MODULE 5

OUTAGE MANAGEMENT

MODULE 5 OBJECTIVES

- To establish the relationship between job assessment, priority development, and fitting outage work into a schedule when all constraints are identified.
- To appreciate the importance of including manpower levelling and support services.

MODULE 5 TOPICS

- Work management system
- Assessing job
- Evaluation, job impact
- Priority Setting
- Constraints
- Materials and tooling
- Contractor integration
- Manpower and training
- Support Services
- Planning Tools

WORK MANAGEMENT SYSTEM

- Main elements of work process:
  - Work / deficiency Identification
  - Evaluation
  - Scheduling
  - Planning
  - Implementation
  - Package closure

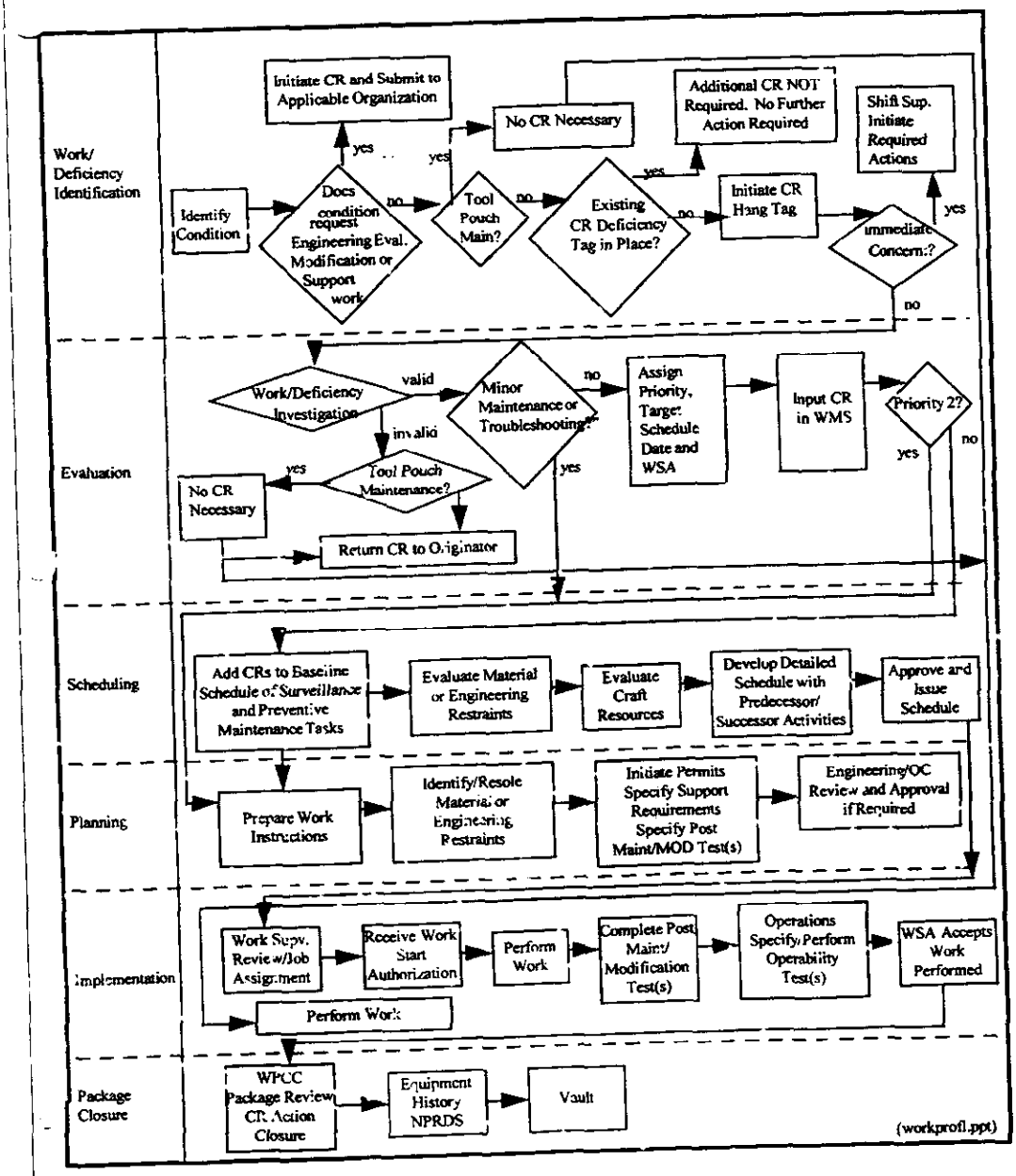
WORK MANAGEMENT SYSTEM

- Accurate estimate of resources is essential
  - Support activities
  - Materials required
  - Manpower
  - Time duration
  - Conflicts / constraints / integration
  - Priorities

WORK MANAGEMENT SYSTEM

- All work must be identified.
- Work is scheduled into an outage plan.
- Detailed planning is done to ensure all information & material is identified for the work.
- All interaction with other systems are identified.

WORK PROCESS FLOWCHART



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ASSESSING JOB

- Assessment of each job
  - Must be done by experienced staff
  - Identification and requisition of required material must be done

ASSESSING JOB

- Support trade activities must be identified e.g.:
  - Scaffolding
  - Insulation removal and reinstallation
  - Support trades - electrical, welders
  - Non-destructive testing
  - Special tooling
  - Special skills staff / crew
  - Special training required

PLANNING AND IMPLEMENTATION OF PLANT MODIFICATION

1. Scope control

    - freeze date important, parts and paper ready to go
    - minimum of 30 days prior to outage (some 60 days)
    - freeze does not mean you can't add something
    - need to have accountability for freeze date

2. Lessons learned should be developed for modifications that go smoothly and or modifications that are difficult to perform. This is especially important for multiple units. Never assume that you will never do this job again.

3. Modification implementation starts with engineering. Need people with installation background as part of the modification team. Walkdowns need to be initiated by engineering and should consider plant and personnel safety.

4. Responsibility for developing modification installation plans should remain with the modification group instead of the planners.

5. More emphasis is needed on modification closure. The modification may be closed with open items, but these items must be tracked with another document.

6. Assign a plant person to work with the craft supervisor to ensure that plant policies are followed.

7. Mock-ups are excellent tools but must be 100 percent accurate.

EVALUATION, JOB IMPACT

- Evaluation and priority setting for an effective outage, scheduling should consider:
  - The elements of an effective organization that participate in scheduling activities.
  - Establish the level of details to be provided.
  - Priorities should be established with go no/go conditions before committing work.

EVALUATION, JOB IMPACT

- Manpower availability, materials at hand, documents on hand etc.
  - Determine the length of each job.
  - Establish policy and practices on use of procedures.
  - Identify shift work and working days and length.

OUTAGE SCHEDULING, HOW MUCH DETAIL

1) **Level of Detail**

- Resource leveling - Most stations do not level resources daily. Those that do, block out a three day window.

- When using the system window concept bulk work is typically completed within the window but it is not individually scheduled.

- Support Activities (scaffold & insulation work) can be effectively managed during an outage as "list item" for the parent work activity. To make this approach successful, effective support activity coordinators are needed to ensure completion of the work and the current status of the "list item" should be reflected on the schedule.

- The number of activities shown on a schedule is based on the need for information by the user of the schedule. As long as schedule activities are properly coded and update meetings ensure the activities current status, the scheduled activities can be condensed.

- Float time can be an effective management tool for tracking scheduled activities. Float time is usually not advertised but can be shown to maintenance supervisors to help prioritize work activities and be used for resource leveling. An accurate status of the work must be obtained before a float time can be generated.

- Scheduling tool usually load-up easily, do not perform "what ifs" by themselves, and are updated once per day. Tools that are too dynamic can be hard to control. These tools supply a daily schedule of work activities and generate work lists for individual groups. System availability plots are generated for operations.

- Post-maintenance testing activities are scheduled in many ways. Scheduling tools are typically used to code retest items. Detailed schedule for post maintenance test activities or a block of time is scheduled at the end of each system window to perform all "list item" Post-maintenance tests.

2) **Outage Lengths and How It Is determined**

- critical path determines outage length
  - activities such as refuel floor activities, steam generator work, and modifications and critical projects
- schedule duration is sometimes based on corporate edict
- outage length is frequently part of the five year plan
- manpower availability sometimes affects outage length

3) **On-line Maintenance**

- most stations expressed a desire to do more
- residents inspectors can impede
- limiting condition for operation (LCOs) only entered to improve safety and reliability
- frag-net LCO work - stations typically use 40 - 60 percent of available limiting condition-for-operation window for planned work
- driving force - some stations do PMs on line but not corrective maintenance unless absolutely necessary.

4) **Schedule Format**

- provide whatever format people will use
- 24 hour day critical path
- provide training to most personnel on schedule format
- front end understanding of milestones is needed

5) **Building the Schedule**

  - create detailed schedule up front to determine critical path & man loading then condense for distribution

This priority system provides guidance for determining the appropriate schedule for activities within the Work Process.

EMERGENCY

Emergency maintenance actions required to be performed immediately to prevent or mitigate the consequences of an accident, prevent the release of radioactive material to the environment or to protect human life and/or property. Emergency maintenance is performed at the discretion of the Shift Supervisor/Emergency Director and MAY start without an approved work package. Emergency Maintenance SHOULD only be used during Emergency Plan events (SPR 930125).

PRIORITY 1

Actions required to restore a system or function to OPERABLE status to decrease the risk of radiation exposure, eliminate a personnel safety hazard, return the plant to full power operation, or satisfy a Tech Spec Limiting Condition for Operation (LCO) action statement. The work SHOULD continue until completed or until the circumstances requiring the priority action no longer applies.

PRIORITY 2

Actions required to mitigate or resolve equipment or component problems which restrict the desired level of plant operation. Priority 2 SHOULD be used only for important activities that must override the normal work schedule.

PRIORITY 3

Actions assigned and coordinated on a routine basis. Priority 3 SHALL be assigned to corrective work that supports plant operations. Priority 3 work MAY be further governed by a scheduling milestone.

PRIORITY 4

Activities which do not impact plant operation or prevent accomplishment of program events or milestones (e.g., rework of non-essential or non-plant equipment, painting, inspections, etc.).

PRIORITY 5

Activities which can be deferred (e.g., outage activities, modifications, activities on hold for budgetary purposes, etc.). Preparatory or prerequisite activities which support a Priority 5 item SHOULD be assigned the priority necessary to provide the required level of support.

EVALUATION, JOB IMPACT

- The major contributors to extending planned outage are:
  - Not having firm criteria before committing to a job.
  - Job turns out to be bigger than initially identified.
  - Equipment stripped down -- then find no spare parts.

EVALUATION, JOB IMPACT

- Modification started
- Drawings wrong
- Interfaces over looked
- Material not available
- Mating parts do not mate

EVALUATION, JOB IMPACT

- Rework required because mid job steps missed.
- Work group not advised of priority - go off for weekend break.
- Appropriate training not provided.
- Start-up/ operating documents not prepared.
- Contract scope not clear etc..., Etc...

PRIORITY SETTING

- Complex process
- Requires good criteria
- Evaluate risk
- Provide for contingency
- Cope with emergent work.

PRIORITY SETTING

- Criteria must be laid down clearly & communicated to all.
- Various dead lines must be met in preparing for the planned outage.
- Team leaders must have check list & be accountable for ensuring all criteria are met.
- Outage manager should personally approve the commitment to every job.

PRIORITY SETTING

- Moving ahead on the basis of promises is a high risk venture & should only be done after careful consideration and with only a few jobs.
- The continuous improvement program is the best way to enforce a disciplined approach on the outage management.

PRIORITY SETTING

- For plant revamps the following 7 points must be considered
  - Scope control
  - Lessons learned
  - Modification implementation
  - developing modification installation plans
  - emphasis needed on modification closure
  - Ensure plant policies are followed
  - Mock-ups must be 100 percent accurate

MOTOR OPERATED VALVES (MOV)

PRE-OUTAGE PREPARATION

Pre-Outage preparations were successfully implemented for 1RE06 Motor Operated activities. Major activities included:

- Scope was established in advance of the outage

- The following supporting activities were completed in advance of the outage:
  - Trailer/furniture setup
  - Communication installation
  - Scaffolding for initial MOV activities
  - Walkdowns by MOV craft
  - Material verifications and parts staging
  - Preparation of contractor mobilization/demobilization plan
  - Contractor manpower was selected and approved.
  - Contractor certification requirements/in processing and training (reduced to 4 days)

- Outage scheduling support was supportive to the successful implementation of the MOV work by:
  - The coordination/levelization of MOV work activities with bus outages, LLRTs and system requirements.
  - ECOs were prepared, reviewed by the trades groups and were available prior to start of the outage.
  - System conflicts were identified and resolved prior to the outage by the NSSS or BOP Coordinator.

- Scope additions were controlled. In each case the MOV Group was consulted as to its ability to perform the required work in the specified duration.

RESPONSIBILITIES

Responsible for implementation of the Motor Operated Valve work scope.

HOW WORK PROCEEDED

Work proceeded well. Work starts were provided essentially as scheduled. All moves performed as required during shutdown. Therefore there was no scope expansion resulting from the plant shutdown. Potential changes in the schedule were identified by the Outage Directors and discussed prior to implementation.

This proved to be very critical as it allowed the MOV Group to develop work-around or prioritize work to support the advances in the schedule. MOV work never became a critical path activity during the outage. All PMTs were completed satisfactory . No rework was required. Additional scope was able to be incorporated without impacting baseline activities. Work was performed utilizing a day and night shift for a duration of 17 days straight without a break in order to support the established MOV schedule. Manpower performance was monitored and the extended work duration did not impact the quality of the work. The completed work scope for the project comprised of:

- 69 lube/inspects
- 31 corrective work orders
- 18 static tests
- 4 dynamic tests

The internal outage goals established by the MOV Group addressing personnel safety, human performance errors, nuclear dose and schedule adherence were all met. The success of this outage can directly be attributed to the support of:

- Outage Planning
- NSSS/BOP Outage Coordinators
- Health Physics
- PMPI for scaffolding/insulation support
- Purchasing
- Planners
- Operation Coordinators assigned to the MOV Group

The cost for contractor support was below the authorized level as a result of the early completion of scope and the release of contractors in advance of the mobilization schedule.

WHAT WORKED WELL

The major contributors were:

- Experienced and integrated MOV Team
- Assignment of 2 Operators to assist MOV implementation during the outage.
- Earlier identification of scope
- Scope addition control
- Implementation of the One Stop Shop
- Experienced Outage Coordinators
- Integrated MOV schedule
- Previous development of 5 year MOV testing schedule
- Midloop coordination and communication
- Performance of MOV testing at power reduced outage scope

AREAS FOR POTENTIAL IMPROVEMENT

- MOV scope for the Circulating Water valve/pipe inspections was identified late.
- Requirement of a trailer to house staff augmentation is no longer necessary.
- Working Monday through Friday the week before the Unit was shutdown did not allow a break in the calculation of overtime exceedence (i.e. the outage started Friday evening and the MOV Group was required to work Saturday).
- Failed to request required beepers for communication.
- An opportunity was lost when the MOV Group refurbished the actuator of HD-0370. Consideration was not given to recapping the valve in parallel with the actuator work even though there was no CR written against the packing. Subsequently during power ascension, the packing blew and a Rubanite injection was required as the valve was unable to be isolated. Recommended solution provided in Recommendation Section under "Packing".
- Reduce administrative support from 2 individuals (1 day/1 night shift) to 1 individual on days only. Program has become streamlined and the resource can be better utilized elsewhere.

RECOMMENDATIONS:

- Operations Support:
  Continue assignment of 2 Operators (1 day/1 night shift) to facilitate work implementation. A key to surviving the anticipated schedule changes was the use of the Operators to develop daily listing of potential work that could be advanced if MOV trade group resources were available. This list was then reviewed and approved by the Outage Co-ordinators. Consideration of utilizing the night Operators to reduce manpower requirements by 1 individual.

- Packing Recommendation:
  All MOV valves which could not be isolated and contained within the outage should be considered for repackaging based on a review of its work history to determine the last time repacking was performed.

- Increase Emphasis on BOP Valve Health:
  Develop planned refurbishment program for MOV actuators and valves to minimize operational failures while at power. This would allow better input into the outage schedules.

- Actuator Refurbishments:
  Evaluate the economics of installing a new actuator rather than rebuilding actuator in-place. The old actuator could be removed/rebuilt after the outage and returned to inventory. This could significantly reduce the installation duration in the outages. As a result more MOV work could be accomplished without expanding outage duration.

- Reduction in Administration Support:
  Reduce administrative support from 2 individuals (1 day/1 night shift) to 1 individual on days only. Program has become streamlined and the resources can be better utilized elsewhere.

- Overtime Exceedance:
  Work a 4-10 schedule the week prior to the outage. This would provide Friday as an off-day and allows overtime to coincide with the start of the outage.

- Circulating Water Project Management:
  Consider assignment of a Project Manager to the upcoming 2REOS Outage. The work presently scheduled exceeds that contained in 1RE06. The duration provided to accomplish this work in 2RE05 is extremely limited.

PRIORITY SETTING

- A effective outage schedule has the following three major components
  - The normally scheduled activities
  - Contingency activities
  - Allowance for emergent work

PRIORITY SETTING

- Contingency activities should be selected based on the following three criteria.
  - Potential impact to the shutdown philosophy.
  - Potential impact on outage duration.
  - Historical data on equipment with previously high test failure rates or difficult repair histories.

PRIORITY SETTING

- Preparation of contingency items should be completed as if items were going to be installed.
  - Prepare engineering/design or other work packages.
  - Procure all parts.
  - Schedule & allocate manpower.
- All contingent items should be budgeted & accounted in cost control system.

MANAGING CONTINGENCY

In Websters dictionary "contingency" is commonly defined as "uncertain," "chance" and "unforeseen", not words we want to associate with an outage.

Central to this definition is that when we speak of contingencies, we speak about dedicating resources. A contingency plan with resources dedicated to it has a much greater chance to be successful than a plan that sits as an idea in someone's head or in a folder in someone's file cabinet. When it becomes necessary to execute your contingency, something undesirable has already happened to require the use of an alternate plan. We want that alternate plan to be ready to work. If there is an overriding message it is "treat your contingency plans as if they are really going to happen."

An effective outage schedule consists not only of your defined outage scope but also of your plan of action when things don't go your way. A schedule is actually comprised of three components. First, of course, is the defined scope. Second are the items we select to include as contingencies. These items are built into the schedule and are listed as work items with a contingency flag when the schedule is issued. Third is a manpower allowance for emergent work. By emergent work, I am referring to those truly unexpected surprises that are part of all of our outages.

Successful contingency planning was based on dedication of resources. Obviously, selection criteria for contingencies is equally paramount. Let's face it, you can't plan for every problem or failure among thousands of scheduled activities. Targeting the proper activities allows for better allocation of the resources devoted to contingencies. Selection criteria should focus on areas of the schedule that are either most vulnerable to the impact of delays or likely to have delays, scheduled and resource loaded. A task of this magnitude needs to be thoroughly planned and staged prior to the outage start in order to minimise its impact if it becomes reality.

A third selection criterion is historical equipment data. If a component has had a high test failure rate or has been difficult to repair, we try to include an activity to encompass past difficulties.

PRIORITY SETTING

- Emergent work.
  - The outage schedule should make allowance for this new work.
  - Emergent work should be reviewed against the shut down safety policy.
  - Emergent work should be accounted for by the cost control system.
  - The post outage critique should include an analysis of the causes for emergent work.

EMERGENT WORK

No discussion of contingency planning would be complete without the inclusion of planning for emergent work. No matter how successful your contingency planning is, the ability to handle emergent work-work that is totally unexpected is essential to the safe, timely completion of an outage. While a key to successful contingency planning is using existing plant work and review processes to schedule targeted items prior to an outage, the ability to handle emergent work centers on the capacity for review and control of new and divergent work during an outage. To achieve proper execution and control of emergent work requires allocated resources above and beyond those described previously. It should be policy to maintain a percentage of your maintenance force available to handle emergent work. When we schedule work for plant maintenance, we manload those work groups to a target between 70 to 80 percent for each outage day. This leaves 20 to 30 percent of this work force available to handle emergent work.

CONSTRAINTS

- Identification of constraints on work is essential to ensure smooth coordination.
  - Constraints have major impact on the overall work of a planned job.
  - Impact on other work. i.e. the need for electrical.
  - Heat treatment of weld may impose longer duration.

CONSTRAINTS

- Precaution to guard against fires / explosions require purge gases?
- working in enclosed vessels require ventilation.

- During pre-outage planning, it is important to identify constraints.
- Build flexibility into management of the outage.
- Avoid an undisciplined approach.

MATERIALS & TOOLING

- Proper material and tooling must be available for a successful outage.
  - Lack of either significantly inhibit a scheduled job.
  - Requisitioning material may have to be done years/ months before outage.
  - Verifying correct material has been delivered. Must be done as a pre-outage activity.
  - Verifying condition of material is satisfactory as a pre-outage activity.

MATERIALS & TOOLING

- Spare parts, identification, requisitioning, procurement & availability to avoid lengthy disruptions - pre outage activity.
- Maintenance dept. accountable for spares.
- "Tools", means tools and equipment such as cranes, lifting slings, jacks
- Test instruments such as ultrasonic detectors, electrical hi pot testers.
- Containers to remove waste.

CONTRACTOR INTEGRATION

- Contractors must be a integral part of every stage of outage .
- Contractors must be part of the team with appropriate representation at pre outage meetings.
- Work scope & responsibilities must be clear & agreed to.

CONTRACTOR INTEGRATION

- Collective agreements must be addressed, potential conflicts or modification resolved before outage starts.
- An owners representative must be available to supervise/manage contract work.
- Training requirements for contractor staff to be considered.
- Safety precautions, emergency response, work protection practices.

Control Of Contractors and Travelling Crews

1 How is contractor performance monitored during an outage?

- Have a penalty/incentive contract for contractor. Incentives are based on overall outage length, returning supervisors, and individual contractor performance (such as man-hour, safety, cost, ALARA and quality).

- Develop set of performance indicators to monitor contractor performance. Development of these performance indicators should be objective to measure performance.

- Performance is rewarded down to the worker level based on performance, safety, and attendance. Give rewards such as hats, pens, parties and belt buckles.

- Important to make sure that the rewards are justified and evenly distributed.

- Key to using contractors, is to make the contract people feel part of the team by rewarding good performance.

2. Advantages/disadvantages of mixing contract and station craftsmen include:

- Group experience was that this has not worked very well. Some success has been seen with the I&C area.

- Disadvantage is turf battles between in-house people and outside union people. Concern for job security and longevity if work is given up to contract groups.

- One way to work these groups together is to use the plant person as a supervisor and provide union supervision to provide assistance in contract dealing.

- Key to getting work groups together is to understand what motivates each group and work these groups to meet their needs.

3. How are traveling crews from other company stations used?

- One utility has just started to use people from other plants within the same system, but does not have experience in this area.
- Another has used them for turbine work and scaffolding, but does not typically use them for safety-related work.
- Problems were identified with travelling crews in the areas of training, fitness for duty, and background investigation.

4. Several of the utilities have long-term maintenance contracts ranging up to five years. Benefits include less cost involved with bringing personnel into the site to work, build better working relationships with the utility, and better understanding of utility work practices. Additionally, long-term contracts improve the quality of personnel on site from the crafts provided since you don't have a constant turnover of personnel.

5. Drawbacks to long-term relationships include:

- complacency and a tendency to take them too much for granted on how they will perform in the future—Need to periodically re-evaluate the relationship with the contract force

6. Methods used to prepare contractors to perform assigned work include the following:

- common qualification between sites within the utility
- use of craft labour to do training or mock-up for work that they will do during the outage

- development of training course that gives training on procedures rather than using required-reading type formats to get this information to the contractor.

- should develop a listing of what procedures are needed to perform a job and train on those items

MANPOWER LEVELING

- Manpower leveling; this major resource must be carefully planned.
  - Primary concerns; accurate estimates for all jobs.
  - Secondary concern; proper mix of trades, no oversights.
  - Last but not least; operator support for trades actions.
- Manpower leveling for operators can be the most demanding.

MANPOWER LEVELING

- Consequences of not having operators at the right time.
  - Lots of trades staff held up from working.
  - System/ services not available & causing delays.
  - Systems not removed/ returned to service in timely manner.

MANPOWER LEVELING

- Manpower leveling is a key job for field supervisors
  - Computers show profile of manpower requirements based on the input .
  - Computers alone cannot solve the problems.
  - No substitute for field supervisory experience

SUPPORT SERVICES

- Support services; a major resource during an outage and must be managed accordingly.
- Support services must be integrated into the outage plan, particularly those that have plant-wide effects. i.e.. electrical
- Provisions have to be made during pre-outage planning for temporary services

SCHEDULING ELECTRICAL BUS OUTAGES

1. How are bus outages scheduled?

- Some schedule both bus trains down during each outage Others schedule every other train each outage.
- Bus outages integrated fitted into the overall schedule (worked to the maximum extent possible
- About half the work on electrical buses support safety related equipment around the clock, half do not.

2. How is impact of bus outages on affected loads taken into account?

- Operations/schedulers take lead for impact of bus outages on other departments.
- Having good feeder lists a necessity/maximize use.
- Use of critique sheets as a lessons learned tool for next outage on buses. (Helps others learn from previous mistakes, etc.)

3. Precautions taken when using temporary power include the following:

- Temporary modifications used and/or bypass jumper system used to install temporary power.
- Temporary services such as electrical power should be identified in the schedule.
- Historic temporary supplies turned into permanent supplies

4. What training do operators get on details and consequences of safety related bus outages?

- Some use the limited capabilities they have available on the simulator to simulate casualties.
- Operations manager briefings to operating crews during requalification training--cover schedule on the outage

SUPPORT SERVICES

- Examples of support services
  - electrical power
  - ventilation
  - service water
  - purge gasses
  - computer networks and terminals
  - chemistry analysis/ sampling
  - quality assurance processes/ checks (company)
  - governmental/ institutional/ codes/ licensing

PLANNING TOOLS

- Computerized planning tools provide the following:
  - Cope with large numbers of individual jobs.
  - Allow speedy computation of resource requirements.
  - Assist in defining the critical path(s).
  - Identification of constraints.

PLANNING TOOLS

- Adaptable for "what if..." Scenarios
- Convenient for updating
- Convenient for modifying schedule
- Good historical record
- No substitute for real brains and experience

OUTAGE SCHEDULING

A. INTRODUCTION

An effective schedule should assist management in maintaining a conservative approach to shutdown safety and in controlling and directing the outage, and should enhance the ability to assess progress. The schedule reflects the long-range plan and day-to-day activities. Effective scheduling can enhance the efficient use of resources significantly by decreasing duplication of support work, decreasing craftsmen's idle time, and ensuring completion of planned tasks.

This chapter provides some important considerations for schedule development.

B. DISCUSSION

Scheduling, an integral part of the overall preparation for outages, is performed concurrently with the planning activities covered in "Outage Planning". The integrated outage schedule is built on details developed during the planning process such as work scope, priorities, job duration estimates, prerequisites and activity interrelations, resources and constraints.

A properly prepared and updated integrated schedule can be a tool to assist in managing outage work. Outage performance cannot be optimized if a schedule is not available to control and properly sequence outage tasks. Sufficient detail should be included to coordinate activity and track progress. More efficient use of support resources can be achieved by grouping individual work items and integrating major tasks. System windows and supporting umbrella tagouts have been used effectively to group work activities, optimize safety system availability, minimize resource needs, and simplify the schedule.

The integrated schedule should form the basis for outage progress reporting and it will remain useful if updated frequently as based on the progress reports.

Effective daily schedules are needed to implement the outage plan represented by the integrated schedule. Management should track and periodically assess performance with respect to the daily schedule. Effectiveness of the daily scheduling process during normal operation can be a good indicator of how effective the daily schedule will be during outages.

The integrated schedule should be reviewed by those responsible for implementation. A critical review for shutdown safety considerations also

should be performed. The schedule should be accepted and widely used by personnel involved in the outage. Preparation of schedules for contingencies

will decrease the time necessary to respond to problems if they occur and will increase the information available for decision-making.

C. GUIDELINES

1. Schedule Requirements

The schedule should be a management tool to control and direct the outage. It should emphasize and embody managements safety expectations and assist managers in ensuring that safety margins are maintained. It should be used by management to determine the critical path and explore alternatives when needed. The outage schedule should be a concise method for tracking completion of outage work, particularly critical path activities. The following are some of the attributes that should be included in the schedule:

- The schedule should be useful. Those individuals expected to follow the schedule must understand that it will make their tasks and the tasks of others easier. They also must understand the importance of their tasks in relation to the outage as a whole

- There should be one overall schedule. The overall schedule should be developed such that a hierarchy of reports of varying detail can be obtained from a common data base. It generally has proven difficult to keep two or more schedules from different data bases consistent during an outage, especially when significant differences in level of detail are shown.

- The schedule report format and level of detail should be appropriate for the user. The level of detail needed by the station manager differs from the level of detail needed by a craft foreman.

- The schedule should be a proactive tool for managing the outage rather than simply be an historical document.

- The schedule should be credible. It should be based on the best information available and reviewed and accepted by those actually responsible for doing the work.

- The schedule should be up to date. The schedule should be updated to reflect changing situations to maintain credibility throughout the outage.

- The schedule should be flexible, within the overall goals of the outage, to produce optimum results in dealing with unanticipated events.

2. Schedule Methods

A computerized scheduling system should be used to be responsive to the needs of managing an outage.

Computerized scheduling offers the following advantages:

- rapid update capability

- ease in exploring alternatives

- resource determination and leveling

- identification of work-site congestion

- reports tailored to user

The success of a computerized planning and scheduling program is very dependent on the knowledge and experience of planning personnel and on the management support, training, and emphasis placed on its use. All supervisory personnel should have a basic understanding of the schedule program appropriate to their needs and uses of the schedule. Training sessions held before the outage can enhance this understanding and explain the reporting, updating, and adherence policies.

3. Schedule Detail

The detail included in the overall outage schedule should ensure availability of safety systems and coordination of work and permit assessment of outage progress. It particularly is important to include details of tasks that have interfaces among the various crafts and support personnel. The following are some examples of the coordination required:

- Operators should be able to anticipate tagout needs and system line-ups for testing and return to service.

- Plant safety personnel should be able to determine in advance the needs for work permits and technician support.

- Quality control personnel and other inspection groups should be able to anticipate the need for their presence at the job site.

- Critical resource needs, such as the polar crane, should be provided in sufficient detail to avoid interference, conflicts, and work delays.

- Major work protection actions, such as initial containment and cavity decontaminations and initial installations of temporary services should be scheduled events.

- Major support activities, such as scaffolding erection, should be adequately defined in the schedule.

For minor jobs, some stations have been successful in identifying support requirements, such as tagging and work permit (WP) requirements, within the coding structure for activities in the schedule. When this is done, it is very important that sufficient training and familiarization be given to enable personnel to interpret the coding easily. Generally it has been necessary to explicitly schedule the support needed for major tasks rather than use only activity coding. A sufficient number of activities should be scheduled to ensure the short-term visibility needed for work coordination and progress tracking. Milestones should be defined for the completion of logical collections of tasks such as jobs within system windows.
These intermediate milestones can provide an overall measure of the progress of the outage and identify tasks significantly behind schedule. Management then can take appropriate corrective action.

Associating detailed work lists with a single scheduled activity such as a system window rather than explicitly scheduling start dates for each job has proven useful. This provides visibility of details but permits the individual tasks to be managed by the responsible departments and/or first-line supervisors. This is successful only when a particular sequence of completing the work is not required, the support and interface requirements are minor, and both a strong daily schedule and good communications exist. Note that the completion of the individual jobs must be closely monitored and progress tracked, or there is a risk that delays in completion of one or more of the jobs can result in major schedule delays.

4. Daily Schedules

Daily schedules ensure that work is coordinated properly even when last-minute schedule changes occur. A daily schedule generally is used as the basis for discussions at daily outage meetings. The daily schedule may be generated by the computerized scheduling program itself or developed separately from information contained in the scheduling program data base.

It is desirable that the daily schedule format used during outages be similar to the daily schedule format used during operations. This avoids the necessity for personnel to be familiar with two methods for controlling activities.

A three-day, look-ahead schedule issued daily has proven useful at many stations. This schedule provides the detail necessary to control the present days' work and provides an opportunity for craft planning over the next few days without an unreasonable amount of data. Extending the look-ahead period longer than about five days and not issuing the schedule on a daily basis increase the risk that data will not be current when needed.

A detailed review of the daily schedule should be an integral part of shift turnover activities to ensure that the oncoming shift is familiar with any short-term adjustments made to the schedule. This is particularly important for control room turnover to ensure that operators know the status of the plant and are familiar with near-term outage work, including tagging needs.

5. System Windows and Umbrella Tagouts

The use of system windows and umbrella tagouts was discussed in "Outage Planning." One of the first steps in developing the overall integrated

schedule is to arrange the system windows logically and tie them to the overall operational plan for the outage. Requirements for safety system availability should guide the arrangement of the windows. Using schedules from previous outages, adjusted to reflect current plans, often can assist in this effort. Over time, basic generic schedules for outages or portions of an outage can be developed and optimized. These generic schedules can form the basis for detailed outage schedules and thus avoid the need to reinitiate the schedule each time.

Activities associated with testing and return-to-service should be completed as soon as possible, preferably before the end of the system window, rather than waiting until near the end of the outage. This will maximize the availability of systems that could be used to mitigate the effects of unexpected events.

6. Schedule Preparation

The following items should be considered during the schedule preparation process:

- The schedule should reflect a conservative approach toward plant safety system availability based on existing plant conditions.

- The schedule should be success-oriented (i.e., contingency plans, with associated schedule duration increases, should not be included). If a contingency plan must be implemented, the schedule then should be revised to fit the particular situation.

- The schedule should be challenging but achievable. It should be consistent with the goals set by management.

- Work should be scheduled using system windows to the maximum extent practical.

- Work items should be coded to identify their discrete locations in the plant. They then can be reviewed by work location to assess the degree of area congestion, minimize duplication of support work such as scaffolding and insulation removal, and improve ALARA planning.

- The schedule should be manloaded and the sequence and timing of activities adjusted to ensure that resource requirements are consistent with resource availability.

- Tests, inspections, or other tasks that could identify additional work should be scheduled as early as possible in the outage to permit time for completion of the additional work within the established outage envelope.

- Significant as-found, post-maintenance, and post-modification testing should be explicitly scheduled. Time should be allotted for testing, line-up, and other activities required for returning systems to service.

- System interactions and operator resources should be considered when scheduling system and plant startup.

- Work on the least reliable train should be scheduled first to ensure that the more reliable train is always available, thus minimizing the potential for unexpected failures.

7. Schedule Integration

Integration of major tasks is a key to successful schedule development. There should be one all-inclusive schedule that includes work to be done by off-site contractors and plant organizations contributing support to the outage, as well as work to be done by site personnel.

Details for specific tasks should be provided by personnel responsible for those tasks. Networks prepared by the responsible organization have proven useful in providing this information. The planning organization should integrate these details into the overall outage schedule.

Manpower and support requirements should be included for maintenance activities. Work that should be integrated includes preventive maintenance, corrective maintenance, modifications, surveillance testing, and in-service inspections.

Off-site contractors should be involved in early planning to ensure their work is integrated into the overall schedule.

8. Schedule Review

Schedule users, including off-site organizations and contractors, should be required to review and comment on the schedule. Several reviews during

the preparation process frequently avoid last-minute problems during the final review. Comments should be resolved before the next revision of the schedule. Support of this activity by line managers is key to ensuring plant safety as well as the success of the outage schedule.

An important aspect of schedule preparation is a critical review. The review should be performed by individuals knowledgeable about the plant, safety requirements, and managements' safety expectations. Some Plants have used multidisciplined groups or the independent safety engineering group (ISEG) to perform this function. This review should identify periods during the outage of particular vulnerability to events such as loss of decay heat removal and loss of power (on site and off site). Rearrangement of system windows should be considered where this will increase the margin of safety, maximize safety system availability, or enhance means to mitigate unexpected events. The results of this review, including the assumptions used and compensatory actions recommended, should be documented. Key station personnel, particularly operators, should be familiar with the review to prevent decisions made during the outage from undermining the assumptions and results of the review.

The reviews should be conducted early enough that the identified changes can be incorporated into the schedule without unduly impacting outage preparation activities. Last-minute schedule changes can impact safety in undesirable and unexpected ways. Manpower loading, parts availability, testing, procedure development, and many other important factors are put into a state of flux if system windows are rearranged just prior to an outage.

The rationale behind specific schedule decisions should be documented and explained to those responsible for implementing the schedule. The explanation also should include the effect of this change on other activities.

Opportunities for schedule improvements should be explored during the review process. This should include review of the technical specifications and other regulatory requirements to determine if changes are possible that could result in work efficiency, shutdown safety, or schedule improvements.

9. Schedule Adherence

Pre-outage planning and schedule integration are effective only if the schedule is followed. Results from the schedule safety review easily can become invalid if the schedule and work sequences are changed without regard to the basis of the review and logic of the schedule. Significant schedule changes should receive reviews similar to the initial reviews of the

schedule. Managers and supervisors should understand that taking systems out of service and performing work out of sequence can degrade the safety margins built into the schedule during pre-outage planning.

10. Format, Progress Reporting, Updating, and Distribution

The schedule should be viewed as a tool by everyone involved in the outage. The information provided to individuals should be commensurate with their responsibility and authority.

The following points on schedule distribution should be considered:

- Detailed information should be limited to the needs of the recipient. For example, a mechanic overhauling a valve may need only start and finish times. The foreman, however should know the work scheduled several days in advance so he can ensure that tools, materials, and required support will be available when needed. The discipline superintendent will require advance schedule information for all his work so he can plan assignments.

- Progress information should be summarized for management personnel, emphasizing problem areas and potential problem areas. Progress associated with the critical path or near-critical path should receive particular attention.

- The schedule information provided should be concise and understandable to the user.

The fundamental principles of a progress reporting system should be simplicity, accuracy, and timeliness. The individuals responsible for the work also should be responsible for progress reporting. To be most effective, the reporting system should be structured to be useful to those reporting and doing the work. The information requested should be limited to the minimum required.

The individuals responsible for progress reporting should be selected by name in advance of the outage. Training should be held for those selected to ensure they understand the reporting system, the information needed, and how the information will be used. The need to report problems should be emphasized. Reporting will be more accurate and timely if the need for the data is understood fully. Vendors and contractors should be included in the progress reporting system as appropriate.

Progress can be reported in a number of ways, some of which depend on the particular scheduling system used. For some systems, reporting start date and remaining duration of the activity has been effective. An effective method is marking up daily schedules used by the work groups and returning them to the scheduling organization. Reporting progress relative to intermediate milestones also is useful.

As mentioned earlier in this chapter under C.1, "Schedule Requirements," the schedule should be current and updated regularly, based on the progress reports. The frequency of updating will depend on the rate of change. For major changed and changes affecting the critical path near-critical path, daily updates may be necessary. The schedule should be maintained credible and should provide the guidance needed to those responsible for performing the work.

CONCLUSION

- Plan the work; Work the plan.
- A well thought out schedule results in a well run outage.
- Well run outage is cheaper than a poorly run outage.
- The principles & techniques for scheduling are an investment with an excellent return.
- Improved outage schedules improves, plant capacity; reliability costs & safety.

RECOMMENDATIONS

- Analyze past performances of company outages & identify areas for improvement.
- Analyze degree of preparation & evaluate the effectiveness of each element of organization.
- Consider roles & responsibilities for contribution to outages for the various departments. Is there an optimal 'outage organization'? Is there a disciplined approach to meet deadlines?