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Power Plant Improvements through Retrofit Projects

Operating power plants can take advantage of retrofit projects to increase their availability, reliability, operational flexibility range, efficiency and/or power output. A myriad of retrofit projects can be implemented. Some examples of typical projects and their associated plant improvements include:

- Availability and Reliability - Addressing Single Point of Failure plant design deficiencies, high failure rate equipment (i.e., Mean Time between Failures, MTBF) and equipment with large failure impact on power generation.
- Efficiency and Output – Gas Turbine (GT) or Steam Turbine (ST) uprates, addition of fuel or condensate preheaters, GT air inlet cooling, GT steam/water injection, cooling tower or Air Cooled Condenser (ACC) uprates.
- Operational Flexibility – GT bypass stack, Heat Recovery Steam Generator (HRSG) or Feedwater (FW) system modifications.

Retrofit projects can be challenging and have a high level of uncertainty. Perhaps uncertainty is the largest driving factor that detracts operators from pursuing plant improvements. Think Forward has participated in a few retrofit projects and, in our experience, starting with a clear definition of the functional objectives and project scope, as well as having good communication among the stakeholders, play a significant role in the success of a project. Some of our key findings are described below.

Relevant Considerations at Conceptual Engineering Stage

"The Devil is in the Details", is an idiom often mentioned in construction projects. Retrofit projects are typically more complex and challenging than green field construction due to the constraints from the existing facilities. Nonetheless, some opportunities are common across different types of projects. In the following lines we discuss lessons learned from footprint limitations, minimizing downtime, and staged scope development.

- Footprint Limitations:

  Typical footprint limitations can include underground obstructions such as water lines, existing foundations with operating equipment, and/or lighting infrastructure. Identifying underground interferences can be done through review of the existing facility engineering drawings, site walk-downs, and/or underground surveying, if needed.

  In the case of the water lines and lighting infrastructure, the retrofit design can avoid interference with most of the obstructions, while a few existing lines can also be rerouted in a relatively inexpensive manner. However, existing foundations for operating equipment requires thinking outside the box. For example, Think Forward has used micro-pile foundations to react large shear loads from a complex structure in a limited work area.

- Minimizing Downtime:

  Minimizing plant downtime is a high priority for plant operators, since downtime can cost hundreds of thousands of dollars in lost revenue per day. Downtime associated with facility retrofits can be reduced through a few different installation approaches. For example, hot-tapping piping interconnections (when applicable) can be used to help minimize outage time. Pipe hot-tapping is an installation approach where the new and existing piping lines are interconnected while the existing pipe is in operation (i.e., active flow). Although this interconnection approach is more expensive than traditional piping interconnection methods, the savings from the avoided downtime often outweighs the higher installation cost.

- Staged Scope Development:

  Defining the functional objectives and project scope in a staged approach allows the stakeholders to communicate their concerns timely, when the design and scope can be adjusted without major setbacks to cost or schedule. The stages we have used to develop projects are: conceptual design, basic engineering design, and project technical specification. First, during conceptual design the functional objectives, operational requirements, and project specific features and requirements are discussed and defined with plant personnel. Site walk-downs are performed to identify site constraints and client specific requirements. Based on this information, an initial analysis is performed to evaluate and trade-off the potential advantages and disadvantages of a few different retrofit approaches, locations, and installation methods.

  At the basic engineering design stage, all of the project's design choices and trade-offs are clearly outlined and vetted with the client. This helps to avoid significant design revisions at later stages that may delay the detailed design or construction of the project. During this stage, the project is further defined through the development of initial design drawings, calculations, specifications, material selection, and specific construction methods. The project interfaces with the existing facility (e.g., power, fuel, water, steam, I&C, etc.) are also clearly identified. Finally, a project technical specification is drafted to clearly describe the project and communicate requirements and design choices that may not be evident from the engineering drawings and specifications.

Retrofit projects certainly are challenging due to site specific and original design constraints. However, good planning, clear project definition, and good communication can help make this type of projects successful and valuable improvements for operating facilities.

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