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SHUTDOWN • TURNAROUND • OUTAGES

Best Management Practices

Key Principles for Successful Shutdown Maintenance Planning

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Maintenance Planning and Scheduling Handbook

Richard Palmer and Associates

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Key Principles for Successful Shutdown Maintenance Planning

- **Introduction to Effective Planning and Scheduling**
  - Benefits of planning and scheduling
  - Additional requirements beyond
  - Principles of planning
  - Principles of scheduling
  - Considering reactive work

Key Principles for Successful Shutdown Maintenance Planning

- **Moving from Weekly Maintenance to Outage Maintenance**
  - Accuracy of task estimates
  - Cycle of improvement, the outage report
  - Controlling scope
  - Short notice outages versus planned turnarounds

Key Principles for Successful Shutdown Maintenance Planning

- **Organizing and Executing Shutdowns**
  - Outage organizing
  - CMMS benefits and cautions
  - Pre-outage, during-outage, and post-outage tasks
  - Defining outage success

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Introduction to Effective Planning and Scheduling

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Benefits of planning and scheduling

Consider P&S for non-outage maintenance

- It's *not* about parts and tools
- It's *not* about using a computer
- It *is* about getting more work done
- Why do we plan?
  - To increase productivity – right answer
  - To provide job packages – wrong answer

Benefits of planning and scheduling

- Tradesperson **“wrench time”** commonly thought to be “80% or so”
- Actual industry avg between 25% & 35%
- Improving from 35% up to 55% wrench time is a 57% improvement (55/35)
- 30 mechanics X 1.57 = 47 mechanics (17 free)
- (Improving from 25% up to 50% would double workforce; 30 free mechanics)

Benefits of planning and scheduling

- 1 planner can plan for 20 to 30 tradespersons
- Value of 1 planner = 17 tradespersons
- Industry rule of thumb: $1 invested in proper maintenance = $10 plant profit
- Value of 1 planner=170 tradespersons?
  - There is money involved

Additional requirements beyond planning and scheduling

- Workforce focus on quality
- Leadership/communication/teamwork
- Storeroom/tools/shops
- PM/PdM/project work
- Skilled workforce including supervision
- Proper work processes

Essence of planning and scheduling

- **Planning** supports improving individual jobs repeated over time: a cycle of improvement for each job
- **Planning** supports advance scheduling by identifying craft skills and labor hours
- **Scheduling** sets goals to assign a sufficient amount of work

Six principles of PLANNING

1. Planners **separate** from crews
2. Focus on **future work**, not chasing parts on current work
3. History **files** at component level
4. Use **planner skill to estimate** labor hours
5. Plans recognize **skill of tradespersons**
6. Recognition of **wrench time** issue

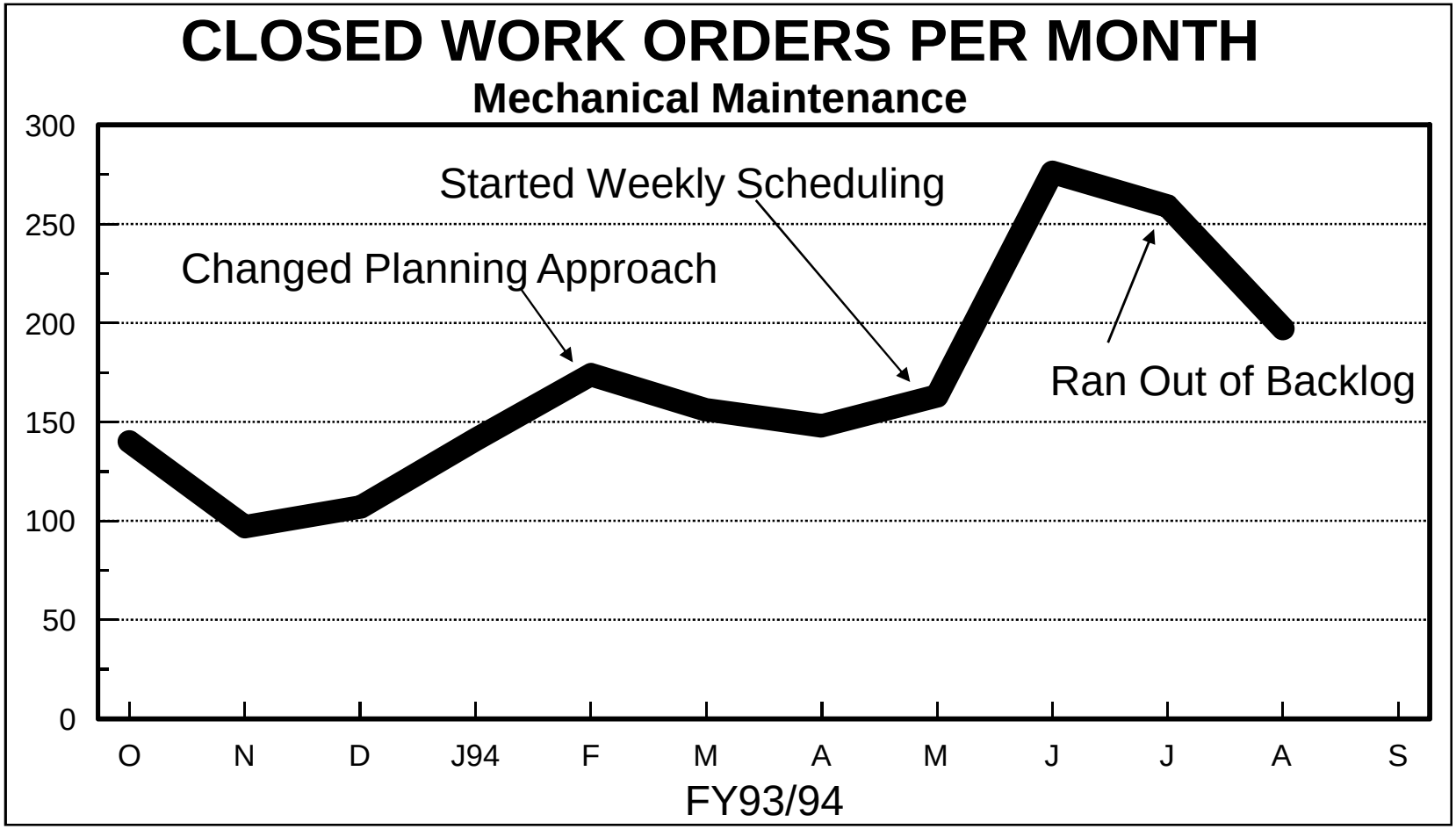
Six principles of SCHEDULING

1. Need **job plans** with craft skills and labor hours
2. Credible **priority system** in use
3. **Forecast** crew labor availability for **week**
4. “Schedule” **100%** available labor hours
5. (**Crew leader** handles daily schedule)
6. Measure weekly **schedule success**

Must consider REACTIVE work

- It's **"okay"** to break the schedule
- Reactive work
  - Don't make crews wait
  - Plan differently: Peek at job and history file; plan scope, skills, and hours
- Emergency work (Unit is down)
  - It's "okay" to chase parts

Success in routine maintenance



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Moving from Weekly Maintenance to Outage Maintenance

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Accuracy of task estimates

- +/- 100% for individual tasks
- +/- 5% to 10% for aggregates of tasks
- **Application:**
  - We can use estimates to control work
  - Don’t get excited about a single task
  - Look for overall progress in areas

Cycle of improvement

- We repeat maintenance over time
- We repeat outages over time
- **Application:**
  - Improve time estimates and quality of individual jobs and outages over time
  - Must have files and good record keeping
  - It's "okay" if "this" outage is not perfect

Cycle of improvement: Files

- Good library
- Outage notebook and outage checklist
- Evolve shutdown and startup checklists
- Hold critique after outage including managers and tradespersons
- Each project manager within outage must write a report following “**project closeout** outline”

Cycle of improvement: Files

- **Project closeout reports**
  - Title and description
  - Work order #
  - Project mgr
  - Start date and substantial completion date
  - Punch list completion date
  - Contractor and subcontractor
  - Purchase order # and issue date

Cycle of improvement: Files

- Project closeout reports (continued)
  - Final project cost
  - Warranty end date
  - 4 copies O&M manuals delivered to maintenance planning dept including
    - Copy of approved submittals (cut sheets)
    - Table of contents
    - Lubrication and PM recommendations
    - Spare parts list
    - Correct size 3 ring binder

Cycle of improvement: Files

- Project closeout reports (continued)
  - Inventory
    - Request to planning dept to add new
    - Request to planning dept to delete obsolete
  - Drawings
    - New drawings hard copy and electronic with equip #'s, meaningful titles, and "as-built"
    - Revisions to existing drawings clearly marked for draftsman to understand

Cycle of improvement: Files

- Project closeout reports (continued)
  - CMMS (Computer Maint Mgt Syst)
    - Obtained new equipment #’s
    - Submitted list of obsolete #’s
  - Training
    - Conducted for Maint and Opns as necessary
    - Submitted any operational procedure changes to Opns
  - List of any special tools used

Controlling scope

- Why? To limit **scope creep**
- Need cut off dates for adding scope
- Need process for adding scope

Controlling scope

- **Know why** we are doing this outage
  - To make a successful investment – right
  - Tradition or To get it done – wrong
- Is outage needed?
- Equipment problems including wear
  - Don’t just fix symptoms every outage, solve root causes
- New technology

Controlling scope

- **Have a strategy** for outages overall
- Plan knowing strategy
  - Large outage every 5 years or
  - Component outage every 2-3 years (HP/IP, LP)
- Do as much as possible outside the outage
  - Yet consider ease of clearing equipment for work
- Publish 1 year and 10 year outage plans
  - Update monthly

Controlling scope: Outage plans

One Year Outage Plan for June 2006 (by season)

Changes

None since last month

New outages

None since last month

Fall 2006 outages

NS 2	TURBINE UPRATE	(10/25/06 – 12/19/06)
NS CT 6	MAJOR OUTAGE/TURBINE WHEEL REPLACEMENT	(09/15/06 -12/15/06)

Spring 2007 outages

NS CT 5	HOT GAS PASS INSPECTION/TURBINE WHEEL REPLACEMENT (ROW 1-3)	(02/17/07 - 05/11/07)
PP 1	INSTALL NOx TIE INS BLR/BFP TURBINE VALVES	(02/24/07 – 04/02/07)
NS 1	INSPECTION/REPAIRS	(4 WEEKS SPRING 2007)
KS CT 7	COMBUSTION INSPECTION	(10 DAYS SPRING 2007)
NS 3	GENERATOR REWIND	(11 WEEKS BEGINNING IN MARCH 2007)

Controlling scope: Outage plans

Ten Year Outage Plan for June 2006 (by unit)

Changes

The fall 2008 NS2 outage has been cancelled

The spring 2010 KS CT3 outage has been lengthened from 7 to 8 weeks

New outages

None since last month

Outages

PP1	INSTALL NOx TIE INS BLR/BFP TURBINE VALVES	(02/24/07 – 04/02/07)
	BOILER/FGD	(02/25/08 – 04/03/08)
NS 1	INSPECTION/REPAIRS	(4 WEEKS SPRING 2007)
	INSPECTION/REPAIRS	(4 WEEKS SPRING 2008)
	INSPECTION/REPAIRS	(4 WEEKS SPRING 2009)
NS 3	GENERATOR REWIND	(11 WEEKS BEGINNING IN MARCH 2007)
	MAJOR OUTAGE	(4 WEEKS FALL 2010)
	MAJOR OUTAGE	(4 WEEKS FALL 2015)

Controlling scope

- **Start** 1½ to 2 years before the outage
- Review **previous outage** reports for what you might expect this time
- **PdM** (predictive maint) group must share info
- Conduct **meetings** (inclg tradespersons) and make “discovery” lists
- Republish **lists** with increasing freq as start date approaches
- **Communicate** with everyone, sideways + up and down + inside and outside

Controlling scope

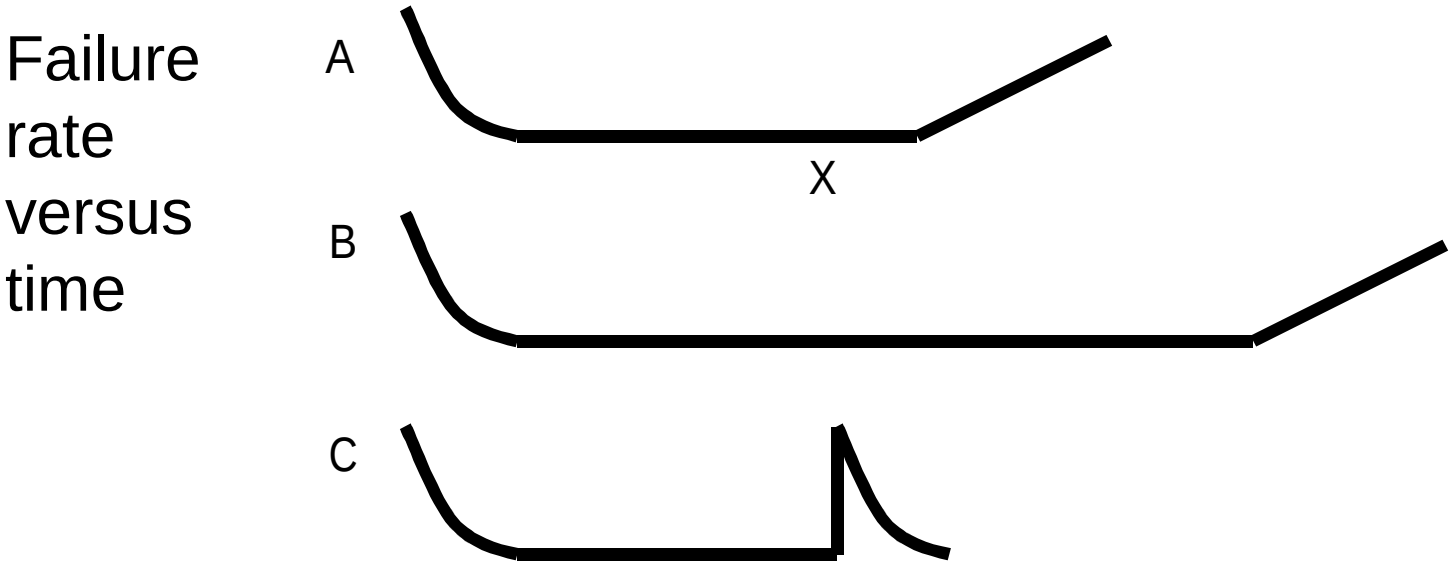
- A lot of **discovery work** added too late will wreck an outage
  - Prevent: Reduce with PdM; Anticipate from history
- Adding discovery work
  - Watch for impact items; items that affect funding, resources, schedule
  - Have review process; who will pay?
  - Don’t sweat little stuff

Controlling scope

- Have **component outages**
  - Easier to defer discovered work
  - Less financial burden, spread out costs
    - $3-5 million every 1-2 years instead of $15-20 million every 5 years
  - Allows focusing resources
  - Less overwhelming

Controlling scope

- **Avoid "routine" rebuilds** which introduce infant mortality



Rebuilding equipment in Figure A at Point X may result in Figure C instead of Figure B

Controlling scope

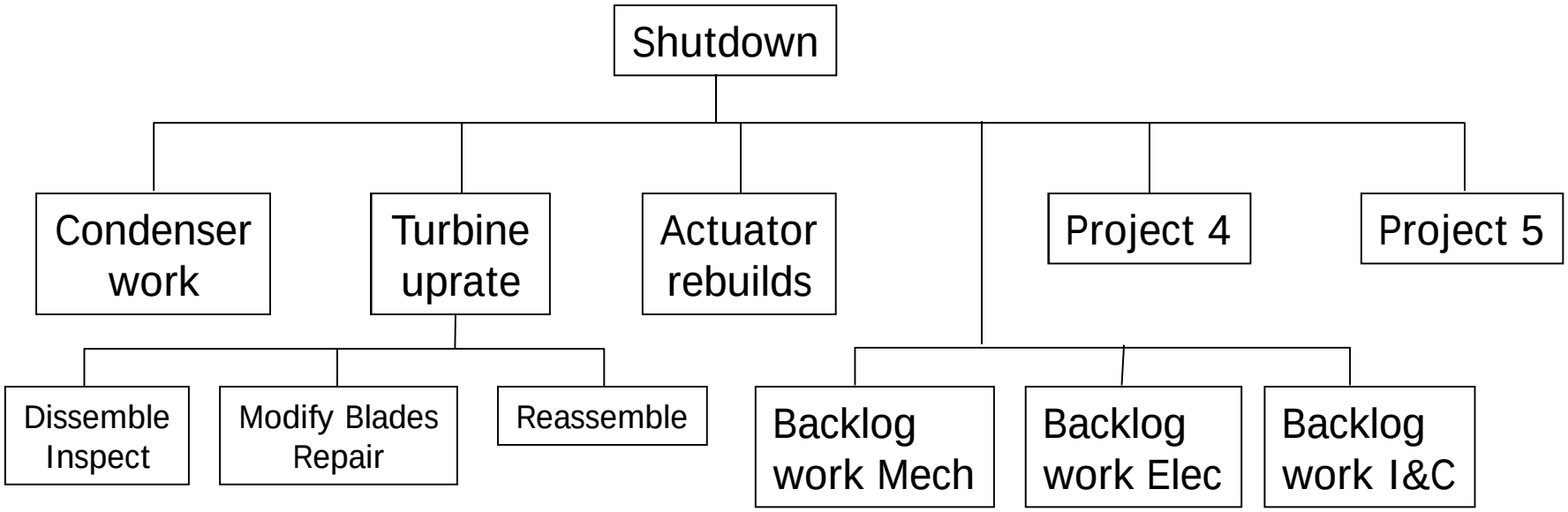
- Routine PM (**preventive maintenance**)
  - Issued well in advance into backlog
  - Planner review for material and contractor needs
  - State “(During Outage)” in title as well as use outage codes
  - Prioritize as “Must”, “Prefer”, “If time”

Controlling scope

- Learn to say **“No”**
- Shutdown manager needs authority
- Scope freeze time
- Need organizational discipline (leadership)

Controlling scope

- Use a **work breakdown structure**
  - Defines scope and deliverables
  - Gives visibility



Short notice outages versus planned turnarounds

- **Identify work** as requiring an outage
- Plan outage work **expediently**
- Pay close attention to **parts** needed
- Take advantage & do as much work as possible **outside planned turnarounds**
- **Be able to find** outage work that can be done within constraints of the SNO

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Organizing and Executing Shutdowns

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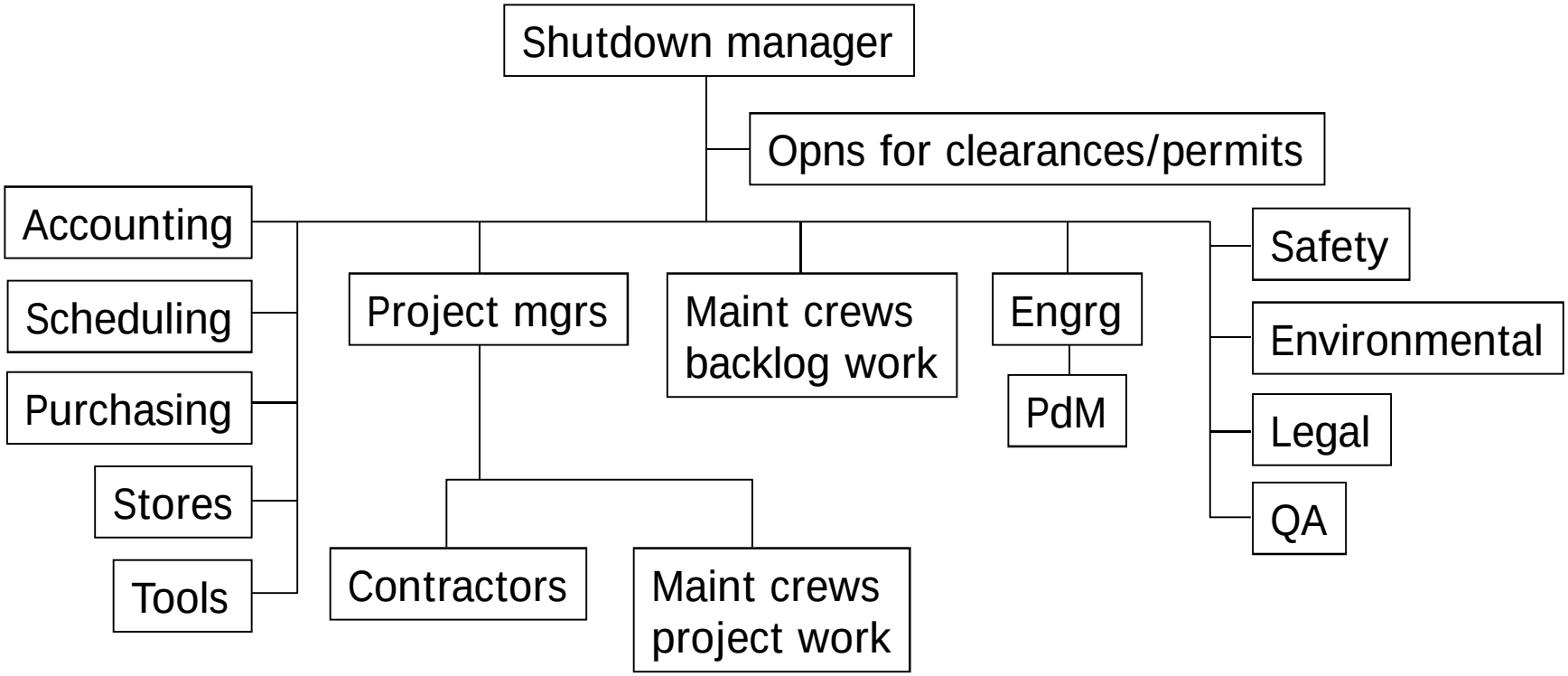
Organizing for outages

- **Shutdown manager**
  - Comprehend technology of the outage
  - Good record keeping
  - Awareness; manage by wandering around
  - Full time for large outages 6 months to a year before start
  - Agreement with sponsor, authority: what, when, who

Organizing for outages

- **Outage organization elements**



Organizing for outages

- **Need defined and known processes**
  - Budgeting, trend program
  - Stores (inventory), tools
  - Purchasing regarding services, labor, material, receiving, laydown
  - Insulation, scaffolding
  - Safety, certification, reporting, work permits, clearances, lockout-tagout, confined space
  - Configuration mgt, design change notification, project closeouts, as-builts

Organizing for outages

- **Know that you have the resources to do the outage!**
  - Funds, Time (before and during)
  - Crafts, welders, engineers, project mgrs, etc.
  - Tools, cranes, fork lifts, etc.
  - Vendors, contractors
- **Avoid dumb overtime that exceeds fatigue limit**

Organizing for outages

- **Budgeting**
  - Need a budget
  - May need a multi-year budget through different fiscal years
  - Funding timing
  - Anticipate some unknowns

Organizing for outages

- **Cost control**
  - Need tool fairly accurate and timely
  - May have to stop some work or raise budget
  - Understand cost reports when controlling project: committed, encumbered, expensed
  - Trend program

Organizing for outages

- **Contractors**
  - Understand any need to contract
  - Contractors need to be familiar with the way you do business
  - Contract for ***known*** circumstances
  - Settle on ***unknown*** circumstances encountered
  - Budget for ***anticipated*** circumstances

Computerized maintenance

- **Benefits**
- Standardize work processes
- Find work orders and parts
  - Identify any outage work with Unit Condition field code (e.g. 2 = requires unit outage)
  - Identify all work orders for this outage with Outage ID field code (e.g. N03 Spring Outage 2007)
- Assign work order #'s to all *projects*; add assigned lead name to each
- Information for metrics and reports
- Helps history; see past work orders

Computerized maintenance

- **Cautions**
- If you don’t know how to do it without a computer, a computer will not help
- Faulty processes / distraction
- Improper costing
- System reliability and speed
- User friendliness
- Cost of system

Executing the shutdown
Schedules

- Pre-outage schedule
  - Tracking to see all
- During-outage schedule
  - Detailed or non-detailed (milestones or flags) okay
- After-outage tasks

Executing the shutdown
Pre-Outage

- **Start** planning this turnaround after the last one on this unit
- Budget, prepare to order long **lead time** items
- Investigate lead times, could be 18 months
- Research vendors and availability, consider other companies and spares

Executing the shutdown
Pre-Outage

- Set aside (kit) **parts** to insure on hand
- Make sure **special tools** are ready
- **Contractors** need to mobilize; space, laydown, trailers
- Be **ready to clear** equipment for work in sensible order
- **Communicate** with everyone, sideways + up and down + inside and outside

Executing the shutdown
Pre-Outage

Start outage on time!

Need organizational discipline

Executing the shutdown
During-Outage

- Can manage to **milestones** instead of a “weekly” schedule
- Regular, short project **meetings**
- Persons don’t resent going to; have opportunity to share
- Note milestones (or flags) or collect % complete per work breakdown structure as appropriate.

Executing the shutdown
During-Outage

- Beware the “90% done” syndrome
- Beware **Parkinson’s Law** (work expands to fill available time)
- Finish outage backlog and do other maintenance work if time left
- Finish outage early if appropriate; but don’t kill self

Executing the shutdown
During-Outage

- **Crew supervisors** do daily or shift schedules and coordinate work
- **Outage planners** can chase parts (Unit is down). May need an expediter
- **Communicate** with everyone, sideways + up and down + inside and outside

Executing the shutdown
During-Outage

- Outage not over until unit is reliably operating
- **Include start up time** as part of the outage schedule
  - Especially with new equipment

Executing the shutdown
After-Outage

- Closeouts
- Critique, lessons learned
- Rate the outage, score numbers
  - e.g. include planned vs unplanned hours and forced outages within 30 days
- Keep in history

Success in outages

- **Outage objective** met; completed scope of work intended; was good investment
- Completed *on* schedule
- Completed *on* budget
- Good safety, environmental, legal performance
- Not overwhelmed by surprises
- Good startup; reliable unit performance

Success in outages

- This outage was better than the last
- Work identified for next outage
- Other information gathered to help next outage

  and finally

- Outage personnel are still friends

Question time

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