

Remote Visual Inspection (RVI) Inspection Types

Quest Integrity provides a comprehensive range of Remote Visual Inspection (RVI) inspection types in order to reduce maintenance costs, avoid confined space entry and minimise shutdown time frames.

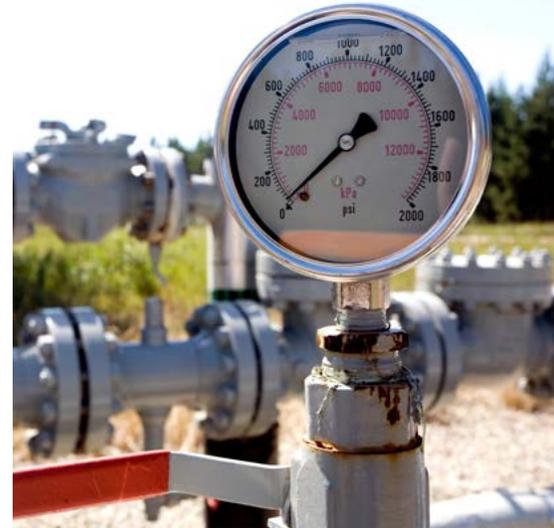
- + Water Tube Boilers
- + HRSG Boilers
- + Condensate Return Systems
- + Pressure Vessels
- + Tanks
- + Pressure Piping
- + Heat Exchangers
- + Fin Fans
- + Gas Turbines
- + Steam Turbines
- + Engines
- + Generators
- + Headers
- + Sea Water Casions/Pumps
- + Aircraft
- + Bacterial Track and Trace
- + QA and QC
- + CIP Evaluation
- + Transformers
- + Air Heaters
- + Electric Motors
- + Debris Retrieval
- + Steam Transport Systems
- + Tankers
- + Silos/Tanks/Cyclones
- + Cooling Water Systems

Water Tube Boiler

During a water tube boiler inspection, large amounts of deposition were found to be present throughout the unit. Fortunately this deposition was detected before serious corrosion and degradation had occurred. The risks of high deposition levels to asset reliability, efficiency, emission levels and life-span were discussed with the client. This information prompted modified boiler operation and enhancements to the water treatment programme.

This water tube boiler, along with other operational units, was scheduled for annual RVI inspections as part of the plant maintenance and inspection schedule. Over the next three years the deposition was removed, resulting in no long-term damage. This process was completed without the application of expensive chemical cleaning.

After three years the client reported increased performance along with reduced emissions and energy costs, and no costs associated with expensive repairs. They attributed their success to early detection through targeted Quest Integrity RVI which gave them the opportunity to make amendments to their operational procedures and implement simple solutions, mitigating the risk of premature tube failures, subsequent repairs and production losses.



HRSB Boilers

An inspection of an HRSB waste heat boiler revealed heavy deposition build up, flow assisted corrosion and areas of isolated corrosion. No indications of water or steam borne material had previously been detected in the water treatment testing. Due to the extent of the flow assisted corrosion and isolated corrosion, many tubes were required to be replaced. HRSB boilers are of a “cut your way in and weld your way out” construction making them expensive to repair.

With the results of the inspection highlighting the deposition and corrosion, the client altered the flow rates and velocities inside the unit and implemented tighter water operational parameters for makeup water and condensate return to suit the unique characteristics of their HRSB units.

Condensate Return Systems

The inspection of a condensate return system that was fed from seven different plants revealed the presence of two types of corrosion and excessive deposition levels. Chemicals used in the respective plants had been entering the condensate system as well as product material. This resulted in premature replacement of the condensate line, which required seven plants to shut down and caused extensive production losses during a peak production season.

Regular inspection of this line prior to leak detection would have detected minor corrosion and identified the source of the problem, providing the client with information to complete early remedial work and extending the system’s life for many years.

Pressure Vessels

An onshore facility planned a shutdown to carry out an RVI inspection programme. The primary issues we had to consider were the length of time required to inspect all vessels and the availability of the man power required.

The Quest RVI In-Spec programme was implemented across all plant vessels using our RVI specific ITPs and VAPs. Our review with the client revealed that 95% of the vessels were able to be inspected for GVI and CVI purposes and did not require a confined space entry to be performed. For those vessels that were selected for the application of RVI, strategically selected access points were chosen to ensure key target areas could be accessed to ensure the integrity of the inspection. These inspection points required minimal mechanical intervention, scaffolding, cranes and riggers. As there were no confined space entry elements and small diameter access points were used, a reduced level of isolations was required which further reduced the costs, personnel involved and the HSE risk profile.

The result was a shutdown duration reduced by 51% along with 85% reduction of associated costs. The results from the RVI inspections were used to form part of the client’s ongoing RBI requirements and strategy for all future shutdowns for both onshore and offshore.



Tanks

A large hydrocarbon storage tank required inspection. There were two main challenges with this tank:

- + The tank had a methane atmosphere and could not be shut down for inspection
- + The only suitable access point available (6 inches) was in the upper centre of the tank

We custom built a large camera unit with high intensity lights to enable use of the available access point and clearly identify all the areas that required inspection. A procedure was developed to enable non-IS electrical equipment to operate in a hydrocarbon atmosphere.

The inspection was completed safely, quickly and without any disruption to the client's production schedule. All relevant information was obtained and the client was able integrate the tank inspection procedure into his RBI system so that future inspections could be completed with the same high level of accuracy.

Pressure Piping

A series of high pressure piping systems were inspected from a well head through and beyond a process plant. A series of camera systems were used to ensure accurate results. Approximately 95% of the entire process piping was covered from strategically located access points.

The client commented that the high level of coverage and subsequent results provided them with a high level of confidence regarding the condition of the plant, and putting it back into service. These results enabled the client to better target other NDT techniques to specific areas where indications or corrosion/erosion had been noted so that future remedial work could be scheduled.

The results from this inspection further assisted their RBI programming and allowed for extended survey periods. The client also commented that the cost per metre to inspect, when compared to other NDT techniques covering the same area, provided exceptional savings.

Heat Exchangers

A series of shell and tube heat exchangers were inspected using RVI techniques.

Tube side

RVI inspection determined that all except one of the units were free from deposits and other issues relating to the integrity and efficiency of the tube bundle. For the one tube bundle that required further cleaning, the head was removed, the tubes cleaned and re-inspected to ascertain the effectiveness of the clean, and the head re-instated.

Shell side

RVI inspection determined the internal condition of the vessel and tube bundle without removal of the bundle.

As none of the work associated with removal of the tube bundles was required, the client saved valuable time, resources and money in a scheduled outage with an extremely short duration.



Fin Fans

RVI techniques were utilised to inspect a series of fin fan units that contained varying levels of deposition. These units were then cleaned and an IRIS inspection was performed which detected some large pitting in some areas. The client requested we re-inspect the cleaned tubes using RVI. Our inspection of the areas of pitting indicated by the IRIS tests found some deposition remaining and no pitting. Further cleaning and RVI was undertaken. We were able to positively prove that there was no pitting in the tubes and show that the IRIS was unable to differentiate deposition and pitting.

This saved the client the cost of re-tubing a set of fin fans unnecessarily. The RVI inspection was more time-efficient and had a higher level of accuracy in detecting deposits that are commonly found in these units. This inspection showed that previous cleaning was not up to standard, revealing that further cleaning was required to reach optimum efficiency.

Gas Turbines

A 10Mw gas turbine was inspected following our gas turbine inspection procedures. The second stage blades in the hot section were found to be severely damaged. The damage was consistent with heat/flame damage, however this would not typically occur in this area of a gas turbine.

Discussions with the client revealed that the unit had been run on a mixture of gas fuel and liquid fuel for a period of time. This explained the longer than designed flame path and the excessive heat in the second stage area.

The turbine was stripped down and the damaged blades and nozzles replaced. As we were able to identify the root cause of the problem, the client was able to modify his gas feed system to prevent liquids from being burned in a turbine that was not designed for liquid fuels.

Steam Turbines

A client with a 25Mw steam turbine had noticed decreased performance and suspected there was some fouling of the blades. Production constraints and supply contracts presented significant challenges regarding off-line time. The typical cool-down period required for our normal RVDI inspection was not desirable.

The turbine was inspected using our umbilical heat exchanger (cooling jacket). The unit was still reading 240° Celsius at the time of the inspection. We detected fouling on the LP side of the Stage 2 blades along with indications of deposition passing through the HP gland seal system. This continued build up of these deposits and the premature wear they create on gland seal systems would have resulted in further decreased performance and more extensive repairs. Early detection proved to be invaluable to the client.

This inspection enabled the client to plan an outage at a more appropriate time in order to replace the blades and repair the gland seal system. The source of the fouling was also traced and the root cause of the problem solved. This unit was only off-line for approximately eight hours as opposed to the normal 48 hours plus.



Engines

While on-site during a scheduled inspection outage, a client asked us to inspect a gas fired V12 engine that drove a large compressor.

The inspection revealed early indications of the exhaust valve seat burning. This information prompted the client to instigate replacement valves immediately and better tune the air/fuel ratio to prevent further damage to other cylinder heads. The client was delighted that the findings had saved the need for a full head reconditioning.

Traditional compression testing would not have detected these early indications and would only have detected the issue with the valve, upon failure. Our RVI procedure detected this prior to failure, saving money and time. These engines are now inspected at the regular service schedule using RVI and subsequent head reconditioning has been fully eliminated outside of engine rebuild schedules.



Generators

Inspection of a generator used in the geothermal industry revealed a particular type of corrosion associated with hydrogen sulphide. Early detection enabled the client to install filter/scrubber systems on the generator's cooling ducts. As we were able to fully ascertain the extent of the corrosion, the client also organised a replacement unit to be built and installed at a later date.

With early detection the client was spared the costs of product losses. The inspection for this type of generator typically takes about three hours which minimises the time the unit is required to be off line. The client elected to monitor the generator and conduct bi-annual inspections.



Headers

Inspection of a steam header with multiple tube penetrations detected a ligament type cracking between the tube penetrations. The approximate length and depth of the cracks were determined and this information shared with engineers and metallurgists. The plant was put back into service but with very short inspection intervals. The inspection procedure was changed from an In-Service type to a "Condition Monitoring" inspection to minimise down time and enable the level and rate of degradation to be ascertained more efficiently.

These headers were re-inspected on a regular basis using a custom made camera tool and our condition monitoring procedure. The inspections were completed efficiently with minimal disruption to production levels. The changes in the crack indications were monitored and checked against minimum material levels. This gave the client time to instigate permanent repair or replacement of the headers and continue production without incurring substantial production losses.



Sea Water Casions/Pumps

The inspection of a seawater lift pump and discharge casion provided information on the following:

- + The condition of the internal protective coating
- + The amount of bio-fouling occurring
- + The condition of corrosion control anodes inside the casion and directly below the inlet
- + Any issues inside the pump regarding the shaft supports, bearings and impellers

This inspection was completed with minimal disruption to the availability of the pump for process operation, and did not cause any loss of production. From the information gathered the client was able to determine that no remedial action was required. The inspection procedure and results were then entered into the clients RBI system.

Aircraft

An aircraft was set for a scheduled inspection. This aircraft had a number of operational issues associated with its working environment. The very windy airport was adjacent to the sea, and the craft did high altitude work adjacent to a ski field.

Upon inspection we noted degradation to the engine from salt ingestion. The information gathered from this inspection placed the engine on 50 hour service intervals until the engine could be replaced. It also resulted in the engine manufacturer changing the coating on the blades in the hot section and the material used in the compressor section of the engine to one more suited to the aircraft's operational environment. The client was able to continue to operate his aircraft with minimal disruption until a new and more suitable engine arrived from the manufacturer.

Bacterial Track and Trace

RVI methods were employed to inspect a food processing facility with high APCs, product contamination issues, higher CIP costs and reduced plant availability for production.

Two issues occurring within the piping systems were identified. The first was ineffective CIP performance in some isolated areas of the system due to piping design/installation. The second was a series of weld structures with defects that harboured bacteria which were not able to be removed during the cleaning process.

All the defective welds were tagged for removal and the areas of piping that were not being cleaned effectively were re-routed. This resulted in a significant 50% increase in production times before a CIP cycle was required. It also reduced the issues associated with product quality enabling the client to sell his product for higher rates.



QA and QC

A series of weld seams had been inspected by torch and mirror, and radiography in a sterile food process system. The client was concerned with the disruption of work during radiography and the limitations of the torch and mirror method.

The Sterile Welding ITP was used as it targets the defects known to cause issues with bacterial and quality control. A series of weld structures that would harbour bacteria and be unable to be cleaned effectively using traditional CIP methods was identified. RVI was able to reach well beyond the torch and mirror limitations and identified weld formations that had been passed by radiography but were actually formations that harbour bacteria and cannot be effectively cleaned.

The client concluded that our inspections were more suitable than previous techniques they had employed. RVI methods enabled access to areas required, provided a high level of definition/accuracy that could not be achieved with radiography, reduced disruption time and increased the coverage per day. This resulted in savings of 75% compared with previous methods. It also ensured that their operational system could be maintained as a sterile environment as required. Results of this inspection were used to further up-skill the welding crews to enable a more consistent defect free welding process.

CIP Evaluation

A client requested RVI inspection to provide information on the effectiveness of a CIP process, which was currently experiencing some issues.

The inspection revealed that the CIP process was not effectively cleaning the system. Product residue, solids and fats were noted in the system with what appeared to be a bio film present in 40% of the process piping. Sections of the piping were replaced and some modifications were made to the CIP system. The results of the inspection pinpointed the exact locations where the CIP process was not performing correctly and subsequent modifications were made to the plant.

This enabled the client to reduce his effective CIP cycle and target a process that was more effective for the type of product being manufactured. It also provided him with longer production times and reduced effluent discharge, chemical and energy use. The product quality was increased providing a longer shelf life.

Transformers

A client wanted to use RVI techniques in an electrical transformer to see if we could remove a foreign object dropped in the unit. The object was successfully located and removed. Further inspection of the unit revealed serious degradation to the insulation and showed that many of the internal packers had loosened, with some falling to the bottom of the unit.

The load on this unit was lowered to prevent a catastrophic failure and the client was able to plan and arrange for a replacement unit. This inspection showed the ability of RVI techniques to detect problems that cannot be detected with traditional testing. As a result of the inspection outcome, the client implemented regular RVI inspections to ensure prevention of premature failures in similar units.



Air Heaters

A client's air heater units for air drying operations were cracking causing steam and associated chemicals to contaminate the food product being processed. RVI inspection revealed a number of issues with the method in which the tube penetrations were mounted in the header and the quality of the welds.

As a result of the inspection, the entire air heater was set to be replaced and a warranty claim was lodged with the manufacturer. The inspection information was also used in a redesign of the units. All new units for this client are now inspected by using RVI techniques to ensure that the joint type is correct and internal weld profile is uniform to prevent stress points, cracking and corrosion. Quest Integrity RVI have developed a specific ITP for these units and a set of standards for the internal weld seam profile that is now used extensively in these units.

Electric Motors

RVI was used to inspect a large electric drive motor that had got wet. The inspection revealed corona was present in and around the windings in the motor. The inspection also detected a number of other issues associated with the condition of the windings, supports, insulation and deposition.

With the results of this inspection the client was able to plan a suitable time to complete the repairs and reorganise plant operation to reduce the loads on the motor. The client requested our inspection programme to be implemented across all their electric motors as part of their maintenance schedule.

Debris Retrieval

A client suspected that a series of recent plant trips may be associated with a particular pressure vessel. RVI was chosen early on in the fault finding process to help determine the cause.

The most time-efficient method of inspection was requested as the plant would be down in a critical production area. The inspection revealed debris blocking the discharge nozzle in the bottom of the vessel. The client was concerned that a confined space entry was required to remove the debris. A confined space entry would require further isolation, venting and purging and would cause further delays in getting the plant restarted.

Using our specialist RVI retrieval tools, we were able to remove all the debris causing the obstruction, eliminating the need for a confined space entry. The vessel was closed up and plant restarted immediately. This is a technique we deploy regularly to remove foreign debris from process plant and also with steam turbine clean out and re-assembly procedures.

Steam Transport Systems

A main steam feed line connected to eight different process plants was inspected. Inspection revealed isolated areas of corrosion in the steam lines. The client was able to investigate and determine that the root cause of the corrosion was a chemical used in the steam generation process. A chemical substitute was found and used.

The client was able to target other NDT techniques in areas where we noted corrosion to ascertain minimum wall thickness levels and complete remedial work as necessary.



Tankers

An RVI inspection of milk tanker bodies revealed two major issues affecting a number of tanker bodies – a particular type of spray ball was not effectively cleaning the tankers, and there was loose internal piping beginning to damage the internal surfaces of the tanker.

The client was able to temporarily remove these tanker bodies from service whilst keeping those with correct spray ball systems and pipe fastenings in service. The loose piping was able to be repaired easily as early detection did not allow for extensive damage to occur.

This inspection did not disrupt the scheduled milk pickups which would have been the case if each unit had been inspected using a confined space entry method.

Silos/Tanks/Cyclones

A series of balance tanks, silos and cyclones were inspected as part of an annual survey. We were able to determine that a number of units were not cleaning correctly. Comparison of these results with the results from previous inspections revealed that several units were developing a “bloom”.

The client was able to replace defective spray balls and modify the CIP process to ensure the unit was cleaned to a more satisfactory standard. They were also able to produce product with a more consistent quality and eliminate costly product down grades.

Cooling Water Systems

A cooling water jacket system in a steel rolling mill was inspected. A large amount of deposition, tuberculation and indications of under-deposit corrosion were found in the system. This was reported to the client who dismissed the initial findings and our draft report. We returned to our office and compiled the finished report with an extract from technical journals on the type of corrosion and formations we had noted. The client read our finished report and began to arrange for the entire system to be re-built.

The client confirmed that the information we had provided at the end of the inspection was true and correct. He also stated that if the inspections had been undertaken earlier, the initial indications would have been identified and, through altering operational processes, prevented the premature degradation and replacement of the system.



Quest Integrity, a TEAM company, is a global leader in the development and delivery of asset integrity and reliability management services. The company's integrated solutions consist of technology-enabled, advanced inspection and engineering assessment services and products that help organizations improve operational planning, increase profitability, and reduce operational and safety risks. Quest Integrity is built on a foundation of leading edge science and technology that has innovated and influenced industry best practices since 1971.