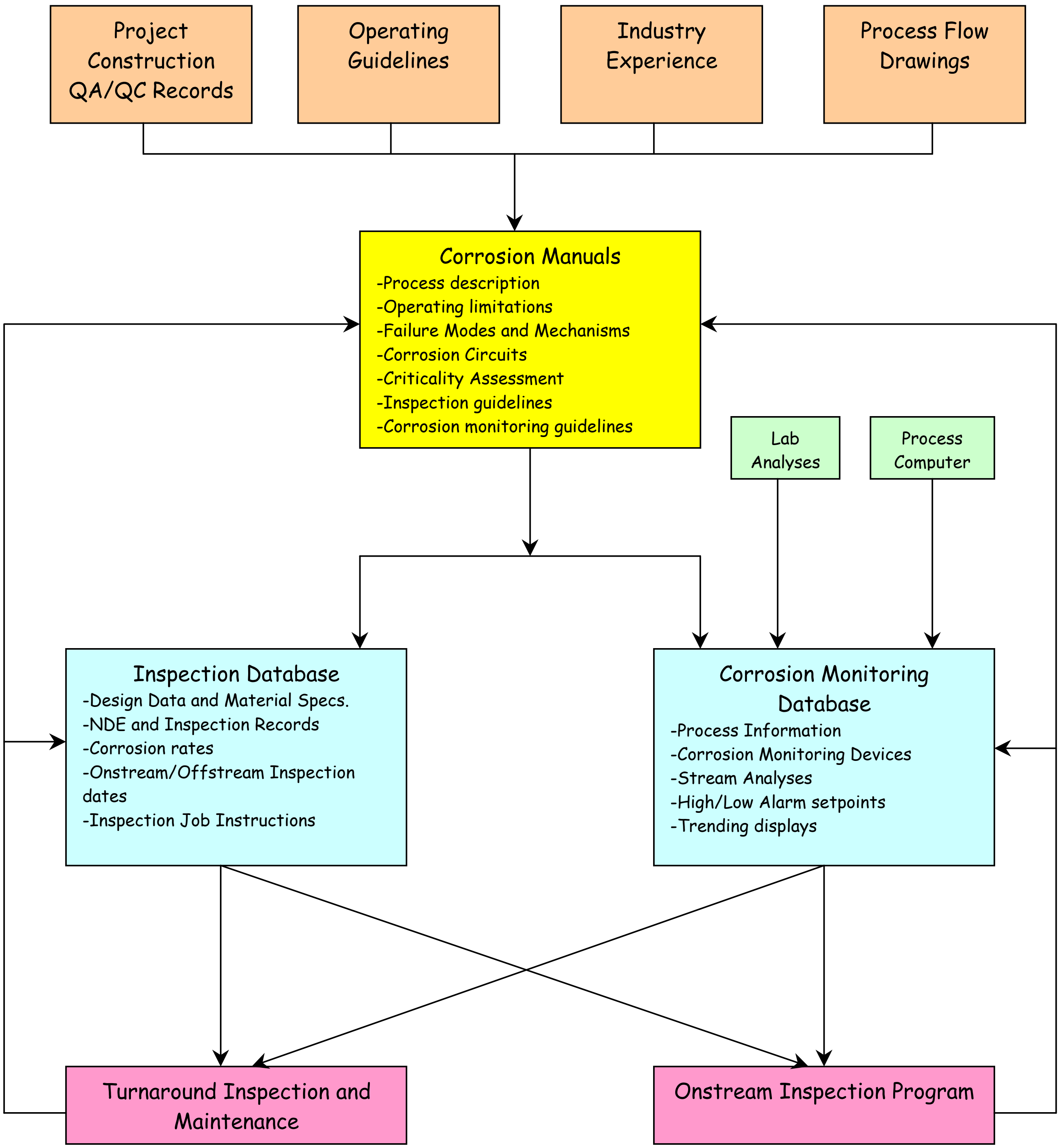

Figure 1 – Integrity Management Plan for Oil and Gas Facility