The following reference documents were utilized for the development of the PCJPB Structure Design Guidelines.

**Caltrain Documents**
- PCJPB Guideline for Excavation Support Systems
- PCJPB Communication/Signal Engineering Standards
- PCJPB Track Standards
- Operations of the PCJPB contract operator – including Operations after an Earthquake
- Caltrain Timetable, Current edition
- PCJPB Station Facility Guidelines, August 1999

**Guidelines, Codes, and Standards**
- American Railway Engineering and Maintenance-of-Way Association (AREMA) – Manual for Railway Engineering
- Federal Railway Administration (FRA) 49 CFR – Part 213 Track Safety Standards
- California Public Utilities Commission (CPUC) - General Orders
- Union Pacific Railroad Guidelines for Design and Construction of Grade Separation Underpass Structures
- Union Pacific Railroad Guidelines for Design and Construction of Grade Separation Overhead Structures
- Burlington Northern Santa Fe Railway Guidelines for Design and Construction of Grade Separation Structures
- Norfolk Southern Guidelines for the Design of Highway Separation Structures Over and Under Railroad
- Caltrans Bridge Design Specification and other Caltrans documents
- AASHTO
- Metropolitan Transportation Authority (MTA) - Design Criteria
- Alameda Corridor Transportation Authority Standards and Procedures – Design Criteria
- Uniform Building Code
- Caltrain - Manual of Design Criteria, Initial Submittal, June 9, 2000, by Parsons Transportation Group
- Design Manual: 7.02 - Foundations and Earth Structures, NAVFAC DM-7.02, September 1986, Department of the Navy
• Design Manual 7.01 – Soil Mechanics, NAVFAC DM-7.01, September 1986, Department of the Navy

Articles, Publications, and Reports

• Risk Assessment and Planning Related to Uncontrollable Interruption of Service from Natural Disasters – ArupRiskConsulting, November 2001

• Bridge Design Fundamentals - by F. Talania – Copyright 1996

• Track Transition Problems and Remedies, AREA Bulletin 742, by Kerr and Moroney

APPENDIX A:

REFERENCE PCJPB TRACK STANDARDS
TYPICAL DOUBLE TRACK SECTION WITH WOOD TIES

NOTES:

1. BALLAST SHALL BE CRUSHED STONE, QUALITY OF BALLAST, SMOOTHNESS AND GRADATION SHALL CONFORM TO CURRENT ROCKS ENGINEERING STANDARDS. BALLAST SHALL BE HANDLED, TRANSPORTED, UNLOADED, PLACED, COMPACTED AND TAMPOED TO AVOID SEGREGATION AND GENERATION OF FINES. FOR DETAILS SEE TS-1000.

2. WALKWAYS AT TIE LEVELS ARE REQUIRED AT SWITCHES AND YARDS WHERE OPERATING PERSONNEL NORMALLY WORK ON THE GROUND.

3. FOR LOCATIONS WITH MORE THAN 2 TRACKS, THE TOP OF RAIL MAY BE LOWERED 3" PER TRACK.

4. SLOPES SHOWN ARE TYPICAL. SITE SPECIFIC CONDITIONS MAY REQUIRE STEEPER OR FLATTER SLOPES AND CHANGES TO THE DITCH DIMENSIONS. REFER TO THE CONTRACT DRAWINGS FOR SITE SPECIFIC DETAILS ON SLOPES AND DITCH DIMENSIONS.

5. FOR EXISTING TRACKS, A 6" LAYER OF SCAFFRED AND COMPACTED EXISTING GRAVEL OR BALLAST (DEGRADED BALLAST) MAY BE USED UNDER THE BALLAST SECTION.

6. FOR NEW CONSTRUCTION A MINIMUM 8" OF HOT MIX ASPHALT CONCRETE OR 8" OF COMPACTED AGGREGATE BASE MATERIAL WILL BE USED UNDER THE BALLAST SECTION OR AS DIRECTED ON THE SITE SPECIFIC CONTRACT DRAWINGS. HOT MIX ASPHALT CONCRETE AND COMPACTED AGGREGATE BASE MATERIAL SHALL BE PLACED AS INDIcATED ON SITE SPECIFIC CONTRACT DRAWINGS WITH 4 TOLERANCE OF PLUS OR MINUS 1".

7. WALKWAYS SHALL CONFORM TO STANDARD PRESCRIBED BY C.F.U.C. GENERAL ORDER NO. 118, STANDARD NO.6.

8. DEPTH OF BALLAST SHALL BE PLACED AS SHOWN WITH A TOLERANCE OF PLUS OR MINUS 1".

TYPICAL DOUBLE TRACK SUPERELEVATED SECTION WITH WOOD TIES

TYPICAL PARTIAL TRACK SECTION WALKWAY

PER CALIFORNIA PUBLIC UTILITIES COMMISSION
GENERAL ORDER NO.118 STANDARD NO.6

PENINSULA CORRIDOR JOINT POWERS BOARD
ENGINEERING STANDARDS
ROADBED SECTIONS FOR WOOD TIE TRACK CONSTRUCTION

Caltrain

D. HAYES
S. SCOFIELD
M. HONEY
C. PAYNE

Track Standards

TS-1025
TYPICAL DOUBLE TRACK SECTION WITH CONCRETE TIES

TYPICAL DOUBLE TRACK SUPERELEVATED SECTION WITH CONCRETE TIES

NOTES:

1. BALLAST SHALL BE CRUSHED STONE, QUALITY OF BALLAST, SOUNDNESS AND GRADE SHALL CONFORM TO CURRENT CPUC ENGINEERING STANDARDS. BALLAST SHALL BE HANDLED, TRANSPORTED, UNLOADED, PLACED, COMPACTED AND TAMPED TO AVOID SEGREGATION AND GENERATION OF FINES. FOR DETAILS SEE TS-1000.

2. WALKWAYS AT TIE LEVELS ARE REQUIRED AT SWITCHES AND YARDS WHERE OPERATING PERSONNEL NORMALLY WORK ON THE GROUND.

3. FOR LOCATIONS WITH MORE THAN 2 TRACKS, THE TOP OF RAIL MAY BE LOWERED 3" PER TRACK.

4. SLOPES SHOWN ARE TYPICAL. SITE SPECIFIC CONDITIONS MAY REQUIRE STEEPER OR FLATTER SLOPES AND CHANGES TO THE DITCH DIMENSIONS. REFER TO THE CONTRACT DRAWINGS FOR SITE SPECIFIC DETAILS ON SLOPES AND DITCH DIMENSIONS.

5. FOR EXISTING TRACKS, A 6" LAYER OF SCARIFIED AND COMPACTED EXISTING GRANULAR RAILROAD ROADBED MATERIAL (DEGRADED BALLAST) MAY BE USED UNDER THE BALLAST SECTION.

6. FOR NEW CONSTRUCTION A MINIMUM 8" OF HOT MIX ASPHALT CONCRETE OR 8" OF COMPACTED AGGREGATE BASE MATERIAL WILL BE USED UNDER THE BALLAST SECTION OR AS DIRECTED ON THE SITE SPECIFIC CONTRACT DRAWINGS. HOT MIX ASPHALT CONCRETE AND COMPACTED AGGREGATE BASE MATERIAL SHALL BE PLACED AS INDICATED ON SITE SPECIFIC CONTRACT DRAWINGS WITH 4 TOLERANCE OF PLUS OR MINUS 1".

7. WALKWAYS SHALL CONFORM TO STANDARD PRESCRIBED BY C.P.U.C. GENERAL ORDER NO. 118, STANDARD NO.8.

8. DEPTH OF BALLAST SHALL BE PLACED AS SHOWN WITH A TOLERANCE OF PLUS OR MINUS 1."
TYPICAL ROADBED IN PAVED AREAS

NOTES:

1. ALL TIES SHALL BE FULLY BOX ANCHORED THROUGHOUT LIMITS OF PAVING AND EXTEND 200' ON EACH END.

2. FLANGEWAY FILLER SHALL BE EXTENDED FROM 100% VIRGIN RUBBER AND INSTALLED ON GAGE AND FIELD SIDES OF RAIL. A MINIMUM 2 3/4" GAP WILL BE MAINTAINED ON THE RAIL SIDE OF THE CROSSING. ON OTHER SIDES ARE ALLOWED, THE FLANGEWAY ON THE RAIL SIDE SHALL FIT FLUSH WITH THE RAIL HEAD.

3. TOPS OF ALL TIES SHALL BE IN A STRAIGHT PLANE, ANY TIE WITH AN IRREGULAR SURFACE SHALL BE REPLACED.

4. AN 8" ASPHALT CONCRETE RAMP SHALL BE INSTALLED AT BOTH ENDS OF THE CROSSING, IN ACCORDANCE WITH CPUC.

5. TYPICAL SAWCUT LINES INDICATED IN THE SECTION SHALL ONLY BE USED IF NO SAWCUT LINE IS INDICATED ON THE SITE SPECIFIC GRADE CROSSING PLAN.

6. THIS TYPICAL SECTION APPLIES TO WOOD TIE APPLICATIONS, AS INDICATED IN SITE SPECIFIC CONTRACT DRAWINGS AND/OR SPECIFICATIONS.

7. FOR NEW CONSTRUCTION A MINIMUM 6" OF HOT MIX ASPHALT CONCRETE OR 8" OF COMPACTED AGGREGATE BASE MATERIAL WILL BE USED UNDER THE BALLAST SECTION REQUIRED TO MEET THE REQUIREMENTS OF THE SITE SPECIFIC CONTRACT DRAWINGS. HOT MIX ASPHALT CONCRETE AND COMPACTED AGGREGATE BASE MATERIAL SHALL BE PLACED AS INDICATED ON SITE SPECIFIC CONTRACT DRAWINGS WITH 4 TOLERANCE OF PLUS OR MINUS.

8. DEPTH OF UNDERDRAIN SHALL BE AS INDICATED IN SITE SPECIFIC PLAN/PROFILE, WHERE GIVEN

9. DEPTH OF BALLAST SHALL BE PLACED AS SHOWN WITH A TOLERANCE OF PLUS OR MINUS 1". AFTER PLACEMENT, BALLAST SHALL BE COMPACTED.

10. AFTER EXCAVATION BELOW SUBGRADE HAS BEEN COMPLETED, BACK FILL TRENCH WITH CRUSHED STONE, GRAVEL OR AS SHOWN ON SITE SPECIFIC PLAN.

11. ALL TIE PLATES IN CROSSING WILL BE 18" PANDROL PLATES AS SHOWN ON TS-4038. ALL E CLIPS WILL BE GUARANTEE AS SHOWN ON TS-4048 AND SCREEN SPREAD SHOWN ON TS-4048.
APPENDIX B:

PCJPB ENGINEERING STANDARDS FOR EXCAVATION SUPPORT SYSTEMS
Excerpted from PCJPB ENGINEERING STANDARDS FOR EXCAVATION SUPPORT SYSTEMS

SECTION 2 – REQUIREMENTS FOR SHORING ADJACENT TO RAILROAD (GENERAL)

2.1 RAILROAD ZONE OF INFLUENCE AND SHORING REQUIREMENTS

The Railroad Zone of Influence is defined on Figure 2.1. The area below the Influence Line is divided into four zones. Requirements and limitations for excavations and excavation shoring systems within each zone are described in detail on Figure 2.1.
FIGURE 2.1 – RAILROAD ZONE OF INFLUENCE
ZONE 1:

- NO SHORING INSTALLATION OR EXCAVATION WILL BE ALLOWED WITHOUT THE SPECIAL WRITTEN PERMISSION OF THE PCJPB.
- ALTERNATES TO SHORED EXCAVATIONS SHOULD BE UTILIZED WHEN POSSIBLE. POTENTIAL ALTERNATES TO SHORED EXCAVATION INCLUDE TEMPORARY RELOCATION OF THE TRACKS AWAY FROM THE EXCAVATION LOCATION AND THE COMPLETION OF THE EXCAVATION WORK DURING A PCJPB APPROVED TRACK OUTAGE.
- IF EXCAVATION IS ALLOWED, THE SHORING SYSTEM SHALL BE DESIGNED FOR LATERAL SURCHARGE DUE TO RAILROAD LIVE LOAD.
- IF EXCAVATION IS ALLOWED, THE SHORING SYSTEM SHALL BE DESIGNED IN ACCORDANCE WITH THE PCJPB ENGINEERING STANDARDS FOR EXCAVATION SUPPORT SYSTEMS.

ZONE 2:

- EXCAVATION REQUIRES SHORING FOR THE PROTECTION OF THE RAILROAD CONSISTING OF CONTINUOUS SHORING WALLS THAT ARE INSTALLED PRIOR TO ANY EXCAVATION.
- EXAMPLES OF ACCEPTABLE SHORING WALL TYPES INCLUDE INTERLOCKED SHEET PILING OR DIAPHRAGM WALLS. DIAPHRAGM WALL TYPES INCLUDE DEEP SOIL MIX WALLS, SECANT PILE WALLS, TANGENT PILE WALLS, AND SLURRY WALLS.
- SOLDIER PILES AND LAGGING WILL NOT BE ALLOWED UNLESS SPECIAL WRITTEN PERMISSION IS GRANTED BY THE PCJPB.
- THE SHORING SYSTEM SHALL BE DESIGNED FOR LATERAL SURCHARGE DUE TO RAILROAD LIVE LOAD.
- THE SHORING SYSTEM SHALL BE DESIGNED IN ACCORDANCE WITH THE PCJPB ENGINEERING STANDARDS FOR EXCAVATION SUPPORT SYSTEMS.

ZONE 3:

- EXCAVATION REQUIRES SHORING FOR THE PROTECTION OF THE RAILROAD.
- THE SHORING SYSTEM SHALL BE DESIGNED FOR LATERAL SURCHARGE DUE TO RAILROAD LIVE LOAD.
- THE SHORING SYSTEM SHALL BE DESIGNED IN ACCORDANCE WITH THE PCJPB ENGINEERING STANDARDS FOR EXCAVATION SUPPORT SYSTEMS.

ZONE 4:

- EXCAVATION REQUIRES SHORING FOR THE PROTECTION OF THE RAILROAD.
- LATERAL SURCHARGE DUE TO RAILROAD LIVE LOAD NEED NOT BE CONSIDERED IN THE SHORING DESIGN.
- THE EXCAVATION SHALL BE PROVIDED WITH A SHORING SYSTEM THAT ACTIVELY SUPPORTS THE SIDES OF THE EXCAVATION AND PREVENTS THE EXCAVATION FACES FROM RAVELING OR MOVING. SLOPED EXCAVATIONS ARE NOT PERMITTED.
- HYDRAULIC AND MECHANICAL TRENCH SHORES WITH SHEETING, TRENCH SHIELDS, AND TIMBER SHORING MAY BE UTILIZED; HOWEVER, INSTALLATION OF THE SHORING SYSTEM MUST BE COMPLETED BEFORE MOVEMENT OF TRAINS IS ALLOWED ON THE ADJACENT TRACK. WINDOWS WITHIN WHICH THE SHORING SYSTEM INSTALLATION MUST BE COMPLETED SHALL BE COORDINATED WITH THE PCJPB.

EXCAVATIONS BEYOND INFLUENCE LINE:

- LATERAL SURCHARGE DUE TO RAILROAD LIVE LOAD NEED NOT BE CONSIDERED IN THE SHORING DESIGN.
- SLOPED EXCAVATIONS ARE DISCOURAGED. (PCJPB MAY REQUIRE SLOPE STABILITY ANALYSIS FOR SLOPED EXCAVATIONS.) SHORED VERTICAL EXCAVATIONS ARE PREFERRED.
- EXCAVATIONS AND SHORING SHALL MEET OSHA REQUIREMENTS.

FIGURE 2.1 (CONTINUED) – RAILROAD ZONE OF INFLUENCE
APPENDIX C:

CLEARANCE DIAGRAMS
PCJPB CLEARANCE REQUIREMENTS FOR NEW CONSTRUCTION OR DESIGN

ANY EXCEPTION TO THIS REQUIREMENT MUST BE APPROVED BY THE PCJPB CHIEF ENGINEER.

NOTES:
OVERHEAD WIRE CLEARANCES SHALL CONFORM TO CALIFORNIA P.U.C. GENERAL ORDER NO. 95 OR AMENDMENTS THEREOF.
ALL SIDE CLEARANCE DIMENSIONS ARE FOR TANGENT TRACK. IN GENERAL, SIDE CLEARANCE FOR CURVE TRACK TO BE 1 FT, 8 IN. GREATER THAN THAT FOR TANGENT TRACK.
RAIL-SIGNAL GRADE SEPARATIONS MAY REQUIRE PROVISION FOR MAINTENANCE ROAD AND/OR ADDITIONAL TRACK.
MOVABLE PARTS OF DOORS, GATES, WINDOWS, ETC. MUST REMAIN CLEAR OF THIS ENVELOPE.

NO PARALLEL UTILITIES INSIDE 18 FT. OF C.L. OF TRACK OR INSIDE OF 1.5% SLOPE FROM END OF T.C.

STATION PLATFORM

FLOW

LINES OVER 20,000 VOLTS
LINES 7500-20,000 VOLTS
LINES 0-750 VOLTS

34 FT.
28 FT.
25 FT.
7 FT.
7 FT.
5 FT.
5 FT.
12 FT.
12 FT.
24 FT.
29 IN.
5 FT. 4 IN.

SIGNED P

EXTREME SMALL
ELECTRIC COMPANY
400 MILLER ROAD, SUITE 102
REDWOOD CITY, CA 94063
7388 - 1088 595-0643

PCJPB STANDARD CLEARANCE OF STRUCTURES

SIGNAL STANDARDS
SECTION 1.3 RAILWAY BRIDGES (1983)

For railway bridges, refer to Figure 28-1-2. The information found in Section 1.1 will apply to this illustration.

Figure 28-1-2. Railway Bridges
APPENDIX D:

CALIFORNIA PUBLIC UTILITIES COMMISSION
GENERAL ORDER No. 26-D
(Supersedes General Order No. 26-C)

Public Utilities Commission of the
State of California

REGULATIONS GOVERNING CLEARANCES ON RAILROADS AND STREET
RAILROADS WITH REFERENCE TO SIDE AND OVERHEAD STRUCTURES,
PARALLEL TRACKS, CROSSINGS OF PUBLIC ROADS, HIGHWAYS AND
STREETS.

Adopted January 19, 1948. Effective February 1, 1948

As Amended:
Decision No. 49823, April 20, 1954, Effective May 10, 1954; Decision No. 55025, May
21, 1957, Effective June 10, 1957; Decision No. 58433, May 19, 1959, Effective June
8, 1959; Decision No. 69783, May 22, 1962, Effective June 11, 1962; Decision No. 86715,
January 23, 1964, Effective February 17, 1964; Decision No. 69854, November 24,
1964, Effective December 14, 1964; Decision No. 74065, April 30, 1968, Effective May
20, 1968; Decision No. 74484, August 6, 1968, Effective August 26, 1968; Resolution
No. ET-1115, November 26, 1968, Decision No. 80051, May 15, 1972, Effective June
5, 1972; Decision No. 86898, January 5, 1977, Effective January 25, 1977; Decision No.

It is hereby ordered by the Public Utilities Commission of the State
of California that the minimum clearance requirements for railroads
and street railroads hereinafter prescribed shall hereafter be observed
in this state in all construction or reconstruction of tracks or structures
adjacent to tracks.

It is hereby further ordered that no railroad or street railroad
Corporation shall operate any cars, trains, motors, engines, or other
rolling equipment over its own or other tracks, except as hereinafter
provided, on which overhead or side clearances, or clearances
between tracks, are less than the minimum herein prescribed, if such
tracks or structures adjacent to such tracks are constructed or recon-
structed subsequent to the effective date hereof.

DEFINITIONS

Section 1

For the purposes of these regulations definitions as hereinafter
prescribed will govern.

1.1 *Height of a Freight Car* is the distance between the top of
rail and the top of the running board.

1.2 *Side of a Freight Car* is that part or appurtenance of a car
at the maximum distance measured at right angles from
the center line of the car.

1.3 *Width of a Freight Car* is twice the distance from the center
line to the side of a car as defined herein.

1.4 *Overhead Clearance* is the vertical distance from the level
of the top of the highest rail to a structure or obstruction
above.

1.5 *Side Clearance* is the shortest distance from the center line
of track to a structure or obstruction at the side of track.
STANDARD GAUGE RAILROADS AND STREET RAILROADS
TRANSPORTING FREIGHT CARS
Section 2—Overhead Clearances

2.1 The minimum overhead clearance above railroad and street railroad tracks, which are used or proposed to be used for transporting freight cars, shall be twenty-two (22) feet six (6) inches. Structures constructed prior to the effective date of this order may be maintained at such clearances as was lawful at the time of construction.

2.2 The overhead clearance above top of rail of such tracks located inside of buildings may be reduced to eighteen (18) feet, provided that this clearance shall apply only to tracks terminating within the building, and further provided, that when an overhead clearance of less than twenty-two (22) feet exists on tracks inside such building, all cars, trains, motors, engines or other equipment shall be brought to a stop before entering such building, the conditions provided to require such stop to be approved by the Commission.

2.3 Unless otherwise provided herein, overhead clearances authorized in this section are applicable only to tracks on which freight cars having a height not exceeding fifteen (15) feet six (6) inches are transported. Freight cars of a height exceeding fifteen (15) feet four (4) inches, but not greater than fifteen (15) feet six (6) inches shall be permanently marked, stenciled, or placarded as hereinafter required, and such markings maintained in a legible condition reading as follows:

"This Car EXCESS HEIGHT."

The markings required in this subsection shall be made permanent on owned cars as soon as practicable with a \( \frac{3}{8} \)" stripe outlining an area not less than seven (7) inches by ten (10) inches, such stripes and lettering to be of a color contrasting with the car body color. All such required markings and placarding shall be placed on the side adjacent to the ladder or hand-holds near the floor line of the car at each of the four corners.

2.4 Freight cars not exceeding a height of fifteen (15) feet six (6) inches may be transported without compliance with the requirements of subsection 2.3 of this order provided that the tracks over which such operations are conducted exhibit throughout the route an overhead clearance of twenty-two (22) feet six (6) inches as required in subsection 2.1 of this order.

2.5 If freight cars of a height greater than fifteen (15) feet six (6) inches are transported or proposed to be transported,
minimum overhead clearances shall be increased by an amount of not less than such additional height provided that such cars are exempt from this subsection when the top running boards have been removed, ladders and hand brakes lowered, cars painted, stenciled, and otherwise modified in compliance with the provisions of Section 231.24 of Part 231. U. S. Safety Appliance Standards (railroad).

Section 3—Side Clearances

3.1 Minimum side clearances from center line of tangent standard gauge railroad and street railroad tracks, which are used or proposed to be used for transporting freight cars, except as hereinafter prescribed, shall be as shown below.

<table>
<thead>
<tr>
<th>Description</th>
<th>Minimum Side Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>All structures and obstructions above the top of the rail except those hereinafter specifically mentioned</td>
<td>8' 6&quot;</td>
</tr>
<tr>
<td>Platforms eight (8) inches or less above top of rail</td>
<td></td>
</tr>
<tr>
<td>Platforms four (4) feet or less above top of rail</td>
<td>4' 8&quot;</td>
</tr>
<tr>
<td>Platforms four (4) feet six (6) inches or less above top of rail when used principally for loading or unloading refrigerator cars</td>
<td>7' 6&quot;</td>
</tr>
<tr>
<td>Platforms previously constructed at clearance not less than seven (7) feet three (3) inches may be extended at such clearance unless such extension is in connection with the reconstruction of the original platform.</td>
<td>8' 0&quot;</td>
</tr>
<tr>
<td>Poles supporting trolley contact conductors supplying motive power to track affected, if of bracket construction, on either single or double main track</td>
<td>8' 3&quot;</td>
</tr>
<tr>
<td>Switch boxes, switch-operating mechanisms and accessories necessary for the control and operation of signals and interlockers projecting four (4) inches or less above the top of rail</td>
<td>3' 0&quot;</td>
</tr>
</tbody>
</table>

C.O. 286)
<table>
<thead>
<tr>
<th>Description</th>
<th>Minimum Side Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.9 Signals and switch stands three (3) feet or less above top of rail and located between tracks where not practicable to provide clearances otherwise prescribed in this order</td>
<td>6' 0&quot;</td>
</tr>
<tr>
<td>3.10 Through bridges supporting track affected, tunnels, water columns and oil columns</td>
<td>8' 0&quot;</td>
</tr>
<tr>
<td>3.11 The clearance for (a) through bridges supporting track affected, (b) water barrel platforms and refuse platforms on bridges and trestles not provided with walkways, (c) handrails, (d) water barrels, (e) water columns, (f) oil columns, (g) block signals, (h) cattle guards, and (i) stock chutes, when all or portions thereof are four (4) feet or less above top of rail, may be decreased to the extent defined by a line extending diagonally upward from a point level with top of rail and five (5) feet distant laterally from center line of track to a point four (4) feet above top of rail and eight (8) feet distant laterally from center line of track; provided, however, that the minimum clearance for handrails and water barrels on bridges with walkways shall be seven (7) feet nine (9) inches, and, provided further, the minimum clearance for fences of cattle guards shall be six (6) feet nine (9) inches.</td>
<td></td>
</tr>
<tr>
<td>NOTE: Unless previously approved by the Commission, the clearances authorized in subsection 3.11 of this order, except as provided for handrails and water barrels, are not permitted on through bridges where the work of trainmen or yardmen require them to be upon the decks of such bridges for the purpose of coupling and uncoupling cars in the performance of switching service on a switching lead.</td>
<td></td>
</tr>
<tr>
<td>3.12 The side clearances specified herein shall not apply to mail cranes during such times as the arms of such mail cranes are supporting a mail sack for delivery, provided that the top arm is not then higher than ten (10) feet eight (8) inches above top of rail and neither arm extends within six (6) feet five (5) inches from the center line of track.</td>
<td></td>
</tr>
<tr>
<td>3.13 Icing Platforms and Supports</td>
<td>7'8&quot;</td>
</tr>
<tr>
<td>3.14 Operations over portions of track adjacent to icing platforms heretofore constructed with a side clearance of less than seven (7) feet eight (8) inches shall be restricted to the movement or switching of trains containing refrigerator cars to be iced, and the necessary use of such tracks for the unloading of supplies required for the operation of the icing dock.</td>
<td></td>
</tr>
<tr>
<td>3.15 Proposed extension of existing icing platforms at less than</td>
<td></td>
</tr>
</tbody>
</table>
seven (7) feet eight (8) inches shall be referred to the Commission for approval before proceeding with such project.

3.16 All minimum side clearances prescribed in this section are for tangent track. In general, all structures adjacent to curved track, shall have a minimum side clearance one (1) foot greater than the minimum side clearance otherwise required for tangent track. Where the Commission has determined that space is limited, the minimum side clearances for structures adjacent to tracks of not over twelve (12) degree curvature may be the same as for tangent track, but where track curvature exceeds twelve (12) degrees, one-half (½) inch for each degree of the curve shall be added to the minimum side clearance required for tangent track.

3.17 The center line of any track constructed in and along a public street shall be at least ten (10) feet from the property line of said street, or if the street has a lawfully established curb line, such track shall be at least ten (10) feet from such line.

3.18 When tracks are operated exclusively for logging purposes, log rollways which serve them may be erected at less than the minimum side clearances herein prescribed.

3.19 Minimum side clearances authorized in this section are applicable to tracks on which freight cars having a width not greater than ten (10) feet ten (10) inches are transported. Freight cars of a width exceeding ten (10) feet ten (10) inches but not greater than eleven (11) feet one (1) inch may be transported for a period of not more than one (1) year after the effective date of this order, provided they shall be permanently marked, stenciled, or placarded, and such markings maintained in a legible condition reading.

"This Car
EXCESS WIDTH."

All such required markings and placarding shall be placed on the side adjacent to the ladder or handholds near the floor line of the car at each of the four corners.

3.20 Except as provided in subsection 3.19 of this order, if freight cars of a width greater than ten (10) feet ten (10) inches are transported or proposed to be transported, minimum side clearances shall be increased by an amount equal to one-half such additional width, and the distance between parallel tracks as provided in subsection 5.4 of this order shall be increased by the amount of such additional width.

Section 4—Overhead and Side Clearances

C.O. 26D
Minimum overhead and side clearances as prescribed in Sections 2 and 3 of this order may be decreased to the extent defined by the half circumference of a circle having a radius of eight (8) feet six (6) inches and tangent to a horizontal line twenty-two (22) feet six (6) inches above top of rail at a point directly over the center line of track; provided, however, that for tunnels and through bridges such radius may be eight (8) feet, and provided further, that subsections 2.3 and 3.19 of this order shall apply hereto.

Section 5—Clearance Between Parallel Tracks

5.1 The minimum distance between the center lines of parallel standard gauge tracks shall be fourteen (14) feet except as hereinafter provided.

5.2 The center line of any standard gauge track, except a main track or a passing track, parallel and adjacent to a main track or a passing track, shall be at least fifteen (15) feet from the center line of such main track or passing track; provided, however, that where a passing track is adjacent to and at least fifteen (15) feet distant from the main track, any other track may be constructed adjacent to such passing track with clearance prescribed in subsection 5.1 of this order.

5.3 The center line of any standard gauge ladder track, constructed parallel to any other adjacent track, shall have a clearance of not less than twenty (20) feet from the center line of such other track.

5.4 The minimum distance between the center lines of parallel team, house and industry tracks shall be thirteen (13) feet.

5.5 Main, siding and yard tracks constructed prior to the effective date of this order with distance of not less than thirteen (13) feet between track centers may be extended without increasing such distances.

Section 6—Other Conditions and Obstructions Adjacent to Tracks

6.1 No merchandise, material or other articles shall be placed or permitted to remain either on the ground or on platforms adjacent to any track at a distance less than eight (8) feet six (6) inches from the center line of track.

6.2 A suitable line or other marker should be maintained at a distance of eight (8) feet six (6) inches from the center line of track, on all platforms, excluding passenger platforms, to indicate the space along edge of the platform which must be kept clear of merchandise, material or other articles.

Section 7—Lading on Open Top Cars

7.1 No movements shall be made of open top cars containing lading extending in excess of fifteen (15) feet six (6)
inches in height above top of rail or extending laterally in excess of five (5) feet five (5) inches from center line of car, except as hereinafter prescribed.

7.2 The operation of cars, the lading of which extends laterally in excess of five (5) feet five (5) inches from center line of car, shall be restricted to lading the size or dimensions of which cannot be reduced.

7.3 All open top cars with lading extending laterally in excess of five (5) feet five (5) inches from center line of car or in excess of fifteen (15) feet six (6) inches in height above top of rail, shall be placarded on the load itself in a conspicuous place when practicable, and the car shall be marked, stenciled, or placarded at locations specified in subsection 3.19 of this order.

7.4 All open top cars with lading extending laterally in excess of five (5) feet five (5) inches from center line of car shall, if train length permits, be trained at least five (5) cars distant from both the caboose and the engine.

7.5 A train order shall be delivered to every train containing any car the lading of which extends laterally in excess of five (5) feet five and one-half (5½) inches from the center line of car or in excess of fifteen (15) feet six (6) inches in height above top of rail, informing the crew of the train that the train includes such car or cars, except that a message may be used for such notification provided that such notification shall be on paper of a fixed distinctive color other than the color used for other messages and that the conductor and engineer shall be required to make such messages available to all other members of the crew and that such messages shall remain in the records of each railroad for a period of not less than 90 days.

7.6 A train order shall be delivered to every train the operation of which may be affected by the presence or movement of a train containing such wide loads, described in subsection 7.5 of the order, informing the crew of the train of that fact, except that a message may be used for such notification provided that such notification shall be on paper of a fixed distinctive color other than the color used for other messages and that the conductor and engineer shall be required to make such messages available to all other members of the crew and that such messages shall remain in the records of each railroad for a period of not less than 90 days.

7.7 Yard supervisors shall be given notifications sufficiently in advance of the arrival of cars, the lading of which extends laterally in excess of five (5) feet five and one-half (5½) inches from center line of car, to enable them to take
necessary precautions to safeguard employees in yard.

7.8 Cars on which the lading exceeds 15'6" above top of rail if otherwise in compliance with these requirements as to width of lading and the nature of which precludes the probability of employees getting on top of or passing over them are exempt from the conditions of this section, provided, however, that if train length permits, any such cars except cars transporting highway trucks or trailers, multilevel freight cars either loaded or unloaded, automobile underframe cars, wood chip cars transporting wood chips when loaded and covered in such a manner to preclude any material from being dislodged en route, and doublestacked container on flatcar (COFC) equipment when containers are precluded from shifting or movement while in transit, shall be trained at least five cars distant from the caboose. For the purpose of this section, automobile underframe cars are either flat cars upon which automobile underframes are stacked and firmly secured in a horizontal position or gondola cars in which such underframes are placed on end and firmly secured to the gondola cars.

NARROW GAUGE RAILROADS TRANSPORTING FREIGHT CARS

Section 8—Overhead and Side Clearances

8.1 For the operation of equipment on narrow gauge tracks, the minimum overhead clearance shall provide a distance above the top of the highest car operated not less than that provided in this order for cars fifteen (15) feet six (6) inches in height operated on standard gauge tracks; the side clearances and distances between center lines of tracks shall provide a distance from the sides of, or between the widest cars operated, not less than those distances herein provided for cars ten (10) feet ten (10) inches in width operated on standard gauge tracks.

8.2 All other requirements of this order where applicable shall be observed by narrow gauge railroads.

RAILROADS AND STREET RAILROADS NOT TRANSPORTING FREIGHT CARS

Section 9—Overhead and Side Clearances

9.1 The minimum overhead clearance above railroad and street railroad tracks which are not used or proposed to be used for transporting freight cars shall be fourteen (14) feet.

9.2 Minimum side clearances of railroad and street railroad tracks which are not used or proposed to be used for transporting freight cars shall be thirty (30) inches from the side of the widest equipment operated, except that for poles supporting trolley contact conductors between
main line double tracks such distance may be decreased to twenty-four (24) inches.

9.3 Minimum overhead and side clearances as prescribed in this section may be decreased to the extent defined by a line extending diagonally downward from a point fourteen (14) feet above the top of rail and four (4) feet distant laterally from the center line of track to a point eight (8) feet above the top of rail and distant laterally thirty (30) inches from the side of the widest equipment operated.

9.4 Minimum side clearances as prescribed in this section may be decreased in bridges, tunnels or subways to the extent defined by a line extending diagonally upward from a point level with the top of rail and five (5) feet distant laterally from the center line of track to a point four (4) feet above the top of rail and distant laterally thirty (30) inches from the side of the widest equipment operated.

Section 10—Clearance Between Parallel Tangent Tracks

The minimum distance between the center lines of parallel tangent tracks shall be not less than the width of the widest car operated plus twenty-four (24) inches.

Section 11—Exceptions

11.1 Minimum clearances prescribed in Sections 9 and 10 of this order may be reduced along passenger platforms subject to approval by the Commission.

11.2 Minimum clearances prescribed in Sections 9 and 10 of this order may be reduced for trackage located in subways and tunnels or compartments thereof, which are used exclusively for railroad passenger traffic; provided that the passenger equipment operated thereon shall have all windows and other openings effectively barred.

PUBLIC ROADS, HIGHWAYS, AND STREETS CROSSING UNDER OR OVER RAILROADS AND STREET RAILROADS

Section 12—Public Roads, Highways, and Streets Crossing Under Tracks

12.1 Where a railroad or street railroad crosses above any public road, highway, or street, a minimum overhead clearance of fifteen (15) feet shall be provided above the surface of such road, highway or street.

12.2 Where a railroad or street railroad crosses above any public road, highway, or street on a single supporting span, a minimum width of twenty-four (24) feet shall be provided for the opening for such public road, highway or street. Where two or more supporting spans are used over the public road, highway or street, a minimum width of twelve (12) feet shall be provided for each opening.

12.3 When the public road, highway or street is occupied by one or more tracks, minimum clearance dimensions shall be
determined by this Commission for the case under consider-

ation.

Section 13—Public Roads, Highways, and Streets Crossing Over Tracks

13.1 Where a public road, highway, or street crosses above any railroad or street railroad track used or proposed to be used for transporting freight cars, the minimum clearances prescribed in this order for such tracks must be observed.

13.2 Where a public road, highway, or street crosses over a railroad or street railroad track which is not used or proposed to be used for transporting freight cars, minimum clearances as prescribed in this order must be provided, except that a minimum overhead clearance of nineteen (19) feet above top of rail shall be provided unless otherwise ordered by the Commission.

GENERAL REQUIREMENTS

Section 14—Electrical Construction

All clearances of electrical construction over, above, adjacent to, along or across railroads and street railroads shall conform to the requirements specified in General Order No. 95, or such other and further general orders covering similar requirements as may be currently effective.

Section 15—Lesser Clearances Lawfully Created Prior to the Effective Date of This Order

Where the overhead or side clearances between a track and any building, structure or facility are less than the minimum prescribed in this order, but were lawfully created prior to the effective date thereof, the minimum clearances prescribed herein shall be provided whenever the building, structure or facility is relocated or reconstructed; however, the Commission will consider specific requests for the future continuance of heretofore lawful clearances at such reconstructed building, structure or facility when application therefor has been made as provided in subsection 16.2 of this order.

Section 16—Exemptions

16.1 Nothing herein shall be construed as preventing the movement of material over tracks when such material is necessary in the construction or maintenance of such tracks, nor in the movement of special work equipment used in the construction, maintenance or operation of the railroad, provided such movements shall be carried on under such conditions as are necessary to provide for the safety of all concerned.

16.2 If in any particular case, exemption from any of the requirements herein is deemed necessary by the carrier concerned, the Commission will consider the application of
such carrier for such exemption when accompanied by a full statement of the conditions existing and the reason why such exemption is asked. Any exemption so granted will be limited to the particular case covered by the application.

16.3 The Commission reserves the right to modify any of the provisions of these regulations in specific cases when, in the Commission's opinion, public safety, convenience or necessity would be served by so doing.

Section 17—Prior Orders, Decisions, and Exemptions

This order supersedes all regulations governing clearances between tracks of railroads or street railways and structures or obstructions adjacent to such tracks heretofore promulgated under General Order No. 26, General Order No. 26-A, General Order No. 26-B, General Order No. 26-C, and Decisions Nos. 36007 and 39472 in Case No. 2290, provided however, that any exemption or deviation heretofore granted and now in force and effect shall not be affected by this order and shall remain in force and effect until the further order of this Commission.

This order shall be effective February 1, 1948.

Approved and dated at San Francisco, California, this 19th day of January, 1948.

PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

By H. L. Farmer
Acting Executive Director

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GENERAL ORDER No. 118

Public Utilities Commission of the
State of California

REGULATIONS GOVERNING THE CONSTRUCTION, RECONSTRUCTION, AND MAINTENANCE OF WALKWAYS ADJACENT TO RAILROAD TRACKAGE AND THE CONTROL OF VEGETATION ADJACENT THERETO.

Adopted April 9, 1963  Effective April 29, 1963

IT IS ORDERED by the Public Utilities Commission of the State of California that each railroad corporation operating in the State of California shall file its standards for the construction, reconstruction and for the subsequent maintenance of walkways adjacent to its tracks as hereinafter required and any future changes or revisions thereof in accordance with the following provisions and shall hereafter, in the construction and reconstruction of its tracks and walkways, observe its standards filed with the Commission in accordance with the provisions of this order:

1. The standards of each railroad corporation operating in the State of California for the construction or reconstruction of walkways adjacent to its tracks shall be filed with the Commission for its approval not later than thirty days after the effective date of this order.

2. Each railroad corporation operating in the State of California shall file with the Commission any change or reissue of its standards for the construction and reconstruction of walkways adjacent to its tracks. No change or reissue of any such standard shall become effective less than five days after approval thereof by the Commission. If the Commission does not approve or disapprove any standard, change or reissue within sixty days after the filing thereof, the change or reissue shall be deemed to be approved. If the Commission disapproves a proposed standard within the sixty day period, the railroad or railroads submitting such standard may file formal application thereafter to the Commission for approval of said standard.

3. The standards of each railroad corporation shall contain provisions for reasonably safe and adequate walkways adjacent to its tracks in all switching areas, and shall provide that all such walkways shall be maintained and kept reasonably free from vegetation as may be appropriate to prevailing conditions, and shall provide for abatement of weeds and brush adjacent to walkways as necessary to prevent the growth of objectionable vegetation encroaching upon such walkways.

4. Each railroad corporation shall furnish the Commission with the name and address of an appropriate general officer, or officers, to whom
complaints relating to the provision and maintenance of walkways pursuant to this order may be reported.

5. The Commission, after hearing, may order the railroad corporation to eliminate any unsafe walkway condition and may specify such reasonable time within which the improvement shall be completed as may be appropriate under the circumstances.

6. Each railroad corporation operating within the State shall pursue a program of improvement of walkways in all switching areas where a substantial amount of switching is performed, along its main, branch and industrial trackage toward substantial conformity with its standards filed with the Commission pursuant to this order.

7. Deviations from the filed standards or the provisions of this order may be authorized by the Commission for any specific installation for good cause upon application by a railroad corporation; which application shall include a full statement of the conditions which prevail at the time and place involved, and reasons why deviation is deemed necessary.

This order shall be effective April 29, 1963.
Approved and dated at San Francisco, California, this 9th day of April, 1963.

PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

By: R. J. PAJALICH, Secretary
GENERAL ORDER No. 118

Public Utilities Commission of the
State of California

Standards Filed by Carriers Subject to General Order 118

STANDARDS FOR CONSTRUCTION AND RECONSTRUCTION
OF WALKWAYS AND MAINTENANCE THEREOF

Reconstruction shall mean the use of more than 50% of material
such as ties, ballast or fill or more than 50% of the current capital
cost of the improvement.

Where such standards would be in conflict with General Order 26-D,
the provisions of General Order 26-D shall apply.

These standards shall not be applicable to:

(1) Tracks in streets or tunnels, existing bridges, grade separation
structures, ferry slips, road crossings, trestles, cattle guards, tracks
adjacent to walks, abutments, platforms, pillars and structures where
minimum widths are otherwise provided for in General Order 26-D.

(2) Within cities, towns, populated or congested areas where in-
sufficient width of right of way is available, except these standards
shall apply to the full width of the right of way available.

(3) During periods of heavy rain or snow, derailments, rock and
earth slides, and other abnormal periods, including reasonable dura-
tion of time after return to normal to permit necessary restoration.

Walkways shall provide a reasonable regular surface with gradual
slope not to exceed approximately one inch to eight inches.
STANDARD No. 1
WALKWAYS ALONG MAIN LINE TRACKS
GENERAL ORDER No. 118

STANDARD No. 2
WALKWAYS ALONG MAIN LINE TRACKS

STANDARD No. 2-A
WALKWAYS ALONG SHORT LINE AND BRANCH LINE TRACKS
STANDARD No. 3

WALKWAYS AT MAIN LINE SWITCHES ENTERING YARDS AND SERVING INDUSTRY TRACKS EXCEPT AS PROVIDED IN STANDARD No. 5
STANDARD No. 4
WALKWAYS ALONG SHORT LINE AND BRANCH LINE TRACKS
STANDARD No. 6

WALKWAYS IN YARDS AND POINTS WHERE INDUSTRIAL SWITCHING IS PERFORMED, BUT NOT LESS THAN 50 FT. IN ADVANCE OF SWITCH.
APPENDIX E:

FEDERAL RAILROAD ADMINISTRATION
PART 213 -- TRACK SAFETY STANDARDS

Subpart A -- General

Subpart B -- Roadbed

Subpart C -- Track Geometry

Subpart D -- Track Structure

Subpart E -- Track Appliances and Track-Related Devices

Subpart F -- Inspection

Subpart G -- Train Operations at Track Classes 6 and Higher

Appendix A to Part 213 -- Maximum Allowable Curving Speeds
Appendix B to Part 213 -- Schedule of Civil Penalties
Appendix C to Part 213 -- Statement of Agency Policy on the Safety of Railroad Bridges

Source: 63 FR 34029, June 22, 1998, unless otherwise noted.

[63 FR 34029, June 22, 1998; 63 FR 45959, Aug. 28, 1998]
Appendix C to Part 213 -- Statement of Agency Policy on the Safety of Railroad Bridges

1. The structural integrity of bridges that carry railroad tracks is important to the safety of railroad employees and to the public. The responsibility for the safety of railroad bridges rests with the owner of the track carried by the bridge, together with any other party to whom that responsibility has been assigned by the track owner.

2. The capacity of a bridge to safely support its traffic can be determined only by intelligent application of engineering principles and the laws of physics. Bridge owners should use, as FRA does, those principles to assess the integrity of railroad bridges.

3. The long term ability of a structure to perform its function is an economic issue beyond the intent of this policy. In assessing a bridge's structural condition, FRA focuses on the present safety of the structure, rather than its appearance or long term usefulness.

4. FRA inspectors conduct regular evaluations of railroad bridge inspection and management practices. The objective of these evaluations is to document the practices of the evaluated railroad and to disclose any program weaknesses that could affect the safety of the public or railroad employees. When the evaluation discloses problems, FRA seeks a cooperative resolution. If safety is jeopardized by a bridge owner's failure to resolve a bridge problem, FRA will use available legal means, including issuance of emergency orders, to protect the safety of railroad employees and the public.

5. This policy statement addresses the integrity of bridges that carry railroad tracks. It does not address the integrity of other types of structures on railroad property (i.e., tunnels or bridges carrying highways) or other features over railroads (i.e., highway overpasses).

6. The guidelines published in this statement are advisory, rather than regulatory, in nature. They indicate those elements FRA deems essential to successful bridge management programs. FRA uses the guidelines when evaluating bridge inspection and management practices.

GUIDELINES

1. Responsibility for safety of railroad bridges
   (a) TRACK OWNER. The owner of the track on a bridge, or another person assuming responsibility for the compliance of that track with this Part under provisions of §213.5, is responsible for ensuring that the bridge is capable of safely carrying all railroad traffic operated on that track, and for specifying the maximum loads that may be operated over the bridge.
   (b) DIVIDED OWNERSHIP. Where the owner of the track on a bridge does not own the bridge, the track owner should ensure that the bridge owner is following a program that will maintain the integrity of the bridge. The track owner either should participate in the inspection of the bridge, or should obtain and review reports of inspections performed by the bridge owner. The track owner should maintain current information regarding loads that may be operated over the bridge, either from its own engineering evaluations or as provided by a competent engineer representing the bridge owner. Information on permissible loads may be communicated by the bridge owner either in terms of specific car and locomotive configurations and weights, or as values representing a standard railroad bridge rating reference system. The most common standard bridge rating reference system incorporated in the Manual for Railway Engineering of the American Railway Engineering and Maintenance of Way Association is the dimensional and proportional load configuration devised by Theodore Cooper. Other reference systems may be used where convenient, provided their effects can be defined in terms of shear, bending and pier reactions as necessary for a comprehensive evaluation and statement of the capacity of a bridge.
   (c) OTHER RAILROADS. The owner of the track on a bridge should advise other railroads operating on that track of the maximum loads permitted on the bridge stated in terms of car and locomotive configurations and weights. No railroad should operate a load which exceeds those limits without specific authority from, and in accordance with restrictions placed by, the track owner.
2. CAPACITY OF RAILROAD BRIDGES

(a) DETERMINATION. The safe capacity of bridges should be determined by competent engineers using accepted principles of structural design and analysis.

(b) ANALYSIS. Proper analysis of a bridge means knowledge of the actual dimensions, materials and properties of the structural members of the bridge, their condition, and the stresses imposed in those members by the service loads.

(c) RATING. The factors which were used for the design of a bridge can generally be used to determine and rate the load capacity of a bridge provided:
   (i) The condition of the bridge has not changed significantly, and
   (ii) The stresses resulting from the service loads can be correlated to the stresses for which the bridge was designed or rated.

3. RAILROAD BRIDGE LOADS

(a) CONTROL OF LOADS. The operating instructions for each railroad operating over bridges should include provisions to restrict the movement of cars and locomotives whose weight or configuration exceed the nominal capacity of the bridges.

(b) AUTHORITY FOR EXCEPTIONS. Equipment exceeding the nominal weight restriction on a bridge should be operated only under conditions determined by a competent engineer who has properly analyzed the stresses resulting from the proposed loads.

(c) OPERATING CONDITIONS. Operating conditions for exceptional loads may include speed restrictions, restriction of traffic from adjacent multiple tracks, and weight limitations on adjacent cars in the same train.

4. RAILROAD BRIDGE RECORDS

(a) The organization responsible for the safety of a bridge should keep design, construction, maintenance and repair records readily accessible to permit the determination of safe loads. Having design or rating drawings and calculations that conform to the actual structure greatly simplifies the process of making accurate determinations of safe bridge loads.

(b) Organizations acquiring railroad property should obtain original or usable copies of all bridge records and drawings, and protect or maintain knowledge of the location of the original records.

5. SPECIFICATIONS FOR DESIGN AND RATING OF RAILROAD BRIDGES

(a) The recommended specifications for the design and rating of bridges are those found in the Manual for Railway Engineering published by the American Railway Engineering and Maintenance-of-way Association. These specifications incorporate recognized principles of structural design and analysis to provide for the safe and economic utilization of railroad bridges during their expected useful lives. These specifications are continually reviewed and revised by committees of competent engineers. Other specifications for design and rating, however, have been successfully used by some railroads and may continue to be suitable.

(b) A bridge can be rated for capacity according to current specifications regardless of the specification to which it was originally designed.

6. PERIODIC INSPECTIONS OF RAILROAD BRIDGES

(a) Periodic bridge inspections by competent inspectors are necessary to determine whether a structure conforms to its design or rating condition and, if not, the degree of nonconformity.
(b) The prevailing practice throughout the railroad industry is to inspect railroad bridges at least annually. Inspections at more frequent intervals may be indicated by the nature or condition of a structure or intensive traffic levels.

7. UNDERWATER INSPECTIONS OF RAILROAD BRIDGES

(a) Inspections of bridges should include measuring and recording the condition of substructure support at locations subject to erosion from moving water.
(b) Stream beds often are not visible to the inspector. Indirect measurements by sounding, probing, or any other appropriate means are necessary in those cases. A series of records of those readings will provide the best information in the event unexpected changes suddenly occur. Where such indirect measurements do not provide the necessary assurance of foundation integrity, diving inspections should be performed as prescribed by a competent engineer.

8. SEISMIC CONSIDERATIONS

(a) Owners of bridges should be aware of the risks posed by earthquakes in the areas in which their bridges are located. Precautions should be taken to protect the safety of trains and the public following an earthquake.
(b) Contingency plans for seismic events should be prepared in advance, taking into account the potential for seismic activity in an area.
(c) The predicted attenuation of ground motion varies considerably within the United States. Local ground motion attenuation values and the magnitude of an earthquake both influence the extent of the area affected by an earthquake. Regions with low frequency of seismic events produce less data from which to predict attenuation factors. That uncertainty should be considered when designating the area in which precautions should be taken following the first notice of an earthquake. In fact, earthquakes in such regions might propagate their effects over much wider areas than earthquakes of the same magnitude occurring in regions with frequent seismic activity.

9. SPECIAL INSPECTIONS OF RAILROAD BRIDGES

(a) A special bridge inspection should be performed after an occurrence that might have reduced the capacity of the bridge, such as a flood, an earthquake, a derailment, or an unusual impact.
(b) When a railroad learns that a bridge might have suffered damage through an unusual occurrence, it should restrict train operations over the bridge until the bridge is inspected and evaluated.

10. RAILROAD BRIDGE INSPECTION RECORDS

(a) Bridge inspections should be recorded. Records should identify the structure inspected, the date of the inspection, the name of the inspector, the components inspected, and their condition.
(b) Information from bridge inspection reports should be incorporated into a bridge management program to ensure that exceptions on the reports are corrected or accounted for. A series of inspection reports prepared over time should be maintained so as to provide a valuable record of trends and rates of degradation of bridge components. The reports should be structured to promote comprehensive inspections and effective communication between an inspector and an engineer who performs an analysis of a bridge.
(c) An inspection report should be comprehensible to a competent person without interpretation by the reporting inspector.
11. RAILROAD BRIDGE INSPECTORS AND ENGINEERS

(a) Bridge inspections should be performed by technicians whose training and experience enable them to detect and record indications of distress on a bridge. Inspectors should provide accurate measurements and other information about the condition of the bridge in enough detail so that an engineer can make a proper evaluation of the safety of the bridge.

(b) Accurate information about the condition of a bridge should be evaluated by an engineer who is competent to determine the capacity of the bridge. The inspector and the evaluator often are not the same individual. The quality of the bridge evaluation depends on the quality of the communication between them.

12. SCHEDULING INSPECTIONS

(a) A bridge management program should include a means to ensure that each bridge under the program is inspected at the frequency prescribed for that bridge by a competent engineer.

(b) Bridge inspections should be scheduled from an accurate bridge inventory list that includes the due date of the next inspection.

13. SPECIAL CONSIDERATIONS FOR RAILROAD BRIDGES

Railroad bridges differ from other types of bridges in the types of loads they carry, in their modes of failure and indications of distress, and in their construction details and components. Proper inspection and analysis of railroad bridges require familiarity with the loads, details and indications of distress that are unique to this class of structure. Particular care should be taken that modifications to railroad bridges, including retrofits for protection against the effects of earthquakes, are suitable for the structure to which they are to be applied. Modifications should not adversely affect the serviceability of the bridge nor its accessibility for periodic or special inspection.

[65 FR 52670, Aug. 30, 2000]
APPENDIX F:

AREMA LIVE LOAD MOMENTS, SHEARS, AND REACTIONS
1.15.1 LIVE LOAD MOMENTS, SHEARS, AND REACTIONS (1995)

For the maximum moments, shears and pier (or floorbeam) reactions for Cooper E 80 live load (Figure 1-2) or alternative live load (Figure 1-3) refer to Table 1-17.

Table 1-17. Maximum Moments, Shears and Pier (or Floorbeam) Reactions for Cooper E 80 Live Load or Alternative Live Load

All Values are for one rail (one-half track load)

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<tr>
<th>Span Length Ft</th>
<th>Maximum Moment Ft–Kips</th>
<th>Maximum Moment Quarter Point Ft–Kips</th>
<th>Maximum Shears At End Kips</th>
<th>Maximum Shears At Quarter Point Kips</th>
<th>Maximum Shears At Center Kips</th>
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### Steel Structures

**Table 1-17. Maximum Moments, Shears and Pier (or Floorbeam) Reactions for Cooper E 80 Live Load or Alternative Live Load (Continued)**

All Values are for one rail (one-half track load)

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<th>Maximum Moment Quarter Point Ft-Kips</th>
<th>Maximum Shears Kips</th>
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Note 1: Quantities for alternate loading marked.

Note 2: At center of span.
1.15.2 SUPPLEMENTAL FORMULAS (1993)

Units are feet and kips.

For $L \geq 288$: $M_{0.5} = 0.5L^2 + 3800$

For $L \geq 101$: $V_e = 2L + 144 - \frac{4398}{L}$

For $L \geq 134.67$: $V_{0.25} = 1.124L + 103 - \frac{4238}{L}$

For $202 \leq L \leq 296$: $V_{0.5} = 0.5L + 62 - \frac{4238}{L}$

For $L > 296$: $V_{0.5} = 0.5L + 66 - \frac{5422}{L}$

For $L \geq 144$: $R = 4L + \frac{7600}{L}$

where:

$L =$ span length

$M_{0.5}$ and $M_{0.25} =$ maximum moments at center and at $\frac{1}{4}$ point respectively

$V_e, V_{0.25}$ and $V_{0.5} =$ maximum shear at end of span, at $\frac{1}{4}$ point and at center, respectively

$R =$ maximum pier reaction from two adjoining spans each of length $L$
APPENDIX G:

EQUIVALENT E80 LOAD FOR EQUIPMENT
Load & Spacing Chart for a Typical 100-Ton Freight Car

Coupler to Coupler Length: 53.13 ft

<table>
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<th>SPAN FT</th>
<th>BENDING FT-KIPS</th>
<th>END SHEAR KIPS</th>
<th>FLOOR BEAM REACTION KIPS</th>
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Moment and Shear Table for 100-Ton car (263000 lbs.)
(String of 10 Cars)
Load & Spacing Chart for a Standard AAR 286,000 lb Freight Car

Coupler to Coupler Length : 41.88 ft

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<tr>
<th>SPAN FT</th>
<th>BENDING FT-KIPS</th>
<th>END SHEAR KIPS</th>
<th>FLOOR BEAM REACTION KIPS</th>
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Moment and Shear Table for 110-Ton car (286000 lbs.)
(String of 10 Cars)
Load & Spacing Chart for a Typical 125-Ton Freight Car

Coupler to Coupler Length : 57.54 ft

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Moment and Shear Table for 125-Ton Car (315000 lbs.)
(String of 10 Cars)
Load & Spacing Chart for a PCJPB Locomotive

Coupler to Coupler Length : 64.25 ft

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<td>904.2</td>
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Moment and Shear Table for 4-PCJPB Locomotives
(String of 4 - F40PH-2C (BLC))
Load & Spacing Chart for a PCJPB Locomotive + Passenger Car

Locomotive Coupler to Coupler Length : 64.25 ft
Locomotive Weight : 290 k

Passenger Car Coupler to Coupler Length : 85 ft
Passenger Car Weight : 127 k
240 Passengers at 150 lbs : 36 k
163 k

<table>
<thead>
<tr>
<th>SPAN FT</th>
<th>BENDING FT-KIPS</th>
<th>END SHEAR KIPS</th>
<th>FLOOR BEAM REACTION KIPS</th>
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<tbody>
<tr>
<td>8</td>
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<td>72.5</td>
<td>72.5</td>
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<td>10</td>
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<td>200</td>
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</table>

Moment and Shear Table for PCJPB 1 Locomotives + 5 Passenger Cars
(1-F40PH-2C Locomotive (BLC) with 5-Gallery Cars)
Load & Spacing Chart for a SD-45 Freight Locomotive

Coupler to Coupler Length: 70.66 ft

<table>
<thead>
<tr>
<th>SPAN FT</th>
<th>BENDING FT-KIPS</th>
<th>END SHEAR KIPS</th>
<th>FLOOR BEAM REACTION KIPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>124.0</td>
<td>71.3</td>
<td>80.6</td>
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<td>10</td>
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<td>12</td>
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<td>115.7</td>
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<td>740.9</td>
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Moment and Shear Table for a SD-45 Freight Locomotive
(String of 5 Locomotives)
APPENDIX H:

MOMENT AND SHEAR RATING OF EQUIPMENT
Moment Rating of Equipment

![Graph showing moment rating of equipment with various types of locomotives and cars against span length in feet.](image-url)

- JPB Locomotive w/ 5 Cars
- 4 JPB Locomotives
- 5 SD-45 Locomotives
- 10-263,000lb Cars
- 10-286,000lb Cars
- 10-315,000lb Cars
Shear Rating of Equipment

![Graph showing shear ratings for different equipment configurations vs. span length.](image)

- JPB Locomotive w/ 5 Cars
- 4 JPB Locomotives
- 5 SD-45 Locomotives
- 10-263,000lb Cars
- 10-286,000lb Cars
- 10-315,000lb Cars
APPENDIX I:

LOCOMOTIVES AND PASSENGER CARS
Locomotive MP36PH – 3C
Unit #923 to #928
**MP36PH-3C for Caltrain Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>Length over coupler pulling faces</td>
<td>70 feet</td>
</tr>
<tr>
<td>Height over cab and carbody (with 42' wheels)</td>
<td>15 feet, 6 inches</td>
</tr>
<tr>
<td>Width over cab handrails</td>
<td>10 feet, 7-1/2 inches</td>
</tr>
<tr>
<td>Bolster centers</td>
<td>43 feet, 3 inches</td>
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<tr>
<td>Weight on rails (fouraxle)</td>
<td>293,500 pounds</td>
</tr>
<tr>
<td>Starting tractive effort</td>
<td>75,000 pounds</td>
</tr>
<tr>
<td>Continuous tractive effort</td>
<td>65,200 pounds @ 18.2 mph</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>82 mph</td>
</tr>
<tr>
<td>Curve negotiation (single-unit)</td>
<td>248 feet (23.1 degrees)</td>
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<tr>
<td>Curve negotiation w/5-foot car</td>
<td>315 feet (18.2 degrees)</td>
</tr>
<tr>
<td>Prime mover</td>
<td>16-645PSB, turbocharged</td>
</tr>
<tr>
<td>Maximum prime mover engine speed</td>
<td>954 rpm</td>
</tr>
<tr>
<td>Prime mover engine idle speed</td>
<td>270 rpm</td>
</tr>
<tr>
<td>Prime mover engine low idle speed</td>
<td>200 rpm</td>
</tr>
<tr>
<td>Engine control system</td>
<td>Webtec D-Iron OES-III</td>
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<tr>
<td>EPA emission compliance</td>
<td>Tier 1</td>
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<tr>
<td>Main generator (traction/compressor alternators)</td>
<td>AR10JBA/CAS</td>
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<tr>
<td>Auxiliary generator</td>
<td>185W &quot;SuperAux&quot;</td>
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<tr>
<td>Traction motors</td>
<td>D7A, d.c.</td>
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<tr>
<td>Trucks</td>
<td>4-wheel, outside swing hanger</td>
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<tr>
<td>Wheelbase</td>
<td>9 feet, 0 inches</td>
</tr>
<tr>
<td>Wheel diameter</td>
<td>42 inches</td>
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<tr>
<td>Braking system</td>
<td>Webtec 26LUL-CSU/Blended</td>
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<tr>
<td>Fuel capacity</td>
<td>2,000 gallons</td>
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<tr>
<td>Lube oil capacity</td>
<td>243 gallons</td>
</tr>
<tr>
<td>Cooling system capacity</td>
<td>270 gallons</td>
</tr>
<tr>
<td>Sand capacity, front/rear</td>
<td>14/20 cubic feet</td>
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<td>HEP output</td>
<td>800kW</td>
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<tr>
<td>HEP engine</td>
<td>CAT 3412 DITA/BSE</td>
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<tr>
<td>HEP alternator</td>
<td>Marathon 572RS-6541</td>
</tr>
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</table>

MotivePower
A Webtec Company

MotivePower Corporation
3600 Boonton Avenue
Boonton, New Jersey 07005
864-222-4450
MotivePower.com
Locomotive F40PH – 3C
Fig. 0-1: F40PH-3C Locomotive, Left Side View (Showing Equipment)

1. Coupler - Type "F"
2. Collision Post
3. Control Console Desk
4. Air Conditioner
5. Main Electrical/High Voltage Cabinet
6. Engine Air Intake Filter Assembly
7. Inertial Filter Blower
8. Traction Motor Blower
9. 18kw Aux. Generator (AC)
10. Silencer
11. 16-645E3C Engine
12. 5-Chime Horn
13. Dynamic Brake Hatch
14. Engine Room Vent
15. Governor
16. Engine Water Tank
17. Cooling Fans
18. Radiators
19. Lube Oil Cooler
20. HEP Engine Room Partition
21. HEP Intake Inertial Filter Blower
22. HEP Inertial Filter Dust Bin Blower
23. HEP Cooling Fan
24. HEP Radiator (5’7” row)
25. HEP Water Tank
26. HEP Engine Muffler
27. HEP Relay Cabinet
28. HEP Contactor Cabinet
29. Hand Brake
30. HEP Engine and Alternator
31. Truck Assembly - GP Single Shoe
32. Yaw Damper
33. Air Compressor
34. Fuel Pump
35. Lube Oil Filter
36. Fuel Preheater/AMOT Valve
37. Fuel Filter Assembly
38. Lube Oil Strainer
39. 2,500 Gallon Fuel Tank
40. Engine Inspection Cover
41. Turbo Lube Pump and Aux. Lube Filter
42. Battery Box
43. Turbo Lube Filter
44. Starting Motors
45. Twin Tower Air Dryer
46. Turbocharger
47. AR10/D14 Main Alternator
48. Electrical Cabinet Air Filter
49. Air Brake Compartment (Subbase)
50. Sand Nozzle
### GENERAL DATA - F40PH-2C LOCOMOTIVE

<table>
<thead>
<tr>
<th>Model Designation</th>
<th>F40PH-2C</th>
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<tr>
<td>Locomotive Type</td>
<td>(B-B)0440</td>
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<tr>
<td>Locomotive Horsepower</td>
<td>3200</td>
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#### Propulsion Diesel Engine

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<tr>
<th>Model</th>
<th>645E3C</th>
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<tbody>
<tr>
<td>Type</td>
<td>Turbocharged</td>
</tr>
<tr>
<td>Number of Cylinders</td>
<td>16</td>
</tr>
<tr>
<td>Cylinder Arrangement</td>
<td>45° “V”</td>
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<tr>
<td>Cylinder Bore and Stroke</td>
<td>9-1/16” x 10”</td>
</tr>
<tr>
<td>Operating Principle</td>
<td>2-Stroke Cycle, Water Cooled</td>
</tr>
<tr>
<td>Full Speed</td>
<td>916 RPM</td>
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<tr>
<td>Idle Speed</td>
<td></td>
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<tr>
<td>Normal</td>
<td>410 RPM</td>
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<tr>
<td>Low</td>
<td>260 RPM</td>
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#### Main Generator Model

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<tr>
<th>Traction Alternator</th>
<th>AR10A6-D14</th>
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<td>(RectifiedOutput)</td>
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<tr>
<td>Number of Poles</td>
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<td>Maximum Voltage (DC)</td>
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<tr>
<td>Maximum Continuous</td>
<td></td>
</tr>
<tr>
<td>Current Rating</td>
<td>4200 Amperes</td>
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<td>Companion Alternator</td>
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<td>Nominal Voltage (AC)</td>
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#### HEP (Head End Power) Diesel Engine

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<th>Model</th>
<th>Cummins KTA-19G4</th>
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<td>Water Cooled</td>
</tr>
<tr>
<td>Number of Cylinders</td>
<td>6</td>
</tr>
<tr>
<td>Cylinder Arrangement</td>
<td>In-line</td>
</tr>
<tr>
<td>Cylinder Bore and Stroke</td>
<td>5.4 x 6”</td>
</tr>
<tr>
<td>Operating Principle</td>
<td>4-Stroke Cycle, Turbocharged</td>
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<tr>
<td>Full Speed</td>
<td>1800 RPM</td>
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</table>

#### HEP (Head End Power) Generator

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<th>Marathon Model</th>
<th>571RSL4534</th>
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<tbody>
<tr>
<td>Available Power Output</td>
<td>500 kW</td>
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<tr>
<td>Nominal Voltage (AC)</td>
<td>480</td>
</tr>
<tr>
<td>Maximum Continuous</td>
<td></td>
</tr>
<tr>
<td>Current Rating</td>
<td>750 Amperes Per Phase</td>
</tr>
<tr>
<td>Frequency (At 1800 RPM)</td>
<td>60 Hz</td>
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<tr>
<td>Auxiliary Generator Voltage (AC)</td>
<td>55 Volts</td>
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<tr>
<td>Rating</td>
<td>18 kW</td>
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#### Traction Motors

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<td>Number</td>
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<tr>
<td>Type</td>
<td>DC, Series Wound Axle Hung</td>
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<tr>
<td>Current Rating</td>
<td></td>
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<tr>
<td>Maximum Continuous</td>
<td>1050 Amperes</td>
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</table>

#### Driving Wheels

| Number                      | 4 Pair                           |
Diameter ................................................................. 42" 

Speed Limitations With Gear Ratio 
   Gear Ratio .......................................................... 60:17 
   Max. MPH without ATS ............................................ 79 MPH 
   Overspeed Set At .................................................. 82 MPH 
   Min. Continuous MPH .............................................. 13.3 

Curve Negotiation Capability 
   • Truck swing limits single unit curve negotiation to a 33° or 174 ft. radius curve. 
   • Two similar units coupled in multiple limited by coupler swing to a 26° or 222 ft. radius curve (equipped with "F" couplers). 
   • Locomotive coupled to a 85' 4" passenger car limited by car coupler swing to a 20° or 285 ft. radius curve (equipped with "F" coupler). 
   • Locomotive coupled to an 85' 4" passenger car limited by jumper cables to a number 8 crossover on 12' 2" track centers. 

Major Dimensions 
   Height Over Air Conditioner ....................................... 15' 10-5/16" 
   Width Over Hand Rails 
      And Vents ......................................................... 10' 8-3/4" 
   Distance Over Coupler Pulling Faces .............................. 64' 3" 

Loaded Weight On Rails (Nominal) .................................. 282,000 lbs. 
Weight On Drivers ................................................... 100% 

Supplies 
   Lube Oil Capacity 
      Standard Capacity Oil Pan ..................................... 243 Gal. 
   Volume Between Low And Full On Dipstick 
      Standard Capacity Oil Pan ..................................... 47 Gal. 
   Cooling System Capacity .......................................... 254 Gal. 
   Sand Capacity 
      Hood End Sand Boxes ......................................... 24.5 Cu. Ft. 
      Cab End Sand Boxes ........................................... 24.5 Cu. Ft. 
   Fuel Capacity ..................................................... 2500 Gal. 
   Air Brakes .......................................................... Type 26L/30A 

Air Compressor 
   Type ................................................................. 2 Stage WLN 
   Number Of Cylinders ............................................... 3 
   Capacity (At 900 RPM) ............................................ 254 Cu. Ft./Min. 
   Air Compressor Cooling Engine Coolant 
   Lube Oil Capacity .................................................. 10-1/2 Gal. 

Storage Battery 
   Number of Cells .................................................... 32 
   Voltage .............................................................. 64 
   Rating (8 Hour) ..................................................... 500 Amp. Hr.
WEIGHTS

The weights as listed below are approximate and are intended as an aid in determining the handling procedure to be used.

<table>
<thead>
<tr>
<th>Item</th>
<th>kg</th>
<th>lb</th>
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<tbody>
<tr>
<td>16-645E3C Propulsion Diesel Engine</td>
<td>16445</td>
<td>36,255</td>
</tr>
<tr>
<td>Starter Motor</td>
<td>35</td>
<td>78</td>
</tr>
<tr>
<td>Starter Motor Bracket</td>
<td>26</td>
<td>58</td>
</tr>
<tr>
<td>Engine Governor</td>
<td>54</td>
<td>120</td>
</tr>
<tr>
<td>Turbocharger</td>
<td>816</td>
<td>1800</td>
</tr>
<tr>
<td>Main Generator And Companion Alternator Assembly</td>
<td>7711</td>
<td>17,000</td>
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<tr>
<td>HEP (Head End Power) Diesel Engine</td>
<td>3085</td>
<td>6800</td>
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<td>HEP (Head End Power) Generator</td>
<td>1792</td>
<td>3950</td>
</tr>
<tr>
<td>Auxiliary Generator And Blower Assembly</td>
<td>454</td>
<td>1000</td>
</tr>
<tr>
<td>Inertial Air Filter</td>
<td>272</td>
<td>600</td>
</tr>
<tr>
<td>Inertial Filter Screen</td>
<td>16</td>
<td>35</td>
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<tr>
<td>Inertial Filter Hatch (Less Filters)</td>
<td>227</td>
<td>500</td>
</tr>
<tr>
<td>Fuel Tank</td>
<td>1701</td>
<td>3750</td>
</tr>
<tr>
<td>Truck Assembly (Single Shoe; Hollow Bolster)</td>
<td>16783</td>
<td>37,000</td>
</tr>
<tr>
<td>Traction Motor</td>
<td>2722</td>
<td>6000</td>
</tr>
<tr>
<td>Axle</td>
<td>601</td>
<td>1325</td>
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<tr>
<td>Wheel</td>
<td>460</td>
<td>1015</td>
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<tr>
<td>Gear 57 Tooth</td>
<td>186</td>
<td>409</td>
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<tr>
<td>Bearing - Inner Race</td>
<td>15</td>
<td>33</td>
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<tr>
<td>Air Compressor</td>
<td>1055</td>
<td>2325</td>
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<td>Air Compressor Shaft</td>
<td>62</td>
<td>136</td>
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<tr>
<td>Air Compressor Shaft Guard</td>
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<td>68</td>
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<tr>
<td>Air Compressor Coupling</td>
<td>22</td>
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<tr>
<td>Lube Oil Cooler</td>
<td>383</td>
<td>845</td>
</tr>
<tr>
<td>Lube Oil Filter</td>
<td>227</td>
<td>500</td>
</tr>
<tr>
<td>Fuel Pump Assembly</td>
<td>37</td>
<td>81</td>
</tr>
<tr>
<td>Fuel Suction Strainer</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Fuel Filter</td>
<td>27</td>
<td>60</td>
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<tr>
<td>Temperature Switch Manifold</td>
<td>9</td>
<td>20</td>
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<tr>
<td>Load Regulator Vane Motor</td>
<td>16</td>
<td>36</td>
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<tr>
<td>Fan Grill Assembly</td>
<td>86</td>
<td>190</td>
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<tr>
<td>Radiator Fan Assembly</td>
<td>318</td>
<td>700</td>
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<tr>
<td>Radiator Core</td>
<td>147</td>
<td>325</td>
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<tr>
<td>Cab Heater</td>
<td>32</td>
<td>71</td>
</tr>
<tr>
<td>Storage Battery (Per Unit)</td>
<td>131</td>
<td>289</td>
</tr>
<tr>
<td>SCR (Generator Excitation)</td>
<td>13</td>
<td>29</td>
</tr>
</tbody>
</table>
Locomotive F40PH – 2C
(Boise Locomotive - BLC)
Unit # 920 to 922
1.1 GENERAL DATA

F40PH-2C LOCOMOTIVE

Model Designation .................. F40PH-2C
Locomotive Type .................. (B-B)0440
Locomotive Horsepower .............. 3200

Propulsion Diesel Engine

Model .......................... 645E3C
Type .......................... Turbocharged
Number of Cylinders ................ 16
Cylinder Arrangement ................. 45° "V"
Cylinder Bore and Stroke ............. 9-1/16" x 10"
Operating Principle ................ 2-Stroke Cycle,
Turbocharged, Unit Injection, Water Cooled
Full Speed ....................... 916 RPM
Idle Speed
Normal .......................... 410 RPM
Low Idle .......................... 260 RPM

Main Generator Model ................ AR10A5-CA5
Traction Alternator .................. AR10
(Rectified Output) .................. AR10
Number of Poles ..................... 10
Maximum Voltage (DC) ................ 1300
Maximum Continuous Current Rating .......... 4200 Amperes
Companion Alternator ................. CA5
Nominal Voltage (AC) ................ 215

HEP (Head End Power) Generator

Model .................. Cummins KTA-19G4
Type .................. Water Cooled Diesel
Number of Cylinders ................ 6
Cylinder Arrangement ................. In-line
Cylinder Bore and Stroke ............. 6.25" x 6.25"
Operating Principle ................ 4-Stroke Cycle,
Turbocharged
Full Speed ....................... 1800 RPM

HEP (Head End Power) Generator

Marathon Model .................. 571RSL4534
Available Power Output .............. 500 kW
Nominal Voltage (AC) ................ 480
Maximum Continuous Current Rating .......... 750 Amperes Per Phase
Frequency (At 1800 RPM) ............ 60 Hz
Auxiliary Generator Voltage (AC) .... 55 Volts
Rating .......................... 18 kW

Traction Motors

Model .................. D78
Number ...................... 4
Type .................. DC, Series Wound Axle Hung
Current Rating
Maximum Continuous ................ 1050 Amperes

Driving Wheels

Number ...................... 4 Pair
Diameter ..................... 42"

Speed Limitations With Gear Ratio

Gear Ratio ...................... 60:17
Max. MPH ..................... 79 MPH
Overspeed Set At ................ 82 MPH
Min. Continuous MPH ................ 13.3

Curve Negotiation Capability

- Truck swing limits single unit curve negotiation to a 33° or 174 ft. radius curve.
- Two similar units coupled in multiple limited by coupler swing to a 26° or 222 ft. radius curve (equipped with "F" couplers).
- Locomotive coupled to a 85' 4" passenger car limited by car coupler swing to a 20° or 285 ft. radius curve (equipped with "F" coupler).
- Locomotive coupled to an 85' 4" passenger car limited by jumper cables to a number 8 crossover on 12' 2" track centers.
**F40PH-2C OPERATOR'S MANUAL**
**SECTION 1 - GENERAL DESCRIPTION**

---

**Major Dimensions**
- Height Over Cooling Fans: 15' 10-5/16"
- Width Over Hand Rails: 10' 8-3/4"
- Distance Over Coupler Pulling Faces: 64' 3"

**Weight On Rails**
- (Nominal): 282,000 lbs.
- Weight On Drivers: 100%

**Supplies**
- Lube Oil Capacity: 395 Gal.
- Volume Between Low And Full On Dipstick: 184 Gal.
- Cooling System Capacity: 254 Gal.
- Cab End Sand Boxes: 24.5 Cu. Ft.
- Fuel Capacity: 2500 Gal.
- Air Brakes: Type 26L/CS-2
- Air Compressor
  - Type: 2 Stage WLN
  - Number Of Cylinders: 3
  - Capacity (At 900 RPM): 254 Cu. Ft./Min.
  - Air Compressor Cooling: Engine Coolant
  - Lube Oil Capacity: 10-1/2 Gal.

**Storage Battery**
- Number of Cells: 32
- Voltage: 64
- Rating (8 Hour): 500 Amp. Hr.

---

*Fig. 1-1: F40PH-2C Locomotive, Left Side View*
Fig. 1-2: F40PH-2C Locomotive, Left Side View (Showing Equipment)

1. Snow Plow Pilot  
2. Coupler - Type "F"  
3. Sand Box  
4. Collision Post  
5. Sandfill  
6. Control Console Desk  
7. Headlight  
8. Air Conditioner  
9. Antenna  
10. Main Electrical/High Voltage Cabinet  
11. Inertial Carbody Filters  
12. Engine Air Intake Filter Assembly  
13. Inertial Filter Blower  
14. Traction Motor Blower  
15. 18kw Aux. Generator  
16. Silencer  
17. 16-645E3C Engine  
18. Dynamic Brake Fan  
19. S-Chime Horn  
20. Dynamic Brake Hatch  
21. Engine Room Vent  
22. Governor  
23. Engine Water Tank  
24. Cooling Fans  
25. Radiators  
26. Lube Oil Cooler  
27. HEP Engine Room Partition  
28. HEP Intake Inertial Filter Blower  
29. HEP Inertial Filter Dust Bin Blower  
30. HEP Cooling Fan  
31. HEP Radiator (6'6" row)  
32. HEP Water Tank  
33. HEP Engine Muffler  
34. HEP Electrical Cabinets  
35. Hand Brake  
36. HEP Engine and Alternator  
37. Truck Assembly - GP Single Shoe  
38. Yaw Damper  
39. Air Compressor  
40. Retention Tank Cleanout  
41. Fuel Pump  
42. Lube Oil Filter  
43. Fuel Preheater/AMOT  
44. Fuel Filter Assembly  
45. Lube Oil Strainer  
46. 2,600 Gallon Fuel Tank  
47. Engine Inspection Cover  
48. Turbo Lube Pump & Aux. Filter  
49. Turbo Lube Pump  
50. HEP Air Start Reservoir #3 MR  
51. Battery Box  
52. Oil Pan  
53. Air Brake Air Reservoir (#1, #2, MR)  
54. Starting Motors  
55. Turbo Filter  
56. Twin Tower Air Dryer  
57. Turbocharger  
58. AR10/CA5 Main Alternator  
59. Electrical Cabinet Air Filter  
60. Air Brake Compartment (Subbase)  
61. Sand Nozzle
1.2 GENERAL DESCRIPTION

The F40PH-2C, illustrated in Fig. 1-1, is a 3200 horsepower diesel-electric locomotive developed for passenger service. The locomotive is equipped with a turbocharged 16 cylinder diesel engine that develops 3200 horsepower at maximum RPM. The main generator converts this mechanical energy into electrical energy which is distributed through the high voltage cabinet to the traction motors. Each of the four traction motors is directly geared to a pair of driving wheels. This model has 60:17 gearing and a maximum operating speed limit of 79 MPH.

The F40PH-2C has a fully enclosed car body as basic equipment. The enclosures provide protected walkways for easy access to the engine room and trailing units. The locomotive is arranged so the short hood or cab end is designated as the front of the unit and marked as such with an "F."

This model is equipped with a secondary engine and generator system referred to as the Head End Power (HEP) System. The HEP system operates independently of the locomotive propulsion diesel engine, and is located over the rear bolster assembly in the rear equipment room. The 500 kW, 480 Volt AC HEP generator is directly driven by the HEP diesel engine and produces 60 Hz power at 1900 RPM.

The Head End Power System generates AC power for electric heating, air conditioning and car lighting for the entire train. The operating controls and appropriate warning lights for this equipment are located on the upper door of the Head End Power Relay Cabinet located adjacent to the HEP engine/generator skid. An additional set of HEP system warning lights are also located on the Head End Power Remote Panel in the cab. A HEP shutdown push button switch is also located on this panel.
Locomotive F40PH - 2
(Overhauled in 1999)
GENERAL DATA

MODEL ......................................................... F40PH-2

LOCOMOTIVE HORSEPOWER ........................................ 3200 H.P.

NUMBER OF CYLINDERS ........................................... 16

CYLINDER BORE AND STROKE ...................................... 9 1/16'' X 10''

FULL SPEED ENGINE R.P.M. ....................................... 916 R.P.M.

STANDBY SPEED .................................................... 720 R.P.M.

IDLE SPEED .........................................................
  NORMAL - 460 R.P.M.
  LOW - 260 R.P.M.

MAIN GENERATOR .................................................. 600 VOLT

HEAD-END GENERATOR ............................................ 480 VOLT

POWER OUTPUT .................................................... 500 KW

MAX. MPH ........................................................... 82

DRIVING WHEELS .................................................. 4 EA.
  DIAMETER. 40''

HEIGHT OVER AIR CONDITIONER .................................. 15' 7.68''

WIDTH OVER HANDBRILS .......................................... 10' 5.50''

DISTANCE OVER COUPLER FACES ................................ 56' 2''

WEIGHT ............................................................
  260,000 LBS.
  +/- 3,500 LBS.

FUEL ............................................................ 1900 GAL.

LUBE OIL ......................................................... 243 GAL.

SAND .............................................................. 49 CU. FT.

BATTERIES ........................................................ 16 CELLS
  74 VOLT

Wheel Loads
  32.5
  130 tons
INTRODUCTION

This manual has been prepared as a guide for railroad personnel engaged in the operation of the 3200 horse-power General Motors Model F40PH-2 locomotive.

The contents are divided into four sections as follows:

1. General Description - Provides general description of major equipment components.

2. Cab Controls - Explains function of cab control equipment used in operating the locomotive.

3. Operation - Outlines procedures for operation of the locomotive and equipment.

4. Troubleshooting - Describes condition, probable cause, and suggested response for possible troubles occurring during operation.

A block of page numbers is allocated to each section, Section 1 starting with page 1-1, Section 2 with 2-1, and the others following in this manner. Figures are identified by section and sequence.

To obtain the most benefit from this manual, it is recommended that the sections be read in the sequence in which they appear.

Information pertaining to maintenance, adjustment, and testing is contained in the Locomotive Service Manual. Instructions for testing and maintenance of individual locomotive components are a part of the standard EMD Maintenance Instruction bulletin series.
GENERAL DATA

Model Designation ..................... F40PH-2
Locomotive Type ...................... (B-B) 0440
Locomotive Horsepower ............... 3200

Diesel Engine
Model ................................. 645E3C
Type ................................ Turbocharged
Number of Cylinders ................... 16
Cylinder Arrangement .................. 45° “V”
Cylinder Bore And Stroke .............. 9-1/16" x 10"
Operating Principle ................... Two Stroke Cycle,
Injection, Water Cooled

Full Speed ............................. 916 RPM
Standby Speed ........................ 720 RPM
Idle Speed ............................. Normal - 460 RPM
Low - 260 RPM

Main Generator Model .................. AR10JDA-D18
Traction Alternator
(Rectified Output) ..................... AR10JDA
Number Of Poles ...................... 10
Nominal Voltage (DC) ................. 600
Frequency (At 720 RPM) .............. 60 Hz
Maximum Continuous
Current Rating ......................... 4200 Amperes
Companion Alternator .................. D18
Nominal Voltage (AC) .................. 215

Head End Generator .................... Delco No. 4997006
Available Power Output ............... 500 kW
Nominal Voltage (AC) .................. 480
Maximum Continuous
Current Rating ......................... 750 Amperes per phase
Frequency (At 1800 RPM) .............. 60 Hz

Auxiliary Generator Voltage ............ (55 VAC) 74 Volts
Rating ................................. 18 kW

Traction Motors
Model ................................. D77
Number ................................. 4
Type ................................ DC, Series Wound
Axle Hung

Current Rating
Maximum Continuous ................. 1050 Amperes

Driving Wheels
Number ................................. 4 Pair
Diameter .............................. 40"

Speed Limitations With Gear Ratio
Gear Ratio ............................. 60:17

NOTE
An overspeed switch in the speed indicator limits the
locomotive speed to 75 MPH.

Max. MPH (Based on rated
RPM of traction motors) .............. 82
Min. Continuous MPH* .................. 13.3

Curve Negotiation Capability

Truck swing limits single unit curve negotiation to a
43° 30’ or 135 ft. radius curve.

Two similar units coupled in multiple limited by
coupler swing to a 33° or 175 ft. radius curve
equipped with “F” couplers.

Locomotive coupled to an 87 ft. passenger car
limited by car coupler swing to an 18° or 315 ft.
radius curve (equipped with “F” coupler).

Locomotive coupled to a standard 50 ft. box car
limited by car coupler swing to a 23° or 250 ft. radius
curve.

Major Dimensions
Height Over Air Conditioner ........... 15' 7.68"
Width Over Hand Rails ................ 10' 5.50"
Distance Over Coupler Pulling Faces ...... 56' 2"

Loaded Weight On Rails ................. 260,000 Lbs.
...................................... ± 3,500 Lbs.

Weight On Drivers ..................... 100%

*Tractive effort at 13.3 MPH = 47,340 lbs. at 1050
traction motor amperes.
SECTION 1
GENERAL DESCRIPTION

INTRODUCTION

General Motors model designation F40PH-2, illustrated in Fig. 1-1, is a 3200 horsepower diesel-electric locomotive intended for passenger service. The locomotive is equipped with a turbocharged 16-cylinder diesel engine that develops 3200 horsepower at maximum RPM. The main generator converts this mechanical energy into electrical energy which is distributed through the high voltage cabinet to the traction motors. Each of the four traction motors is directly geared to a pair of driving wheels. The gear ratio of the traction motor to the wheel axle determines the maximum operating speed of the locomotive. This model has 60:17 gearing which could provide a top speed of 82 MPH, but an overspeed switch in the speed indicator limits the locomotive speed to 75 MPH.

The F40PH-2 has a fully enclosed cabbody as basic equipment. The enclosures provide protected walkways for easy access to the engineroom and trailing units. This arrangement allows routine maintenance while the locomotive is in service. The locomotive is arranged so that the short hood or cab end is designated as the front of the unit and marked as such with an "F". The enclosed design demands that the operator move the locomotive in the forward direction to maintain normal operating visibility.

This model is equipped with a secondary electrical generator referred to as the Head End Generator. It is located at the front end of the diesel engine (although this is the rear of the locomotive), between the accessory rack and the air compressor. This generator is driven through a 1:2 ratio gear box which provides a generator speed of 1800 RPM for an engine speed of 900 (916) RPM.
Bombardier Bi-Level Cars
Cab and Trailer Type
Figure 1-1-1. Car General Arrangement and Specifications (Sheet 1 of 2)
### Nominal Car Weights

| Coach Car - approx. (empty) | 119,000 lb |
| Cab Car - approx. (empty) | 122,000 lb |

### Electrical System

- Nominal Voltage (head end power provided by generator on locomotive 480 Vac, 3 Phase, 60 hz)
- Low voltage dc power 72 Vdc
- Low voltage ac power 120 Vac
- Locomotive control voltage 74 Vdc

### Nominal Car Dimensions

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (over coupler faces)</td>
<td>85 ft. 0 in.</td>
</tr>
<tr>
<td>Width</td>
<td>9 ft. 10 in.</td>
</tr>
<tr>
<td>Height</td>
<td>15 ft. 11 in.</td>
</tr>
<tr>
<td>Wheel diameter (new)</td>
<td>33 in.</td>
</tr>
<tr>
<td>Radial wheel wear</td>
<td>1-1/2 in.</td>
</tr>
<tr>
<td>Height floor to ceiling lower level</td>
<td>6 ft. 7 in.</td>
</tr>
<tr>
<td>Height floor to ceiling upper level (at car centreline)</td>
<td>6 ft. 7 in.</td>
</tr>
<tr>
<td>Height floor ceiling intermediate level (at car centreline)</td>
<td>7 ft. 0 in.</td>
</tr>
<tr>
<td>Height top of rail to top side door step</td>
<td>18 in.</td>
</tr>
<tr>
<td>Height top of rail to intermediate level floor (new wheels, car empty)</td>
<td>51 in.</td>
</tr>
<tr>
<td>Height coupler centreline to top of rail</td>
<td>34-1/2 in.</td>
</tr>
<tr>
<td>Truck wheelbase</td>
<td>8 ft. 6 in.</td>
</tr>
<tr>
<td>Trucks centres</td>
<td>64 ft.</td>
</tr>
<tr>
<td>Door width (passenger)</td>
<td>52 in.</td>
</tr>
<tr>
<td>Door width (end) (Coach)</td>
<td>28 in.</td>
</tr>
<tr>
<td>Door width (end) (Cab)</td>
<td>22-1/2 in.</td>
</tr>
<tr>
<td>Track gauge</td>
<td>4 ft. 8-1/2 in.</td>
</tr>
</tbody>
</table>

---

**Figure 1-1-1. Car General Arrangement and Specifications (Sheet 2 of 2)**
Gallery Cars
Cab and Trailer Type
CHAPTER 1
GENERAL DESCRIPTION

1.1 INTRODUCTION (Figures 1–1, 1–2)

The Push–Pull Gallery Rail Cars delivered under Contract No. C–60281JPB were designed and built by Nippon Sharyo Seizo Kaisha, of Japan, for commuter passenger service on the Peninsula Corridor between San Francisco, San Jose and Gilroy. These cars are very similar to the original Gallery cars and are completely compatible in mixed consists. A major difference in these cars is the addition of a wheelchair lift and other ADA enhancements.

The two types, cab cars (Figure 1–1) and trailer cars (Figure 1–2), are similar in appearance. Each car has an A–end and a B–end. The A–end contains the toilet room on both cars, and the toilet room side is designated as the left side of the cars. The major difference between cars is the operator’s control cab in the upper level at the front (B–end) of each cab car (referred to as the F–end, when the cab is the lead car controlling a consist). The cab equipment enables complete control of the locomotive and consist in “push” mode. Trains of up to ten cars can be operated, using one or more locomotives, providing a safe, comfortable ride at speeds up to 100 mph, track conditions permitting. (Currently, PCJPB’s maximum operating speed is 79 mph.)

The Gallery design provides two levels of passenger seating on either side of the vestibule located in the center of each car. Upper levels have single seats along each side, and lower levels have double seats on each side. The A–end and B–end seating orientations are opposite, with both facing the car center. Access to the gallery level is via stairs on each side of the entrance vestibule. Table 1–1 gives the seating capacity for each type of car:

<table>
<thead>
<tr>
<th>CAR TYPE</th>
<th>LOWER LEVEL</th>
<th>UPPER LEVEL</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cab Car</td>
<td>50 + 2 Wheelchairs</td>
<td>42</td>
<td>92</td>
</tr>
<tr>
<td>Trailer Car</td>
<td>74 + 2 Wheelchairs</td>
<td>48</td>
<td>122</td>
</tr>
</tbody>
</table>

The interior design permits both types of cars to accommodate up to 100 standing passengers, using both levels, as necessary during peak periods.
Figure 1–1. Cab Car Configuration
Figure 1–2. Trailer Car Configuration
1.2 VEHICLE STRUCTURE

The cars are completely constructed of stainless steel, except for the end underframes, which are low alloy—high tensile (LAHT) steel. All car ends have full—height collision posts designed to withstand extreme forces. Each car has eight (8) jacking pads at locations under each end of the car and at both ends of each bolster (Figure 1—3). The cars are completely insulated to provide thermal protection for efficient heating and cooling; similarly, acoustical insulation assures effective sound deadening for passenger comfort. Pilots, mounted on the B—end of each cab car, provide protection to undercar equipment.

![Diagram of vehicle structure with jacking pads marked]

Figure 1—3. Jacking Pad Locations

1.3 VEHICLE REFERENCE DATA

Consist Alignment:
- Push—Pull Service .......... 1 to 10 cars
- Pull—Only Service ........... Up to 18 cars

Length Over Coupler Faces ............... 85 Ft. (nominal)

Width:
- Interior .......................... 9 Ft. 3 In.
- Exterior (Extreme Over Mirrors) ..... 10 Ft. 10 In.
- Exterior (Extreme Over Sill Steps) 9 Ft. 9 In.

Height: (Above Top of Rail)
- Extreme .......................... 15 Ft. 11 In.
- Coupler Centerline ............... 2 Ft. 10 1/2 In.
- End Platform ...................... 4 Ft. 3 In.

Weight:
- Cab Car ......................... 127,000 Lbs.
- Trailer Car ...................... 122,000 Lbs.

Wheel Diameter (New Wheel) ............ 36 In.

Minimum Curve Radius (Coupled Cars) .... 250 Ft.

Power:
- Hotel Power ..................... 480 vac
- Battery power ................... 75 vdc (Nominal)
- Auxiliary Power ................. 120 vac

Air Pressure (Operating/Main Reservoir) .... 140 psi
1.4 EXTERIOR ARRANGEMENT (Figure 1-4)

The exterior appearance of the cab and trailer cars is generally quite similar, with differences confined to those items that enable cab cars to lead and control a consist in “push” operation. The ends of each car are equipped with jumper cables and receptacles used to trainline the 480 vac primary power and the control functions for the cars and locomotive. Passenger entry and exit is through a pair of bi-parting, pneumatically operated, sliding pocket doors at the center of each car, which open to the vestibule area. One side of each door opening is equipped with a wheelchair lift, and exterior door and wheelchair status lights are provided.

Handholds and side sill steps are provided at the corner of each car end. Additional handholds are installed on each side of the center doors and on the car ends on either side of the coupler. The B—end of each cab car has a ladder and handholds to facilitate access to the car roof. Exterior rear—view mirrors and “blue flag” brackets are mounted adjacent to the sliding sash windows of the operator’s and observer’s stations, and their front windows are equipped with windshield wipers. A chime horn and an antenna are mounted on the roof on the B—end of each cab car.

Cab cars are also equipped with a dual sealed—beam headlight unit, two rear warning (marker) lights, and two multiple—mode “ditch” or “crossing” lights mounted on either side, about 4 1/2 feet above top of rail. Sliding end—doors accessing the lower level on both cars are opened manually and closed automatically; the doors can be locked from either side with the standard key, and a latching device is provided to hold them open. A handbrake is installed outside of the end door on the B—end of each car. The B—ends of the cab cars also have a “C—1” back—up valve with a whistle at this location. Windows are installed along the upper and lower levels on each side of the cars; sixteen windows (8 per side) are removable “escape” windows.

![Diagram of Cab Car Exterior Arrangement](attachment:image)

Figure 1—4. Exterior Arrangement — Cab Car
1.5 INTERIOR ARRANGEMENT (Figures 1–5, 1–6, 1–7, 1–8)

The A-end and B-end passenger areas of each car are separated by a center vestibule, entered through the exterior doors via the stairs or the wheelchair lift. Access from the vestibule to the passenger seating areas is through bi-parting sliding doors, pneumatically operated by a large pushbutton on both the vestibule and the compartment sides. Sensitive edges in the doors cause them to automatically recycle upon striking an object, and a readiness accessible emergency release is provided to allow manual operation. The vestibule area is also equipped with control stations for the exterior doors; a P/A intercom station; wheelchair lift controls, indicators and alarms; emergency tools, and two conductor's valves.

On the cab car, immediately inside the B-end are stairways leading to the left and right side gallery seats, and on the lower level, six bicycle racks are provided, along with seating for 20 passengers. The lower level of the A-end compartment has a toilet on the left side, provisions for two wheelchairs on the right side, stairways to the gallery on each side, and seating for 30 passengers.

On the gallery level, the B-end seats 20 passengers and the A-end 22 passengers. On the trailer car, both levels of the A-end are configured the same as that of the cab car. The trailer's B-end with no bicycle racks, seats 44 passengers on the lower level and 26 passengers on the gallery level. Parcel racks are installed on the gallery level. Entry to the toilets in both cars is through a manually operated sliding door with a passage lock that can be unlocked from the outside with a standard coach key. Water is stored in a 50 gallon tank mounted in the ceiling above the toilet room.

Interior climate is modulated by heating, ventilation and air conditioning systems. Each car has thermostatically controlled overhead and floor heaters and two units that deliver a conditioned mixture of fresh and recirculated air through diffusers, with separate controls for the A and B ends of each car. The cars also have provisions for layover heat. A locker for electrical equipment and its controls is located in each of the four stairwells of both cars.

Interior lighting is provided by lines of overhead fluorescent fixtures running the length of the A and B ends on each side in the passenger areas of both levels. Four of the fixtures on each side on each level (total 16 per car) also function as battery-operated emergency lighting. Passenger lighting is enhanced by individually controlled reading lights mounted above each passenger seat. Other fixtures provide lighting in the toilet rooms, vestibule areas and stairwells.
Figure 1–5. Cab Car Interior Arrangement
Figure 1–6. Cab Car Vestibule Area
Figure 1–7. Trailer Car Interior Arrangement
Figure 1-8. Trailer Car Vestibule Arrangement
1.6 CONTROL CAB ARRANGEMENT (Figure 1-9)

The transverse control cab on the upper level, B-end of each cab car, has two positions, the operator's on the right and the observer's on the left. The operator's position has an array of controls and indicators that enable complete operation of a train in the "push mode." The only train control feature at the observer's position is a B–3–B emergency brake valve. Both positions have a fully adjustable, swiveling cab seat, sun visors for front and side windows, rear view mirrors, electrically heated windshields with wipers, and individually controlled ceiling lights. Access to the cab from the gallery is through an outward-opening door on each side of the cab, opened from the outside with a standard coach key, and from the inside by a crash bar that allows immediate egress from the cab. The cab is air conditioned by the central unit.

The operator's console contains controls for direction, power and braking, air gauges, a speed indicator, locomotive condition indicators and alarms, emergency cut offs, and various switches to control cab and vehicle equipment. On the operator's left is the cab switch control panel, the train radio unit and handset, and the horn control. A sanding control is on the right. The Cab Control Unit (braking), alerter valve and operator's cab heater are mounted under the console. A crew locker is provided adjacent to the door, behind the operator. The rear wall contains the cab relay panel, a circuit breaker panel, and a wall-mounted fire extinguisher.

On the observer's side, an electric water cooler is mounted on the center equipment cabinet. The B–3–B emergency brake control valve is mounted on the left side of the small console under the windshield, and two alarm buzzers and an alarm bell are located on the right, above the windshield. A cab heater, a relay valve and a small air reservoir are located beneath the console, and a crew locker is positioned behind the observer's seat.
Figure 1–9. Control Cab Arrangement
1.7 UNDERCAR EQUIPMENT ARRANGEMENT (Figure 1–10)

Cab car equipment mounted under the B—end includes the coupler and draft gear, the warning bell, the sand box and sand control valves. The junction boxes and receptacles for the trainline jumpers are mounted in this area on both the A and B ends. Behind this equipment is the B—end truck, and behind it on the left side are the brake equipment valves, the transformer and battery charger, and the wheelchair lift control box. In the same area on the right side are the decelostat and the car batteries. Wheelchair lift equipment is installed under the vestibule on both sides.

On the cab car's A—end, beyond the vestibule area, the left side contains the toilet discharge valve and brake equipment, and on the right side the brake system items and the wheelchair lift control box. The remaining area inboard of the truck on both the left and right sides contains air brake equipment and air reservoirs, then the A—end truck. Outboard of the truck are the draft gear and coupler, with the trainline receptacles and junction boxes mounted on either side.

Trailer car equipment on the B—end includes the coupler and draft gear, the trainline receptacles and junction boxes, followed by the truck. Inboard of the truck on the left side are brake equipment valves, the transformer and battery charger, and the wheelchair lift control box. In the same area on the right side are the decelostat and the car batteries. Wheelchair lift equipment is installed under the vestibule on both sides. The A—end equipment arrangement is generally the same as on the cab car.
1.8 TOILET ROOM ARRANGEMENT (Figure 1-11)

The toilet room is equipped with stainless steel fixtures: toilet, wash basin, tissue holder, towel dispenser and waste paper receptacle. Other features include a mirror, coat hook, soap and seat cover dispensers, convenience outlet, ceiling light, ceiling P/A speaker, air diffuser, exhaust fan, and a smoke alarm. Handholds and other handicapped accommodations are provided.

Figure 1-11. Toilet Room Arrangement
1.9 WHEELCHAIR LIFT (Figure 1-12)

The cab cars and the trailer cars are equipped with two wheelchair lifts, installed under one side of the vestibule steps on each car. The lifts are stored under the bottom step, and the stairway handrails are part of the lift mechanism; accordingly, when the lift is stowed, the steps can be used for regular loading and unloading of passengers. A key-operated switch mounted under each PA/IC box in the vestibule is used to enable the two control panels governing the deployment of each lift. The interior control panel is located in the face of the partition between stairways, and the exterior control is adjacent to the vestibule door opening. The lift controls are fully integrated with the train control circuits to prevent train or lift operation unless all safety interlocks are satisfied.

Figure 1-12. Wheelchair Lift Arrangement
### GENERAL DATA

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<tr>
<th>Category</th>
<th>Details</th>
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</thead>
<tbody>
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<td>Caltrain Cab-Car Model</td>
<td>21 EA.</td>
</tr>
<tr>
<td>Caltrain Coach Car Model</td>
<td>73 EA.</td>
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<td>Seating Capacities</td>
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<td>Coach-Car 144</td>
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<td>Interior 9' 3&quot;</td>
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<td></td>
<td>Exterior 10' 10&quot;</td>
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<td></td>
<td>Coach-Car 122,000 LBS.</td>
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<td>Window Material</td>
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<tr>
<td>Battery Power</td>
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<tr>
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<td>100 M.P.H.</td>
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<td>Profile 1:20</td>
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Overhauled Gallery Cars
(1999-2002)
PENINSULA CORRIDOR
JOINT POWERS BOARD
PUSH PULL COMMUTER RAIL CARS
CAB CARS 4000–4020
TRAILER CARS 3800–3851

OPERATING MANUAL

Caltrain

ALSTOM

APRIL 2002
1.1 INTRODUCTION (Figures 1−1, 1−2)

The Push−Pull Gallery cars covered in this manual are those originally designed and built by Nippon Sharyo, of Japan (NS), and delivered in 1985. In year 2000, these cars were completely overhauled by Alstom Canada Inc., Transport (ALSTOM). The ALSTOM overhaul updated many systems and features, and replaced others with completely new equipment. In some cases, the overhauled cars received the same current design equipment as the new Gallery Cars, also built by NS, and delivered in year 2000. The new NS cars and the ALSTOM overhauled cars are completely compatible when operated in mixed consists. The information in this manual covers only the overhauled ALSTOM cars, with references to features that are the same as those found on the new NS cars.

The two types, Cab Cars (Figure 1−1) and Trailer Cars (Figure 1−2) are similar in appearance. Each has an A−end and a B−end. The major differences being on the Cab Car, where the front or B−end has an operating cab on the upper level and a toilet room on lower level of the A−end. The cab equipment enables complete control of the locomotive in the "push mode." Trains of up to ten (10) cars in "push mode" or up to eighteen (18) cars in "pull mode" can be operated safely and comfortably up to maximum authorized speeds.

The cars are gallery type, with two levels of passenger seating arranged on either side of a center vestibule. Upper levels have single, fixed seating along each side, and the lower levels have double, fixed seats on each side. The A−end and B−end seating orientations are opposite, with both facing the car center vestibule. Access to the gallery level is via a stairway on each side. Table 1−1 shows the seating capacity for each type of car.
Table 1–1. Seating Capacities

<table>
<thead>
<tr>
<th>CAR TYPE</th>
<th>LOWER LEVEL</th>
<th>UPPER LEVEL</th>
<th>TOTAL</th>
</tr>
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<tr>
<td>Cab Car</td>
<td>70 seated / 46 A–end</td>
<td>43 seated / 23 A–end</td>
<td>113</td>
</tr>
<tr>
<td>Trailer Car</td>
<td>95 seated / 48 A–end</td>
<td>52 seated / 26 A–end</td>
<td>148</td>
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<tr>
<td>Trailer Luggage</td>
<td>91 seated / 43 A–end</td>
<td>52 seated / 26 A–end</td>
<td>143</td>
</tr>
</tbody>
</table>

The interior design permits both types of cars to accommodate up to 100 standing passengers, using both levels, as necessary, during peak travel times. Cab cars have bicycle racks, located on the B–end, which can store up to 24 bicycles. (For comparison, the ALSTOM Cab Car seats 21 more passengers and the Trailer Car 26 more than the new NS car configurations, attributable to differences in toilet room size and seating arrangement.)

1.2 VEHICLE STRUCTURE

Generally, there have been no significant changes to the vehicle structure resulting from the overhaul process. The vehicles are completely constructed of stainless steel, except for the end underframes which are low–alloy high tensile (LAHT) steel. The roof and side sheets are longitudinally corrugated and spot welded to the structural members. The car ends are reinforced with collision posts, a buffer sill and a transverse beam above the end sill. The "F" end of Cab cars has added reinforcement and an anti–telescoping feature. Each car has eight (8) jacking pads at locations under each end of the car and at both ends of each bolster (Figure 1–2). The cars are insulated to provide thermal protection for efficient heating and cooling, and sound deadening for passenger comfort. Pilots are mounted on the B–end of each Cab Car to protect underfloor equipment.
Figure 1-1. Cab Car Configuration
1.3 VEHICLE REFERENCE DATA

Consist Alignment:

- Push—Pull Service ............... 1 to 10 cars
- Pull-only Service ............... Up to 18 cars

Maximum Speed .................. 100 mph

Length Over Coupler Faces ........ 85 feet (nominal)

Width:  
- Interior ....................... 9 feet 3 inches
- Exterior (Extreme Over Mirrors) .... 10 feet 10 inches
- Exterior (Extreme Over Sill Steps) .... 9 feet 9 inches

Height: (Above Top of Rail)

- Extreme .......................... 16 feet 10¾ inches
- Coupler Centerline ............... 2 feet 10 ½ inches
- End Platform ...................... 4 feet 3 inches

Clearance of Carbody (Above Top Rail) .... 1 foot 4 7/8 inches
(Excludes Battery Box and Pilot)

Clearance of Truck Components (Above Top Rail) 3 1/8 inches

Weight:  
- Cab Car ....................... 120,000 lbs.
- Trailer Car ..................... 118,000 lbs.

Wheel Diameter (New Wheel) .......... 36 inches

Minimum Curve Radius (Coupled Cars) .... 250 feet

Power:  
- Head End Power ................. 480 vac
- Battery Power ................... 75 vdc (Nominal)
- Auxiliary Power .................. 120 vac

Air Pressure (Operating / Main Reservoir) .... 140 psi
1.4 EXTERIOR ARRANGEMENT (Figure 1-3)

Generally, there have been no significant changes to the vehicle's exterior arrangement in the overhaul process, except for minor changes to items such as signage and indicators, as described.

The exterior appearance of the cab and trailer cars is generally quite similar, with differences confined to those items that enable cab cars to lead and control a consist in "push" operation. The ends of each car are equipped with jumper cables and receptacles used to trainline the 480 vac primary power and the control functions for the cars and locomotive. Passenger entry and exit is through a pair of bi-parting, pneumatically operated, sliding pocket doors at the center of each car, providing access to the vestibule area.

Handholds and side sill steps are provided at the corner of each car end. Additional handholds are installed on each side of the center doors and on the car ends on either side of the coupler. The B-end of each cab car has a ladder and handholds to facilitate access to the car roof. Exterior rear-view mirrors and "blue flag" brackets are mounted adjacent to the sliding sash windows of the operator's and observer's stations, and their front windows are equipped with windshield wipers. A chime horn and an antenna are mounted on the roof on the B-end of each cab car.

Cab cars are also equipped with a dual sealed-beam headlight unit, two rear warning (marker) lights, and two multiple-mode "ditch" or "crossing" lights mounted on either side, about 4 1/2 feet above top of rail. Sliding end-doors accessing the lower level on both cars are opened manually and closed automatically; the doors can be locked from either side with the standard key, and a latching device is provided to hold them open. A handbrake is installed outside of the end door on the B-end of each car. The B-ends of the cab cars also have a "C-1" back-up valve with a whistle at this location. Windows are installed along the upper and lower levels on each side on both cab and trailer cars; sixteen windows (8 per side) are new—type "emergency exit" windows, new battery box on cab car, toilet piping and tank.
1.5 INTERIOR ARRANGEMENT (Figure 1-4)

Significant changes to the interior arrangement on cab and trailer cars include pneumatically operated vestibule doors, new style seating, new toilet room equipment and arrangement, upgraded lighting, and new headliners and flooring.

The A-end and B-end passenger areas of each car are separated by a center vestibule, entered through the exterior doors via stairs. Access from the vestibule to the passenger seating areas is through bi-parting sliding doors, pneumatically operated by upper and lower pressure pads on both the vestibule and the compartment sides. Sensitive edges in the doors cause them to automatically recycle upon striking an object. Manual operation of the doors is allowed without the use of a release mechanism. Access to the manual door hook is provided by an access door at the lower AR and BL vestibule wall locations. The doors can be held open using a manual door hook. The vestibule area is equipped with control stations for the side entry doors; a P/A intercom station; door opening and closing indicators; and two conductor's valves.

On the cab cars, immediately inside the B-end are stairways leading to the left and right side galleries with seating for 20 passengers. The lower level has six bicycle racks and seating for 24 passengers. The A-end has similar stairways to the galleries, which seat 23 passengers. The lower level has seating for 46 passengers, and a toilet on the left side (far end). Entry to the toilet is through a manually operated door with a passage lock that can be unlocked from the outside. Water is stored in a 50 gallon tank mounted in the ceiling above the toilet room. The trailer cars, with no toilets or bicycle racks, seat 96 passengers on the lower level and 52 passengers on the gallery level. Trailer cars with luggage racks seat only 91 passengers on the lower level. Parcel racks are installed on the gallery level of all cab and trailer cars.
Figure 1–4. Cab Car Interior Arrangement (Sheet 1 of 2)
Figure 1–4. Cab Car Interior Arrangement (Sheet 2 of 2)
Interior climate is modulated by heating, ventilation and air conditioning systems. Each car has thermostatically controlled overhead and floor heaters and two HVAC units that deliver a conditioned mixture of fresh and re-circulated air through diffusers, with separate controls for the A and B ends of each car. The cars also have provisions for layover heat. A locker for electrical equipment and related controls is located in each of the four stairwells of both cars.

Interior lighting for cab and trailer cars is provided by lines of overhead fluorescent fixtures running the length of the A and B ends on each side in the passenger areas of both levels. Fixtures on each side on each level are equipped with battery-operated emergency lighting. Other fixtures provide lighting in the toilet rooms, vestibule areas and stairwells.
Figure 1–5. Cab and Trailer Car Vestibule Area
Figure 1-6. Trailer Car Interior Arrangement (Sheet 1 of 2)
Figure 1-6. Trailer Car interior Arrangement (Sheet 2 of 2)
1.6 CONTROL CAB ARRANGEMENT (Figure 1-7)

Changes to the cab include some new control equipment items and indicators, a new speed indicator, and new operator’s seats.

The transverse control cab on the upper level B—end of each cab car has two positions, the operator's on the right and the observer's on the left, as you enter the control station. The operator's position has an array of controls and indicators that enable complete operation of a train in the "push mode." The only train control item at the observer's position is a B-3-B emergency brake valve. Both positions have an adjustable cab seat, sun visors for front and side windows, exterior rear view mirrors, electrically heated windshields with wipers, and individually controlled ceiling lights. Access to the cab from the gallery is through an outward-opening door on each side of the cab, opened from the outside with a standard coach key, and from the inside by a crash bar that allows immediate egress from the cab. The cab is air conditioned by the central unit, conditioned by the central unit, and heated by two cab heaters.

The operator's station contains controls for direction, power and braking, air gauges, a speed indicator, locomotive condition indicators and alarms, emergency cut offs, various switches to control locomotive and vehicle equipment, the train radio unit and handset, the horn control, and a sanding control. The D-1 "Deadman" foot valve pedal is mounted on the floor in the right front corner, and the sanding control valve is located above it. A crew locker is provided outside the cab adjacent to the door, on each side. The rear wall contains an alarm buzzer and a wall-mounted fire extinguisher.

An electric water cooler and a number plate box are mounted on the center equipment console. On the observer's side, the B-3-B emergency brake control valve is mounted on the left side under the windshield. A cab heater, a relay valve and a small air reservoir are also installed.
Figure 1-7. Control Cab Arrangement
1.7 UNDERCAR EQUIPMENT ARRANGEMENT (Figure 1–8)

Cab car equipment mounted under the B–end includes the coupler and draft gear, the warning bell, the sand box and sand control valves. The junction boxes and receptacles for the trainline jumpers are mounted in this area on both the A and B ends. Behind this equipment is the B–end truck, and behind it on the left side are the brake equipment valves, and the transformer and battery charger. In the same area on the right side are the car batteries.

The toilet discharge lines are mounted on the cab car's A–end, with valve access from both sides of the car. The remaining area inboard of the truck on both the left and right sides contains air brake equipment and air reservoirs, then the A–end truck. Outboard of the truck are the draft gear and coupler, with the trainline receptacles and junction boxes mounted on either side. Trailer car equipment on the B–end includes the coupler and draft gear, the trainline receptacles and junction boxes, followed by the truck. Inboard of the truck on the left side are brake equipment valves, the transformer and battery charger. In the same area on the right side are the car batteries. The A–end equipment arrangement is generally the same as on the cab car, except for the equipment related to the toilet.

1.8 TOILET ROOM ARRANGEMENT (Figure 1–9)

Significant changes have been made to the toilet room. Additional space in the room was created by incorporating new equipment with a different layout. The toilet room is equipped with stainless steel fixtures: toilet, wash basin, tissue holder, towel dispenser and waste paper receptacle. Other features include a mirror, coat hook, soap and seat cover dispensers, ceiling light, ceiling P/A speaker, air diffuser, exhaust fans and appropriate handholds.
Figure 1-8. Undercar Equipment Arrangement
Budd Cars
INTRODUCTION

The cars covered by this manual are designed for push-pull operation in consist with one or more EMD Model F40PH or equivalent locomotives equipped with head-end power generators. The train can be controlled from either the lead locomotive or from the engineman’s control position at the opposite end of the train consist.

Cars are of two types—control trailer cars and blind trailer cars. Control trailer cars are equipped with an engineman’s control position at the #1 end and a lavatory at the #2 end. Blind trailer cars have no control position or lavatory.

480 VAC 3-phase 60 HZ power for lighting, heating, air conditioning and electrically operated auxiliary equipment is provided from the head-end power plant of the locomotive. Provision is made for emergency lighting in the event this power is interrupted.

64 volt batteries are provided on Control Trailer Cars only, as a power source for certain train operating functions such as E.P. Brake Control, radio, headlight and marker lights, speed recorder, gauge lights, windshield heaters, and cab signal/speed control equipment. Battery power is also provided for the public address/intercom system in the event of interruption of head-end power. Battery charging power is provided from the head-end power system.

Body end doors and vestibule side doors are manually operated. Body end doors can be locked.

Operating controls and accessories are located to provide ready access during operation of the cars.
MBTA OPERATING MANUAL
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CAR ARRANGEMENTS & EQUIPMENT LOCATION
1.1 GENERAL

1.1.1 Road Numbers:
   A. Control Trailer Cars, Class CTC-2: 1400 to 1406 inclusive.
   B. Blind Trailer Cars, Class BTC-2: 400 to 417 inclusive.
      Blind Trailer Cars, Class BTC-2A: 425 to 430 inclusive.
      Blind Trailer Cars, Class BTC-2B: 450

1.1.2 Seating Capacity:
   A. Control Trailer Cars: 92
   B. Blind Trailer Cars: 99

1.1.3 Hand Brake: all cars #1 end vestibule, left side.

1.1.4 Fire Extinguisher: all cars, center of passenger compartment, left side, above windows.

1.1.5 Emergency Tools: all cars, center of passenger compartment, right side, above windows.

1.1.6 Emergency Brake Valves:
   A. Control Trailer Cars (3):
      1) #1 end vestibule, left side, on side of collision post above hand brake.
      2) #1 end, Passenger compartment suspended from low ceiling, over right edge of aisle.
      3) #2 end, Passenger compartment suspended from low ceiling, over left edge of aisle.
   B. Blind Trailer Cars (2):
      1) #1 end, Passenger compartment, suspended from low ceiling, over right edge of aisle.
      2) #2 end, Passenger compartment, suspended from low ceiling, over left edge of aisle.

1.1.7 Conductor’s Signal pushbuttons, all cars (9)
   A. One in ceiling at each vestibule behind diaphragm opening.
   B. One adjacent to each stepwell, under side sill.
1.2 CONTROL TRAILER CARS

1.2.1 Interior - See Figure 1.2.1

A. #1 end vestibule - right side
   1) Engineer's control station.
   2) Engineer's cab heater.
   3) 120 VAC convenience outlet on rear wall adjacent to carbody sliding end door post.
   4) PA/Intercom Handset receptacle and switch on collision post. Hanger on rear of vestibule end door.
   5) PA/Intercom station on rear wall adjacent to carbody sliding end door post.

B. #1 end vestibule - left side
   1) Handbrake.
   2) Emergency brake valve
   3) Fireman's cab heater
   4) Fireman's switch panel

C. #1 end vestibule overhead
   1) Conductor's signal pushbutton
   2) Engineer's air grille and shutter control

D. Passenger Compartment - Right side
   1) Electric Locker - #1 end only
      a) Passenger side (rear)
         (1) Lighting Control Breaker and Switch Panel. See Figure 2.2
         (2) 120 VAC Convenience outlet - near aisle
   2) Emergency tools - center of car above windows
   3) Layover Heat Thermostat - center of car, below first rear facing seat cushion.
   4) Toilet Compartment - #2 end
      a) Drinking water cooler - exterior, aisle side
      b) 120 VAC convenience outlet, below water cooler trash receptacle.

E. Passenger compartment - left side
   1) Train Control Locker
      a) Circuit breaker panel inside locker compartment. See Figure 2.3
   2) Fire extinguisher - center of car, above windows
F. Passenger compartment - ceiling areas
   1) Low ceilings, #1 end and #2 end
      a) One emergency brake valve with red handle protruding through low ceiling panel at each end.
      b) One fresh air damper handle at each end directly over center of aisle.
   2) High ceiling area, center of car
      a) One air conditioning duct damper handle, directly over center of aisle.

G. #2 end vestibule
   1) Conductor's signal pushbutton - center, overhead, behind diaphragm
   2) 50 gallon water supply tank - above ceiling, left side

1.2.2 Undercar - See Figure 1.2.2
A. Right side, starting at #1 end, proceeding to #2 end
   1) Conductors Signal Pushbutton
   2) Sandbox - (sandtrap under sand box)
   3) #1 Truck Brake Cut-Out Cock
   4) Decelostat Valve
   5) 480/120 volt Transformer
   6) Decelostat Control box
   7) Supply Reservoir - (air brake)
   8) Air Brake Control Valve group
   9) Battery charger
   10) Battery box (64V Nickel Cadmium battery)
   11) Battery disconnect switch
   12) Jumper cable storage box
   13) Retention Tank Drain
   14) Potable water tank fill fitting
   15) Main Reservoir Cut-Out Cock
   16) Brake Pipe Angle Cock
   1) Conductors Signal Pushbutton

B. Left side, starting at #1 end, proceeding to #2 end
   1) Conductors Signal Pushbutton
   2) Sandbox - (sandtrap under sand box)
   16) Brake Pipe Angle Cock
   15) Main Reservoir Cut-Out Cock
   17) Main reservoirs (2)
1.3 BLIND TRAILER CARS

1.3.1 Interior - See Figure 1.3.1

A. #1 end vestibule - right side
   1) PA/Intercom Handset receptacle and switch on collision post.
   2) PA/Intercom station on rear wall adjacent to carbody sliding door post.

B. #1 end vestibule - left side
   1) Handbrake

C. #1 end vestibule center, ceiling
   1) Conductor's Signal Pushbutton adjacent to diaphragm

D. Passenger Compartment - Right Side
   1) Electric Locker - #1 end only
      a) Passenger side (rear)
         1) Lighting and Control Breaker and Switch Panel. See Figure 2.2.
         2) 120 VAC Convenience outlet - near aisle

1.3.2 Car Exterior - See Figure 1.2.3

A. Brake indicating lights - right side, #1 end, above window level.
B. Brake indicating lights - left side #2 end, above window level.
C. Headlight - above #1 end vestibule
D. Radio antenna - above headlight
E. Air Horns - behind headlight
F. Bell - to left of headlight
G. Illuminated Number Boards
H. Marker Lights
2) Emergency tools - center of car above windows
3) Layover Heat Thermostat - center of car, below first rear facing seat cushion.

E. Passenger compartment - left side
1) Fire extinguisher - center of car, above windows

F. Passenger compartment - ceiling areas
1) Low ceilings, #1 end and #2 end
   a) One emergency brake valve with red handle protruding through low ceiling panels at each end.
   b) One fresh air damper handle at each end directly over center of aisle.
2) High ceiling area, center of car
   a) One air conditioning duct damper handle, directly over center of aisle.

G. #2 end vestibule
1) Conductor's signal pushbutton - ceiling adjacent to diaphragm.

1.3.2 Undercar - See Figure 1.3.2
A. Right side, starting at #1 end, proceeding to #2 end
1) Conductor's Signal Pushbutton
2) #1 Truck Cut-Out Cock
3) Decelostat valve
4) 480/120 volt Transformer
5) Decelostat Control Box
6) Supply Reservoir - (air brake)
7) Air Brake Valve group
8) Battery box (no batteries on BTC cars)
9) Jumper Cable Storage Box
10) Main Reservoir Cut-out Cock
11) Brake Pipe Angle Cock
1) Conductor's Signal Pushbutton

B. Left side, starting at #1 end, proceeding to #2 end
1) Conductor's Signal Pushbutton
10) Main Reservoir Cut-Out Cock
11) Brake Pipe Angle Cock
12) Air conditioning compressor/condenser unit
1. CONDUCTOR’S SIGNAL PUSHBUTTON
2. #1 TRUCK BRAKE CUT-OUT COCK
3. DECELOSTAT VALVE
4. TRANSFORMER - 480/120 VAC
5. DECELOSTAT CONTROL BOX
6. SUPPLY RESERVOIR (AIR BRAKE)
7. AIR BRAKE VALVE GROUP
8. BATTERY BOX (NO BATTERIES BTC CARS)
9. JUMPER CABLE STORAGE BOX
10. MAIN RESERVOIR CUT-OUT COCK
11. BRAKE PIPE ANGLE COCK
12. AIR CONDITIONING CONDENSOR/COMPRESSOR UNIT
13. HVAC CONTROL BOX
14. MAIN 480 VAC CIRCUIT BREAKER PANEL
15. FRESH AIR THERMOSTAT
16. MAIN POWER JUNCTION BOX (480 VAC.)
17. #2 TRUCK BRAKE CUT-OUT COCK

BTC UNDERCAR
Fig. 1.3.2

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BRAKE INDICATING LIGHTS

BTC EXTERIOR
Fig. 1.3.3
Caboose
Chicago and North Western bay window caboose with cushion underframe.

Light weight 48,000 lbs.
Locomotive GP40-2
GENERAL INFORMATION

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Designation</td>
<td>GP40-2</td>
</tr>
<tr>
<td>Locomotive Type</td>
<td>(B-B) 0440</td>
</tr>
<tr>
<td>Locomotive Horsepower</td>
<td>3000</td>
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<td>Loaded Weight On Rails</td>
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<tr>
<td>Minimum Basic</td>
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<tr>
<td>Maximum Basic</td>
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<tr>
<td>Diesel Engine</td>
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<td>Model</td>
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<tr>
<td>Operating Principle</td>
<td>Two Stroke Cycle</td>
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<tr>
<td>Number Of Cylinders</td>
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<tr>
<td>Cylinder Arrangement</td>
<td>45° &quot;V&quot;</td>
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<tr>
<td>Compression Ratio</td>
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<td>Rotation (Facing Flywheel End)</td>
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<td>Idle Speed</td>
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<td>Full Speed</td>
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<td>Maximum Continuous Current</td>
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<td>Special - Model WBG</td>
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</table>
GENERAL INFORMATION (CONT'D)

Lube Oil Capacity - Nominal
3-Cylinder Model .................................................. 10 Gallons
6-Cylinder Model .................................................. 18 Gallons

Compressor Displacement At 900 RPM
3-Cylinder Model .................................................. 254 Cu. Ft./Min.
6-Cylinder Model .................................................. 400 Cu. Ft./Min.

Storage Battery
Model ................................................................. MS420
Number Of Cells .................................................... 32
Voltage ................................................................. 64
Rating (8-Hour) ..................................................... 420 Ampere Hr.

Traction Motors
Model ................................................................. D77
Type ................................................................. Direct current, series wound axle hung with rubber nose suspension to damp torque shock.

Current Rating
Maximum Continuous ................................................ 1050 with 62:15 Gearing
................................................................. 1075 with 59:18 Gearing

<table>
<thead>
<tr>
<th>Gear Ratio</th>
<th>Max. Speed</th>
<th>Minimum MPH For Full Horsepower</th>
<th>Minimum Continuous MPH</th>
<th>Tractive Effort At Minimum Continuous Speed</th>
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<tbody>
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<td>62:15</td>
<td>65</td>
<td>22.9</td>
<td>11.3</td>
<td>55,400</td>
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<td>61:16</td>
<td>70</td>
<td>24.8</td>
<td>11.2</td>
<td>52,100</td>
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<td>60:17</td>
<td>76</td>
<td>26.9</td>
<td>11.2</td>
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<td>59:18</td>
<td>82</td>
<td>28.9</td>
<td>12.1</td>
<td>45,700</td>
</tr>
</tbody>
</table>

Basic Performance Control - PF21

Truck Data - GP40-2 Locomotive With Basic Truck
Wheel Diameter .................................................. 40"
(Index groove provided for wheel diameter control)
Rim ................................................................. 2-1/2"
Basic Journal Boxes ........................................... 6-1/2" x 12" roller bearing with lateral thrust taken up by cushioning directly by the box.
Brake Rigging
Basic ................................................................ Single Composition Shoe
Extra ................................................................. 4 Wheel Clasp Brake

Dimensions
Between Bolster Centers ........................................ 34'
Truck Wheel-Base ................................................... 108"

vertical Wheel-Rail Loads
Static Wheel Load .................................................. Nominally 32,000 lbs
(Basic locomotive weight of 256,000 lbs)
GENERAL INFORMATION (CONT'D)

Dynamic Wheel Loads ........................................... 5000 to 7000 lbs
(Variation due to journal spring deflection resulting from operation on 1-3/4" peak to valley loaded rail profile.)

Lateral Wheel-Rail Loads
Steady state net force between leading outside wheel and rail (dry rail, no sanding) and without influence of lateral centerplate load due to coupler angle and buff load level.

5° Curve .......................................................... 5000 to 7000 Lbs.
10° Curve ....................................................... 8000 to 10,000 Lbs.

With sanding or improved wheel-rail friction under high tractive effort, lateral forces increase by about 40%.

Curve Negotiation Capability

140 Ft. Radius - 42° Curve – Represents minimum single unit curve negotiation for a basic clasp brake truck as limited by truck to carbody rotation.

240 Ft. Radius - 24° Curve – Represents minimum curve capability for two GP40-2 units in multiple as limited by footboards.

302 Ft. Radius - 19° Curve – Represents minimum curve capability of a GP40-2 coupled to a standard 50'-box car as limited by coupler swing.

Supplies

Lube Oil Capacity .................................................. Basic Oil Pan 243 Gal.
Increased Capacity Oil Pan ............................. 395 Gal.
Usable Oil

(Volume between "Full" and "Low" on dipstick)

Basic Oil Pan .................................................. 47 Gal.
Increased Capacity Oil Pan ........................... 184 Gal.

Fuel Capacity

Basic .............................................................. 2600 Gal.
Special Available ............................................. 3600 Gal.

Cooling System Capacity ........................................ 254 Gal.
Sand Capacity ................................................... 56 Cu. Ft.

Major Dimensions

Distance, pulling face of coupler to centerline of bolster .................. 12' 7"
Distance between bolster centers .................................. 34' 0"
Distance, pulling face front coupler to rear coupler ....................... 59' 2"
Width over cab sheeting ........................................ 10' 0"
Height, top of rail to top of cooling fan guards ....................... 15' 4-7/16"
Width over basic arm rests ....................................... 10' 4"
**EIGHTS**

The weights as listed below are approximate and are intended as an aid in determining the handling procedure to be used. Weights represent lbs per unit as described.

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight</th>
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<tbody>
<tr>
<td>16-645E Diesel Engine</td>
<td>32,500</td>
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<tr>
<td>Starter Motor</td>
<td>80</td>
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<tr>
<td>Starter Motor Bracket</td>
<td>60</td>
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<tr>
<td>Engine Governor</td>
<td>120</td>
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<tr>
<td>AR10 Main Generator Assembly</td>
<td>16,000</td>
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<tr>
<td>Auxiliary Generator And Blower Assembly</td>
<td>1000</td>
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<tr>
<td>Inertial Air Filter</td>
<td>600</td>
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<td>Inertial Filter Screen</td>
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<td>Inertial Filter Compartment And Hatch</td>
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<td>Inertial Filter Hatch (Less Filters)</td>
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<td>Fuel Tank 3200 Gal.</td>
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<td>Fuel Tank 2600 Gal.</td>
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<td>Truck Assembly</td>
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<tr>
<td>Traction Motor</td>
<td>6000</td>
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<td>Axle</td>
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<td>Wheel</td>
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<tr>
<td>Gear 62 Tooth</td>
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<td>Bearing - Inner Race</td>
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<td>Air Compressor</td>
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<tr>
<td>Air Compressor Shaft</td>
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<tr>
<td>Air Compressor Shaft Guard</td>
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<tr>
<td>Air Compressor Shaft Guard Coupling</td>
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<tr>
<td>Lube Oil Cooler</td>
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<td>Fuel Pump Assembly</td>
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<td>Fuel Suction Strainer</td>
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<td>AC Cabinet Assembly</td>
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<td>Fuel Filter</td>
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<td>Temperature Switch Manifold</td>
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<td>Load Regulator Vane Motor</td>
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<td>Dynamic Brake Fan Assembly</td>
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<tr>
<td>Dynamic Brake Grid Shorting Contactor</td>
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<tr>
<td>Fan Grill Assembly</td>
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<tr>
<td>Radiator Fan Assembly</td>
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<td>Radiator Core</td>
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<td>Cab Heater</td>
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<tr>
<td>Storage Battery</td>
<td>289</td>
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<tr>
<td>SCR (Generator Excitation)</td>
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