

## 2. APTA PR-IM-RP-002-98 Recommended Practice for Passenger Rail Equipment Technical Documentation

Approved January 22, 1998  
**APTA PRESS Task Force**

Authorized March 17, 1999  
**APTA Commuter Rail Executive Committee**

**Abstract:** This document defines a development process and organizational details to be used as a model to procure railcar technical documentation. This document details the requirements for operations and maintenance manuals and illustrated parts catalogs to achieve maximum utility and on-the-job practicality.

**Keywords:** front-end analysis, manuals, railcar technical documentation

Copyright © 1998 by  
The American Public Transportation Association  
1666 K Street, N. W.  
Washington, DC, 20006, USA

*No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of The American Public Transportation Association.*

## Introduction

(This introduction is not a part of APTA PR-IM-RP-002-98, Recommended Practice for Passenger Rail Equipment Technical Documentation.)

This introduction provides some background on the rationale used to develop this recommended practice. It is meant to aid in the understanding and usage of this recommended practice.

This recommended practice describes the components and necessary steps for the development of a technical documentation system.

If this document is used to procure manuals as part of a coach or locomotive procurement, the technical specifications should be reviewed to minimize the duplication of information that may be contained in the maintainability or reliability analysis.

This recommended practice provides guidance on how to procure technical and maintenance information that is complete and easily understood by the personnel responsible for the operation, inspection, and maintenance of rail equipment.

## Participants

The American Public Transportation Association (APTA) greatly appreciates the contributions of the following individual(s), who provided the primary effort in the drafting of the *Recommended Practice for Passenger Rail Equipment Technical Documentation*:

Rich Conway

Bill Woodring

At the time that this recommended practice was completed, the Passenger Rail Equipment Safety Standards (PRESS) Maintenance Committee included the following members:

### **Rich Conway, Chair**

John Condrasky  
 Ken Donnelly  
 Michael Dorsi  
 Tom Grant  
 Tom Lutz

Chuck Prehm  
 Tom Rowbottom  
 Robert Scarola  
 Michael Scutero  
 James Stoetzel

**Table of Contents**

1. Overview .....2.4

    1.1 Scope .....2.4

    1.2 Purpose .....2.4

2. Definitions, abbreviations, and acronyms.....2.4

    2.1 Definitions .....2.4

    2.2 Abbreviations and acronyms .....2.5

3. Developmental approach.....2.5

    3.1 Step 1-Analysis.....2.5

    3.2 Step 2-Design .....2.6

    3.3 Step 3-Development.....2.6

    3.4 Step 4-Testing and validation .....2.6

    3.5 Step 5-Production .....2.6

    3.6 Step 6-Updating.....2.6

4. Front end analysis (FEA) .....2.6

    4.1 Equipment list (ELIST).....2.7

    4.2 Maintenance allocation chart (MAC).....2.8

    4.3 Task analysis .....2.9

    4.4 Target audience analysis .....2.9

5. Functional analysis .....2.9

    5.1 Functional system breakdown.....2.10

    5.2 Block diagrams and diagram descriptions .....2.10

    5.3 Assembly diagrams and diagram descriptions .....2.11

    5.4 Failure symptom analysis.....2.11

6. Manuals .....2.11

    6.1 Operating manual .....2.12

    6.2 Train crew fault isolation guide.....2.12

    6.3 Description and theory manual.....2.12

    6.4 Maintenance procedures manual.....2.13

    6.5 Tool and test equipment manual .....2.13

    6.6 Illustrated parts catalog (IPC) .....2.13

# APTA PR-IM-RP-002-98

## Recommended Practice for Passenger Rail Equipment Technical Documentation

### 1. Overview

The purpose of this document is to define the development process and organizational details to be used as a model in the development of contractor-provided passenger car technical documentation. This document details the requirements for maximum utility and on-the-job practicality for operations and maintenance manuals and illustrated parts catalogs. By implementing the front-end analysis process described herein, technical documentation developers can ensure that all operating and maintenance task requirements are identified. Once the tasks are identified, they can be developed (written) in any format to satisfy local documentation needs and specifics for newly manufactured equipment.

The passenger rail industry phased this recommended practice into practice over the six-month period from July 1 to December 31, 1999. The recommended practice took effect January 1, 2000.

#### 1.1 Scope

This recommended practice covers all technical documentation used to manufacture, maintain, or otherwise support the operation of passenger rail equipment.

#### 1.2 Purpose

This document should be used to procure passenger rail equipment technical documentation.

### 2. Definitions, abbreviations, and acronyms

#### 2.1 Definitions

For the purpose of this recommended practice, the following terms and definitions apply:

**2.1.1 documentation developer:** The organization responsible for delivery of passenger car technical documentation to the railroad.

**2.1.2 maintenance allocation chart (MAC):** A chart or table used to determine what passenger rail equipment items require maintenance, what maintenance is required on those items, what type of knowledge or skill is required to perform that maintenance, what type of facility will be used to perform the maintenance, when the maintenance is required, and how long each task will take to complete.

**2.1.3 periodic maintenance:** The performance of selected inspection and maintenance actions on systems or sub-systems. Regulatory agencies or the railroad may set the frequency of these actions. The frequency may be expressed as a function of time (i.e. days, weeks, or months) or of utilization (i.e., mileage, cycles, etc.).

The scope of these inspection and maintenance actions must be in full compliance with all applicable federal, state, and local regulations.

**2.1.4 special tool:** Any tool that is not a common hand tool and is not commonly available to railroad maintenance employees.

**2.1.5 special test equipment:** Any portable test unit, rack, or equipment specifically required for use on the equipment being delivered under contract, and/or any PTU or test equipment not currently and commonly in use on the railroad.

**2.1.6 system-by-system functional orientation:** A means of organization in which all items shall be listed in the system where they function. If an item has dual functionality, it shall be listed where it has primary functionality. Conflicts as to function will be resolved by the railroad.

## 2.2 Abbreviations and acronyms

APTA	American Public Transportation Association
ELIST	equipment list
FEA	front end analysis
IPC	illustrated parts catalog
MAC	maintenance allocation chart
OEM	original equipment manufacturer
PTU	portable test unit

## 3. Developmental approach

The American Public Transportation Association (APTA) recommends that a "systems" approach be required in the development of technical support manuals that includes the steps of analysis, design, development, and production. In the systems approach, all elements related to the objectives established for the manuals shall be considered for their impact on the final product. Deliverable manuals shall be developed using the following six-step process:

### 3.1 Step 1-Analysis

The analysis step in the systematic development of technical manuals requires that the objectives of each deliverable be established to determine exactly what will be required in the areas of equipment, personnel qualification and training, tools and test equipment, support, and performance conditions. This step shall define the function that the manuals are expected to perform in view of equipment operation and maintenance requirements, level of experience of the railroad's operating and maintenance personnel, and maintenance and operating conditions.

### **3.2 Step 2-Design**

In the design step, the particular manual requirements, as identified in the analysis step, shall be used to define the technical content and level of detail for all materials. Comprehensive outlines shall be developed, style and format samples prepared, and agreement reached on the types of presentations to be used for operating, maintenance and fault isolation.

### **3.3 Step 3-Development**

In the development step, the actual drafting of materials shall be accomplished based on the analyses and the design prepared in Steps 1 and 2. Draft manuals will include all text and illustrations.

### **3.4 Step 4-Testing and validation**

This step requires that the manuals be evaluated against pre-determined, clearly specified design requirements and conditions.

Validation of the maintenance tasks will be conducted during the draft development period by using survey procedure. The railroad will select procedures drafted by the documentation developer, set validation criteria for each procedure, select representative members of the target audience, and conduct validation sessions. In these sessions, selected railroad personnel will use the manual to perform operating, maintenance, and fault isolation tasks on completed railcars.

Draft manuals shall be tested and revised until effective versions are produced and successfully demonstrated. Revisions shall be based on feedback from personnel involved in the testing, members of the target audience, the documentation developer's subject matter experts, and the railroad's review. When inaccuracies and ineffective presentations are identified, the documentation developer shall revise deficient materials and revalidate until the performance objectives are met.

### **3.5 Step 5-Production**

Only after draft documentation has been reviewed, validated, and approved can production of the manual deliverables begin.

### **3.6 Step 6-Updating**

The documentation developer shall develop and install a system to ensure that all materials produced are kept current with the latest in equipment design changes as they occur and through the end of the warranty period or as specified by contract.

## **4. Front end analysis (FEA)**

The documentation developer shall complete analyses of all railcar equipment, of operating and maintenance tasks, and of the target audience (manual users). The

documentation developer shall insure that all resulting manuals are produced in full recognition of the FEA results. As part of this responsibility, the documentation developer shall enact effective measures to guarantee that all appropriate technical and maintenance aspects of the railcar designs (including the designs of sub-contractors), are coordinated, accurately presented, and sufficiently treated by the manuals.

Portions of the FEA will yield text regarding equipment and component theory of operation as well as practical maintenance information in addition to providing the background data by which decisions are to be made regarding staff needs included in the manuals. Such resource materials will be in the form of integrated block diagrams, wiring tables, cabling and piping diagrams, and charts. These items shall be incorporated into the maintenance manuals, as required, to enhance their usability.

The FEA products that shall be provided for review and approval are:

- a) Equipment list (ELIST)
- b) Task analysis
- c) Target audience analysis
- d) Maintenance allocation chart (MAC)

#### **4.1 Equipment list (ELIST)**

The ELIST lists all items in a functional orientation based on a pre-determined system organization. It shall list all items that will require maintenance in a system-by-system functional orientation, down to the lowest level maintainable item and shall show each item's relationship to the next higher level. A system-by-system functional orientation means that all items shall be listed in the system where they function. If an item has dual functionality, it shall be listed where it has primary functionality. Conflicts as to function will be resolved by the railroad.

The ELIST is organized in a top-down hierarchy of system, sub-system, assembly, sub-assembly (or component group), component, and part, showing each item's relationship to the next higher level. Standard hardware is not included.

Each item listed will have a unique number identifier (code) that grows through the hierarchy. Only the system number must be predetermined. Some items that are common in 2 or more systems may also have predetermined number designators (relays, contactors, circuit boards, etc.).

An ELIST format will show the code, the item description and the original equipment manufacturer (OEM) part number. The OEM part number is important and may be different from the car builder part number in which case both numbers must be listed for the same item.

## 4.2 Maintenance allocation chart (MAC)

Once the ELIST is complete and approved it is used as the model for the MAC. The MAC is a chart or table used to determine:

- a) What items require maintenance;
- b) What maintenance is required on those items;
- c) What type of knowledge or skill is required to perform that maintenance;
- d) What type of facility will be used to perform the maintenance;
- e) When the maintenance is required;
- f) How long each task will take to complete.

As the MAC is developed, the documentation developer shall take into consideration the following:

- a) **Consistent levels of detail** for the breakdowns of assemblies used in more than one vehicle system shall be ensured. For example, if electric motors are detailed to list access cover, brushes, brush-holder, commutator and mounting brackets, all electric motors shall be consistently listed in that manner.
- b) **Tasks that call for tests** are to be prescribed in order to determine the need to replace a part. For instance, fuses are to be checked for continuity before they are replaced unless a break is visually obvious. Other than preventative maintenance, procedures that call for replacement of parts without the use of fault isolation techniques and logic **are prohibited**.
- c) **Overhaul tasks** shall be required in the manuals whenever appropriate for maintenance and economy. The documentation developer shall obtain the required information from the suppliers of equipment and components and include it in the manuals. The railroad's option to subcontract overhaul tasks shall have no bearing or effect on the documentation developer's responsibility to supply all overhaul information needed to maintain the vehicles and equipment in the most efficient manner in accordance with manufacturers' recommendations .
- d) **Tools and test equipment list** (a list of all tools and test equipment required to maintain the cars) shall be prepared and the item number noted on the MAC. The list shall include:
  - Tool or test equipment number
  - Full name of the item
  - Railroad reference number (as required)

**NOTE--**List should specify the special tools and special test equipment information developed during the target audience analysis (Section 4.4).



### 4.3 Task analysis

In task analysis, each task to be covered in the manuals shall be documented for draft development. The analysis shall identify and document the conditions, standards and steps for each task. The task analysis may be performed using available engineering and production drawings, but all task descriptions shall be physically verified by the documentation developer on the equipment.

### 4.4 Target audience analysis

The railroad shall provide the documentation developer with job descriptions of each existing railroad craft that will perform maintenance on the new equipment. Descriptions will consist of:

- a) General craft divisions
- b) Minimum entry-level education required
- c) Entry-level capabilities for use of special tools and test equipment
- d) Entry-level experience prerequisite

To initiate the target audience analysis the documentation developer shall, using the MAC (see Section 4.2), identify the minimum technical qualifications required to properly perform each maintenance task.

The documentation developer's target audience analysis shall consider the background, theoretical knowledge and level of proficiency needed by maintenance technicians performing maintenance on the new equipment. This analysis shall compare maintenance and operating personnel requirements (which are determined from the needs of the vehicle design), to descriptions of available personnel provided by the railroad. Special consideration shall be given to the skills and knowledge required to operate and maintain the unit equipment of a design or function that is new to the railroad and to all special tools and test equipment specific to, or being delivered with, this new equipment. The gap between current and newly required skills and knowledge can be expected to be larger in the area of new unit equipment special tools and test equipment. These deficiencies shall be enumerated by the documentation developer in the approved target audience analysis.

In the documentation developer's target audience analysis report, all tasks on the MAC shall be sorted by technical ability required to perform such tasks. Each task group shall be analyzed to identify all specific new skills and knowledge that shall be required of maintenance personnel. The report shall identify specific gaps between existing and required knowledge.

## 5. Functional analysis

Functional analysis occurs after the ELIST is complete (Section 4.1). The materials developed at this stage shall be incorporated in the manuals as needed to provide information regarding:

- System components
- Theory of operation
- Maintenance
- Fault isolation

## 5.1 Functional system breakdown

This breakdown shall be prepared based on the ELIST (Section 4.1) to show each system and each functional group within that system. Each functional group shall represent equipment items that perform a discrete operation within the equipment. At each level of sub-division, all assemblies shall be accounted for by assignment to a functional group. The functional system breakdown shall be in a block diagram form to show the hierarchical structure of system, sub-system, group, assembly and sub-assembly.

## 5.2 Block diagrams and diagram descriptions

Functional block diagrams shall be prepared for each system identified in the equipment analysis and functional system breakdown. Each diagram shall be designed to provide manual users with:

- A clear illustration of the components of the system down to the lowest maintainable items;
- An understanding of the functional relationships between parts of the system and of the system's relationship to other systems;
- A basis for performing fault isolation procedures.

A functional description shall be provided for each block diagram to provide, in narrative form, a description of the components, functions, and inter-relationships shown on the diagram. Each description shall be titled to match the corresponding diagram and sequenced to follow the flow of the diagram from left to right. There shall be an introduction providing a general description of the purpose, outputs and inputs, operation, and components of the system or portion of the system covered in the diagram. There shall be a detailed description of each equipment item shown on the block diagram. The level of detail in the description shall match that shown in the diagram. That description shall include the purpose and operation of the item and its direct interaction with other items shown as inputs or outputs. All statements shall use terms that describe observable or measurable inputs or outputs and shall not refer to entities such as electron, waves, holes or other abstract concepts unless those details are essential to the purpose of the particular description.

The block diagrams and their descriptions shall be designed to clarify and completely convey the theory of operation of the system and to convey how each part of the system works to support each mode of operation.

### 5.3 Assembly diagrams and diagram descriptions

Detailed diagrams shall be provided for each system to show a complete physical picture of the system as a whole and of each equipment item within that system.

The assembly diagrams shall show equipment in realistic on-car locations and in correct physical relationships to other system components. Detailed assembly drawings shall be provided to show the internal parts of assemblies or groups and shall illustrate basic principles of operation. The diagrams shall use layouts and symbols approved by the railroad. Equipment shall be grouped and titled consistently with the identification of that equipment as shown on the block diagrams.

A functional description shall be provided for each diagram. The description shall be of sufficient detail to provide a clear understanding of:

- Physical location
- Functional characteristics of each state of operation of the group/assembly
- Inputs and outputs
- Critical fault isolation points

### 5.4 Failure symptom analysis

Failure symptom analysis tables shall be prepared to show all potential equipment failures at any level from consist down to component and part. The tables shall be organized by symptom for observable equipment failures and symptoms shall be identified in terms of observable indicators only.

The tables shall list all possible causes for each symptom and shall indicate the lowest level of maintenance at which each fault isolation step and corrective action can be performed (i.e. operator, running, heavy). A separate table shall be provided for each block diagram.

## 6. Manuals

Operating and maintenance manuals and parts catalogs shall be developed based on the FEA (Section 4) and the functional analysis (Section 5). The deliverable manuals are:

- a) Operating manual
- b) Train crew fault isolation guide
- c) Description and theory manual
- d) Maintenance procedures manual
- e) Tool and test equipment maintenance manual
- f) Illustrated parts catalog

The manuals shall cover all operating, maintenance, and special stores procedures required by the railroad to successfully operate and support the vehicles. The goal of manual design and development shall be completeness and accuracy of coverage in the most concise manner possible.

Any sub-contractor materials used shall be completely integrated into contractor-produced materials, which shall be designed, developed, and presented in a single style, conforming to the style and format detailed here. All materials produced as a result of this document shall appear to have been produced "by a single hand".

## 6.1 Operating manual

The operating manual shall provide the train crew (operator, conductor and assistant conductor) with all the equipment-specific information needed to prepare for, conduct, and complete a run-in revenue service. The manual shall include all the fault isolation procedures and on-the-road repairs that the crew is authorized to perform in case of equipment problems.

## 6.2 Train crew fault isolation guide

The train crew fault isolation guide shall include, in summary form, all fault isolation and on-the-road repair procedures contained in the operating manual. This guide shall be produced in a 3-1/2 inch (8.9 cm) by 8-1/4 inch (21 cm) format (employee timetable size) for portability.

## 6.3 Description and theory manual

The description and theory manual will consist of an introduction and two chapters:

- Chapter 1-Description/functional operation
- Chapter 2-Troubleshooting

*Chapter 1-Description/functional operation* shall include the functional analysis material (functional system breakdown, block diagrams with diagram descriptions, and assembly diagrams with diagram descriptions, (see Sections 5.1, 5.2, and 5.3) developed during the FEA. These materials shall provide the user with a full understanding of the components, operation, and interaction of each system. The “theory of operation” section shall include a narrative description of the operation of the system in all states and modes of operation.

*Chapter 2-Troubleshooting* shall present the fault isolation tables developed during the FEA failure symptom analysis. The information will be presented in tabular format. All electrical components will be identified by device designation and all tasks will reference the appropriate MAC number (see Section 4.2)

## 6.4 Maintenance procedures manual

The maintenance procedures manual shall consist of introductory material and two chapters:

- Chapter 1-Maintenance plan
- Chapter 2-Maintenance procedures

*Chapter 1-Maintenance plan* identifies all scheduled maintenance required. The plan will indicate when to perform maintenance tasks. The plan will detail all of the tasks needed to perform a particular maintenance function. The plan will outline all tasks, in proper sequence, required to perform tests and inspections. The plan will describe all tasks required for each periodic inspection and the projected hours needed for each task. All of these requirements shall be identified during the FEA and be clearly documented on the MAC.

*Chapter 2-Maintenance procedures* shall describe all running and heavy repair maintenance procedures and shall include system locator and task-specific locator diagrams, and all required assembly schematics and support diagrams. It shall provide maintenance personnel with all the information they need to perform all of the running repair and heavy repair tasks listed on the MAC. The procedures shall be presented in MAC numeric order; tasks shown on the MAC as "obvious" shall not be included in this manual.

Any procedure requiring the use of special tools or test equipment shall include instructions for set up and use. This shall apply to both portable and on-board special tools and test equipment.

## 6.5 Tool and test equipment manual

The tool and test equipment manual shall include procedures for setup, operation, and maintenance (including fault isolation) of all specific tools and test equipment, such as PTU and test racks being provided or required specifically for the maintenance of the equipment being delivered.

## 6.6 Illustrated parts catalog (IPC)

The IPC shall list and describe every item of each system. The list shall include:

- a) Figure and index number
- b) Contractor and sub-contractor part number
- c) Part description
- d) Quantity
- e) Railroad reference number (as required)

The parts listing shall be designed to show each part's relationship to the next higher assembly. The listing shall also include a reference to the figures in which full, cut-away, and exploded drawings will show all parts.

The IPC shall include "how to use" instructions and a system tables of contents. Each table shall include two separate listings:

- a) Numerical by figure index number
- b) Alphabetical by name of part