

Appendix B. MANUFACTURE AND TESTING OF RAILS.

ENGLAND AND WALES.

SCOTLAND.

IRELAND.

ENGLAND AND WALES.														SCOTLAND.			IRELAND.			
QUESTIONS.	CAMBRIAN.	FURNESS.	GREAT EASTERN.	GREAT NORTHERN.	GREAT WESTERN.	LANCASHIRE AND YORKSHIRE.	LONDON BRISTOL AND SOUTH COAST.	LONDON AND NORTH WESTERN.	LONDON AND SOUTH WESTERN.	MANCHESTER SHEFFIELD AND LINCOLNSHIRE.	MIDLAND.	NORTH EASTERN.	SOUTH EASTERN.	CALEDONIAN.	GLASGOW AND SOUTH WESTERN.	HIGHLAND.	NORTH BRITISH.	GREAT NORTHERN OF IRELAND.	GREAT SOUTHERN AND WESTERN.	
By what process is the Steel for Rails manufactured?	Bessemer Acid.	Bessemer Acid.	Bessemer.	Bessemer Acid.	Ingots from which Rails are made to be cast of best Steel for the purpose, made from English or Spanish hematite ore and charcoal speckles.	Bessemer Acid.	Bessemer Acid.	Bessemer Acid.	Bessemer Acid.	By all processes.	Bessemer Acid.	Bessemer Acid with Hematite Iron. Bessemer Basic process with Cleveland Iron.	Bessemer Acid.	Bessemer. Bessemer or other equally approved process.	Bessemer Acid.	Bessemer.	Bessemer Acid.	Bessemer Acid.	Bessemer Acid.	
(1) Bessemer Acid																				
(2) Siemens Martin Acid									Siemens Martin Acid.											
Basic in Siemens Martin Hearths																				
To what tests are Rails subjected before acceptance?																				
Bending	No Specification.	3 feet 6 inch length to be cut from rails, and placed on supports 3 feet apart, and shall then receive a blow from a weight of 1 ton, falling from a height of 20 feet without breaking, and without a permanent deflection of more than 3 inches.	A Rail to be placed, ball-head uppermost, on bearings 3 feet 6 inches apart. Weight of 16 tons to be suspended from centre. Deflection not to exceed $\frac{1}{2}$ of an inch after weight has been on half-an-hour, permanent set after removal not to exceed $\frac{1}{8}$ of an inch. The same Rail placed ball-head uppermost on bearings 3 feet 6 inches apart must bear two blows from ball weighing 1800 lbs. from a height of 8 feet without breaking, and without deflecting more than 1 inch.	5 feet length placed on solid iron supports, having foundations 3 feet 6 inches clear apart, and shall then receive successive blows from a weight of 1120 lbs. falling a height of 10 feet. Rails not to break before or under the third blow, not take a permanent set after the first blow exceeding $\frac{1}{4}$ inch.	5 feet length to be cut off one Rail from each end. This to be placed ball head upwards on two iron supports having solid foundations, with centres 3 feet 6 inches apart, then subjected to blows from a falling ball weight of one ton without fracture or deflection beyond the following:—First blow 7 feet, initial deflection $\frac{1}{2}$ inch to $1\frac{1}{2}$ inch, second blow 20 feet, total deflection 3 inches to $4\frac{1}{2}$ inches. If the Rail after the second blow has not deflected 3 inches it is to be subjected to a third blow with the same weight from a fall of 12 feet, the deflection after the third blow to be not less than $\frac{1}{4}$ inch.	5 feet length placed ball-head uppermost on perfectly firm beams 3 feet 6 inches apart must bear one blow from a weight of one ton, falling a height of 20 feet, without fracture, the permanent set not to be less than $\frac{1}{2}$ inch nor to exceed four inches.	A Rail to be placed ball-head uppermost on iron bearings 3 feet 6 inches apart to receive two blows from a weight of 1 ton falling a height of 20 feet, without causing greater permanent deflection at first blow than $\frac{1}{4}$ inch, or than $\frac{3}{4}$ inch at second blow.	Rails placed on bearings, centres 3 feet apart, and shall then receive a blow from a weight of one ton, falling a height of 20 feet, when the permanent deflection shall not be less than 3 inches.	12 feet length placed on bearings 3 feet apart must bear a blow from a weight of 1 ton falling from a height of 23 feet. Permanent set not to be less than $\frac{1}{2}$ inch or more than $1\frac{1}{2}$ inch.	5 feet length placed on solid iron bearings 3 feet 6 inches clear apart, and shall then receive blows from a weight of 10 cwt, falling a height of 10 feet. Rails not to break before or under the third blow, nor take a permanent set after the first blow exceeding $\frac{1}{4}$ inch.	Rail placed on bearings 3 feet 6 inches apart must not deflect more than a quarter of an inch with a weight of 30 tons suspended from the centre.	Rails to be placed on bearings 3 feet apart, and shall then receive two blows from a ball weighing one ton, falling a height of 6 feet. Not to show any signs of fracture, and permanent deflection not to exceed one inch.	A short length of Rail placed on bearings 3 feet apart must bear a blow from a weight of 1 ton falling 14 feet without a greater permanent set than $\frac{1}{4}$ inch, or more than $\frac{3}{4}$ inch at the second blow. Each Test Rail must bear two blows from a weight of 1 ton falling a height of 12 feet without breaking, or more deflection than 1 inch for each blow.	Each Rail placed on bearings 3 feet apart shall bear a weight of 40 tons suspended midway between the bearings without a greater deflection than $\frac{1}{2}$ inch, and without any permanent deflection after the test has been on for one hour. Also two blows from a weight of 1 ton falling a height of 12 feet without breaking, or more deflection than 1 inch for each blow.	Not less than 12 feet length of Rail, placed on bearings 3 feet apart, shall bear a weight of 20 tons midway between the bearings without permanent deflection, and at least without fracture.	A Rail to be placed ball-head uppermost on bearings 3 feet 6 inches apart, must bear a weight of 1 ton falling a height of 14 feet without deflecting more than $\frac{1}{4}$ inch, and without showing any signs of fracture.	A Rail placed on bearings 3 feet apart, must stand two blows from an iron ball weighing 1 ton, falling upon it from a height of 20 feet without breaking, and without a greater permanent set than $\frac{1}{4}$ inch.	A Rail placed on bearings 3 feet apart, must bear a weight of 16 tons without permanent set, and a weight of 20 tons without breaking.	A Rail placed on bearings 3 feet apart, must bear two blows from a ball weighing 1 ton, falling from a height of 20 feet, without deflecting more than 3 inches.	
Chemical	No Specification.				Carbon from 40 to 50 per cent. Silicon „ 10 to 20 „ Manganese „ 95 to 98 „ Sulphur as low as possible, not to exceed .05 per cent. Phosphorus as low as possible, not to exceed .08 per cent.			Bessemer Acid Steel. Carbon „ 40 to 45 „ Silicon „ 10 to 15 „ Sulphur „ 10 to 15 „ Phosphorus „ 10 to 15 „ Manganese „ 95 to 98 „ Iron „ 99.95 to 99.99 „	Siemens Martin Acid Steel. Carbon „ 40 to 45 „ Silicon „ 10 to 15 „ Sulphur „ 10 to 15 „ Phosphorus „ 10 to 15 „ Manganese „ 95 to 98 „ Iron „ 99.95 to 99.99 „	Per cent. Carbon to be from 3 to 45 Silicon not to be more than .05 Phosphorus .02 to .05 Sulphur „ 0.01 to .05 The only metals shall be Iron and Manganese.		Rails not to contain less than 0.45 per cent. of Carbon.								
Tension																				
Breaking weight in tons per square inch.	100 tons placed ball-way between bearings of 3 feet 6 inches.				Not less than 40 nor more than 48 tons per square inch.			30 to 35 tons.												
Extension—per cent.					Not less than 20 per cent. in 2 inches.			About 15 per cent. on lengths of 10 inches.												
Contraction of Area—per cent.					Not given.			About 22 per cent.												
Particulars as to the relative merits of Hard and Soft Steel.								A rather high Steel is used to insure a greater measure of safety.		We endeavour to secure Rails which, while being hard (to resist wear), are not brittle.	Mild Steel has little to fracture.		No data.							

MANUFACTURE

ENGLAND

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B. MANUFACTURE AND TESTING OF RAILS.

ENGLAND AND WALES.

GREAT WESTERN.	LANCASHIRE AND YORKSHIRE.	LONDON, BRIGHTON, AND SOUTH COAST.	LONDON AND NORTH WESTERN.	LONDON AND SOUTH WESTERN.	MANCHESTER SHEFFIELD AND LINCOLNSHIRE.	MIDLAND.	NORTH EASTERN.	SOUTH EASTERN.
Ingots from which Rails are made to be cast of best Steel for the purpose, made from English or Spanish hæmatite ore and charcoal spiegeleisen.	Bessemer Acid.	Bessemer Acid.	Bessemer Acid.	Bessemer Acid.	By all processes.	Bessemer Acid.	Bessemer Acid with Hematite Iron. Bessemer Basic process with Cleveland Iron.	Bessemer Acid.
	.....	.....	Siemens Martin Acid.	.....		.....		.....

5 feet length to be cut off one Rail from each cast. This to be placed bull head upwards on two iron supports having solid foundations, with centres 3 feet 6 inches apart, then subjected to blows from a falling iron weight of one ton without fracture or deflection beyond the following:—First blow 7 feet, initial deflection $\frac{1}{2}$ inch to $1\frac{1}{2}$ inch, second blow 20 feet, total deflection 3 inches to $4\frac{1}{2}$ inches. If the Rail after the second blow has not deflected 3 inches it is to be subjected to a third blow with the same weight from a fall of 12 feet, the deflection after the third blow to be not less than $4\frac{1}{2}$ inches.	5 feet length placed bull-head uppermost on perfectly firm bearers 3 feet 6 inches apart must bear one blow from a weight of one ton, falling a height of 20 feet, without fracture, the permanent set not to be less than $2\frac{1}{2}$ inches nor to exceed four inches.	A Rail to be placed head uppermost on iron bearings 3 feet 6 inches apart to receive two blows from a weight of 1 ton falling a height of 20 feet, without causing greater permanent deflection at first blow than $1\frac{1}{2}$ inches, or than $3\frac{1}{2}$ inches at second blow.	Rails placed on bearings, centres 3 feet apart, and shall then receive a blow from a weight of one ton, falling a height of 20 feet, when the permanent deflection shall not be less than 3 inches.	12 feet length placed on bearings 3 feet apart must bear a blow from a weight of 1 ton falling from a height of 20 feet. Permanent set not to be less than $1\frac{1}{8}$ inch or more than $1\frac{1}{2}$ inch.	5 feet length placed on solid iron bearings 3 feet 6 inches clear apart, and shall then receive blows from a weight of 10 cwts. falling a height of 10 feet. Rails not to break before or under the third blow, nor take a permanent set after the first blow exceeding $1\frac{3}{8}$ inches.	Rail placed on bearings 3 feet 6 inches apart must not deflect more than a quarter of an inch with a weight of 20 tons suspended from the centre. Rail placed on bearings 3 feet 6 inches apart to receive two blows from a weight of one ton falling 12 feet without breaking or deflecting more than 3 inches.	Rails to be placed on bearings 3 feet apart, and shall then receive two blows from a ball weighing one ton, falling a height of 5 feet. Not to show any signs of fracture, and permanent deflection not to exceed one inch.	A short length of Rail placed on bearings 3 feet apart must on first blow from a weight of 1 ton falling 14 feet not have a greater permanent set than $2\frac{1}{2}$ inches, or more than $3\frac{1}{2}$ inches at the second blow. Each Test Rail must bear reversing and straightening under the 1 ton weight falling 14 feet at each blow.
Carbon from .40 to .50 per cent. Silicon „ .10 to .06 „ Manganese „ .95 to .85 „ Sulphur as low as possible, not to exceed .08 per cent. Phosphorus as low as possible, not to exceed .08 per cent.	None specified.	None specified.	Bessemer Acid Steel. Per cent. Carbon ..... .20 to .40 Silicon Trace „ .10 Sulphur ..... .01 „ .10 Phosphorus .01 „ .10 Manganese... .25 „ 1.25 Iron 99.53 „ 98.05	Siemens Martin Acid Steel. Per cent. Carbon ..... .25 to .50 Silicon ..... .01 „ .25 Sulphur ..... .05 „ .10 Phosphorus .05 „ .15 Manganese... .25 „ 1.25 Iron 99.39 „ 97.75	Carbon to be from .3 to .45 Silicon not to be more than .06 Phosphorus ditto .06 Sulphur ditto .06 The only metals shall be Iron and Manganese.	None specified.	Rails not to contain less than 0.45 per cent. of Carbon	None specified.
			100.00 100.00 100.00 100.00	None specified.				
Not less than 40 nor more than 48 tons per square inch.				30 to 35 tons.				
Not less than 20 per cent. in 2 inches.			About 15 per cent. on lengths of 10 inches.				None specified.	
Not given.			About 22 per cent.					
.....	.....	.....	A rather Soft Steel is used to insure a greater measure of safety.	We endeavour to secure Rails which, while being hard (to resist wear), are not brittle.	Mild Steel less liable to fracture	.....	.....	No data.

OF RAILS.

			SCOTLAND.				IRELAND.	
MIDLAND.	NORTH EASTERN.	SOUTH EASTERN.	CALEDONIAN.	GLASGOW AND SOUTH WESTERN.	HIGHLAND.	NORTH BRITISH.	GREAT NORTHERN OF IRELAND.	GREAT SOUTHERN AND WESTERN.
Bessemer Acid.	Bessemer Acid with Hematite Iron. Bessemer Basic process with Cleveland Iron.	Bessemer Acid.	Bessemer, Siemens, or other equally approved process.	Bessemer Acid.	Bessemer.	Bessemer Acid.	Bessemer Acid.	Bessemer Acid.
.....		.....		.....	.....	Siemens Acid.	.....	.....
.....	
Rail placed on bearings 3 feet 6 inches apart must not deflect more than a quarter of an inch with a weight of 20 tons suspended from the centre. Rail placed on bearings 3 feet 6 inches apart to receive two blows from a weight of one ton falling 12 feet without breaking or deflecting more than 3 inches.	Rails to be placed on bearings 3 feet apart, and shall then receive two blows from a ball weighing one ton, falling a height of 5 feet. Not to show any signs of fracture, and permanent deflection not to exceed one inch.	A short length of Rail placed on bearings 3 feet apart must on first blow from a weight of 1 ton falling 14 feet not have a greater permanent set than $2\frac{1}{2}$ inches, or more than $3\frac{1}{2}$ inches at the second blow. Each Test Rail must bear reversing and straightening under the 1 ton weight falling 14 feet at each blow.	Each Rail placed on bearings 3 feet apart, shall bear a weight of 40 tons suspended midway between those bearings without a greater deflection than $\frac{3}{8}$ inch, and without any permanent deflection after the load has been on for one hour. Also two blows from a weight of 1 ton falling a height of 12 feet without breaking, or more deflection than 1 inch for each blow.	Not less than 15 feet length of Rail, placed on bearings 3 feet apart, shall bear weight of 40 tons suspended midway between these bearings without greater deflection than $\frac{3}{8}$ inch, and without any permanent deflection after the load has been on for one hour. Also two blows from a weight of 1 ton falling a height of 12 feet without breaking, or more deflection than $1\frac{1}{4}$ inch for each blow.	A Rail to be placed bull-head uppermost on bearings 3 feet 6 inches apart, must bear a weight of 20 tons midway between the bearings without permanent deflection, and 36 tons without fracture. A Rail placed on two supports, 3 feet apart, must stand two blows from an iron ball weighing 1 ton, falling upon it from a height of 20 feet without breaking, and without a greater permanent set than $3\frac{1}{2}$ inches.	A Rail placed on bearings, 3 feet 8 inches apart, must bear one blow from a weight of 1 ton falling a height of 15 feet without deflecting more than $2\frac{1}{4}$ inches, and without showing any imperfections.	A Rail placed on bearings 3 feet apart must bear a weight midway between the bearings of 23 tons without permanent set, and 35 tons without breaking. A Rail placed on bearings 3 feet apart must bear three blows from a ball weighing 18 cwt., falling from a height of 9 feet, without deflecting more than 3 inches.	A Rail placed on bearings 3 feet apart must bear a weight of 23 tons without permanent set, and a weight of 35 tons without breaking. A Rail placed on bearings 3 feet apart must bear three blows from a ball weighing 1 ton, falling a height of 9 feet without deflecting more than 3 inches.
None specified.	Rails not to contain less than 0.45 per cent. of Carbon	None specified.	None specified.	.....	.....	None specified.	Detail not given.	None specified.
.....	None specified.	No data.	.....	.....	30 tons per square inch of sectional area.	.....	32 to 39 tons.	.....
				.....	.....		16 to 23.	
				.....	.....		Not taken.	
.....	.....	.....	.....	We prefer Steel for Rails to be of the hard side.	.....	.....	Soft Steel Rails less liable to fracture in the line.	.....