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FUNCT.ANALY.WORKSHOP

JUN 27 1990

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FROM: John J. Linehan, Director
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Assurance Project Directorate
Division of High-Level Waste Management, NMSS

SUBJECT: REPOSITORY FUNCTIONAL ANALYSIS REVIEW AND WORKSHOP

On July 2 and 3, 1990, the CNWRA will conduct a short workshop on functional analysis and will also present the results to date of their WSE&I repository functional analysis study. The workshop is to: 1) explain the concept and method employed in the CNWRA functional analysis; and, 2) to work with the NRC staff in reviewing and adding to the repository functions identified. As has been discussed with you or your staff by Phil Altomare, it is requested that you arrange for your Branch staff that could contribute to or benefit from the workshop to attend.

The agenda for the workshop and functional analysis review is attached. Also attached for your information is the draft work plan for the functional analysis and a draft Technical Operating Procedure for the conduct of functional analysis. The contribution of the NRC staff is important to obtain as complete a designation of repository functions as possible which in turn will be utilized to evaluate

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the completeness of 10 CFR Part 60. We would greatly appreciate your support in this effort. Please contact Phil Altomare if you have any questions and to inform him as to who will attend from your Branch.

Thank you for your cooperation.

/S/

John J. Linehan, Director
Repository Licensing and Quality
Assurance Project Directorate
Division of High-Level Waste Management, NMSS

Attachment: As stated

cc: W. Ott, RES
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FUNCTIONAL ANALYSIS WORKSHOP

AGENDA

MONDAY JULY 2, 1990

10:00 AM - 11:30 AM	DISCRIPTION OF FUNCTIONAL ANALYSIS PROCESS
11:30 AM - 12:00 AM	DISTRIBUTION AND EXPLANATION OF REPOSITORY FUNCTIONAL REQUIREMENTS HIERARCHY
1:00 PM - 4:00 PM	STAFF INDIVIDUAL REVIEW OF MATERIAL; TED ROMINE, CNWRA, AVAILABLE FOR QUESTIONS

TUESDAY JULY 3, 1990

9:00 AM - 12:00 AM	REVIEW AND ADDITION TO REPOSITORY FUNCTIONAL REQUIREMENTS
1:00 PM - 4:00 PM	CONTINUATION OF WORKSHOP AS APPROPRIATE

MEETING LOCATION:

- MONDAY	ROOM 4-B-13, WHITE FLINT NORTH
- TUESDAY	ROOM 14-B-13, WHITE FLINT NORTH

ATTACHMENT 1

WORK PLAN FOR REPOSITORY FUNCTIONAL ANALYSIS

I. BACKGROUND

A functional analysis of the geologic repository will be performed as one of the parts of the Center five-part background study for a potential rulemaking related to Repository Operational Criteria (ROC). The full scope of that study is described in the Work Plan for Repository Operational Criteria.

The repository functional analysis will identify all functions necessary for (1) preparation of the waste for disposal (a primary system function that has the potential to be performed at the repository site), (2) disposal of waste in excavated geologic media, (3) postclosure containment of the radioactive wastes, (4) limiting the rate of release of radionuclides, and (5) isolating radionuclides from the accessible environment. The part of the Repository Functional Analysis that deals with the repository operational phase will tie to the activities that deal directly with the potential rulemaking. This analysis will provide a comprehensive basis for the identification of repository operations phase functions that are important to radiological health and safety (i.e., those functions that fit within the NRC regulatory charter). The results of this analysis will be recorded, reviewed by Center and NRC technical personnel, and reported to the NRC in a letter report. Details of the analysis are expanded in this Work Plan.

The repository functional analysis is contained in the current Center Operations Plan as part of the overall Nuclear Waste Management System Functional Analysis, and is funded as a WSE&I Element activity. The schedule for performance of the repository analysis is shown in the Gantt Chart in Figure 1. Estimated costs are provided in Table 1.

II. TASK DESCRIPTION

Geologic Repository Functional Analysis

1.1 Prepare a Draft Technical Operating Procedure (TOP), with an attached List of Considerations (Checklist), applicable to the Repository Functional Analysis.

- o The TOP shall state the purpose and objective(s) of functional analysis, and, together with the Checklist, shall provide specific guidance for the analysts in the conduct of the Repository Functional Analysis.

1.2 Perform the Repository Functional Analysis and Modify the Checklist as Needed.

- o Systematically identify the functions of the geologic repository in accordance with the draft TOP. The repository functional analysis shall be conducted independent of existing regulatory criteria. The analysis may be expedited by the use of information developed in previous analyses of items with comparable objectives.

- Record the results of the analysis (i.e., the geologic repository functional requirements) in a numbered, textual list format indented for each level of the functional structure.

- Revise and/or augment the List of Considerations (checklist) as appropriate during the conduct of the analysis.

1.3 Review the Results of the Functional Analysis.

- Ensure that the functional analysis addressed the developed checklist.

- Perform a "test of completeness" by a limited comparison of the identified functional requirements with related material such as 10 CFR Part 50 and Part 72, the DOE BWIP System Functional Analysis (SC-BWI-CR-023, March 20, 1987), and the DOE functional analysis for a Yucca Mountain repository (DOE/RW-0268P, March, 1990).

- Review the identified repository functions for clarity of description.

1.4 Finalize the Functional Analysis TOP and submit to the NRC for approval.

1.5 Prepare a Relational Grouping of the Repository Functions.

- Categorize the functions into relational groups. After the analysis is completed and reviewed, categorize the functions into relational groups; for example: (a) directly related to pre-closure HLW handling and storage, (b) indirectly related to pre-closure HLW handling and storage, (c) not related to pre-closure HLW handling and storage, (d) related to pre-closure radiation health and safety, (e) related to containment and controlled release of radionuclides and/or, (f) related to isolation of radionuclides.

1.6 Correlate Regulatory Requirements to the Repository Functions.

- Correlate the Systematic Regulatory Analysis (SRA) Regulatory Requirements with the repository functions identified in the Repository Functional Analysis. Perform a "Sufficiency Test" of 10 CFR Part 60 (i.e., identify any repository functions that are not addressed).

- Identify any repository functions that are inadequately addressed in 10 CFR Part 60. This comparison may provide the basis for augmenting or amplifying Regulatory Uncertainties identified in CNWRA 90-003.

1.7 Perform an Integrated Review and QA Review.

- o Review the integrated results of the Repository Functional Analysis, the relational grouping, the correlation of the Regulatory Requirements to the repository functions and the Sufficiency Test.

- o Perform a QA review of the above products.

1.8 Report the Results of the Functional Analysis and Sufficiency Test to the NRC.

- o Prepare a letter report to the NRC that briefly describes the conduct of the Repository Functional Analysis, the review of the products, and the results of the correlation and sufficiency test. Also briefly describe any inadequacies identified in 10 CFR Part 60. Attach the list of repository functions and their correlation with 10 CFR Part 60.

III. ESTIMATED LEVEL OF EFFORT

The following expertise is considered essential for the geologic repository functional analysis: health physics, nuclear engineering, systems engineering, civil engineering, mining engineering, mechanical engineering, materials scientist, structural engineering, electrical engineering, ventilation engineering, geotechnical engineering, geochemist, geohydrologist, geomorphologist, and structural geologist (rock mechanics). The estimated costs are given in Table 1.

IV. SCHEDULES/MILESTONES

(IM = Intermediate Milestone)

1.8 Report the Results of the Functional Analysis and Sufficiency Test to the NRC	7/13/90 - IM

V. CONTACT(S)

- ~~NRC Technical Lead: Dr. Jerome R. Pearring (301) 492-0508~~
- NRC Program Element Manager: Mr. Philip M. Altomare (301) 492-3400
- CNWRA Principal Investigator: Mr. John P. Hageman (512) 522-5152
- CNWRA WSE&I Element Manager: Mr. D. Ted Romine (512) 522-5208

Program Element Manager

Center WSE&I Element Manager

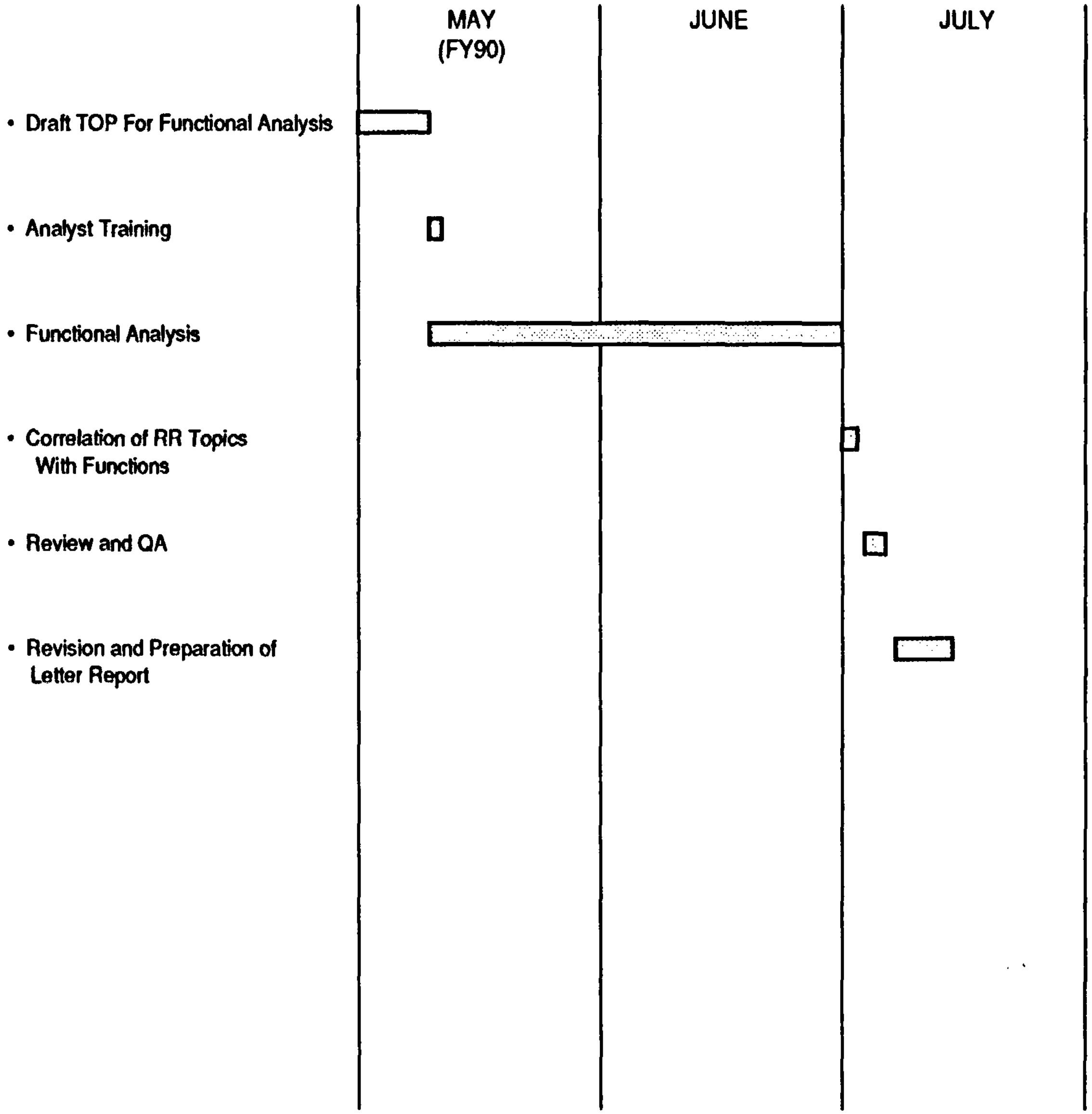


Figure 1. Geologic Repository Functional Analysis

TOP-001-07 HIGH-LEVEL WASTE MANAGEMENT SYSTEM FUNCTIONAL ANALYSIS

1. PURPOSE AND SCOPE

This procedure provides instructions concerning the preparation and content of functional analyses of the high-level nuclear waste management system authorized by the Nuclear Waste Policy Act of 1982 (NWPA) and amendments, and related legislation. This is one of a series of procedures prepared by the Waste Systems Engineering and Integration (WSE&I) Element to provide the necessary controls for conduct of Systematic Regulatory Analysis (SRA) as a part of the overall Program Architecture (PA) process. This procedure is established in accordance with the provisions of Technical Operating Procedure (TOP) 001, "Program Architecture Development and Maintenance".

It is contemplated that the functional analysis will be performed for the overall waste management system in as many as three parts encompassing each of the major segments of that system for which the NRC has licensing responsibilities: an interim storage facility (e.g., the Monitored Retrievable Storage (MRS)), if approved by the Congress, the transportation cask(s), and the geologic repository. These functional analyses will serve a variety of purposes in the licensing process including the following:

(1) Identification of all functions necessary for the accomplishment of the system mission to provide a comprehensive basis for the identification of functions related to radiological health and safety (i.e., those functions that fit within the NRC regulatory charter), and

(2) Provision of the basis for the determination of the sufficiency (i.e., completeness) of existing applicable regulations and the selection of functions for which regulatory criteria will be developed.

These actions are necessary precursors to the development of the complete and integrated regulatory strategy, and the license application review strategy and performance assessment strategy derived from it. These strategies, in turn, serve to bound the individual compliance determination strategies, appropriate compliance determination methods and associated information requirements selected and developed for each Regulatory Requirement in the conduct of the SRA process.

2. DEFINITIONS

2.1 SYSTEM MISSION

The system mission is the purpose of the system; that is, the specific objective(s) the system is intended to accomplish. The mission of the high-level nuclear waste management system is defined as "the permanent isolation of high-level radioactive waste from the accessible environment". This definition is derived from the NWPA and applicable regulations, primarily 10 CFR Part 60 and 40 CFR Part 191.

2.2 FUNCTIONAL REQUIREMENTS

Functional requirements are those functions the system must perform (i.e., what the system must do) to accomplish the system mission. The scope of each individual function includes all capability(ies) that must be provided and all action(s) necessary to perform that function. This involves capabilities to be provided and actions to be performed by items such as a geologic setting, facilities, equipment, software, personnel, associated procedures, or any combination thereof.

2.3 FUNCTIONAL ANALYSIS

Functional analysis is the systematic top-down decomposition of the system mission into its mission-dependent functional requirements. The system mission is first broken down into the primary functions required for its accomplishment. Then, working one level at a time, each function is analyzed to identify the lower-level functions required for its accomplishment. In addition to the capabilities and actions required of the individual functions, this analysis identifies, as applicable, the interfaces and sequences of those capabilities and actions.

3. RESPONSIBILITY

3.1 The WSE&I Element Manager is assigned responsibility for the conduct of functional analysis activities and the maintenance of the resulting lists and/or diagrams described in this procedure.

3.2 Other responsibilities are as described in TOP-001, Section 3.

4. CRITERIA

4.1 Techniques. Three techniques are in common usage for functional analysis. In order of decreasing complexity they are (1) logic flows/networks (commonly accompanied by "time-lines", which constitute a high-order operations analysis), (2) functional flows, and (3) trees. These techniques have been in use for several decades in many industries for both system (functional) analysis and program analysis. Examples include functional breakdowns or analyses, requirements allocation, system breakdowns, logic or event diagrams (e.g., management networks, fault tree analyses), maintenance diagrams and spares trees. One of the key attributes of these techniques is that they provide proven methods for systematic subdivision of a complex entity in a disciplined manner. Detailed analytical processes can then be applied at the lower levels with assurance of complete coverage of the total system or program.

Logic flows/networks (and, often, time-lines) are necessary for the functional analysis of systems (or subsystems) that operate in a variety of different modes, scenarios, and/or environments that must be considered in various combinations and sequences. Functional flows, the most commonly used analysis technique, are appropriate for simpler systems with a modest number of alternative operating modes.

The nuclear waste management system mission, however, involves a basically serial sequence of functions with alternative operating modes limited principally to contingency or emergency provisions. Consequently, the functional analysis for this system is readily accomplished by the development of a functional requirements tree. This approach also provides the most visible traceability to the system mission and, as a result, clearly demonstrates the necessity of each function. Therefore, the "tree" technique has been chosen as the means of developing the functional requirements for use in SRA.

4.2 Analysis Requirements. These analyses have three key requirements. The first is to avoid preconceptions by defining the functional requirements in a manner that is independent of site-specific conditions, design solutions (e.g., a specific emplacement approach), or pre-existing regulatory requirements. This is done, in part, by defining the minimum number of requirements and/or properties for the system concept used in the analysis. The requirements and properties are intended solely to bound the overall system concept for which functional requirements are to be identified. For the waste management system these are limited to those inherent in the NWPA and the basic system mission:

- o Disposal of high-level nuclear waste including spent fuel and defense wastes,
- o Interim storage (e.g., MRS, as approved by Congress),
- o Disposal in a deep mined geologic repository, and
- o Multiple barriers, including the geologic setting and at least one enclosed container, to ensure long-term containment and isolation from the accessible environment.

An associated requirement is that the products of the functional analysis are to be applicable to any site and are to allow for any detailed design and operations approaches that would satisfactorily accomplish the system mission.

The third requirement is to identify all functions necessitated by the system mission free of overt or hidden judgments of their relative importance. The actual importance to safety and waste isolation will be established by subsequent analyses based on performance assessment and sensitivity studies.

Assurance of the satisfaction of these requirements will be provided by the use of a disciplined approach to the analyses. This discipline is to be imposed by a set of standardized questions and a checklist used at every step in the analyses. The satisfaction of these requirements also will be verified by independent review of each branch of the functional requirements tree.

5. PROCEDURE

5.1 Conduct of the Functional Analyses

5.1.1 The functional analysis must always be focused solely on the generic functions of a physical system (i.e., a site, facilities, equipment, software, personnel and procedures) that would perform the system mission. Activities such as prelicensing research, site characterization, design, licensing and construction are elements of the program that will produce the system. These may be the subject of a separate program analysis.

The conduct of a valid analysis requires strict adherence to the distinction between system and program, to the requirements and properties described in section 4.2 above, and to the use of the standardized questions and the sequence of analysis given below. This level of discipline is best maintained if the analysis is performed by small groups (i.e., 3 to 5 persons) under the leadership of an experienced "facilitator". These groups are to be composed of scientists and/or engineers who provide experience and expertise in the technical discipline(s) appropriate to the parent function and the level-of-detail being analyzed.

5.1.2 The functional analyses of the nuclear waste management system shall begin with the system mission as defined in section 2.1, above. The primary (high-order) functions shall be identified in response to the question, "What capabilities must the system provide* and what actions are necessary and sufficient to perform this mission?" Lower-level functions shall be defined in response to the question, "What actions/capabilities are necessary and sufficient to completely satisfy this (higher-level parent) function?" The appropriate question is to be pursued at each level of each branch of the functional requirements tree until each level is considered complete as defined below.

5.1.3 The key to the successful development of any tree-structured analysis is a systematic, disciplined breakdown, level by level, using a consistent set of criteria and/or questions; i.e., each level of each branch must be exhausted to the extent of current knowledge before going to the next lower level or to another branch.

This basic method, which is illustrated in Figure 1, Functional Analysis Development Sequence, shall be followed in the conduct of the high-level nuclear waste management system functional analyses. The steps illustrated in the figure are explained below.

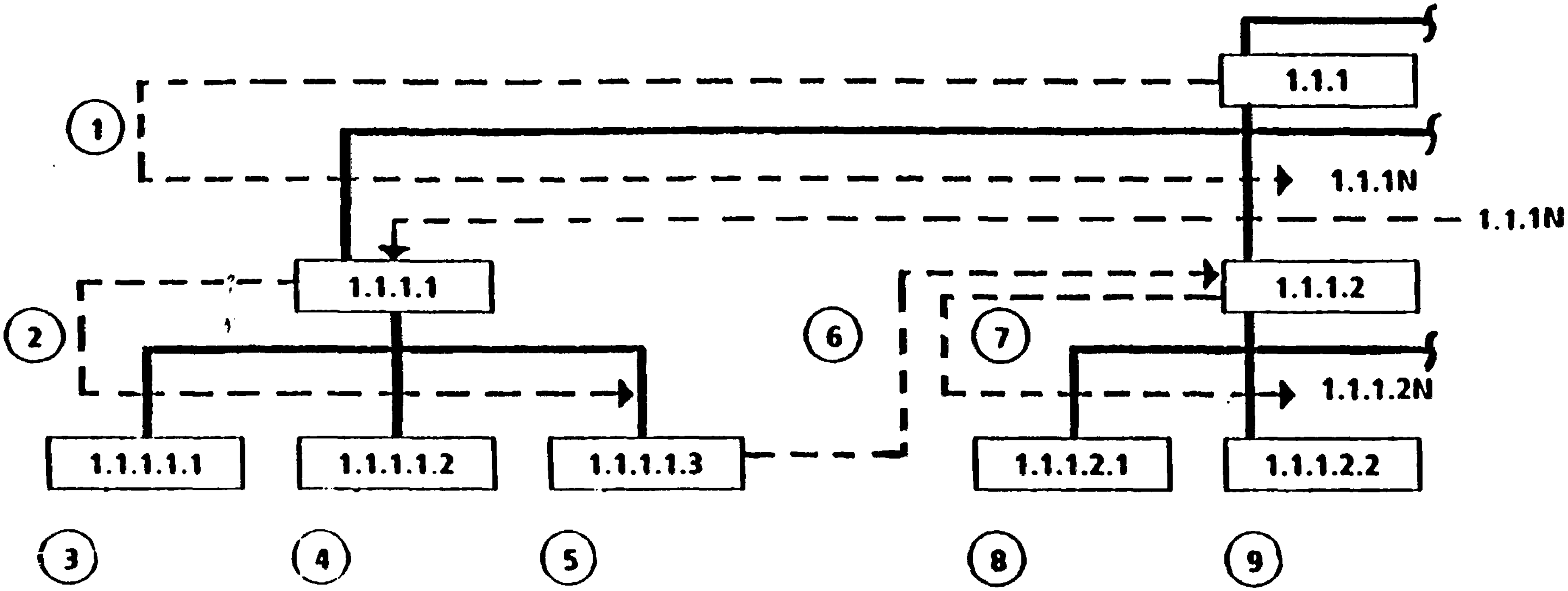
Step 1. Fully develop the first level of functions under a given parent function (in this example, under function 1.1.1) by completing responses to the applicable question. Refer to the checklist provided as an attachment to this procedure to aid in the identification of appropriate functions.

Review the description of each function for completeness and clarity. Ensure that each function and its description fits within the minimum system requirements and properties defined in section 4.2, above; and that it is independent of site-specific conditions, design solutions or pre-existing regulatory criteria.

Assign an identifying number to each function using the standard decimal numbering system illustrated in Figure 1.

FIGURE 1

FUNCTIONAL ANALYSIS DEVELOPMENT SEQUENCE



Step 2. Move to the leftmost function of those just developed (in this example, function 1.1.1.1) and repeat the process of Step 1.

Step 3. Continue the process of Steps 1 and 2 until the first branch of functions is complete. The development of a branch normally terminates naturally when it reaches the point at which

an appropriate or meaningful function can no longer be identified without the assumption of an approach to satisfying the subject parent function (e.g., the assumption of a site condition or property, a subsystem selection, or a design solution).

Due to the regulatory application of the analyses to be performed under this procedure, there are two additional conditions for truncating the development of a branch. First, if none of the functions identified at the same level of a single branch are related in any way to radiological health or safety, that branch is to be terminated at that level with a note to that effect. Second, unless specific direction is provided to the contrary, a branch only need be developed to the level at which the NRC expects to provide regulatory oversight and/or guidance to the applicant. Development of the functional analysis to this level will provide a comprehensive reference source for use in the development of oversight planning, compliance determination methods, and other elements of the program.

Step 4. Move back up the tree structure one level to the second function from the left (in this example, function 1.1.1.2) and develop the functions under that parent function.

Step 5. Continue until all functions linked together on that level of that branch are completed.

Step 6. Move back up the tree two levels (in this example, to function 1.1.2).

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* The term "provide" refers to (1) the functions the system must accomplish and (2) the properties and capabilities of the facilities, equipment, software, material, personnel, services and procedures that correlate directly to these functions and that are necessary for their accomplishment. "Provide," in other words, relates to system actions and capabilities, not how the items that would perform those functions would be designed or procured.

Steps 7, 8, 9, etc. Repeat this basic process until all branches are completed, always asking the applicable question and referring to the checklist.

5.1.4 Revise and/or augment the checklist as appropriate during the conduct of the analysis.

5.1.5 Perform a "test for completeness" on the functional requirements. The test is to consist of a limited review of available, related material; the identification of functions contained or implied that may also be required by the HLW management system; and the consideration of those functions for inclusion in the subject analysis. Related material is to include:

- o Basalt Waste Isolation Project (BWIP) System Functional Analysis Document, DOE-Richland SD-BWI-CR-023, March 20, 1987
- o Waste Management System Requirements Document, Volume IV MGDS, DOE OCRWM, March 1990
- o To the extent applicable, 10 CFR Part 50 and 10 CFR Part 72

This test may be performed in conjunction with the review(s) required by section 5.1.6.

5.1.6 The product(s) of functional analysis shall be reviewed for three primary attributes: (1) completeness, (2) correctness of content, and (3) clarity of meaning. The sequence of review shall follow the sequence of development described in section 5.1.3 and Figure 1. It is intended that review and verification occur as soon as practicable following development of the lower-level functions for each primary system function. Preliminary reviews of selected lower-level branches may be performed at the direction of the Manager, WSE&I.

Those who perform the review and verification of functional analyses shall meet two qualification standards: (1) They shall possess the capability in terms of training and experience to have conducted, or to have effectively contributed to the conduct of, the analyses whose results they are reviewing, and (2) they shall not have participated in the conduct of those particular analyses that are the subject of the review.

Specific features to be examined by reviewers are to include, but not necessarily be limited to: (1) adherence to the requirements of sections 4.2 and 5.1.1, (2) appropriate consideration of the candidate functions provided in the checklist, (3) verification that the functions follow from the standard questions of section 5.1.2, (4) adherence to the development requirements of section 5.1.3, Step 1 (second and third paragraphs) and Step 3, and (5) observance of the Exclusions of section 5.3.

5.2 Special Situations

5.2.1 On occasion, it may be beneficial to include in the functional analyses a "dummy" level to simplify the breakdown analyses. For example, in the analysis of the geologic repository it may be useful to make such a "dummy" subdivision on a time or program phase basis (i.e., preclosure, closure and decommissioning, and postclosure) because of the differences in some functions and conditions during those periods.

5.2.2 It is common to find that the same function appears in more than one branch of the complete structure. On occasion it may be found that a function is common to the same levels of all branches within a larger branch. Where this condition is found, the functions generally should be consolidated and raised to the common next higher level. This is analogous to a Boolean simplification. This should not be done if it is likely that the relationship might be confused or made less obvious. In rare instances, such a commonality may be found to exist at more than one level. In such cases, the function may be raised to the highest common level.

5.3. Exclusions

It is important to note that a functional analysis only identifies system mission-dependent functional requirements. A functional analysis does not, and is not intended to perform any of the following:

- o Quantify or place specific limits on the functions. This is accomplished independently by the analysis and allocation of quantitative performance requirements and/or design criteria.

- o Identify the relative importance of the functions. This is accomplished independently by performance assessments and sensitivity studies. [It should be noted that until appropriate performance assessment models are developed and validated, program needs may dictate the ranking of functions on the basis of expert judgment.]

- o Analyze licensing, design, construction or other project-related activities. The functional analyses to be performed under this procedure are limited to the examination of the functions of the waste management system.

- o Identify specific structures, systems, subsystems or components that may perform required functions, or designs therefor. Such allocation of functional requirements and design analysis is beyond the scope of functional analysis and NRC activities and is the responsibility of the DOE. On occasion, examples of subsytems or components commonly used to perform a given function may by cited, but only for the purpose of aiding the understanding of the description of the function.

- o Identify functions unique to (1) environmental impact, (2) socio-economic questions, or (3) licensing procedures. These concerns act as requirements or constraints on site selection, design approach and/or the licensing process; that is, on activities of the program that will authorize and produce the system. However, in general, since they are not related to radiological health and safety and are not necessary for the physical isolation of waste, they lie outside the scope of the waste management system mission. Functions that are common to the system mission and such concerns as those above are included in the system functional analysis.

6. FORMAT GUIDE FOR THE FUNCTIONAL ANALYSIS

The functions identified in the functional analysis shall be recorded in a numbered, textual list format indented for each level of the structure. This list may be translated to a graphical format such as that illustrated in Figure 2; however, such translation is not required for analyses performed in accordance with this procedure.

7. RECORDS

Records shall be developed and maintained in accordance with sections 4.3, 4.4 and 4.8 of TOP-001, and the general provisions of Chapters 5, 6, and 17 of the Center Quality Assurance Manual (CQAM). The functional requirement list and, if prepared, the functional requirement diagrams identified in section 6, above, shall be maintained by the WSE&I Element Manager.

8. QUALITY ASSURANCE

8.1 Quality Assurance shall verify, through independent surveillance, reviews or audits, that this procedure is implemented and followed by Center personnel in the performance of functional analyses, and in the development and maintenance of functional requirement lists and, if prepared, functional requirement diagrams identified in section 6, above.

8.2 Functional requirement list and/or functional requirement diagrams together with supporting text that are submitted to the NRC shall be certified by a Quality Assurance review and sent to the appropriate NRC office in the form requested by the NRC.

8.3 Either electronic or hardcopy objective evidence is acceptable for independent verification of actions taken in executing this TOP. Records shall be maintained of audits performed on the activities related to this TOP.

8.4 This procedure has been developed and shall be controlled in accordance with Chapters 5 and 6 of the CQAM.

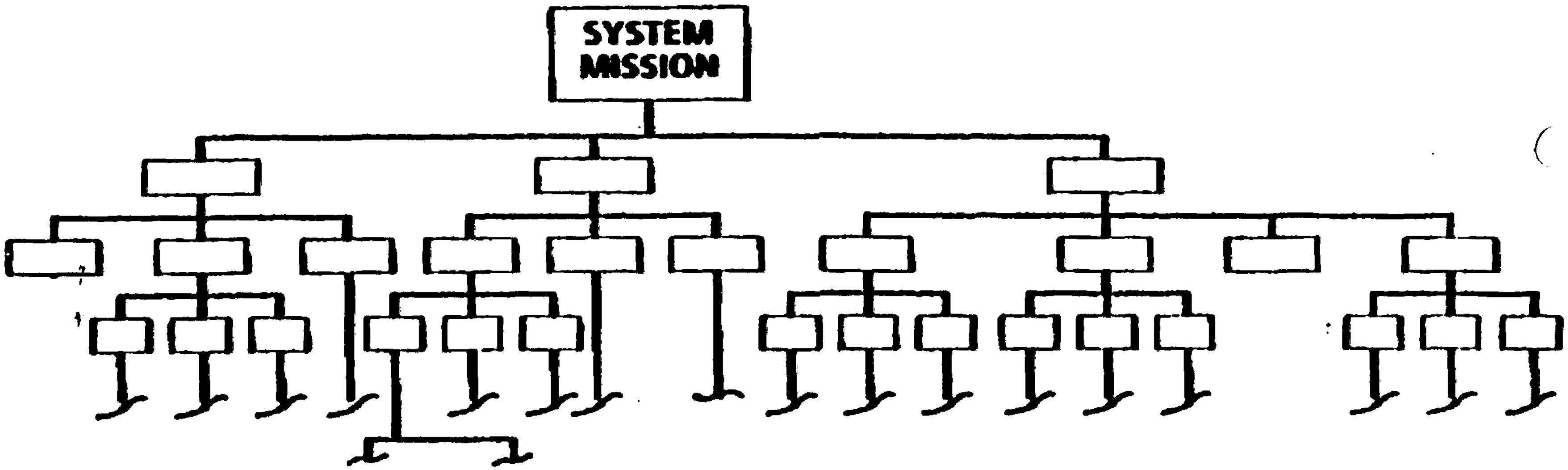

Figure 2. Structure of System Functional Analysis.