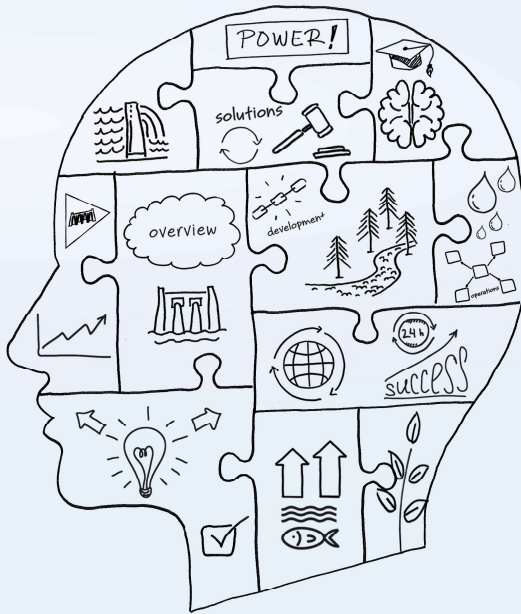


 Waterpower.
HYDRO BASICS COURSE



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Session 6: Day-to-Day Operations

Instructor

Steve Wenke

Senior Manager – Mana Consulting

Background and Context

- More than 40 Years in the industry
- Chief Engineer for a Utility for more than 25 years
 - Responsible for Managing the Generating Assets – assure that facilities operate as expected.
 - Responsible for public and personnel safety, protection of the assets, and optimizing the value of those assets
 - Field support, O&M best practices, asset and facility planning, training, equipment assessments, general support
- My father was an operator at various hydro stations and ultimately over the transmission system

Steve Wenke has worked more than 40 years in industry, most all of it with generation and hydro more specifically. He has worked plant greenfield and brown field construction, plant maintenance, engineering, project management and planning. Collectively, has worked on or managed nearly \$1 billion in projects in his career.

More germane to this material, grew up at hydro stations as his father was an operator at hydro stations during his growing up years. Ultimately, his father retired after a 43 career as a System Operator (Transmission Operator). This background has led to a unique understanding of the role of operations in context of the larger picture of managing assets. Further, his life experience of growing up on these remote sites give insights to some of the issues faced by this group.

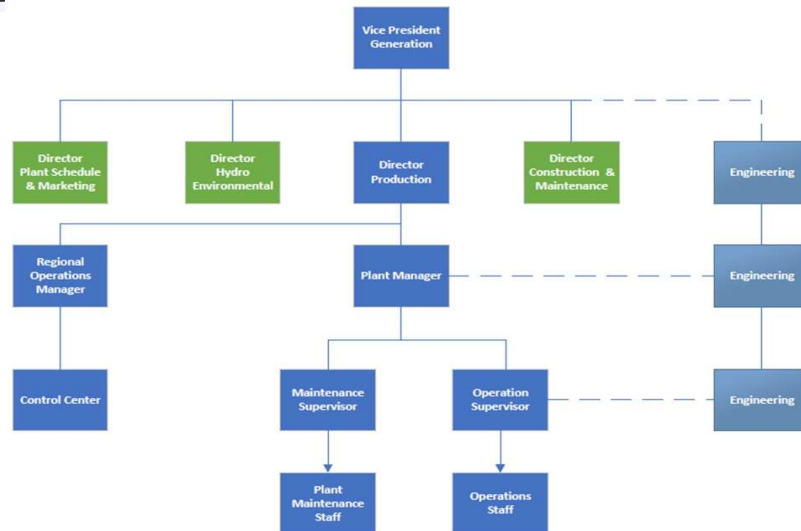
Fundamental Management Goals

1. Ensure Public and Personnel Safety
2. Ensure Assts are Protected
3. Achieve the Value Expected from the Asset
4. Optimize the Value of the Asset
5. Planning for Future

As Day-to-Day Operator, your function is to execute your job so these goals can be achieved.

All management for generating assets is trying to accomplish these simple goals. There are a lot of derivatives of these fundamental items, but these are the simple list.

Typical Plant Organization



A typical plant organization includes a responsible executive and a direct chain of command to the plant operations and plant maintenance staffs. Other related groups are frequently part of the same organization such as Scheduling, Environmental, FERC Licensing and Compliance, and often Construction and Maintenance. Engineering and Engineering Management can be dispersed about and is more organization specific. However, you do need operations, maintenance, and project engineering talents.

Day to Day Operations

- Managing the Water
- Safety, Security
- Environmental Concerns
- Operations of the units
- Plant alarms
- Budget and Maintenance
- Labor Agreements
- Community (Plant tours, meetings, etc.)
- Major Projects and Contracting
- Putting it all together – *“A Typical Day at the Plant”*



The items here are the outline of the presentation. It is important to keep these management objectives in mind.

Plant Manager

- Hires, supervises, mentors, and develops employees
- Coordinates activities with external support services (safety and health, contractors, environmental, compliance, and Technical Support)
- Communicates information from upper management to the plant team and back up the chain to the regional offices
- Coordinates outages within region and with transmission owner/operators
 - Takes care of unplanned outages quickly and efficiently
- Ensures compliance with regulatory agencies such as NERC / WECC, FERC, State Ecology offices, Regional and Local Regulators

Need to understand the responsibilities of the manager so we can gain some insights as to what the day to day needs to accomplish

Plant Manager

- Ensures all employees have the proper training for public and personnel safety
- Ensures all employees have the proper training to meet the needs of the mission of the plant
- Assures that personnel entering the site have appropriate safety measures in place
- Responsible for the plant budget
- Keeps the lights on



These are the covenants that need to be conveyed from the Plant Manager to the operating staff. The basics of managing the asset need to be included in these objectives

The Most Important Job – Manage the Water!



Teton Dam - 1976



Oroville Dam - 2019



South Fork Dam – 1889
(Johnstown Flood)

The people standing on the rooftops in this striking image are likely sightseers who have come to see the flood destruction.

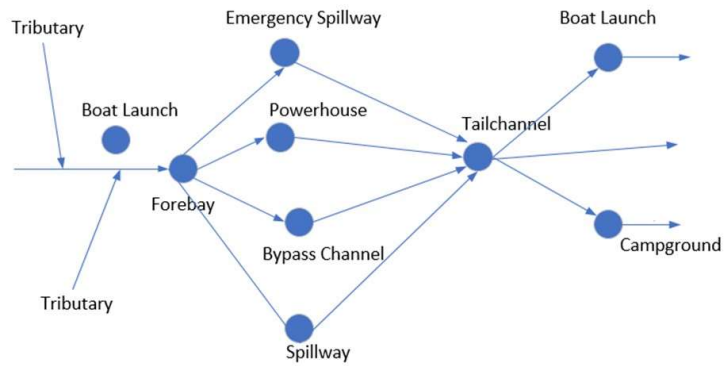
Sources: Johnstown Area Heritage Association; New Civil Engineer; ASDSO

Managing the water is the most important thing a person needs to do in day to day. These are examples where the water was not able to be managed and the catastrophes that resulted. In these three cases, all could have been prevented but there were underlying problems that were not identified until after the fact. As an operator, you need to know what causes these and what to look for.

e.g. piping through earth fill dam, eroding foundation conditions, failure to anticipate weather event.

Managing the Water

- River management can be complex as there can be multiple places with different requirements



Safety and Security

- Dam Inspections
 - Movement?
 - Piping?
- Project Safety – Monitoring Public or Reservoirs and other facilities and access



Inspection of dams and Spillgates and other water conveyance, such as penstocks, canals, locks, etc. is crucial.

The image on the top left shows a place where the pipe was not straight. An operator noticed this and reported it. It turned out the top “lift” of the spillway had moved and there was an inherent design problem with this dam which was remedied.

The image above shows the proximity of a fisherman to a spillway which could open any time. This is a situation that needs to be managed. Probably ask the fisherman to move. There are times where law enforcement needs to be called to support these concerns.

Safety and Security

- Dam Safety / Emergency Action Plans (EAPs)
 - Table Top Exercises
 - Functional Exercises
 - Tests
- Project Safety – reservoir, rivers, switchyards, and powerplants
- Site Access – how to manage an entire reservoir?
- Property management on the reservoir



Most dam owners have emergency response plans should a potential or actual event occur. These can be practiced in a variety of ways. FERC regulated project require these EAP's

Site access management is important. As illustrated by the fisherman in the previous slide. The public can get into places that are unsafe

Also, management of reservoir property is a part of this. Encroachment is a common issue.

Safety and Security

- The facilities are protected through numerous different strategies
 - Physical
 - Gates
 - Fences
 - Barricades
 - Police forces
 - Virtual
 - Cameras
 - Security systems
 - Card access
 - Information Technology
 - Cyber Attacks



As with everything, physical and cyber security are paramount. This can range from special security forces to simply locking the door. Cyber is critically important. Often water control systems are computer controlled and of those controls are compromised, the public could be at risk.

Personnel and Plant Safety

- First Aid, CPR, Confined Spaces, Rescue
- Hazardous Materials and Chemicals
- Lock Out / Tag Out Procedures
- Water Work Way Procedures
- Environmental Response (i.e. Oil Release?)
- Job Hazard Analysis (JHA)/ Tailboards
- Personnel Log In / Log Out
- Stop Work Authority



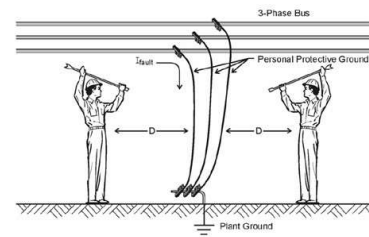
Plant personnel need to be familiar with a myriad of safety procedures, practices, and materials.

Personnel and Plant Safety

- Electrical Safety
- Fall Protection
- Personnel Protective Grounding
- Confined Spaces & Entry
- High Voltage Areas
- Specialized Training

Facilities Instructions, Standards, and Techniques
Volume 5-1

Personal Protective Grounding for Electric Power Facilities and Power Lines



We will do everything within our power to ensure all employees make it home safely at the end of the day!!

As these are high voltage, utility electrical facilities, they often have different electrical safety issues beyond normal electrical safety. Personnel **MUST** be familiar with these practices.

Environmental Concerns

- Operations Considerations

- Reservoir Levels
- Minimum Flows
- Ramp Rates
- Bypass Flows
- Aesthetic Flows
- Aeration
- Water Quality Measures and Concerns
- Permit Compliance



This photo illustrates several things. First the public use of the river. You can see the “bathtub ring” of where the water level normally is. By dropping operations, you can actually strand boaters on beaches as the water lowers. Similarly, you can flood when the water comes up. These can be normal operations.

Ramp rates, minimum flows and other water quality concerns are generally to support fish and fisheries.

Environmental Concerns

- **Monitoring Compliance**
 - **Oil Release**
 - Sumps, Transformers, Bearings, Governors, Oil Storage
 - **Hazardous Waste Management**
 - On Site Sources
 - Inventory of use
 - **Water Systems**
 - Cooling Water
 - Septic Systems
 - Sump Systems
 - Water Drainage Systems



Generator Step Up Transformer

Uncontrolled releases from a system in a hydro plant have a high likelihood of discharging directly into the river unless these control systems are managed, maintained, and exercised periodically.

Environmental Concerns

- Recreational Sites
 - Campgrounds
 - Boat Launches
 - Swimming Areas
- Fish Facilities
 - Fish Ladders
 - Fish Traps
 - Hatcheries
- Cultural Concerns



Source: Chelan Co PUD, The Dalles Dam, Avista

Recreational facilities are all around. In these photos you can get some idea of the places that require some monitoring or managing. Note how close the swimmers are to a spillway.



There are multiple ways a hydro unit can be operated to support the Bulk Electric System. These operations can be manual but are often controlled with automated systems or controls.

Other control modes are Automated Generation Control (AGC) for frequency control.

Again, water levels are critical items here.

Unit Operations

- Must Use your Senses
 - Listen – for unusual sounds
 - Smell – smoke, burning smells, ozone
 - Feel – vibration in the floor, shocks

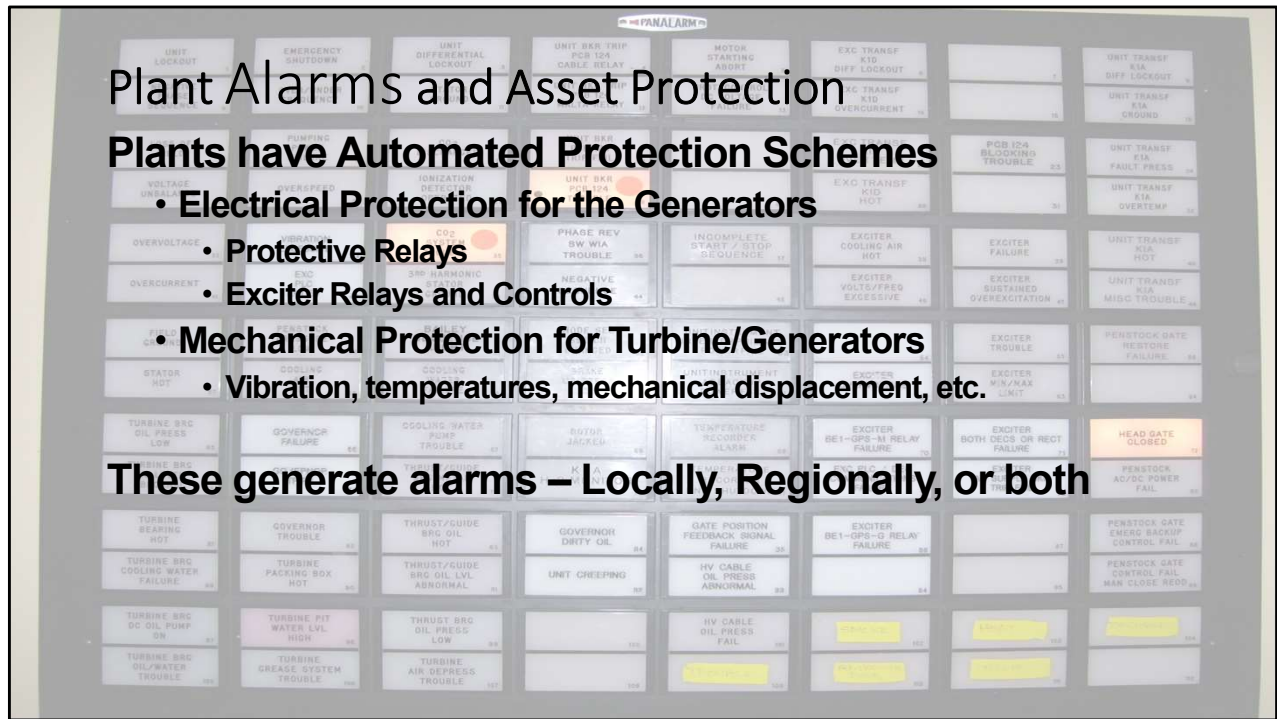


The best thing a manager can see is their operator doing nothing. That means everything is working like it is supposed to. That is a good thing!!

Finally, as an operator, you MUST know what to do when something happens. You often don't have time to think but only re-act as you have been trained. For that reason, you need to know procedures, processes, and consequences of actions.

Operators are continually trained on how they need to respond when any number of things could happen. They also spend time thinking things through themselves to help them anticipate what they need to do. A stereo typical operator is a person who always finds the problems with things – kind of a negative Nan. While this trait can be frustrating to work with, remember, they are actually doing their job in trying to anticipate what might happen and what needs to be done. Many procedures and saves have been made when an operator comes up with a scenario that hadn't been thought about before and it allows the team to come up with the appropriate procedure.

Operators often don't have the time to analyze an event. They need to know what to do.



Plant Alarms and Asset Protection

Plants have Automated Protection Schemes

- **Electrical Protection for the Generators**
 - **Protective Relays**
 - **Exciter Relays and Controls**
- **Mechanical Protection for Turbine/Generators**
 - **Vibration, temperatures, mechanical displacement, etc.**

These generate alarms – Locally, Regionally, or both

Plant protection systems cause alarms as well as conditions that are approaching a protective action.

Protection actions generally shut the unit down immediately. Alarms generally provide an opportunity to inspect or change something to keep the unit on line.

Plant Alarms and Asset Protection

Manned facilities...

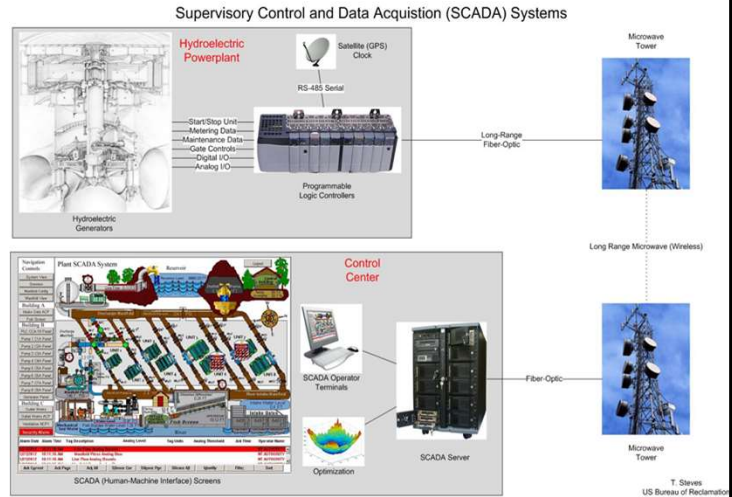
- **When a condition exists that is outside norms, an Alarm sounds in control room.**
 - **The operator must identify the alarm and assess what actions are needed (i.e. protect the asset)**
 - **Change a setting in a unit?**
 - **Report the change to dispatchers and other “real time” operations**
- **The operator needs informs the facility manager for the facility of the issue.**
 - **The facility manager prioritizes employees to resolve issues.**

The operator has authority to address many alarms. Often these are procedures that have been well established. If there are questions, then the management chain is often consulted. If there is a safety or asset protection issues, the operator is likely given the autonomy to act as they see best.

Plant Alarms and Asset Protection

For plants that are remotely operated or after hours...

- Alarm sounds in local control room and at the Remote Control Center.
 - If possible, the Remote Operator takes mitigating action
- The Remote Control Center calls the facility manager
- The facility manager determines who is on call and dispatches employees, as needed.



For remote operations, procedures are similar. Many control systems allow a remote operator to take remedial action through remote controls – similar to if someone was there. However, there may be some limitations. (For example, you may have a procedure that says you cannot release water through a spillway unless a person inspects the channel to assure it is all clear.)

If call outs are required, those are arranged through the manager.

Plant Alarms and Asset Protection

- In either instance, if additional support is needed, the facility manager or support crews can coordinate with plant personnel.
- Managers will determine the proper subject matter experts (SMEs) who can provide necessary support.
- If remote support is not adequate, the SMEs can mobilize, typically in less than 24 hours and provide onsite assistance.

As was illustrated in the org chart earlier, there are a number of resources available to address issues that arise. Often specialized consultants are needed and contracting needs to be involved. A unit off line is costly and it is usually an “all hands on deck” response.

Budget and Maintenance

- Each Plant has its own budget
 - Personnel
 - Consumables
 - For Personnel
 - Training
 - Coffee
 - Chairs
 - Paper and Pencil
 - Forms
 - For managing equipment
 - Cleaning supplies
 - Greases, solvents, etc.
 - Special Tools
 - For caring for Rec Facilities
 - For Fish Facilities
 - Any Use Fees
 - Water Rights
 - Community Permits
 - Community Involvement
 - Sponsorships
 - Support



Each Plant Manager is responsible for creating the appropriate operating budget for their facility. This includes training, supplies, and tools. There are often a number of other “community” needs that are needed to be a good neighbor.

Budget and Maintenance

- These Expenses are part of the cost of production.
- The lower these costs, the higher return on the multi-million investments.



These budgets are critical to the financial performance of the plant. The other key is reliability of the equipment and the availability to run when called upon. This is a reliability item too. There are many ways companies address this. Asset Management practices are gaining more traction. This does cause the operator to create more records so Asset Managers can assess the equipment.

Labor Agreements

- Many Facilities have Labor Agreements with local Unions
 - These contracts define Job Descriptions, Work Conditions, and Wages
 - They also define many administrative actions such as
 - Work/Rest Periods
 - Shift Rotations
 - Vacations
 - They also define the relationships of workers and management
 - Personnel Discipline
 - Layoffs



For the most part, generating stations are organized by the IBEW Electrical Utility Workers side. However, a number of unions can also be involved. Pipefitters, Boilermakers (welders), Teamsters, Crane Operators, Electrical Workers, Laborers, and others.



Labor Agreements

- Federal Labor Laws define many of the process that must be followed
 - These often cover multiple years
 - Are subject to Good Faith Negotiations
- Benefits
 - Assures a trained and qualified workforce
 - Clearly defines worker/management relationships
 - Collective interests are shared

Highlight that the primary disbenefit is the lack of flexibility for both management and employees to address either things that come up or changes in the business.

Labor Agreements

- There are still numerous sites that are not governed by formal Union Agreements
 - Primary Difference is jobs are often more “multi-functional”
 - Management does have increased ability to both favorably or negatively effect things. (This is depending on a point of view.)
 - There is no incentive for management to hire unqualified workers, but there can be differences in how the training is accomplished.

Often Union provide apprenticeships to train personnel. These are overseen by Journeymen who provide on-the-job-training. Additionally, an apprentice must pass certain skill and knowledge tests provided by the Union. A structured system.

Frequently, non-Union contract personnel are trained with on-the-job experiences and hired by resume'. They often encompass multiple similar skills and are not relegated to a single craft.

An illustration is a union mechanic for a utility can only work on those items in their craft. Even though they may have a side job wiring houses, they would not be able to wire anything on a union job. A non-Union mechanic, could perform wiring as well.

As discussed, there are trade-offs with both methods. Unions do have a place!

Community Engagement

- Often Part of Local Agencies
 - Volunteer Firefighters
 - School Board Members
 - Community Event Volunteers
- Local Community Sponsorships
 - Fund Raising Events
 - Civic Events
 - Sponsor Student Projects (FFA/4H/Scouts)
 - Sports Tournaments
- Public Tours
 - Schools
 - Organizations



Tour Group of Grand Coulee Dam

Source: USABR



Tour Group of Auglaize Dam

Source: The Bryan Times, 2013

Frequently, because of their remoteness, plant personnel are very engaged in their communities. This comes in various forms, some of those are listed here.

Maintenance

- Operating a hydropower facility requires a large amount of maintenance which correlates into significant costs in both labor and non-labor.
 - Optimizing maintenance tasks and intervals is critical.
 - Utilizing technology to decrease maintenance and improve reliability
- Planning and scheduling of outages and special projects.
- Planning budgets for future years.
- Inventory for maintenance activities.
 - Including consumables and replacement parts
- Ensuring proper staffing and experience.
- Coordination with the system Control Center.



Maintenance is a broad topic. Many items talked here about operations can also be performed by on-site maintenance personnel. This topic here talks more about heavier maintenance such as replacement of equipment, updating systems, replacing wore out systems, etc.



Maintenance

- Depending on needs at the facility, there may not always be employees with the exact skills to meet demands of the workload.
- Employees with specific skill sets can be brought in to maximize efficiency at the facility.
 - This can include design, onsite testing, training of employees, and more.

Often, specialize maintenance personnel are needed to perform the necessary checks and commissioning on systems. Most all equipment in a power station is very specialized and special purpose.

Major Projects and Contracting

- These are commonly initiated through other elements of the power plant organization (recall early slide)
- Once in progress, responsible for site safety and security
- Coordination with contractor programs
- Assuring Clearances are safe and managed
- May involve inspection and reporting
- Water Work Procedures are Critical

Some work that is maintenance is so large that it moves still another functional group for heavy maintenance and construction. This can include control upgrades, generator rewinds, unit alignment, wicket gate repairs and can go up to unit replacement/refurbishment

Even with these larger efforts, local station personnel need to be aware of the work, often are the ones who issue clearances, and can serve as overall inspectors for purposes of safety and work progress.

Putting it All Together

- Plant Rounds
- Plant Records
- Shift Change

We have talked about the different elements, now want to shift to a “day in the life” of an operator.

If you were an operator, you would have these responsibilities:

Typical Plant Rounds

Environmental Compliance Checks

- Minimum flows
- Aeration
- Report spills oils or hazardous materials
- Ramping rates
- Reservoir levels
- River Flows



Need to record these and provide record to demonstrate compliance with these operating requirements. Responsible to see that automated systems perform as required and to report if a requirement is violated. This is an obligation.

Typical Plant Rounds

- Powerhouse sump cleanup and containment
- Generator and other cooling water discharges
- Lubricant storage
- Stormwater
- Sandblasting, painting, cleaning, etc.
- Transformer containment – record keeping
- Oil sheen present in tailrace



As a hydro station sits on the river, the plant must make certain that containment and treatment systems all work as intended. If a release is made, it must be reported.

One of the current trends is agencies requiring an inventory of all hazardous liquids that come on and leave the site. This can go down to weighing rags to see how much they have soaked up. The operator is often responsible for generating this compliance record.

Typical Plant Rounds

- Depression air system
- Service air and water
- Cooling water supply strainers
- Trashrack
- Spillways
- Gates



Depression air systems are systems that “blow down” the water around the turbine and allow the unit to spin in air. This allows the generator to act as a synchronous condenser which can control the voltage. It can also serve as spinning reserves.

Trashracks and monitoring the trash accumulation is a critical function. These can collapse if they are not managed.

Typical Plant Rounds

- Excitation system (slip rings, brushes for DC rotor)
- Governor
- Generator step-up transformer
- Switchyard
- Fire Protection (CO₂ System)
- Generator and Turbine Bearings



These are the primary systems of the units. They often have gage boards and other instruments which operators read and record on an hourly basis, 24 hours a day. In most cases, even remote operated facilities have a person check in the site at least once a week, if not once a day.

Typical Plant Rounds

- . Visual inspection of all switchgear and readings on the Unit Breakers.
- . Visual inspection of all switchgear and inspection of indicator lamps and Relays.
- . Visual inspection of main distribution panel
- . Visual inspection of all HVAC systems and equipment.
- . Visual inspection and readings of all Transformers.
- . Inspections and readings of all Generator and Pump monitoring equipment.



A powerhouse is an industrial building with a variety of systems needed to support the primary business. HVAC Systems, drinking water systems, sewage treatment systems, cooling water systems, drainage collection and discharge systems, lighting systems, AC power distribution. All of these need to be monitored and maintained

Typical Plant Rounds

- . Auxiliary Machinery check on all floors using look, listen, feel and smell during rounds.
- . Readings and checks of all air systems for High- and Low-Pressure air.
- . Inspections of the sight glasses on all units for Air Depression, oil levels, etc.
- . Inspections and readings on the cooling water pumps and supplied cooling water for shaft seals.
- . Readings of the Penstock and Draft Tube pressures.
- . Inspection and readings on Turbine Bearings and Thrust Bearings.



More systems that need to be monitored and managed. Frequently, day to day maintenance is done by on-site plant personnel. It could be an operator or an on-site maintenance person.

What happens with all this information?

- At the shift change, plant issues and conditions are discussed between incoming and outgoing personnel
- Any problems identified are logged and communicated to management
- Hourly readings are recorded in the control room for the plant and each machine. These are archived for use and documentation
- Unit Start times and Stop times are recorded
- Clearances issued and maintained are recorded
- Station access Records (who comes in and who goes out.)

There is usually a 15 minute overlap of shifts – local or remote

As you coming on the shift, you inherit the problems that are ongoing. When you leave, it is no longer your problem. When you come back on your next shift, that problem is probably gone but new ones have come up.

Conclusion for Day-to-Day Operations

- Key to fulfill most of management obligations
 - Public Safety
 - Personnel Safety
 - Protection of Asset
 - Performance of the Asset
- Operating Personnel have a full plate of responsibilities
 - Even when they don't appear they are working
- Records are Crucial
 - Regulatory Compliance
 - Records of Equipment performance and problems.

The station operator (local, remote, and combo) is the eyes, ears, and nose of management to assure the operations are safe, the asset protection systems are functioning and the asset is not operating in a harmful area, and that the different operating modes are functioning as they are intended.

The records kept are formal and official. Often there are protocols on how records must be kept. These can be driven by regulating bodies such as OSHA or FERC.

- Water
- Safety
- Protection
- Operating
- Optimizing

Questions?

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