A THREE-PRONGED APPROACH

Hans-Joerg Buob, AST Turbo USA Inc., USA, discusses three integral areas of critical rotating equipment installation that should be considered in order to achieve success.

The US shale abundance, compounded by energy export limitations, has led oil and gas companies to build new processing plants, with multi-billion-dollar expansion projects also underway. While most of the plants are being built in Texas and along the Gulf Coast, major investments are also under construction or nearing completion in many of the US' northern and southern states.

The shale gas boom created thousands of new jobs over a short period of time, as qualified workers and experts were suddenly in demand nationwide. A shortage of experienced rotating equipment experts with extensive knowledge of new installations was shown to be a significant handicap. Previously, few new plants were being built, so the demand for qualified workers in this industry was limited. The industry was also suffering from a loss of specialists from the baby boom generation, who were entering retirement.

The shortage of skilled manpower in the industry has a significant impact on the execution of new projects. The missing expertise affects quality, safety on site and the predictability of project progress. Costly 'acceleration programmes' are put in place to avoid delays. This can lead to cost overruns, safety problems and other adverse effects, without fully recovering from the previously induced delays.

An anticipatory, pro-active and in-advance planned installation approach can help to support the timely delivery of critical rotating equipment. This article provides an overview of three key approaches that can lead to the successful installation of critical rotating equipment.

Observation

During the first months of a new installation, the focus is on the structural and foundation work. This is the area where most of the action is and where most progress can be observed. Little attention is paid to the storage and preservation of the delicate and expensive rotating equipment that may have already arrived. During that early phase, hundreds of crates of different sizes and contents are exposed while they are stored outdoors. This can cause the equipment to fall into disrepair. When the rotating equipment is eventually needed, it is often found to be disorganised, incomplete or in an unserviceable condition, especially if the material was not properly protected during the on-site storage phase. In some cases, these circumstances can lead to repair work or material re-orders. This can be a time-consuming process, as some rotating equipment parts are non-standardised and, therefore, unavailable from stock.

A shortage of skilled labour can lead to a high manpower fluctuation, which in turn may result in another unplanned critical impact on individual projects. The projects lose important site specific knowledge with every departure, as often only the workers know the exact status of specific tasks, for example. Handovers between the personnel that are leaving a project and those that are joining often do not take place properly. This instability may lead to confusion concerning the status of the equipment and tasks. Proper torquing of larger flanges is one area that is typically left incomplete by one shift and then not properly handed over to the next shift.

The lack of adequate construction resources and discontinuity that is caused by personnel fluctuation can inadvertently lead to poor quality and slow progress, which may have serious consequences. The implications may apply to individual contractors and/or the entire construction company over the course of the project.

While major changes may result in improved performance and prevent stonewalling of a project, they can also have

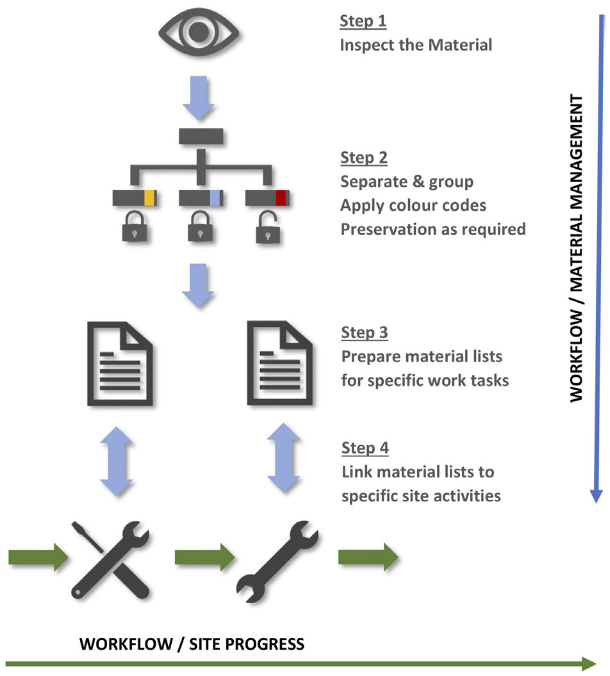

Figure 1. Material management process flowchart.

severe consequences. It would be ideal to start with the best possible resources and complete the project in a timely manner.

The basis for successful installation of rotating equipment in a large plant is a thorough and careful consideration of the following three areas:

- Material management.
- Quality assurance/quality control (QA/QC) during installations.
- The 360˚ installation approach.

Material management

The shipment of critical rotating equipment for a major plant entails hundreds of single packages and cradles, which include capital spare parts, erection spare parts, loose piping, instrumentation, special tools and numerous other materials. These packages and cradles must be inventoried, stored, preserved and, finally, installed or handed over to a steady state operation team. A simple material management system is thus essential for a timely and successful installation. At first, the entire material delivery is checked for completeness before the shipment must be separated according to the planned installation sequence. Subsequently, these must be linked to the specific site activities on the equipment installation. The following colour coded separation has been useful in various projects:

- Core material for installation.
- Auxiliary material for installation.
- Special tools and consumables.
- Start-up spares.
- Capital and hand-over spares (simplified).

The rotating equipment expert is ultimately responsible for the installation involved in these steps. The expert's knowledge is essential for allocating the material and parts to the respective work activities, defining the adequate preservation, and identifying any missing material. Fast access to all of the material remains a key success factor throughout the project, including successful start-up. The material handling system needs to be continuously updated so that the installation team is in control of all the hardware at any time during the project.

QA/QC during installations

It is important to develop an installation quality plan and a checklist during the project's 'kick-off' phase. The quality plan should be developed by an unbiased rotating equipment expert in order to guarantee long-term reliability. This will include the original equipment manufacturer (OEM) and end-user's specified checks, but it also goes beyond in terms of planning and detail in order to avoid re-work and quality issues. Hold points, verification and notification milestones must be determined and finalised during this stage. Moreover, the quality plan will determine any unclear responsibilities between the customer supervisor, the OEM technical advisor and the labour contractor upfront. A solid QA/QC plan is a control document that keeps track of the quality of the installation process and ensures progress is achieved without costly re-work.

The 360° installation approach

On new installations, the 'flange-to-flange' mentality of various OEM site representatives is widespread. Most of the time, the focus is only on the supplied equipment and there is a lack of willingness to look beyond the limits of supply scope. Instead of contributing to a common solution, complaints and accusations between the different contractors are frequent occurrences. Needless to say, this becomes tedious on a personal level, can negatively impact the mood of the project and is time-consuming.

The 360˚ installation approach avoids such conflicts by involving all of the stakeholders throughout the project on a continuous basis. Thereby, all of the stakeholders need to understand the installation procedure and the interfaces, and they also need to be aware of the project expectations. With the 360˚ installation approach, various potential risks are discussed early and the most critical risks are mitigated to avoid negative project impact.

Case study

The following example explains the 360˚ installation approach on the basis of a case-related practical example. A high pressure process pipe system was designed by an engineering company with as few flange connections as necessary in order to prevent the risk of gas leakages during operation. However, this design was not suitable for performing the hydrotests on the piping system because the pipe design did not allow for the removal of pipe spools underneath the compressor deck. Unfortunately, it was also impossible to install high pressure rated blind flanges between the process pipes and the compressor nozzles. The only solution to the problem was to lift the compressor off the baseplate. This allowed the process to perform pipe hydrotests without any pipe modifications. On the other hand, activities around the compressor were relocated to a shop area to reduce delays on the compressor commissioning to a minimum. The compressor, now with the dry gas seals installed, was re-installed on the base frame after a successful pressure test of the process piping.

This cost-ffective solution was only possible by scheduling a 360˚ meeting in advance. During this meeting, all possible

Table 1. Example of QA/QC checklist for a new installation project – erection phase

Item	Task description	Reference	Category	Sign-off (checkboxes)			Material list	Remarks
				OEM	QA/QC	Contractor		
1	Erection of compressor							
1.1	Check location of the anchor bolt pockets (X and Y position)	OEM Drawing XX-nnnn-00v	Verification	☐	☐	☐		
1.2	Chip foundation concrete surface	Inspection Sheet IS XX-1.1	Verification	☐	☐	☐		
1.3	Set and fix liners	Record Sheet RS XX-1.1	Verification	☐	☐	☐	Material List ML XX-1.3	
1.4	Place compressor baseplate on the foundation	Lifting study LS XX-1.1	Verification	☐	☐	☐		
1.5	Position baseplate in X, Y and Z direction	Record Sheet RS XX-1.2	Verification	☐	☐	☐		
1.6	Install foundation bolts and washers		Verification	☐	☐	☐	Material List ML XX-1.4	
1.7	Baseplate leveling	Record Sheet RS XX-1.3	Verification	☐	☐	☐		
1.8	Install motor on the baseplate • Preparation of motor shims • Set motor on compressor baseplate	Lifting study LS XX-1.2	Verification	☐	☐	☐	Material List ML XX-1.5	
1.9	Primary alignment: motor to compressor • Compressor and motor soft foot check and adjustment • Alignment of motor to compressor	OEM Drawing XX-nnnn-00v	Verification	☐	☐	☐		
1.10	Hold point • QA/QC, contractor and OEM to review and approve the primary alignment data	Pre-grout alignmnet package	Hold	☐	☐	☐		Sign off pre-grout alignmnet package. Release for grouting
1.11	Preparation for grouting: • Framework		Notification	☐	☐	☐		
1.12	Grouting: pouring and curing		Verification	☐	☐	☐	Material List ML XX-1.6	

Hold: test should not be carried out without the owner's representatives in attendance.
Notification: the owner's representative requires prior notification of the test but the test may proceed if the representative is not present at the specified time.
Verification: the owner's representative will verify the requirements of the task by reviewing, at his discretion, the documentary evidence.

solutions and scenarios were discussed with all the stakeholders, such as the engineering company, the pipe construction company, the QA/QC team and the rotating equipment specialist. Due to the cooperation between these stakeholders, it was possible to address and locate the problem at an early stage – at a point in time when the project was not exposed to a critical risk.

Conclusion

The installation of new critical rotating equipment is a complex undertaking, involving many hurdles and risks that need to be properly addressed and mitigated. Critical factors include a retiring workforce, a high fluctuation of manpower on the projects, and a large number of concurrent projects and budget constraints.

Fostering a pro-active 'can-do' approach, complemented by competent and experienced rotating equipment engineers with a dedicated installation background, can effectively implement the key elements by advanced planning, paying attention to detail, understanding the work flow and looking beyond system boundaries.

Investing in and focusing on the three key elements, material management, QA/QC management and the 360° installation approach, eventually pays dividends in the long-term by ensuring on-time start of commercial production and high quality installation.