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## **SECTION B – CHAPTER 6: PROCEDURES**

Sections 450-8.016(b)(1)(D) and 450-8.016(b)(1)(E) of County Ordinance Code Chapter 450-8, as amended by Ordinance 2006-22<sup>1</sup>, requires Stationary Sources to address the following within their Human Factors Program: operating procedures; maintenance safe work practice procedures; and maintenance procedures for specialized equipment, piping and instrumentation. The intent of this chapter is to address the inclusion of human factors considerations in the operating, safe work practice, and maintenance procedures, and within the programs developed and implemented to manage these procedures (i.e., development, review). It is not the intent of this chapter to address the general operating or maintenance procedure requirements specified by Sections 450-8.016(a)(2) and 450-8.016(a)(5).

This chapter identifies those human factors elements that must or should be developed, and includes methods that Stationary Sources may adopt to meet the requirements. “Guidelines for Writing Effective Operating and Maintenance Procedures”<sup>2</sup> states that, “Procedure writing is an exercise in the use of human factors”. Personnel must be involved in the development and maintenance of procedures for them to “buy in” to their use. Procedures must also be written to avoid the latent conditions that could cause active failures (e.g., format, conciseness of statements, written for the user). Stationary Sources electing to use assessments other than those described in this chapter to perform human factors assessments on operating, maintenance procedures, and safe work procedures, must consult with CCHMP representatives.

### **6.1 PROCEDURE MANAGEMENT SYSTEM**

Stationary Sources should consider developing written guidelines that summarize the accepted manner in which procedures are to be written, reviewed, revised, and maintained. Stationary Sources are encouraged to incorporate human factor considerations directly into their written guidelines (e.g., define or restrict use of vague terms like check, verify, confirm). One of the outcomes of these guidelines would be to ensure that new procedures are created, or existing procedures are modified, only according to a defined set of rules.<sup>2</sup> Stationary Sources may develop an audit/verification program in lieu of completing latent conditions checklists for each procedure. The procedure management system at the Stationary Source must include mechanisms for evaluating the current situation, developing procedures (including identifying procedures to write and format), reviewing and approving procedures (including an evaluation of procedural errors), and maintaining procedures current and accurate on a daily basis. These mechanisms are discussed below.

#### **6.1.1 EVALUATING CURRENT SITUATION**

The latent conditions checklist included in Attachment A<sup>13</sup> and described in Chapter 3 includes a section entitled “Activity/Task”. If the Stationary Source elects to apply the checklist, they must ensure that it is appropriately applied and that the causes of any indicators or questions receiving a “No” are completely identified. The questions in the checklist are indicators of larger potential

deficiencies (i.e., addressing the indicators may resolve the symptom but not the disease). Application of the checklist and requirements for resolving findings is discussed in detail in Chapter 3.

## **6.1.2 DEVELOPING PROCEDURES**

### **6.1.2.1 INITIAL DEVELOPMENT**

Stationary Sources must first determine which procedures to write or to verify that they have written procedures for every task deemed necessary. When determining if a written procedure is needed, assume that, in the absence of a procedure, the task will either not be done or not be done consistently. If the consequence of not performing a task or performing a task in an arbitrary manner is acceptable, a written procedure is probably not required.<sup>10</sup> For uniformity in procedure development, written criteria that defines levels of frequency, criticality, complexity and procedure requirements is encouraged.<sup>2</sup> Stationary Sources should follow traditional employee participation requirements when determining whether a written procedure is needed.

Stationary Sources may find it beneficial to start by reviewing existing procedures, work instructions, training matrices, and the most hazardous or unreliable processes (e.g., high risk work)<sup>3</sup> or hazardous maintenance task and comparing it to job function descriptions or competency models to ensure that there is a proper match. A number of Stationary Sources may rely on original equipment manufacturer or vendor manuals that contain written operating or maintenance procedures. If so, Stationary Sources should make sure that these documents are available, up to date, and accurate. There are several drawbacks to using vendor manuals and/or equipment manuals. For example, many may be written generically in terms of process application, or describe a broad application of makes/models of equipment. They may also provide only cursory, or non-existent, cautions and warnings associated with a task. Therefore, Stationary Sources should verify that such referenced manuals include, or procedures are augmented to contain, information to the appropriate level of detail determined at your site to reflect your worker's competency and human factors program<sup>3</sup>. Stationary Sources should address routine activities as well as infrequent tasks, shared tasks, or tasks requiring assistance from operators or maintenance personnel from other areas/crafts.<sup>3</sup> Training Needs Assessments, Process Hazard Analyses (Section B: Chapter 4), Job Safety Analysis (if conducted), and standing preventative maintenance work orders are all resources for identifying and selecting tasks that may require written procedures. Criteria should be developed and maintained to determine when a written procedure is warranted rather than using work instruction, a job aid, job task, guideline, call list, work order, activity checklist, or other term that a Stationary

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Source may use for describing other “informal procedure” or “non-comprehensive task descriptions”.

### **6.1.2.2 TASK ANALYSIS**

Stationary Sources must develop a process for procedure development that includes identifying the hazards associated with the tasks and incorporating input from personnel with expertise in the process (both in the steps required to conduct the task and in the precautionary notes included as consequences of deviating from the procedure). One method for developing comprehensive task descriptions and procedures is to conduct task analyses. Task analysis techniques may be applied during the design mode, audit mode, or retrospective mode. Task analysis can help to ensure that the most efficient method (e.g., safest, least time consuming) is identified, and that discrepancies between individuals and shifts are eliminated. Task analysis results may be used as input to the content of operating/maintenance procedures, training, and operating/maintenance manuals. Task analysis results may also be used during incident investigations (Section B: Chapter 5) to explicitly identify differences in the prescribed way of performing a task and the actual way it was performed. Several acceptable task analysis techniques exist such as Hierarchical Task Analysis, Tabular Task Analysis, and Timeline Analysis<sup>5</sup>. When performing a task analysis, Stationary Sources should also remember to consider all operating modes, maintenance activities, and all other related activities. The CCPS Guidelines for Risk Based Process Safety states: “One common error in conducting a task analysis is to focus only on activities that occur at the time that the analysis is done. In doing this, the analysis is likely to miss certain non-routine modes of operation”. This should be expanded to apply to maintenance procedures in which non-routine activities that maintenance personnel perform may be missed.

Task analysis is a resource-intensive activity that may or may not be the most efficient or effective method for creating the task description. CCHMP believes that a task analysis should only be used to determine which procedures are necessary and not used to eliminate existing procedures. If the Stationary Source elects to eliminate an existing procedure, a separate methodology, such as a procedure needs assessment, should be developed by the Stationary Source to document the assessment process. Such assessment should include a rationale for elimination of the procedure and should include review and considerations by existing trained and qualified personnel satisfying employee participation requirements.

Stationary Sources, not already performing task analysis, should therefore consult with employees and their representatives as to whether task

analysis is appropriate for them. Task analysis is provided as one example method to apply for developing comprehensive task descriptions and procedures. If a Stationary Source elects to use alternate methods, they should still consult with employees and their representatives if they are not already performing the alternate method.

### **6.1.2.3 GAPS AND OVERLAPS**

When developing procedures, Stationary Sources must also ensure that interrelated procedures are reviewed and that gaps and overlaps are eliminated. In particular, it is important to review boundary operations and shared resources and equipment. This can be accomplished through a gap analysis. Questions such as: Do the steps go beyond the purpose/scope? Is a procedure's last step the same as another's first step? Do any responsibilities overlap? should be asked.<sup>3</sup> Procedures should also be reviewed to look for interrelated procedures and ensure they have clear, distinct, and non excessive cross references.<sup>10</sup> CCHMP believes that a gap analysis is a tool for creating procedures and eliminating overlaps/redundancies within procedures, not for eliminating procedures.

### **6.1.2.4 FORMATTING**

Stationary Sources must identify a format that can be consistently applied to all written procedures within a unit, functional activities, or Stationary Source. Procedures should then be revised to reflect the accepted format, on a schedule to be determined by the Stationary Source. Different formats (e.g., lengthy training documents, written procedures, checklists) may be appropriate if the Stationary Source has a tiered operating structure (i.e., Operator 1, Operator 2, etc.) and clearly differentiates the level of training required to properly conduct the specified task (e.g., if Task A can only be performed by Level 1 Operators (the most experienced) or maintenance journeyman, a checklist may be appropriate).<sup>3</sup> Examples of effective procedure format are listed in Section 6.2. The level of detail and format for each procedure must be commensurate with the lowest level of experience of personnel responsible for conducting the task. Stationary Sources should develop criteria that support this level of detail in the written procedures. This is especially true for maintenance procedures where Stationary Sources should be able to rely on the level of expertise/experience they have in their workforce. This means that Stationary Sources should document the expected knowledge and duties (e.g., skill sets) for each maintenance position such that the level of detail in a written maintenance procedure would not need to include individual steps below that defined skill set. Nevertheless, if your Stationary Source uses cross-trained maintenance personnel or rely on contract maintenance, you may need maintenance procedures that are written to a much higher level of detail<sup>3</sup>. Stationary

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Sources must develop a mechanism for organizing the procedures so that they are easy to locate (particularly emergency operating procedures).

#### **6.1.2.5 EMPLOYEE PARTICIPATION**

Employees responsible for developing and maintaining the procedures must be trained in rules for writing effective instructions<sup>4</sup>. The requirements for procedures are discussed in more detail in Sections 6.2 and 6.3. Appropriate employees must participate in developing, reviewing, finalizing, and maintaining procedures, including identification of latent conditions existing within the procedures that could cause or exacerbate an active failure.

#### **6.1.3 REVIEWING AND APPROVING PROCEDURES**

Stationary Sources must develop programs to review and approve procedures to ensure that they are accurate, current, and that the effects of procedural errors are fully understood. One method for evaluating whether the procedure is current and accurate is to require employees to observe other employees performing the procedure. Deviations or discrepancies between the written procedure and the actual practice should be identified and resolved. Stationary Sources may also elect to combine procedure review and refresher training by requiring personnel to “walkthrough” the procedure with their supervisors.

One method for ensuring that the effects of procedural errors are fully understood and appropriately documented is to conduct an error analysis. Stationary Sources routinely have personnel with expertise and experience in the process/task review procedures and identify when precautionary notes should be inserted. However, Stationary Sources may elect to conduct a more detailed, predictive analysis to identify consequences of deviating from the procedures. Formal error analysis can help to ensure that necessary precautions are identified at certain steps, that unnecessary steps are eliminated, and that employees actually understand the importance of each step as opposed to performing steps just because “that’s the way its always been done”.<sup>3</sup> Several acceptable error analysis techniques are Barrier Analysis, Work Safety Analysis, Procedural PHA and Human Error HAZOP (Section 4.3).<sup>5,6</sup>

Section 450-8.016(a)(2) requires that the Stationary Source annually certify that operating procedures are current and accurate. Stationary Sources should develop a process to verify that maintenance procedures as well as safe work practice procedures are current and accurate.

#### **6.1.4 MAINTAINING PROCEDURES**

Section 450-8.016(a)(2) requires Stationary Sources to review current operating practice, including changes that result from changes in process chemicals, technology, and equipment, and changes to Stationary Sources as often as necessary to assure that they are reflected in the existing operating procedures. Stationary Sources must develop a program for employees to revise operating procedures as necessary as opposed to just during the formal annual review. Stationary Sources should develop a similar process that allows employees to revise maintenance procedures and/or safe work procedures as necessary to assure that they reflect existing practices and procedures. Stationary Sources must also ensure that only current, approved versions of procedures are accessible to employees or contractors.

Employees must be trained in the importance of maintaining the procedures current and accurate. Employees should be trained to understand that the procedures are essential work documents and represent the only approved method for performing work. Otherwise there may be unacceptable consequences that may or may not be immediately evident (e.g., increasing process temperature too quickly may result in metal fatigue and premature equipment failure).

Other additional changes may also necessitate a review for the adequacy or appropriateness of existing procedures. Section 450-8.016(b)(1)(B) requires Stationary Sources to conduct a Management of Organizational Change prior to staffing changes for changes in permanent staffing levels/reorganization in operations or emergency response. Chapter 7, Management of Organizational Change, will address the mechanism for conducting the staffing review. It is not the intent of this chapter to discuss general management of organizational change issues; however, the following aspect should not be overlooked: the management of organizational change process must ensure the review of procedures that require simultaneous tasks, or that require tasks to be conducted by certain positions or skill sets.

Section 450-8.016(a)(6), Management of Change, contains requirements for the Stationary Source to update operating procedures or practices associated with a change. Stationary Sources should assure that, if a change subject to the Management of Change requirements affects maintenance procedures or safe work procedures, these are also updated.

#### **6.2 WRITTEN OPERATING PROCEDURES**

Each Stationary Source must develop an operating procedure format, which is appropriate for them given the type of Stationary Source (i.e., continuous, batch), the type of procedure (e.g., normal, emergency, startup, shutdown), internal standards (e.g., ISO 14000, corporate requirements) and the existing regulatory requirements (e.g., risk

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management program, OSHA process safety management). The intent of this section is not to dictate the content and format of operating procedures, but rather to provide general elements of effective procedures which Stationary Sources must or should incorporate.<sup>2,3,5</sup>

- Procedure title and number (if appropriate) should be easy to locate and accurately describe the nature of the activity
- The last step of the procedure should be identified
- Temporary procedures should be clearly identified
- Each procedure should note the procedure user (e.g., engineer, operators, maintenance, health and safety staff, level of experience)
- Each step should be written as a command
- Use common words
- Avoid vague terms (i.e., leave no room for guessing or interpreting word meaning)
- Spell out first use of acronyms and abbreviations
- Each step should include only one action. This will help to ensure that employees will not “overlook” an assumed but unwritten step
- Steps that should be performed in a particular sequence should be numbered and listed sequentially
- Critical step sequencing should be preceded by a caution or warning
- Whenever possible, the procedures should reference equipment or instrumentation by unique number or name
- Page layout (e.g., line spacing, length of lines, and font size) should not negatively affect readability
- Procedures should neither reference steps from nor excessively reference other procedures or documents
- Precautionary statements (e.g., warning, caution, notes) should be clearly defined and placed immediately before the step to which they apply
- Precautionary statements should stand out from procedure steps
- Procedure “branching” (e.g., return to step 3) should be minimized
- Sign offs should be required for verifying critical steps of a procedure
- Steps within procedures to be performed by multiple employees should be clearly indicated and possibly require checklists or sign offs
- Complex procedures or procedures that require more than one shift to perform should require check-offs or sign offs
- Steps that require contingencies or criteria to assist the employee should precede the action (i.e., if the temperature is above XX, set the flowrate to the following range YY-YYY)
- Formulas or tables should be included when procedures require calculations (i.e., minimize “in your head” calculations)
- Incorporate feedback loops as appropriate in the procedure so that employees can verify that their activities were correct
- Non-routine personal protective equipment necessary to complete the procedure should be listed at the beginning of the procedure and immediately before the step

- to which they apply (alternatively a step to don or use the PPE)
- Instructions and conditions when by-passing shutdown systems or interlocks is allowed should be specified<sup>12</sup>
- Write all steps necessary for the operating task (e.g., do not list “startup compressor” if there is more than a simple push-button to press)

### **6.3 MAINTENANCE AND SAFE WORK PROCEDURES**

The County’s Industrial Safety Ordinance requires that human factors be considered in safe work practices and maintenance procedures for specialized equipment, piping, and instrumentation. The question then is what is considered specialized? Webster’s defines specialized as: “highly differentiated especially in a particular direction or for a particular end, designed, trained, or fitted for one particular purpose or occupation”. Therefore specialized equipment, piping, and instrumentation can be viewed as equipment, piping, and instrumentation that are designed for a specific process or purpose. The Stationary Source should identify which equipment, piping and instrumentation are included in this category. The Stationary Source should maintain the rationale for this identification for CCHMP to review. These procedures should include many of the same formatting elements given in Section 6.2 as well as additional elements to ensure that the human element is considered, latent conditions are identified and potential for human error is reduced. The intent of this section is not to dictate the content and format of maintenance procedures, but rather to provide general elements of effective procedures, which Stationary Sources must or should incorporate. The following is intended to be a general list of elements the Stationary Source should consider when developing their maintenance procedures:<sup>7,8,9,11</sup>

#### **6.3.1 MAINTENANCE PROCEDURE ELEMENTS**

- Elements listed in Section 6.2
- List the craft or personnel to which the procedure is applicable
- Labeled graphics should be included for the user’s benefit
- Sufficient detail must be used to reduce interruptions (i.e., times that the user must stop the procedure or put the procedure down)
- The procedure should include the Scope and Purpose
- Special tools and equipment necessary to complete the job should be listed at the beginning of the procedure
- Specific or unique cleaning supplies should be noted
- Appropriate health and safety information should be included or referenced
- The personal protective equipment necessary to complete the procedure should be listed at the beginning of the procedure and immediately before the step to which they apply
- Should include required follow-up actions or tests and identify the user who must be notified as appropriate
- Consider identifying critical maintenance tasks



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- Consider including self-checks that should be used during maintenance activities

### **6.3.2 SAFE WORK PRACTICES ELEMENTS**

The same requirements discussed in Section 6.3.1 can be applied to Safe Work Practices as well. For the purposes of this section, Safe Work Practices include those involved with performing hot work, line opening (breaking), lockout / tagout, and confined space activities. Safe work practices are often supplemented with permits. The Stationary Source may also include the permits in their evaluations of Safe Work Practice for human factors. Due to the nature of safe work, the Stationary Source should also carefully evaluate these practices for any latent conditions. Additional elements that should be considered are listed below<sup>10</sup>:

- Elements listed in Section 6.3.1
- Steps to drain, purge, or clean the equipment, if applicable
- Safeguards to protect against the hazards, for example, isolation of energy sources and process materials
- Required monitoring of worksite conditions and worker performance
- A method to formally turn over control of the equipment from operations to the group responsible for the maintenance work

### **6.4 EMERGENCY OPERATING PROCEDURES**

The same requirements for procedures discussed in Section 6.2 apply to emergency procedures as well; however, emergency procedures must be particularly easy to access and clear to understand. During emergencies employees will be required to make quick decisions based on different conditions or parameters under stressful conditions. Accessibility may be enhanced by using different colored paper, or separated and placed in a brightly colored binder for emergency procedures. Although electronic copies of emergency procedures are acceptable, printed copies that are maintained current and accurate must be readily available (i.e., within easy reach) to personnel. Clarity in understanding may be enhanced by using larger font type than usual, or by using lists in conjunction with simplified drawings. Decision aids (e.g., flow charts, decision trees, and quick yes/no answers) may be used to assist the operator in making correct decisions.

The following list of information was adapted from CCPS's Guidelines for Writing Effective Operating and Maintenance Procedures and the Process Safety Institute training manual "Writing Effective Operating and Maintenance Procedures". This list includes types of information Stationary Sources may include in emergency operating procedures:

- Acknowledging and silencing alarms
- Responsibilities for performing specific actions during the emergency
- Appropriate PPE and other protective devices (e.g., safety showers, emergency carts)
- Special tools, materials, or chemicals

- Additional hazards not present during normal operations
- Location and use of emergency equipment
- Location of alternate/redundant controls stations or panels
- Location of manual stops and shutoffs for systems normally under automatic control
- Decision aids
- Safe operating limits and other indicators
- Shut down lists, diagrams
- Consequences of deviation
- Steps to place the process in a safe or self-sustained mode
- Steps to shut down the process in the safest, most direct manner
- Conditions under which the user may have to stop and evacuate
- Required communication, announcements, and notifications, including initiating the Emergency Response plan
- Instructions and conditions when by-passing emergency shutdown systems or interlocks is allowed should be specified<sup>12</sup>
- Steps to return the process to safe operating limits if possible or practical

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<sup>1</sup> Modifications were made to the Contra Costa County's Industrial Safety Ordinance (ISO) in 2006. Major changes made to the human factors program requirements included requiring human factors evaluations of maintenance safe work practice procedures and maintenance procedures for specialized equipment, piping, and instruments. Since the corresponding City of Richmond's Industrial Safety Ordinance has not been amended, Stationary Sources subject to the City of Richmond's ISO are encouraged to comply with the County ISO amendments.

<sup>2</sup> CCPS (1996), *Guidelines for Effective Operating and Maintenance Procedures*

<sup>3</sup> Process Safety Institute training manual *Writing Effective Operating and Maintenance Procedures*, 2005

<sup>4</sup> Williams and Gromacki, *Eliminating Error-Likely Situations During Procedure Updates*, Presented at AIChE 32<sup>nd</sup> Loss Prevention Symposium, 1998

<sup>5</sup> Kirwain, Barry, *Evolving Human Factors in Offshore Operations*, 1996

<sup>6</sup> CCPS (1994), *Guidelines for Preventing Human Error in Process Safety*

<sup>7</sup> CCPS (2006), *Guidelines for Mechanical Integrity Systems*

<sup>8</sup> Ricci, Katrina, *Human Factors Issues in Maintenance Publication Design*, Presented at SAE DOD Maintenance Symposium, 2003

<sup>9</sup> CCHMP audit observations of best practices

<sup>10</sup> CCPS (2007), *Guidelines for Risk Based Process Safety*

<sup>11</sup> CCPS (2007) *Human Factors Methods for Improving Performance in the Process Industries*

<sup>12</sup> Facilities should follow the most recent version of ISA 84.00.01 standards or equivalent regarding proper approvals, analysis, and procedures for by-passing independent protection functions.

<sup>13</sup> CCHMP added additional questions for evaluation of latent conditions that may help improve the overall human factors program in 2010. Stationary Sources should review Attachment A to incorporate into their latent conditions checklists.