Paper machine rebuild schedule and execution plan

DALE STEWART

How do we get there from here? A clear and specific plan will go a long way toward smoothing the rebuild process.

This checklist for scheduling and executing a paper machine rebuild is the roadmap you need to set you on the right path. Everything from planning and developing the project schedule to progress reporting and final execution of the plan is covered here. Follow these guidelines to improve your odds for a successful rebuild project.

Planning the project schedule

Information required for schedule preparation

Scope of work. The first step in preparing the schedule is to obtain a written description of the scope of work that outlines the existing conditions and equipment and describes what modifications and replacements are to be made. The scope should describe not only the work involved but also any pertinent information from the owner that may enhance the planning effort. This may include directed start or end dates or outage dates that coincide with other planned mill outages. Scope deviation is the main cause of cost and schedule overruns.

Drawings, specifications, tie-in lists. A complete set of engineering drawings is necessary to prepare an accurate construction plan and schedule. This includes flowsheets or piping and instrument diagrams; plot plans; mechanical layouts and elevations; architectural, piping, electrical, instrument, and heating, ventilation, and air conditioning (HVAC) design; and vendor equipment drawings.

Existing as-built drawings should be utilized to clearly identify existing conditions and illustrate equipment and materials that are to remain as is. Drawings should be prepared for equipment that is to be removed (possibly modified) and reinstalled and equipment that is to be removed and salvaged or scrapped. This information allows the constructor to preidentify affected equipment.

Equipment and construction specifications provide the scheduler with more complete information needed to fully plan the project. This may include equipment assembly sequencing instructions, special grout for anchor bolts that provides a quick cure time, etc.

The tie-in list is a useful tool to both plan the project schedule and guide the work's execution. The lists should contain a unique assignment number for each tie-in and describe in detail what is to be tied in and exactly where it is located. Reference drawing numbers should be identified and material purchase and delivery and storage information should be included. A scheduled installation date should be added to the tie-in list as it is developed.

Equipment lists. The equipment list is used as a cross reference to perform a quality check to ensure that every piece of equipment and material item has been included and its installation carefully planned. The listing should include all new equipment, all existing equipment to be reused, and the equipment's related drive horsepower requirement. The list should include mechanical, electrical, HVAC, and instrument control equipment.

Vendor quoted equipment and drawing delivery durations. You must have an accurate delivery duration period provided by the equipment vendors. This must include the date when the equipment drawings will be submitted to the design engineer for review and incorporation into the overall project design and when the equipment is to be delivered to the mill site for installation. Both dates are critical to both the engineering design schedule and timely execution of the construction schedule.

The vendor quotation dates are used to prepare the detailed procurement schedule. They will become milestone activities on the summary guide schedule and will be totally integrated into the engineering and construction schedules.

Workforce availability. You must determine if the work is to be done by union, open shop, or merit shop mechanics. This decision may be dictated by the mill's labor union contract agreements. Once a decision is made, it is necessary to determine the availability of qualified craftsmen in the numbers needed, by discipline, from the local area or what number must be recruited from outside the area. A well qualified construction contractor often will have a following of key experienced lead mechanics that can be utilized on the project.

If there is an abundance of craftsmen available, the outage work can be scheduled on three eight-hour shifts daily, seven days per week (56 hours per week). If limited mechanics are available, it may be necessary to schedule two 12-hour shifts daily, seven days per week (84 hours per week). The eight-hour shifts are preferable because they are less physically demanding and therefore increase the efficiency of the workers.

It is essential that the critical-path outage work continue around-the-clock.

Site conditions. An access study is required to determine construction parking facilities; personnel access into the mill's fenced secure areas; personnel convenience facilities, including rest rooms, eating areas, drinking water, and store facilities; and related foot travel distances to calculate predictable craft efficiencies.

The access investigation for allowing delivered equipment to be moved and off-loaded into the paper machine room includes determining locations and sizes of entrance doorways, aisles, floor openings, and hatchways and determining associated floor loading capacities.

Space inside and outside the machine room, at both ground and operating floor levels, must be identified to allow staging and preassembly of new equipment components for expedient transfer and installation during the outage.

The existing overhead machine room crane(s) must be inspected and placed in reliable condition. This includes inspecting and replacing worn cables, brake linings, starter coils, etc. and performing lift tests. The outage work's critical path is dependent upon the almost continuous use of the overhead crane(s).

Mill maintenance personnel often will need to use these cranes during the outage for such things as removing and reinstalling rolls. Careful coordination is needed to avoid construction interference.

The planner should coordinate with the construction mechanical superintendent to devise a rigging plan and route for handling the removal of heavy, bulky equipment and new equipment installation. Significant time can be saved by removing existing paper machine components in the largest modules possible, including the headbox, fourdrinier, and press frames. The assembled weight of these items may exceed the overhead crane's load limits. This may cause partial disassembly of the modules to comply with the crane's capacity, which will increase outage time.

The same philosophy applies to the installation of new equipment. The rigging plan affects the schedule duration.

Project estimate and budget work breakdown structure. It is important that the estimate or approved budget contain sufficient detail to allow unit weighing of each scheduled construction activity. This provides the tools needed to quantify installation duration based upon both quantities to be installed and the workforce size needed to accomplish the task. The construction schedule's unit weighing allows both progress measurement through time phasing and quantity based performance and a productivity tracking system. These systems are necessary for controlling the project.

Client restraints list. Client input must become part of a project's plan and schedule. The client may have imposed directive dates from its customers to produce a certain quality or quantity of paper by a selected time, which in turn determines the start or finish date for the project.

Normally, "time is of the essence" is the deciding philosophy that dictates having the project executed as quickly as possible. Certainly it is essential to minimize the paper machine outage duration to maximize production availability. Many paper machines today generate hundreds of thousands of dollars in cash flow each day, and every second is precious to the owners and stockholders.

The mill should provide a schedule identifying its planned preventive maintenance outages to allow planning for multiple tie-ins and equipment interference relocations during the preoutage phase of the project.

Part of a project's basic philosophy should be to maximize the preoutage work effort on an economical straight-time basis to minimize the outage work requirements. The mill should identify its maintenance and operational work plans that are to occur during the outage to coordinate the contractor and mill work activities and avoid interference. Dual usage of the overhead crane is an example.

Site visit. The planner should visit the job site to review the existing paper machine arrangement, building layout, accessibility, overhead crane rating and access, and doorway and hatch openings; to interface with mill management for coordination of restraints; to locate space for staging and preassembly; to prepare a list of demolition items; to test baseplates; to locate existing optical alignment plugs; and generally to gather basic planning data.

Detailed drawing list. The Equipment/Procurement/Construction (EPC) planner should obtain a detailed listing of drawings from the engineering design leaders, along with their estimated workhours, to prepare an integrated detailed engineering design schedule.

If the scheduler is planning the construction phase only, he needs the engineering drawing released for construction (RFC) dates and the procurement schedule equipment delivery dates. After the basic information is obtained, the planner/scheduler can prepare the summary level EPC schedule.

Planning the integrated project execution

Engineering. The logical sequence of events and activities required to support construction requirements should be planned.

Procurement. The timing and sequence of events for developing equipment and material specifications and inquiries; obtaining vendor quotes; placing purchase orders; receiving vendor equipment drawings; and material and equipment delivery should be planned. The vendor's drawings delivery should be integrated to support the engineering schedule's detailed design activities. The equipment delivery dates then act as restraints to starting activities in the construction schedule.

Preoutage construction plan. Develop a list of work that can be accomplished "on-the-run," while production is in progress. This may include adding white water systems, a vacuum system, hydraulic systems, new screens, cleaners, refiners, tanks and tile chests, condensate systems, and a distributed control system, along with associated pumps, agitators, drives, piping, electrical equipment, and instrument controls. Access into the machine room may require new wall or floor openings and cribbing under elevated floors to accept temporary heavy loads.

A preliminary optical alignment check should be made to establish existing equipment integrity.

Plan to have a thorough inspection made of the overhead cranes, accompanied by corrective maintenance to ensure reliability.

New equipment should be received one month prior to the outage and checked thoroughly to ensure that all items have been received. New equipment should be preassembled into large mod-

ules for expedient installation, and it should be staged near its use point.

Any mill-planned paper machine shutdowns can be utilized to make intermediate piping, electrical, and control wiring tie-ins to reduce the work load planned for the longer outage.

The preoutage schedule activities should be planned so they can be done on a straight-time basis for optimum cost. The preoutage work activities should gradually increase to allow the heaviest buildup of work and related manpower just prior to starting the outage. This will allow selection of the best mechanics from all those available, pretraining in safety requirements, and a thorough indoctrination to the outage scope of work.

Outage construction planning. The machine rebuild philosophy is to minimize production downtime by getting as much work accomplished in preoutage as possible and then to use the maximum workforce that can perform safely and efficiently in the tightly congested, confined spaces at the paper machine during the outage. Work should be scheduled around-the-clock with priorities established by the critical path schedule.

Paper machine rebuild constructability planning includes maximum preassembly before shutdown, removing large module sections, concentrated concrete demolition and replacement, and the use of quickset grouts. The normal mechanical ground-up construction evolution sequence should be used and coordinated with associated piping, electrical, and controls. The different craft disciplines should be sequenced to avoid interference and unsafe practices.

The shutdown plan should include the time required by mill operators to empty affected stock and white water chests and tanks so that they can be opened and washed clean. All piping should be flushed and drained. All affected machine clothing and all scrap broke and reels of paper should be removed. The machine should be thoroughly washed to avoid slipping on slime and for fire prevention. Mill maintenance should remove any rolls requiring recovering or grinding to avoid interference with construction. Shutdown timing should be such that the machine is ready "just-in-time" for construction to begin work at the prescribed hour.

The plan should sequence construction completion by process systems that can be checked out individually so there will be an organized startup. This will allow training the mill operators and mechanics while they assist with final checks, including piping flushes and leak tests, motor direction checks, coupling alignment and lubrication checks, and initial dynamic testing. The startup must be closely coordinated with mill operations and vendor service representatives to allow quick final run-in checks prior to and immediately following the clothing reinstallation.

Post-outage construction. Post-outage construction planning includes those activities that can be done after the machine is released for operation. Normally, this includes installing insulation; painting; removing obsolete equipment; piping, electrical, and control equipment; demolishing obsolete concrete foundations and structures; and refinishing pavement.

This low priority post-outage work ensures having a nominal sized construction crew on-site performing useful work which can be stopped at any time for reassignment on the paper machine to correct problems that may develop during the initial trial test runs.

Developing the schedule

Different levels of detail in planning and scheduling are required to organize, direct, monitor, and control the different phases of a project's work progress. The following scheduling documents should be utilized to identify and control the work.

Summary level guide EPC schedule

This is a summary milestone schedule which illustrates the complete machine rebuild work plan from inception through startup. It is calendar-phased and reflects in summary form key process engineering and design points, procurement of major items, and preoutage, outage, and startup activities. It is used as the guide for preparing more detailed schedules and can be used for preparing the estimate's cost escalation and spending curves. It should contain constructability critical-path logic and include mill directed restraints.

Detailed engineering schedule

The detailed engineering schedule should be prepared in concert with the process designers and engineering discipline design leaders using a detailed drawing list and workforce estimates. It should be sequenced in a logical manner so that each design discipline supports and is coordinated with the others.

The schedule content should identify and define work tasks, establish interrelationship milestone events, assign task responsibility, develop critical-path method (CPM) logic, weigh the activity with budgeted workhours, and provide a process to measure engineering progress and productivity through an earned value formula.

The engineering schedule should identify release for design, release for approval, and release for construction dates. The engineering drawings' RFC dates are restraints to starting construction activities.

Procurement schedule and subcontractor schedule

A detailed procurement schedule should be developed utilizing information obtained from the process engineer or available vendor quotes. The schedule should identify specification development and approval for inclusion in the purchase inquiry, quotation receipts and analysis, placement of purchase orders, and delivery of vendor drawings and equipment. An expeditor report should become a part of the material control documents.

Preoutage and outage schedule

A detailed schedule should be developed using fully integrated critical-path precedent network diagrams that illustrate the plan's constructability logic. The start of the construction activities are restrained by engineering drawing releases and equipment delivery. Schedule timing should be such that equipment can be off-loaded and placed directly upon its foundation anchors where possible. This avoids the cost of double handling from storage and the risk of transfer damage and allows construction progress to accelerate.

The construction schedule should be computerized and resources, both workhours and material quantities from the estimate, associated with each activity.

The preoutage schedule should include progress reports and productivity rates. The computerized schedule should be sorted by area, or by discipline responsibility, and include a workforce schedule by calendar week. Weekly meetings should be held to review the upcoming construction work requirements.

The outage schedule should be similar in content to the preoutage schedule, except the calendar should be by shift, each day.

CPM

All schedules should use either arrow or precedent network diagraming to logically sequence the constructability plan and establish a realistic critical path method network.

Computer software

A software package should be used to manage the schedule and provide the following enhancements:

- Identify critical-path analysis, including float
- Provide quick analysis and easily read progress reports
- Provide sorts as desired by area, early, average, and late start and finish dates by category, discipline, or subcontract, printed in barchart or network format by shift and by day, with each task unit weighted with budgeted quantities and workforce hours
- Identify key milestones, including drawing RFC, equipment delivery, interim shutdowns, and other desired enhancements.

The schedule's accuracy is based upon the following assumptions:

- The scope of work is well defined and will not change.
- The engineering design is accurate based upon actual field measurements.
- The engineering design allows maximum preinstallation of new equipment prior to the outage.
- The equipment vendor's quoted delivery dates for both drawings and equipment are accurate as quoted.
- The owner's forecast of routine outages allows periodic progress tie-ins for piping, electrical, and controls.
- Competent construction supervision and craftsmen are available who have previous pulp and paper mill experience and safety training and awareness.
- The existing equipment is correctly aligned and level.
- The existing baseplates are suitable for reuse.
- The overhead cranes are reliable and will accommodate lifts.
- The equipment vendor representative (erector) is competent and dedicated to fast-track compliance.
- Arrangements have been made to ensure early equipment delivery to verify completeness and allow preassembly and prestaging near the machine.
- The new equipment has been preassembled at the factory, aligned, leveled, and bolted out, tapered dowel pins installed, and shipped to the site in large modules ready for quick reassembly; this includes prepiping and tubing, with conduit and wiring running to a splice box mounted on the frames.
- All new control equipment has been preprogrammed, calibrated, and pretested.
- Access into and out of the work area is uninhibited, including aisles, door openings, hatchways, and temporary openings.
- Sufficient competent workforce is available to work shifts around-the-clock throughout the outage.
- No mill labor agreement affects the access and workhours of construction workers.
- Mill operations and maintenance personnel will not interfere or interrupt construction activities and will be available when needed to support startup, checkout, and testing procedures.

These are some of the items normally having an impact on the duration of a paper machine rebuild. If the planner attempts to add time contingencies into the schedule for any variances caused by these assumptions, the schedule will reflect an unrealistic longer duration.

It is essential that the scope of work be well defined and all of the aforementioned factors fully considered when planning and scheduling a project.

Routine schedule reporting

The scheduling documents should be maintained daily with formal reporting frequency as follows:

- The engineering schedule should be updated monthly with progress percent complete by drawing and earned value.
- The procurement schedule should be updated monthly and indicate progress. Expediting reports should be issued weekly.
- Construction and subcontractor preoutage schedules should be updated monthly along with progress reports (weekly one month prior to the outage). A three-week look-ahead schedule and craft performance curves should be distributed weekly.
- The construction outage schedule should be sorted by shift, day, and craft discipline and updated and distributed each shift.
- Detailed work packages which include construction instructions, engineering drawings, bills of materials, and special tools and equipment should be prepared to further enhance work execution.

Project execution plan

The schedule documents described above should control paper machine rebuild projects. They should clearly describe the full scope of work to be accomplished during each phase. Each activity should be scheduled in a selected calendar frame. Activities should be sorted by area and work discipline. Each activity should be

weighted with its budgeted workhours and quantities to allow progress and productivity measurement. Logic network ties establish critical-path relationships. Activities should be arranged in the calendar sequence in which they are scheduled, beginning with the first activity and ending with the final activity.

Paper machine rebuild projects should be executed in the following sequence:

1. Develop the detailed scope of work, cost estimate and spending curve, and summary level project schedule.
2. Review, justify, and receive authorization to proceed.
3. Develop specifications and procure equipment.
4. Prepare design engineering drawings and instructions.
5. Execute preoutage construction.
6. Execute outage and post-outage construction.

The work should be executed as planned and described in the critical-path method schedule. All mill activities should be thoroughly coordinated with the construction work to avoid interference and delays.

A general superintendent should be appointed to supervise and coordinate the work activities on each shift during the outage. He or she coordinates the use of the overhead cranes and establishes priorities when there is simultaneous demand for them. The general superintendent ensures that all work is executed in a safe manner and meets the prescribed quality standards. He or she leads the checkout and startup team, coordinating these efforts closely with the mill's supervision throughout the startup.

As construction work is completed and checked out, mechanics' safety locks and tags are removed from electric starters and isolation valves, and systems are released to mill operation.

A limited number of construction mechanics remain for a nominal period of time to complete post-outage work and to be available for unplanned debugging. TJ

Stewart is service manager, pulp & paper division, at Rust International Corp., P.O. Box 101, Birmingham, AL 35201-0101.