

ADVISORY MECHANICAL COMMITTEE
EQUIPMENT ENGINEERING DEPARTMENT

THE CHESAPEAKE AND OHIO RAILWAY COMPANY
ERIE RAILROAD COMPANY
THE NEW YORK, CHICAGO AND ST. LOUIS RAILROAD COMPANY
PLATE MARQUETTE RAILWAY COMPANY

STANDARD MAINTENANCE EQUIPMENT INSTRUCTIONS NO. 39

INSPECTION OF LOCOMOTIVE TROUBLE-PRONE PARTS

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INSTRUCTIONS FOR INSPECTION OF LOCOMOTIVE MACHINERY PARTS No. 39

I - SCOPE

General

1. These instructions cover the inspection of all parts entering into the construction of the locomotive, except the boiler and tank which are covered under "Instructions for Inspection of Boiler and Tank". It is the intent here to cover only the most important points of inspection which should be given special attention and these instructions are not to be taken by the inspector as comprising all of the necessary inspection, and in no way releases him of the responsibility of detecting defects occurring at other points of construction. Where tolerances are given the limits are intended for a limited number of parts rather than a general practice and are to be rigidly adhered to by all assistant inspectors and only waived by the chief inspector when in his judgment the tolerance can be exceeded on a limited number of such parts without serious detriment to the locomotive. In all cases where the assistant inspector's decision is questioned by the builder, whether the decision is based on these instructions or otherwise, the assistant inspector is to refer the builder to the chief inspector for final decision, and must avoid giving the builder the impression, that his, the assistant's decision, is to be considered as final. All inspectors are to cooperate with the builder to the extent of making every effort to detect defective workmanship or material as soon as possible, and thus avoid an accumulation of these defects, or the assembling of defective parts. The chief inspector is to furnish each assistant with a copy of these instructions, and to see that the assistant understands and is familiar with, and that he is checking all parts in accordance with these instructions. Where the chief inspector is called upon for a decision as to the disposition of a part upon which his assistant and the builder do not agree, he is to give the matter careful consideration before rendering his decision. If in his opinion the importance of the decision justifies it, he may either handle the subject directly with, or refer the builder to the Chief Mechanical Engineer for a final decision. Inspectors must be familiar with all requirements of the locomotive specifications and drawings, and see that these requirements are

I - SCOPE (Cont.)

being fulfilled. The inspector is to inspect for satisfactory use all material and specialties as soon as possible after delivery at the builder's works. The inspector should at all times be able to report accurately on the progress of the work under his supervision. Inspectors should avoid all unnecessary interference with the progress of the work, observe all shop rules and regulations, and never interfere with or instruct workman, dealing solely with foreman on questions pertaining to inspection. Inspector should witness all tests and check all alignments and important dimensions on all of these locomotives, and in addition to this he should check to every item of these instructions a sufficient number of locomotives in every detail part mentioned to satisfy himself that the workmanship and material entering into the construction of the locomotives will be satisfactory on all of the locomotives.

G-10 - ASH PANS

Clearances

1. Ash pans after being applied to the locomotive are to be inspected to see that all parts are properly secured, and that there is no unnecessary obstruction of air opening around budding. See that pan clears all parts, to which it is not rigidly secured, sufficiently to avoid rubbing or interference with moving parts, such as grate levers, truck frame, wheels, etc. Inspect slides and rigging to see that there is sufficient clearance to permit full opening of hopper and that no part of rigging under any operating condition will come in contact with moving parts, such as truck frame, wheels, etc. See that slides open and close easily, and that satisfactory stops are provided to prevent opening of slide to the extent that it will fall out of the guides. Also see that all parts of rigging and pan are at least five (5) inches above top of rail when locomotive is in working order.

G-11 - AXLES

Material
and
Machining
Defects

1. All axles should be carefully inspected in the rough and after machining for cracks, seams and checks. The journals of all axles, after finishing machine cut and before any grinding is done, should be given careful inspection to see that there are no seams, cracks, checks, tool marks, ridges or other defects in journals, fillets or shoulders. Should these defects appear to be surface defects and the builder after calling inspector's attention to same machines the defect out without exceeding a maximum of one sixteenth (1/16) inch undersize in wheel fit diameter or one thirty-second (1/32) inch undersize in journal diameter, the inspector may accept a limited number of these axles in which the defect is so removed within these limits, providing the undersize is also taken care of in the bearings for these axles. The journals and wheel seats must be straight and perfectly round, void of taper or flat spots. The journals must have a smooth finish, free from all machine tool or grinding marks. Check all fillets to see that they check with drawing.

G-II - AXLES (Cont.)

Truck
Axles,
Engine,
Trailer,
and Tender

2. The finished axle is not to vary from the specified dimensions in excess of the following limits:

Dimension	Plus	Minus
Overall length	1/16"	1/32"
Center to center of journals	1/32"	1/32"
Length of journals	1/16"	1/32"
*Diameter of journal	.015"	.015"
*Diameter of wheel seat	1/16"	1/32"

*For A.R.A. axles allow A.R.A. Tolerances.

*Except as specified under material defects.

Driving
Axles

3. The finished axle is not to vary from the specified dimensions in excess of the following limits:

Dimensions	Plus	Minus
Overall length	1/32"	1/32"
Diameter of journal	.010"	.010"

*Except as specified under material defects.

G-15 BOLTS, NUTS AND STUDS

Threads
and
Fit

1. All bolts, nuts, and studs used in securing important connections are to be inspected to see that they are well fitted, and that the threads are well formed.

G-16 - DRIVING BOXES

Castings

1. All castings of driving boxes, bearings and cellars should be inspected before and after machining, for cracks, blow-holes and other casting defects.

Machining
and
Fitting-up

2. The machining of bearing fit to be fairly smooth, straight and true to gauge. Inspector to see that bearing is pressed into box at proper tonnage, and to inspect the fit after bearing has been pressed in to see that the bearing fits tight in the box at all points. After bearing and cellar have been applied to the box the shoe and wedge faces are to be checked. The distance between the two faces is to be measured at the top and bottom, and crosswise. A tolerance of one sixty-fourth (1/64) inch plus or minus the specified dimension, and a difference in either the top and bottom or crosswise dimensions of two thousandths (.002) inch may be allowed. Check shoe and wedge faces to see that they are parallel with bore and perpendicular to hub face of box. A tolerance of one sixty-fourth (1/64) inch plus and nothing minus the specified dimension, may be allowed between center of shoe and wedge fits, and hub face of box, and three thousandths (.003) inch plus or minus in width of shoe

G-16 - DRIVING BOXES (Cont.)

and wedge fits. The box saddle seats are to be parallel to the bore and within one sixteenth ($1/16$) inch plus or minus the specified dimension. The bearing should be bored to allow the specified axle clearance. All boxes should be tried when in place on the journals to see that they have the proper fit, and that the clearance between cellar and journal is not less than one eighth ($1/8$) inch nor more than one quarter ($1/4$) inch at any point, for oil lubrication and not less than $1/16$ inch nor more than one-eighth inch for grease lubrication. See that cellar (or spreader where used) fits snug in box and that perforated plate where used is properly fitted to axle and cellar. Examine hub plates, and shoe, and wedge face liners when applied, to see that they bear solid against box and are straight across faces, and that hub face is perpendicular to bore. Where Economy Driving box cellars are used, great care should be taken to see that all parts work freely, that the springs set perfectly vertical, and that the perforated plate has exactly the same radius as the axle journal.

G-17 - TRUCK BOXES

A.R.A.
Design

1. Boxes and details made to A.R.A. design or similar are to be checked to A.R.A. tolerances and gauges.

Other
Designs

2. For truck boxes similar to the conventional design of driving boxes, the inspection is to be along the same line as for driving boxes, except that more liberal tolerances may be allowed. Check wedge plate bearing on trailer boxes of this design. Truck brasses are not to be tapered in bore more than $1/32$ inch, back of brass to be straight. Place engine truck brass in box and check hub face of box for being square with bore.

G-18 - BRACKETS

- Application
1. Inspector is to see that all important brackets are properly fitted to the parts to which they are attached, that the two contact surfaces are well fitted together, and are not drawn together by the connecting bolts or studs. He is to see that the bracket is properly lined up vertically and horizontally to take the part which it supports. He is also to inspect cast brackets for cracks and other defects. Where lugs are provided on bracket for supporting the parts carried by the bracket, the inspector is to see that the supported part rests on the lugs, and is not hung on the bolts or studs.

G-19 - BRAKE EQUIPMENT

Testing

1. When the equipment has been installed and all connections made, it is to be tested to see that there are no leaks, that all brake shoes apply, and release properly, and that all parts of rigging have proper clearance when

G-19 - BRAKE EQUIPMENT (Cont.)

applying and releasing brakes. Before installing equipment, see that all pipes and air passages are blown out to avoid any stoppage in air passage by foreign matter. See that all parts of equipment usually removed in making running repairs can be easily removed without removal of other parts. Make test to see that governor is properly set. Inspector to witness pyrometer and all other tests.

G-20 - FOUNDATION BRAKES

Assembly

1. Inspector should see that all parts are properly assembled, that there is no twist or binding at connecting points, that all parts have proper clearance, that all case-hardened pins or bushings are properly hardened, that all pins are easily removed without removal of other parts, that all cotter pins are applied and opened, that there is sufficient clearance between hangers and other parts to prevent rubbing or binding on curves, and that all safety hangers are applied.

G-21 - BUMPERS

Application

1. Inspector should see that bumpers are properly butted up to end of frame or front deck casting, and the connecting bolts properly fitted.

G-22 - CAB

Application

1. See that cab is properly lined up horizontally, vertically and sidewise. See that cab sheets are reasonably free of waves. See that cab is properly fitted to boiler and that there are no unnecessary openings in cab.

G-23 - CAB DETAILS

Application

1. Inspector should see that doors, windows, ventilators and like parts are properly applied and work freely to full opening and closure, that all cab appliances are conveniently located and have sufficient clearance for operating.

G-26 - VALVES AND COCKS

General

1. All valves and cocks, when applied, should be tried to see that they open and close easily, and tested to see that they do not leak. A few valves and cocks selected at random from those furnished by each manufacturer should be taken apart and inspected for fit and workmanship on detail parts, especially seats and threads. See that a sufficient clearance is provided around all valve handles to give easy access for operation.

G-27 - WATER GAUGE

Locating
Gauges

1. When the boiler has been applied and secured in place on main frames and the frames leveled both lengthwise and crosswise with a spirit level, the level of the high point of crown sheet is to be located on the back head by means of a hose filled with water. Care is to be taken to see that there are no air pockets in hose. The level line thus located on back head is to be pricked for future reference. The water column and gauges are to be located from this line. After gauges have been applied, the frames are to be releveled and the boiler gradually filled with water until it begins to run out of bottom gauge cock, when the water supply is to be shut off and the water above the high point of the crown measured by means of a chalked stick inserted through test hole in top of boiler. The height of water over crown should be not less than that specified, not more than three eighths ($3/8$) inch over that specified. At the same time that water begins to run out of bottom gauge cock it should be visible in both water glasses. The right and left water glasses should register the same within one eighth ($1/8$) inch. Inspector should make sure that there are no restrictions to flow of water through gauge cocks or water gauges. Inspectors should see that water gauges are fitted up in such a way that there is no possibility of the bottom gasket creeping under, and into the glass. He should alternately open and close water glass cocks to see that there is a free flow through both cocks.

G-29 - CRANK PINS

Material

1. Inspector should inspect pins before and after machining, but before grinding to see that there are no seams or checks in pins.

Machining

2. After pins are finished ready to apply to wheels, they are to be inspected to see that journals are straight, (without taper), smooth, round and free from ridges, tool marks, grinding cuts, seams and checks. A tolerance of plus or minus one one-hundredth ($.010$) inch in diameter and one sixty-fourth ($1/64$) inch in combined length of journals may be allowed. The wheel fit must be a smooth machine finish, round, straight (without taper), and free from circumferential seams or checks. A tolerance of plus or minus one thirty-second ($1/32$) inch in diameter may be allowed. Inspector to witness pressing of all crank pins into wheels, and see that they are pressed in at proper pressure. Inspector to also inspect pin after being pressed into wheel to see that the pin is a good fit in wheel and

G-29 - CRANK PINS (Cont.)

that it is set square with the hub face of wheel. The threads on threaded ends must be well formed, and nuts properly fitted with collar set well up against pin shoulder. No shimming of washers permitted.

G-30 - CROSSHEAD

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| Castings | 1. Crosshead and gib castings are to be closely inspected for cracks and bad blow holes, especially around piston rod hub. |
| Machining | 2. Inspect machining to see that gib bearing faces, crosshead pin and piston rod fits, and inside faces of hub in main rod fit have a smooth finish. The horizontal bearing faces of gibs are to be parallel with each other. The vertical faces are also to be parallel with each other. The center line of piston rod bore to be parallel with both the vertical and horizontal bearing faces of gibs, with no variation allowed in the specified dimensions between these bearing faces and the piston rod bore, either vertically or transversely. The center line of crosshead pin fit to be parallel with the horizontal faces of gibs and perpendicular to their vertical faces with the dimension between the horizontal faces and pins center line as specified. The inside hub faces of main rod fit to be parallel to vertical faces of gibs, with the transverse distance between the center line of the fit and the center line of the gib fits as specified. A tolerance of 50 percent over the total vertical or transverse crosshead guide clearance specified may be allowed, but nothing under. This variation may be in the crosshead, or in the guides, or partly in both. Also a tolerance of one sixty-fourth ($1/64$) inch plus between hub faces of main rod fit may be allowed. Where these variations occur a corresponding allowance must be made in other dimensions affected by these variations, which dimensions have previously been specified as having no tolerance, such, as for instance, should the excess guide clearance be due to the crosshead being under size between guide fits, the distance between gib faces would have to be less than that specified, whereas should the extra clearance occur in the guide, the spacing between gibswould have to be to drawing. |
| Crosshead Pin | 3. Inspect crosshead pin fit in crosshead, and see that specified draw is allowed. Crosshead pin also to be subject to the same inspection as crank pins with the same tolerances allowed. |

G-31 - CYLINDERS

Casting

1. Inspector is to inspect casting thoroughly for cracks, blow-holes and other defects. After cylinder has been bored and before bushing is applied, cylinder is to be tested with water under pressure as specified. The inspector is to witness test on all cylinders. He should make sure that cylinder is full of water before pressure is applied. This can be done by leaving cylinder open at the high point until filled with water. He should also see that pressure gauge is located in a line directly connected with cylinders. See that all sand, cores and fins are removed from steam port and passages.

Machining

2. After cylinder has been bored, and before test is applied, inspector is to check thickness of wall all around barrel to see that it is the required thickness. Also check thickness of outside wall of steam ports, and thickness of frame bolting flange. Inspect bore of barrel and steam chest for finish and defective machining or casting. Witness application of cylinder and steam chest bushings to see that they are properly applied, and that they have a good fit in cylinder. Check bores of bushings after they are applied to see that they are straight, and round, and to specified dimensions, in diameter, length, port openings, distance between ports and length over bushings and grinding faces. Also check dimensions between cylinder and frame bolting flanges to center of barrel and steam chest both front and back. When a pair of cylinders have been bolted together, check distance between center of bores of the two cylinders, both barrel and steam chest, front and back, width of frame fit, butt ends of frame fits to grinding faces of barrels, top of frame fits to center of barrels, and vertical distance between center of steam chest and center of barrel. On the first pair of cylinders in addition to the foregoing dimensions, inspector should check all other important dimensions, as soon as possible, to see that the cylinders have sufficient metal to finish to the desired dimensions, and that all bosses are properly located, and that there will be sufficient chipping metal around flange to maintain specified dimension between boiler seat and frame fit. In this respect, inspector should keep in mind that, in all cases to detect a defect before any progress has been made on the job, is not only helping the builder, but reflects to his credit, and will make the builder more inclined to concede to any request the inspector may make necessary to obtaining good work. The following tolerances may be allowed from the specified dimensions:

G-31 - CYLINDERS (Cont.)

Dimension	Plus	Minus
Barrel, diameter of bushing bore.	.010"	.010"
Barrel, taper of bushing bore.	Not more than	.006"
Barrel, out-of-round, bushing bore.	Not more than	.008"
Barrel, length	1/32"	1/32"
Barrel, wall thickness	1/4"	0
Steam Chest, diameter of bushing bore.	.006"	.006"
Steam Chest, out-of-round bushing bore.	Not more than	.003"
Steam Chest, taper of bushing bore.	Not more than	.002"
Steam Chest, between admission edges of ports	Exact to Gauge	
Steam Chest, width of port	Exact to Gauge	
Center to center of barrels.	1/32"	1/32"
Barrels to be paralalled.	Within a scant	1/64"
Barrel center to frame fit-vertical	1/32"	1/32"
Barrel center to frame fit-horizontal.	1/32"	1/32"
Barrel center to steam chest center-vertical.	3/32"	3/32"
Barrel center to steam chest center-horizontal.	3/32"	3/32"
Barrel grinding faces to frame butt lug.	1/32"	1/32"
Between vertical faces of frame fits.	1/32"	1/32"
Frame fit to be parallel to barrel vertically and horizontally.	within	1/64"
Shoulder in cylinder barrel for bushing fit in height	.005"	0
Distance between shoulder in steam chest bore for valve bushing.	0	.008"

It is not the intent to allow, on any one cylinder or pair of cylinders, two or more tolerances so related that the error becomes an accumulative error. The inspector must use his own judgment in such cases. Inspector should check ports in steam chest bushings to see that the plane of a circular section taken through the admission edges of the ports is perpendicular to the bore. Check frame fit to see that horizontal and vertical faces are square with each other, that the vertical faces are parallel, and the horizontal faces, or top of fit are in a straight line, or same horizontal plane. Inspect grinding surfaces to

G-31 - CYLINDERS (Cont.)

insure a satisfactory finish, and that there are no tool marks on joint. See that stud holes are not drilled through into steam ports.

G-32 - CYLINDER DETAILS

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| Cylinder Heads | 1. Inspect cylinder heads for casting defects, thickness of metal and condition of joints. Also check contour of inside faces to see that specified piston clearance can be obtained. Water test cylinder heads for leaks. |
| Steam Chest Covers | 2. Check covers for casting defects and machining, special attention being given back cover. |

G-37 - DRAWGEAR

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| Application | 1. Check all parts of drawgear to see that it is properly applied and meets all of Interstate Commerce Commission requirements. |
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G-39 - ECCENTRIC

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|-----------------|---|
| Eccentric Crank | 1. Check eccentric crank for material defects. See that center of pin to center of bore is to the dimension specified, that pin is parallel to bore, and that the offset of center of pin bearing with face of bore is to the specified dimension. See that the eccentric crank is properly fitted to crank pin, also that the key, pin and bolts are a good fit, and that crank is up against pin shoulder before drilling bolt holes. A tolerance on the diameter of the eccentric crank pin of three thousandths (.003) inch minus may be allowed. |
| Eccentric Rod | 2. Check eccentric rod to drawing. Tolerances of plus one sixty-fourth ($1/64$) inch in width of jaw opening, of minus ten thousandths (.010) inch in length of bushing and plus two thousandths (.002) inch in bore of bushing may be allowed. Inspect bushing fit in rod. |

G-40 and 41 - ENGINE TRUCKS

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|---------------------------|---|
| Detail Parts | 1. All detail parts entering into the construction of the front and trailer trucks are to be checked for material and machining defects or errors before assembling in trucks. |
| Assembly Two Wheel Trucks | 2. Check radius bar length, pin hole to center of axle and allow a tolerance of one eighth ($1/8$) inch plus or minus the dimension specified. Tram truck frame, before wheels and boxes are applied, to see that radius bar pin hole is central with outside center of pedestal faces. |

G-40 AND 41 - ENGINE TRUCKS (Cont.)

A tolerance of one thirty-second ($1/32$) inch off center may be allowed. Try swing casting to see that it swings freely full swing off center. Check distance from center casting to radius bar pin center. After wheels and boxes are applied, check boxes for proper fit on pedestals, check lateral. The total lateral may exceed that specified by one sixteenth ($1/16$) inch, but must not be less than that specified. See that axle and wheels have proper clearance at all points.

Assembly
Four
Wheel
Trucks

3. Check lateral, box fit and clearances with same tolerances as on the two wheel truck. Tram truck wheels. Axle spacing may be one sixteenth ($1/16$) inch plus or minus that specified, and have a difference in tram on the two sides of the truck of as much as one sixteenth ($1/16$) inch. See that center casting is in center of truck, and centrally located between the two axles, and swings freely. Check springs, spring equalizers, and hangers for clearance. Check application of all lateral motion parts to see that they are properly applied.

G-42 AND 43 - ERECTION

Frames
and
Details

1. When frames are set up in the erecting shop the inspector is to give them a general inspection for material and machine defects and general finish. Inspector should check the setting up of each pair of frames to see that the spacing inside is to the specified dimension, making this check at top and bottom and at each jaw, before and after braces, crossties and cradle have been temporarily secured in place. Check the pair with a straight edge and spirit level, before and after crossties, braces and cradle have been secured in place by temporary bolts, to see that the tops of the pair of frames are level, both lengthwise and crosswise, including cylinder seats. Also check top and sides of frame, with a tight line, for being straight. Try shoe faces of main pedestal jaws and cylinder seat lugs, with straight edge, to see that the two frames line up at these points. Frames must be made to line up at these points. See that frame braces, crossties and cradle fit between frames, and that they are not sprung or drawn into place, and where the fit includes two or more surfaces of the frame, see that the fit has a good bearing on all surfaces. Check alignment of cradle with frame vertically and horizontally. Before checking any alignment of frame, see that pedestal binders are drawn up tight in place, and that the fit is satisfactory, as loose binders or refitting of binders later may upset the alignment. See that all frame keys are applied before engine is wheeled.

G-42 and 43 - ERECTION (Cont.).

Check center pin guide bore in front deck casting to see that it is central with frames, and that it is the specified distance from front truck radius bar pivot pin hole. Check location of trailer radius bar pin hole in cradle casting. Check guide yoke crosstie to see that the seat for shoulder on valve gear frame is located as specified with respect to frames and cylinders, and that it is the same height from top of both frames. See that truck radius bar pin hole is central between frames.

Cylinders

2. All crossties, frame braces and cradle should be temporarily secured in place before applying cylinders to frames. When cylinders are applied, check the frame fit to see that cylinders are well fitted to frames at all points, and not drawn in place. Inspector should be present when cylinders are applied. After cylinders have been secured to frames by temporary bolts, a center line should be passed through both cylinder barrels and extended to rear end of frames. The inspector should check the accuracy of this line as being central with cylinder bore, both front and back. He should then check the distance from this center line to top and sides of frame, opposite both the front and rear pedestals. Check shoe pedestal faces of main jaw for being perpendicular to this line. This may be done by a straight round bar, secured in place against pedestal faces of both frames, with an offset arm approximately three (3) feet long firmly fitted on end of the bar. The tip end of arm to extend out to touch cylinder center line. The arm then swung first ahead, and then back, the difference between the tip end of arm and the line in the two positions will indicate the amount the pedestals are out of square with the cylinder line in a length twice the arm length. See that cylinder key is well fitted. Inspector should have several cylinder frame bolts, on each pair of cylinders, driven back to examine fit. Just before final application of pistons and valves, the inspector should see that cylinders are thoroughly blown out with steam, after which he should make a close inspection of barrels, steam chest, ports and all steam passages for any foreign matter.

Boiler
Alignment

3. The boiler, resting on rear support, should be lowered at front end until it just clears cylinder saddle. The inspector should see that it is held in this position while cylinder saddle is being scribed for chipping. This to prevent boiler weight cocking cylinder, and giving a false chipping line. After cylinder saddle has been chipped, and boiler is ready to apply, the boiler should again be lowered at front to just clear cylinder, and while in this position, after checking boiler to cylinder fit, inspector should check the alignment of the boiler with

G-42 and 43 - ERECTION (Cont.)

the frame, both vertically and horizontally, and at several points, as at each boiler course, and front and back of firebox, before boiler is lowered onto cylinders. Inspector should inspect the fit of cylinder saddle bolts on each engine, and witness all bolts driven. Check distance from front of mudring to shoe face of main pedestal of frame.

Waist
Sheets

4. Inspector should see that all waist sheet angles or tees are relieved at the ends so as not to cut into boiler. See that the body of all waist sheet and furnace bearer plate bolts are of sufficient length to give a good bearing in angles, sheets and castings. See that waist sheets and furnace bearer plates have a good bearing on the shoulders provided on crossties and like castings. See that angles secured to boiler line up properly with crossties.

Guides

5. The inspector should check all guides for proper alignment with center line of cylinder. This check should not be made until the boiler has been completely mounted, all bracing applied and frame pedestals in working position, thus avoiding the upsetting of alignment by application of super weight on frames. See that all vertical wearing faces of the guide or guides are parallel with each other the entire width and length of faces, i. e., for instance, in case of the two guides of the double bar type, with both guides of the same width, a straight edge placed across the outer vertical faces of the two guides should bear for the entire vertical height of both guides, the same to be true on the inner faces. See that horizontal bearing faces are parallel both crosswise and lengthwise. Examine guide bolt fits. See that guide yokes are square with frame and guide yoke ends hang plumb, that faces of guide carrying lugs are level, and that yoke ends are not sprung in line.

Crosshead

6. Inspector should witness application of crosshead to guide and check the guide clearance, witness driving up and keying of piston rod in crosshead, and when front cylinder head has been applied, he should check the scribing of striking points on guides, at the same time seeing that crosshead overtravels bearing faces of guides, both ahead and back. Check wrist pin fit and clearance at guide yoke.

Wheels

7. Inspector should witness wheeling of engine. Inspect shoes and wedges to see that they fit up to box and frame, top and bottom, that flanges clear crossties and other castings, that wedges set up proper distance above pedestal binder, that shoes are properly fitted to frame, and between binder and top of pedestal. Check lateral on all wheels. See that hub faces of boxes are practically parallel with wheel hub faces, that wheels have sufficient clearance at all points,

G-42 AND 43 - ERECTION (Cont.)

to more than allow for extreme lateral movement under worn conditions, and possible vertical movement of wheels. Check spring rigging at all points for clearances, seeing that ends of equalizers do not strike frame, that pins and keys are properly fitted and secured in place, and that saddles are well seated on boxes. See that trucks have sufficient clearance at all points, and that truck frames set level when full load is applied. When side rods have been applied, and engine rolled sufficiently to settle weight on springs, the inspector should tram the engine, first inspecting shoes and wedges, to see that wedges are set up tight, and that pedestal binders are up in place. He should then check centers in wheels, and see that crank pins are not on the fore or aft dead centers before tramping.

Rods

8. Inspector should witness the application of all rods, examining the fits on crank pins. After washers and nuts have been applied, he should check lateral on pins. Check clearance to see that rods and knuckle pins have sufficient clearance, allowing for extreme lateral under worn conditions, especial attention being given wheel counterbalances, guides and crossheads in all possible positions. Try rods on fore and aft centers to see that they do not bind on pins, but first see that all wedges and binders are up tight before trying rods. If, on tramping engine, any change is found necessary in shoes and wedges, the rods should be tried again after change has been made. Try piston clearance with cylinder heads. With main wheel lateral equally spaced, see that main rod is moved freely on wrist pin.

Valve
Gear

9. Inspector should witness application of all distribution valves, seeing that they are properly applied, and that the rings have proper opening. He should check valve setting and scribing of port openings. Check all valve rigging pin connections, to see that pins and bushings are properly fitted, and that rod jaws, or other parts do not bind. See that bushings have specified oil grooving, and that all oil holes are cleaned out and drilled through, and line up with hole in bushing. On Walschaert gear, see that the link hangs plumb and swings in a line parallel to main frames. Check application and location of valve gear frames, locating and leveling gear frame by centers of main trunnions. See that the gear is square with main frames. See that guide yoke ends are properly located, and are plumb with frames.

G-42 and 43 - ERECTION (Cont.)

General 10. The erecting shop inspector should familiarize himself with all parts of these instructions, and should give all detail parts a general inspection as soon as delivered to erecting shop, witness all tests conducted in the erecting shop, check all important alignment of parts, see that all parts are properly applied, and properly secured, that all nuts are tight, that all important bolts have proper fit, that bolt holes are reamed clean and round with no shoulders or flat spots, that all parts have proper clearance, and that no part extends outside of specified track clearance.

Tolerances 11. The following tolerances may be allowed in erecting:

Dimensions	Plus	Minus
Between frames inside.	1/64"	1/64"
Frames parallel with each other inside.	within .010"	
Frames straight across top of pair.	within .010"	
Frames level across top of pair.	nothing out of level	
Frames straight lengthwise on top.	within .010"	
Frames straight lengthwise on side.	within .008"	
Top of cradle at rear end to top of frame.	3/8"	3/8"
Engine truck center pin guide to radius box pivot pin.	1/32"	1/32"
Center line of cylinder to top of frame at front.	1/32"	1/32"
Center line of cylinder to top of frame at back	1/4"	1/4"
Center line of cylinder to side of frame at front.	1/64"	1/64"
Center line of cylinder parallel to side of frame.	within 3/32" in 20 feet.	
Main pedestal faces perpendicular to cylinder center line in distance across pair of frames.	a slight variation which may be taken care of in shoe.	
Boiler central with and parallel to sides of main frames for lengths of courses and firebox.	central within 1/8"	parallel " 1/4"
Boiler to top of main frames at front course.	1/16"	1/16"

G-42 AND 43 - ERECTION (CONT.)

Dimensions	Plus	Minus
Boiler to top of main frames front of mudring.	1/16"	1/16"
Boiler to top of main frames back of mudring.	3/8"	3/8"
Front of mudring to main jaw of frame.	1/4"	1/4"
Guides parallel vertically and horizontally with cylinder center line.	within .003"	
Center line of cylinder to face of guides, vertically.	.003"	.003"
Center line of cylinder to face of guides, horizontally	.003"	.003"
Vertical distance between guide faces.	.003"	.003"
Corresponding vertical faces of guides parallel with each other, tested lengthwise and vertically within length or spread of guides.	within .003"	
Valve gear frames to main frame, horizontally and vertically.	1/16"	1/16"
Valve Gear Trunnion bores parallel with tops of main frames.	within 1/64"	
Valve Gear Connecting Rod or Link to swing parallel to side of main frames.	within .005" in length of travel	
Driving wheel lateral-total over that specified.	1/16"	0"
Driving wheels out-of-tram less than	1/32"	1/32"
Driving axles parallel	within 1/64"	
Rod lateral over that specified	1/64"	0"
Piston to cylinder head clearance	1/16"	1/16"
Opening in valve ring from that specified	.005"	.005"
Back cylinder head grinding face to main pedestal face	1/16"	1/16"
Back cylinder head grinding faces of the two cylinders to main pedestal jaw to be the same	within 1/32"	

G-44 - EXHAUST STAND

- Ca ng
1. Inspect casting for defects and removal of all fins and sand from steam passage. Examine machining of joint. Check size of restricted opening, and diameter of nozzle bore, allowing plus or minus one thirty-second (1/32) inch in bore of nozzle.

C-44 - EXHAUST STAND (Cont.)

- Test 2. Inspector should witness exhaust stand tested as specified.

C-45 - FIREDOOR

- Application 1. Check application to see that frame is properly fitted to backhead. Try firedoor to see that it opens and closes properly.

C-46 - FRAMES

- Casting 1. When frames are received at builder's works, inspector should check same for cracks and blowholes and make a rough check on first pair of frames, of all important dimensions. The frames should be further checked, after every machine operation for cracks, seams and blowholes. The inspector is to use good judgment, in rejecting frames for these defects, in permitting welding of cracks, seams or blowholes. The location and extent of defects are important considerations. Where seams or cracks are to be welded, they should be chipped out, the inspector examining the "V" before welding. Welding to be in accordance with Railroad Company's Standard Practice. Examine all drilling to detect any internal cracks or blowholes.

- Machining 2. Inspector should check machining of frames, after each machine operation, for all dimensions and finish. The following tolerances may be allowed on some of the important dimensions:

Dimensions	Plus	Minus
Thickness of frame.	.010"	.010"
Taper in thickness, top to bottom.	Not over .010"	
Cylinder lug to main pedestal.	1/64"	1/64"
Top of frame to top of cylinder seat.	1/32"	1/32"
Main pedestal to other pedestal	1/64"	1/64"

Top of frame, faces of pedestal jaws, cylinder lug and frame filler seats are to be square with inside face of frame. All scale is to be removed from frames, and unfinished edges rounded. Check cradle fit for squareness, accuracy in dimensions, and distance from top of frame. Check shoe faces of pedestal jaws to see that they are square with top of frame.

C-46 - FRAMES (Cont.)

Pedestal
Binders

3. Inspector is to check fitting of pedestal binders to frame toes, seeing that they have a good bearing on toes, and, when well driven up, that they have a draw within one sixteenth ($1/16$) inch of that specified. When all binders have been fitted in place, check frame for being straight on top and sides, and see that cylinder seat is parallel to top of frame, and that jaws have specified spread top and bottom. The top of frame must be straight, and the cylinder seat parallel, with practically no tolerance allowed. On the side the frame must be straight within one sixty-fourth ($1/64$) inch.

Shoes
and
Wedges

2. Inspector should check shoe and wedges for frame and box fits, which should be to specified dimensions. After frames have been assembled in erecting shop, he should tram shoes and wedges, taking care to see that binders are drawn up tight, and that the faces of opposite shoes and wedges are in a straight line with each other. All tramming to be from main jaw to other jaws, with practically no tolerance allowed.

C-47 - FRAME DETAILS

Castings

1. Inspector should inspect all castings carefully after scale has been removed for cracks and blowholes.

Machining

2. Check frame fits of crossties, cradles, foot plates and like castings to see that they are square, and that faces of fits on one side are parallel with those on opposite side of engine. Gauge fits between frames, allowing a tolerance of one sixty-fourth ($1/64$) inch, plus or minus. Check all shoulders or seats for support of other parts for being the specified distance to, and proper alignment with frame fits.

C-50 - GUIDES

Material

1. Inspect all guides carefully for seams and checks.

Machining

2. Check all guides to see that they have a smooth finish, are to specified dimensions, and that the faces are square. The following tolerances may be allowed:

Dimensions	Plus	Minus
Guides square for width of face within		.002"
Opposite bearing faces parallel within		.002"
Distance between opposite bearing faces.	0"	.004"

G-50 - GUIDES (Cont.)

Bearing faces of guides must be straight, length of guide, with practically no tolerance.

G-51 AND 52 - GRATES AND DETAILS

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| Castings | 1. Inspect castings for cracks. Check center and side frames for being straight. |
| Assembly | 2. When grates have been applied, inspector should inspect application to see that they have specified spacing and side clearance. Try dumping grates to see that they operate freely, and that all grates dump to specified angle. See that shaker handle has proper clearance for operating. See that grates are level when locked in place. See that shaker rods and levers have sufficient clearance, and that all pins are keyed. Check clearance for center frame expansion. See that frame does not bind in supports. |

G-53 - HANDRAILS AND STEPS

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|-------------------------|--|
| Handrails | 1. See that all handrails and grab irons have the proper hand clearance, are straight, securely fastened, and meet Interstate Commerce Commission requirements. |
| Steps | 2. See that steps are level, have sufficient foot clearance, are securely fastened, meet Interstate Commerce Commission requirements, and are located to specified dimensions. |
| Other Safety Appliances | 3. Inspector should see that all safety appliances meet Interstate Commerce Commission requirements. |

G-54 - HEADLIGHT AND WIRING

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|--------------|---|
| Installation | 1. Inspector should see that headlight wiring and other electrical equipment is properly installed, and operates satisfactory. See that all wiring is free from any rubbing, and is well insulated from any electrical conductor, or extreme heat that may burn out insulation. See that all switches are conveniently located. See that all removable covers at conduit connections are accessible for removal. Check generator voltage. |
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G-55 - INJECTORS AND FEEDWATER HEATERS

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| Installation | 1. Inspector should see that all parts are properly located, and securely fastened in place, that all pipes are securely clamped, and that the connections line up, and are not sprung in place. Inspect brazing at |
|--------------|---|

G-55 - INJECTORS AND FEEDWATER HEATERS (Cont.)

connections, and see that joints are not marred.
Test operation of injector and feedwater heater.
Test all lines for leaks.

G-57 - JACKET AND LAGGING

Lagging

1. See that lagging is so applied, where specified, as to form an even surface support for jacket. See that pipes are neatly lagged, where specified, and that lagging is well secured.

Jacket

2. See that all jacketing is neatly applied and free from indentations. See that jacket overlaps at the top to prevent water leaks. No piecing of jacket permitted.

G-58 - VALVE GEAR

Assembly
and
Application

1. Inspector to check dimensions of all details of gear; tramming distance between all pin connections where accuracy is of importance. See that bushings are well fitted. Try pin fits for diametrical clearance in bushings. The diametrical clearance on pins one and one half (1-1/2) inch in diameter or less, should not be less than one thousandth (.001) inch, nor more than four thousandths (.004) inch, for pins over one and one half (1-1/2) inch in diameter, the minimum clearance should be two thousandths (.002) inch, with a maximum of five thousandths (.005) inch, except on Pilliod gear. Pilliod Company's tolerances for pin clearances are to be followed, on parts fitted up by Pilliod Company. Inspect lateral bearing faces of all rod jaws, trunnions, and connecting parts to see that lateral faces are parallel, or that the lateral clearance at all connections is practically the same all around. See that pins fit well on tapered part of pin. Test casehardening of pins and bushings. See that combination lever has sufficient clearance in valve crosshead to permit full swing of lever. See that all parts line up without being sprung in place. On Walschaert gear, see that link block is properly fitted in link. Check drilling of oil hole and grooving of bushing. Inspector to check all valve setting and alignment of gear frame and link support with main frame.

G-60 - LUBRICATION

Machining

1. Inspect all fittings for condition of thread and joint, diameter of choke, and for blowholes in castings. Inspect brazing where fittings are brazed to pipes.

G-60 - LUBRICATION (Cont.)

Application 2. See that piping is free of pockets, that it slopes towards the part lubricated, and that all connections are properly made. Test out lubricator to see that it feeds to all parts lubricated. Disconnect pipes after test and pump by hand to make sure that the proper amount of oil is being feed through the pipes.

G-62 - PILOT

Application 1. Inspector should check pilot height above rail when engine is in working order.

G-63 AND 64 - PIPING

Application 1. See that all piping is properly secured, against vibration, by clamps, and that piping is free of pockets. See that piping is not subject to rubbing by moving parts, and that piping is blown out before being applied. After piping has been applied, test all connections for leaks. See that all pipe connections are accessible, and can be readily disconnected. Piping should be relieved as much as possible, of strains due to expansion, or movement of parts to which the piping is attached. This may be accomplished, where the installation of flexible joints is not specified, by properly arranged bends in pipe line. Inspector should see to this in inspecting pipe application. All flexible joints should be so arranged, as to furnish flexibility to the piping in the line of strain. See that connections are so located in piping, that where the piping is subject to frequent removal in making running repairs, a short section of the piping may be removed without disturbing other piping. Check sand pipes to see that they are the proper height above rail, and are properly located with wheel and rail. Where pocketing of any piping is unavoidable, see that drain valves are applied at low points.

G-65 - PISTON

Piston

1. Inspect riveting of bull ring to see that rivets are well driven. Check width of bull ring, the distance of its faces to the faces of the hub, width, depth and location of ring grooves. The outside diameter of bull ring may be one, one-hundredth (.01) inch under specified size, but nothing over. Check fit of packing rings in piston and cylinder, and see that they are applied as specified. Check contour of piston for cylinder head clearance.

Piston
Rod

2. Check all dimensions of piston rod, and examine rod for seams or checks. A tolerance of three thousandths (.003) inch, plus or minus, in diameter of body of piston rod, and one thirty-second (1/32) inch, plus or

G-65 - PISTON (Cont.)

minus, in length of rod, between crosshead and piston fits, may be allowed. The rod must be a smooth finish between fits. Inspect the fits of all piston rods in crosshead and piston, and witness application of rods to these parts. Examine threads on rod and in nut, and see that nut is a tight fit on rod. See that all shoulders are joined by clean cut fillets. This also applies to axles and crank pins.

G-66 - PLUGS

- Machining
1. Inspect plug threads to see that they are well formed, and have the proper taper. Also threads in plug holes for form and taper. See that plugs screw in the proper distance, and fit taper of hole.

G-68 AND 69 - REVERSE LEVER AND GEAR

- Assembly and Application
1. Subject pins, bushings, connections, and other like parts to the same inspection as outlined for valve gear parts. See that reverse shaft radius bar lifter pins are square with main frames so that lifter hangs plumb in all positions of reverse shaft arm. Check bore of reverse shaft bearings to see that the two bearings on opposite sides line up with each other, and that the center line through the two bearings is square with main frames. Check all parts for clearances, in all operating positions. Test out reverse cylinder, when all reverse gear and valve gear have been applied. See that reverse shaft arms are a good fit on shaft.

G-71 - RUNBOARDS

- Application
1. Check the brackets for proper alignment, before runboards are applied. See that runboards are arranged to provide safe passage along boards, that they have the required clearance for passage the full length of board, that they are free from foot obstructions, and are secured to brackets with button head bolts. Check outer edge for being within the specified track clearance. See that all runboards and steps have roughened tread,

G-72 - MAIN AND SIDE RODS

- Main Rod
1. Inspect all rods for seams, checks, and tool marks. Check all rod dimensions. Rods having webs of channel five eighths ($5/8$) inch or more in thickness, a tolerance of three thirty-seconds ($3/32$) inch, plus or minus, may be allowed in thickness of web, and the web may be the same amount of tolerance off of center. For rods with

G-72 - MAIN AND SIDE RODS (Cont.)

webs under five eighths ($5/8$) inch thick, the two tolerances are to be restricted to one sixteenth ($1/16$) inch. A tolerance of one thirty-second ($1/32$) inch, plus or minus, in either the thickness of the flanges, or overall depth of rod, may be allowed, on all channel rods. A tolerance of one sixteenth ($1/16$) inch, plus or minus, may be allowed in width of flange, provided the flange is the specified thickness. The width of the front end of the main rod may be three thousandths ($.003$) inch, plus or minus, the specified thickness. Rod must tram on both sides of rod to specified dimension between center of bushings. Both sides should tram the same, but one sixty-fourth ($1/64$) inch, plus or minus, may be allowed in length. All sections, through back and front end of rod, to be practically as specified, only small tolerances being allowed. See that front end bushing keys have proper draw, that edges of rods are rounded off, that all bores for bushings are smooth, round and straight, and that slotted sections of rod are free from tool marks. Check rod for being straight, and for front end being central with back end, or if offset, to have the specified offset. In checking straightness of rod, see that the straight line with which check is made is square with bore of rod bushing, and that the body of the rod is parallel to this line. A straight edge and square should be used for this check. See that front end of rod has sufficient guide clearance to allow for up and down movement of wheel. All fillets to be carefully checked to see that they are as specified on drawings and that they are free of all tool marks.

Side
Rods

2. Inspect rods for seams, checks and tool marks. Check all dimensions, channel side rods to be allowed same tolerances for channel section, as that allowed on main rods. For rectangular section rods, a tolerance of one thirty-second ($1/32$) inch, plus or minus, may be allowed in thickness or depth of the body of the rod. All eye sections should be held close to the specified dimensions. The bore for bushing should be smooth, round and straight. See that all edges are rounded off. Tram all rods, tramping both sides of rods between bearing centers. Both sides must tram the same, but a tolerance of eight thousandths ($.008$) inch may be allowed in distance between centers. Check rods for straightness and offsets using same method as on main rod. The rod must be practically straight, but a tolerance of one thirty-second ($1/32$) inch may be allowed in the offsets as measured from any one face of rod, provided there is sufficient clearance between rod and counterbalance, and other parts of the locomotive, and

G-72 - MAIN AND SIDE RODS (Cont.)

that the jaws and tongues of knuckle connections line up. Where rod has been offset for clearance sake, no tolerance is to be allowed that will reduce the amount of clearance specified. Check jaws and tongues at knuckle connections for specified taper and lateral play.

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|-----------------|---|
| Bushings | 3. Inspector should witness pressing of bushings into rods to see that they have a good fit, and are pressed in at proper pressure. Check all dimensions. A tolerance of, plus or minus, two thousandths (.002) inch may be allowed in diameter of bore of inner bushing, and five thousandths (.005) inch in length of bushing, or over the two bushings considered as one, in case of floating bushing application. Check lubrication drilling and grooving. On floating bushing, check allowance for expansion on outside diameter and clearance on inside diameter. |
| Knuckle Pins | 4. Check dimensions of knuckle pins and pin fit in rod. See that the pin has the specified draw and does not extend through rod on inside more than the specified amount. A tolerance of two thousandths (.002) inch under the specified diameter may be allowed. |
| Grease Cavities | 5. Inspect machining of grease cavities and application of plugs. |

G-73 - SANDBOXES

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|-------------|---|
| Application | 1. See that all sandboxes are well cleaned out before shipping or filling with sand. Test sanders. See that all sand pipes feed freely and that there are no leaks in air line. |
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G-74 - SMOKEBOX

- | | |
|-------------|--|
| Arrangement | 1. Inspector should see that all castings over openings in smokebox are well fitted to smokebox, that netting angles are fitted up close to smokebox sheets, that all openings or holes in smokebox are thoroughly sealed to prevent air leaks, and that netting and damper plates are properly fitted. Make inspection of smokebox just before closing up box for firing up to see that exhaust nozzle and all other parts are secured in place and that all loose bolts, nuts and other foreign parts are removed. |
| Test | 2. Inspector should see that smokebox is thoroughly tested for air leaks in accordance with specifications, and that all leaks that may develop are thoroughly sealed before engine is accepted. |

G-75 - SMOKESTACK

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| Casting | 1. Check casting to see that there are no cracks or blowholes, and that the walls around stack opening are the specified |
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G-75 - SMOKESTACK (Cont.)

thickness at all points.

Application 2. Inspector should check alignment of stack with exhaust nozzle by arrangement of staff seated on nozzle tip seat, and see that the stack, at no point in the stack opening is out of alignment more than one sixteenth ($1/16$) inch. Check stack opening for out-of-round allowing a tolerance of one quarter ($1/4$) inch. See that stack is well fitted to smokebox. See that extensions are properly fitted to stack, that they are the specified distance above exhaust stand, and are in alignment with stack.

G-76 AND 77 - SPRINGS AND RIGGING

Details

1. Inspect all spring saddles and other castings for cracks, and other casting defects. Check saddles for specified thickness of metal, length and spread, seeing that they are proper spread before machining, in order to insure a square seat on box. Check all hangers, and equalizers to see that they are not forged under size at any section, that drilling is central with boss, and square with hanger, that there are no forging defects, such as inferior welds, and that the distance between holes is that specified. See that all bushings and pins are properly case-hardened, have specified oil grooving and holes, that holes in bushing line up with holes in the part to which they are fitted, that bushings have a good fit and that pins are a good fit in bushings. Check equalizers for length between connecting points.

Assembly

2. When rigging is assembled in place, see that all parts have sufficient clearance, that hangers do not rub frames, and that hangers have sufficient clearance in springs. When engine is in working order, see that spring rigging sets level, all springs and equalizers being practically level to the eye when viewed from side of engine.

G-78 - STEAM GAUGE, SAFETY VALVES, ETC.

Steam
Gauge

1. Inspector should see that all gauges have been properly tested and that the two gauges used in setting safety valves check with each other. See that gauge dial is readily visible to the enginemen. See that insulating blocks are in place, and that syphon is blown out before it is connected up.

Safety
valve

2. Inspector should witness setting of all safety valves, seeing that they release and close at the specified

G-78 - STEAM GAUGE, SAFETY VALVES, ETC. (Cont.)

pressures.

Steam
Turret

3. Check casting for cracks, blowholes and thickness of walls. Inspect all tapping of holes, machining of valve seats and joints of ring between turret and boiler. See that turret is properly blown out and and cleaned before applying.

G-79 & 81 - STEAM PIPES AND SUPERHEATER

Steam
Pipes

1. Check castings for thickness of walls, cracks and blowholes. See that all joints of pipes and rings when finished are free of sand spots or blowholes. Inspector should witness all tests of steam pipes before and after they are applied in place.

Super-
heater

2. Inspector should inspect all unit and header joints and joint rings, see that all parts are properly applied, that units are the specified distance from back tube sheet, that shields are applied and bolts are double nutted where specified.

Super-
heater

3. Inspector should witness all superheater tests. After inspector has made sure that the specified pressure is being applied to all parts, he should, with a light, inspect each unit joint separately, joint between header and dry pipe, and all other steam joints, that may be under test at the time. When the inspection in the front end is completed with the pressure maintained, the inspector should inspect each individual unit from firebox end, having arranged for a light to be reflected from the front end of each unit while being inspected. All leaks should be satisfactorily corrected and superheater retested until found satisfactory.

G-82 - TANK VALVES

- Application 1. Inspector should try tank valves to see that they open and close properly and do not leak. See that tank hose is the proper length, that it is applied so as to give the least kink to hose in all operating positions, and that it is not subject to rubbing by other parts.

G-84 - TENDER BRAKES

- Application 1. See that all safety hangers and cotters are applied, and that all parts of rigging have the proper clearance. Test application and release of brakes to see that shoes clamp wheels under application and swing free when released. Check brake cylinder piston travel to see that the specified travel is obtained. See that

G-84 - TENDER BRAKES (Cont.)

rods do not bind in jaws.

G-85 - TENDER FRAME

- Casting 1. Check casting for casting defects, for thickness of walls and relative alignment and location of surfaces. Check water bottom frames for leaks.
- Machining 2. Check machine surfaces and drilling for location and alignment with other parts. Check center casting and distance between castings. See that side bearings have the specified spacing, and that they have the specified clearance when trucks are applied.

G-86 - TENDER DRAW GEAR

- Details 1. Check yoke, keys and other detail parts for material defects, and for being to the specified dimensions, special attention being given those dimensions for which tolerances are specified on drawings. See that drawbar pin holes are bushed as specified.
- Application 2. Inspect application of gear to see that it is properly applied and meets Interstate Commerce Commission requirements.

G-87 - TENDER STEPS AND GRAB IRONS

- Application 1. Check steps for proper height from rail, and for foot clearance. See that grab irons are straight, that they have the required grip clearance, and that they are within the specified track clearance.

G-89 - TENDER TRUCK

- Details 1. Check A.R.A. type of truck frames, and bolsters to A.R.A. tolerances.
- Assembly 2. See that truck frames on opposite sides are parallel, and that axles are parallel within one sixteenth ($1/16$) inch. Tram truck, allowing tolerances of three sixteenths ($3/16$) inch plus, and one eighth ($1/8$) inch minus specified dimension between axle centers. Check arrangement of trucks of A.R.A. design to A.R.A. tolerances. For the inspection of trucks of designs other than the A.R.A., the inspector is to be guided by tolerances allowed on similar parts of A.R.A. trucks.

G-91 - THROTTLE AND DRY PIPE

- Throttle
1. Inspect all joints, see that throttle has specified lift, test out throttle for leaks, see that valves are properly fitted and do not bind at any point in opening and closing, that balanced valves are free to seat themselves and are not drawn down onto seat, and that all pins are keyed with keys well opened. Check rigging to see that pins are properly fitted, that no part of rigging binds at any point and that all keys are applied and well opened. On dome throttle check height from top of throttle and clearance with dome cap when throttle is open. Try opening and closing throttle to see that all parts work freely, and that lever has sufficient hand clearance. See that lever latch seats well in quadrant notches.
- Dry
Pipe
2. Inspect fits of sleeves to dry pipe, see that sleeves fit well and where riveted to pipe, that all rivets are tight. Inspect sleeve joints and joint rings, for finish, grinding and sand holes. Inspector should witness test on all dry pipes.

G-92 - BOOSTER

- Assembly
- 1.* Inspect booster arrangement for clearances under all operating conditions. See that all booster piping is well supported, and that the ball connections are so arranged as to take full swing of trucks without straining the pipe connections. Test out booster to see that all parts operate satisfactorily, and that there are no leaks in pipe lines.

G-94 - DISTRIBUTION VALVE

- Machining
and
Fitting
1. Inspector should check valve machining and fitting up very closely, using snap and pin gauges for all important dimensions, limiting tolerances allowed, to only a few thousandths. See that rings are free, but snug fit in grooves, that all fits are neat fits, that rings are parallel with each other and that nuts fit tight on valve stem and are well drawn up. Check distances between edges of rings to railroad company's standard gauges. Check valve stem for length and diameter and see that it has a good fit in crosshead. Inspect key fit in crosshead. The valve crosshead total vertical or lateral clearance between guides should not be less than one thirty-second ($1/32$) inch, nor more than one sixteenth ($1/16$) inch.

G-95 - WHEELS

Driving
Wheel
Centers

1. Castings should be sandblasted to remove all scale. After scale has been removed, inspector should inspect castings for cracks and other casting defects. Inspector should check all finished dimensions, especially axle and crank pin bores and offsets of surfaces with hub face, such as rim and counterbalance offset with hub faces, thickness between faces of axle and crank pin hubs, distance between bores and diameter of wheel. See that all machining is either square with or parallel to the wheel's hub face. Inspector should see that all wheels are pressed on axles and crank pins pressed into wheels at the specified tonnage. See that the tonnage increases gradually as the wheel goes on the axle and is not boosted up by a shoulder on the axle or in bore of wheel. When both wheels have been pressed on, check the distance between hubs and rims at intervals of 90 degrees around hub and rim to see that the wheels are parallel and that the spacing is that specified. Wheels should be mounted before tires are applied, and, after mounting, inspector should make a thorough check around hubs for any cracks that may have developed in mounting. Check quartering of wheels. See that axle and crank pin bores are straight and round, and have a smooth finish free from shoulders. Check counterbalancing of wheels and weights of parts counterbalanced. Inspector to witness all counterbalancing and pouring of lead in centers. Weights of each pair of wheels are to be taken and not a single pair as representative of the class. Pure lead with five per cent antimony added is to be used in filling counterbalances. See that all pockets in counterbalance are thoroughly cleaned before being filled with lead. The difference in the unbalanced weight of two wheels on the same axle must not exceed 50 pounds. The difference between the total unbalanced weight on the two sides of the locomotive must not exceed 100 pounds. The per cent of reciprocating weight balanced must be within two per cent plus or minus that specified.

Driving
Tires

2. Check bore, diameter and contour of tires. See that diameter and contour are to specified dimensions and meet Interstate Commerce Commission's requirements as to diameter of tires on the same axle or in same wheel base. See that tires are properly fitted to wheels, that they have a good bearing on wheel rim at all points and that spacing between tires is to specified dimensions, measured at intervals of 90 degrees.

Driving
Wheel
and
Tire
Tolerances

3. The following tolerances may be allowed on driving wheel centers and tires:

Dimensions	Plus	Minus
Diameter of axle bore	1/16"	1/16"
Diameter of crank pin bore	1/32"	1/32"
Thickness of wheel hub	0	1/32"

For mounting on axle, unless otherwise specified, bore of wheel may be tapered six thousandths (.006) inch for one (1) inch from inner face of hub.

G-95 - WHEELS (Cont.)

Dimensions	Plus	Minus
Taper in crank pin bore (large diameter outer side.)	Taper .004"	
Wheel in quarter	Within .010"	
Axle and crank pin bores square with hub face.	Practically Square	
Offset of rim with hub face	1/32"	1/32"
Outer face of counterbalance to inner hub face.	0"	1/16"
Center of axle bore to center of crank pin bore.	Practically nothing	
Width of tire	1/32"	1/32"
Diameter of tire tread	1/32"	1/32"
Wheel hub spacing	.006"	.006"
Tire spacing measured over flanges	1/32"	1/32"
Tire spacing measured between inner faces.	1/8"	1/8"

Truck
Wheels

4. Wheels with separate tires to be subjected to an inspection similar to that of driving wheels with like tolerances. All drilled holes in forged steel, cast iron or cast steel truck wheels are to have the edges of holes rounded off to prevent starting of cracks. Forged steel, cast iron or cast steel wheels, having been inspected at the manufacturers, should be checked for finish bore and mounting on axle. See that bore is straight and round, and that it is central with and parallel to tread. Check hub faces for being square with bore and for offset with rim, also check thickness of hub. In mounting, see that wheels, on the same axle, do not vary in tread diameter more than one sixteenth (1/16") inch, and that spacing, measured over flanges, does not vary from the specified dimension more than one thirty-second (1/32) inch, plus or minus. Hub spacing, on trailer and front engine trucks, should not vary from the specified dimension more than one thirty-second (1/32) inch, plus or minus. See that all truck wheels are mounted with the distance between wheel flange and center of journal within one thirty-second (1/32) inch of the specified dimension. Inspector to witness mounting of all wheels, seeing that they have a good fit on axle, and are pressed on at the specified pressure.

G-96 - WHISTLE

- Assembly 1. Inspect machining of detail parts. Test whistle when applied to see that same operates satisfactory, and has a clear sound.

G-99 - MISCELLANEOUS

- Inspector's Records 1. The chief inspector should see that all assistants report to him the witnessing of all tests, the checking of all important dimensions and alignments, and submit to him a record of all mounting pressures. The chief inspector should at all times have a complete up-to-date record of these reports on his file. Each assistant should report to the chief inspector, all defective work not corrected or accepted, immediately upon the part leaving his zone of inspection.
- Stamping 2. Inspector should see that all parts are stamped as specified, and on parts having serial numbers, keep a record, by the serial numbers, as to which engine each part is applied.
- Running Test 3. While the engine is being fired up, and made ready for the running test, the inspector should go over the engine thoroughly to see that all defective work, detected in other departments, has been corrected; all parts have been properly applied; all nuts are tight; all cotters applied; the workmanship on painting is satisfactory; engine and tender decks line up as specified; there is sufficient clearance between front of tank and back of cab, and top of tank and top of cab; jacket neatly applied without indentations; cab details are conveniently located; no evidence of boiler or other steam leaks; couplers are the specified heights; there is sufficient clearance between driving box and pedestal cap; spring rigging is level; truck frames set level; pipes are well supported by clamps; there is sufficient clearance between the driving box saddle and top and sides of frame, between ends of springs and other parts, between spring hangers and frames and frame crossties, between driving wheels and other parts, and between rods and other parts; drawbar keeper plates are in place; grab irons are straight and have proper clearance; dome casing and sandbox fit well around the base; tank hose is properly applied; the distance from rear tank ladder, headlight and other parts to coupler face meet the Interstate Commerce Commission requirements; the cylinders fit down snug on main frames; the general appearance of the engine and tender is satisfactory; and that all parts of the engine and tender meet the Interstate Commerce Commission requirements. When the boiler pressure has been raised to the specified working pressure, the inspector should test cylinder heads for leaks, making sure that full pressure is maintained on the head tested, by opening and closing cylinder cocks. If leaks occur that cannot be stopped by tightening of the nuts, the inspector should retest the head, after the leak has been corrected, and then have the engine

C-99 - MISCELLANEOUS (Cont.)

moved immediately and retest the head the second time, to make sure that the leak has been properly corrected. When all cylinder head leaks have been made tight, the inspector should see that casings are properly applied. While testing cylinder heads, the inspector should see that no leaks have developed in the cylinder. Test cylinder cocks. Check valve travel and piston clearance. Pump engine to see that there is no excessive lost motion in rods. Test engine for blow pass piston or valve rings. Try piston packing for leaks. Inspect throttle shaft or rod packing for leaks. Sound engine as a check on valves being square. Have engine placed on a test curve and observe whether all parts clear, then move engine over the curve observing how the wheel flanges take the curve. Have engine checked for track and tunnel clearances. Try bell and whistle. Witness setting of safety valves. Test out feedwater heater, injector and booster. See that the sanders operate, and that the lubricator feeds to all points. Open smokebox door and examine front end. Try out electrical equipment. Check brake cylinder piston travel, both on engine and tender. Try brakes to see that brakes apply and release properly, that there are no air leaks, and that the governor is properly set. Try out all special appliances. Inspector should have engine operated up and down test tracks, riding same and making observations to see that engine operates satisfactory. Where trial trips are made, the inspector should ride the engine on these trips. At termination of the trial trip, inspector should examine all bearings for running hot. Witness weighing of engine.

Remarks

4. These instructions, while written for the inspection of new locomotives, may be applied to the shopping of old locomotives, except that tolerances for worn or undersize parts will have to be based on the railroads condemning limits. Other tolerances prescribed herein for fit tolerances, etc. will apply as specified, except where to maintain the tolerance on the alignment of any two parts involves an operation that cannot be readily carried out, except at a great expense to the railroad, such as may occur in the alignment of cylinders with frames. In such cases the inspector will have to use his own judgment as to whether the defect is serious enough to justify the expense of correcting same.