SPECIFICATIONS FOR P. C. C. CAR

Effective April 1, 1947

These Specifications supersede
all previous issues.

Explanatory Note

Sections 1-5 inclusive cover the basic specifications applying to the construction and equipment of all P.C.C. cars. These Sections provide, however, certain options regarding alternate constructions or equipment as set forth in detail in Section 6.

Section 6 (Options and Other Contract Conditions) is a form which must be filled in to supply all additional information required when the Specifications are used for ordering cars or for obtaining bids on their construction. Instructions for the handling of Section 6 will be found on the cover thereof.

Section 7 comprises Dimensions and Weights, Bills of Material and a list of T.R.C. Drawings as referred to throughout the Specifications.

Schedules are also contained herein which give more specific information for various models of the complete car and for the various types of trucks, springs, wheels brakes and brake actuators that are approved by the Advisory Committee on P.C.C. Cars of the American Transit Association.

These Specifications are supplied exclusively to assist in the manufacture and purchase of the products covered hereby. All publication, reproduction and broadcast of any part hereof are prohibited, all such rights being specifically reserved in Transit Research Corporation.

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CHANGE SHEET

DATE	REVISIONS, ADDITIONS AND DELETIONS
December 15, 1948	The following pages were revised: III, 51, 55, 65, 66, 67, 77, 86, 91, 105, 119, 120, 125, 133, 139, 141, 143, 154, 155, 157, 19 in Section 6. Page VII was added. Drawing No. 4-2h1 was added.
June 1, 1950	The following pages were revised: VII, 11, 17, 18, 27, 33, 34, 48, 54, 55, 71, 75, 91, 102, 103, 104, 107, 108, 109, 110, 111, 112, 113, 115, 125, 156, 157, 158 and 17 and 19 in Section 6. The following drawings were revised: B2-1b1, B2-6a1, B2-6e4, B3-1b1, B3-2a1, B3,4a1, B3-8a1, B3-11a1, C2-2a2, C3-1a1, F2-1a1. The following drawings were added: 2-9h1, B2-8a1, B2-8c1. The following drawings were removed: B2-6e2, B2-6e3.

SPECIFICATIONS FOR P.C.C. CAR

Effective April 1, 1947

SECTION 1 - DEFINITIONS, SCOPE, INSPECTIONS AND TESTS

1.01 Definitions of Terms

As used in these Specifications:

(a) The term "Manufacturer" means the original manufacturer supplying materials, equipment or apparatus for installation on the car.

(b) The term "Truck Builder" means the manufacturer of the car trucks.

(c) The term "Car Builder" means the builder of the car body.

(d) The term "Company" means the purchasing organization or its authorized representatives.

(e) The term "T.R.C." means Transit Research Corporation.

(f) The term "P.C.C." refers to the Electric Railway Presidents' Conference Committee which developed the general design of the "P.C.C. Car" and various of the improvements incorporated therein, and which has been succeeded by the Transit Research Corporation.

1.02 Scope

(a) These Specifications cover all labor, tools, materials, parts, apparatus and equipment (except as otherwise specifically noted herein or stated in writing by the Company) required for the construction and assembly of the number of P.C.C. type cars indicated in the Company's accompanying inquiry or order, as the case may be, completely tested and ready for operation when received on the property of the Company.

(b) The cars to be built hereunder shall include the latest developments as approved by the Advisory Committee on P.C.C. Cars of the American Transit Association and by the Transit Research Corporation, unless otherwise specified by the Company.

(c) See Section 6.01 for a complete outline of the sections, schedules, drawings, bills of material and other data making up these complete Specifications.

1.03 Responsibilities of Car Builders, Truck Builders, and Manufacturers

(a) Each item of equipment or apparatus, including the trucks and the completely equipped car body furnished under these

1.03 Responsibilities of Car Builders, Truck Builders, and Manufacturers (Cont'd)

(a) (Cont'd)

Specifications, shall be designed and built strictly in accordance with the requirements as stated herein.

(b) Car Builder, except as otherwise provided in Section 6.02(a) shall furnish all labor, tools and materials, parts and apparatus necessary for the construction and equipping of the car body. Car Builder shall supply and assemble (completely wired, tested and ready for service) all apparatus and materials specified, including trucks, motors, brake equipment, control and other electrical equipment, heating and ventilating equipment, door operating equipment, lighting equipment, etc. In addition, the Car Builder shall furnish all miscellaneous materials and parts not otherwise specifically provided for, as may be necessary to meet the requirements of these Specifications as to the cars to be furnished hereunder, and shall assume responsibility for the proper fitting together of all parts, with necessary clearances for successful operation.

(c) Truck Builder, except as otherwise provided in Section 6.02(b) shall furnish all labor, tools and materials necessary to construct the trucks in accordance with these Specifications, and to install therein or assemble therewith, all apparatus and parts to be mounted on said trucks, including wheels, motors, track brakes and other brake equipment, ready for installation under the car. Truck Builder, however, shall not be required to furnish or install any electric wiring, including connections from motors and magnetic track brake shoes to car body.

(d) Each Manufacturer of equipment, apparatus or parts shall provide all labor, tools and materials necessary to make, assemble and completely test, ready for installation by Car Builder or Truck Builder, as the case may be, the equipment or apparatus to be furnished by said Manufacturer, together with all materials and parts required to make his equipment completely operable in accordance with these Specifications. Certain drawings and bills of material covering various items of equipment and parts are included herein for the convenience of the interested parties. It shall be specifically understood, however, that the omission of any drawing or schedule, or reference thereto, or of any part or item from any drawing or schedule, or from these Specifications, which is required to make the equipment or apparatus furnished by any Manufacturer or Builder fully complete and suitable for successful performance of the functions for which it is intended, shall not relieve said Manufacturer or Builder from furnishing the required items or parts under these Specifications.

I.03 Responsibilities of Car Builders, Truck Builders and Manufacturers (Cont'd)

(e) Manufacturers of all materials, apparatus and parts shall cooperate to the fullest extent with the Car Builder or Truck Builder as the case may be, during design and construction, to insure proper use or installation of their products. They shall give prompt notice to the Company if the use or installation proposed by the Builder is not satisfactory to them.

I.04 Guarantees

(a) The Car Builder shall guarantee material and workmanship in the car body and the installation of all equipment and apparatus. He shall, without charge to the Company, replace any materials and equipment and make good any workmanship furnished by him, that prove defective or inadequate within a period of 12 months from date of receipt of the car by the customer.

(b) The Truck Builder shall guarantee material and workmanship in the trucks and the installation of all equipment and apparatus. He shall, without charge to the Company, replace any materials and make good any workmanship furnished by him, that prove defective or inadequate within a period of 12 months from date of receipt of the car by the customer.

(c) The foregoing limited guarantee on car body and trucks shall be applicable only to those features of design and to parts and materials approved by the Advisory Committee on P.C.C. Cars, under its rules of procedure, and by the Transit Research Corporation. Unless otherwise agreed to in writing by the Company, Car Builder and Truck Builder shall fully guarantee for a period of 12 months from date of receipt of the car by the customer both with respect to design and functioning, and material and workmanship, any feature or part which may be accepted by the Company without the approvals as provided above.

(d) Except when otherwise specifically noted, Manufacturers shall guarantee design, functioning, material and workmanship of the equipment they respectively supply. They shall replace, without charge to the Company, material, parts or complete apparatus that prove defective or inadequate in any way within a period of 12 months from the date of receipt of the car by the customer.

(e) Wherever under these Specifications, the Builder or Manufacturer desires to offer substitute products for those named herein, in accordance with the opportunity afforded by the term "or equal", he shall submit a complete list of all such items and shall obtain approval in writing by the Company for such substitutions. The Company may require the submission of samples for inspection and test, and/or special

1.04 Guarantees (Cont'd)

(e) (Cont'd)

guarantee as a condition to acceptance of any or all such proposed substitutes.

1.05 Changes

(a) No departure shall be made from these Specifications nor any change made in material, design, or selection of equipment approved hereunder, without the written approval of the Company. Any changes which are authorized during the progress of design or construction shall be made promptly by the Car Builder, Truck Builder or the Manufacturer, as the case may be.

(b) If the changes are such as to alter the cost of the cars built hereunder, the difference from the contract price shall be stated in writing at the time the proposed change is submitted for approval, and when accepted in writing by the Company shall be credited or debited on the contract price, as the case may be.

1.06 Inspections

(a) Authorized representatives of the Company shall have access to the plants of the Car Builder, Truck Builder and Manufacturers supplying material or parts for these cars, for the purpose of inspecting materials and workmanship during the progress of the work.

(b) Car and Truck Builders and Manufacturers shall extend to the Company's representatives full cooperation and necessary facilities to permit the convenient inspection of all materials, work and equipment supplied hereunder. This shall include supplying copies of all drawings, diagrams and data which may be needed properly to inspect and check the design, construction, assembly, installation, workmanship, clearance, tolerance and functioning of the cars, trucks, equipment and parts thereof, supplied hereunder. At the Car Builder's plant there shall be provided a pit of proper depth and length to permit inspection and testing of all parts and equipment located under the car.

(c) The presence of the Company's representatives in the plant of Manufacturer or Builder shall not in any manner lessen the responsibility of said Manufacturer or Builder in respect to meeting all requirements of these Specifications. The Company shall have the right to reject all material and workmanship which do not fully conform to these Specifications or to accepted practice.

(d) If the Company shall have reasonable evidence that defective work has been permitted by a Builder or Manufacturer, or

1.06 Inspections (Cont'd)

(d) (Cont'd)

that defective materials have been used, and shall desire to make an examination of work partly or fully completed, the Builder or Manufacturer shall furnish the appliances and labor for making such investigation and inspection as may be required by the Company. Any imperfect construction or materials which may be disclosed shall be promptly corrected. If investigation discloses no defect, the expense of such investigation shall be borne by the Company.

(e) All work of whatever kind on these cars, and all parts and equipment therefor, which during the progress of construction shall become damaged from any cause whatsoever, shall be made good at the expense of the Builder or Manufacturer in whose plant the damage occurs.

(f) Material, equipment and apparatus which have been inspected and accepted by the Company shall be so marked or so stored that they can be identified readily.

(g) Material or equipment intended for use on these cars or the parts thereof, which shall be rejected by the Company as unsuitable, or not in conformity with these Specifications, shall be corrected to comply with these Specifications, or shall be clearly marked and so disposed of as to assure that it will not be used or offered for use again on these cars, and proper material shall be substituted without delay.

1.07 Tests and Adjustments

(a) Facilities and Requirements

(1) The Car Builder shall provide at his plant, a suitably level test track of proper gauge, length and alignment to permit the acceleration and deceleration, and other operating tests specified below. This track shall be equipped with overhead trolley wire energized with not less than 550 volts d.c. potential measured at the car during full acceleration.

(2) All working and moving parts, and all operating devices and controls of each car and its equipment, shall be tested and put in proper operating condition by the Car Builder and approved by the Company in writing before cars are loaded for shipment. The Car Builder shall perform all of the tests and shall make all of the adjustments specified hereinbelow.

(3) The name and title of the representative of the Company in whose name all approvals and authorizations on behalf of the Company shall be made hereunder, shall be as provided in Section 6.08.

1.07 Tests and Adjustments (Cont'd)

(b) *Car Wiring Tests*

(1) Ring out all wiring circuits to insure continuity and polarity after assembly and installation of all equipment.

(2) Make a direct current ground insulation test on each car as follows: (a) disconnect all ground wires; (b) disconnect the storage battery at its terminals; (c) connect all circuits together and then connect to a 600 volt d.c. source through a voltmeter. If this test shows freedom from a ground connection, the a.c. test specified below shall be applied. If the d.c. test does not show freedom from a ground connection, the point or points at which such ground occurs shall be determined and the insulation made satisfactory to the Company before the a.c. test is applied.

(3) Make an alternating current ground insulation test on each car after separating the connection between nominal 600 volt circuits and nominal 32 volt circuits required above. Apply for one minute an alternating current of 800 volts to all 32 volt circuits, or of 680 volts with 32 volt apparatus, including the generator of the motor generator set, connected in circuit. Apply for one minute an alternating current of 2200 volts to all 600 volt circuits, or of 1870 volts with 600 volt apparatus, including the motor of the motor generator set, connected in circuit. In each case a circuit breaker, set to open at a current slightly greater than the charging current, or a bank of lamps of proper combined voltage shall be connected in series. If this circuit breaker remains closed or if lamps do not light, the insulation to ground shall be considered satisfactory.

All wires, cables and/or equipment that do not meet the requirements of the high potential tests shall be removed and replaced by the Car Builder. After replacement of any such defective parts, materials or equipment, the car shall be subject to retesting.

(4) Reconnect ground connection and storage battery and then test all 32 volt and all 600 volt circuits on each car for proper functioning, including all lighting and all auxiliary circuits and each switch of the operator's gang switch.

(c) *Motor and Brake Controller*

(1) Pull down trolley and test and adjust pressure required to depress acceleration and braking pedals to correspond with the requirements in Section 4.04(b).

1.07 Tests and Adjustments (Cont'd)

(c) (Cont'd)

(2) With the trolley down, test the propulsion motor controller for correct sequence of operation by depressing the power pedal and observing the functioning of the various pieces of equipment involved. Rectify any failure to function in proper sequence before proceeding with the remaining tests.

(3) With the trolley down, depress brake pedal of each car slowly through measured distances and check functioning of brake controller and equipment for both proper sequence and the relationships between braking events tabulated in Section 4.04(n).

(d) *Brakes*

(1) Adjust the potential of the M.G. set on each car to the specified voltage range.

(2) Adjust the drum brake to give the required maximum brake pressure equivalent to 3140" lbs torque at 2000 r.p.m. or approximately 20 m.p.h.

(3) Adjust the height of the magnetic track brake shoes above the rail to 1/4" for each truck. Operate the motor generator set, then make full application of the magnetic track brakes and adjust current and voltage controls of motor generator set as may be necessary to maintain proper charging voltages during and after release of this load.

(e) *Car Performance Tests*

(1) On each car, make acceleration tests over the test track. Connect an indicating ammeter in the main motor circuit and an indicating voltmeter across the motor circuit. If adjustments are required to obtain the current values corresponding to the rates of acceleration specified in Section 4.02, these adjustments shall be made by a representative of the electrical manufacturer.

(2) On each car, make deceleration tests over the test track. Equip the car with such meters, including recording accelerometer, as may be needed to measure friction brake application, dynamic current and track brake current. Make all necessary adjustments to obtain proper synchronization of the three forms of braking and the rates of deceleration specified in Section 4.02, except that if adjustments of the dynamic brake control should be found necessary, these adjustments shall be made by a representative of the electrical manufacturer.

1.07 Tests and Adjustments (Cont'd)

(e) (Cont'd)

(3) All performance characteristics shall comply with the requirements of these Specifications. If the car or any equipment fails to satisfy these objectives, the necessary adjustments shall be made and the car shall be subjected to retest as directed by the Company.

(f) *Miscellaneous Body Tests and Adjustments*

(1) Check one or more completed cars, as may be determined by the Company, for truck clearance on a curve of 32' center radius. This shall be done by running the car around a curve of that radius or by other equivalent means.

(2) Test roof and windows of each car for weather tightness, with motor generator set operating, by subjecting them to a jet of water at 40 lb. pressure from an open end 3" I.D. hose at a distance of 5'. Any leaking parts shall be made weather tight to the satisfaction of the Company.

(3) Check and adjust the doors and their operating mechanism on each car to assure smooth functioning, attainment of the speed specified in Section 6.09(14)(e) and proper functioning of interlocks.

(4) Adjust the headlight of each car to meet the beam characteristics given in Section 3.11(h).

(5) Check speed of windshield wiper.

(6) Check thermostats on each car to give the desired temperature range as specified in Section 6.09(16)(b) and (c).

(7) Check the operation of the damper actuator on each car.

SPECIFICATIONS FOR P. C. C. CAR

Effective April 1, 1947

SECTION 2 - MATERIALS AND WORKMANSHIP

2.01 General

(a) All materials entering into the construction of these cars shall be of first class quality. All workmanship shall be of high grade and shall conform to the best manufacturing practices in all respects.

(b) Unless otherwise specified, all materials shall conform to A.S.A. and/or A.S.T.M. specifications.

(c) All material intended for use in these cars shall be marked or stored so as to be readily identified, and shall be adequately protected during handling and storage.

(d) All interior unpainted metal trim shall be satin finish, and all exterior unpainted metal trim shall be bright finish unless otherwise specified.

(e) Lumber shall be thoroughly air seasoned or kiln dried before using and shall be dressed on all surfaces to full dimensions.

(f) Plywood, other than flooring, shall be three-ply poplar, with phenolic resin glue, or equal.

(g) Cotter pins, screws, bolts and nuts shall conform to American national standards and shall be cadmium plated or approved equivalent unless otherwise specified. Cadmium plating is to conform to the latest revision of A.S.T.M. specification A 165, Type N.S.

(h) All interior exposed screws, #10 or larger, shall be Phillips Head, Reed & Prince or equivalent.

(i) Bolts, nuts, cap screws, machine screws and self tapping screws shall be suitably locked.

(j) Rivet holes and bolt holes shall be accurately located and aligned, and when necessary during assembly, holes shall be reamed round to specified size in position. Hand driven steel rivets shall be driven hot and shall completely fill the holes. Rivets may be cold driven when adequate mechanical equipment is available therefor. Heads shall be concentric with the shank of the rivet. Exposed heads shall be free from rings, fins, pits and burns.

(k) Huck rivets may be used in locations approved by the Company.

(l) Joints shall be properly fitted, whether exposed or concealed.

2.01 General (Cont'd)

(m) Where metal is riveted or bolted to metal in the car structure, contact surfaces shall be free of dirt, grease, rust and scale and shall be coated with a suitable metal base primer which will not interfere with later enamel or lacquer application.

(n) Where wood and metal surfaces are placed together, the wood is to be coated with white lead and oil or approved aluminum paint and the metal is to be coated with a primer of the type specified in (m) above.

(o) Where wood and wood are placed together both abutting surfaces shall be coated with white lead and oil or approved aluminum paint.

(p) All hidden metal shall be given one heavy coat of approved metal base primer and one coat of approved sealer. All hidden wood shall be given two coats of white lead and oil, or two coats of approved aluminum paint.

(q) All bolts or rods passing through wood shall be coated with white lead and oil or approved aluminum paint over those parts imbedded in the wood.

(r) Where roller guides are required for control rods they shall be made of Micarta with the layers of reinforcing fabric at right angles to the axis of the rollers. or approved equal.

(s) Chromium plating shall conform to the latest revision of A.S.T.M. specification A 166, Type F.S.

2.02 Steel

(a) *Structural and Sheet Steel*

(1) The underframe and other parts of the car body structure (including equipment compartments and cable ducts) subjected to street wash shall be made of the materials known commercially as Corten, Yoloy, Armco HT 50 or Mayari R, or approved equal. Equipment compartment covers are elsewhere specified to be made of aluminum alloy.

(2) The roof ends or hoods of the car body shall be made of deep drawing, copper bearing, open hearth steel with copper content of not less than 0.20% nor more than 0.25%.

(3) Side sheets, posts, steps and cable and rod ducts therein, shall be made of material having greater corrosion resisting properties than copper steel, unless otherwise specified by the Company.

2.02 Steel (Cont'd)

(b) Axles

(1) Axles shall be made of SAE 4140 to 4145 steel or SAE 8645 to 8650 steel, heat treated to develop a minimum tensile strength of 100,000 lbs./sq.in.; elongation of not less than 20% in 2"; reduction of area of not less than 50%. The endurance limit shall not be less than 50,000 lb. per sq. in. computed in the outermost fiber. The Company reserves the right to make fatigue tests on a reasonable number of axles to determine the endurance limit.

(2) If such axles are taken from the production line and prove to have the required endurance limit, the Company will reimburse the Manufacturer therefor.

(3) Axles which show any sign of surface cracking after finishing shall not be accepted.

(4) Heat numbers of all axles shall be recorded by the truck manufacturer and he shall mark each axle on one end with an individual serial number which shall identify the heat number from which the axle was made.

(c) Steel Castings

(1) Steel castings shall be commercially sound throughout. The Company reserves the right to cut up one or more of each shape from time to time to determine the character of metal in parts not exposed by the various machining operations. If castings are found to be porous or otherwise commercially unsound, the material destroyed shall be at Manufacturer's expense.

(2) All steel castings used in the truck structure shall be made of electric furnace steel, heat treated to produce the following physical properties or better:

Tensile strength	80,000 lb. per sq. in. min.
Yield point	50,000 " " " " "
Elongation in 2"	22%
Reduction of area	30%

(3) The king pin and the base thereof which form part of the body bolster structure shall be made of electric furnace steel conforming to the physical characteristics in (2) above.

(4) The upper member of the center bearing shall be made of cast steel corresponding to S.A.E. 1035 in composition and shall be heat treated for Brinell hardness of about 225. It shall be finish ground after heat treatment.

2.02 Steel (Cont'd)

(c) (Cont'd)

(5) Steel castings used in locations not referred to herein shall be selected for composition and characteristics best suited to the application, by the manufacturer or builder concerned, but shall be subject to approval by the Company.

(d) *Stainless Steel*

(1) Stainless steel shall conform to the latest revision of those parts of A.S.T.M. specification A167 covering Grade 3, Type 304 material with No. 6 finish.

(2) Buffing and polishing of stainless steel, where required, shall be done in an approved manner and without the use of any composition containing iron or iron oxide.

2.03 Aluminum

(a) This division of the Specifications is intended to supply such information as is required for aluminum parts called for in the body of the Specifications. It is also intended as a guide in the selection of proper aluminum alloys in the event approval should be given to substitute such alloys for parts specified to be made of steel.

(b) The aluminum materials specified below are identified by the designations used by Aluminum Company of America and shall conform to the specifications given therefor in the latest revision of the publication "Alcoa Aluminum and Its Alloys."

(c) The second column of the following tabulation gives the recommended alloys for the principal parts of a car. These alloys are selected for one or more of the following reasons: strength, corrosion resistance, ease of fabrication, first cost. Alternative materials are tabulated for certain parts. In such cases, that material is to be used which is indicated by the principal consideration in each individual case.

RECOMMENDED ALUMINUM ALLOYS

Part	*Alloy Specification*	*Method of Fabrication*
Posts	61S-T extruded sections	Offsets formed cold
Roof carlines and purlines	61S-W extruded sections	Form cold to shape
Floor stringers	61S-T rolled sections	Use as received
Belt rail	61S-T rolled bar	Use as received
	61S-T extruded sections	Use as received

2.03 Aluminum (Cont'd)

(c) (Cont'd)

RECOMMENDED ALUMINUM ALLOYS (Cont'd)

Part	*Alloy Specification*	*Method of Fabrication*
Drawbar	61S-T 3" O.D. x 1/2" wall extruded tubing	To be fabricated hot in "O" and heat treated to "T" condition
Roof side plt.	52S-1/4 H sheet or plate	Form cold in press
	61S-T extruded shape	Use as received
Side sills	Alclad 14S-W rolled shapes	Use as received*
	61S-T rolled shapes	Use as received*
	61S-T extruded shapes	Use as received*
End sills	61S-T extruded shapes	Form cold to shape desired
Underframe shapes	Alclad 14S-W rolled shapes	Use as received*
	61S-T rolled shapes	Use as received*
Gusset plts. in all framing	Alclad 24S-T sheet or plate	Shear to shape from std.
	52S-1/4 H sheet or plate	Sizes of sheet or plate
Side sheets	Alclad 24S-T	Use as received
	52S-1/4 H sheet or plate	Use as received
Roof sheets	Alclad 24S-T	Form cold if necessary
	52S-1/4 H sheet or plate	Form cold if necessary
Roof end corners	52S0 sheet or plate	Form cold with press or Pettinghill hammer
Roof end sheets	52S-1/4 sheet or plate	Form cold
Dash sheets	Alclad 24S-T	Form cold
	52S-1/4 H sheet or plate	Form cold
Under-car compartment	52S-1/4 H sheet or plate	Form cold in press
Interior finish	3S-1/2 sheet or plate	Use as received. Shear from standard sizes
Headlining	3SH sheet or plate	Use as received. Shear from standard sizes
Decorative or finish molding	63S-T5	Use as received

***If formed hot the material must be heat treated subsequently to restore physical properties.**

2.03 Aluminum (Cont'd)

(c) (Cont'd)

RECOMMENDED ALUMINUM ALLOYS (Cont'd)

Part	*Alloy Specification*	*Method of Fabrication*
Window sash guides	63S-T5 extruded	Use as received
Strength castings	195-T6 heat treated castings	Finish machine and use
Castings misc.	B-214 castings	Finish machine and use
Handrails and stanchions	61S-T tubing	Use as received

(d) Forming shall follow instructions given by Aluminum Company of America for specific alloys and specific parts. The following paragraphs give somewhat general specifications which shall be used as guides:

(1) When necessary to form sheets and shapes the radii of bends shall be so specified as to permit cold forming when possible.

(2) When the conditions are such that 61S-T alloy cannot be satisfactorily worked cold the alloy should be obtained in the "W" condition, worked cold and subsequently artificially aged to the "T" condition.

(3) When structural shapes are formed from sheet by machine, such as brakes, bulldozers, presses, etc., either cold or hot, the tools shall be polished as smooth as possible and lubricated with tallow, lard oil and kerosene, or 600 W oil.

(4) When aluminum alloys are heated for the purpose of forming, provision shall be made for indicating the temperature of the metal during the entire operation.

(e) Joints may be made by riveting or by welding, following instructions given by Aluminum Company of America. The following paragraphs give somewhat general specifications which shall be used as guides:

(1) The use of aluminum rivets is preferred in those parts of the structure subject to corrosive attack and difficult to protect permanently by means of paint.

(2) Aluminum rivets shall be made of 53S-T 61 alloy driven cold to and including 3/8" diameter, and hot at 950 to 1050° F. over that size. Attention is called to the fact that the shear value of these rivets is only about half that of a steel rivet and that this fact must be taken into account in designing the joint.

2.03 Aluminum (Cont'd)

(e) (Cont'd)

(3) Steel rivets shall preferably be driven cold. If conditions require hot driving, the riveting operation shall be so performed as not to raise the aluminum alloy parts to an undesirably high temperature, about 400° F.

(4) Electric spot welding and fusion welding by oxyhydrogen, oxyacetylene, carbon arc, metallic arc, or argon shielded tungsten arc may be used. Instructions for both equipment and practice shall be obtained from Aluminum Company of America.

(f) Contact surfaces shall be protected as indicated in the following paragraphs:

(1) Where aluminum comes in contact with aluminum the abutting surfaces shall be cleaned with a chemical metal cleaner as recommended by the Aluminum Company of America, following the instructions furnished by the manufacturer of the cleaner. After the surfaces are clean and dry they shall be painted with one coat of zinc chromate primer, U. S. Navy Specification 52P18 or one equal in performance.

(2) Steel members which contact aluminum alloy members should be primed in detail with red lead or may be given the same priming coat as the aluminum. Before priming, the steel should be cleaned to remove all mill scale, rust and other surface deposits.

(3) Where wood, Agasote or canvas surfaces contact aluminum, the latter shall be treated as above and the other material shall be given two coats of aluminum paint on the contact surface.

(4) In the case of connections at the floor line and below, all joints entirely of aluminum alloys, aluminum alloys to steel, aluminum alloys to non-metallic materials, especially wood, should not only be primed in detail, but should also be sealed with a suitable caulking compound, such as Alumilastic Grade "C-B" fortified with zinc chromate.

(5) Finish or top coats of paint on understructure should use one or two coats of aluminum paint containing two pounds of Albron paste No. 205 per gallon of vehicle meeting Navy Specification 52V12 or one equal in performance. Top coatings for underframes to be used as anti-noise or anti-abrasive coatings may be: (a) Dednox Company's Dednox No. 553, (b) Texaco Car Cement No. 1401, or (c) Minnesota Mining Company's EC244. All aluminum alloy sheets or shapes in contact with car insulation should be painted with one or two coats of aluminum paint as described above.

2.04 Rubber

(a) *General*

(1) All rubber specified herein shall be so compounded and cured that it will perform satisfactorily in car operation at any temperature between -40 and +120° F. and shall have the longest possible commercial life consistent with obtaining the other characteristics specified.

(2) Unless otherwise specifically stated herein all tests shall be conducted according to the latest revisions of A.S.T.M. test procedures for rubber goods.

(3) Specimens shall be tested two to ten days after manufacture.

(4) When tests are specified to be made at any particular temperature, the Company and Manufacturer shall agree in advance on the factor to be applied to readings obtained at any other temperature.

(5) When tests for drift under load are specified they may be made at any convenient temperature between 50° F. and 80°F. provided that the temperature at the beginning and end of the test is the same. The test shall be made under conditions subjecting the rubber specimen to continuous vibration. This may be obtained from vibration of the building caused by operating machinery, or it may be produced artificially by a small motor carrying an off-center weight, or by equivalent means. If produced artificially the frequency of vibration shall be between 1000 and 2000 cycles per minute.

(6) The Manufacturer shall guarantee all rubber parts to be free from defects of material and workmanship. For all parts made by curing rubber to metal, any premature failure between metal and cement or cement and rubber occurring when the part is used in normal service and according to the provisions of this specification, shall be considered as caused by a defect of material and/or workmanship.

(7) Unless otherwise specifically provided or agreed upon between Manufacturer and Company, metal parts to which rubber is cured shall be made of S. A. E. 1020 hot rolled steel and shall be suitable for brass plating after pickling.

(8) Synthetic rubber may not be substituted for natural rubber unless so specified hereafter.

(b) *Rubber Truck Springs*

(1) Rubber truck springs shall be so compounded, designed and cured as to meet the load and other requirements of

2.04 Rubber (Cont'd)

(b) (1) (Cont'd)

Section 5.09 when used in trucks of the type specified in Section 6.01 and the Truck Schedule referred to therein.

(2) All rubber truck springs shall be capable of meeting the following drift test: when the spring is subjected to a load corresponding to its maximum static load applied continuously for a period of 240 hours, the increment of deflection between the end of the 24th and the end of the 240th hour shall not be greater than 0.010" per in. of total final deflection. The Manufacturer shall supply test equipment and shall test for drift, at his expense, one spring in each lot of 200 or fraction thereof.

(c) *Rubber Stops for Track Brake Spreader, for Bolster bumpers and for Rubber Snubbers.*

(1) These stops may be made of natural or synthetic (GRS) rubber.

(2) The rubber parts shall be so compounded, fabricated and cured that the durometer hardness, measured with a Shore Type A durometer on the end of stop in the free condition shall be 60 ± 3 at a temperature between 70° and 90° F.

(3) The rubber shall have the highest resistance to abrasion which is compatible with the other characteristics herein specified.

(d) *Torque Arm Stabilizer Bracket Bushing for Truck B-2*

(1) The two cylindrical halves shall be made of natural rubber.

(2) The rubber parts shall be so compounded, fabricated and cured that the durometer hardness, measured with a Shore Type A durometer in the free condition, shall be 53 ± 3 at a temperature between 70° and 90°F.

2.04 Rubber (Cont'd)

(e) Rubber Sandwich Wheel Disks

(1) Detailed specifications for the rubber sandwich wheel disks to be provided for the type of resilient wheels specified in Section 6.01 are given in the Wheel Schedule referred to therein.

(2) The rubber manufacturer shall check the thickness of each sandwich and mark the side where the thickness is maximum.

(f) Springs for Trolley Board.

(1) These springs must be made of natural rubber.

(2) The rubber parts of these springs shall be so compounded, fabricated and cured that the deflection of a spring, when mounted in a 3" diameter container and subjected to a load of 150 lb., shall be 3/8" ± 1/32" at a temperature between 70° and 90°F. The load shall be run up to 150 lb. and back to zero five times before this test is made. The Manufacturer shall supply test equipment and shall test at his expense one spring in each lot of 100 or fraction thereof to check fulfillment of this deflection specification.

(3) When the spring is subjected to a load of 150 lb. continuously for 240 hours, the increment of deflection between the end of the first 24 hours and the end of 240 hours shall not exceed 0.004" per in. of total final deflection. The Manufacturer shall supply test equipment and shall test at his expense, one spring of each lot of 200 or fraction thereof to check fulfillment of this drift specification.

(4) The Manufacturer shall supply test equipment and test at his expense, all springs under a load of 700 lb. to check strength of bonds.

(g) Rubber Door Edges

(1) All U-shaped door edges must be made of natural rubber.

(2) They shall be free of major defects of material and work-

2.04 Rubber (Cont'd

(g) (2) (Cont'd)

manship. A slightly roughened surface shall not be considered a defect.

(3) The Manufacturer shall supply test equipment and test specimens, and shall perform at his expense such tests as are specified hereinafter.

(4) When fabric insert is omitted, the Manufacturer shall furnish an adequate number of test pieces 6"x6"x3/32" of the same material as used in the door edges and with equivalent cure. These pieces shall be so selected that they are representative of each batch of rubber used during the production of the order, and there shall be at least one set of test pieces for every 400 door edges, or part thereof.

(5) When using the 6"x1/2" A.S.T.M. dumbell type test specimen as given in latest revision of A.S.T.M. specification D 15, Methods of Sample Preparation for Physical Testing of Rubber Products (General Requirements), and in latest revision of A.S.T.M. specification D 412, Methods of Tension Testing of Vulcanized Rubber, the tensile strength shall not be less than 3500 lb. per sq. in. nor the elongation less than 550%.

(6) The tensile strength of the rubber shall not be reduced more than 25% when subjected to 96 hours of accelerated aging in an air oven at 70°C (158° F.), the aging and testing being done as provided in the latest revision of A.S.T.M. specification D 573, Method of Test for Accelerated Aging of Vulcanized Rubber by the Oven Method.

(h) *Rubber for Door and Window Seals and Glazing Strips*

(1) All rubber for door and window seals and glazing strips shall be extruded and shall be free of major defects of material and workmanship. This must be natural rubber.

(2) The durometer hardness measured with a Shore Type A durometer at a temperature between 70° and 90° F. shall be as follows:

Door and window seals - Not greater than 50
Glazing strips - " " " "

(3) The Manufacturer shall supply test equipment and test specimens and shall perform at his expense such tests as are specified hereinafter.

(4) The test specimens shall be cut from the extruded material, and at least one tensile strength and elongation

2.04 Rubber (Cont'd)

(h) (4) (Cont'd)

test and one accelerated aging test shall be made on the material used for each car order of 25 cars or part thereof. If the compound or cure, or both, are changed during the production of material for one car order, at least one test of each type shall be made for each different batch.

(5) When using the 6"x1/2" A.S.T.M. dumbell type test specimen (or smaller size if the size of the part necessitates) by the methods specified in 2.04(g)(5) for rubber door edges, the tensile strength and elongation shall not be less than the following:

	Tensile Strength	*Elongation*
Door and window seals	2000 lb/sq.in.	500%
Glazing strips	2700 lb./sq.in.	450%

(6) The tensile strength of the rubber shall not be reduced more than 25% when subjected to accelerated aging by the methods specified in 2.04(g)(6) for rubber door edges.

(i) *Rubber Roof Mat*

Rubber used for roof mat shall be 3/16" thick and shall be made of material which will maintain a high dielectric value when exposed to the elements, including bright sunlight. This mat material shall be capable of withstanding a test of 10,000 volts for one minute as prescribed in latest revision of A. S. T. M. specification D 178, "Rubber Matting for Use Around Electrical Apparatus or Circuits not Exceeding 3000 Volts to Ground."

2.05 Glass

(a) *Glazing Schedule*

(1) The front windshield, the left front vestibule sash adjacent to the operator's position, and the rear sash of the rear vestibule shall be glazed with nominal 1/4" safety plate glass meeting the specifications given hereinafter.

(2) All glass openings in doors and the side sash of the rear vestibule shall be glazed with nominal 7/32" safety sheet glass meeting the specifications given hereinafter.

(3) All other side sash except that included in (1) and (2) above shall be glazed with double strength, "A" quality, clear window glass, meeting the specifications given hereinafter, or approved heat rays screening glass, or safety glass as specified in Section 6.09(1).

2.05 Glass (Cont'd)

(a) (Cont'd)

(4) Standee Window openings may be provided with 3/16" tinted plate glass, safety glass, double strength DSA glass, or heat rays screening glass, as specified in Section 6.09(2).

(b) Safety Glass

(1) All safety glass (plate and sheet) shall be of the laminated type, consisting of two pieces of glass bonded with "Plexigum" or a plasticized polyvinyl butyral resin membrane approximately 0.015" thick and resistant to ultra-violet and visible light and heat.

(2) For safety plate glass each of the laminated pieces shall be approximately 0.115" thick. For safety sheet glass each of the laminated pieces shall be approximately 0.091" thick.

(3) When an individual light is laid on a truly flat surface, the glass shall not indicate a bow of more than 0.030" per lineal foot.

(4) The overlap of one sheet of glass with respect to the other at an edge shall not exceed 1/32". Corners and burrs shall be ground smooth and all edges shall be seamed.

(5) The over-all dimensions of individual lights as supplied shall be held within 1/16" of the dimensions ordered.

(6) The bond between the two sheets of glass and the membrane shall be of such quality that when the glass is broken by shock, by twisting or by direct impact, there will be no material separation between the laminations.

(7) There shall be no appreciable variation in color in the individual lights of laminated plate or sheet glass when examined over a white background.

(8) All lights of laminated plate shall be so nearly free from haze that the laminated glass shall have approximately the same clarity as a light of the same nominal thickness of plate glass when viewed against a north light.

(9) Occasional specks of foreign material are permissible provided such specks do not exceed 0.020" in greatest dimensions and are not within the central three-quarters of the area of the light.

(10) No lights containing unbonded areas (let-goes) shall be accepted.

2.05 Glass (Cont'd)

(b) (Cont'd)

(11) Safety plate glass shall be of such quality that there is no apparent distortion of vision when viewing objects on a line of sight making an angle of 30° with the plane of the glass. Safety sheet glass shall produce no apparent distortion on a line at right angles to the plane of the glass.

(12) All questions regarding the quality of safety plate or sheet glass shall be settled by the test methods prescribed in the American Standards Association's latest revision of American Standard Z26.1, "Safety Code for Safety Glass for Glazing Motor Vehicles Operating on Land Highways."

(c) *Double Strength, "A" Quality, Window Glass*

Double strength, "A" quality, clear window glass or heat rays screening glass shall conform in all respects to the specifications therefor contained in the latest revision of Federal Specifications DD-G-451, "Glass; Flat for Glazing Purposes."

2.06 Paint and Painting

(a) *Materials and General Requirements*

(1) The interior and exterior of the car body shall be painted in accordance with instructions of the Company as to color scheme, striping and lettering, using products supplied or recommended by the paint Manufacturer designated in Section 6.09(3). Unless modified by the written recommendations of said paint Manufacturer, which shall in turn be approved by the Company, the painting schedules specified hereinbelow for the various parts of the car, shall be followed.

(2) All paint materials which are to be superimposed to form a finish shall be mutually compatible. Unless otherwise specified herein, or authorized in writing by the paint Manufacturer or Company, all paint materials shall be used at can consistency. When thinning is authorized, only thinners recommended for the purpose shall be used, and only to the extent recommended.

(3) During construction, the requirements of Section 2.01(p) regarding protection of all hidden surfaces including metal doors shall be fully met. After erection, the interior shall be given one coat of primer with a sealer coat on the back side sheets and end sheets below the belt rail. The sealer coat may be a material similar to Lucas cement, which would tend to prevent drumming.

2.06 Paint and Painting (Cont'd)

(a) (Cont'd)

(4) Before painting of the finished car body structure, all dents, roughness or other surface imperfections shall be removed by straightening, filing and sanding. Where necessary, minor imperfections in metal surfaces may be built up with solder, but, in that event, such areas shall be treated with a neutralizing solution before painting, as may be recommended by paint Manufacturer.

(5) Painting materials shall be either brushed or sprayed as provided hereinbelow or as modified therefrom by recommendations of paint Manufacturer. Each coat shall be uniformly applied over all surfaces to be covered and shall be free from runs, sags or other application defects. Painting shall be done by experienced labor, using proper equipment under competent supervision. Painting of the completed body structure shall be done in a clean, dry atmosphere at a temperature not less than 68° F.

(b) *Exterior Painting*

That part of the exterior of the car body consisting of side panels, front and rear panels, letter boards and metal parts of roof, step risers, and ends of step wells shall be finished as follows:

(1) Thoroughly clean the metal of all rust, scale, dirt, oil and grease by sand blasting or cleaning with an oil-free cleaning solvent, steel wool and sandpaper to provide a painting surface acceptable to Company.

(2) Immediately after cleaning and before exposure can affect the cleaned surface, spray one coat of metal primer. Air dry 48 hours unless a shorter period is recommended by the Manufacturer of the primer.

(3) Spray one coat of surfacer. Air dry 24 hours unless a shorter period is recommended by the Manufacturer of the surfacer.

(4) Knife where necessary with glazing composition. Air dry over night.

(5) Putty where necessary with hard putty. Air dry over night.

(6) If the roughness of the metal requires it, apply one solid coat of glazing composition by means of a brush and trowel to a smooth surface. Air dry over night.

(7) Spray second coat of surfacer. Air dry 24 hours unless a shorter period is recommended by the Manufacturer of the surfacer.

2.06 Paint and Painting (Cont'd)

(b) (Cont'd)

(8) If the surface is rough or otherwise imperfect after this operation, apply a third coat of surfacer or repeat the puttying and glazing and follow with a third coat of surfacer, as may be necessary.

(9) Wet sand to smooth surface using either pumice blocks or No. 180 and No. 240 sandpaper. Air dry over night.

(10) Spot prime with metal primer if necessary to cover bare metal areas produced by sanding. Air dry over night.

(11) Dry scuff lightly.

(12) If lacquer is to be the top coat, spray two coats of surfacer thinned as recommended by the Manufacturer thereof. Air dry one hour for each coat.

(13) Dry scuff very lightly as may be necessary.

(14) Apply two coats of lacquer, thinned as recommended by the Manufacturer thereof. Air dry one hour for each coat.

(15) Letter and stripe as specified in detail by Company.

(16) If a synthetic enamel is to be the top coat, omit step (12) above, apply one coat of enamel, air dry over night, apply a flash coat of enamel and one hour later apply one solid coat of enamel. Then proceed to step (15) above.

(c) *Back of Head Lining and Side Lining Panels*

Apply two coats of white lead and oil or aluminum paint prior to application in the car, allowing ample time for drying between coats.

(d) *Face of Side Lining Panels*

Finish as follows:

(1) Brush on one coat of primer prior to application on the car and air dry 48 hours.

(2) Spray two coats of surfacer prior to application on the car and air dry 24 hours.

(3) Sand to smooth surface with No. 240 wet or dry sandpaper, finishing off with No. 320 paper.

(4) Spray one coat of surfacer thinned as recommended by the Manufacturer thereof. Air dry one hour.

2.06 Paint and Painting (Cont'd)

(d) (Cont'd)

(5) Scuff sand very lightly.

(6) Spray two coats of selected final finish thinned as recommended by the Manufacturer thereof.

(e) *Face of Head Lining Panels*

Finish in accordance with (d) above, omitting steps (4) and (5).

(f) *Back of Metal Headlining Panels*

Clean and give one heavy coat of metal primer or aluminum paint and one coat of sealer, allowing ample time for drying between coats.

(g) *Face of Metal Headlining Panels*

Finish as follows:

(1) Clean metal of all rust, scale, dirt, oil and grease by the use of appropriate solvents and by hand sanding.

(2) Immediately after cleaning and when dry, spray one coat of metal primer. Air dry for 48 hours.

(3) Spray one coat of surfacer. Air dry for 24 hours.

(4) Putty where necessary with hard putty and air dry over night.

(5) Spray second coat of surfacer. Air dry 24 hours.

(6) Sand to smooth surface with wet or dry No. 240 sandpaper.

(7) Spray two coats of selected final finish. Air dry overnight between coats.

(h) *Remainder of Interior*

Finish as follows:

(1) Thoroughly remove all rust, scale, dirt, oil and grease by scrubbing with steel wool and by the use of a suitable solvent.

(2) Immediately after drying spray one coat of metal primer. Air dry 48 hours unless a shorter period is recommended by the Manufacturer thereof.

2.06 Paint and Painting (Cont'd)

(h) (Cont'd)

(3) Spray one coat of surfacer. Air dry 24 hours unless a shorter period is recommended by the Manufacturer thereof.

(4) Putty where necessary with hard putty. Dry over night.

(5) Spray second coat of surfacer and air dry 24 hours unless a shorter period is recommended by the Manufacturer thereof.

(6) Sand to smooth surface with No. 240 wet or dry sandpaper.

(7) Spray one coat of surfacer thinned as recommended by the Manufacturer thereof. Air dry one hour.

(8) Scuff sand very lightly.

(9) Spray two coats of selected final finish as recommended by the Manufacturer thereof.

(10) Apply decalcomania letters and numbers and protect with two pencil coats of clear varnish.

(i) *Roof*

If not all steel, prior to application of canvas, putty all nail and screw holes and give wooden part of roof a heavy priming coat of white lead and oil on which the canvas shall be stretched while the paint is wet. The canvas shall then be given a sealer coat followed by two coats of roof finish, each coat being brushed on after the previous coat has thoroughly air dried. When chemically prepared roof canvas is used, it shall be given a primer coat in addition to the sealer, before the finish coats are applied.

(j) *Under Frame*

The under frame, including equipment hangers and other attached steel parts shall be given two coats. The first of these shall consist of oxide of iron metal primer and the second shall be an approved metal protective paint.

(k) *Battery Compartment*

The battery compartment shall be given one spray coat of approved acid resistant black asphaltum paint.

(l) *Trucks*

(1) As provided in Section 5.13(a), the truck Manufacturer shall apply one coat of approved metal primer on all exposed surfaces of trucks.

2.06 Paint and Painting (Cont'd)

(l) (Cont'd)

(2) Before installation under the car, the car builder shall clean off all accumulated dust, dirt or other foreign matter by means appropriate to the purpose and shall then spray a final coat of approved truck paint, and air dry.

(m) *Wheels*

(1) The wheel Manufacturer shall apply one coat of approved metal primer to all external surfaces of the wheels with the exception of the tread surface of the tire and the bore of the hub.

(2) Before painting, the surfaces to be covered shall be thoroughly cleaned of all rust, scale, oil, grease and dirt.

(n) *Undercoating*

When specified in Section 6.09 (59), the undersides, steps and skirts, as specified, will be sprayed with an approved undercoating. This material must retain its plasticity and be resistant to acids, salts and alkalis. It must be fire resistant and easily removed with a torch.

2.07 Welding

(a) The Car Builder, Truck Builder and each Manufacturer shall be responsible for the quality of the welding done by his organization, and all welders employed in the making of welds on structures or products built under these Specifications shall have been tested to determine their ability to operate the welding equipment to be used in making the types of welds required hereunder and to produce satisfactory welds therewith.

(b) The Company shall have the right to require the making of test welds by any operator to determine his ability to produce satisfactory welds of any given type. The Company shall also have the right to require the making of test welds to settle any question which may arise as to the suitability of any welding method or procedure used during production. The recommendations of the American Welding Society as contained in the latest revision of their "Standard Qualification Procedure" shall be followed in the making of tests and the settlement of other questions which may arise hereunder regarding welding practice.

(c) Before welding of any sort is started, parts to be joined shall be properly cleaned. All corrosion or rust, oil, water and other foreign material shall be removed by processes or methods acceptable to the Company.

(d) All parts which are to be joined by welding shall be adequately supported in proper interrelation by tables, jigs, or fixtures.

(e) Welding rod or wire or filler metal shall be chosen with respect to make, type and size by Car Builder or Truck Builder or Manufacturer, as the case may be, who shall assume full responsibility for the character of the work produced.

2.07 Welding (Cont'd)

(f) Filler metal shall be purchased in packages of convenient sizes, and shall be marked with the following information:

Make
Specification number
Diameter
Net weight

This material shall be stored so as to protect it from damage, and so that it can be easily identified. Filler metal shall be issued and handled in such a way as to prevent materials of a given specification being mixed with those of another specification.

(g) In case a question shall arise regarding the suitability of given electrodes, shielding material or filler metal for the work covered by these Specifications, the latest revision of the joint American Welding Society and A.S.T.M. tentative specifications for Filler Metal, Iron and Steel, shall govern.

(h) Current, voltage, distance, flame and other variables shall be so controlled as to give a reasonably smooth weld free of gas pockets, oxide inclusions, excessive variations in width and thickness, excessive wandering, and spattering.

(i) Penetration of weld metal into the bottoms of angles and vees, and fusion at these points shall be complete. Weld metal shall run into the base metal at the finished surface of the weld in a smooth curve approximating tangency to the surface of the base metal so as to avoid sudden change of section and resultant concentration of stress.

(j) The method used in depositing weld metal shall be chosen so as to minimize warpage and locked-up stresses. To this end, tack welding, skip welding, offset welding and other devices and sequences now well known in the art shall be used where necessary.

(k) Parts rotating at high speed and other parts in which locked-up stresses serve as a source of danger shall be heat treated after welding for stress relief. When the base metal contains 0.3% carbon or less, this shall be done by heating the structure slowly in a furnace to a temperature of 1100° to 1200° F., holding for one hour per inch of thickness at that temperature, and then cooling slowly to at least 250° F. before removal from the furnace. When the carbon content of the base metal is above 0.3% the annealing temperature shall be 1425° to 1475° F.

(l) Finished welds which have a thickness greater than 1/4" shall be made with at least two beads. The scale shall be completely cleaned off the underlying bead and surrounding metal after cooling and before the next bead is deposited.

2.07 Welding (Cont'd)

(m) The following requirements shall be met by welding rod or wire used for the various types of welding indicated:

(1) For manual electric fusion welding, electrodes shall be of the heavily coated, shielded arc type, unless otherwise specifically approved by the Company.

(2) For automatic electric fusion welding, uncoated electrode wire may be used when necessary.

(n) For carbon arc welding, a shielded carbon arc shall be used. The method and material for shielding and the filler metal, if used, shall be best suited to provide welds of good quality under the conditions encountered.

(o) Manual fusion welding by the gas process may be used in butt welding of sheets 3/32" and less in thickness and, at the option of the Company, in other work.

(p) *Spot or Plug Welding*

(1) Spot or plug welding to produce welds which carry structural stresses, as for example those fastening side sheets to structural members, shall be done only with equipment fitted with time, current, and pressure control.

(2) The Builder or Manufacturer shall determine experimentally, or in other acceptable fashion, the proper setting of the controls and shall then provide against unauthorized changes.

(3) The size, shape, and surface conditions of electrodes required to give satisfactory welding and acceptable finish shall be determined similarly and a complete record made thereof. Thereafter, the electrodes shall be dressed to these conditions as frequently as the character of the work requires.

(4) The Builder or Manufacturer shall so treat surface marks resulting from welding as to eliminate all visible defects in the finished surface.

2.08 Wire and Cable

(a) *Conductor Material*

(1) All conductors shall be of soft annealed copper, properly tinned, and shall have the properties and characteristics specified in the latest revision of A.S.T.M. specification D 27, "Insulated Wire and Cable: Class AO, 30% Hevea Rubber Compound."

2.08 Wire and Cable (Cont'd)

(a) (Cont'd)

(2) Stranding shall be as given in the tabulation in Section 7.03(f) hereof, instead of as in Table 1 of A.S.T.M. specification D 27.

(3) Wires for control and auxiliary circuits shall not be smaller than No. 12, except for special apparatus, such as heat or ventilation control equipment, where special types of wires are recommended for use by the manufacturers for interconnection of their various pieces of equipment.

(b) *Paper Separator*

A paper separator shall be used between copper and rubber insulation, except that the separator may be omitted if a free stripping type of insulation is used. The paper separator is not required on asbestos insulated wire and cable.

(c) *Rubber Insulation*

(1) Rubber insulation shall conform to either the latest revision of A.S.T.M. specification D 27, "Insulated Wire and Cable: Class AO, 30% Hevea Rubber Compound," or of A.S.T.M. specification D 353, "Insulated Wire and Cable: Performance Rubber Compound."

(2) The thickness of rubber insulation and the number and type of coverings over the insulation shall be as given in the tabulation in Section 7.03(f) hereof.

(3) Tape used with rubber insulation shall have a thickness of at least 0.010" and shall be frictioned on both sides with rubber, and applied with a suitable overlap.

(4) Braids used with rubber insulation shall be at least equal to A.S.T.M. standard braid as covered in the latest revision of A.S.T.M. specification D 27. They shall be thoroughly saturated with black flame retarding and moisture resisting compound.

(5) Motor lead terminals shall have rubber insulation of the type specified in paragraph (1) above.

(6) An oil resistant synthetic jacket which has been approved by the Underwriters' Laboratories for car and trolley bus wiring shall be used for the outer jacket of track brake and motor leads.

(7) All insulated wire and cable shall meet the Underwriters' approval.

2.08 Wire and Cable (Cont'd)

(d) *Asbestos Insulation*

(1) The thickness of the component parts of asbestos insulation shall be as given in the following table and the components shall be applied to the bare conductor in the order indicated from left to right therein:

Size AWG	*Stranding*	*Thickness First Wall Felted Asbestos, in.*	*Thickness Wall V.C., in.*	*Thickness Second Wall Felted Asbestos, in.*	*Thickness Asbestos Braid, in.*	*Maximum* O.D., in.*
12	19/.0179	.010	.030	.015	.045	.310
8	7/.0486	.010	.030	.015	.045	.367
6	133/.0141	.015	.030	.020	.045	.456
3	133/.0199	.015	.030	.020	.045	.546
1	19/.0664	.020	.030	.030	.045	.614

* Min. O.D. is 90% of Max. O.D.

The average thickness of braids shall comply with the requirements outlined in the above table. The minimum thickness shall be not less than 90% of the average thickness.

(2) Felted asbestos shall consist of best quality, long-fibre, chrysotile asbestos commercially free from foreign particles of dirt, cotton seed and metallic oxides. It shall be well carded to prevent lumps and irregularities in the finished cable. After extraction of impregnating compound it shall contain not less than 80% by weight of asbestos. The total iron content shall not exceed 4% by weight of asbestos and the magnetic iron content shall not exceed 2% by weight of asbestos.

(3) The felted asbestos shall be applied to form a smooth wall of uniform thickness as specified in the table in Section 2.08(d)(1), with the conductor well centered. It shall be thoroughly dried and completely saturated with a flame, heat and moisture resisting compound. This compound shall retain its initial qualities during the normal life of the cable. The compound shall develop no injurious chemical action within itself or with any component parts of the completed cable.

(4) Varnished cambric insulation in asbestos insulated wires and cables shall consist of a high grade varnished cloth, substantially free from blisters or other imperfections, applied with a lubricating compound between layers. It shall comply in all respects with the requirements for varnished cloth outlined in the latest revision of the Standards for Varnished Cambric Insulated Cable of Insulated Power Cable Engineers Association.

2.08 Wire and Cable (Cont'd)

(d) (Cont'd)

(5) Asbestos braids shall be closely woven from a good quality, long-fibre chrysotile yarn containing not less than 80% by weight of asbestos. The total iron content shall not exceed 6% by weight of asbestos. The magnetic iron content shall not exceed 2% by weight of asbestos. Asbestos braid shall be saturated with a flame, heat and moisture resisting compound.

(6) All asbestos insulated wire and cable shall meet the Underwriters' approval.

(e) *Varnished Cambric Insulation*

Varnished cambric insulated cables shall conform to the latest revision of the "Standards for Varnished Cambric Insulated Cables" of the Insulated Power Cable Engineers Association, and shall meet the Underwriters' approval.

(f) *Solder and Tape*

All solder and tape used in wiring the car shall be of approved materials and shall be applied in an approved manner.

(g) *Wire and Cable Sizes and Uses*

The sizes, types of insulation, and uses shall be as given in the tabulation in Section 7.03(f).

2.09 Wiring

(a) *General*

(1) The work shall be performed by or under the direction of an experienced wireman. Wire used in ducts shall be free of kinks.

(2) The wiremen shall be provided with appropriate tools for skinning insulation, cutting, tinning, soldering and attaching mechanical or compression type terminals to the conductors.

(3) Care must be taken in removing insulation from the conductor to avoid nicking of the wire or strands of the conductor cable.

(4) A solder pot having automatic temperature control shall be used.

(b) *Solder and Flux*

Solder shall be at least equal in quality to that designated as S.A.E. No. 1, Class B. A flux of non-corrosive type shall be used, and shall be applied immediately before soldering.

2.09 Wiring (Cont'd)

(c) *Tape*

Insulating tape shall be of the quality and type which is suitable for use with the insulation on the conductor. Splicing tape shall consist of a good quality unvulcanized rubber insulation which will fuse quickly when applied. Friction tape shall be made of a good quality cotton tape filled with a heavy rubber compound that will resist aging and provide insulation suitable for 600 volts. The materials used shall not discolor or corrode the copper wire.

(d) *Tinning*

Ends of conductors shall be thoroughly cleaned and tinned by immersion in molten solder. Care must be exercised to prevent burning the insulation and excessive flowing of the solder along the conductor. Terminals which are attached by soldering shall be thoroughly cleaned and recently tinned before attachment to the conductor.

(e) *Terminals*

Conductors may be soldered to terminals or they may be attached by mechanical means where the use of an approved type of solderless terminal has been authorized. Where possible the terminal used shall be of the type which will securely grip and hold the insulation on the conductor of No.10 size or smaller. Conductors which will be subjected to motion relative to the terminal shall be protected by suitable means to minimize breakage of the conductor at or near the terminal.

(f) *Motor Terminals*

As specified in Section 6.09 (58), motor terminals shall be attached to the motor leads either by means of an approved type solderless compression terminal or with silver cadmium solder having a melting point of about 740°F. The terminal cup shall contain only sufficient molten solder to fill the cup after the conductor has been inserted, as shown on T.R.C. Drawing No. 4-3g1.

(g) *Splicing and Tapping*

(1) Splicing of conductors is not recommended. Where it is unavoidable, the spliced joint shall be mechanically as strong as any other part of the conductor, without the use of solder. However, the joint shall be soldered to insure electrical continuity and wiped or filed to remove fins and burrs of hard solder. Approved solderless connectors may be used for splicing. The joint shall be insulated with tape so as to be at least equivalent to the insulation on the conductor. The outside diameter of the spliced portion of the cable after the tape insulation is applied shall not exceed the outside diameter of the unspliced

2.09 Wiring (Cont'd)

(g) (1) (Cont'd)

portion by more than 40%. The finished splice shall be painted with one coat of approved insulating compound.

(2) Where a conductor is tapped onto another conductor of either the same or different size, the method of attachment and insulation described in (1) above shall apply.

(h) *Standard Assignment of Wire Numbers*

All trolley or third rail (600 volt) feeds, battery (32 volts) feeds, control and auxiliary circuits will be numbered as shown on T.R.C. Drawing No. 2-9h1.

SPECIFICATIONS FOR P. C. C. CAR

Effective April 1, 1947

SECTION 3 - CAR BODY

3.01 General

(a) The car body shall be designed to provide necessary clearance for track gauges varying from 5' 4-1/2" down to 42" and shall conform to T.R.C. Drawings No. 3-1a1; 3-1a2 or 3-1a3, according to specified width. The dimensions of the car shall conform to Sections 6.01(a) and 7.01. The post and seat spacing shall be 28½" center to center, and standee windows shall be provided above the sash.

(b) The general appearance and dimensions of the body shall conform to T.R.C. Drawing 3-1b1 and its weight, completely equipped and ready for mounting on trucks, shall be 19,500 lb. without roof ventilation; or 20,500 lb. with roof ventilation, as an approximate objective.

(c) The car body structure shall provide ducts for an underframe ventilating system as shown diagrammatically on T.R.C. Drawing No. 3-1c1, as specified in Section 3.02(c).

(d) Insofar as practicable, equipment supports and housings shall be incorporated into body structure so that the maximum usefulness of metal can be obtained, and so that the equipment of competitive manufacturers may be mounted interchangeably. Car builders and equipment manufacturers shall cooperate to accomplish this.

(e) The car body shall be a welded structure throughout, except that screwed or bolted fastenings shall be used for removable parts and that rivets may be used at locations where welding is impracticable. Whenever rivets are to be used, drawings showing the details of the design shall be submitted for approval by the Company.

(f) The car body structure shall be designed so that jacks or cradles may be used for lifting within a distance approximately 2' either side of the center line of the bolster and under front and rear bumper.

(g) The connection between car body and trucks at the king pins shall be such that the trucks will be raised with the car body unless intentionally detached therefrom.

(h) The floor is to be level from end to end of car (i.e. there are to be no ramps) except that there is to be a raised platform at the operator's position as specified hereinafter.

3.01 General (Cont'd)

(i) Equipment and enclosures, except life guard, which are hung under the car, shall give a ground clearance of not less than 7" with total passenger load of 18,200 lb. static condition and 25" diameter wheels.

(j) Adequate drainage gutters shall be provided over all side windows and doors.

(k) The operator's seat and foot controls shall be mounted on a small steel platform raised 7" above the level of the car floor, and the positions of foot pedals and seat shall be standardized as shown on T.R.C. Drawing No. 3-1-k1.

3.02 Framing Structure

(a) *Material*

All steel used in the fabrication of the car body structure and its associated parts shall conform with Section 2.02.

(b) *Bolster*

(1) The car body bolster shall be a built-up structure of formed and welded steel plates as shown on T.R.C. Drawing No. 3-2-b1 carrying a cast steel king pin and center bearing member as shown on T.R.C. Drawing No. 3-2b1a.

(2) The Car Builder shall provide a perforated bronze or micarta conical washer or approved equal as shown on T.R.C. Drawing No. 3-2b2 for insertion between the center bearing surfaces.

(3) The king pin shall be mounted on the bolster at right angles with the floor.

(c) *Ventilating Ducts*

(1) Provision shall be made in the design of the bolster and body framing for adequate air ducts, and connections thereto, so that ventilating air for propulsion motors will be taken from a point other than directly under the car floor, i.e. from the blind side of the car near the side sill as shown on T.R.C. Drawing No. 3-1c1.

(2) The connections from the body air ducts to the motors shall be through a bellows arrangement. These connections shall function smoothly without interference or rattling during the operation of the car.

(3) All motor ventilating ducts and openings therefrom and thereto shall have an effective cross sectional area of not less than 39 sq. in. per motor. Ducts shall be built so as to be reasonably and permanently airtight.

3.02 Framing Structure (Cont'd)

(c) (Cont'd)

(4) Provision shall be made in the car body framing for heating and ventilating ducts required for the complete car heating and ventilating system as specified in Section 3.10 and as shown on T.R.C. Drawing No. 3-1c1. Stainless steel may be used for inside covers.

(5) Suitable screens or louvres or both shall be provided to prevent admission of rain, snow or street wash at the intake openings of all ventilating ducts. Intake screens or louvres shall be removable for cleaning ducts.

(d) *Floor Cable Ducts*

(1) Provision shall be made in the design of the body underframe and floor installation for horizontal steel ducts, as shown on T.R.C. Drawing No. 3-2d1, to contain cables and control rods.

(2) These shall be of such width and length, and so located as adequately to accommodate all longitudinal control rods, cables and wire to be installed in this location. They shall have no sharp edges at points where wire insulation may be damaged.

(3) Where control rods are used in ducts, they shall be separated from cables by permanent metal partitions. Permanent metal partitions shall be used to separate low and high voltage circuits.

3.03 Roof

(a) The car roof framing shall consist of metal carlines with appropriate longitudinal members, all suitably fastened by welding to posts and side framing, so as to obtain an integrated structure of adequate strength and rigidity.

(b) All transverse and longitudinal members of the roof framing shall be so designed and disposed as to facilitate the fastening of trolley base supports, stanchions and roof covering, and the installation of ventilating ducts, roof wiring, lighting fixtures and other required equipment in a secure, convenient and workmanlike manner.

(c) The roof over both front and rear vestibules, and between body corner posts, shall be covered with sheet steel as specified in Section 2.02(a)(2), and electrically welded to steel carlines. If specified in Section 6.09(53) wood shall be used to cover the roof for a section extending 10' forward and 8' rearward of the center of the trolley base to a width approximately 38" from the longitudinal center line.

3.03 Roof (Cont'd)

(d) The portion of the roof not covered by steel shall be covered with 3 ply, 5/16" poplar plywood in sections of approximately 6', made up with phenolic resin glue and premolded to shape. These panels shall be bolted to the carlines and installed so that all cross joints shall occur directly over the center of a carline. Before installation, the underside and edges of the plywood shall be given two priming coats of white lead and oil. The joint between wood and steel roof covering shall be made in an approved manner to prevent any noise or leakage.

(e) The plywood part of the roof shall be covered with No. 8, pretreated cotton duck. Before installation of the canvas, the upper surface of the plywood shall be given a heavy priming coat of white lead and oil. The duck shall then be tightly stretched in one piece, while the paint is still wet, and shall be securely fastened with copper tacks. The joint between canvas covered plywood and steel part of the roof shall be finished in a workmanlike manner to insure permanent water tightness.

(f) Provision shall be made to prevent the trolley rope from rubbing on the surface of the rear hood.

3.04 Ceiling and Side Lining

(a) The ceiling shall be primed on the upper surface as specified in Section 2.06(f). The ceiling shall be arranged to receive and to support the type of lighting fixtures selected, and also to form a longitudinal ventilating duct.

(b) The ceiling shall be made of 3/16" Tempered Presdwood, aluminum, or approved equal. The underside of carlines shall be covered with approved cork adhesive tape or approved equal before fastening the lining. The latter shall be primed on the upper surface as specified in Section 2.06(c), and shall be so installed as to prevent sagging. All cross joints shall occur at carlines.

(c) The side lining below the window sill, to the point where it joins the inside steel sheet of the side sill ventilating duct, shall consist of 1/8" Tempered Presdwood or approved equal, applied and fastened in an approved manner so as to permit ready removal for maintenance. When used to form air ducts the edges of this lining shall be so fastened as to prevent objectionable air leakage or noise. The side lining shall be primed on the back surface as specified in Section 2.06(c).

(d) The lining construction shall include the plastic arm rest when specified in Section 6.09(4).

3.05 Floor and Steps

(a) The car floor shall consist of 13/16", 3-1/4" face, tongue and groove, long leaf yellow pine, or of 3/4" five ply, resin glued plywood as specified in Section 6.09(5)(a). It shall be securely bolted to the flanges of all floor supports unless otherwise provided in Section 6.09(5)(b). All edges and joints and the underside of floor boards shall be slushed with white lead as the floor is laid. In order to bring the floor to the proper level as specified in paragraph (d) hereinafter, hardwood fillers shall be placed over each underframe member to which the floor is bolted. Strips of suitable waterproof felt, approximately 1/16" thick and at least as wide as the metal covered, shall be placed between the metal and the wood fillers. After installation, those parts of the under side of the floor which are not protected from the weather by apparatus compartments are to be covered with an approved waterproof protective covering.

(b) The bolts used for fastening the floor to steel members as specified above shall be plain 1/4" stove bolts.

(c) The floor is to be level from end to end of the car except for the operator's platform specified above.

(d) The floor cable ducts shall be covered with 1/8" thick Tempered Presdwood over the entire area of the ducts and cemented in place. Thereupon the upper surface of the wood floor and this Tempered Presdwood covering over ducts shall be dressed level and smooth, and prepared for application of the floor covering material specified.

(e) The floor covering in the aisle, front vestibule and under seats shall be of the kinds specified in Section 6.09(5)(c). Color markings may indicate the width of the aisle. The material in front vestibule and aisle shall be so cut and applied that it can be replaced without disturbing the covering under the seats.

(f) Where the floor covering reaches the walls of the car body it is to be finished with a suitable cove molding screwed in place in a workmanlike manner. Sanitary corner castings or pressings shall be fitted at all corners.

(g) The top of the operator's platform shall be fitted with floor covering material similar to that used in the car and it shall be finished at the edges with a suitable steel molding held firmly in place.

(h) At the front doorway the steps shall be provided with coverings and nosings of the type specified in Section 6.09(6). On the first and second steps the coverings and nosings shall be fastened to the steel step foundations. On the third, or floor level step, the nosing shall be gained into the wooden flooring flush with the top of the floor covering and securely fastened.

3.05 Floor and Steps (Cont'd)

(i) At the center doorway the top step shall be treated similarly to the top front step. When treadle operated doors are to be used, the treadles shall be applied to the lowest and the second step as further specified in Section 3.08 hereinafter, and the area outside the mats shall be covered with an approved plastic flooring material flush with the top of the treadle and sloped as specified below. When no treadles are used, the lower and intermediate center steps shall be finished as specified above for the front steps.

(j) Step treads may be made of material having non-skid properties and distinctive color to outline the step tread. Step risers should have a distinctive color in sharp contrast to the tread. Method of treatment is optional.

(k) The slope of the steps shall be 1/4" toward the outside.

3.06 Windows

(a) All glass of the body except in doors shall be mounted as specified in Section 6.09(7)(a). When frames are used they shall be made of stainless steel as specified in Section 2.02(d).

(b) All such frames and sash shall be so arranged that they are easily removable for repairs or replacement.

(c) All sash shall have internally rounded corners, both inside and outside the car, to facilitate cleaning.

(d) The glass to be used in various openings shall be as specified in Section 2.05.

(e) All glass other than that in the doors is to be held in place with rubber glazing channel as specified in Section 2.04(h).

(f) The window in the front vestibule to the left of the operator's position shall include a stationary and a movable frame, arranged with the latter toward the front end of the car and mounted on a vertical hinge or pivot. Devices used for fastening this hinged or pivoted sash in the closed and open positions shall be rugged and easily manipulated, and shall hold the window firmly in any chosen position against the action of wind pressure and car vibration.

(g) All side sash, except the rear corner sash, shall be interchangeable.

(h) Where window raising mechanisms are used, they shall be of a rugged automotive type as specified in Section 6.09(7)(b). The lower member of this mechanism shall attach to the sash frame, not to the glass itself. Movable sash, except the last side sash at the rear and the operator's hinged or pivoted window, shall raise at least 11".

3.06 Windows (Cont'd)

(i) Sash guides shall permit easy operation and shall be of the non-rattling type. They shall be thoroughly weather-stripped in an approved manner.

(j) The lower member of all side sash in the body of the car and vestibules shall carry a rubber sealing strip which will form a tight water seal against the window sill, or against the guard window, and present a uniform exterior appearance. The rubber sealing strip shall conform to the specifications given in Section 2.04(h). There shall be arranged an upper weather strip of approved design which will contact the upper member of the sash when in the closed position in such a manner as to provide a weather-tight joint.

(k) Sash and window guards when used shall be made of stainless steel and be as small and unobstrusive as possible.

(l) When specified in Section 6.09(8), window guards or ventilating sash shall be provided as selected.

(m) When specified in Section 6.09(9)(a), curtain roller brackets shall be installed at all sliding sash openings for the installation of roller curtains. Provisions shall be made for a suitable finish at the top of window openings that shall extend continuously around the car except at windshield and door openings.

(n) The molding shall be so arranged that the curtain in its raised position will not extend below the clear window opening.

(o) When specified in Section 6.09(9)(b), roller curtains of double faced material to be selected and approved by purchaser, shall be provided and installed and shall be mounted on approved metal curtain rollers fitted with rubber noise insulating fixtures.

(p) Standee windows shall be located as indicated in Section 7.01(a), unless otherwise specified in Section 6.09(10) and shall be provided with glass, mounted in a rubber moulding as specified in Section 6.09(2).

(q) The standee window shall be as long as practicable between posts without showing sash lifting mechanism.

(r) A standee window shall be located over each side sash except: (1) over the rear side sash on both sides of the car; (2) over the front side sash at the left of the motorman; and (3) over the front side sash at the door side where the space is occupied by the side sign.

3.07 Seats

(a) A full set of passenger seats as provided in Section 6.09(11)(a) shall be installed in accordance with the Company's seating plan drawing referred to therein.

3.07 Seats (Cont'd)

(b) Seat construction shall be of the lightest possible weight consistent with moderately low first cost, reasonable maintenance and long life.

(c) Limiting seat dimensions are given on T.R.C. Drawing No. 3-7c1.

(d) All cross seats, except the rear seat, shall be made of welded tubular steel frame. The aisle side shall be securely bolted to the floor in a workmanlike manner. The window side shall be fastened securely to the car side frame.

(e) Unless otherwise specified in Section 6.09(11)(b), cross seats shall be fitted with integral foot rests.

(f) The top member of all cross seats, except the rear seat, shall be arranged to serve as a hand rail.

(g) All seats shall have spring upholstered cushions and padded backs, both of approved construction. Thickness of back at knee height shall be as small as practical (approximately 1/4") permitting maximum leg room between seats. Seats shall be covered with material as specified in Section 6.09(11)(c).

(h) Unless otherwise provided in Section 6.09(11)(d), exposed tubing on the seat back shall be stainless tubing, satin finished over those parts visible when the seats are in place in the car.

(i) An operator's seat of type specified in Section 6.09(12) shall be installed in each car. It shall be adjustable through 6" fore and aft, and vertically in three steps, 19", 21" and 23" above the operator's platform, measured at the front edge of the cushion. Adjustment shall be easy and rapid without the use of tools, but shall give a positive lock when the seat is in position. Seat shall be designed to withstand the full reaction of the operator's body in operation of foot pedals for car control and braking.

(j) The operator's seat shall be designed to provide the maximum of comfort and, in particular, it shall provide for proper circulation of air around operator's body.

(k) The seat across the end of the rear vestibule is to consist of seat cushions upholstered similarly to other cross seats, with padded seat backs fitted into framing provided by the Car Builder and forming an integral part of the car body.

(l) When specified in Section 6.09(13) a conductor's seat of suitable design shall be provided in accordance with Company's seating plan drawing.