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 Chapter 4.0  
 Quality Assurance

NUREG-1280  
 Revision 1

Segregation of customer scrap during processing is accomplished by cleaning the dissolver and accountability weigh tank before and after the recovery campaign. Additional processing of dissolver residues should be handled in the same manner unless the quantity involved is less than 1 FKG or the measurement uncertainty is less than  $\pm 5\%$  at the one  $\sigma$  level.

**4.9. Human Errors [§74.59(h)(3)]**

**Requirement** The rule requires that a licensee incorporate checks and balances in the MC&A system to control the rate of human errors in MC&A information.

**Intent and Scope** The objective of this requirement is to reduce the frequency of human errors affecting MC&A information and to enhance the likelihood of detection when they do occur. This can be achieved by a system of checks and balances in MC&A information systems that involve generating, collecting, processing, computing, analyzing, summarizing, and reporting data.

**4.9.1 MC&A Procedures**

Describe the MC&A procedures developed to perform MC&A tasks, the features of these procedures that contribute to minimizing human errors in MC&A data, and the control methods used to ensure that current procedures are in place and are being used appropriately. Control methods may include maintenance of a list of procedures, periodic review by operators and during audits, use of sign off cover sheets, and validation during training sessions. The FNMCP should describe where procedures are available for subsequent monitoring during NRC inspections.

**Affirmations:** MC&A procedures are developed and implemented in a manner that ensures that the frequency and consequences of human errors will be minimized.

MC&A procedures are formatted in a manner that facilitates a reduction in human errors and helps make errors easier to identify.

**Acceptance Criteria:** Procedures have been developed and are used that will control the rate of human error in MC&A data.

- Specific procedures are available to guide personnel in performing major or complex tasks associated with MC&A.
- Procedures are sufficiently explicit and comprehensive to promote error-free performance by the least skilled or least

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experienced person that will be assigned to perform the tasks specified by the procedures.

- Procedures are based on the activities required to effectively accomplish the task.
- Procedures are self-contained to avoid the need to refer to supporting documents.
- Procedures are written with flexibility in the sequence of events whenever possible.
- Knowledgeable personnel prepare and review procedures before they are implemented.
- Lengthy and/or complex procedures are validated by means of field tests to ensure their clarity, comprehensiveness, and effectiveness.
- Personnel are required to use and follow appropriate procedures in performing complex MC&A tasks or tasks that affect MC&A.

The format of MC&A procedures is arranged to help to reduce the rate of human error and to detect mistakes.

- The complexity, sentence length, and grammatical structure are appropriate to the educational level of the least qualified user.
- Short sentences with concise and unambiguous language are used.
- The level of detail in instructions is adequate to avoid errors of omission.
- No more than three simple task elements are included per step. More complex actions are separated into additional steps.
- Procedures are formatted to allow experienced personnel to concentrate on major headings or capsule descriptions, while more detail is provided in clearly demarcated fashion for less experienced personnel. Procedures may be formatted in "cookbook" fashion for ease of use when appropriate.

- All steps and tasks are stated as actions. The sequence of steps and tasks in a procedure is in the same sequence followed to accomplish the objective of the procedure.
- Attention-getting warning and precaution notices are placed immediately preceding applicable steps and, where required, are also summarized at the beginning of the procedure.
- Summary information is included at the beginning of every procedure. All required supplies, tools, test equipment, documents, and protective measures are listed at the beginning of the procedure.
- All applicable referenced documents are listed in one section of the procedure.
- Quality control and quality assurance points are identified.
- Decision-making cues are clearly stated.
- Sub-tasks and sub-tests are set off with separate headings or by an appropriate indentation.
- The sequence of steps is logical and accurate.
- Unnecessary memory recall is avoided.
- The need for personnel to perform calculations and conversions is avoided whenever possible.
- Data collection tables and data reduction aids are provided if lengthy tests and calculations cannot be avoided.
- Pre-printed forms for recording data are utilized when practical.
- Multiple copies of forms, if needed, are generated automatically in the data collection phase.
- Formatting is neat and simple and is consistent among all related procedures.

Questions and Answers:

- Q** Why should there be no more than three actions per step in a procedure?
- A** By restricting the amount of information that personnel are required to remember while performing a procedure, there is a greater probability that the procedure will be performed correctly. Remembering precise, numerical information is

not a task that humans perform well. Using checklists or preprinted forms are methods to limit the amount of memorization required while reducing dependence on often bulky procedures.

**Q** What is configuration control and how is it applied to procedures?

**A** Configuration control is a method by which the current official copies of procedures are maintained and controlled. Procedures that may be used in configuration control include sign offs by a responsible person on the released version, numbering and dating versions, and periodic checks of the individual procedures under the control of the procedure custodian or holder to make sure that current copies are being used.

#### 4.9.2 Job Performance Aids

Describe the job performance aids to be utilized for highly complex MC&A tasks to control the rate of human error in MC&A data.

**Affirmations:** MC&A procedures include job performance aids, where applicable, that help to reduce the frequency of human errors.

**Acceptance Criteria:** Job performance aids are provided for complex MC&A tasks.

- Job performance aids assist novice users in their performance while not hindering the performance of experienced users.
- Terms and labels match common usage for equipment labels and legends.
- Quantities and dimensional units correspond to referenced displays, documents, and information.
- Uncommon and inconsistent abbreviations are avoided.
- The presentation of illustrations, graphs, and tables, if used, is consistent throughout the procedure.
- Checklists or data tables are provided for lengthy prerequisites, tests, and calculations.
- Illustrations are used in place of long descriptions where possible.

- Illustrations are placed so that they can be referenced easily from the text section.
- Illustrations are clearly labeled and easy to read.
- All tables and graphs are clearly labeled in quantitative terms.

Questions and Answers:

Q What are some successfully used job performance aids?

A Several job performance aids (JPA) are illustrations and diagrams, graphs for interpolation, approximate times to complete specific jobs, clearly stated decision-making cues and clues to the correct decision given specific cues, and data reduction aids. JPAs are good as long as they do not cause the procedure to become difficult to use because of too many aids, the wrong types of aids, or presentation in an inappropriate manner. If the procedure can be written so that an experienced user can omit unnecessary aids meant for novice users, that in itself is a JPA and will encourage procedure usage.

Q Some of the notation and labels used on equipment at specific facilities may not be current with respect to recommended terminology. Should procedures use current terminology, or be consistent with the equipment?

A Ideally, equipment should be brought into compliance with the current idea of "best" notation on labels and panels. However, confusion could occur because personnel at the facility are accustomed to that terminology, so these labels probably should not be changed. In any case, procedure terminology should be consistent with equipment, as should forms and other information to be employed by personnel at the facility.

4.9.3 *Automation of MC&A*

Describe the methods and technologies used to automate MC&A functions and the features of these methods that contribute to minimizing human errors in MC&A data.

Affirmations: MC&A activities associated with collecting and processing data, recordkeeping, and auditing are automated where it is practical and advantageous to do so.

Acceptance Criteria: MC&A data are directly collected, inputted, checked, manipulated, reported and audited by computer where it is practical and advantageous to reduce the consequences and frequency of human error in MC&A data as much as practical.

4.9.4 Human Error Quality  
Control

Describe the quality control system that will be used to monitor the frequency and types of human errors.

Describe the techniques that will be employed to minimize the frequency and consequences of human errors and enhance the likelihood that they will be detected when they do occur. The description should address the use of:

- Control methods to ensure that current procedures are in place and being used,
- Job performance aids,
- Automated data processing,
- Personnel training and qualification,
- Preprinted forms,
- Multiple copy forms, and
- Data verification.

Affirmations:

A quality control system is in place to monitor the frequency of human errors and permit categorization of the types of errors encountered.

Acceptance Criteria:

Statistical quality control systems are used to track the effectiveness of human error control measures and the frequency of human error in MC&A systems, and should be used to alert management whenever the rate of human error is in an out-of-tolerance condition.

- The quality control system is capable of determining if and when an individual, procedure, or process makes more errors than is reasonably expected.
- The quality control system is capable of determining both (1) the individuals who require retraining due to their frequency of committing errors and (2) the procedures and processes that should be revised to produce fewer human errors.
- Double checklists are provided to allow periodic, random auditing of data collection by a supervisor or other independent person that checks the results of the first person's work and signs off when the work is complete and accurate. Each data collection form should be checked by the originator to verify that the data are accurate.

- When MC&A data processing is automated, quality control systems are also automated, so that out-of-tolerance conditions, human errors, and other warnings can be detected promptly.
- A configuration management plan is established for vital MC&A equipment, computer software, and manuals.
- Configuration control measures are performed systematically and immediately reflect all changes as they are made.
- Procedures and technical manuals are stored, indexed, filed, and controlled in a manner that ensures easy retrieval and availability.
- Estimates of human error rates are based on a human reliability analysis of the data collection process to determine a reasonable rate of human error in MC&A data for the specific licensee.
- Reasonable estimates of human error rates include input regarding equipment design, plant policies and practices, and written procedures.
- Reasonable estimates of human error rates include input regarding situational and personnel factors that may produce errors.
- Any potential problems that can reasonably be resolved following a human reliability analysis are resolved and the estimates of a reasonable error rate recalculated.

Questions and Answers:

- Q** What minimum level of human error is reasonably achievable with respect to MC&A data?
- A** The degree and amount of human error in MC&A data depends on the systems that are in place to provide checks and balances to reduce errors. An effective program to reduce human error would employ techniques that limit human error by reducing the chances for errors to be made and not creating error-likely situations in the design of the work. However, without totally eliminating the human element from MC&A, there is no way to eliminate human error totally. Table 1 lists some of the applicable human error rates and situational multipliers from Swain and Guttman (1983).

- Q** Why should an independent observer be used to sign off on checklists and other work?
- A** An independent observer is useful in the event that a person makes a mistake, since an independent observer will often see mistakes whereas the person who made the original mistake, using the same logic or reviewing the work rather quickly, will be less likely to recognize the problem.

Table 1 Errors Rate Associated with MC&A Data Collection

These values are adapted from Swain and Guttman (1983) and reflect some typical error probabilities for human activities in the MC&A process. For additional data and information on its usage, please refer to the cited document.

<u>Potential Error</u>	<u>Estimated Error Rate</u>
Failure to perform rule-based actions correctly when written procedures are available and used .....	0.005
written procedures are not available or used .....	1.0
Omitting a step or important instruction from a formal procedure .....	0.003
oral instructions .....	negligible
Writing an item incorrectly in response to a formal procedure .....	0.003
oral instructions .....	negligible
Carrying out a plant policy scheduled task such as periodic tests performed weekly, monthly, etc .....	0.01
Using a written test or calibration procedure properly .....	0.01
Using a checklist properly .....	0.5
Omitting items when procedures have check-off provisions and are correctly used .....	0.003
incorrectly used .....	0.01
Omitting items when written procedures are available and are not used .....	0.05
Errors of commission in reading and recording quantitative information from unannounced displays	
analog meter .....	0.003
digital readout .....	0.001
chart recorder .....	0.006
printing recorder with large number of parameters .....	0.05
graphs .....	0.01
recording tasks .....	0.005
simple arithmetic calculation .....	0.01
Estimated probabilities that a checker will fail to detect errors made by others	
routine tasks, checker uses written materials .....	0.1
routine tasks, checker uses no written materials .....	0.2
one-of-a-kind checking with alerting factors .....	0.05
special measurements .....	0.01
Modifications of estimated error rates for the effects of stress and experience level	
low stress .....	x2
optimum stress .....	x1
moderately high	
stress novice .....	x4
skilled .....	x2
extremely high stress (life threatening)	
novice .....	x10
skilled .....	x5