APTA STANDARDS DEVELOPMENT PROGRAM
RECOMMENDED PRACTICE
American Public Transportation Association
1300 I Street, NW, Suite 1200 East, Washington, DC 20005

APTA PR-IM-RP-002-98, Rev. 2
First Published: March 17, 1999
First Revision: February 13, 2004
Second Revision: August 9, 2017

APTA Passenger Rail Equipment Safety Standards (PRESS) Inspection & Maintenance Working Group

Passenger Rail Equipment Technical Documentation

Abstract: This *Recommended Practice* defines a development process and organizational details to be used as a model to procure rolling stock 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, rolling stock technical documentation, technical documentation

Summary: This document defines the development process and organizational details to be used as a model in the development of contractor-provided passenger car technical documentation. It 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.

Scope and purpose: This *Recommended Practice* covers all technical documentation used to manufacture, maintain or otherwise support the operation of passenger rail equipment. This document should be used to procure passenger rail equipment technical documentation.

Table of Contents

Participants

The American Public Transportation Association greatly appreciates the contributions of the **APTA Passenger Rail Equipment Safety Standards (PRESS) Inspection & Maintenance Working Group**, which provided the primary effort in the drafting of this document.

At the time this standard was completed, the working group included the following members:

Paul Kovacs, *Chair*
Lea+Elliott

Dave Elliott, *Vice Chair*
LTK Engineering Services

Stephen Bonina, *WSP*
Gordon Campbell, *Interfleet Technology Inc.*
John Condrasky, *WABCO Transit Division*
Joshua Coran, *Talgo, Inc.*
Richard Curtis, *Curtis Engineering Consulting*
Ever Diaz, *Keolis commuter Services*
Marc Gagné, *TDG Transit Design Group*
Ben Holland, *Bay Area Rapid Transit District*
Tony Jones, *Voith Turbo Scharfenberg*
Lloyd Mack, *LTK Engineering Services*
Mike Porter, *LTK Engineering Services*
Martin Schroeder, *CH2M*
Sherman Shreves, *SEPTA*
Richard Seaton, *TDG Transit Design Group*
James Skaggs, *International Electronic Machines*
Jeff Thompson, *SEPTA*
Dan Wilson, *Miami-Dade Transit*
Cliff Woodbury, *LTK Engineering Services*

Project team
Nathan Leventon, *American Public Transportation Association*

Introduction

This introduction is not part of APTA PR-IM-RP-002-98, Rev. 2, "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 document.

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 rolling stock or locomotive procurement, then 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.

Passenger Rail Equipment Technical Documentation

1. Developmental approach

The American Public Transportation Association 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 a systems approach, all elements related to the objectives established for the manuals should be considered for their impact on the final product. Deliverable manuals should be developed using the six-step process outlined in the following sections.

1.1 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 should 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.

1.2 Step 2: Design

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

1.3 Step 3: Development

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

1.4 Step 4: Testing and validation

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

Validation of the maintenance tasks will be conducted during the draft development period by using a 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 rolling stocks.

Draft manuals should be tested and revised until effective versions are produced and successfully demonstrated. Revisions should 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 should revise deficient materials and revalidate until the performance objectives are met.

1.5 Step 5: Production

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

1.6 Step 6: Updating

The documentation developer should 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.

2. Front-end analysis

The documentation developer should complete analyses of all rolling stock equipment, of operating and maintenance tasks, and of the target audience (manual users). The documentation developer should ensure that all resulting manuals are produced in full recognition of the front-end analysis results. As part of this responsibility, the documentation developer should enact effective measures to guarantee that all appropriate technical and maintenance aspects of the rolling stock designs (including the designs of subcontractors), are coordinated, accurately presented and sufficiently treated by the manuals.

Portions of the frontend analysis 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. Other such resource materials will be in the form of integrated block diagrams, wiring tables, cabling and piping diagrams, and charts. These items should be incorporated into the maintenance manuals, as required, to enhance their usability.

The following are front-end analysis products that should be provided for review and approval:

- equipment list (ELIST)
- maintenance allocation chart (MAC)
- task analysis
- target audience analysis

2.1 Equipment list (ELIST)

The ELIST lists all items in a functional orientation based on a predetermined system of organization. In addition to listing all safety items required by the railroad for completion of inspection and maintenance tasks, it should list all items that will require maintenance in a system-by-system functional orientation, down to the lowest-level maintainable item, and should show each item's relationship to the next higher level. A system-by-system functional orientation means that all items should be listed in the system where they function. If an item has dual functionality, it should 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, subsystem, assembly, subassembly (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 should be predetermined. Some items that are common in two 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 should be listed for the same item.

2.2 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 the following:

- what 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
- how long each task will take to complete

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

- **Consistent levels of detail** for the breakdowns of assemblies used in more than one vehicle system should be ensured. For example, if electric motors are detailed to list access cover, brushes, brush holder, commutator and mounting brackets, then all electric motors should be consistently listed in that manner.
- **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 preventive maintenance, procedures that call for replacement of parts without the use of fault isolation techniques and logic are prohibited.
- **Overhaul tasks** should be required in the manuals whenever appropriate for maintenance and economy. The documentation developer should 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 should 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.
- **A tools and test equipment list** (a list of all tools and test equipment required to maintain the cars) should be prepared and the item number noted on the MAC. The list should include:
    - tool or test equipment number;
    - full name of the item; and
    - railroad reference number (as required).

    NOTE: List should specify the special tools and special test equipment information developed during the target audience analysis (Section 2.4).

2.3 Task analysis

In task analysis, each task to be covered in the manuals should be documented for draft development. The analysis should 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 should be physically verified by the documentation developer on the equipment.

2.4 Target audience analysis

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

- general craft divisions
- minimum entry-level education required
- entry-level capabilities for use of special tools and test equipment
- entry-level experience prerequisite

To initiate the target audience analysis, the documentation developer should, using the MAC (see Section 2.2), identify the minimum technical qualifications required to properly perform each maintenance task.

The documentation developer's target audience analysis should consider the background, theoretical knowledge and level of proficiency needed by maintenance technicians performing maintenance on the new equipment. This analysis should 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 should 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 should 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 should be sorted by technical ability required to perform such tasks. Each task group should be analyzed to identify all specific new skills and knowledge that should be required of maintenance personnel. The report should identify specific gaps between existing and required knowledge.

3. Functional analysis

Functional analysis occurs after the ELIST is complete (Section 2.1). The materials developed at this stage should be incorporated in the manuals as needed to provide information regarding the following:

- system components
- theory of operation
- maintenance
- fault isolation

3.1 Functional system breakdown

This breakdown should be prepared based on the ELIST (Section 2.1) to show each system and each functional group within that system. Each functional group should represent equipment items that perform a discrete operation within the equipment. At each level of subdivision, all assemblies should be accounted for by assignment to a functional group. The functional system breakdown should be in a block diagram form to show the hierarchical structure of system, subsystem, group, assembly and subassembly.

3.2 Block diagrams and diagram descriptions

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

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

The block diagrams and their descriptions should 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.

3.3 Assembly diagrams and diagram descriptions

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

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

- physical location
- functional characteristics of each state of operation of the group/assembly
- inputs and outputs
- critical fault isolation points

3.4 Failure symptom analysis

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

The tables should list all possible causes for each symptom and should 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 should be provided for each block diagram.

4. Manuals

Operating and maintenance manuals and parts catalogs should be developed based on the front-end analysis (Section 2) and the functional analysis (Section 3). The following are the deliverable manuals:

- operating manual
- train crew fault isolation guide
- description and theory manual
- maintenance procedures manual
- tool and test equipment maintenance manual
- illustrated parts catalog

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

Any subcontractor materials used should be completely integrated into contractor-produced materials, which should 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 should appear to have been produced "by a single hand."

4.1 Operating manual

The operating manual should 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 should include all the fault isolation procedures and on-the-road repairs – and respective safety precautions as needed – that the crew is authorized to perform in case of equipment problems.

4.2 Train crew fault isolation guide

The train crew fault isolation guide should include, in summary form, all fault isolation and on-the-road repair procedures contained in the operating manual. This guide should be produced in a 3½ in. (8.9 cm) by 8¼ in. (21 cm) format (employee timetable size) for portability.

4.3 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

4.3.1 Chapter 1

Chapter 1, Description/Functional Operation, should include the functional analysis material (functional system breakdown, block diagrams with diagram descriptions, and assembly diagrams with diagram descriptions (see Sections 3.1, 3.2 and 3.3), developed during the front-end analysis. These materials should provide the user with a full understanding of the components, operation and interaction of each system. The theory of operation section should include a narrative description of the operation of the system in all states and modes of operation.

4.3.2 Chapter 2

Chapter 2, Troubleshooting, should present the fault isolation tables developed during the front-end analysis and 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 2.2)

4.4 Maintenance procedures manual

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

- **Chapter 1:** Maintenance Plan
- **Chapter 2:** Maintenance Procedures

4.4.1 Chapter 1

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

4.4.2 Chapter 2

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

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

4.5 Tool and test equipment manual

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

4.6 Illustrated parts catalog (IPC)

The IPC should list and describe every item of each system. The list should include the following:

- figure and index number
- contractor and subcontractor part number
- part description
- quantity
- railroad reference number (as required)

The parts listing should be designed to show each part’s relationship to the next higher assembly. The listing should also include a reference to the figures in which full, cutaway and exploded drawings will show all parts.

The IPC should include “how to use” instructions and a systems table of contents. Each table should include two separate listings:

- numerical by figure index number
- alphabetical by name of part

Definitions

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

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.

periodic maintenance: The performance of selected inspection and maintenance actions on systems or sub-systems. Regulatory agencies or the operating authority 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.

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

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.

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

Abbreviations and acronyms

APTA	American Public Transportation Association
ELIST	equipment list
IPC	illustrated parts catalog
MAC	maintenance allocation chart
NATSA	North American Transportation Services Association
OEM	original equipment manufacturer
PRESS	Passenger Rail Equipment Safety Standards
PTU	portable test unit

Summary of document changes

- Document formatted to the new APTA standard format.
- Sections have been moved and renumbered.
- Scope and summary moved to the front page.
- Definitions, abbreviations and acronyms moved to the rear of the document.
- Two new sections added: “Summary of document changes” and “Document history.”
- Some global changes to section headings and numberings resulted when sections dealing with references and acronyms were moved to the end of the document, along with other cosmetic changes, such as capitalization, punctuation, spelling, grammar and general flow of text.
- Replaced instances of the acronym FEA, which in this document had represented “front-end analysis,” with “front-end analysis” to create consistency in use of the FEA acronym throughout the PRESS documents. (In all other PRESS documents where the acronym FEA is used, the acronym is for finite element analysis.)
- Names of participants updated.
- Language changes made regarding consistency in the use of rolling stock, vehicle, railcar, and coach.

- Language changed to reflect recommended practice status of document.
- Addition of reference to safety items, procedures and precautions.
- Addition of APTA and PRESS to "Abbreviations and acronyms."
- Participants list updated.

Document history

Document Version	Working Group Vote	Public Comment/ Technical Oversight	CEO Approval	Policy & Planning Approval	Publish Date
First published	Jan. 22, 1998	—	—	March 17, 1999	March 1999
First revision					Feb. 13, 2004
Second revision	April 28, 2017	May 1, 2017	July 19, 2017	August 1, 2017	August 9, 2017