

PROCESS ANALYSIS-EFFECTIVE WORK MANAGEMENT

The most effective way to evaluate a maintenance or modification activity and performance of that activity is by direct observation. Such observations can then be compared to an established protocol covering both managerial and technical aspects of the work. This is especially true for work performed on critical equipment. Direct observation of more than a small portion of any of these work activities is made difficult or impossible by factors such as the following:

- The complexity of the activity and the interfaces involved
- The multi-shift performance of the activity (time dependency)
- The relatively short time that can be spent on observations

Process analysis can be an effective substitute for direct observation to evaluate performance. Highlights of a process analysis include the following:

1. Select the applicable work packages for the specific critical equipment to be evaluated and review the following in detail:
 - Are the work package requirements complete and clear?
 - Do the requirements reflect good work standards and practices?
 - Are related activities identified and considered in the work plan?
 - Are the Supporting Documents up to date and included in the work package?
 - Was closeout timely and complete?
2. Determine the method used to ensure that technical requirements are incorporated into the maintenance or modification work package.
3. Determine if the method and system used to plan and schedule the maintenance or modification is adequate.

4. Determine if the personnel assigned to perform the work are sufficiently knowledgeable to properly complete the work.
5. Determine if coordination and control of the work activities are maintained between the Maintenance Supervisor, Safety/Environmental Specialist, the QA Specialist, and the Chief Engineer or his designee.

Process Analysis is a useful tool for a variety of reasons beyond assessing the performance of maintenance and modification work. Creation of the details of a Process Analysis is a good exercise for management to develop and document their statement of how they want to have the work performed and who will be responsible for doing the job as they have specified. Imagine including a process analysis task as part of a new maintenance worker's qualification requirements or as an on-the-job training method. This will familiarize the new worker with what is expected of them and also give them experience in proper documentation, QA/QC aspects of the work, proper communications and reporting, and taking care of special items like tools, jigs, and fixtures. They will also gain a sense of self confidence since they will not be wondering if they are doing the right thing, guessing about critical items, or just leaving the work for the next shift.

Operating Experience Review Results

Based on failure cause determination in numerous studies over the years, analysts reported that a significant number of failures were related to poorly designed and implemented management systems. The failures were commonly attributed to "personnel errors, miscellaneous, or unknown" causes but can be related to the aforementioned poorly designed and implemented management systems. If management is not providing its maintenance and modification staffs with training, procedures, resources, time, leadership, and competent supervision, they are their own worst enemy because these management systems shortcomings cause approximately **fifty percent** of the equipment and system functional failures! The biggest value in maintenance and modification program development is ensuring one has a competent

staff and the associated management systems are effective. Only then can one proceed to specify effective maintenance and modification activities and intervals. To demonstrate the effectiveness and value of the Process Analysis tool, refer to the following completed sample application actually performed at an operating industrial facility for a critical, environmentally sensitive system. This particular example could be modified to suit individual needs, but it should be a good starting point for any interested party.

**MAINTENANCE PROCESS ANALYSIS CHECKLIST WITH TYPICAL STATUS
ENTRIES FOR A METALS PROCESSING SYSTEM**

SOURCE DOCUMENTS INCLUDE PMs, VENDOR O&M MANUALS AND INSTRUCTIONS, STAKEHOLDER O&M REQUIREMENTS, AND REGULATORY REQUIREMENTS (especially Environmental Health Safety [EHS] requirements)

Requirement	Item	Status	Date/Initial
REVIEW OF WORK PACKAGE DETAIL	MATERIAL	Materials/Parts and Tools should be listed on a separate Check List that would be issued out with the PM since the CMMS will not allow any parts or tools to be listed on the PM work order. Also included on the separate check list would be P.P.E. requirements and a L.O.T.O. list of applicable valves, power sources, etc. for use during an Annual PM. Daily and Quarterly PM's as per the O&M manual are inspections only and do not require shut down or tag out of the unit.	
	TOOLS, FIXTURES, RIGGING		
	TEST EQUIPMENT		
	WELDING	NA	
	NDT	NA	
	QA/QC HOLD POINTS	QA/QC, inspection hold/witness points are already being done in that the equipment is visually inspected at least four times per shift, the Total DP is recorded five times per shift, all four Manometers mounted on the unit are recorded twice per shift and an inspection by the QC Specialist is done once per week in accordance with EHS requirements for this critical equipment.	
	PMT/ACCEPTANCE CRITERIA	The cognizant maintenance supervisor keeps all the logs dealing with the equipment and also reviews the logs every day. A post maintenance test requirement is not currently listed on the Annual PM but could be added as a task to start up the unit, run for five to ten minutes, observe spray nozzle operation, check for any unusual noises and vibration, etc.	

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DO REQUIREMENTS REFLECT GOOD WORK STANDARDS/PRACTICES	REVIEW/APPROVAL	The requirements reflect good work standards and practices in general with some recommendations for improvement. Some changes have already been implemented, for example, another Quarterly PM was made for the Control Technician to inspect the rinse cycle and verify operation. We would also recommend that a task be added to this PM to check all alarms for proper operation and report any deficiencies to the cognizant maintenance supervisor. This is actually already being done and Corrective Maintenance Work Orders are written and completed to correct any problems it just isn't currently written on the PM sheet, but such notation will be added by the QC Specialist to ensure no open ended entries exist for this equipment.	
	EQPT/PROCESS SAFETY HAZARDS	We recommend that all safety hazards are listed on the check list along with the personal safety requirements (P.P.E.). QA/QC requirements are currently being fulfilled on this unit.	
WAS CLOSEOUT TIMELY AND COMPLETE	REVIEWED BY MANAGEMENT LEVEL PERSONNEL	The close out of the PM's and DP readings are always timely and complete. The review by supervisor/ manager level personnel is being done on a routine basis.	
	RESOLUTION OF DISCREPANCIES	The resolution of the discrepancies found in this review and included as recommendations are subject to approval by the EHS Department Head based on the EHS Department specifications including the acceptance criteria.	
SUPPORTING DOCUMENTATION	WORK ACTIVITY AUTHORIZATION AND COMMUNICATIONS	Supporting documents currently include: Hard copies of the PM's that were issued out through the CMMS on a weekly basis, Confined Space Entry Permits issued by Facility Safety for internal maintenance and Annual PM's normally accomplished during YES, O&M Manual provided by the manufacturer, Three different logs that pertain to the Metal Scrubber, Controlled Document procedures and Environmental Operation and Maintenance Requirements, Attachment G, EXHIBIT IVc. Proper work activity authorization and communications are being done as is required. We also would recommend a few more changes and additions to the maintenance procedures on the PM sheets.	

Requirement	Item	Status	Date/Initial
	SAFETY PERMITS- FLAME, TANK ENTRY, TAGOUTS, ETC.	As mentioned earlier we recommend a check list to include tag out information and all safety and P.P.E. requirements, this would then be another supporting document.	
	WORK RELEASE BY SHIFT SUPERVISOR	Proper work activity authorization and communications are being done as is required.	
	MAINTENANCE PROCEDURES	CMMS PM schedules with task information. O&M instruction for Task OM 1. Vendor O&M Manual.	
RELATED ACTIVITIES	APPROVED WORK SPECIFICATIONS AND REQUIREMENTS	Related activities for the equipment Work Package do include work specifications and requirements currently known as Equipment Operating Instructions that were developed by maintenance supervisors and approved by the maintenance manager and the EHS Department Head. The original edition was submitted in January of 2010 and the most current is dated January 31, 2014, this is part of the Maintenance Department's Controlled Document Program.	
	SPARE PARTS IDENTIFIED AND STAGED	Spare parts are currently not listed on the PM's but we would recommend including a material/parts list to the proposed PM check list.	
	UPDATED MAINTENANCE HISTORY	Maintenance history is maintained for at least five years in the Maintenance Department archives by filing all PM records from the previous year.	
	CONTROLLED PROCEDURES USED	Maintenance procedures are currently in accordance with the Controlled Document/ Operating Instructions (OM 1). the only preventive maintenance that is included on the Quarterly PM is a procedure for unstopping of the spray nozzles if it is needed, there is nothing included as to preventive maintenance on the two pieces of moving machinery on this unit, the exhaust fan and the sump pump. There is no mention of preventive maintenance on either one of these in the O&M Manual either but we recommend adding the maintenance of them to the Quarterly PM. Normal industry standards and procedures would apply to these units, i.e. grease the zirc fittings, check/replace drive belts, amp readings, and vibration analysis readings.	

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	M&TE CALIBRATION PROCEDURES	We recommend buying a spare set of Manometers and have them calibrated by a certified test laboratory for the year end shutdown work, then swap them out with the current Manometers and do the same with them the next year; this should satisfy any questions as to the accuracy of the DP readings.	
HOW ARE TECHNICAL REQUIREMENTS INCORPORATED IN THE O&M WORK PACKAGES		Preventive Maintenance, Corrective Maintenance and Operation procedures, tolerances and PM frequencies have been written directly from the OM maintenance and operation manual, controlled document maintenance procedures signed off by the maintenance manager and the EHS department representatives. Copies of the startup/baseline readings will need to be supplied by the engineering department personnel who performed the acceptance testing for inclusion in the maintenance work package.	
WORK PLANNING AND SCHEDULING METHODS	RESPONSIBILITIES	The CMMS is the maintenance scheduling software in use at this time. There are many drawbacks at this time with this system. We are not getting consistent PMs issued when they need to be and there is no ability to attach tech sheets, checklists, tool and material lists etc. to the PM when it does issue. The IT department completely controls the CMMS and does not advise the maintenance and operations departments when they make changes. Neither the maintenance nor the operations department has any way of making corrections, additions or customizations. Everything right now that must be added or customized must be done by developing and attaching hardcopy sheets as needed.	
	CHANGE CONTROL FOR CONTINGENCY PLANNING	Due to the above problems with the CMMS, changes and contingencies must be administered on a case by case basis and applied as the need arises.	
	COMMUNICATION OF MAINTENANCE REQUIREMENTS	Maintenance requirements are communicated via the CMMS work orders sufficiently edited by the supervisor performing the shift lineout to overcome any problems associated with the CMMS shortcomings listed above. Tasks that must be performed can be identified there and issued to maintenance personnel.	

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	MAINTENANCE WORK ASSIGNMENTS	<p>The maintenance manager and shift supervisors who prepare the shift lineouts assign personnel to perform the work. These lineouts are then provided to the operations supervisor or his designate for coordination and information purposes. Coordination plans are discussed at the daily, morning planning and scheduling meeting.</p>	
WORKER COMPETENCY	EQUIPMENT AND SYSTEM FAMILIARITY	<p>Personnel assigned to perform the work are provided with orientation training on the system and equipment and specialty training in their work classification for the system and equipment under the Formal OJT program administered by qualified O&M personnel.</p>	
	FORMAL QUALIFICATION AND CERTIFICATION	<p>Personnel assigned to perform the work are licensed and certified by either an outside licensing authority or through the documented Formal OJT program administered by qualified O&M personnel. All licensing and certification documentation is kept in an auditable file.</p>	
	DO THE WORKERS HAVE SUFFICIENT KNOWLEDGE TO DETECT ABNORMALITIES AND DEFICIENCIES	<p>Personnel assigned to perform the work meet the minimum qualifications for their job classification which includes the ability to identify off-normal conditions and mitigate problems associated with off-normal operation. The orientation training on the system and equipment and specialty training in their work classification for the system and equipment under the Formal OJT program ensures their skills are applicable to the specific facility equipment.</p>	
	HAVE THE MAINTENANCE PERSONNEL PERFORMED SIMILAR MAINTENANCE ACTIVITIES	<p>The current O&M staff personnel typically assigned to work on this system and its equipment each has a minimum of 2 years O&M experience at this facility regarding this equipment.</p> <p>As part of their training at facility, personnel assigned to perform the work cannot be signed off on their training until they can demonstrate a proficiency of completing the required tasks per the Formal OJT Program.</p>	

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COORDINATION AND CONTROL OF THE O&M PROCESS BETWEEN THE MAINTENANCE MANAGER, THE EHS SPECIALIST, AND THE QA SPECIALIST	IS THE STATUS OF THE MAINTENANCE CORRECTLY REFLECTED ON THE SCHEDULE?	YES. All completed work orders are reviewed by the cognizant maintenance supervisor and/or the maintenance manager.	
	DO PERSONNEL REVIEW THE MAINTENANCE PROCEDURES PRIOR TO STARTING WORK?	NO. A line item to include review of maintenance procedures prior to performing the work needs to be included in a check list attached to the work order. An addition to the Formal OJT Program to include qualification in the prerequisites/corequisites checklist (attached) is recommended to address this deficiency,	
	DOES THE MAINTENANCE PROCEDURE PROVIDE ADEQUATE INSTRUCTION TO SUCCESSFULLY PERFORM THE WORK?	YES. The maintenance procedure provides adequate instruction to successfully perform the work however it is recommended that a checklist and a tool and materials list be attached.	
	ARE SPECIAL TEST INSTRUMENTS, TOOLS, AND JIGS AND FIXTURES SPECIFIED IN THE PROCEDURE?	NO. See above.	
	DOES THE PROCEDURE REFERENCE THE APPLICABLE DOCUMENTATION NEEDED FOR THE WORK?	NO.	
	ARE APPROPRIATE DATA SHEETS INCLUDED AS ENCLOSURES TO THE PROCEDURE?	NO. Enclosures and attachments cannot be included with the work orders since that is not a capability of the CMMS. These must be generated and attached manually.	

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	ARE PROVISIONS PROVIDED FOR LISTING DISCREPANCIES?	Discrepancies are currently listed on the work order sheet reviewed by the supervisor and/or the Maintenance Manager. No formal provisions are currently provided due to the limitations of the CMMS.	
	IS TAGOUT OF EQUIPMENT ADMINISTRATIVELY DEFINED?	YES. LOTO procedures for all equipment have been approved and issued	
	ARE COMMUNICATION REQUIREMENTS BETWEEN O&M PERSONNEL SPECIFIED?	YES. The communication requirements are specified in the "Shift Supervisor's Standing Orders" (Effective 2/21/2007).	
	IS THE MAINTENANCE PERFORMED IAW THE PROCEDURES?	YES.	
	ARE SYSTEM AND EQUIPMENT LINEUPS IAW WITH PROCEDURES AT ALL TIMES?	YES.	
	IS TWO PERSON VERIFICATION PERFORMED AS SPECIFIED?	NO.	
	DO SUPERVISORS TAKE PROPER FOLLOW-UP ACTION ON DISCREPANCIES?	YES.	
	IF ACCEPTANCE CRITERIA ARE NOT MET, IS THE EQUIPMENT DECLARED OUT OF SERVICE AND APPROPRIATE ACTION TAKEN IN ACCORDANCE WITH WORK CONTROL PROCEDURES?	UNKNOWN. This matter is specified in the EHS source documents, but an implementing strategy does not exist. This could be addressed through the shift supervisor's standing orders or the EHS corrective action program procedures.	

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	ARE APPROPRIATE MANAGERS INFORMED?	YES. All completed work orders are reviewed by the supervisor and/or the maintenance manager.	
	ARE LIMITS, PRECAUTIONS, SYSTEM CONDITIONS, DATA REQUIRED, ACCEPTANCE CRITERIA, AND PROCEDURAL STEPS ADEQUATELY ADDRESSED?	YES. As previously mentioned, the O&M manual, start-up/baseline information and controlled document maintenance procedures signed off by the Maintenance Manager and the EHS department personnel are on file.	

PREREQUISITES AND COREQUISITES CHECKLIST

Typical items for systems/equipment maintenance and modification work

reviewed by Planning and Scheduling

<u>Items</u>	<u>Initials</u>	<u>Date</u>
• Procedures up-to-date and validated	_____	_____
• All drawings up-to-date and available	_____	_____
• All work orders prioritized and scheduled for execution	_____	_____
• Qualified personnel available/special training complete	_____	_____
• Vendor documentation current and available	_____	_____
• QA, engineering, operations, and others ready	_____	_____
• Required PM/PDM complete	_____	_____
• Special equipment verified operational and available (measuring and test equipment, special tools, jigs and fixtures-these should be in controlled inventory)	_____	_____
• Job site availability verified (Includes unique equipment availability, e.g., cranes, as well as access control, staging, and scaffolding)	_____	_____
• Job site preparation complete	_____	_____
• Completion criteria specified	_____	_____
• Post maintenance testing specified	_____	_____
• All parts available and shelf-life requirements met	_____	_____
• Final documentation specified and forms included	_____	_____

References:

1. Huzdovich, James, "Getting More Than Data Processing Out of a CMMS" (Paper presented at the Enterprise Asset Management Summit 2006, Las Vegas, Nevada, March 10, 2006).
2. Huzdovich, James, "Part I-Elegant Maintenance Management-Manifesting the Big Picture", Maintenance Technology, June 2007.
3. Huzdovich, James, "Part II-Elegant Maintenance Management-The Road to Success", Maintenance Technology, October 2007.
4. Huzdovich, James, "Part III-Addressing the Training Dilemma", Maintenance Technology, June 2008.