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Transportation Operations Functions of the Federal Waste Management System

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TRANSPORTATION OPERATIONS FUNCTIONS OF THE FEDERAL WASTE MANAGEMENT SYSTEM

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ABBREVIATIONS, ACRONYMS, AND DEFINITIONS

Accountability	Refers to those record-keeping and verification activities utilized to monitor the possession, use, and transfer of special nuclear material (e.g., plutonium, uranium enriched in the isotope 233 or 235)
ALARA	As low as reasonably achievable
CFR	Code of Federal Regulations
CMF	Cask Maintenance Facility
C of C	Certificate of Compliance (for shipping cask)
CHEM-TREC	Chemical Transportation Emergency Center
Custody	Term utilized in the standard contract for spent fuel and HLW (10 CFR 961.11, Article VI.B2) and is interpreted to mean to take physical possession and control of the material provided for shipment by the purchaser (utility/waste generator)
DOE	Department of Energy
DOT	Department of Transportation
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
FFBD	Functional flow block diagram
f.o.b.	Designation that means "free on board" and implies loading equipment on a conveyance at a designated location. The point at which title and responsibility are transferred from the seller to the buyer is usually designated after this abbreviation (e.g., f.o.b., origin)
FWMS	Federal Waste Management System
HLW	High-level radioactive waste

Incidental maintenance	Term utilized in the standard contract for spent fuel and HLW (10 CFR 961.11) to identify minor maintenance work performed by the purchaser (utility/waste generator) on shipping casks furnished by DOE
Intermodal transfer	Operation in which conveyance of a shipping cask is transferred from one surface mode of transportation to another
Maintenance reminder file	Record-keeping function that tracks scheduled maintenance requirements for equipment
Modification (cask)	Involves a change to a cask design and attendant technical and regulatory assessments (e.g., safety analysis report, C of C)
MRS	Monitored retrievable storage
NEPA	National Environmental Policy Act
NRC	Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act
OCC	Operational Control Center
OCRWM	Office of Civilian Radioactive Waste Management
OEMT	Operational emergency management team
Offsite radioactive shipping record	Document which provides a shipment description, shipping instructions, documentation of contamination/radiation monitoring, and certification that the material is properly classified, described, packaged, marked, and labeled for transport
QA	Quality assurance
Repair	Involves restoration of a failed component using corrective maintenance procedures to bring it into compliance with current C of C

Reconfiguration (cask)	Replacement of selective cask internals to permit transport of different fuel or waste types (may involve replacing inserts to accommodate a different fuel length to a complete basket changeout to transport a different waste type)
"Red tag"	Identification to physically label a component as being out of service
Routine maintenance	Involves the performance of scheduled preventive maintenance activities to avert component failure and may be time-directed, condition-directed, or inspection/test-directed
Shipper	Person (or his agent) who tenders a shipment for transportation; term also includes persons who prepare packages for shipment and offer packages to a carrier for transportation by signature on the shipping paper
SRD	Systems Requirements and Description
Stores	System function that purchases, inventories, and distributes system consumables and spare parts
TSEMP	Transportation System Engineering Management Plan
Transfer of Title	Point of law at which transfer of ownership occurs; standard contract for spent fuel and HLW (10 CFR 961.11) which designates that title of the material shall pass to DOE at the purchaser's (utility/waste generator) site upon taking custody of the material
TOS	Transportation Operations System
Unloaded cask	Cask from which the radioactive waste has been removed; however, residual internal contamination prevents it from being classified as empty

Waste acceptance	Function involving acceptance of shipments of spent fuel and HLW in accordance with the standard contract for disposal (10 CFR 961.11) or the memorandum of agreement with DOE's Office of Defense Programs; acceptance functions may include observation of waste preparation, packaging, and loading activities and/or verification of waste description and documentation
WG	Waste generator

TRANSPORTATION OPERATIONS FUNCTIONS OF THE FEDERAL WASTE MANAGEMENT SYSTEM

ABSTRACT

The Department of Energy's Office of Civilian Radioactive Waste Management is developing a national repository for spent nuclear fuel and high-level radioactive waste to implement the requirements of the Nuclear Waste Policy Act. As part of this effort, the Transportation Operations Project Office (TOPO) of the Department of Energy in Oak Ridge, Tennessee, has been assigned the responsibility of accepting the spent fuel and high-level waste from waste generators and transporting them to appropriate Federal Waste Management System facilities. As part of the TOPO planning activities, it is first necessary to identify the functions that are required to fulfill the mission needs and the project objectives.

This document discusses the functions that are required to (1) accept the waste, (2) transport the waste, and (3) provide the mandatory support activities. These functions are independent of any organizational structure and reflect a conventional and generally accepted transportation system involving casks; ancillary equipment; truck, rail, and barge transporters; cask and vehicle maintenance facilities; traffic management activities; and other related support system subelements. Where appropriate, the functions are ordered to identify their relationship with each other. This relationship is depicted graphically in functional flow block diagrams (FFBDs). The FFBDs provide (1) a definition of the functions that the systems must perform; (2) a tool to aid in the identification of important issues and trade-off studies; (3) an important method for tracing requirements and decisions back to essential functions; and (4) a basis for allocating the functions, a process that will identify where, how, and by whom they will be performed.

---

1. INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this report is to document the functions and functional relationships that are necessary to accomplish the Transportation Operations Project Office's (TOPO's) mission of accepting and transporting spent fuel and high-level waste from waste generators to Federal Waste Management System (FWMS) facilities. The emphasis is on

transportation operations, which assumes that all necessary facilities are in place and equipment designs and specifications are available to permit the system to operate properly. The cask systems to be used are under development through DOE/ID. The scope of the report is to describe all necessary functions in sufficient detail to support the completion of the TOPO Functional Requirements and Descriptions Report in FY 1989.

As discussed herein, the report is compatible with the draft Waste Management System Requirements and Description (SRD),* which identifies the three main functions of the transportation system as follows: (1) to accept the waste, (2) to transport the waste, and (3) to provide the necessary support functions for the accept and transport activities. These are intended to be independent of any organizational structure. They reflect a conventional and generally accepted transportation system involving irradiated fuel and waste casks; ancillary equipment; truck, rail, and barge transporters; cask and vehicle traffic management organizations; maintenance facilities; and other related operational systems (see Fig. 1).

In describing the functions, it was necessary to identify and briefly discuss the functions of the systems at the interfaces. The functional flow diagrams presented here uniquely identify the functions of those systems external to the transportation operating system through the use of dashed-lined borders for their function boxes. Effort has been made to avoid overspecifying these external functions since fully defined interfaces with the MRS, geologic repository, waste generators, and other external private or public entities are yet to be developed. Carriage functions normally performed by common, contract, or private carriers are considered to be internal. This should not be interpreted to suggest that a determination has been made regarding the structure of DOE's organization or contractor/subcontractor relationships for accomplishing waste transportation. The interface between the DOE and the private sector transportation infrastructure is not yet fully defined. However, in developing the TOS, the DOE intends to fully comply with the mission of the NWPA, which requires the use of private industry to the maximum extent possible.

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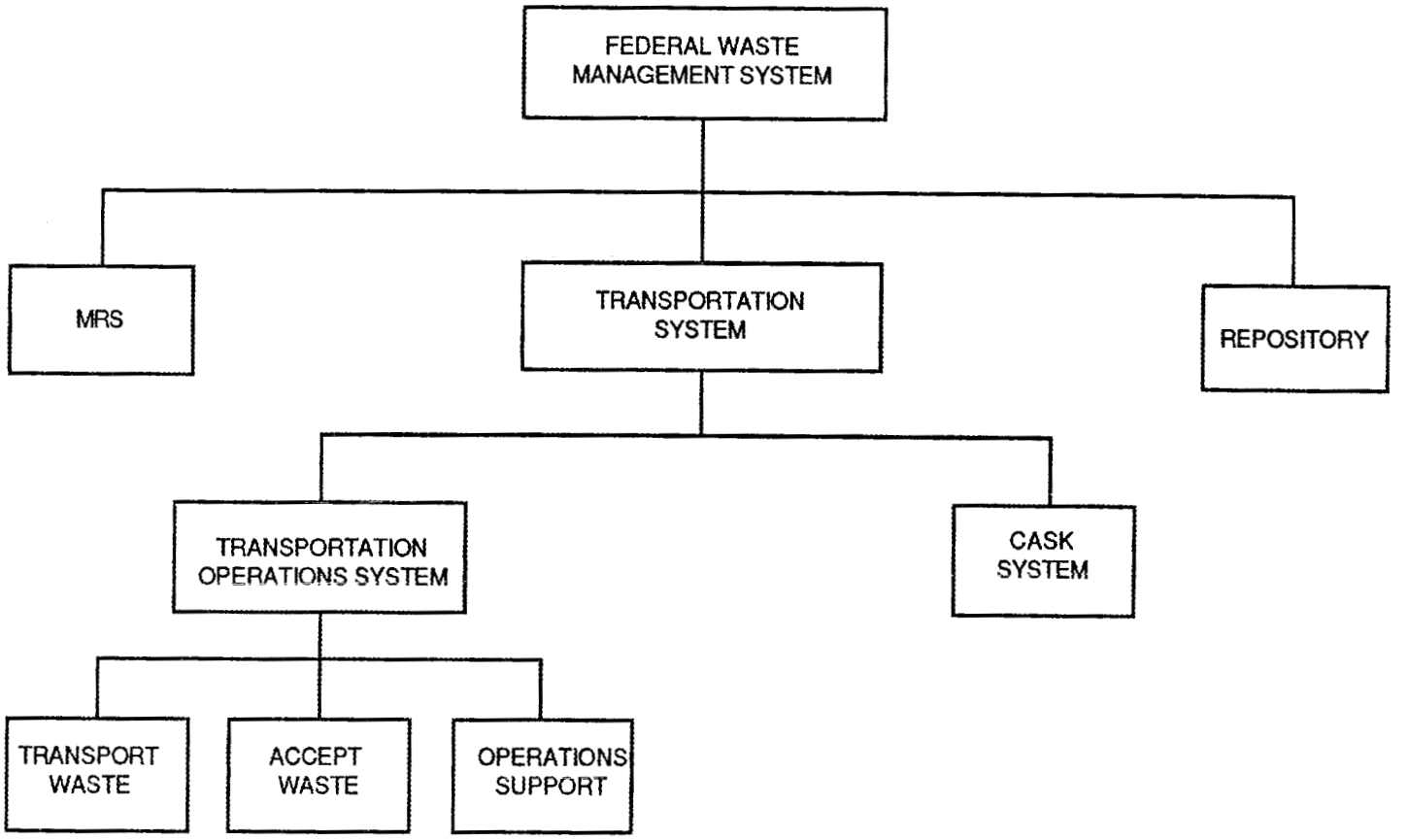

Fig. 1. Elements of the Federal Waste Management System.

1.2 BACKGROUND

This report is the documentation of activities of a group of transportation experts, called the "Core Group," established and chartered by the TOPO, of the Office of Civilian Radioactive Waste Management (OCRWM) (see Appendix A). The membership of this group was limited to facilitate rapid progress toward a draft report. Upon completion of the draft report, copies were forwarded to a group of individuals, identified as the Extended Core Group, who are knowledgeable in various facets of cask operations and transportation of radioactive material (see Appendix A). After individual review, the Extended Core Group met for a two-day question-and-answer session with the Core Group. Within a few weeks of the meeting, the members of the Extended Core Group provided individual comments on the report. Resolution of these comments was the responsibility of the Core Group. The present report summarizes these efforts.

1.3 DOCUMENT STRUCTURE

The document treats the functions in three ways: (1) providing a narrative discussion of the functional flows, (2) offering a tabular outline which summarizes the functions and the functional hierarchy, and (3) providing the functional flow block diagrams (FFBDs). For purposes of continuity and understanding, each of the Sects. 3, 4, and 5 provides the narrative, the functional outline, and the higher-level FFBDs. To facilitate reading, the function numbers used in the functional outline and FFBDs are given in parentheses at the end of each section heading in the narrative description.

Following standard practice, the FFBDs are tiered and numbered by major functional areas. The three main requirements of the system, identified in the Waste Management SRD, are shown in the Level I FFBD and include "accept," "transport," and "support" functions (see Fig. 2). Also shown is an additional function (block 4.0), "Transport Waste from MRS to Repository." The functions inherent in block 4.0 are not developed in this document but are very similar to those identified in 2.0. The lower-level FFBDs take each of the other blocks shown in the Level I diagram and expand the extent of detail. This process is

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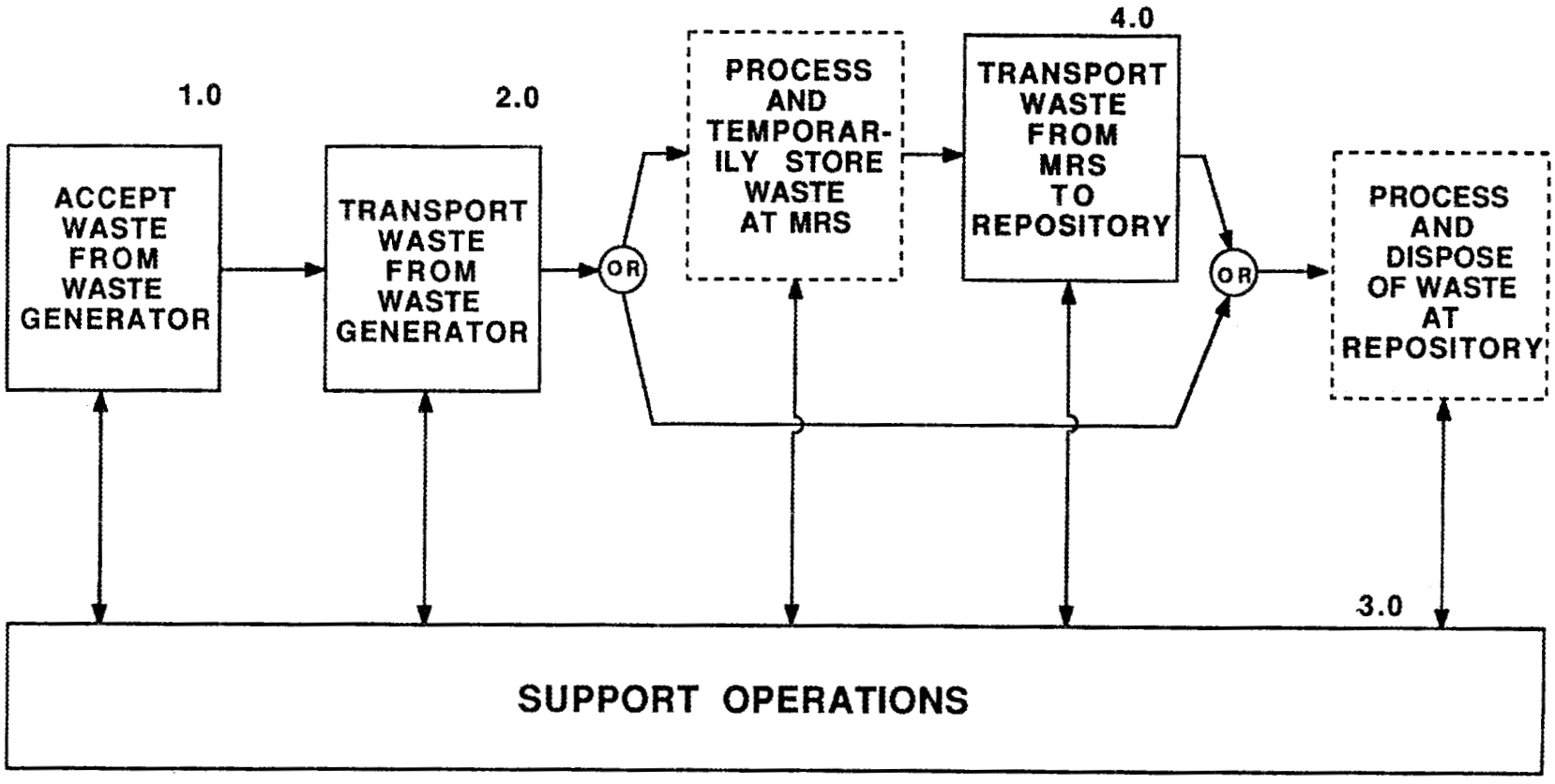

Fig. 2. Functions of the Transportation Operations System.

LEVEL I
FUNCTIONAL FLOW
BLOCK DIAGRAM
TRANSPORTATION
OPERATIONS
SYSTEM

repeated for some, but not all, lower-level activities identified in the functional outline. In general, an effort has been made to include sufficient detail in the functional flows to explain the full scope of the three high-level functions (1.0, 2.0, and 3.0) and to document current knowledge about projected future nuclear waste transportation operations. Flows were not provided for those that are not closely associated with day-to-day operations (e.g., 3.11 Regulatory Compliance) or that are believed to be adequately described in the open literature (e.g., 3.15 Quality Assurance). These functions tend to be more administrative in nature and frequently involve activities that can be carried out simultaneously with other activities; consequently, these functions are difficult to flow.

1.4 RELATIONSHIP TO OTHER OCRWM DOCUMENTS

The functions presented herein have been developed pursuant to the mission definition given in the OCRWM Mission Plan and OCRWM Systems Requirements and Description Documents. This is the required next step in the system development process.

1.5 SYSTEMS ENGINEERING PROCESS

The systems engineering process (SEP) is a structured and iterative technique of progressing from a mission need, as reflected in the OCRWM Mission Plan, to a system which is built, tested, demonstrated, and ready for operation. A typical flow diagram for the SEP, as given in DOE Order 4700.1, is shown in Fig. 3. As shown, once the mission need, project objective, and overall constraints are delineated, the next step is to perform what is termed functional analysis.

The first step in functional analysis is to analyze system objectives, utilizing the mission plan as the fundamental base-line document, so as to identify system functions and subfunctions to satisfy the objectives. This step is typically performed using the FFBD as the primary tool. Once the FFBDs for a system are constructed, each function is analyzed to pinpoint the requirements inherent in the performance of that function. These functions will then be allocated, a

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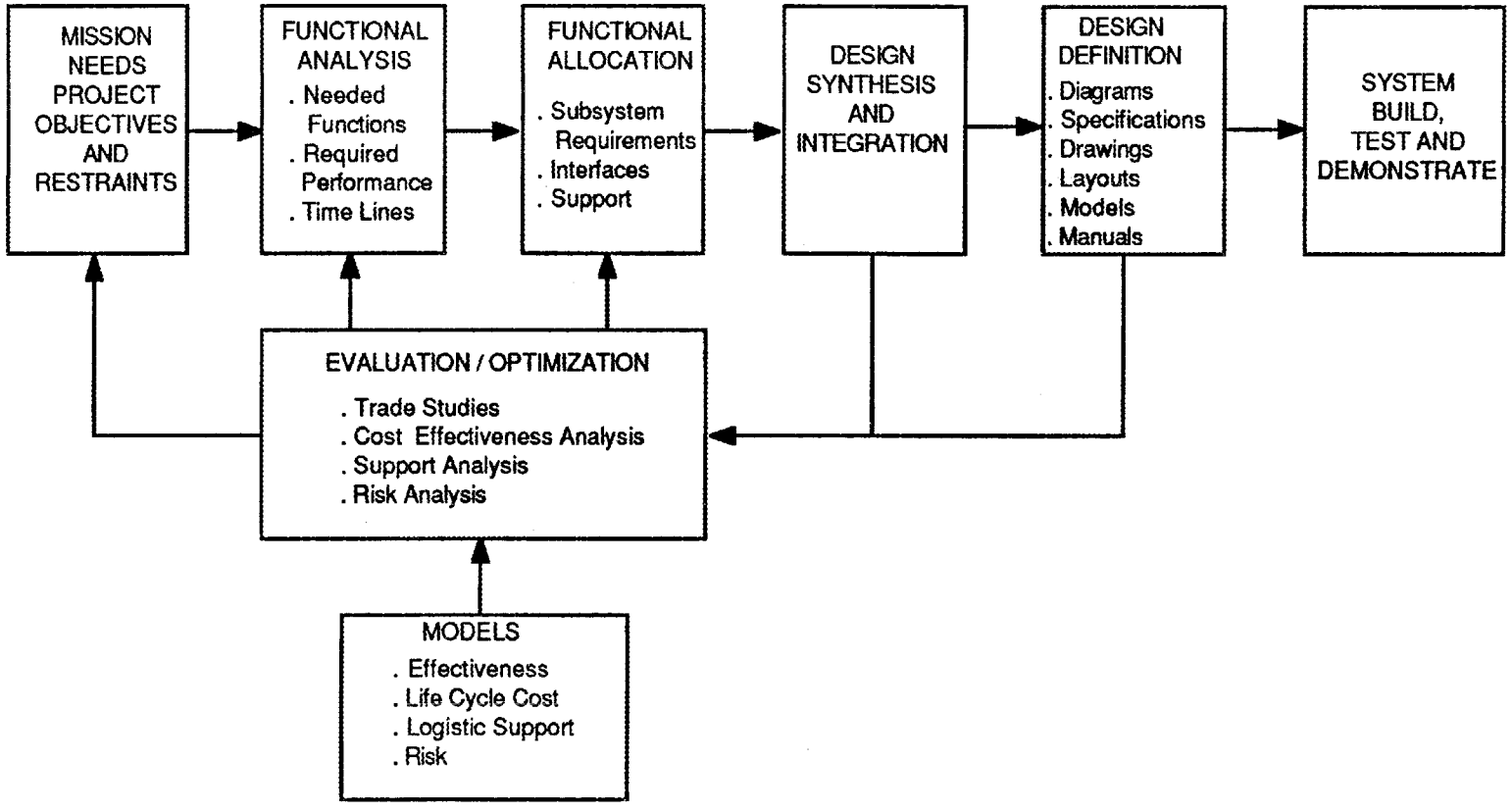

Fig. 3. Systems engineering process.

process that will determine where, how, and by whom they are to be performed.

The FFBDs are the initial products in an iterative approach to system definition, development, and operation. They provide:

1. a definition of the functions that the system must perform and the order in which they must be performed;
2. a tool for aiding in the identification of issues, trade-off studies, and decisions on system characteristics;
3. an important method for tracing requirements, concepts, decisions, and trade-off studies back to essential functions; and
4. a basis for undertaking the functional allocation.

2. ASSUMPTIONS

The functions identified in this document are based on, and compatible with, the OCRWM Waste Management SRD, the draft Transportation System Engineering Management Plan (TSEMP), and the authors' interpretation of the "Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste" (10 CFR 961.11) between the government and the nuclear power generating utility companies. In addition, a number of assumptions have been made by the Core Group in the development of these functions, the most significant ones of which are described below.

1. Functional descriptions and flow block diagrams focus on reactor-to-repository spent fuel transportation operations. However, most functions are equally applicable to HLW-to-repository, reactor-to-MRS, and MRS-to-repository (function 4.0) operations as well. Variations in the functional descriptions for these operations will be developed later.
2. The Transportation System (as defined in the TSEMP, the Business Plan, and the Institutional Plan) has been developed and acquired and is ready to be placed in operation. That is, the outline and the FFBDs do not account for functions that must be performed only during the system development stage. However, it is recognized that additional component acquisition and system improvements will occur subsequent to startup, and these functions have been accounted for.
3. Transportation operations for federal agency waste generators [e.g., those producing defense high-level waste (DHLW)] will be very similar to those for nonfederal organizations (e.g., utilities).
4. The "Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste" (10 CFR 961.11) requires the exchange of certain information between DOE and the purchaser (e.g., utilities). This information is, in part, the same as that required by the transportation system for carrying out both its long- and short-range planning functions and is assumed to be available for this purpose.
5. The multiplicity of functions indicated (particularly as shown in the Field Services FFBD in Sect. 5.3) is not intended to indicate a

multiplicity of personnel; it is expected that several of the described functions can be carried out by a few well-trained individuals or small crews.

6. Major utility interface plans and long-lead time facility modifications (if any) will be resolved prior to transportation system startup, and only minor interface details for each shipping campaign will need to be checked and confirmed during normal operations.

3. ACCEPT FUNCTIONS (1.0)

The functions and related activities developed in this section are confined to those which directly support DOE in its acceptance of fuel and wastes at a waste generator site. They are largely drawn from, and/or interpreted from, information in the generic utility contract (10 CFR 961.11). Transport-related activities are discussed in Sect. 4, while support functions, including identifying and selecting DOE-furnished equipment, selecting the mode of transport, scheduling, and training, are included under transportation operations support elements in Sect. 5.

The accept functions are shown in FFBD 1.0 (see Fig. 4). Subfunctions of this FFBD are shown in Appendix C.

It should be noted that as actual operating experience is obtained, DOE may determine that the "observe, verify, and obtain" functions may be reduced to occasional audit functions or even eliminated if safety and accuracy of information would not be compromised. The generic utility contract leaves this action to DOE's discretion. The detailed content of the accept function is given below in outline format.

- 1.0 Accept waste from waste generator
  - 1.1 Observe preparatory activities*
    - 1.1.1 Observe waste preparation
    - 1.1.2 Observe waste packaging
    - 1.1.3 Observe cask loading
    - 1.1.4 Observe required inspections*
  - 1.2 Verify waste description*
    - 1.2.1 Verify waste accountability
    - 1.2.2 Verify waste classification
    - 1.2.3 Verify physical characteristics
  - 1.3 Obtain and verify transport documentation*
    - 1.3.1 Determine whether material is properly loaded, packaged, marked, labeled, and readied for transportation

*Functions denoted by asterisk have FFBDs.

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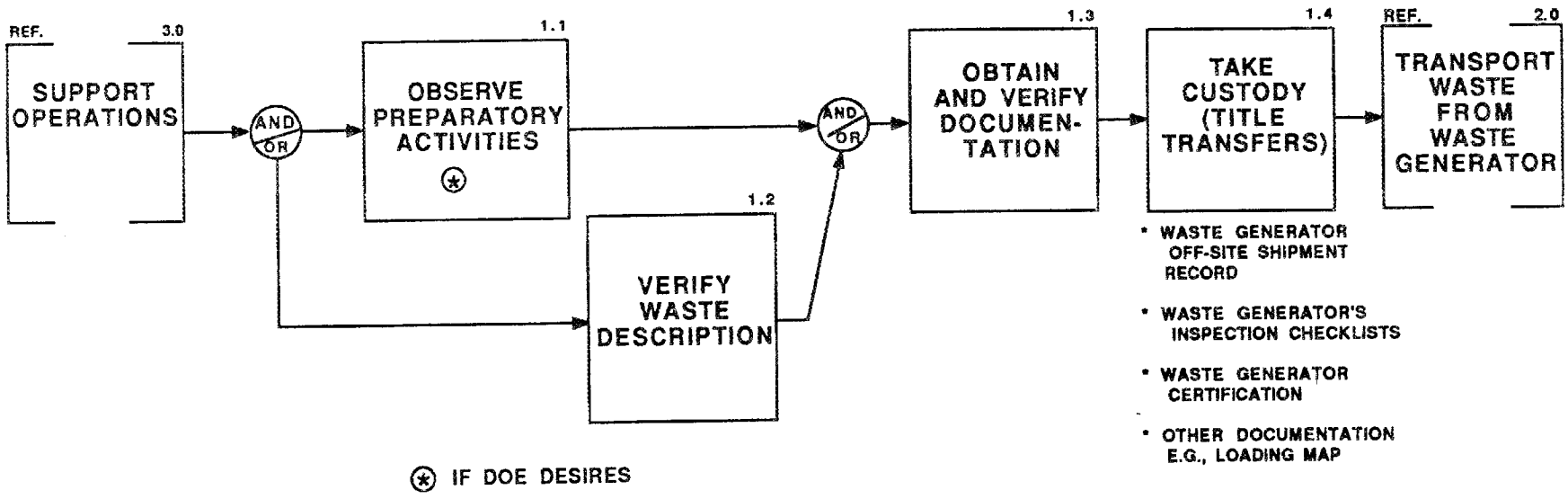

Fig. 4. Functions for accepting waste from the waste generator.

1.0
FUNCTIONAL FLOW BLOCK DIAGRAM
ACCEPT WASTE FROM WASTE GENERATOR

1.3.2 Obtain and verify waste generator certification(s)

1.3.3 Obtain and verify waste generator off-site radioactive shipment record

1.3.4 Obtain other documentation (e.g., cask loading map and check lists),

1.4 Take custody (title transfers)

1.4.1 Transfer custody, as evidenced in writing

The accept function described in the Waste Management SRD and utility contract includes taking custody and title to the spent fuel waste and obtaining appropriate documentation. Associated with this is a waste accountability function, the scope of which is yet to be defined. Because the waste is received in a cask ready for shipment, the accept functions may consist of accepting appropriate documentation concerning the waste from the waste generator and/or observing selected waste generator operations regarding waste preparation and delivery. DOE does reserve the right to observe these operations when considered necessary; therefore, they are identified as "observe" functions in Sect. 1.1 of the outline. Having determined that the waste is properly described, packaged, and prepared for transportation, DOE will take custody of the material, as evidenced in writing, at the origin site, f.o.b. carrier. Title to the material passes to DOE upon completion of these custody transfer activities.

4. TRANSPORT FUNCTIONS (2.0)

Transport functions begin at the point where DOE has taken custody of the waste and has obtained a waste generator off-site shipment record and certification of readiness of shipment for transport. The functions end with delivery and turnover at an FWMS facility. The transport functions discussed in this section apply only to loaded cask shipments; shipments of unloaded casks, special equipment, tools, and supplies to and from a facility are defined as support functions and are discussed in Sect. 5.6. All surface modes of transport are assumed to be available. Intermodal transfers can be used where appropriate; however, special intermodal functions related to barge transport have not been developed and will be added later.

The functions associated with the transport of waste from a waste generator are given in FFBD 2.0 (see Fig. 5). Subflows of portions of FFBD 2.0 are given in Appendix C. The preshipment activities are subdivided and based on the transport mode of highway and railroad, primarily because of the distinct operational differences the two.

The detailed content of the transport function is given below in outline format.

2.0 Transport Waste from Waste Generators*

- 2.1 Perform preshipment activities*
  - 2.1.1 Perform preshipment preparations for highway transport-loaded cask*
    - 2.1.1.1 Verify cask-to-trailer tie-downs
    - 2.1.1.2 Inspect cask for security seal
    - 2.1.1.3 Inspect cask system loading documentation
    - 2.1.1.4 Take final contamination smears and verify within limits
    - 2.1.1.5 Perform initial readiness check-trailer

*Functions denoted by asterisk have FFBDs.

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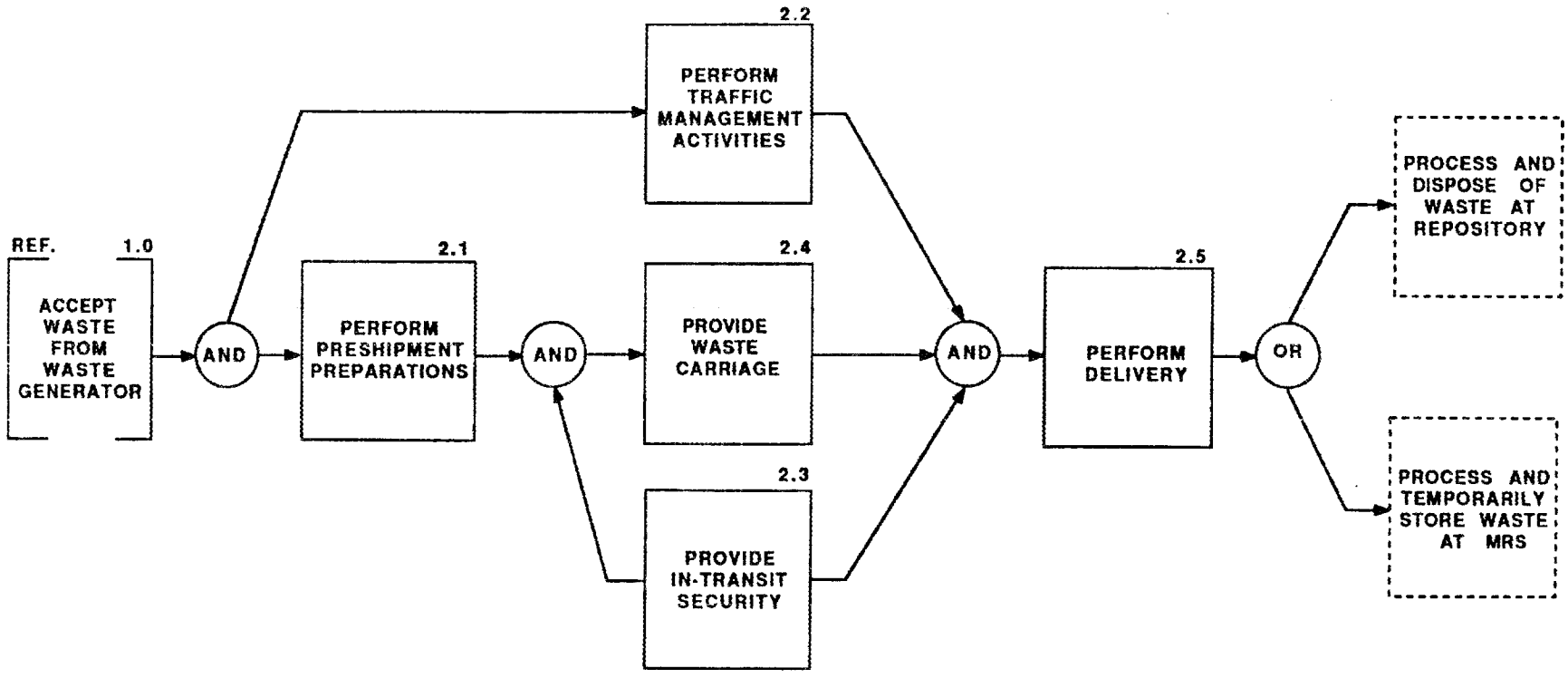

Fig. 5. Functions associated with transporting waste from a waste generator.

2.0
FUNCTIONAL FLOW
BLOCK DIAGRAM
TRANSPORT WASTE
FROM WASTE GENERATOR

2.1.1.6 Perform tractor operational readiness check

2.1.1.7 Transfer drivers and tractor to site

2.1.1.8 Assemble driver's "packet" - emergency response information, route, schedule, etc.

2.1.1.9 Conduct predispatch driver's conference

2.1.1.10 Connect tractor to trailer

2.1.1.11 Perform radiation compliance survey

2.1.1.12 Perform final readiness check - tractor/trailer

2.1.1.13 Notify vehicle inspector

2.1.1.14 Perform administration check on completeness of compliance items

2.1.1.15 Prepare bill of lading and sign shipper's certification

2.1.1.16 Release shipment to carrier

2.1.2 Perform preshipment preparations for rail transport-loaded cask*

2.1.2.1 Inspect cask-to-car tie-downs

2.1.2.2 Inspect cask for security seal

2.1.2.3 Inspect cask system loading documentation

2.1.2.4 Take final contamination smears and verify within limits

2.1.2.5 Perform mechanical condition walk-around

2.1.2.6 Notify railcar inspector

---

*Functions denoted by asterisk have FFBDs.

2.1.2.7 Perform administration check on completeness of compliance items

2.1.2.8 Move to site "blocking" area with site prime mover

2.1.2.9 Accumulate in blocking area until shipping quantity is reached

2.1.2.10 Receive locomotive at site

2.1.2.11 Couple railcar to site prime mover and move to site boundary

2.1.2.12 Move escort car to train assembly area

2.1.2.13 Assemble train

2.1.2.14 Assemble railroad representative "packet"

2.1.2.15 Perform brake tests

2.1.2.16 Check communication and security equipment

2.1.2.17 Check dose rate in closest occupied location

2.1.2.18 Prepare bill of lading and sign shipper's certification

2.1.2.19 Release shipment to carrier

2.1.3 Perform preshipment preparations for barge transport-loaded cask

2.2 Perform traffic management activities*

2.2.1 Perform dispatch administration

2.2.2 Perform dispatch operations

2.3 Provide in-transit security

2.4 Provide waste carriage*

2.4.1 Perform pickup activities

*Functions denoted by asterisk have FFBDs.

2.4.2 Acquire in-transit permits (if required)

2.4.3 Transport waste

2.4.4 Perform communication activities

2.4.5 Perform in-transit maintenance

2.4.6 Perform intermodal transfer (if required)

2.5 Perform delivery*

2.5.1 Notify destination of pending arrival

2.5.2 Transfer shipment documentation to authorized personnel/deliver payload to consignee

2.5.3 Identify special needs to staff for non-routine activities

2.5.4 Check vehicle for operational readiness for unloaded return

In every case, a loaded cask is received from a waste generator by the TOS. It should be noted that the "accept" function as described in FFBD 1.0 differs from the preshipment activities given in FFBD 2.1 and, indeed, forms the initiating activity for transporting the waste. Preshipment functions represent those steps which are taken between the time a transport system (i.e., cask and vehicle) is delivered to TOS from the waste generator and the time that the transport system is delivered to a carrier for shipment. These activities are designed to verify carrier personnel and equipment readiness, provide instructions to carriers, ensure proper shipping documentation and package certification, and determine that cask temperature, radiation levels, and contamination levels are within regulatory limits. Throughout this activity the role of TOS is mainly one of coordination, administration and overchecking, and relying on others (e.g., utility personnel, carrier personnel) to carry out much of the hands-on work. The underlying objective is to ensure that the outgoing shipment is both safe and in compliance with all requirements.

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*Functions denoted by asterisk have FFBDs.

The shipping modes of highway, rail, and barge differ from each other in that several casks will probably be moved on a single train or barge, whereas trucks will be dispatched singly. This difference places an accumulation function within the railroad and barge activities. Most other aspects of preshipment activities are similar.

During the waste carriage function (see FFBD 2.4), it is possible that incidents or accidents might occur that would create an emergency condition. Functions related to emergency response activities have been developed using, as guidance, DOE Order 5500.1A and "Transportation Operational Emergency Management Team Plan for NWPA Activities" (draft March 1988) and are discussed in Sect. 5.5 of this report.

In addition to those listed in Sect. 2, the specific assumptions applicable to transport functions are as follows:

1. Contingency plans, procedures, equipment, facilities, and personnel are assumed to be required in the transportation system to cope with unplanned/unscheduled/abnormal events or incidents that may occur while the loaded cask is enroute. These may include route changes, delays due to accidents or weather, equipment breakdowns, etc.
2. Carriage is assumed to be by Interstate Commerce Commission common and/or contract carriers; accordingly, the carrier-provided function of "provide transport" has not been developed in detail.

5. SUPPORT FUNCTIONS (3.0)

Numerous support activities must be provided for by the transportation support system to enable the "accept" and "transport" functions (discussed in Sects. 3 and 4) to be carried out. These functions will be performed by trained personnel using computer software and hardware, cask and related equipment, facility resources, and combinations of these. The functions identified and described in this section have been developed independent of any organizational structure or support system description; however, they are intended to guide the preparation of the support system description and the development of that system and related operating plans. Eighteen support functions have been identified in Sects. 5.1 through 5.18. The appropriate functional outline is given in each of these sections. The first six functions (5.1 through 5.6) are primarily operational in nature and have FFBDs. Those functions and subfunctions for which FFBDs were developed are indicated in the outline by an asterisk.

5.1 TRAFFIC PLANNING (3.1)

Traffic planning functions are essential to ensure that waste transportation resources are applied effectively. Traffic planning is subdivided into two functional sets: 3.1.1, "Campaign Planning and Analysis," and 3.1.2, "Route Planning and Analysis." These functions are expected to begin several years prior to any shipping activities so that the waste generator and the DOE will be ready to transport on schedule.

Integrated campaign planning and analysis are functions that are necessary to provide the effective deployment of transportation resources. As such, they include the maintenance of records which indicate the deployment status of the system components on a day-by-day basis. This information will cover not only casks and vehicles, but also ancillary equipment, reconfiguration components (cask baskets), and maintenance and field service resources. Other planning functions include (1) issuing operations orders to initiate and coordinate deployment of resources and (2) identifying the appropriate casks and ancillary equipment to be used for each campaign.

An important planning function involves coordinating transportation operation schedules with the waste generators and the repository or MRS (receiving) facilities. The contract between DOE and the waste generators (10 CFR 961.11) indicates that certain information must be exchanged between those two parties. Because much of that information is required years in advance of actual shipments, it can also be used for advanced planning. It is this advanced planning function that can be used, in part, to support cask and equipment purchases, the scheduling of shipments, and a host of other activities.

Route planning and analysis are functions that are necessary to the development and maintenance of highway, rail, and waterway route plans. These functions include, for example, the collection of information from states concerning planned major highway construction or maintenance activities that could affect previously designated routes, support of the regulatory compliance functions in interactions with DOE and NRC for the approvals of route plans, and the maintenance of information concerning state actions related to state-designated routes.

The functional outline is given below; the FFBD for 3.1 is also shown in Fig. 6.

3.1 Traffic Planning*

3.1.1 Campaign Planning and Analysis*

3.1.1.1 Coordinate transportation campaign plans with MRS/repository operations plans and with waste generator Delivery Commitment Schedule (DCS) and Final Delivery Schedule (FDS) - support development of DCSs and FDSs

3.1.1.2 Support DOE responses to waste generator requests for emergency deliveries or for exchanges in delivery schedules

3.1.1.3 Replan transportation operations, as needed, to accommodate changes in waste generator delivery schedules, changes in repository/MRS operations schedules, changes in transportation system availability, approved emergency

*Functions denoted by asterisk have FFBDs.

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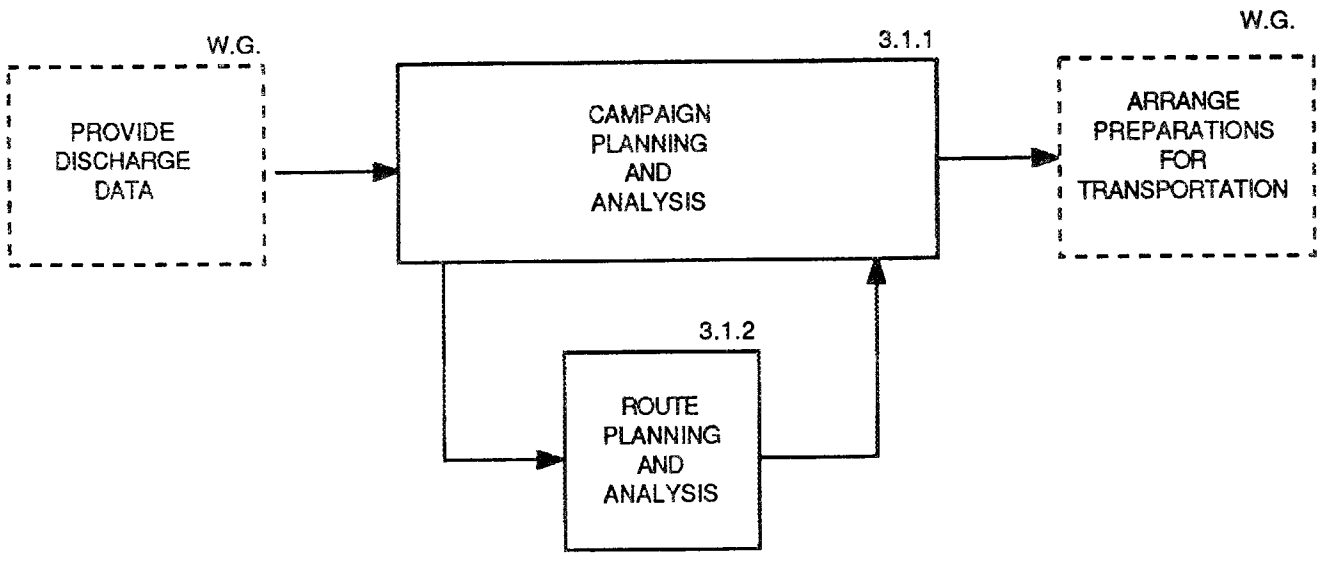

Fig. 6. Functions associated with traffic planning.

3.1
FUNCTIONAL FLOW
BLOCK DIAGRAM
TRAFFIC PLANNING

deliveries, or approved exchanges in delivery commitments

3.1.1.4 Monitor deployment status of the waste transportation system

3.1.1.5 Conduct logistics analyses to support campaign planning, identify schedule conflicts, and develop alternative deployments to help resolve the conflicts

3.1.1.6 Issue campaign plan information to transportation, MRS/repository, and waste generator operations groups and coordinate transportation campaign planning interfaces both within the transportation system and with external systems

3.1.1.7 Monitor repository/MRS and waste generator operations status

3.1.2 Route Planning and Analysis*

3.1.2.1 Monitor state, tribal, and railroad carrier route designation activities

3.1.2.2 Collect, monitor, and maintain route conditions information, including driver/rail crew/coast guard reports on highway/roadbed and other route conditions and forecasts by state/railroads/others regarding route condition and maintenance plans

3.1.2.3 Prepare route plans for planned highway shipments of route-controlled quantities of radioactive materials for submittal to the NRC (coordinate with Regulatory Compliance Functions in Sect. 5.11)

3.1.2.4 Coordinate with railroads to prepare rail route/interchange point designations for planned rail shipments of spent fuel and/or HLW

3.1.2.5 Support integrated campaign planning logistics analysis functions (3.1.1.5) by identifying routing alternatives

3.1.2.6 Waste transport route planning

*Functions denoted by asterisk have FFBDs.

5.2 MAINTENANCE (3.2)

The maintenance activities of this subsection include maintenance planning, routine maintenance, off-normal maintenance, repair, and modification. Excluded from maintenance is reconfiguration, where casks are converted from one internal configuration to another to accommodate different fuels; however, it is recognized that reconfiguration could occur in conjunction with some maintenance activities. Decontamination of cask internals is not considered a routine maintenance operation and, therefore, was not included in the maintenance FFBD. Internal decontamination is addressed in Sect. 5.4. The maintenance functional outline (see Fig. 7) is given below.

3.2 Perform Maintenance*

- 3.2.1 Perform maintenance planning and scheduling*
- 3.2.2 Perform maintenance operations*
- 3.2.3 Perform repairs*
- 3.2.4 Perform modifications*

One key to the smooth operations and minimum disruption of the transport system lies in the ability to plan and schedule maintenance properly. The outline for the planning and scheduling maintenance functions is given below; the corresponding FFBD is given in Appendix C.

- 3.2.1.1 Receive cask system information
- 3.2.1.2 Establish maintenance schedule and activity requirements on a cask-system basis
- 3.2.1.3 Coordinate with traffic planning as needed
- 3.2.1.4 Request procurement of special equipment
- 3.2.1.5 Enter maintenance requirement information into reminder file
- 3.2.1.6 Enter drawings and specifications into equipment file

*Functions denoted by asterisk have FFBDs.

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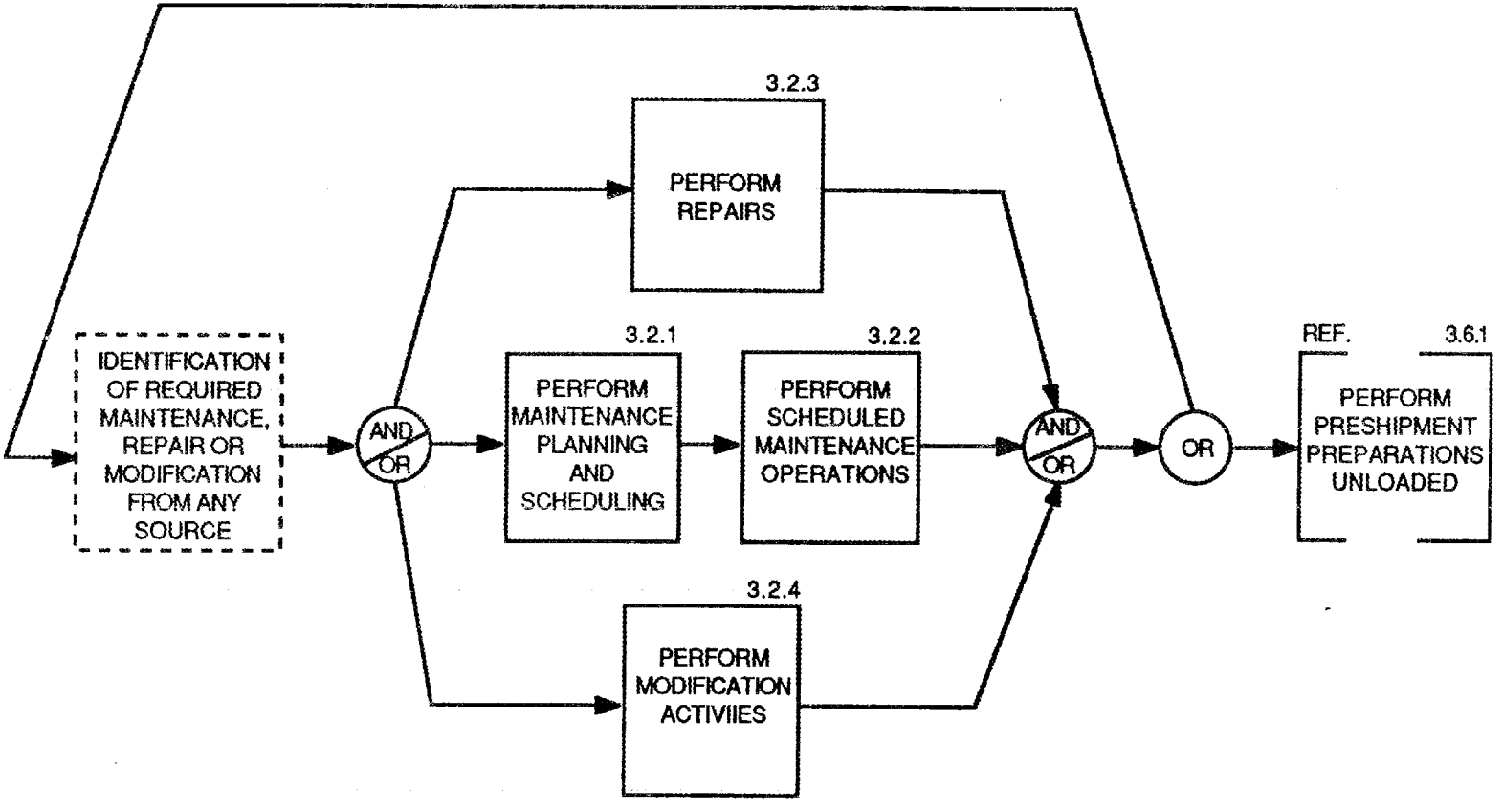

Fig. 7. Maintenance activities.

3.2
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM MAINTENANCE
ACTIVITIES

3.2.1.7 Acquire and file maintenance procedures

3.2.1.8 Generate maintenance order

3.2.1.9 Coordinate with dispatching for receipt of cask/vehicle required for maintenance

3.2.1.10 Develop final maintenance schedule for cask-system item

Routine maintenance begins with the gathering of data on specific casks, vehicles, and ancillary equipment as they are initially received into the TOS for use. All pertinent media such as drawings, specifications, manuals, and the Certificate of Compliance form the basis for maintenance. Some of these activities are intended to be preventive, while others are mandatory for regulatory compliance. As each piece of equipment is received into the system, its maintenance "clock" must start and then its maintenance history must be tracked throughout the service life. Coordination of maintenance activities with operations is essential for the uninterrupted supply of qualified equipment for service. The scheduling of equipment for maintenance is the responsibility of the planning and traffic activities based on input from maintenance; maintenance, of course, has the responsibility for its internal planning and scheduling as well as the maintenance records function. Unscheduled maintenance, although nonroutine, is generally handled in a manner similar to the scheduled activities. Indeed, it is acknowledged that maintenance items cannot always be identified at the outset and additions to the routine or scheduled list are frequently a result of an off-normal or unscheduled maintenance activity.

Most maintenance will probably be performed at a specialized facility, but incidental maintenance may be performed elsewhere such as at the waste generator's site or a rail/truck repair facility. The functional outline for maintenance operations is given below.

3.2.2 Perform maintenance operations*

3.2.2.1 Receive item for maintenance

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*Functions denoted by asterisk have FFBDs.

3.2.2.2 Prepare for maintenance

3.2.2.3 Assess needs for unscheduled maintenance, repairs, or modifications

3.2.2.4 "Red-tag" equipment that is out of service

3.2.2.5 Issue request for special maintenance equipment and procedures

3.2.2.6 Perform maintenance activities and reassemble equipment

3.2.2.7 Verify operation and remove "red tag"

3.2.2.8 Notify dispatching of availability for operation

3.2.2.9 Return special equipment and procedures

3.2.2.10 Collect/report problems and trend analysis data

3.2.2.11 Update equipment maintenance file information

3.2.2.12 Update equipment maintenance reminder file information

The maintenance activities apply to casks, vehicles, and support equipment such as lifting yokes, etc. Once the cask and equipment are received at a maintenance facility, the items to be maintained are "red tagged," effectively identifying them as nonusable until the maintenance has been completed. After maintenance has been completed and checked to determine that the equipment can operate properly, the "red tag" is removed and the equipment is returned to service. Normal maintenance activities ensure that the equipment meets the standards required by the Certificate of Compliance.

Details of the routine maintenance FFBD are given in Appendix C. Damage and repair always invoke the requirements for both regulatory compliance and engineering assessments and frequently create the need for development of specific procedures and specialized equipment. Repair work may be performed at any number of locations, depending on the severity of the damage and/or the nature of the repair. The recording of

repair activities on a cask-by-cask or item-specific basis is a maintenance function. The functional outline for repairs is given below. Details of the repair FFBD are presented in Appendix C.

3.2.3 Perform repairs*

3.2.3.1 "Red-tag" cask system/equipment/vehicle

3.2.3.2 Repair cask/equipment

3.2.3.2.1 Request regulatory compliance assessment

3.2.3.2.2 Request engineering assessment

3.2.3.2.3 Request QA assessment

3.2.3.2.4 Plan repair activity

3.2.3.2.5 Acquire repair procedures

3.2.3.2.6 Acquire special repair equipment

3.2.3.2.7 Coordinate repair schedule with traffic planning

3.2.3.2.8 Develop repair schedule for equipment

3.2.3.2.9 Prepare work order

3.2.3.2.10 Obtain procedures approval

3.2.3.2.11 Mate repair resources with equipment
- Move cask/equipment to repair facility
- Move repair resources to cask/equipment

3.2.3.2.12 Perform repairs

3.2.3.2.13 Inspect and test cask/equipment; verify compliance with NRC certification

3.2.3.2.14 Close out work order

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*Functions denoted by asterisk have FFBDs.

3.2.3.2.15 Remove "red tag"

3.2.3.2.16 Update cask/equipment history file

3.2.3.2.17 Notify traffic planning and traffic management of cask/equipment availability

3.2.3.3 Perform vehicle repairs

3.2.3.3.1 Document repair items for vehicle repairs

3.2.3.3.2 Request regulatory compliance assessment, as required, for vehicle or associated equipment repairs

3.2.3.3.3 Request engineering assessment, as required, for vehicle or associated equipment repairs

3.2.3.3.4 Notify dispatch operations regarding vehicle's operational status

3.2.3.3.5 Notify maintenance regarding needed repairs

3.2.3.3.6 Schedule repair work

3.2.3.3.7 Prepare work order or purchase order

3.2.3.3.8 Move vehicle to repair facility

3.2.3.3.9 Move resources to vehicle

3.2.3.3.10 Perform repairs

3.2.3.3.11 Inspect and test repaired items

3.2.3.3.12 Close out work order; remove "red tag"

3.2.3.3.13 Notify dispatch of vehicle availability

3.2.3.3.14 Notify maintenance of completed repairs, and provide information to update vehicle maintenance and repair records

Modification is regarded as a relatively rare activity as compared with routine maintenance and repair and is likely to involve a change to the Certificate of Compliance. Modification activities are jointly planned by operations, regulatory compliance, engineering, QA, and maintenance. Although the need for a modification could be discovered during routine operation or as a consequence of maintenance or repair activities, it is assumed that such a need may also arise from changing programmatic requirements. Implementation of such modifications is the functional flow described in this subsection. A modification has many of the requirements of initial cask design, certification, and fabrication and is expected to be treated in a similar fashion, depending on the equipment that is slated for modification. As was the case with repairs, modification activities are not likely to be comingled with routine maintenance work. Modification could occur at several of sites, depending on the equipment. Modification data must be entered into the overall maintenance records on a cask-by-cask or an item-specific basis.

3.2.4 Perform modifications*

3.2.4.1 Request regulatory compliance assessment/ approval

3.2.4.2 Request engineering assessment

3.2.4.3 Request QA assessment

3.2.4.4 Plan modification activities

3.2.4.5 Acquire modification procedures

3.2.4.6 Acquire special equipment and materials

3.2.4.7 Coordinate with traffic planning

3.2.4.8 Finalize modification schedule

3.2.4.9 Prepare modification work order

*Functions denoted by asterisk have FFBDs.

3.2.4.10 Receive approval of procedures

3.2.4.11 Move cask or equipment to modification facility

3.2.4.12 "Red-tag" cask or equipment

3.2.4.13 Perform modification

3.2.4.14 Inspect and test modification

3.2.4.15 Close out modification work order

3.2.4.16 Remove "red tag"

3.2.4.17 Notify traffic planning of cask availability

3.2.4.18 Update cask/equipment history file

In each of the above activities, the maintenance function terminates with a transfer of responsibility to those functions that are responsible for returning the cask or equipment to service. Details of this modification FFBD are given in Appendix C.

5.3 FIELD SERVICES (3.3)

Field services provide the technical support functions required by the transportation system in the field; for example, numerous functions have been identified that are critical to the proper functioning of the transportation system and must be carried out at waste generation facilities, along routes, and at other FWMS facilities. These functions may be advisory in nature, may consist solely of observations and appropriate information transfer, or may involve activities as in the case of cask or vehicle maintenance during transport. Field service functions include reviewing equipment inventories and inspecting equipment needed for cask handling at a site, confirming compatibility between equipment and waste generator facilities, providing technical advice during loading and unloading operation, and training of site personnel. It can also include review and approval of appropriate waste preparation/cask loading procedures and verification of waste generator preparation activities (which will facilitate the DOE acceptance of loaded casks), as well as confirmation of the proper classification of

waste material to be shipped. Engineering support functions (Sect. 5.13) will provide necessary technical services required by field services.

The functional outline for field services is divided into three parts, depending on where these services take place. The breakdown includes origin (waste generator) site, in-transit field services, and destination field services (see Fig. 8). Only the origin site functions are identified in the outline (shown below) and are described in FFBD 3.3.1 in Appendix C. The in-transit and destination site functions will be developed later.

3.3 Field Services*

3.3.1 Perform origin site field service activities*

3.3.1.1 Assemble information for waste generators

3.3.1.2 Prepare advanced arrangements for service contractors

3.3.1.3 Review interfaces and assemble equipment/supplies lists and other check-off lists

3.3.1.4 Distribute lists to traffic planning, equipment maintenance and storage, and stores

3.3.1.5 Identify training requirements for waste generator and services suppliers

3.3.1.6 Identify qualifications for field services personnel, required for campaign

3.3.1.7 Receive waste generator plans for waste preparations

3.3.1.8 Visit waste generator site to confirm interface compatibility, review procedures, requirements, and training needs

3.3.1.9 Coordinate with waste generator to resolve potential deviations from requirements

3.3.1.10 Assemble training material for waste generator site operations

*Functions denoted by asterisk have FFBDs.

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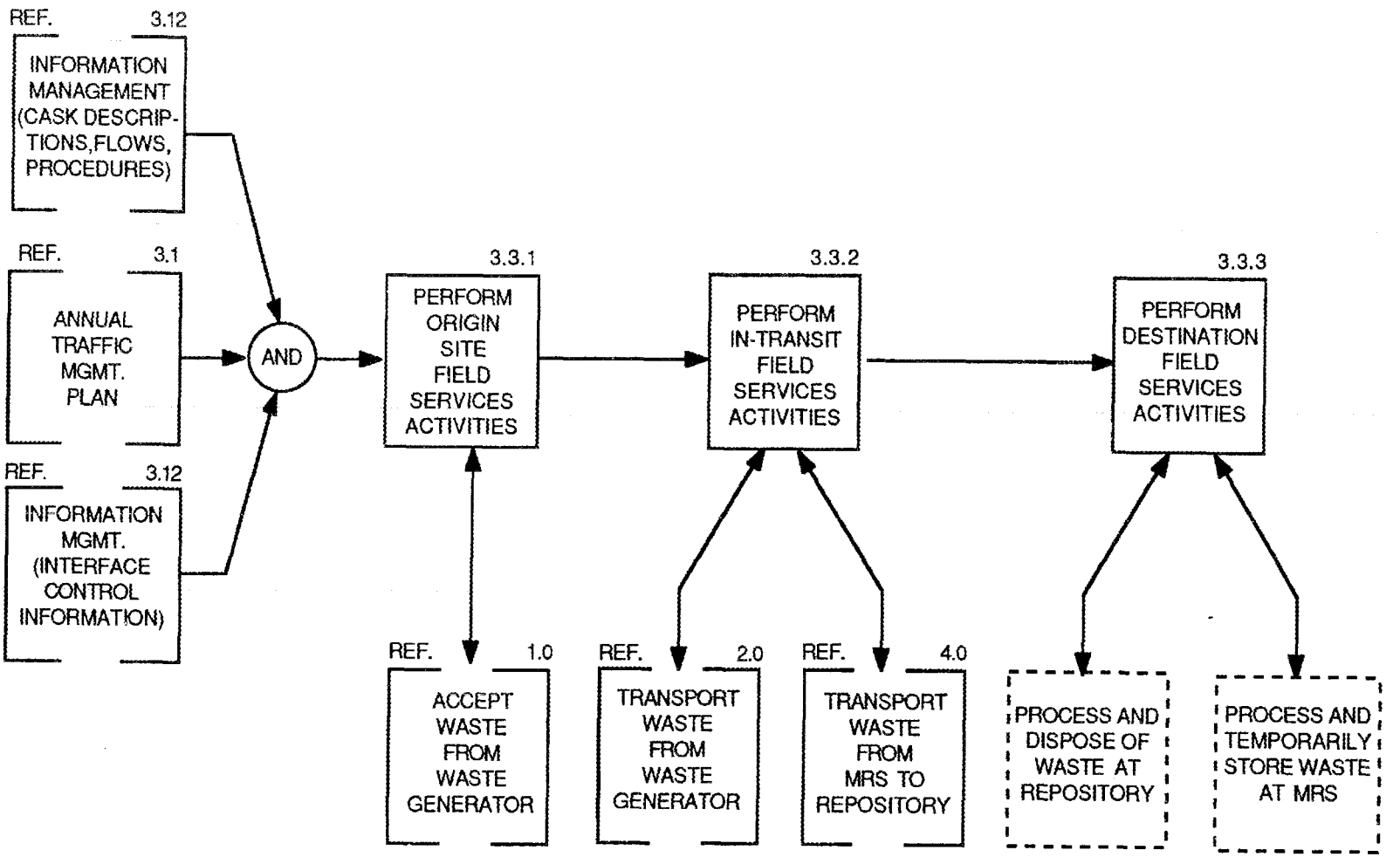

Fig. 8. Functions of field services.

3.3
FUNCTIONAL FLOW BLOCK DIAGRAM PERFORM FIELD SERVICES

3.3.1.11 Train waste generator and local services suppliers as required/requested for waste preparation

3.3.1.12 Inventory and inspect consumables, spare parts, and equipment

3.3.1.13 Conduct walk-around and receiving inspections of unloaded cask systems

3.3.1.14 Train waste generator personnel in cask handling and reconfirm interface compatibility

3.3.1.15 Coordinate with waste generator to resolve any problems

3.3.1.16 Notify dispatch operations of potential delay due to equipment problems (as required)

3.3.1.17 Coordinate and approve incidental maintenance

3.3.1.18 Hold cask system at waste generator for corrective action

3.3.1.19 Report shipment status to dispatch operations

3.3.1.20 Provide technical support to waste generator for cask loading/handling

5.4 RECONFIGURATION (3.4)

From time to time, some casks will require reconfiguring (e.g., the changing of cask internals) in order to accept the next scheduled waste type. This function can vary from changing inserts in spent fuel baskets to allow for the shipment of different-length fuel to a complete basket change-out to permit the movement of a different type of waste (e.g., canistered fuel). The reconfiguration function may occur at the waste generator repository, MRS, or Cask Maintenance Facility, depending on the scope of the reconfiguration and logistical considerations. The functional outline for cask reconfiguration is given below, and the FFBD is given in Fig. 9.

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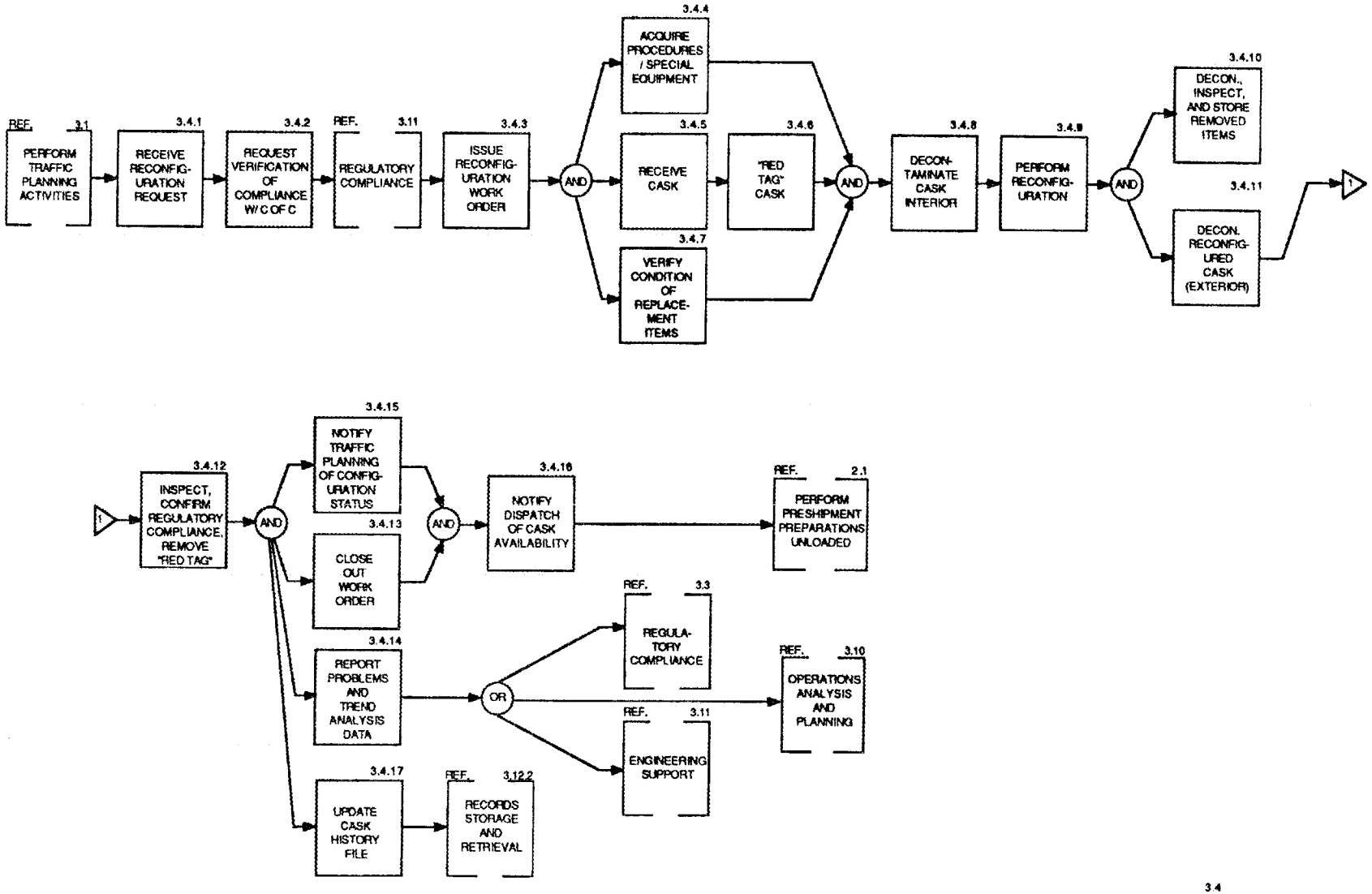

Fig. 9. Reconfiguration function.

3.4
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM CASK SYSTEM
RECONFIGURATION

3.4 Perform Cask System Reconfiguration*

3.4.1 Receive reconfiguration request

3.4.2 Request verification of compliance with cask's Certificate of Compliance

3.4.3 Issue reconfiguration work order

3.4.4 Acquire procedures/special equipment

3.4.5 Receive cask

3.4.6 "Red-tag" cask

3.4.7 Verify condition of replacement items

3.4.8 Decontaminate cask internals

3.4.9 Perform reconfiguration

3.4.10 Decontaminate, inspect, and store removed items

3.4.11 Decontaminate reconfigured cask exterior

3.4.12 Inspect, confirm regulatory compliance, and remove "red tag"

3.4.13 Close out work order

3.4.14 Report problems and trend analysis data

3.4.15 Notify traffic planning of configuration status

3.4.16 Notify dispatching of cask availability and return cask to service

3.4.17 Update cask system item history file

5.5 EMERGENCY RESPONSE AND RECOVERY (3.5)

Emergency response and recovery functions are subdivided into normal business "nonemergency" functions and actual "incident/accident" emergency response functions. This subdivision is consistent with DOE Order 5500.1A and evolving OCRWM Transportation emergency management system structure and operational plans. The normal nonemergency functions are largely maintenance of transportation system capabilities,

*Functions denoted by asterisk have FFBDs.

plans, and procedures to support DOE emergency management system (DOE-EMS) responses to transportation emergencies/incidents; actual incident/accident emergency response functions include execution of those plans and procedures, if requested, in the event of an actual emergency. During normal operations of the system, TOS expects to maintain and supply information to the DOE-EMS on a continuous basis and respond to any request for support as soon as it is received from the EMS. The functional outline is given below; the FFBD for function 3.5 is given in Fig. 10.

3.5 Emergency Response and Recovery*

3.5.1 Routine operations*

3.5.1.1 Maintain liaison with DOE-EMS

3.5.1.2 Maintain ER staff readiness

3.5.1.3 Maintain generic ER plans/procedures for FWMS transportation emergencies

3.5.1.4 Prepare campaign-specific ER data packages

In the event of an actual incident/accident, emergency response actions will most likely be triggered by a call from persons at or near the scene. These persons may be from the carrier organization, local police, fire or civil defense organizations, or state officials. The calls may be directed to a number of places, including DOE/HQ, a DOE field office, or even CHEM-TREC. The functions identified herein are applicable when the operating elements of the TOS are called; their initial response will be to ensure that proper communications with DOE/HQ are followed by actions called for in documented procedures.

Following an unexpected event in transit, the initial determination of a true "radiological emergency" may be made by those on the scene (e.g., state police); followup confirmation and other actions will depend on good communications between responsible parties. If it is finally determined that no radiological emergency exists, the response will probably become a field services activity. Otherwise, the response

*Functions denoted by asterisk have FFBDs.

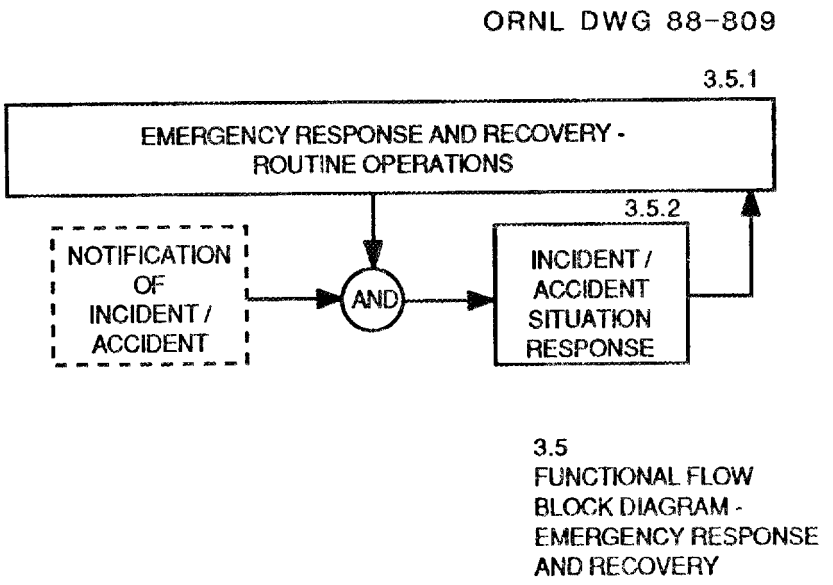

Fig. 10. Emergency response and recovery.

functions will proceed as indicated below and shown in FFBD 3.5.2. It is important to recognize that actions by TOS personnel will always be coordinated with Emergency Management System personnel at DOE/HQ and the appropriate DOE field office.

Functions related to recovery operations may vary widely but will ensure that all radioactive materials will be removed from the scene of any accident/incident.

3.5.2 Incident/accident situation response*

- 3.5.2.1 Make appropriate notification/interactions
- 3.5.2.2 Initiate operational emergency response
- 3.5.2.3 Obtain/maintain flow of information from operations emergency response team to other entities
- 3.5.2.4 Establish Operational Control Center (OCC) contact with on-scene coordinator
- 3.5.2.5 Dispatch additional specialists from OCC/contractors if requested
- 3.5.2.6 Provide technical assistance if required
- 3.5.2.7 Initiate preparation of recovery/procedures
- 3.5.2.8 Arrange for required staff/equipment/ services
- 3.5.2.9 Monitor recovery activities
- 3.5.2.10 Provide additional support as required
- 3.5.2.11 Complete recovery activities
- 3.5.2.12 Notify appropriate personnel of recovery completion
- 3.5.2.13 Document entire incident/accident
- 3.5.2.14 Document lessons learned

The FFBD for function 3.5.2, "Incident/Accident Operations," is presented in Appendix C.

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*Functions denoted by asterisk have FFBDs.

5.6 TRANSPORT UNLOADED CASKS (3.6)

The three main functional requirements of the transport system given in the waste management SRD include (1) accepting waste, (2) transporting waste, and (3) supporting the system. The movement of unloaded casks through the system was not discussed. Therefore, this function has been addressed as a separate support activity here. The casks are referred to as "unloaded" rather than "empty" because an internally contaminated cask without fuel assemblies may not be considered empty according to DOT definitions. In addition to the repository, the sources of these unloaded casks could be the Cask Maintenance Facility (CMF) following maintenance operations, newly purchased casks, and other facilities at which repair or modification operations have been carried out. This transport function will occur among the facilities of the FWMS and the Waste Generator sites. Rail and truck are the only shipping modes considered in depth; barge will be discussed later. The outline for this function is given below.

3.6 Transport Unloaded Casks*

- 3.6.1 Perform preshipment activities*
  - 3.6.1.1 Perform preshipment activities - highway transport-unloaded*
    - 3.6.1.1.1 Perform vehicle operational readiness check (vehicle without cask)
    - 3.6.1.1.2 Take possession of unloaded cask on vehicle
    - 3.6.1.1.3 Determine shipping classification
    - 3.6.1.1.4 Inspect cask system preparation documents
    - 3.6.1.1.5 Take final contamination smears and verify within limits
    - 3.6.1.1.6 Perform initial readiness check - trailer

*Functions denoted by asterisk have FFBDs.

3.6.1.1.7 Drivers and tractor move to site

3.6.1.1.8 Assemble drivers "packet" - emergency response information, routes, schedules, etc.

3.6.1.1.9 Conduct predispatch drivers' conference

3.6.1.1.10 Connect tractor to trailer

3.6.1.1.11 Perform radiation compliance survey

3.6.1.1.12 Perform final readiness check - tractor/trailer

3.6.1.1.13 Perform administration check on completeness of compliance items

3.6.1.1.14 Prepare bill of lading and sign shipper's certification

3.6.1.1.15 Release shipment to carrier

3.6.1.2 Perform preshipment activities - rail transport-unloaded*

3.6.1.2.1 Perform vehicle operational readiness check (vehicle without cask)

3.6.1.2.2 Take possession of unloaded cask on railcar

3.6.1.2.3 Move locomotive to the site

3.6.1.2.4 Determine shipping classification for the unloaded cask, e.g., LSA, Type B quantity

3.6.1.2.5 Inspect cask system preparation documents for completeness and compliance with preparation requirements

*Functions denoted by asterisk have FFBDs.

3.6.1.2.6 Take final contamination smears and verify compliance with DOT shipping limits

3.6.1.2.7 Perform mechanical condition walk-around (rail car)

3.6.1.2.8 Perform administrative checks on completeness of compliance items, including placards, labels, and shipping documents

3.6.1.2.9 (For multiple car shipments) move cask system car to the site blocking area using the site prime mover

3.6.1.2.10 (For multiple car shipments) accumulate cask system cars in the site blocking area until the shipping quantity is achieved

3.6.1.2.11 Couple cask system car(s) to site prime mover and move to site boundary

3.6.1.2.12 Assemble train

3.6.1.2.13 Assemble shipment documents packet for the railroad representative

3.6.1.2.14 Perform brake tests

3.6.1.2.15 Check communications equipment

3.6.1.2.16 Perform radiation compliance survey

3.6.1.2.17 Prepare bill of lading (BOL) and complete shipper's documentation

3.6.1.2.18 Release shipment to carrier

3.6.1.3 Perform preshipment activities - barge transport-unloaded

3.6.2 Perform carriage - unloaded

3.6.3 Perform traffic management activities

Following the preshipment activities shown above in 3.6.1, carriage is provided under 3.6.2 in the outline. Traffic management activities associated with the movement of unloaded casks is included under 3.6.3 in the outline. These flow are depicted in Fig. 11, with details given in Appendix C.

Unloaded casks will be periodically transported from the repository to the CMF for a variety of maintenance functions, and then to the waste generator site and/or the MRS for reloading. Unloaded casks will also be transported from the MRS to the next waste generator site for reloading. Unloaded casks will be transported from the CMF after maintenance (and/or reconfiguration) to the waste generator site for reloading. Prior to shipment, the unloaded casks will be classified as empty, LSA, Type B, or other, depending on the level of contamination contained in the cavity at the time of shipment. The shipping papers will be prepared accordingly.

5.7 SYSTEM ENHANCEMENT PROJECTS (3.7)

As the TOS develops and matures, it can be expected that some of the functions and activities can be improved. The system will be enhanced in those areas in which a cost-effective improvement or a safety-related improvement can be made. Although these potential improvements cannot be identified now, they will become obvious once the TOS starts operations. An FFBD has not been developed for this function.

5.8 TRANSPORTATION SYSTEM WASTE MANAGEMENT (3.8)

The transportation system is expected to involve several facilities that will be part of the TOS responsibilities and that will generate some radioactive wastes for which disposal in a licensed facility will be required. These wastes (primarily low-level radioactive materials) will be treated, packaged, and transferred to a low-level waste facility for

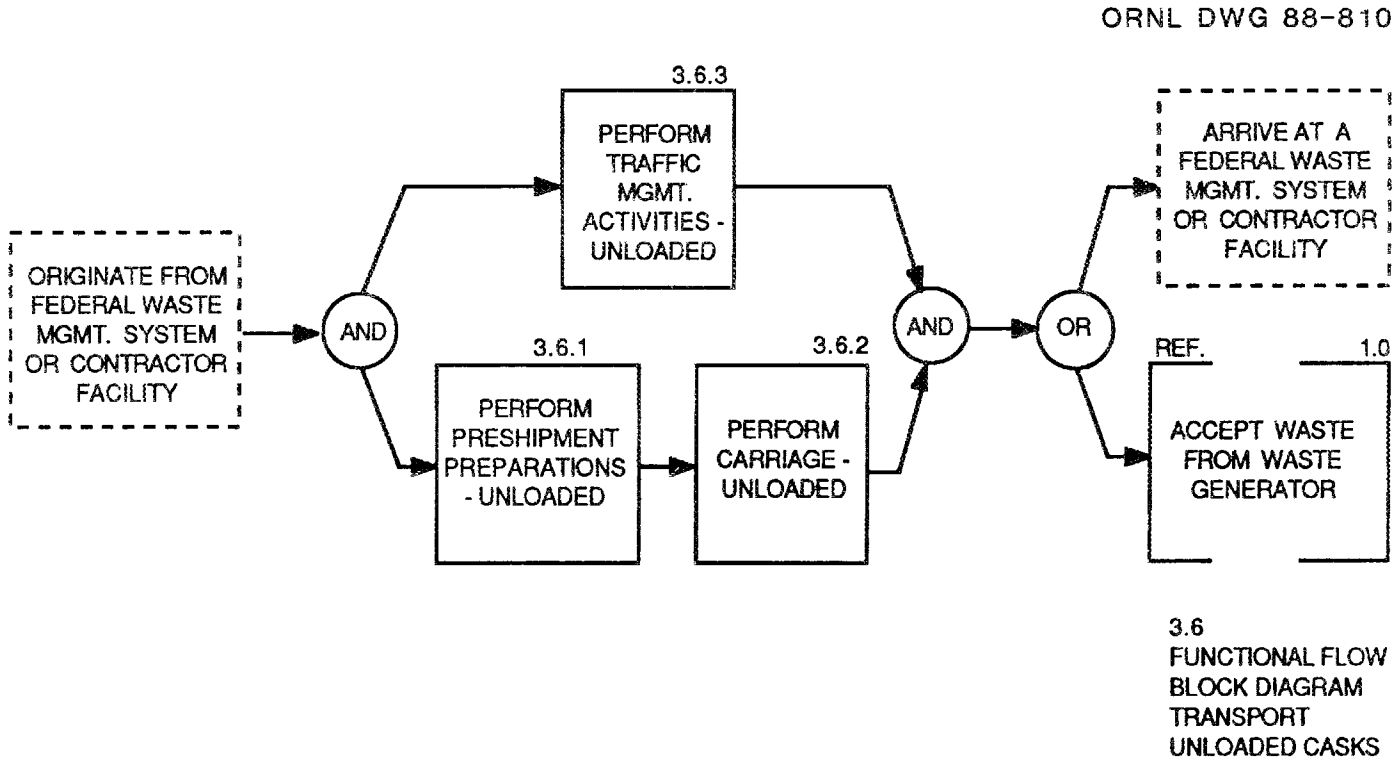

Fig. 11. Function associated with transport of unloaded cask.

processing and disposal. Other nonradioactive wastes will be processed in accordance with accepted good practice for industrial materials.

It is also anticipated that each cask will be retired from service after it has served its useful life. At that time, it will be necessary to decontaminate, decommission, and dispose of these casks. Additional decontamination and decommissioning activities will be required for other transportation system components when they reach the end of their useful lifetimes. The extent of this function will not be completely known until all transportation equipment and facilities have been defined. Therefore, the functional outline, given below, is simple in structure. An FFBD was not developed for this function.

3.8 Transportation System Waste Management

3.8.1 Treat and dispose of wastes

3.8.2 Decontamination and decommissioning (D&D)

5.9 TRAINING (3.9)

Training activities are an integral element of transportation support functions and will allow system acceptance and transport activities to be accomplished in a safe, efficient manner and in compliance with applicable statutes, regulations, and DOE orders. This training will be primarily for staff members employed in the TOS. Provisions for training transportation system operations staff and interfacing with personnel at waste generator sites and NWPA facilities will need to be developed. The training program for selected TOS staff members will include initial staff training, requalification training, and replacement training. An important precursor to this is the development and training of the training staff. The initial staff training program for support facilities would be designed to produce competent, trained personnel at all levels of the organization, with training based on employee experience and intended assignment. The requalification program would provide ongoing training and qualification of personnel commensurate with their position and regulatory requirements. The replacement program would be designed to supply qualified personnel to open positions within the operations organization.

Training of transportation field service and other transportation operations personnel will be required for waste acceptance activities; cask handling operations; road-worthiness inspections of cask system equipment; enroute and tracking activities, physical protection tasks; emergency response functions; and cask system equipment operation, servicing, maintenance, and performance testing. Training of interfacing personnel at waste generator sites will include cask handling and loading operations and incidental maintenance of cask system equipment. Training will include classroom sessions using audiovisual aids, as well as subsequent "dry" runs with cask system equipment. Depending on the final transportation system configuration and scope of service contracts, specific training responsibilities may be delegated to several organizations. The functional outline for the training activities is presented below. An FFBD was not developed for this function.

3.9 Training Program Maintenance and Implementation

- 3.9.1 Develop and maintain training programs and procedures
- 3.9.2 Transportation system training
  - 3.9.2.1 Radiological health training for transportation systems personnel
  - 3.9.2.2 Transportation system policies and procedures
  - 3.9.2.3 Occupational health and safety
  - 3.9.2.4 Security operations
- 3.9.3 Records generation

5.10 OPERATIONS ANALYSIS AND PLANNING (3.10)

Operations analysis and planning functions will include assessing current transportation activities, long-range planning, and identifying and evaluating alternatives. The evaluation of activities will include monitoring, analyzing, and providing transportation system feedback with regard to performance, cost, and schedule parameters as specified in the Transportation Business Plan (Sect. 5.3.3 of ref. 4). Examples of

items to be tracked include quality assurance (QA) parameters; accident/incident rates; cask system equipment availability/utilization factors; compatibility with utility handling facilities; radiation exposure histories for TOS workers; transporter servicing, maintenance, and repair costs; transportation/operation costs; recurring problems and delays, and compliance with training, inspection, and shipment schedules. Trending and analysis of collected data will be utilized to maintain or improve system safety and efficiency by providing input to the QA, operations, and maintenance programs. Operations analysis activities will also be utilized, in part, to identify potential system enhancement needs. It is anticipated that long-range transportation plans will be developed by using waste generators' 5-year commitment delivery schedules and 10-year discharge projections. These plans could be utilized to provide input to DOE waste acceptance priority/capacity reports, to assess fleet size and modal mix requirements, and to identify cask system equipment acquisition/replacement needs. The functional outline for operations analysis and planning activities is presented below. An FFBD was not developed for this function.

3.10 Operations Analysis and Planning

- 3.10.1 Current operations evaluation
  - 3.10.1.1 Performance parameters
  - 3.10.1.2 Cost parameters
  - 3.10.1.3 Schedule parameters
- 3.10.2 Long-range planning/alternatives
  - 3.10.2.1 Identify and evaluate alternatives
  - 3.10.2.2 Provide input to DOE acceptance priority/capacity reports
  - 3.10.2.3 Develop long-range transportation plan

5.11 REGULATORY COMPLIANCE (3.11)

Activities within this function will involve the interaction between the TOS and regulatory agencies [e.g., maintenance of the NRC Certificate

of Compliance (C of C) for casks]. The work will consist of supporting performance and documentation of cask testing prior to first use and subsequent routine (shipment basis) and periodic inspections/testing. Regulatory compliance functions primarily consist of documenting and verifying that cask maintenance and repair activities are in accordance with the C of C. In addition, they include preparing requests for modifications to the cask C of Cs, as necessary, to maintain the cask fleet in its operational condition. When transportation facilities are built which require licensing by the NRC or an agreement state (as might be the case with a Cask Maintenance Facility), regulatory compliance functions also include interfacing with the licensing entity in matters pertaining to that license, such as communicating and documenting activities, agreements, etc. Other functions include coordinating applicable emergency planning and radiological/environmental monitoring programs; processing applicable permit fees/license renewal applications; and supporting personnel qualification activities. Significant interaction with the Environmental Protection Agency (EPA), where emissions from fixed facilities are concerned, is also possible. Title 40 activities may include support of assessments which may be required to ensure ongoing compliance with the National Environmental Policy Act (NEPA). All of these responsibilities will require the interaction with QA functions (Sect. 5.15), Transportation System Waste Management (Sect. 5.8), Information Management (Sect. 5.12), and Engineering Support (Sect. 5.13).

Regulatory compliance functions will also support, where appropriate, transportation operations activities relative to routing, emergency response, prenotification, ALARA compliance, ancillary equipment calibration and testing, vehicle inspection and testing, shipping documentation, accident/incident reporting, in-transit physical protection, and other Title 10 and 49 requirements.

The functional outline for regulatory compliance is presented below. An FFBD was not developed.

3.11 Regulatory Compliance

3.11.1 Federal agency and state/tribal/local regulatory interactions

3.11.2 Cask Certificate of Compliance maintenance and revisions

3.11.2.1 Maintain QA program to verify that cask is tested, operated, and maintained as described in the C of C

3.11.2.2 Evaluate unusual events

3.11.3 Facility license and permit maintenance

3.11.3.1 Title 10 licensing

3.11.3.2 Title 40 permitting

3.11.4 Operation support

3.11.4.1 Title 10 activities

3.11.4.2 Title 49 activities

3.11.4.3 Records support

3.11.4.4 Transportation operations review

5.12 INFORMATION MANAGEMENT (3.12)

The operation of the transportation system will necessitate the development and maintenance of an extensive body of data. These data will be used to provide input to planning and licensing activities, and development of facilities, equipment, services, and interfaces of the TOS, in addition to serving as a history of prior activities. The information will be stored in different, easily retrievable formats, depending on the nature and quantity of the data.

The information to be stored includes, in part, C of C data, licensing data, as-built cask and facility drawings, state interface and requirements data, federal and state legislative data, shipping records, maintenance and repair records, accountability records as required, health physics records, and QA records. These data bases will also provide a status report for each cask in the fleet. The files will contain information on the current configuration of a cask, its current basket and spacers, what fuel it can accept, etc. An FFBD was not developed.

5.13 ENGINEERING SUPPORT (3.13)

Engineering support functions for the TOS will include design, analysis, and other engineering operations to support licensing, regulatory, and equipment acquisition activities. These functions will also provide engineering support to field services and maintenance activities. The functional outline for engineering support activities is presented below. An FFBD was not developed.

3.13 Engineering Support

- 3.13.1 Special equipment design
- 3.13.2 Acquisition support
- 3.13.3 Regulatory support
- 3.13.4 Technical support to field services
- 3.13.5 Technical support to maintenance
- 3.13.6 System enhancement

5.14 HEALTH, SAFETY, AND ENVIRONMENT (3.14)

The operation of the TOS will be monitored for full compliance with applicable terms of the Occupational Safety and Health Act (OSHA), the Environmental Protection Agency (EPA), applicable DOE orders, and state regulations. Specific emphasis will be placed on radiation safety, industrial safety, and protection of the environment.

Radiation safety will be effected through the use of access controls, monitoring, contamination control, and training in both normal and emergency operational procedures. Administrative controls and records will be maintained in order to ensure minimal radiation exposure levels. Facility effluents will be monitored for radioactivity and other contaminants.

Industrial safety will be emphasized through active measures such as training, safety system surveillance, monitoring, and recertification. Incident response capabilities will be provided to minimize the effects of unusual events when they do occur. Personnel will be monitored for fitness for duty in accordance with standard industrial practices.

Environmental safety for both facilities and operations will be maintained to the highest extent possible. Both active and passive systems will be used to ensure minimal impact to the environment from both normal and off-normal operations. The functional outline for Health, Safety, and Environment activities is given below. An FFBD was not developed.

3.14 Health, Safety, and Environment (interface with 10 CFR 19, 20; OSHA; EPA; DOE orders; state regulations)

3.14.1 Radiation safety

3.14.2 Industrial safety

3.14.3 Environmental safety for TOPO facilities and operations

5.15 QUALITY ASSURANCE

The QA program adopted by the TOS will be compatible with the OCRWM QA plan and use a graded approach for applying DOE's QA requirements. That is, each technical work activity will be evaluated to determine the significance of the work activity as it relates to safety and programmatic objectives. Applicable QA requirements, as identified in the ANSI NQA-1, are then imposed on each work activity based on the results of this evaluation. More stringent requirements will be imposed on those activities that are critical to the success of the mission; in cases where the failure of an activity would be of little consequence to the program, less stringent requirements will be imposed. These requirements are imposed only after agreement has been reached between the project manager and the QA specialist for the TOS.

Procurement documents will define the QA requirements for each subcontract. Subcontractors are required to document the approach they expect to use in meeting the requirements defined in the procurement documents. Surveillance will be used as the primary verification tool to ensure that subcontractors are meeting the applicable QA requirements. The functional outline for QA is presented below. An FFBD was not developed.

3.15 Quality Assurance

3.15.1 Develop/implement QA program

3.15.2 Perform QA/QC engineering activities

3.15.3 Maintain QA records

5.16 EQUIPMENT AND SERVICES ACQUISITION (3.16)

It is assumed that complete specifications for approved cask systems are available prior to startup of the waste management system and that cask system prototypes and major required facilities, if any, have been approved, designed, sited, licensed, and constructed. However, it is expected that a wide variety of specialized equipment, tools, spare/repair parts, and services, as well as the cask/vehicle fleet, will remain to be acquired. This gives rise to the acquisition functions (purchasing and contracting) given in this section. The information (designs, specifications, quantities, schedules, etc.) needed to fulfill the acquisition functions largely results from the traffic planning functions in Sect. 5.1, maintenance functions in Sect. 5.2, field services functions in Sect. 5.3, and engineering support functions in Sect. 5.13. Cask system servicing/maintenance/repair functions are expected to require extensive facilities and equipment and, therefore, involve purchasing and contracting activities.

The functional outline for Equipment and Services Acquisition is presented below. An FFBD was not developed.

3.16 Equipment and Services Acquisition

3.16.1 Fleet procurement

3.16.2 Ancillary equipment design/procurement

3.16.3 Spare parts/consumables

3.16.4 Major equipment repairs

3.16.5 Carrier services (e.g., carrier contracting, maintenance services)

5.17 TRANSPORTATION SYSTEM MANAGEMENT (3.17)

This central management function will provide traditional management and general administrative support activities for the operation of the TOS. These include the development and management of overall system-related plans and related budget activities. Also included are the liaison and interfacial activities between the TOS and other systems, as appropriate. The outline for TOS management activities is given below. An FFBD was not developed.

- 3.17 Transportation System Management
  - 3.17.1 General administration
  - 3.17.2 System direction and control
  - 3.17.3 Budgeting
  - 3.17.4 Liaison

5.18 EXTERNAL RELATIONS AND POLICY (3.18)

This function is concerned primarily with supporting the FWMS interactions with all public and private organizations external to the DOE system that are interested in matters which would impact the operating transportation system. The areas of support covered by this function include external relations, TOS policy development, and information services. The subfunctions that must be carried out are addressed in the outline given below.

- 3.18 External Relations and Services
  - 3.18.1 Policy and External Relations
    - 3.18.1.1 Support FWMS interactions with outside organizations
    - 3.18.1.2 Provide transport operations-related information as requested
    - 3.18.1.3 Support FWMS interactions with states and tribes
    - 3.18.1.4 Support FWMS international program

3.18.1.5 Maintain TOS policies to support and implement the NWPA

3.18.1.6 Support FWMS management in DOE national energy policy activity

3.18.1.7 Monitor regulatory, legislative, and legal activities that impact TOS

3.18.2 Information Services

3.18.2.1 Maintain TOS information development plans

3.18.2.2 Support FWMS by providing media material and a speakers' bureau

The FWMS is expected to interact with outside organizations such as the National Conference of State Legislators, the National Congress of American Indians, the League of Women Voters, the Western Interstate Energy Board, and the Southern States Energy Board. Interactions with these organizations will be maintained within the policy guidelines of the FWMS to provide accurate information as rapidly as possible.

This primary function will also include policy development activities to ensure that the TOS works in concert with other DOE organizations and within the guidelines and requirements of the Nuclear Waste Policy Act and its amendments. This cooperative effort will entail monitoring state and governmental regulatory, legislative, and legal activities that impact the TOS. By maintaining the necessary awareness of the DOE system and external forces that may help shape that system, the TOS will also be capable of providing information to the public and federal organizations as requested by the FWMS.

6. ACKNOWLEDGMENT

The support work performed by Mr. L. D. Dixon, Science Applications International Corporation, on the development of the functional flow block diagrams, is acknowledged and appreciated.

7. INFORMATION RESOURCES/REFERENCES

1. "Nuclear Waste Policy Act of 1982," Public Law 97-425, Jan. 7, 1983.
2. Mission Plan for the Civilian Radioactive Waste Management Program, Vol. I of III, Office of Civilian Radioactive Waste Management, Washington, D.C., DOE/RW-0005, 1985.
3. OCRWM Mission Plan Amendment with Comments on the Draft Amendment and Responses to the Comments, Office of Civilian Radioactive Waste Management, Washington, D.C., DOE/RW-0128, 1987, p. 61.
4. Waste Management System Requirements and Description (SRD), Draft Revision, February 1988.
5. Transportation Business Plan, Office of Civilian Radioactive Waste Management, Washington, D.C., DOE/RW-0046, January 1986.
6. Transportation Institutional Plan, Office of Civilian Radioactive Waste Management, Washington, D.C., DOE/RW-0094, August 1986.
7. Waste Management System Description, Draft, November 1987.
8. General Requirements for a Mined Geologic Disposal System, RW-0090, OGR/B-2, Rev. 3, March 1987.
9. 10 CFR 71, 10 CFR 73, 49 CFR 171-178, 215, 390-397.
10. "Emergency Management System," DOE Order 5500.1A, Feb. 26, 1987.
11. Transportation Operational Emergency Management Team Plan for NWPA Activities, Draft, March 1988.
12. Siting Alternative Cost Study for a Spent Fuel Shipping Cask Maintenance Facility, H&R 285-1/R1, December 1986.
13. Preliminary Definition of the Transportation Operations System, S. M. Stoller Corporation, February 1988.
14. Cask Fleet Operations Study, ORNL/Sub/87-00421/1, Nuclear Assurance Corporation, February 1988.
15. A Cask Fleet Operations Study, ORNL/Sub/87-06604/1, Transnuclear, Inc., March 1988.
16. Analysis of Radiation Dose from Operation of Postulated Reference Transportation Systems, DOE-H/TPO-001, November 1987.
17. DOE Off-Site Radioactive Shipment Record, DOE-ID F5480.1A, July 1983.

18. "Management of Base Technology for Radioactive Material Transportation Packaging Systems," DOE Order 1540, Draft, Nov. 29, 1986.

19. "Material Transportation and Traffic Management," DOE Order 1540.1, May 2, 1983.

20. OCRWM-DP Programs Memorandum of Agreement RW-1 Memo, June 4, 1985.

21. "Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste," 10 CFR 961.11.

22. Transportation Systems Engineering Management Plan (TSEMP), Draft, July 1987.

8. APPENDIXES

8.1. Appendix A. CORE GROUP MEMBERS

Name	Affiliation
C. R. Attaway	Oak Ridge National Laboratory
R. E. Best	Science Applications International Corporation
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S. C. Kline	S. M. Stoller Company
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R. R. Rawl	Oak Ridge National Laboratory

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S. Grady	Science Applications International Corporation
C. Dale Hansen	Westinghouse, Hanford
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P. A. Bolton	Roy F. Weston Associates
E. L. Wilmot	DOE/HQ

8.2. Appendix B. FUNCTIONAL FLOW BLOCK DIAGRAMS METHODOLOGY*

The initial step in the system engineering process formulates a functional description of the system. Functional flow block diagrams are developed for the primary purpose of structuring system requirements in functional terms; the main emphasis is on accuracy and completeness rather than on format. As an aid in developing, interpreting, and providing standardization necessary to control interfaces, certain basic rules and symbols have been developed and are followed in the physical layout of the functional diagrams. These requirements are described in subsequent paragraphs. The general format and basic symbols for functional diagrams are illustrated in Fig. B.1.

1. **Level designation.** Functional flow block diagrams are designated as top level, first level, second level, and so on. The top-level functional diagram describes the gross operational functions. The subsequent-level diagrams represent progressive expansions of individual functions of the preceding level.
2. **Function numbering.** Functions identified on the diagrams at each level are numbered in a manner that preserves the continuity of functions and provides information with respect to function origin throughout the system. The indenture numbering related to flow diagram level is illustrated in Fig. B.2. Functions that further indenture these top functions contain the same parent identifier and are coded at the next decimal level for each indenture. For example, if more than one function is required to amplify function 1.0 at the first level of indenture, the sequence will be 1.1, 1.2, 1.3, . . ., 1.n. In expanding function 1.2 at the second level, the numbering will be 1.2.1, 1.2.2, . . ., 1.2.n. Where several levels of indentures appear on a single functional diagram, the same pattern is maintained. While the basic ground rule is to maintain a minimum level of indentures on any one particular flow, it may become necessary to include several levels to preserve the continuity of functions and to minimize the number of flows required to functionally depict the system. The general criteria for the

*This material was excerpted from U.S. Army FM 770-78.

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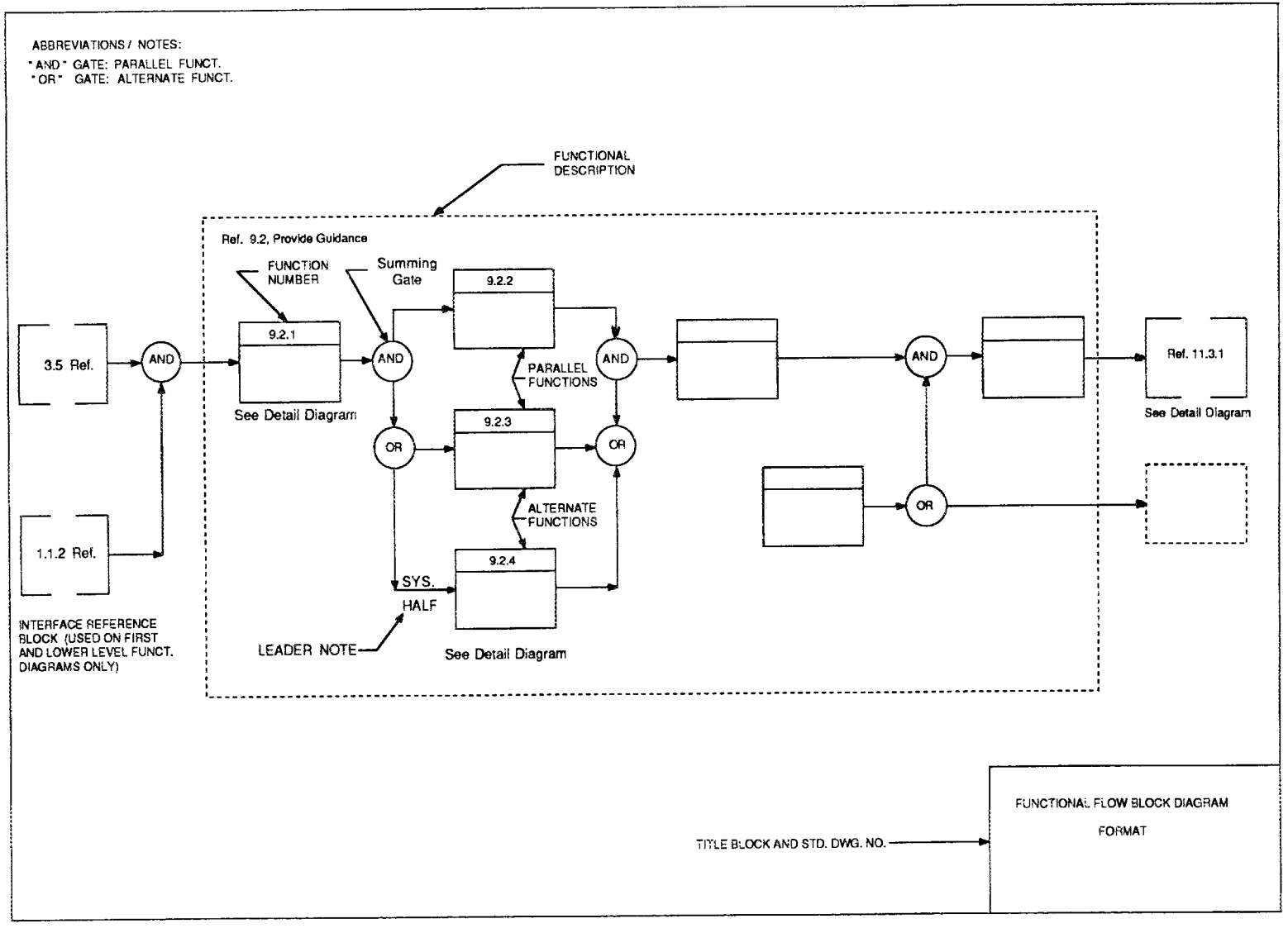

Fig. 3.1. Functional flow block diagram showing general format and symbols.

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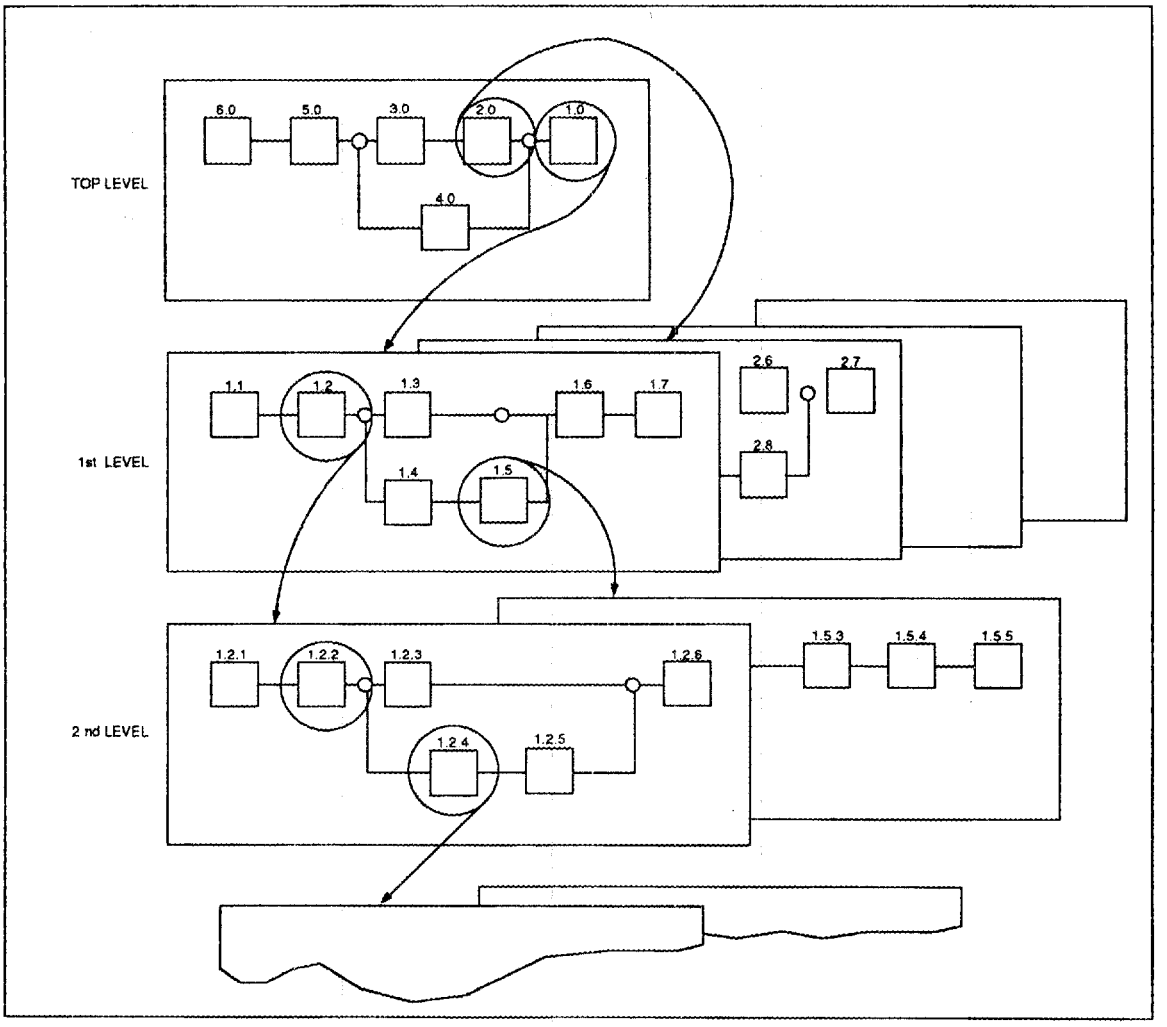

Fig. B.2. Indenture levels and traceability.

number of functions and level of indentures appearing on any particular flow are accuracy, traceability, and clarity of presentation.

3. **Function block.** Each separate function on a functional flow block diagram is presented in a single box enclosed by a solid line. Blocks used for references to other forms are indicated as partially enclosed boxes, each of which is labeled "Ref" and bears its own number. Each function may be as gross, or as detailed, as required by the level of the diagram on which it appears, but it will designate a discrete action to be accomplished.
4. **Flow connection.** Lines connecting functions indicate only the functional flow and represent neither a lapse in time nor any intermediate activity. In depicting the flow, vertical and horizontal lines between blocks indicate that all functions so interrelated must be performed in either a parallel or a series sequence as indicated.
5. **Flow direction.** Functional flow block diagrams are drawn so that the functional flow is from left to right and the reverse flow, as in the case of a functional loop, is from right to left. However, where other considerations dictate a different arrangement to highlight a physical area, level of maintenance, or other significant consideration, an alternative arrangement might be employed.
6. **Summing gates.** A circle is used to depict a summing gate. As in the case of functional blocks, lines enter and/or exit the summing gate as appropriate. The summing gate is used to indicate the convergence and/or divergence of parallel or alternate functional paths and is annotated with the terms "AND" or "OR," respectively. The term AND is used to indicate that parallel functions leading into the gate must be accomplished before proceeding into the next function or that paths emerging from the AND gate must be accomplished after the preceding function. The OR gate indicates that alternative paths may lead to, or follow, a particular function. The term OR is used to indicate that any of several alternative paths (alternative functions) converge to, or diverge

from, the OR gate. An AND gate may have multiple inputs and outputs. All of the input functions must be completed prior to passage through the gate. An OR gate may have multiple inputs or outputs, but not both. The summing gate, which precedes parallel and alternative functional paths, is repeated at the end of those functional paths when this redundancy increases the clarity of the diagram.

7. **Numbering procedures for changes to functional flow block diagrams.** In order to provide a rapid means for changing flows without causing extensive or chain-reaction revision of numbering, the addition of functions to existing data is accomplished by locating the new function in its correct position without regard to subsequence of numbering. That is, once a function has been assigned a number, it will maintain that same number even if new functions are inserted in the flow diagram before it.

8. **Abbreviations, notes, and leder notes.** Abbreviations are used in flow blocks to increase the understandability of functional flow block diagrams and to reduce the space required. Generally, these abbreviations are restricted to those commonly understood in the program. Functional diagrams, while logically arranged, are not logic networks in the mathematical sense; and gates alone are not adequate to avoid ambiguity in all cases. To minimize the problem, leader notes are used for clarification. Leader notes are placed near a line entering or leaving a function when additional clarification is required. Leader notes are used particularly in conjunction with OR gates to indicate criteria of selection.

9. **Title block.** A title block is placed in the lower right corner of the drawing. The formal title for top-level diagrams is "Top-Level Functional Diagram . . . System." The title for lower-level diagrams is the same as the title of the reference block, that is, the function being detailed.

8.3. Appendix C. TOS FUNCTIONAL FLOW BLOCK DIAGRAMS

INDEX TO DIAGRAMS

Title	FFBD No.
Transportation Operations System	Level 1
Accept Waste from Waste Generator	1.0
Observe Preparatory Activities	1.1
Verify Waste Description	1.2
Obtain and Verify Transport Documentation	1.3
Transport Waste from Waste Generators	2.0
Perform Preshipment Preparations - Loaded	2.1
Perform Preshipment Preparations for Highway Transport - Loaded Cask	2.1.1
Perform Preshipment Preparations for Rail Transport - Loaded Cask	2.1.2
Perform Traffic Management Activities (Loaded)	2.2
Provide Waste Carriage	2.4
Perform Delivery	2.5
Traffic Planning	3.1
Integrated Campaign Planning and Analysis	3.1.1
Route Planning and Analysis	3.1.2
Perform Maintenance Activities	3.2
Perform Maintenance Planning and Scheduling	3.2.1
Perform Scheduled Maintenance Operations	3.2.2
Perform Repairs	3.2.3
Repair Cask or Equipment	3.2.3.2
Perform Vehicle Repairs	3.2.3.3
Perform Modification Activities	3.2.4

INDEX TO DIAGRAMS (Continued)

Title	FFBD No.
Perform Field Services	3.3
Perform Origin Site Field Service Activities	3.3.1
Perform Cask System Reconfiguration	3.4
Emergency Response and Recovery	3.5
Emergency Response and Recovery - Routine Operation	3.5.1
Incident/Accident Situation Response	3.5.2
Transport Unloaded Casks	3.6
Perform Preshipment Preparations - Unloaded	3.6.1
Perform Preshipment Preparations - Highway Transport - Unloaded	3.6.1.1
Perform Preshipment Preparations - Rail Transport - Unloaded	3.6.1.2

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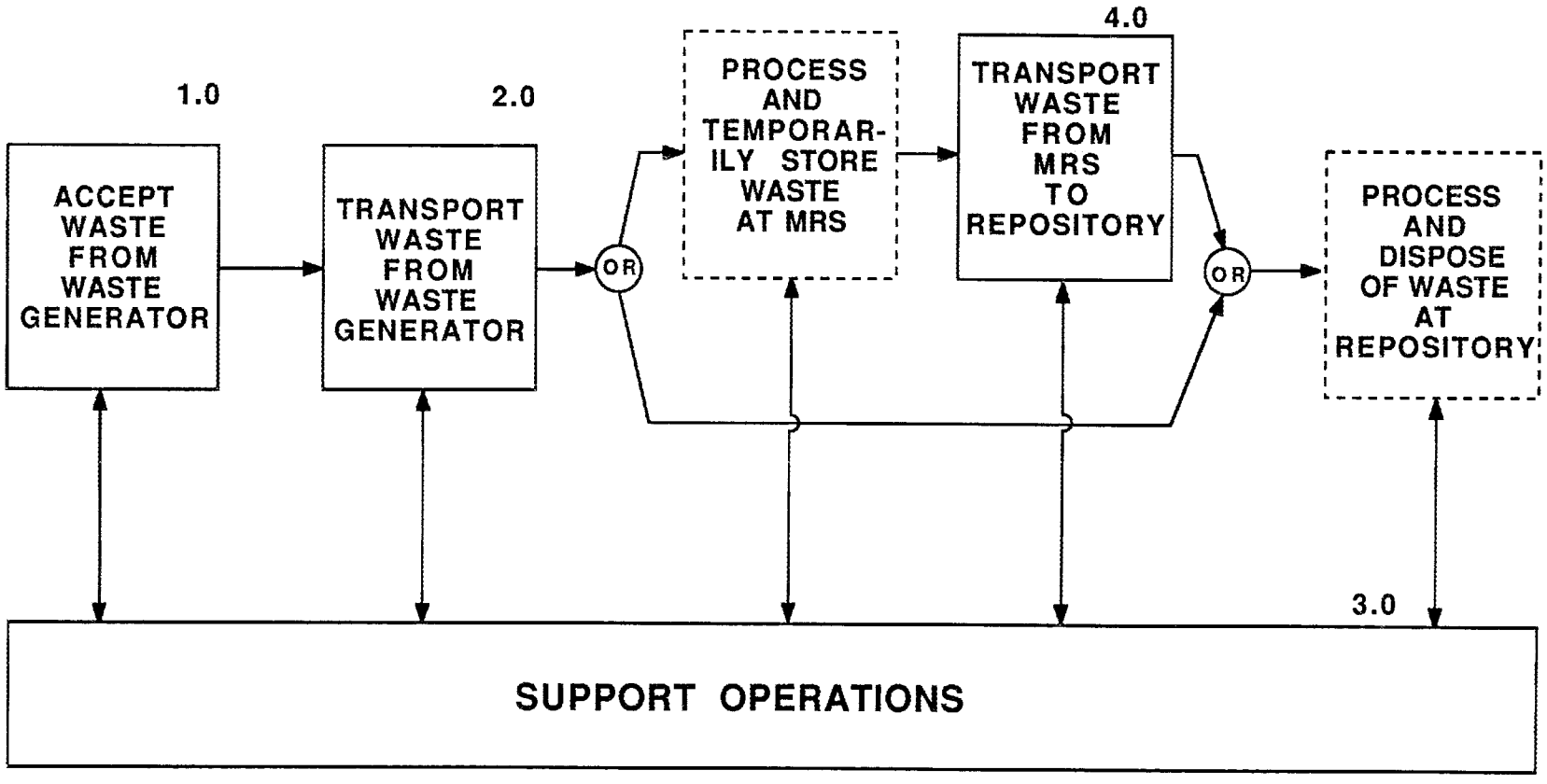

LEVEL I
FUNCTIONAL FLOW
BLOCK DIAGRAM
TRANSPORTATION
OPERATIONS
SYSTEM

1.0

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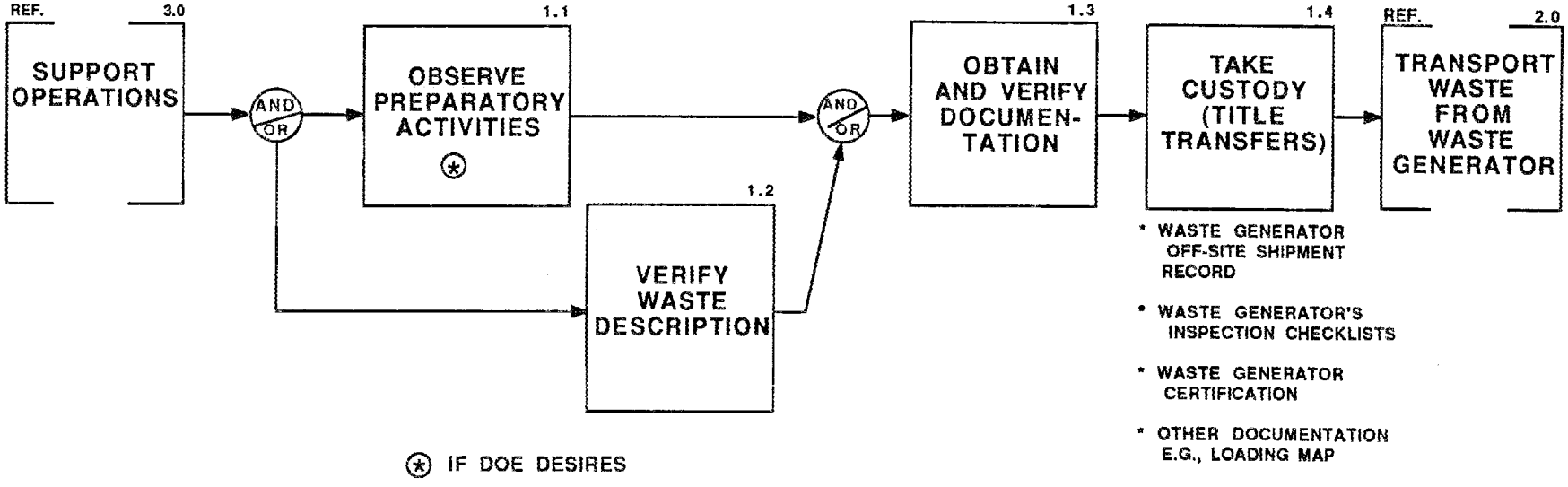

1.0
FUNCTIONAL FLOW
BLOCK DIAGRAM
ACCEPT WASTE
FROM WASTE
GENERATOR

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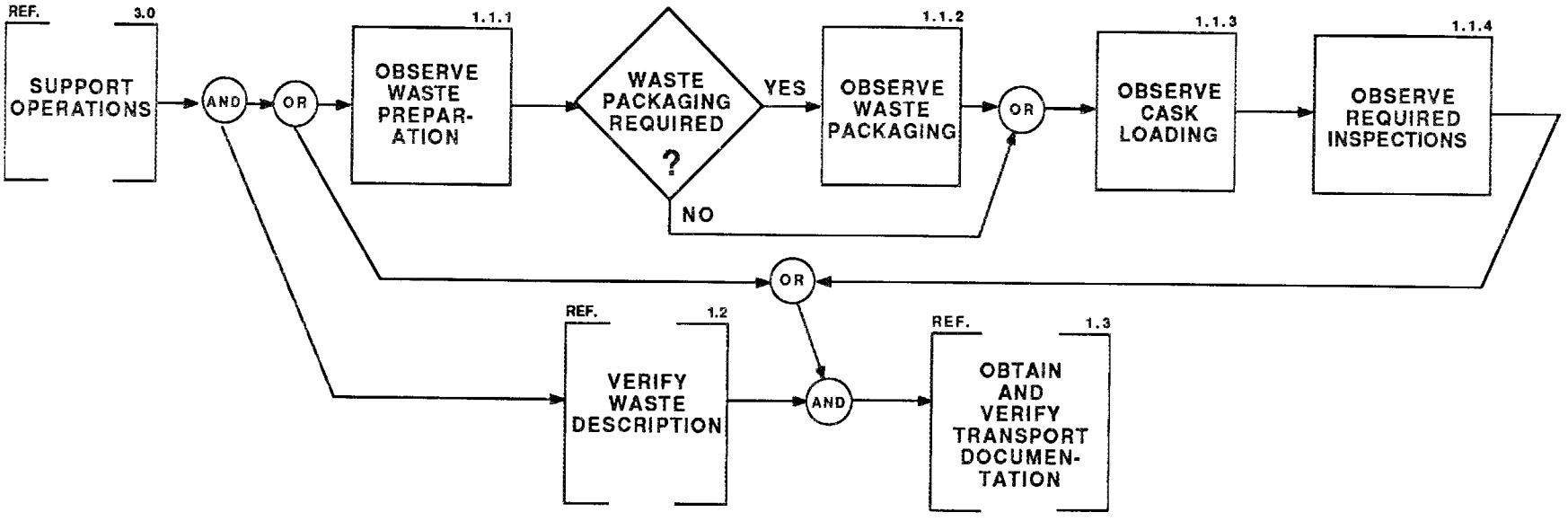

1.1
FUNCTIONAL FLOW BLOCK DIAGRAM
OBSERVE PREPARATORY ACTIVITIES

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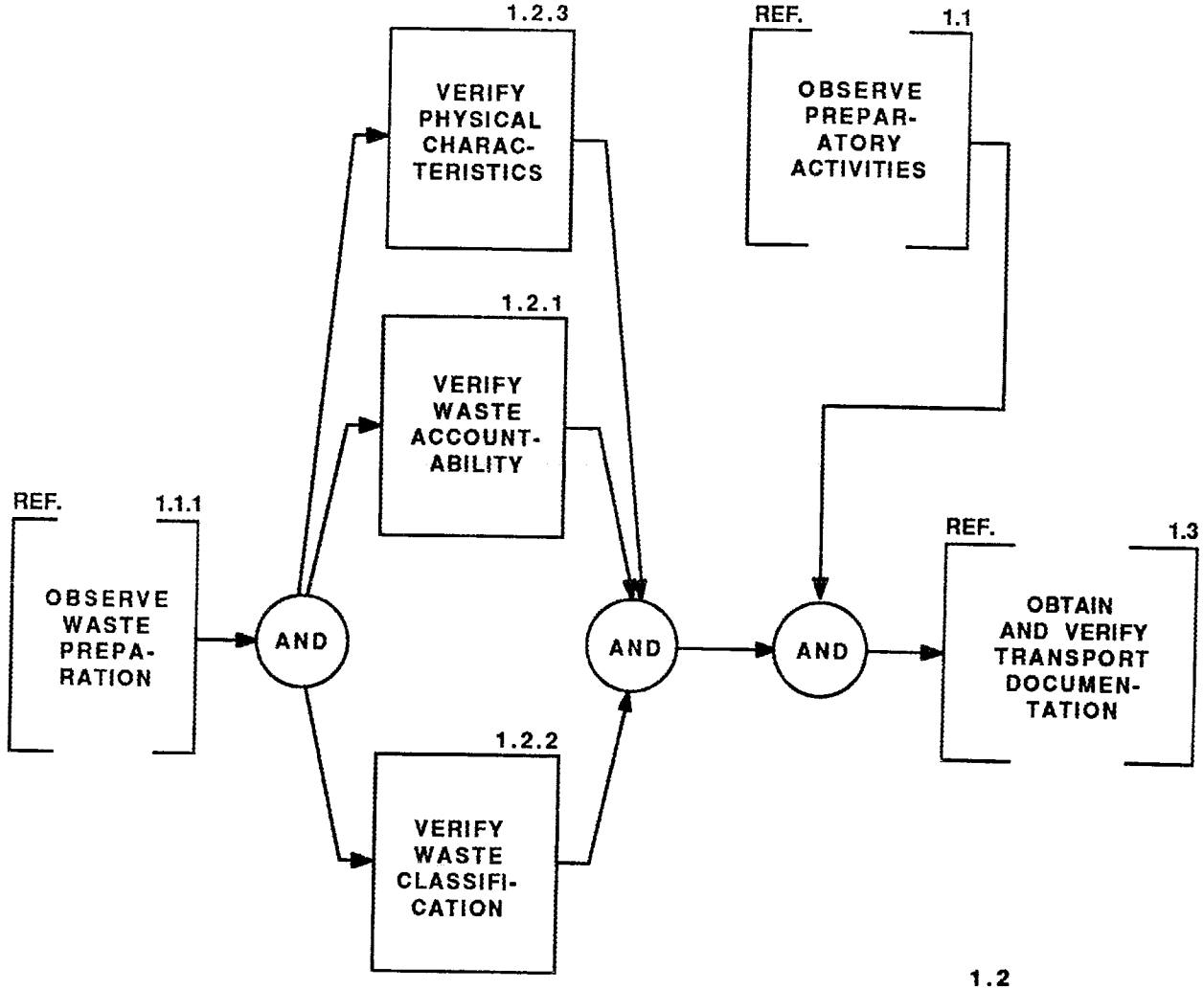
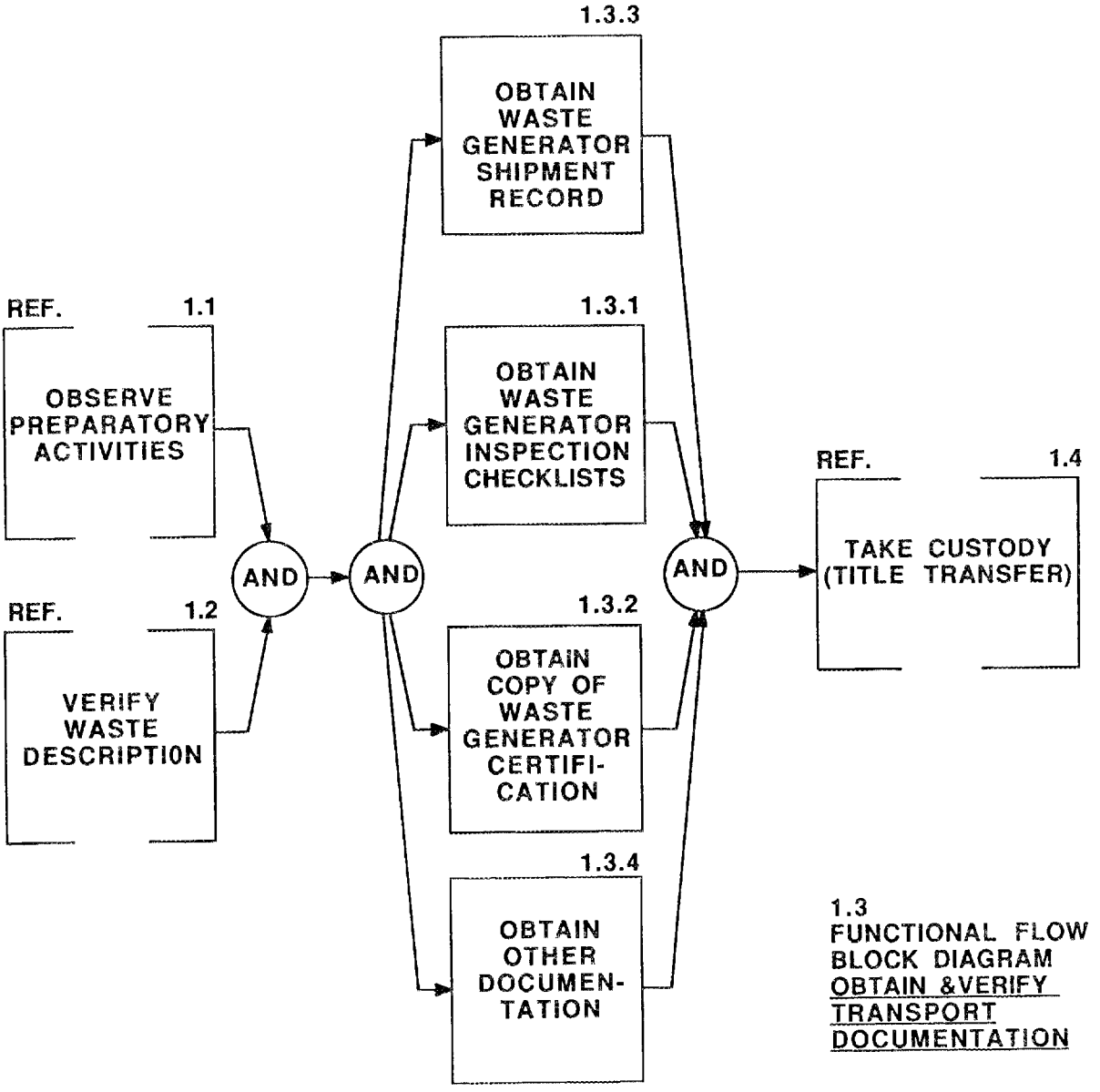


1.2
FUNCTIONAL FLOW
BLOCK DIAGRAM
VERIFY WASTE
DESCRIPTION

ORNL DWG 88-815

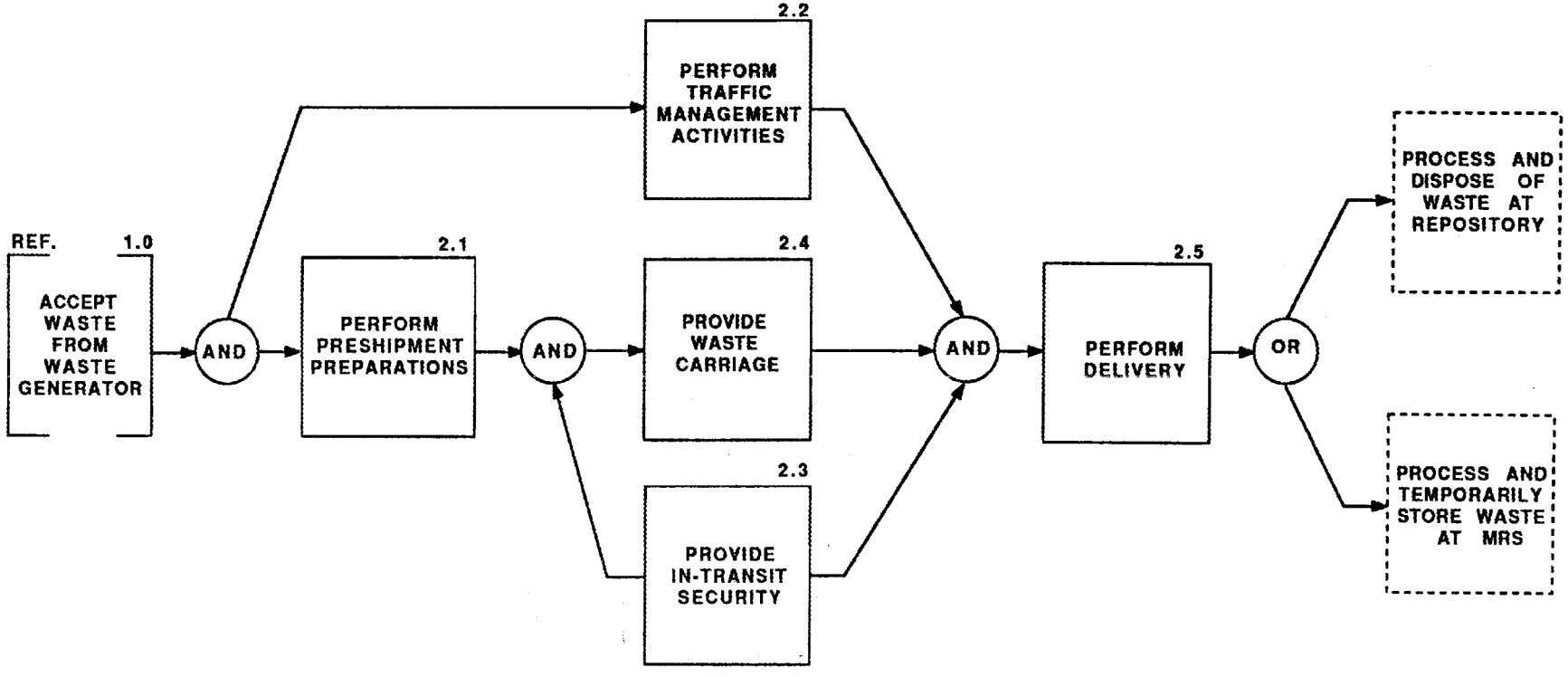


1.3
FUNCTIONAL FLOW
BLOCK DIAGRAM
OBTAIN &VERIFY
TRANSPORT
DOCUMENTATION

1.3
FUNCTIONAL FLOW
BLOCK DIAGRAM
OBTAIN &VERIFY
TRANSPORT
DOCUMENTATION

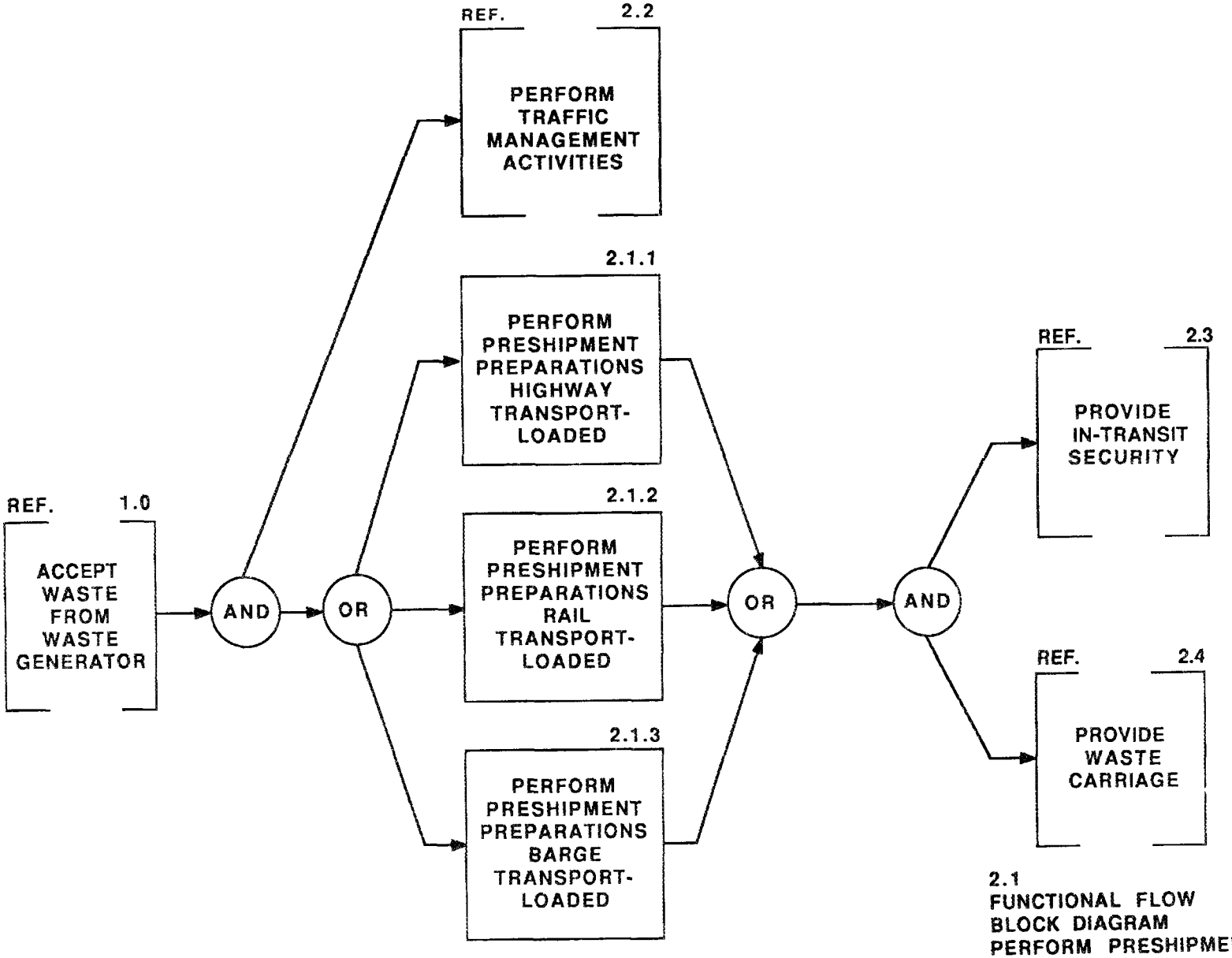
2.0

ORNL DWG 88-804



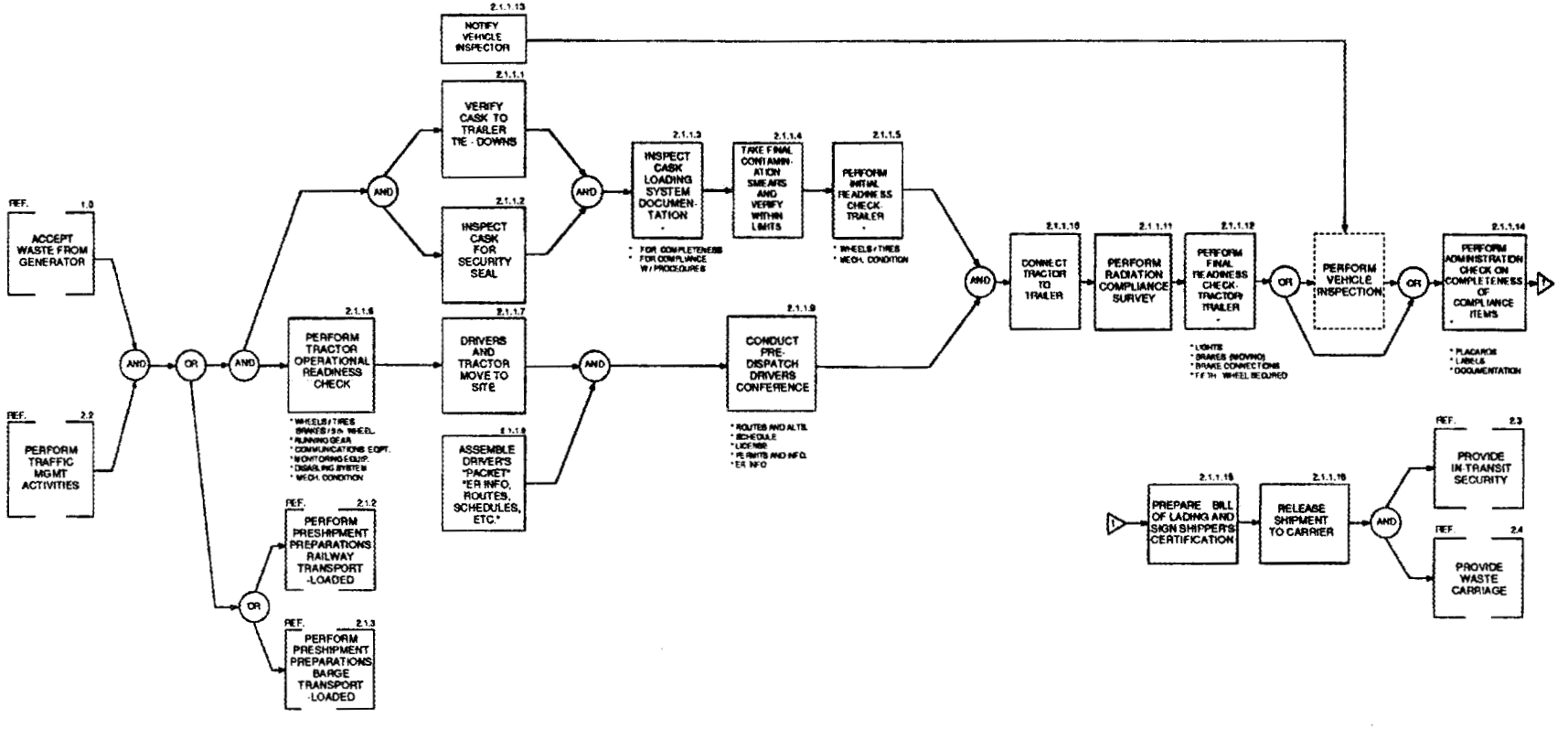
2.0
FUNCTIONAL FLOW
BLOCK DIAGRAM
TRANSPORT WASTE
FROM WASTE GENERATOR

ORNL DWG 88-816



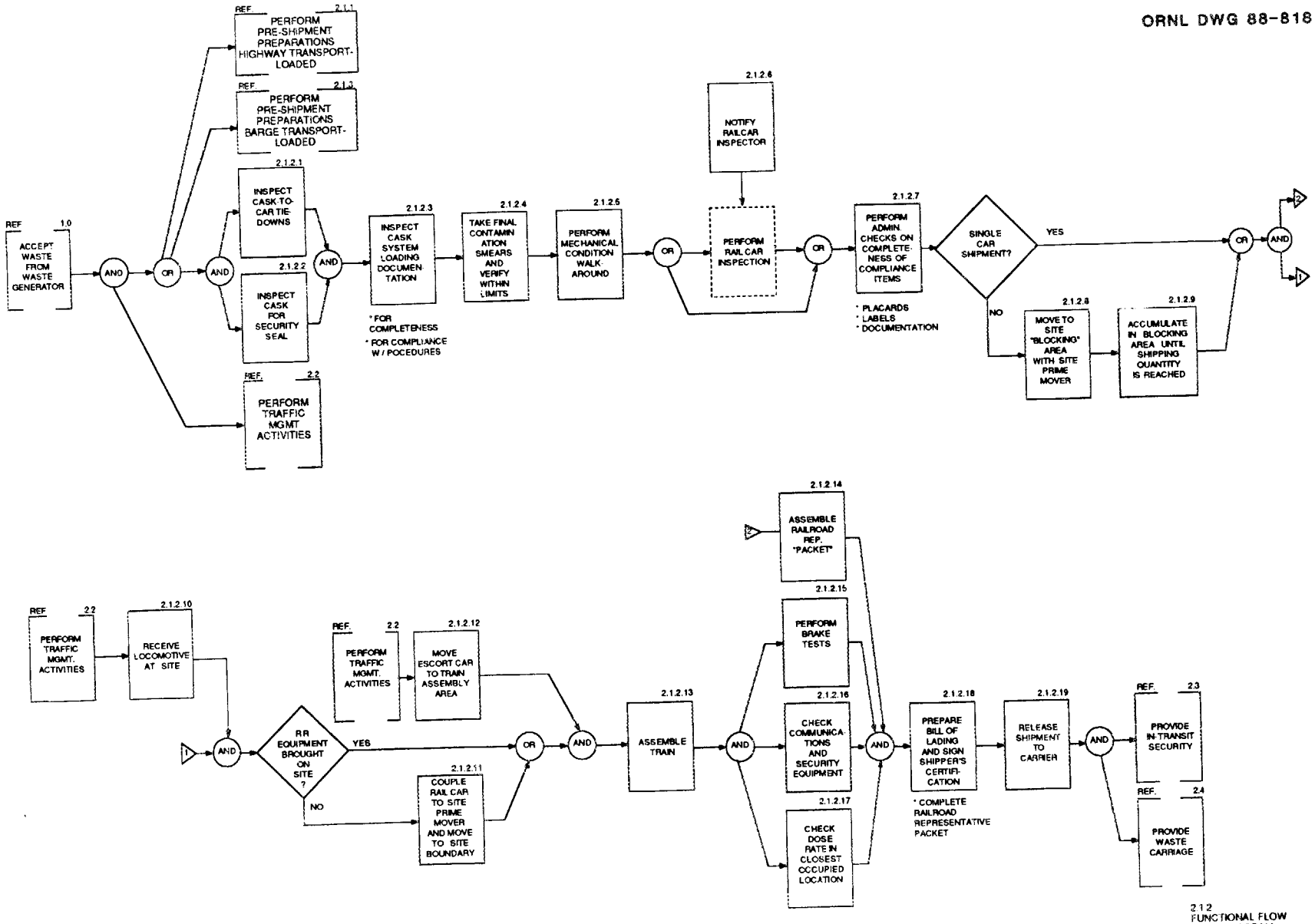
2.1
FUNCTIONAL FLOW BLOCK DIAGRAM
PERFORM PRESHIPMENT PREPARATIONS-LOADED

ORNL DWG 88-817



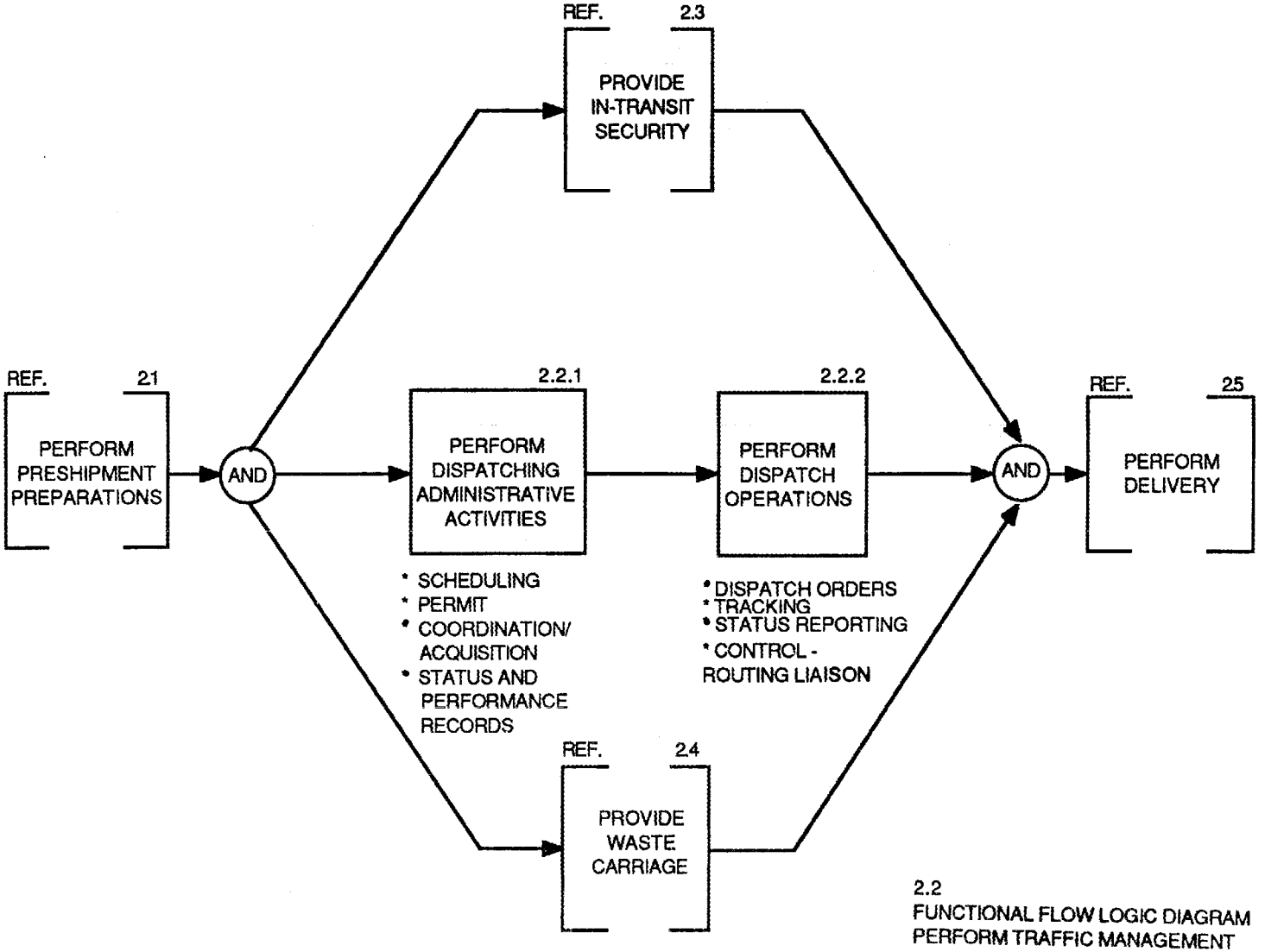
2.1.1
FUNCTIONAL FLOW BLOCK DIAGRAM
PERFORM PRESHIPMENT PREPARATIONS HIGHWAY TRANSPORT-LOADED

ORNL DWG 88-818



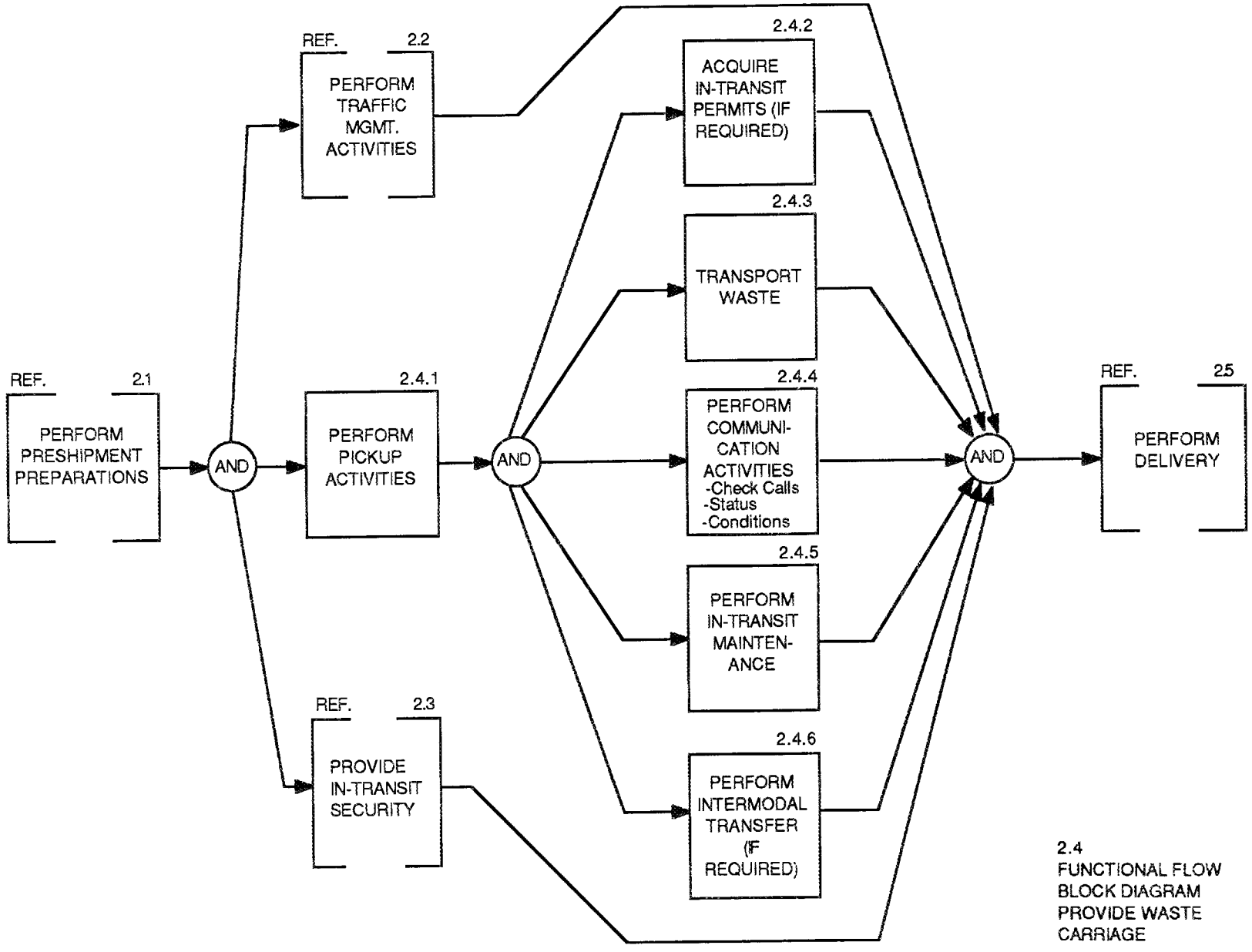
2.1.2
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM PRE-SHIPMENT
PREPARATIONS RAILROAD
TRANSPORT-LOADED

ORNL DWG 88-819



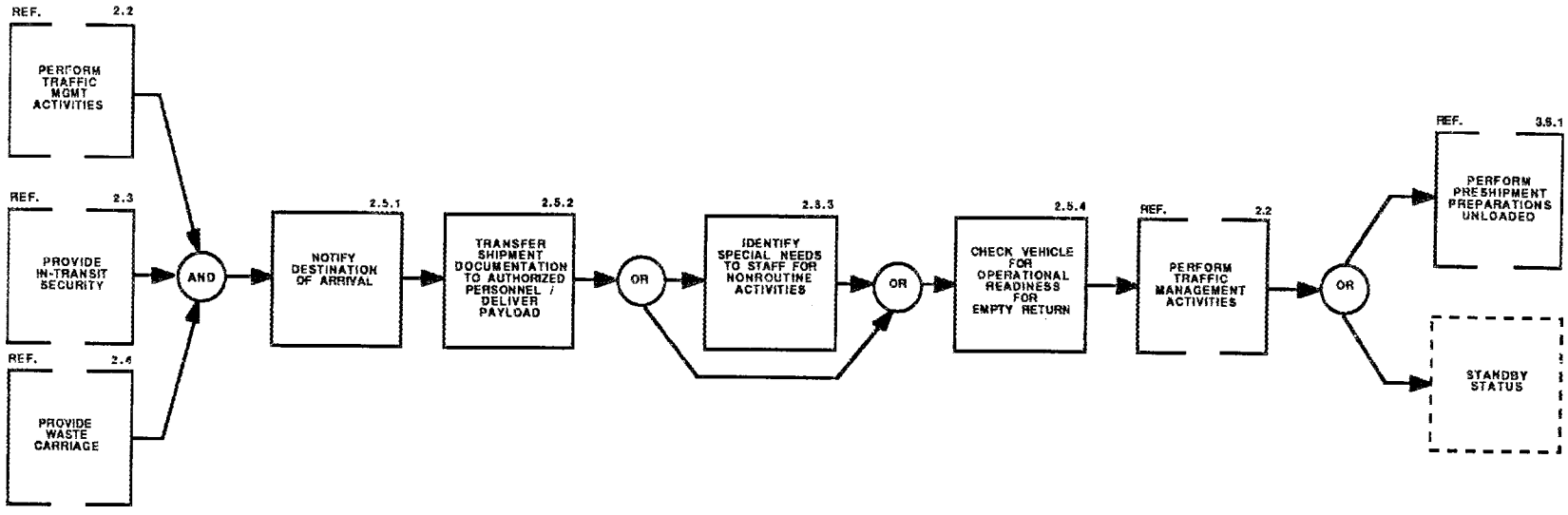
2.2
FUNCTIONAL FLOW LOGIC DIAGRAM
PERFORM TRAFFIC MANAGEMENT
ACTIVITIES (LOADED)

ORNL DWG 88-820



2.4
FUNCTIONAL FLOW
BLOCK DIAGRAM
PROVIDE WASTE
CARRIAGE

ORNL DWG 88-821

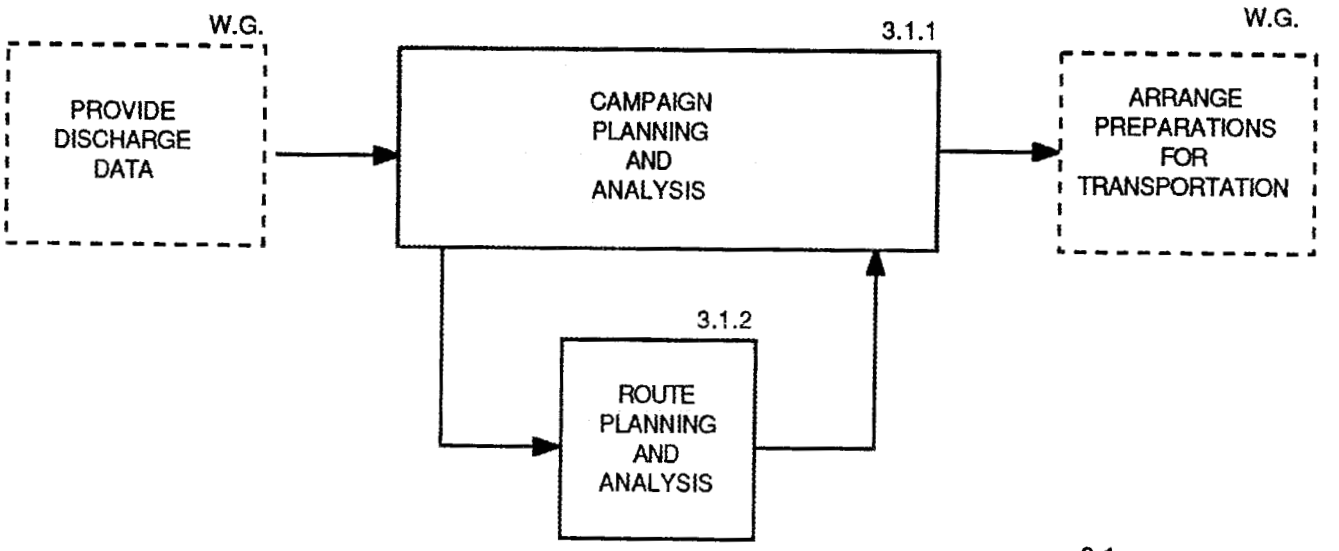


2.5
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM DELIVERY

3.0

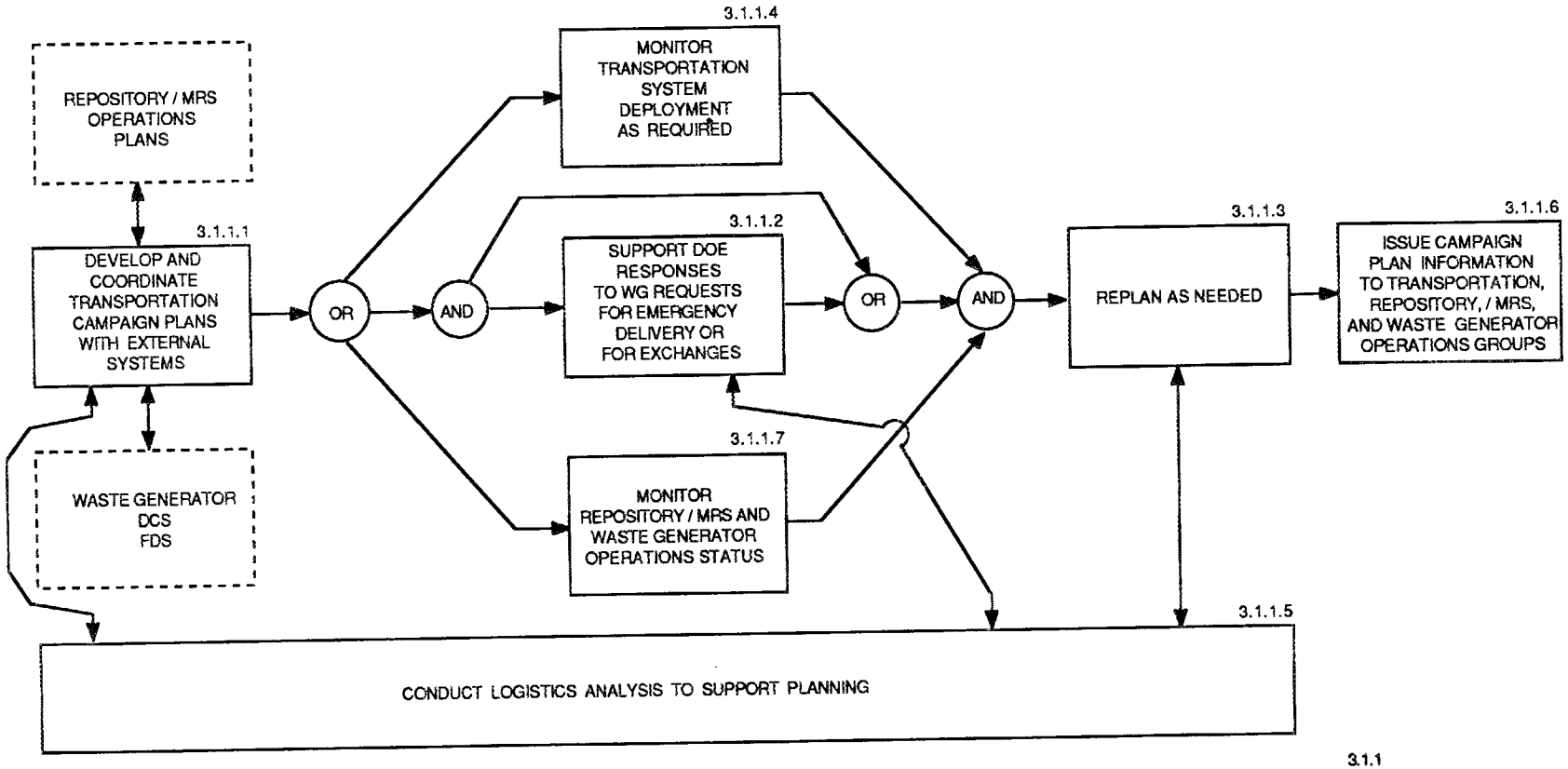
3.1

ORNL DWG 88-805



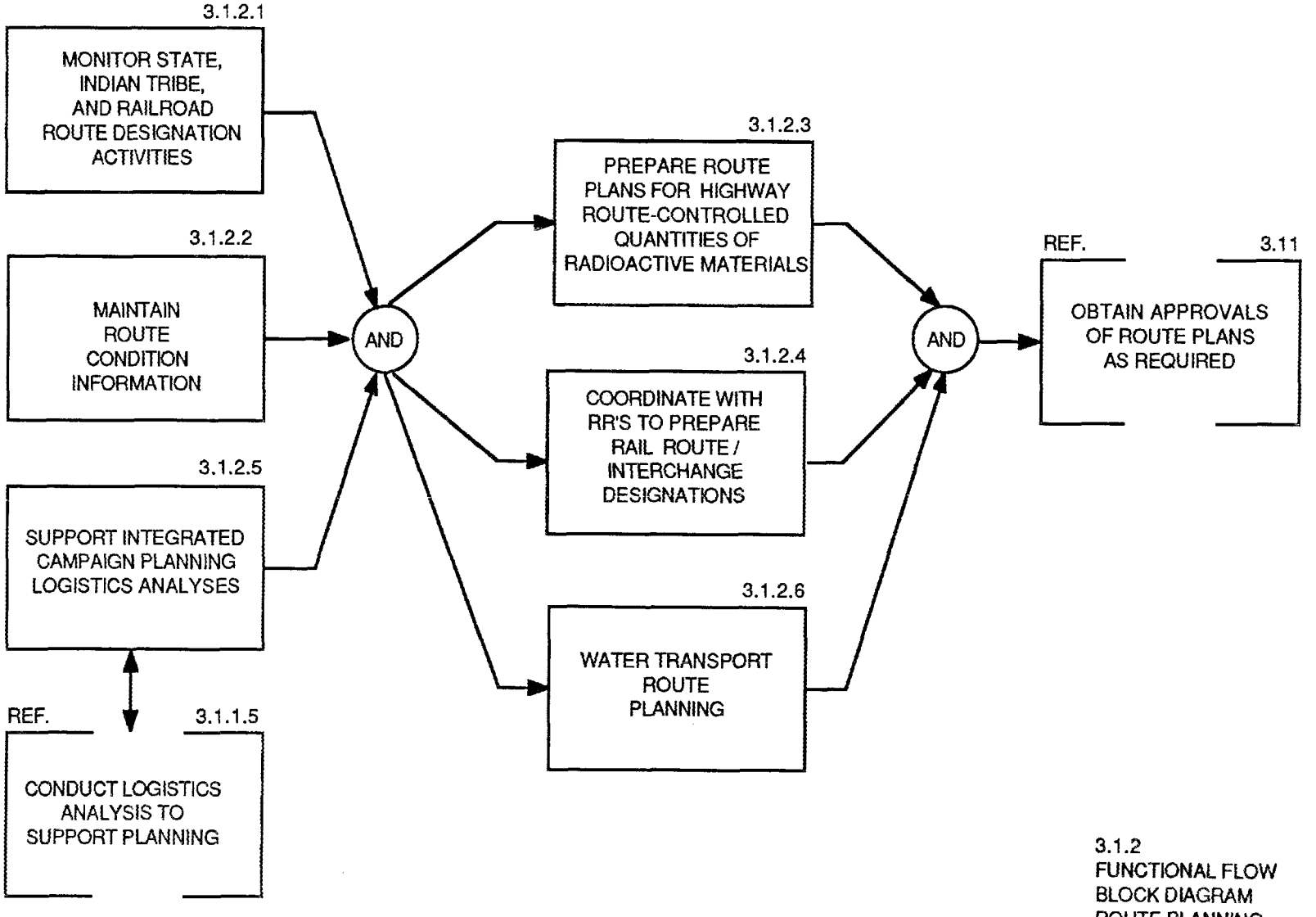
3.1
FUNCTIONAL FLOW
BLOCK DIAGRAM
TRAFFIC PLANNING

ORNL DWG 88-822



3.1.1
FUNCTIONAL FLOW
BLOCK DIAGRAM
INTEGRATED CAMPAIGN
PLANNING AND ANALYSIS

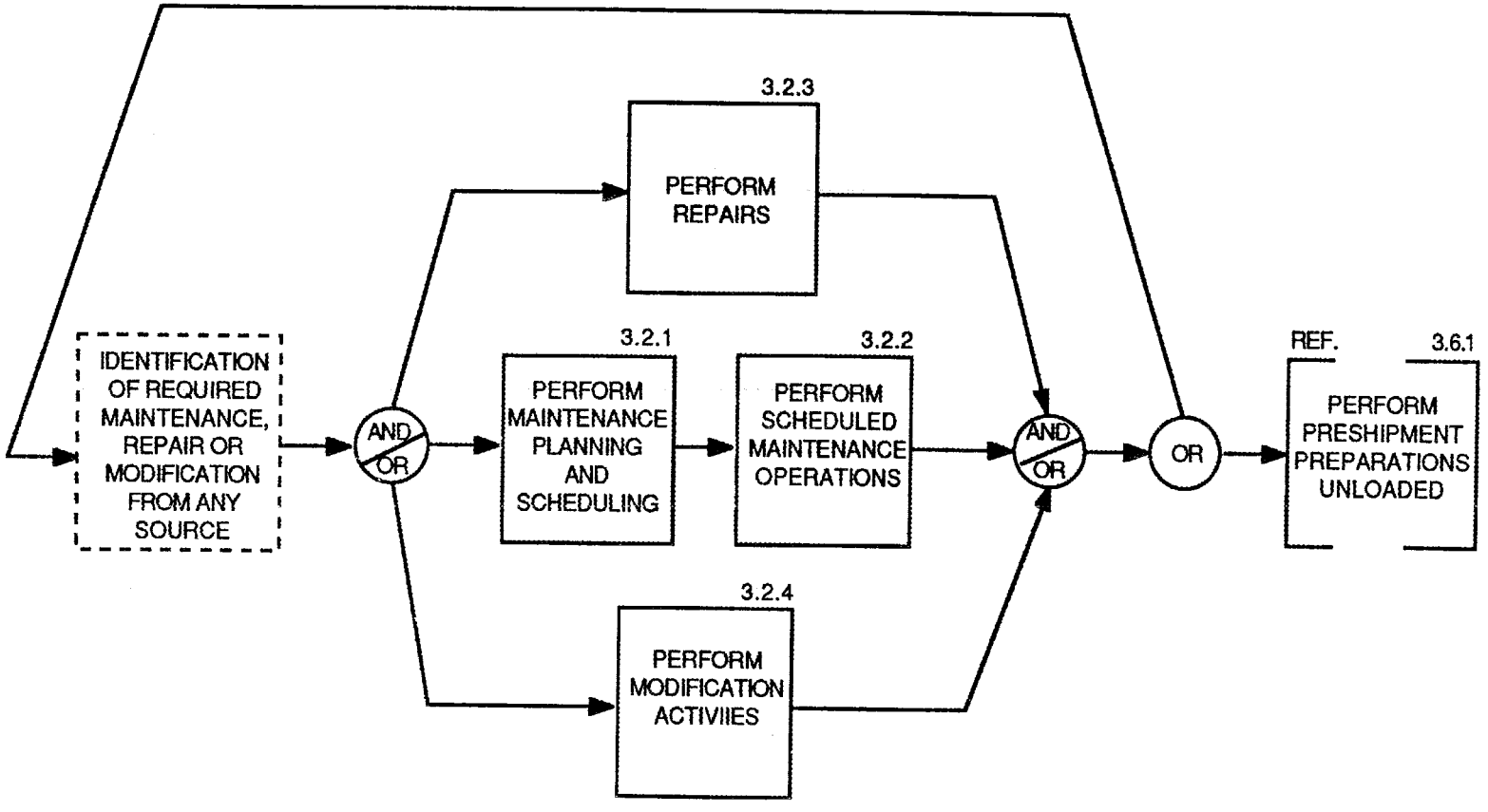
ORNL DWG 88-823



3.1.2
FUNCTIONAL FLOW BLOCK DIAGRAM ROUTE PLANNING AND ANALYSIS

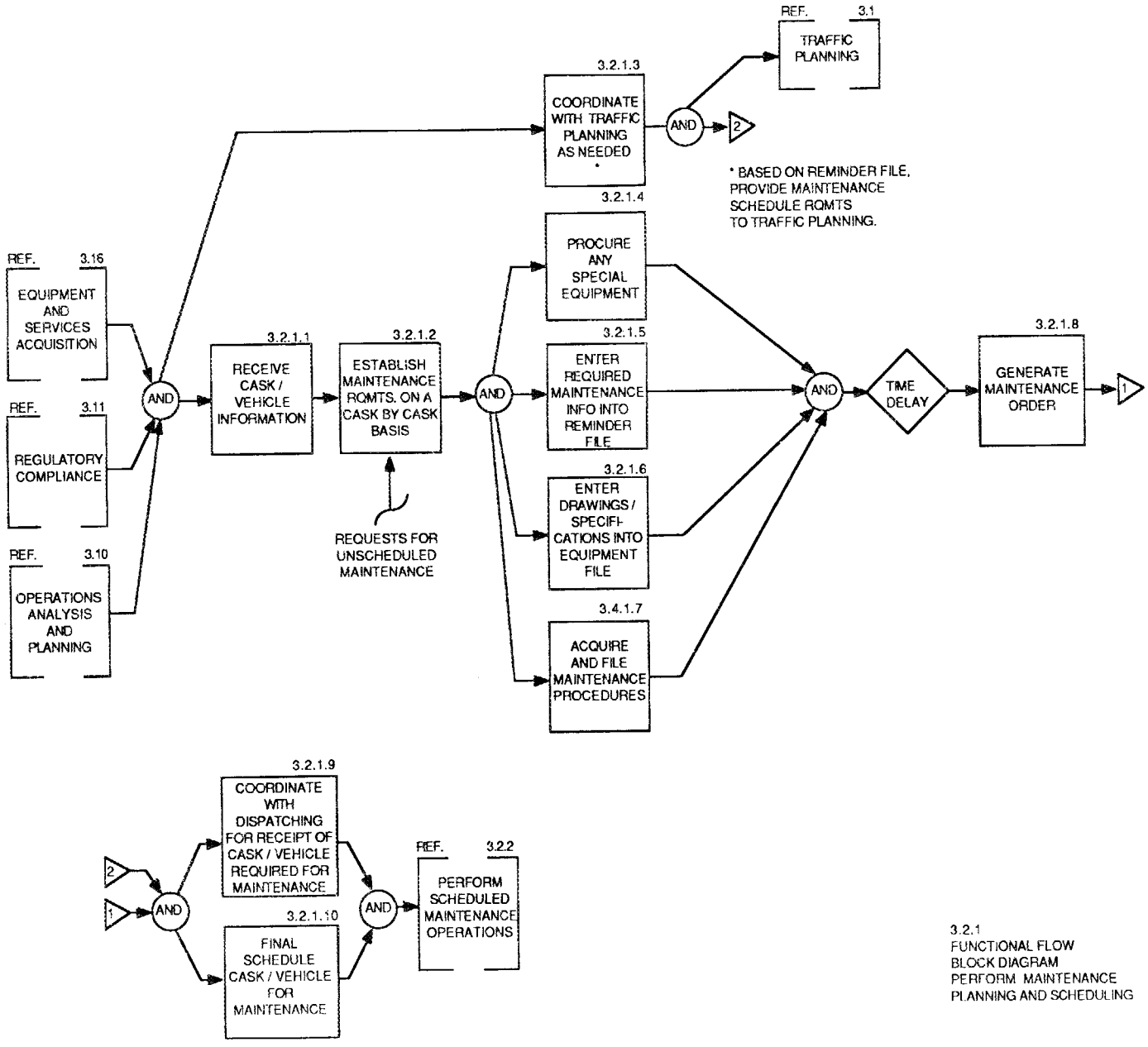
3.2

ORNL DWG 88-806



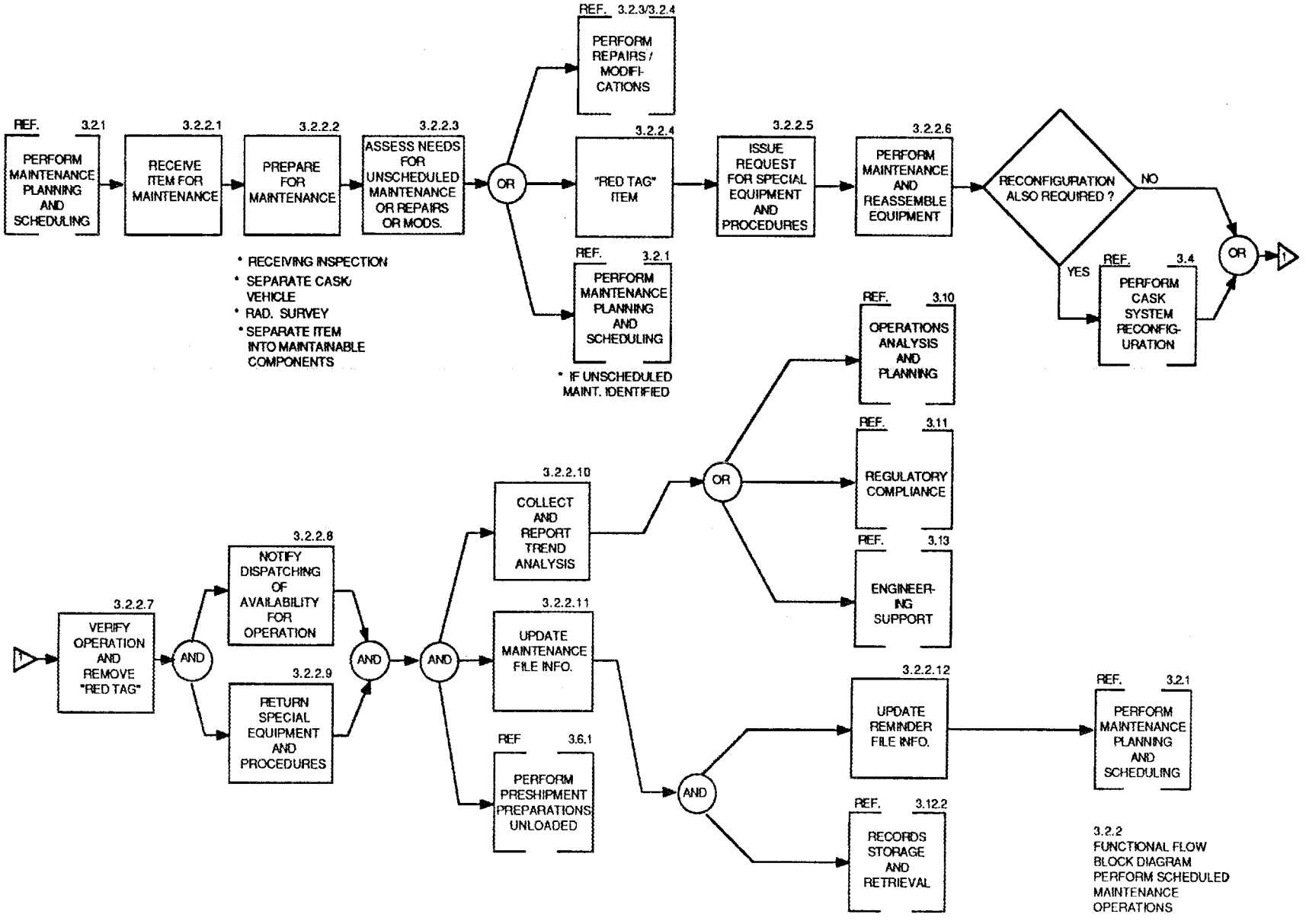
3.2
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM MAINTENANCE
ACTIVITIES

ORNL DWG 88-824



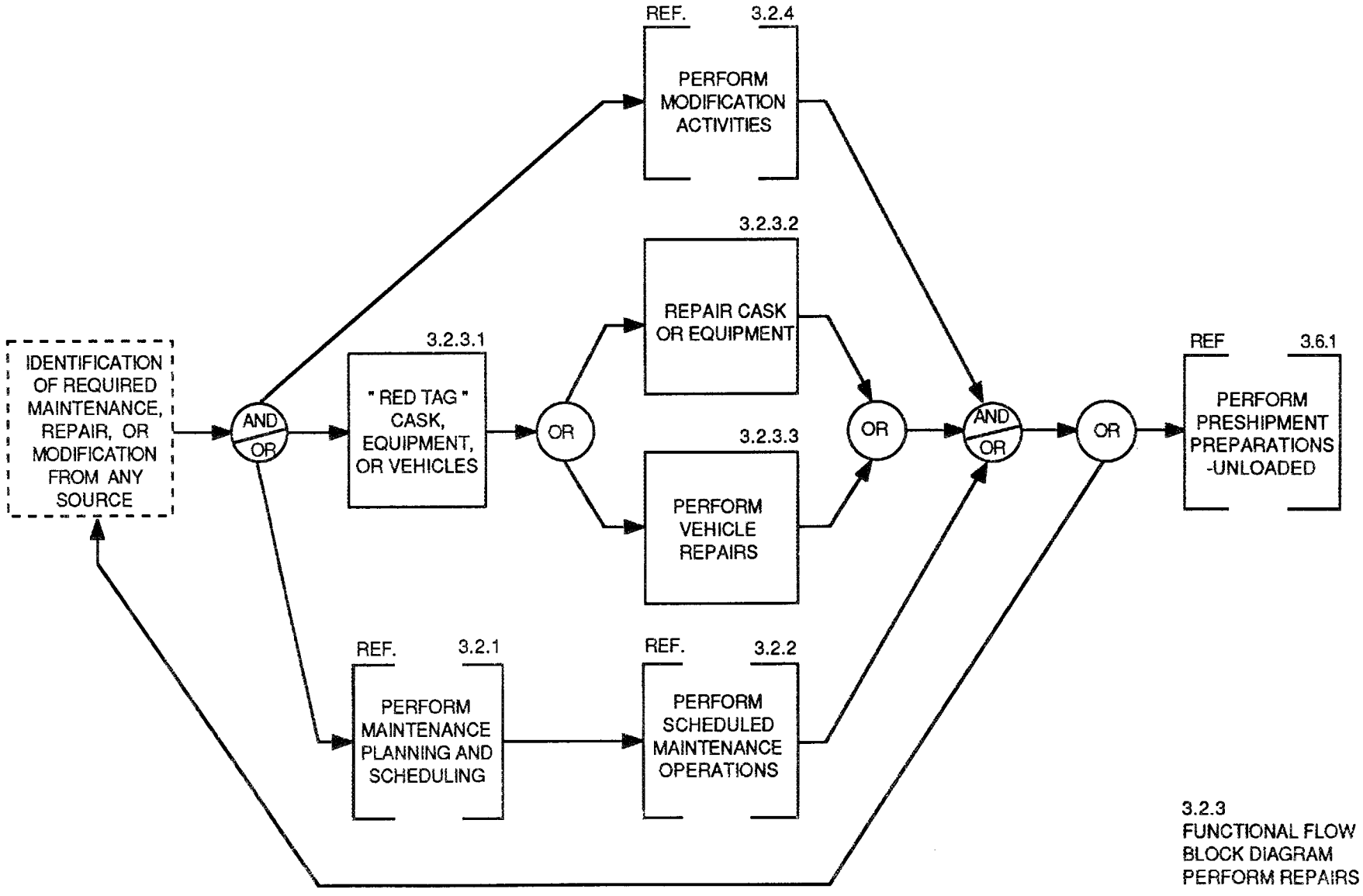
3.2.1
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM MAINTENANCE
PLANNING AND SCHEDULING

ORNL DWG 88-825



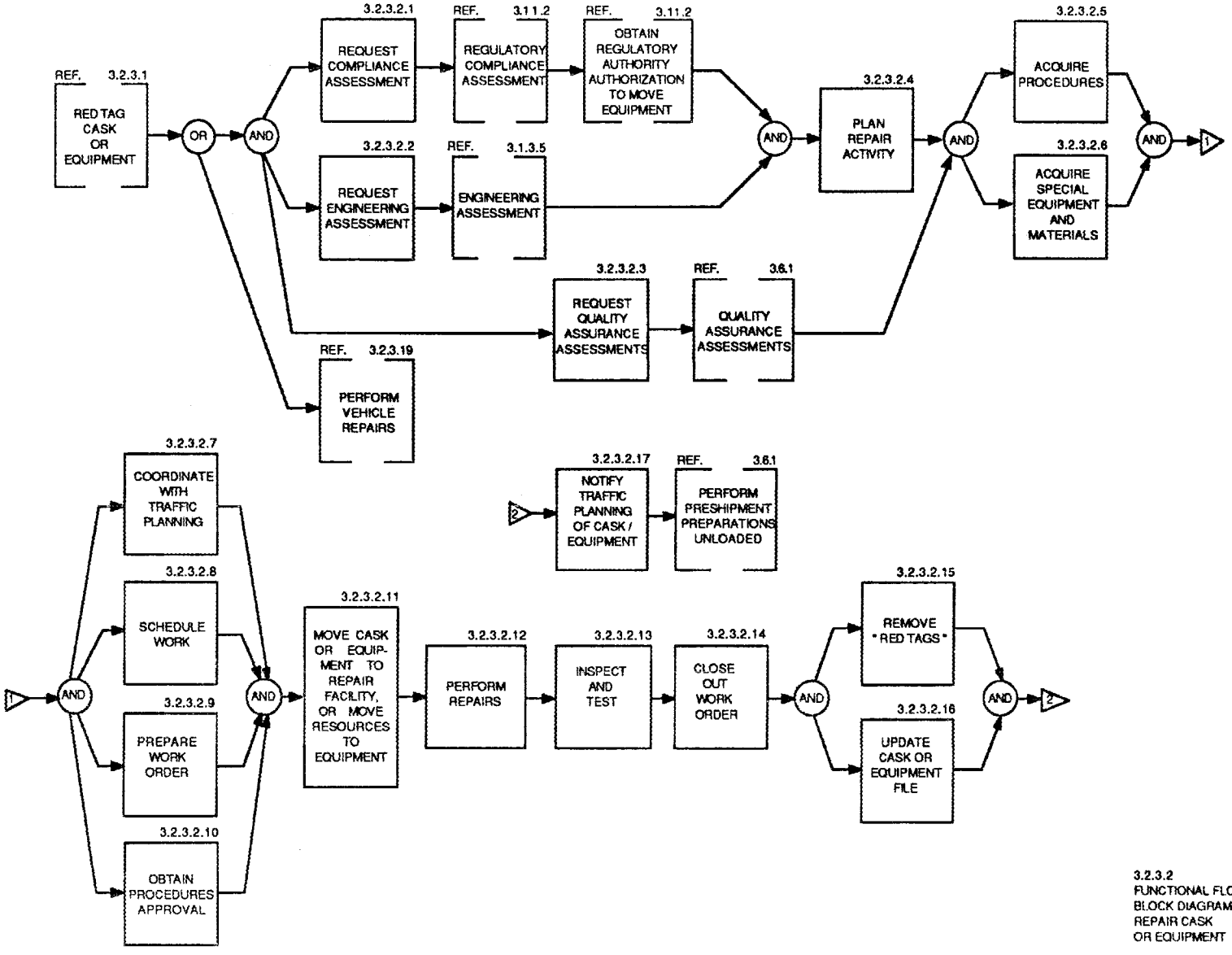
3.2.2
FUNCTIONAL FLOW BLOCK DIAGRAM
PERFORM SCHEDULED MAINTENANCE OPERATIONS

ORNL DWG 88-826



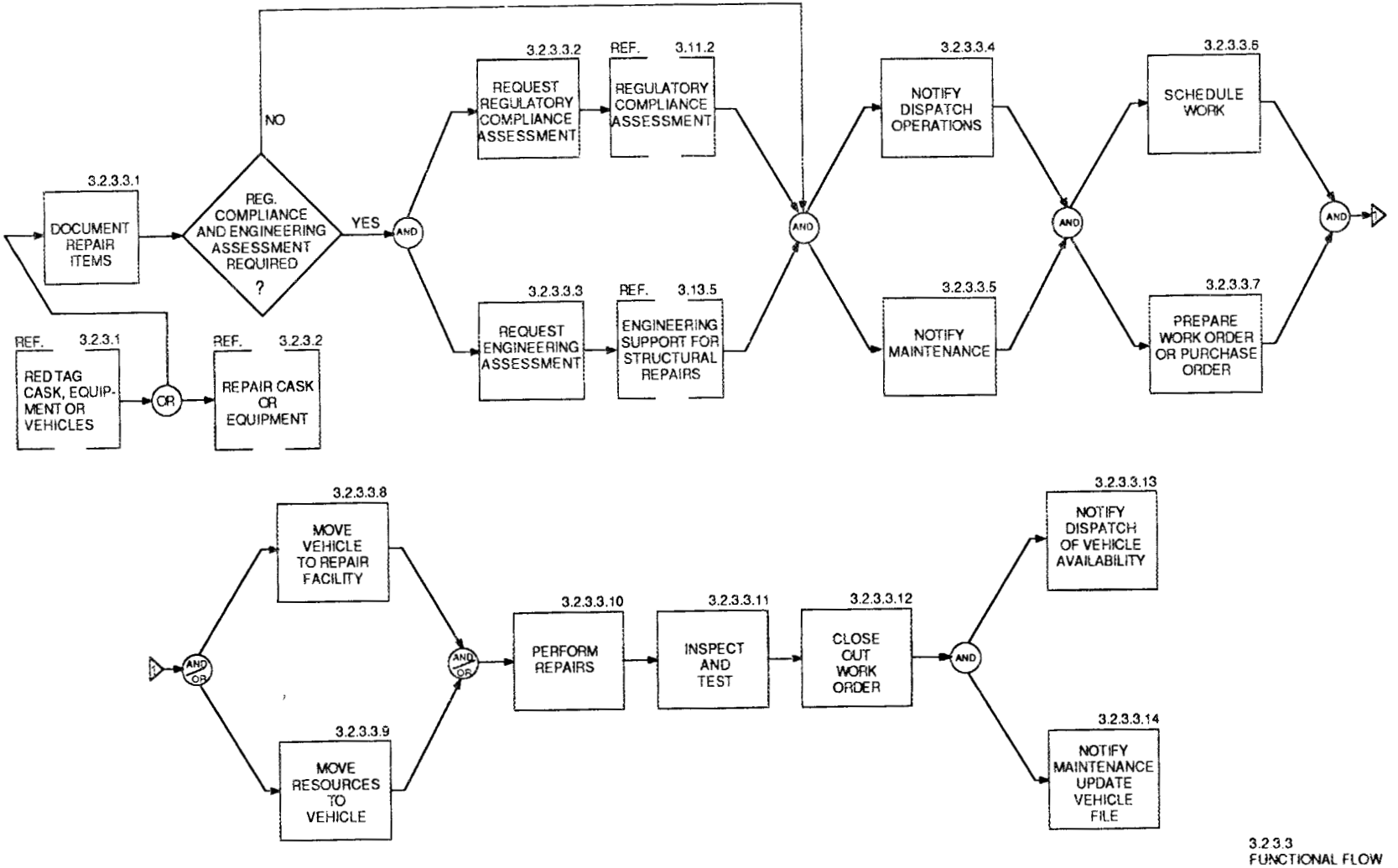
3.2.3
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM REPAIRS

ORNL DWG 88-827



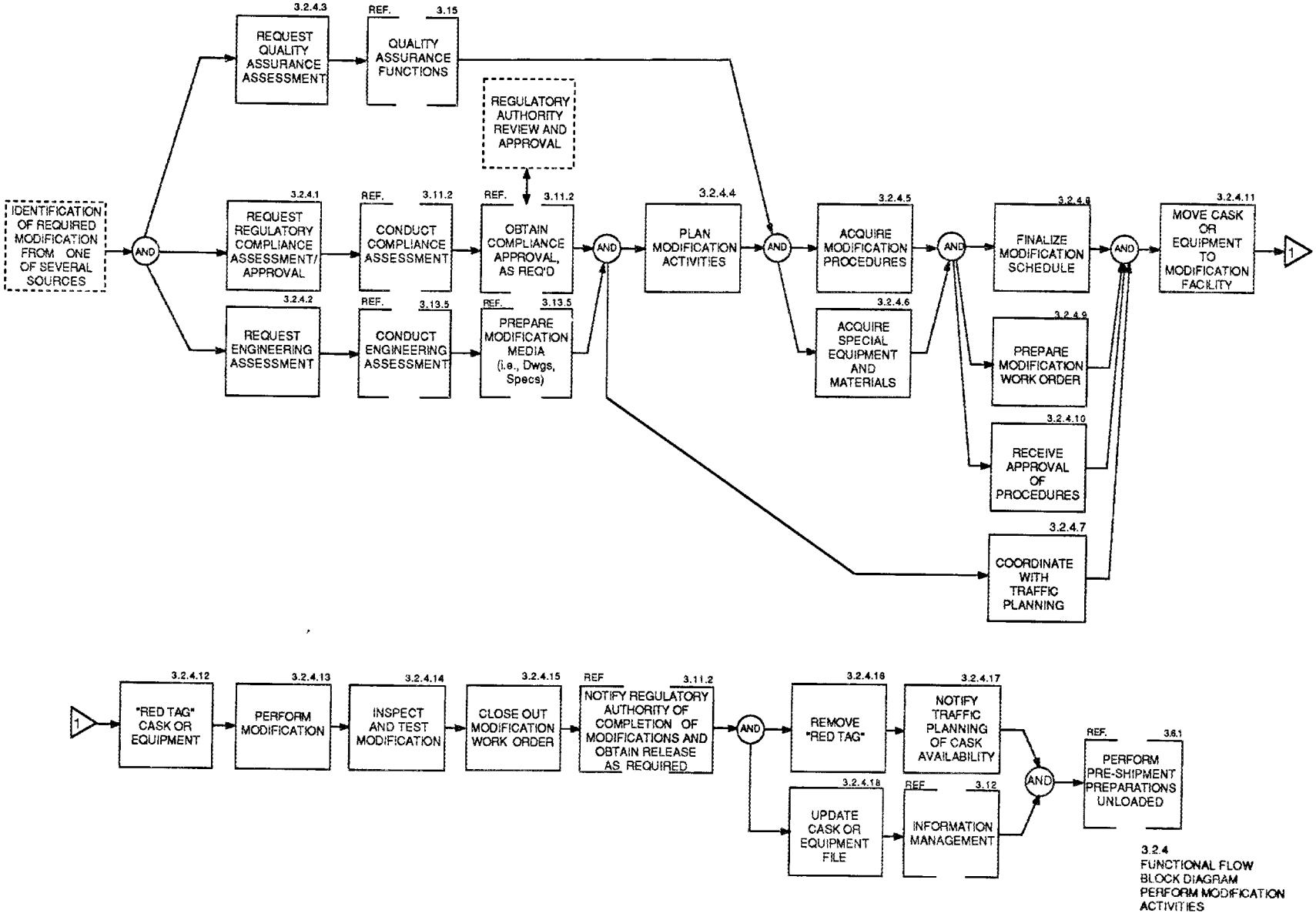
3.2.3.2
FUNCTIONAL FLOW
BLOCK DIAGRAM
REPAIR CASK
OR EQUIPMENT

ORNL DWG 88-828



3.2.3.3
FUNCTIONAL FLOW BLOCK DIAGRAM
PERFORM VEHICLE REPAIRS

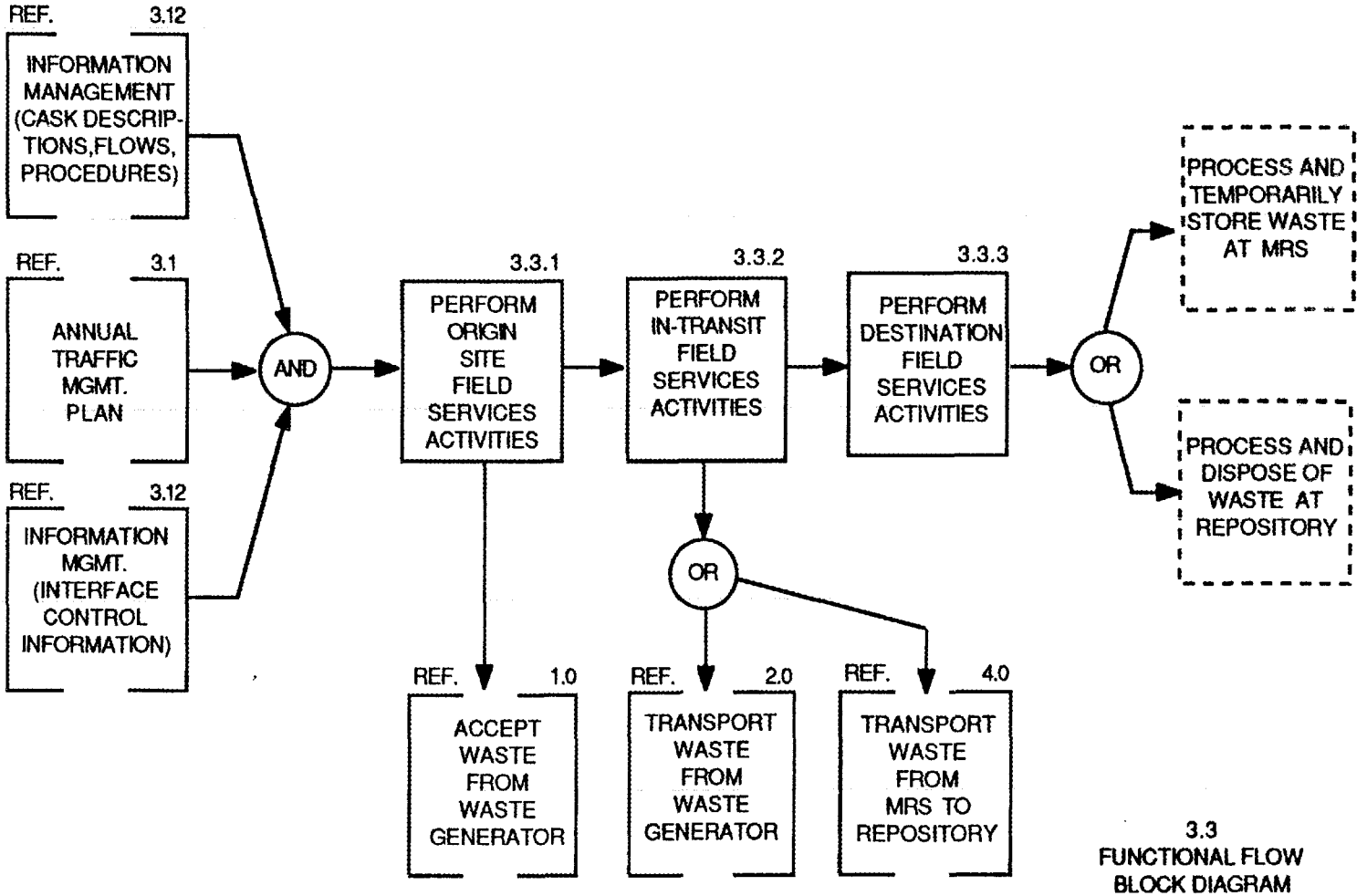
ORNL DWG 88-829



3.2.4
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM MODIFICATION
ACTIVITIES

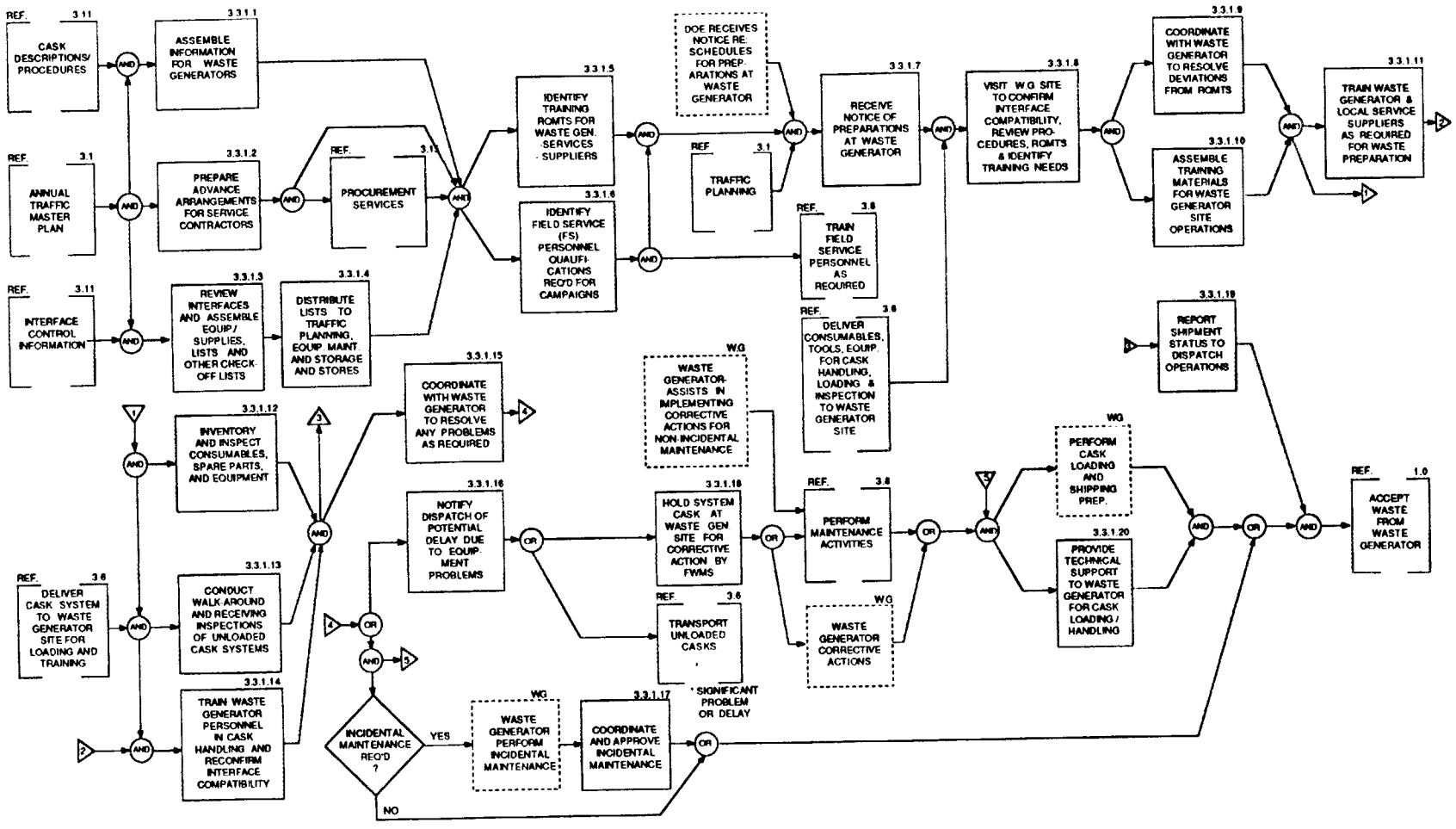
3.3

ORNL DWG 88-807



3.3
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM FIELD
SERVICES

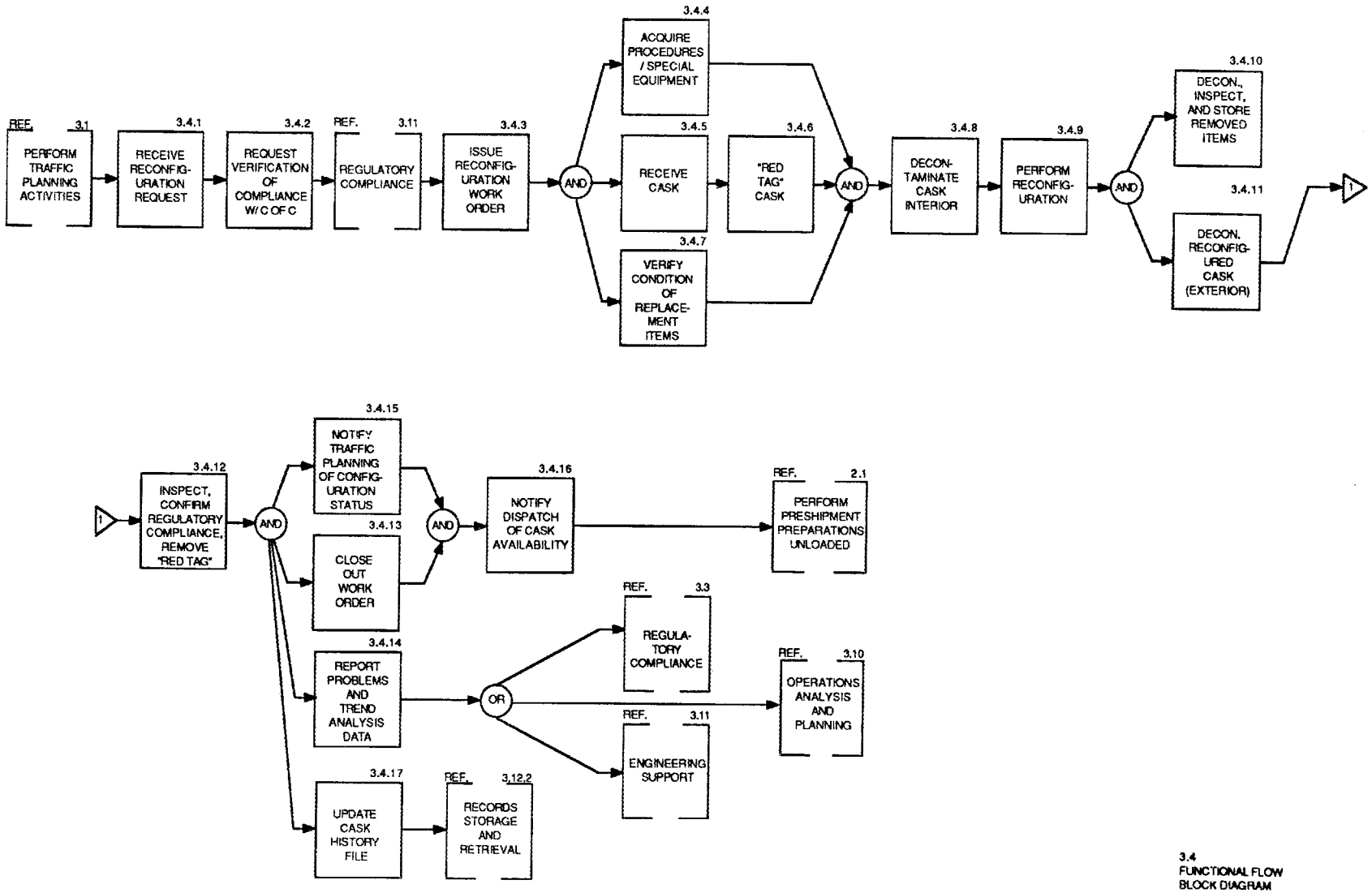
ORNL DWG 88-830



3.3.1
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM ORIGIN SITE FIELD
SERVICES ACTIVITIES

3.4

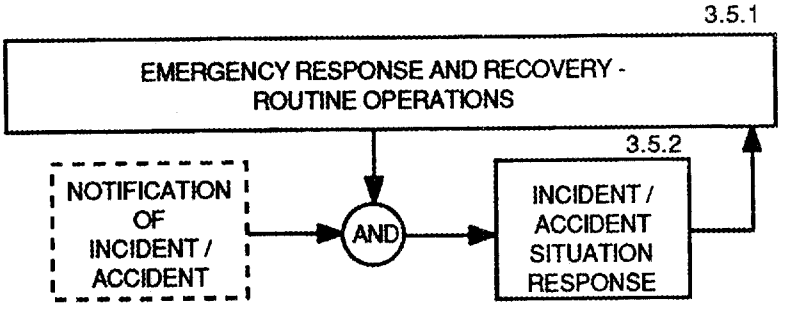
ORNL DWG 88-808



3.4
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM CASK SYSTEM
RECONFIGURATION

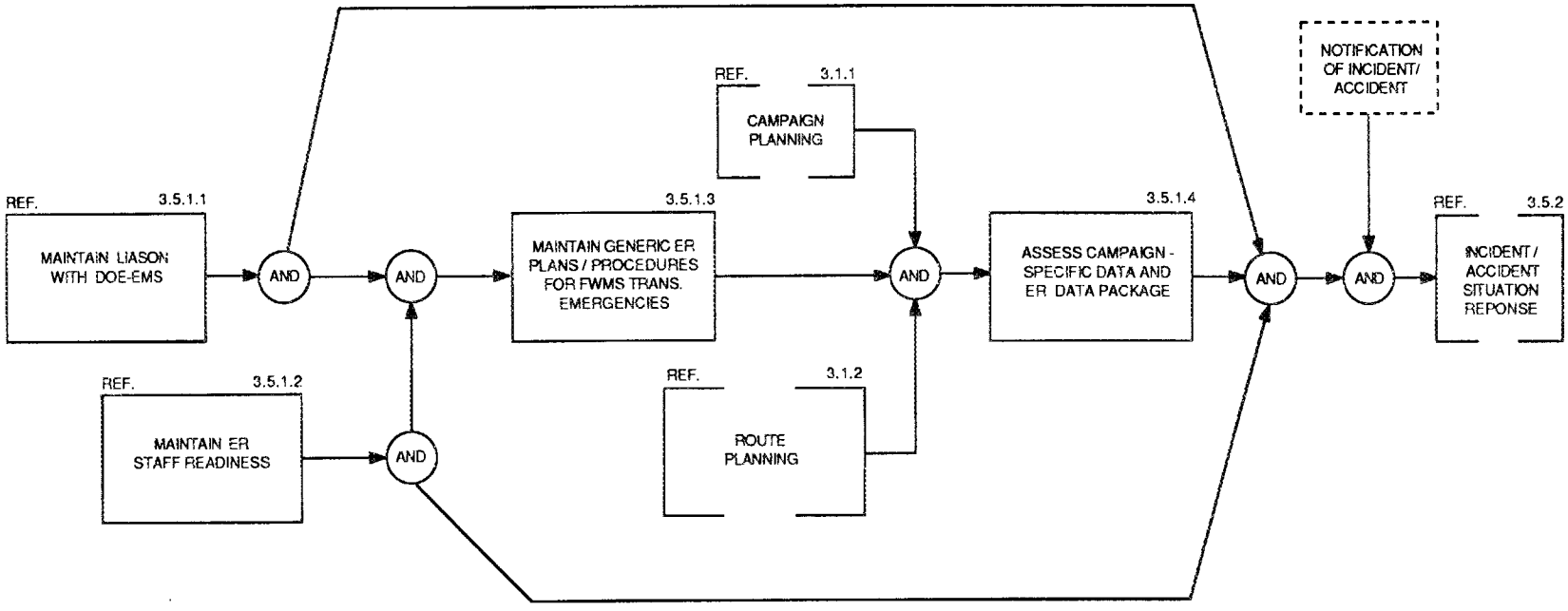
3.5

ORNL DWG 88-809



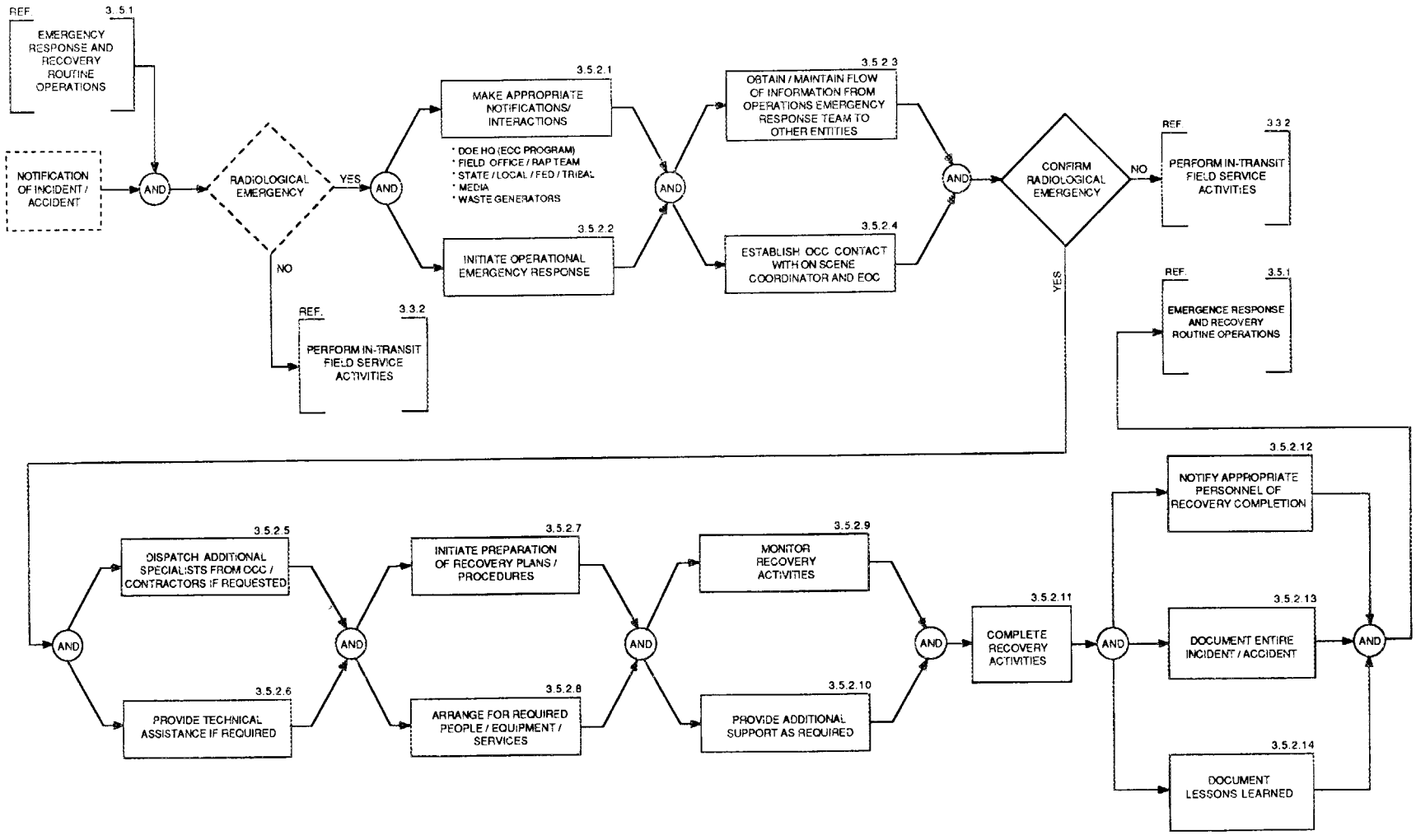
3.5
FUNCTIONAL FLOW
BLOCK DIAGRAM -
EMERGENCY RESPONSE
AND RECOVERY

ORNL DWG 88-831



3.5.1
FUNCTIONAL FLOW
BLOCK DIAGRAM-
EMERGENCY RESPONSE
AND RECOVERY-
ROUTINE OPERATION

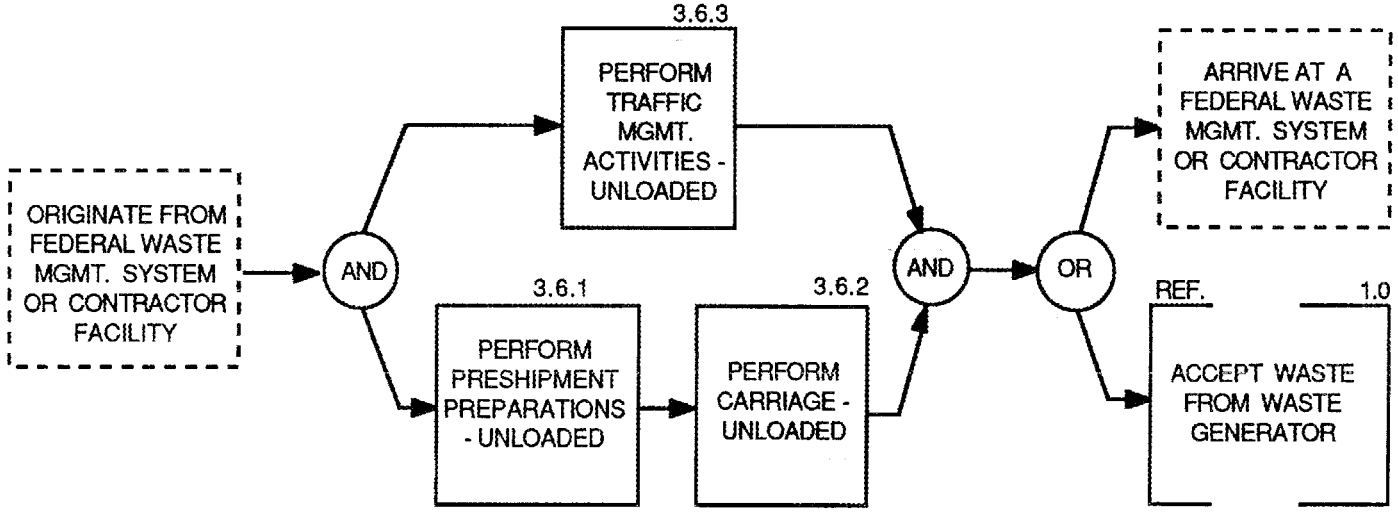
ORNL DWG 88-832



3.5.2
FUNCTIONAL FLOW
BLOCK DIAGRAM-
INCIDENT / ACCIDENT
SITUATION RESPONSE

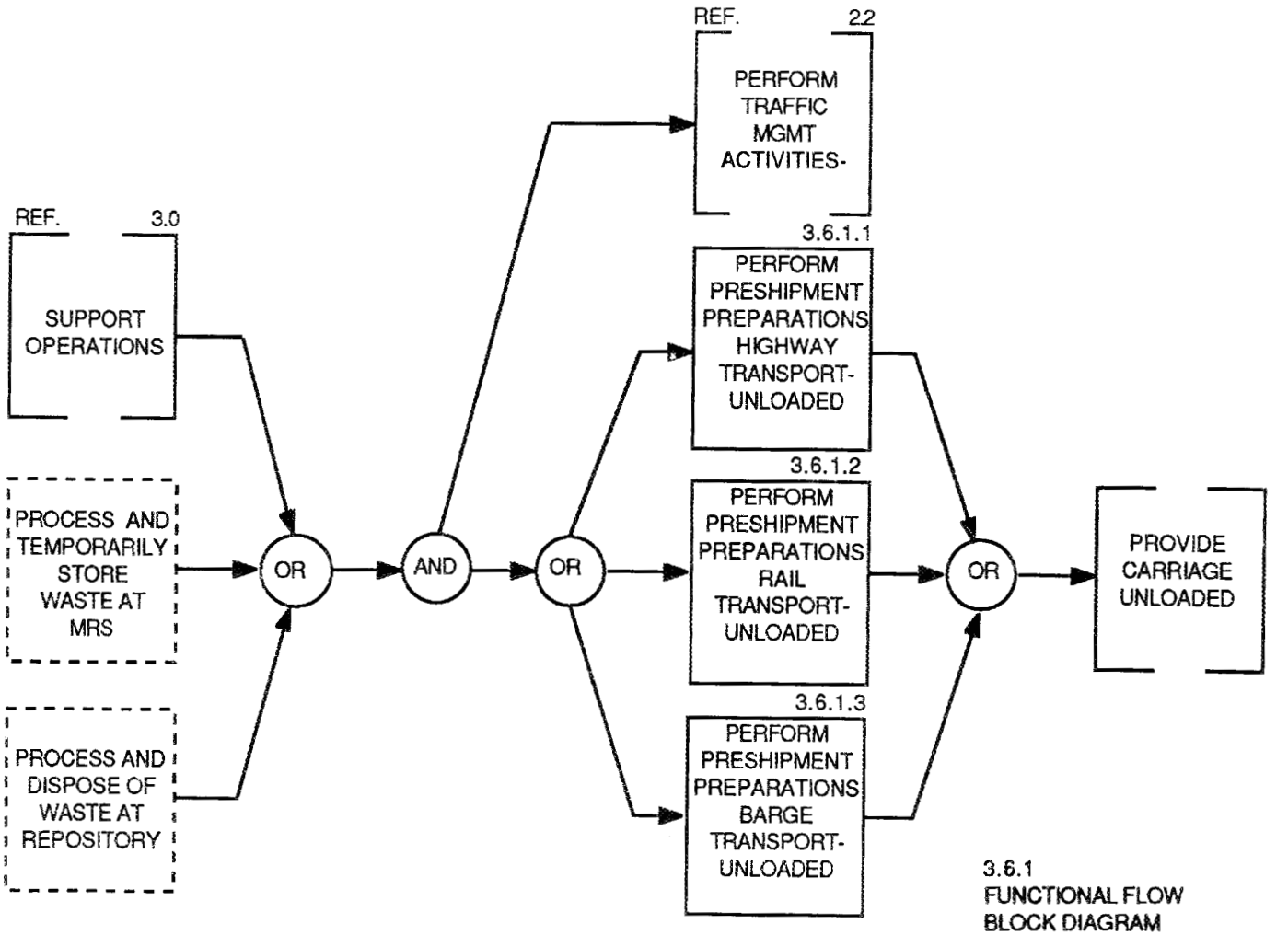
3.6

ORNL DWG 88-810



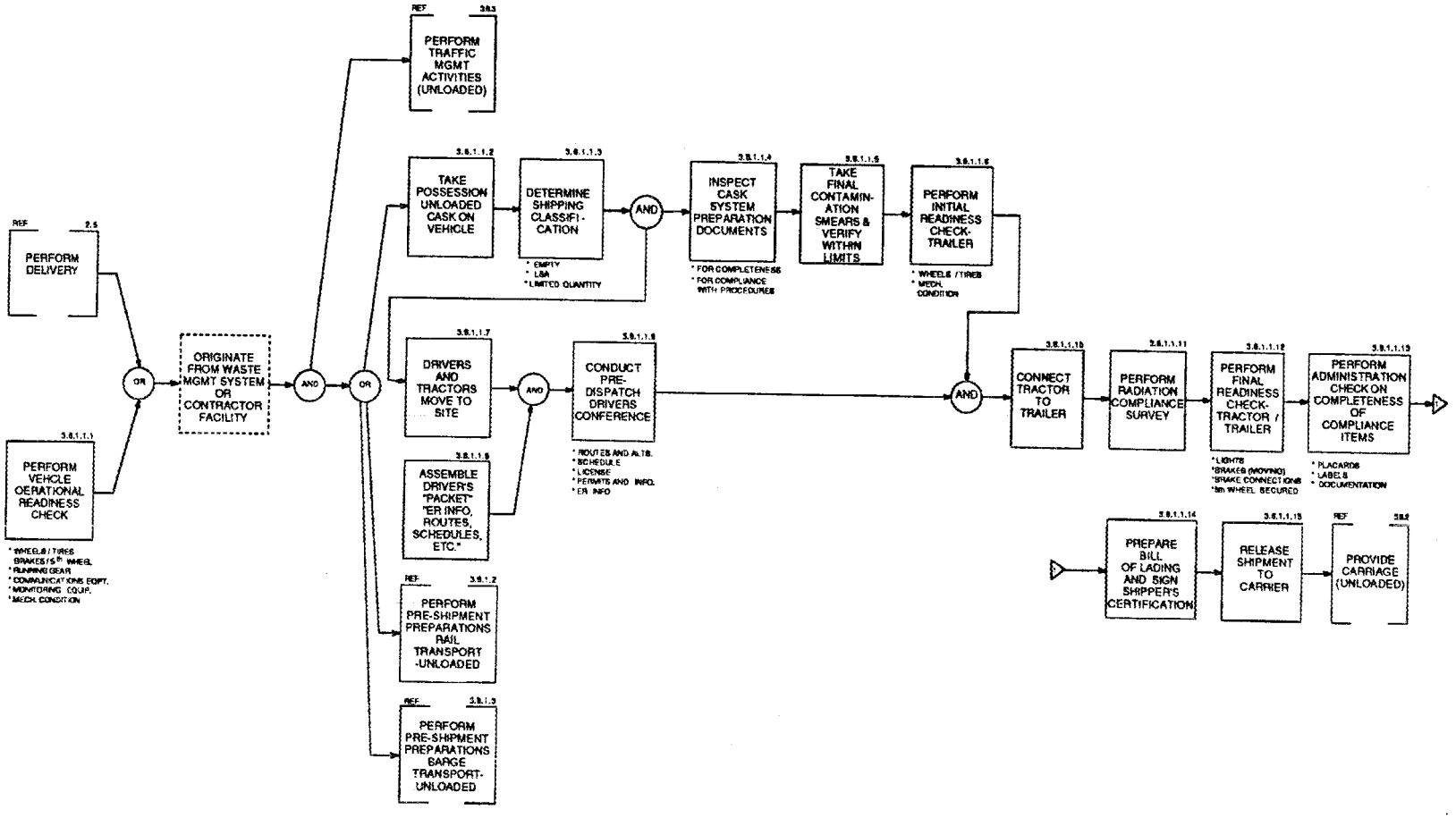
3.6
FUNCTIONAL FLOW
BLOCK DIAGRAM
TRANSPORT
UNLOADED CASKS

ORNL DWG 88-833



3.6.1
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM PRE-SHIPMENT
PREPARATIONS -UNLOADED

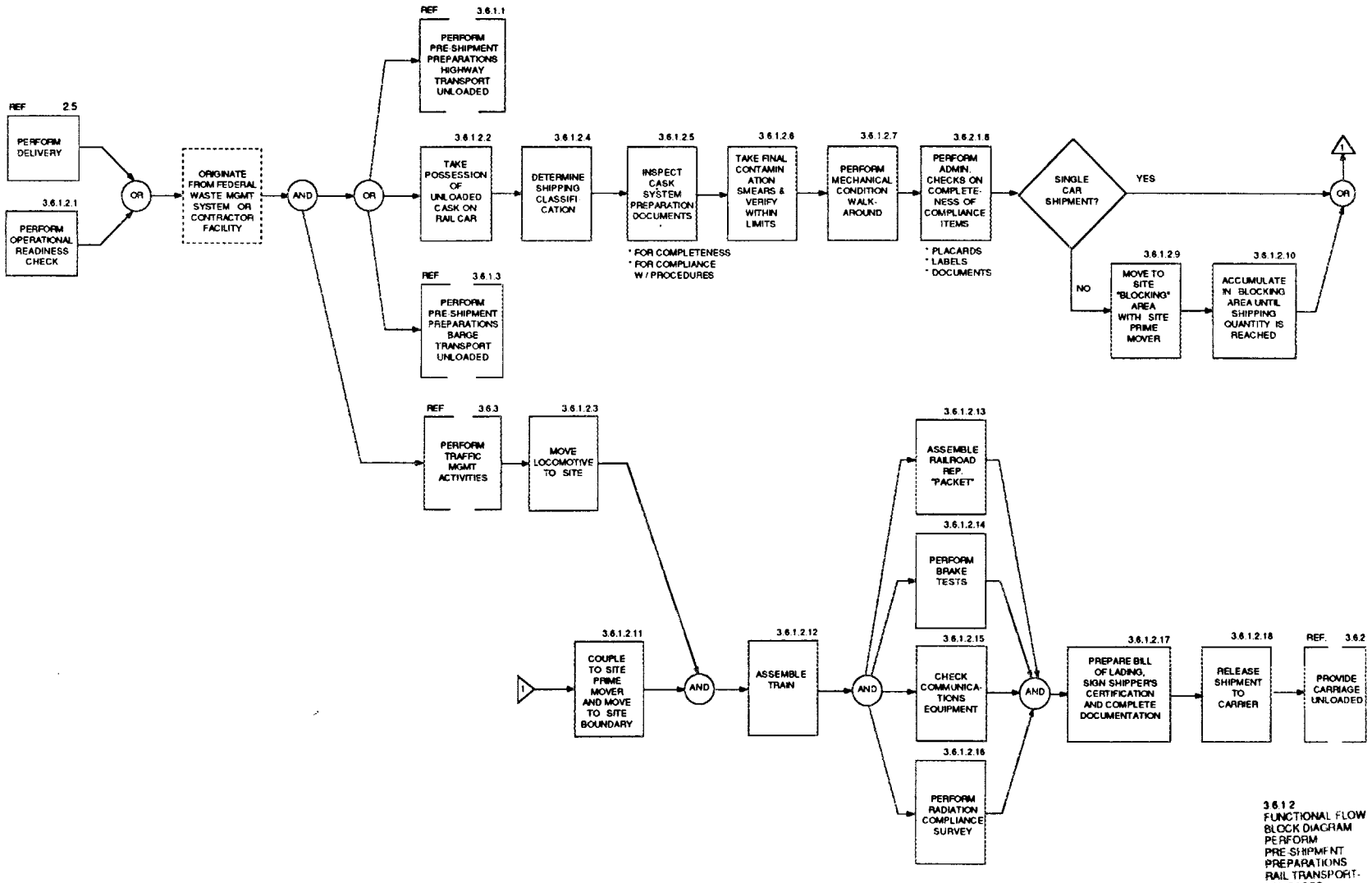
ORNL DWG 88-834



ASSUME: TYPE B QUANTITY IN EMPTY CASK

3.8.1.1
FUNCTIONAL FLOW
BLOCK DIAGRAM
PERFORM
PRE-SHIPMENT
PREPARATIONS
HIGHWAY TRANSPORT-
UNLOADED

ORNL DWG 88-835



3.6.1.2
FUNCTIONAL FLOW BLOCK DIAGRAM
PERFORM PRE-SHIPMENT PREPARATIONS RAIL TRANSPORT-UNLOADED

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