THE ARAB REPUBLIC OF EGYPT

REPORT

ON THE REVIEW OF THE ROLLING STOCK RECTIFICATION

FOR

EGYPTIAN RAILWAYS

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FOR
EGYPTIAN RAILWAYS

DECEMBER, 1979

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

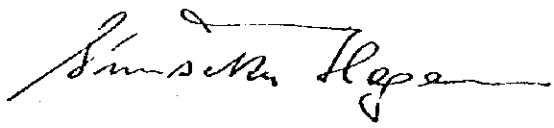
PREFACE

By mutual agreement with the Government of the Arab Republic of Egypt, the Government of Japan had decided to undertake a pre-feasibility study for modernization of the Egyptian railways, and the study was executed by the Japan International Cooperation Agency (JICA).

In view of importance of the said Project, JICA proceeded with its survey work in October 1978 after engaged in the preliminary survey starting from July in the same year and committed its survey team to hold a discussion meeting in March 1979 for briefing of the draft final report upon its presentation to the officials concerned. Submitted herewith is the final presentation of the report finalised by completion of the whole domestic work portion. Indeed, it will be the greatest pleasure to us all, if this presentation of the report can help furtherance of the Project toward its earliest implementation and development and, besides, contribute much to closer friendship and goodwill between the Arab Republic of Egypt and Japan.

In closing of the remarks as the President, I wish to express my heartfelt thanks to all the persons concerned who extended kindest cooperation and assistance during the full period of our committment in this study.

December 1979



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SUPERVISORY COMMITTEE AND SURVEY TEAMS

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1. INTRODUCTION

1.1 OUTLINE

This Report summarises the survey result on review of the rolling stock specifications, as a part of the technical assistance items which the Egyptian Railways have requested for from Japan with a view to modernising the existing railway in Egypt.

Today, there are many diesel locomotives, Diesel Multiple Units, diesel cars, passenger cars and freight cars now in operation within the service area of the Egyptian Railways. In fact, however, in view of the time limit, the specifications for this review have been scoped only to cover the diesel locomotive (Spec. No. 1170) and the third-class bogie carriages (Spec. No. 998) which are in urgent need of review for the Egyptian Railways, together with their related rolling stock material and parts of common use. Since the locomotives and passenger cars now being procured by the Egyptian Railways in accordance with those specifications amount to a considerable number, which may also be procured in the future as well, it can be said that the review of such specifications will certainly produce a very significant effect.

In reviewing the specifications, it has been intended to improve the functional reliability of rolling stock with trouble-free preventive care and the availability of such rolling stock by introduction of the world newest technology as well as by application of the internationally standardized specification. It goes without saying that full consideration has been given to the local peculiarities of the Egyptian Railways, as represented typically by such climatic conditions as high temperature and sand dust and also be riding habit of the local inhabitants.

Besides the above, one of the distinguished features contained in this Report is consideration given to how to modernise not only the hardware such as rolling stock and its component parts but also the software covering the test procedures for final acceptance.

The site surveys have been also another task of the survey team, in parallel with the reviewing service of the specifications, together with technical discussions so far made with the representatives from the Egyptian Railways. The results of those surveys and discussions are found very useful and informative, and the contents are reflected in this Report in a significant manner.

The method of reviewing the specifications is not to newly draft the specifications for amendment but to indicate views and comments for revision on an item-by-item basis of the presently applied specifications.

1.2 OUTLINE OF ITINERARY OF MAIN SURVEY TEAM

December 5 (Tue.), 1978	Visit to Cairo Office of JICA
	Interview with Chairman of Egyptian Railways
6 (Wed.), 1978	Visit to Embassy of Japan
	Discussions with Egyptian Railways
7 (Thu.), 1978	Discussions with Egyptian Railways
9 (Sat.), 1978	Discussions with Egyptian Railways
10 (Sun.), 1978	Survey of Egyptian Railways, Burak workshop
11 (Mon.), 1978	Survey of Semaf National Factory of Egypt
12 (Tue.), 1978	Survey of existing cars on the line between Cairo and Alexandria
13 (Wed.), 1978	Discussions with Egyptian Railways
14 (Thu.), 1978	Final discussions on Reports with Egyptian Railways
16 (Sat.), 1978	Submission of progress reports to Chairman of Egyptian Railways

2. SUMMARY

2.1 DIESEL ELECTRIC LOCOMOTIVES (Spec. No. 1170)

The specification is so proposed as to give certain degree of marginal allowance to the power-driving performance for the purpose of causing no troubles. In this sense, it is recommended to introduce the conceptional idea of de-rating. Futhermore, since there were plural number of unknown factors involved in the way of determination on both load and speed, it has been emphasised that any basis for calculation, such as the number of axles as the necessary basis for calculation of the train resistance, should be preferably indicated in the specification. In order to prevent any possible cavitation for engine operation it has been proposed that water quality should be also indicated clearly.

Conventionally, the diesel locomotives of various types were imported from different areas of the world to Egypt, where engines, generators and motors of wide variety have been long in use without interchangeability and at reduced availability factor. With regard to those main equipment, it has been proposed that the operating performance and general structure should be put into certain restriction and the specification dealing with such equipment by their specific brand name should be converted into that indicating them by name of common noun.

The comments for revision cover 32 items in total, including the proposed dust-proof construction of rolling stock for trouble-free prevention, establishment of the calculation formula on the brake for safety improvement, improvement of maintenance and operating practice by standardization of the instruments mounted on the operating control board and introduction of duplicate design conception by using two head lamps.

Besides those as above, in order to establish the testing procedures for final acceptance the guideline on the test method is drafted in Appendix 1.

2.2 THIRD-CLASS BOGIE CARRIAGES (Spec. No. 998)

In view of the need to reduce the weight it has been recommended that the exterior plate of car body should be made of weather-proof high tensile steel with thinner plate thickness and either pressed steel or light shaped steel should be used for the frame.

For improvement of riding comfort it has been suggested that the characteristic feature of glass fiber to be used as insulating material should be clearly specified.

To improve maintenance ability of the rolling stock it is proposed that, for instance, the diaphragm type be adopted for hood and the toilet be of F.R.P. fabricated construction. Use of the solid rolled wheels and change in sequential order of tire fitting for the bogie are also proposed from same viewpoint as above.

Comments for revision cover 34 items in total. For referential purpose, Appendices 2 and 3 give the outline of the guideline for testing procedures to help establishment of the test method for completion of the rolling stock structure and its final acceptance.

2.3 COMMON PARTS AND MATERIALS

With regard to the common parts review has been made for each specification covering axles (Spec. No. M2), tyres (Spec. No. M4), springs (Spec. No. M6), volute and helical springs (Spec. No. M7), rolled steel disc wheel centres (Spec. No. M9A) and solid rolled steel wheels (Spec. No. M9B). For materials review has been extended to each specification covering steel castings (Spec. No. M10), grey iron castings (Spec. No. M13), special cast iron (Spec. No. M14), sheet glass for rolling stock (Spec. No. M106) and gas oil (Spec. No. M170).

To be mentioned specially with regard to the wheel is wide acceptance of the solid rolled wheel. The rolled wheel has a great advantage in speed-up, test inspection and repair. Therefore, it has been emphasised that it would be appropriate to further improve the present specification for wide acceptance in the future.

Most of the reviewed items in the field of common parts and materials are related to metallurgical review of metalic ingredients, non-breaking test such as supersonic wave flaw detection or magnetic flaw detection. Those review cover 29 items on common parts and 5 items on materials. For referential purpose Appendix 4 includes a comparative list on international standards such as JIS, JRS, UIC, BS and AAR.

3. DIESEL ELECTRIC LOCOMOTIVES (SPEC. NO. 1170)

1. Requirements

Although power output and duties of the locomotive are entered parallelly, duties are considered to have priority.

However, duties appearing in the specification should be amended or supplemented to correct the following inadequacies:

(1) Weight and number of axles of the heavy trains as listed in Item 4 of the "duties" are unknown and shall be supplemented.

The above requirement should preferably be entered as following; "The train is a freight train with total weight of 1500 tons and the number of axles are 100".

(Note) The proposal is made to clarify the characteristics of the locomotive so that the locomotives proposed by various manufacturers will fairly be compared by this specification.

(2) It shall supplementally be described that "Maximum speed of the locomotive shall also be attainable with fully worn wheels".

Also, it shall be specified that "Characteristics of the locomotive shall be calculated and described in diagram with half worn wheels". In relation to these requirements, service-limit of the ER-standard tire for DEL shall clearly be stated.

(Note) The expression of locomotive performance depends on the diameter of the wheels. It shall be specified the worn status of the wheels.

(3) In the page 12 offering data (d) of the specification, it is stated, that running resistance shall be calculated by Davis formula, however, number of axles of the passenger or freight train is required for Davis formula. Therefore, number of axles shall be described to each article.

Davis formula is as shown below, where w is the average axle load, which can only be calculated from the total weight of the train and the number of the axles.

Following formula also indicates the converted Davis formula in metric system:

Davis Formula;

$$\text{Loco}: \quad R = 1.3 + \frac{29}{w} + 0.03\,V + \frac{0.0024\,AV^2}{w \cdot n} \text{ Lbs/short t}$$

$$\doteq 0.65 + \frac{13.15}{w} + 0.00932\,V + \frac{0.004525\,AV^2}{w \cdot n} \text{ kg/metric t}$$

$$\text{Goods:} \quad R = 1.3 + \frac{29}{w} + 0.045\,V + \frac{0.005\,AV^2}{w \cdot n} \text{ Lbs/short t}$$

$$= 0.65 + \frac{13.15}{w} + 0.01398\,V + \frac{0.0009428\,AV^2}{w \cdot n} \text{ kg/metric t}$$

$$\text{Pass}: \quad R = 1.3 + \frac{29}{w} + 0.03\,V + \frac{0.00034\,AV^2}{w.n} \text{ Lbs/short t}$$

$$= 0.65 + \frac{13.15}{w} + 0.00932\,V + \frac{0.0006411\,AV^2}{w.n} \text{ kg/metric t}$$

where,

R: Running resistance

w: Average Axle load, short t or metric t

n: Number of axle

V: Speed, mile/hr or Km/hr

A: Front area

Loco	50 short t	105 ft^2 or 9.75 m^2
	70 short t	110 ft^2 or 10.25 m^2
	120 short t	120 ft^2 or 11.15 m^2
Goods	85 - 90 ft^2	or 7.85 - 8.35 m^2
Pass		120 ft^2 or 11.15 m^2

(4) It is stated in paragraph (d) that "on level and inclined tracks", however, these values shall be specified.

It should preferably be specified as following; "on 0% , 5% , 10% and 15% inclined tracks".

(5) In paragraph (d), it is stated that "25 ton, 60 ton and 90 ton loaded wagons", it should be supplemented with the number of axles. For example, following explanation shall preferably be made as; "25 ton - 2 axles, 60 ton - 4 axles and 90 ton - 6 axles loaded wagons".

(6) In paragraph (e), it is stated that "600 tons passenger and 1500 tons freight trains", however total number of these axles shall be described. For example, following explanation shall preferably be made as "600 tons - 40 axles passenger and 1500 tons - 100 axles freight trains".

(7) Although both specifications and characteristic curves of the diesel engine are required in paragraph (f), the specification requirement should preferably be deleted; because true requirements here are characteristics of the locomotive and main machinery and not for the characteristics of each independent machinery. The specification of the diesel engine shall be requested separately in paragraph 6 Diesel Engine.

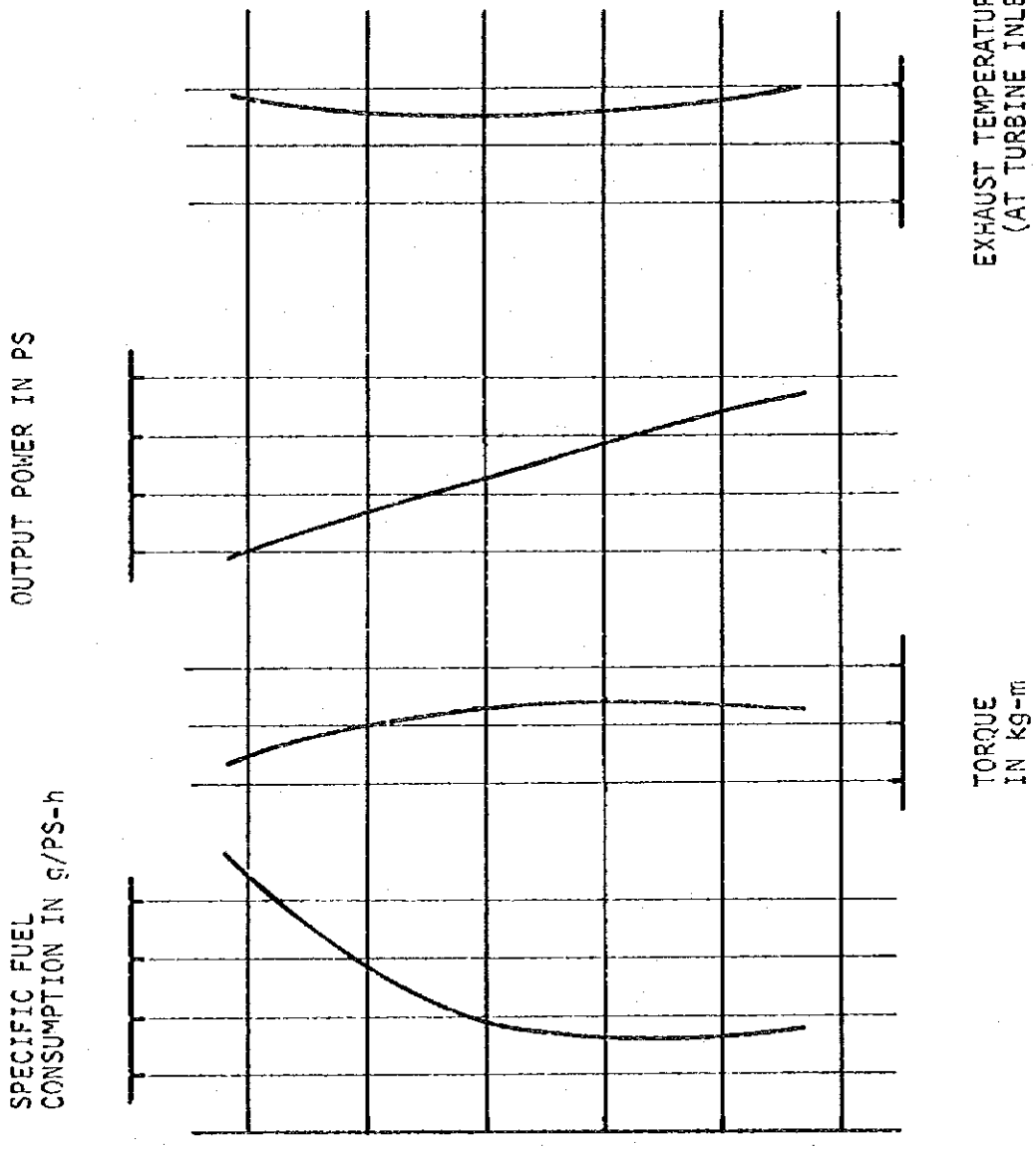
Characteristic curves should be required to be forwarded in the style as shown in attached.

(8) Although characteristic curves for the traction motor and main alternator are requested in paragraph (g), the requirement is not clear, and it should preferably be requested by the form as attached hereto.

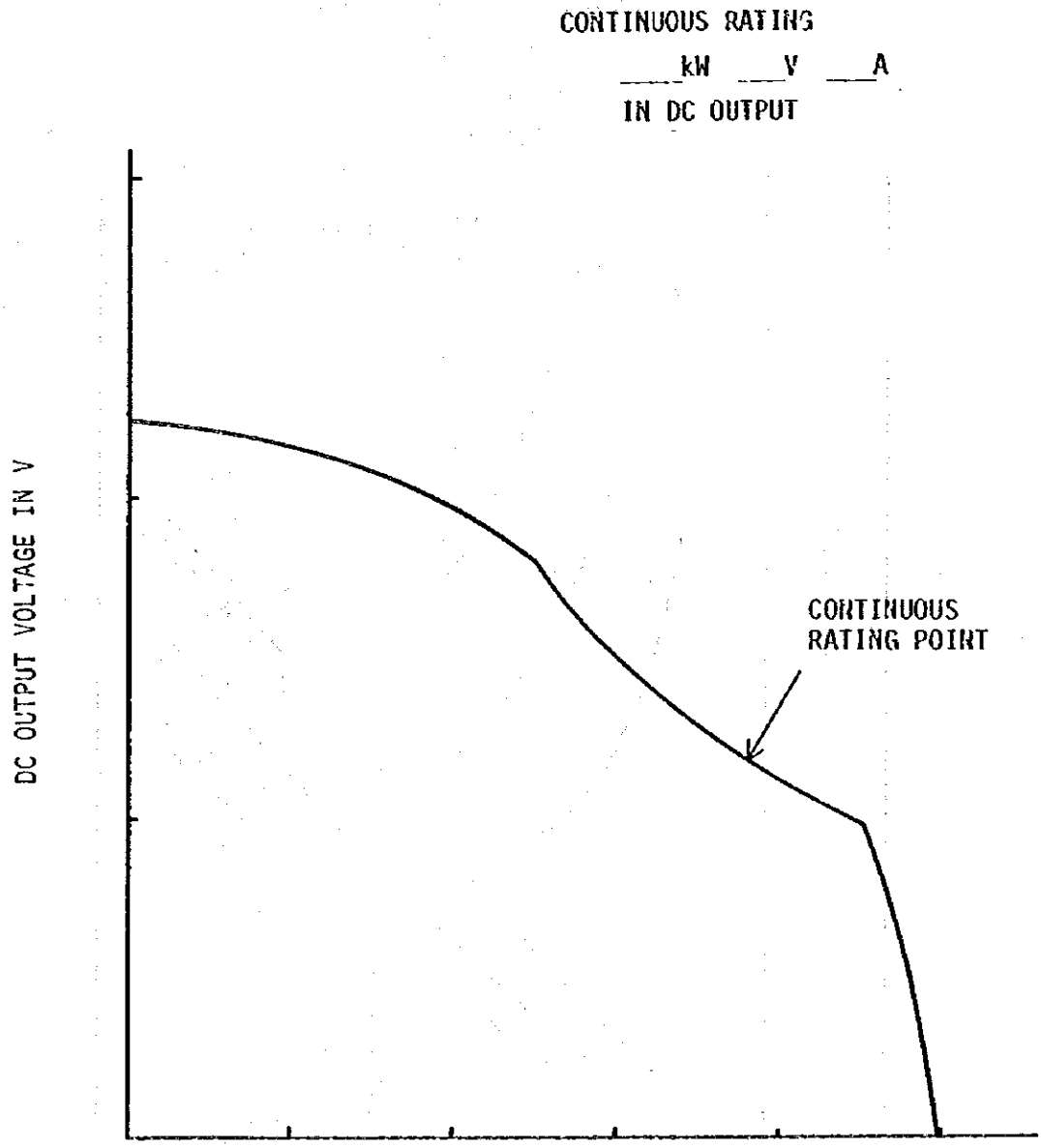
Attached data:

a. PERFORMANCE CURVES OF DIESEL ENGINE
b. CHARACTERISTIC CURVE OF MAIN ALTERNATOR
c. CHARACTERISTIC CURVES OF TRACTION MOTOR
d. SPEED - TRACTIVE EFFORT CHARACTERISTIC CURVE
e. HAULING LOAD - BALANCING SPEED CURVES ON INCLINED TRACKS

(Note) To easier the comparison of data forwarded by various locomotive manufactures.



PERFORMANCE CURVES OF DIESEL ENGINE



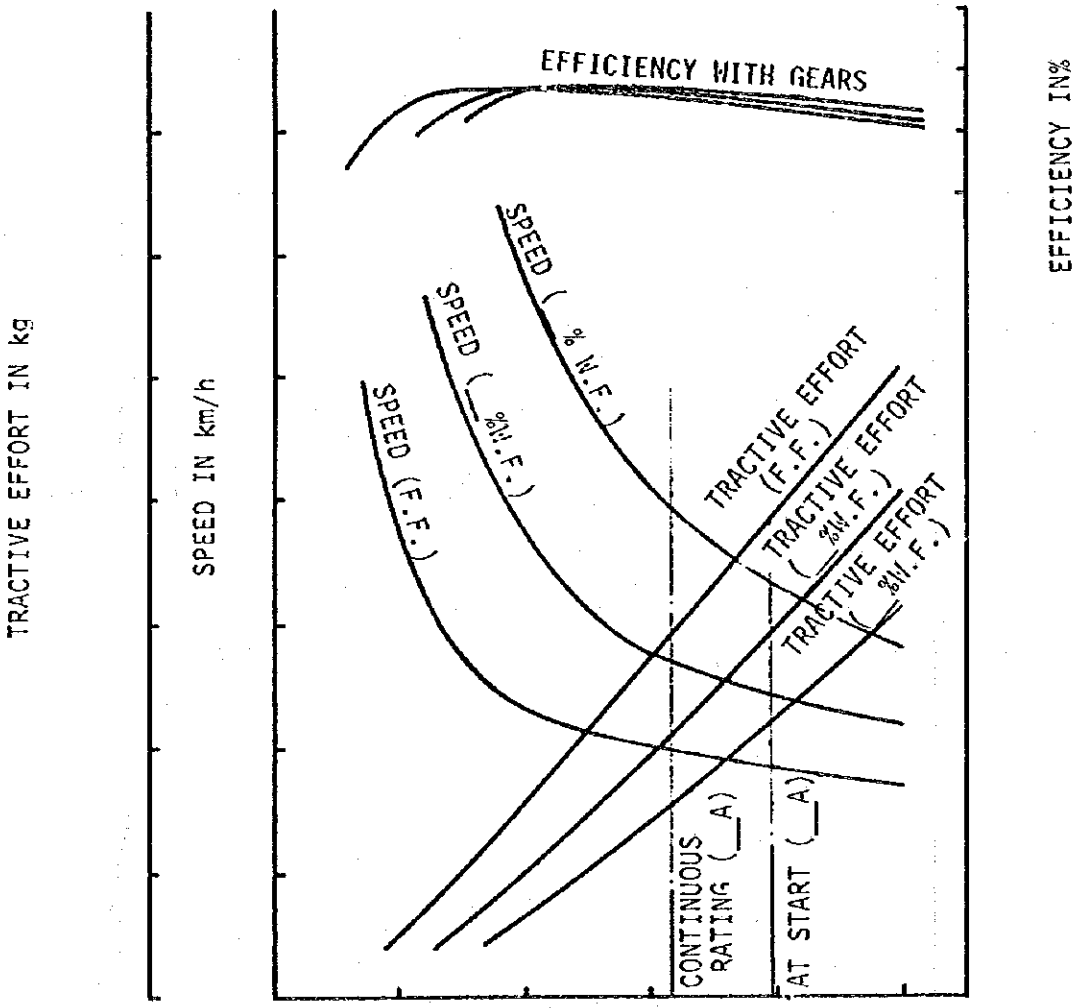
CHARACTERISTIC CURVE OF MAIN ALTERNATOR

CONTINUOUS RATING ___ kw-___v-___A-___RPM

GEAR RATIO ___/___

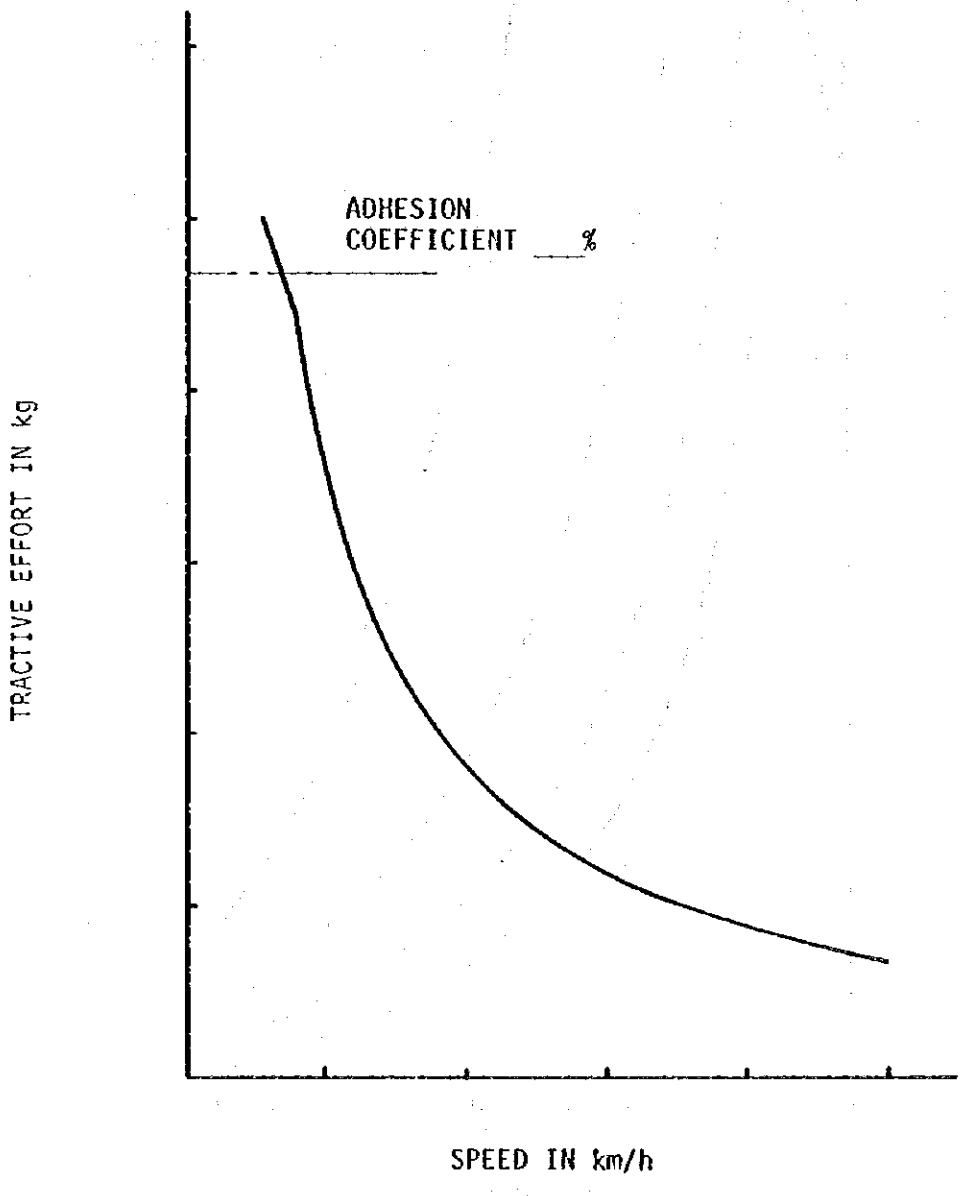
MODULE __

WHEEL DIA. ___mm(Cal. ___mm_)

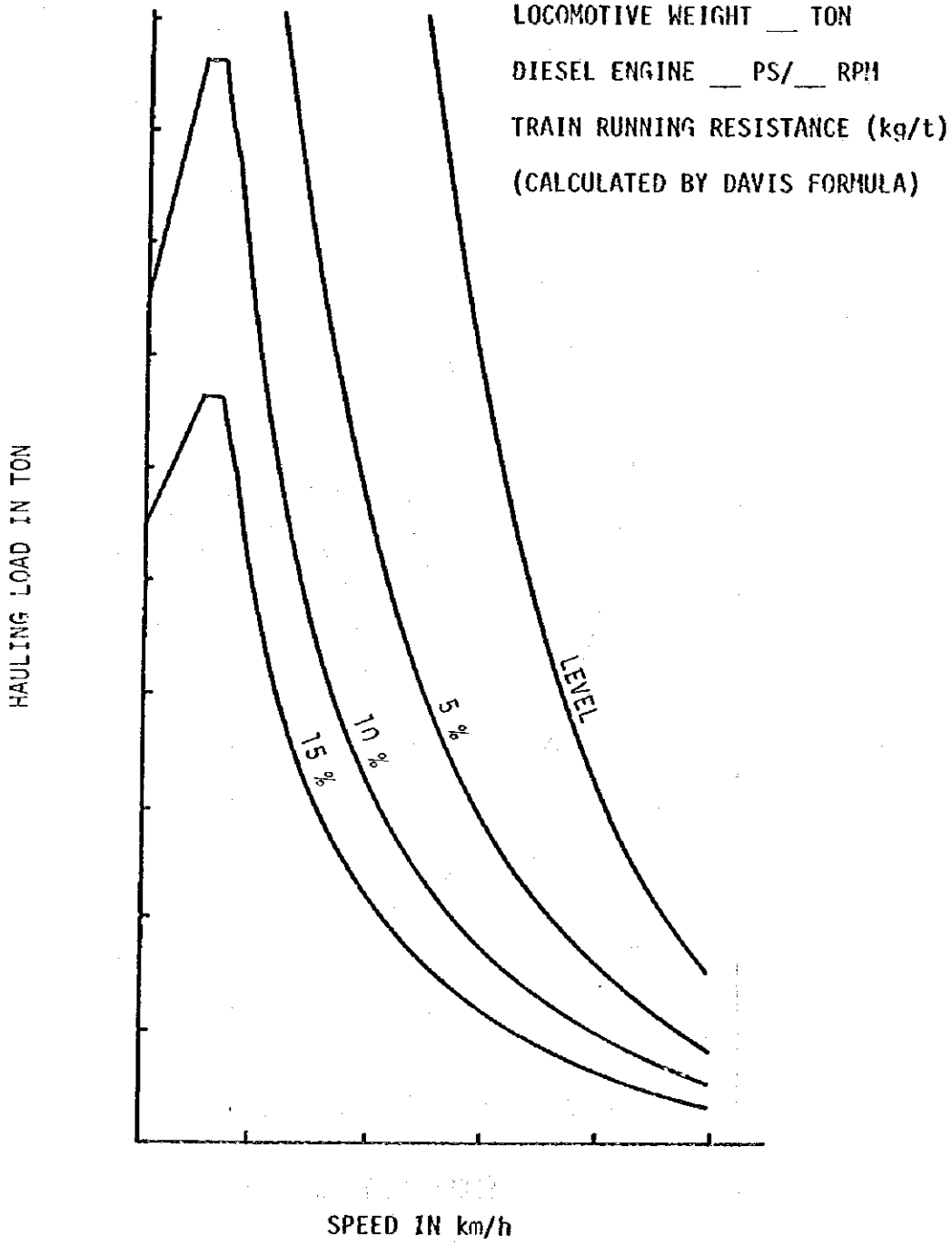


CHARACTERISTIC CURVES OF TRACTION MOTOR

DIESEL ENGINE ____ PS/____ RPM
LOCOMOTIVE WEIGHT ___ TON
WHEEL ARRANGEMENT _____



SPEED-TRACTIVE EFFORT CHARACTERISTIC CURVE



HAULING LOAD-BALANCING SPEED CURVES
ON INCLINE TRACKS

(9) For verification of locomotive performance:

Performance of the locomotive, especially the drag-performance, shall at least be measured and verified on the actual locomotive in the case of introducing new model.

In case measuring instruments are not available, the test shall shill be performed even by procuring the instruments anew, especially a dynamometer.

(Note) Checking of locomotive performance on paper only may often lead to obtain different value with actual locomotive, by the accmulation of various errors on the estimation of losses.

It is preferable to keep actual performance of the locomotive measured on the rail with actual machine, for the efficient operation of the locomotives.

It may also be necessary to measure the performance of acting locomotives, to know the changes by aging.

(10) The sentences from "Offers should be submitted in three copies" appeared at tenth line of the right column of the page 11 of this specification to the prior to the sentence to read "(C) DELIVERY TIME EVALUATION" in page 12 are preferable to be inserted next to the sentence to read as "The maximum speed of the Locomotive is to be limited by 100 km/hr" at about middle of the left column of the page 11.

(Note) To make what are concerned with locomotive performance as one bundle.

(11) Calculations for the braking distance and braking time shall be required. For the calculation, conditions shall be specified, and shall preferably to do as following:

a. It shall be for locomotive only.
b. For level and straight track.
c. Maximum initial speed shall be 100 km/hr.
d. Calculations shall be performed for maximum service braking and emergency braking.

Formulas being used by JNR for the calculation of braking distance and braking time are shown below:

i) Brake shoe pressure

$$P = \frac{\pi}{4} D^2 p n \eta E$$

where,

P: Brake shoe pressure kg,
D: Diameter of the brake cylinder cm,
p: Net pressure of the brake cylinder kg/cm^2,
n: Number of the brake cylinders,
η: Efficiency of the brake rigging,
E: Brake rigging ratio

ii) Mean friction coefficient between tire and brake shoe:

$$f_m = \frac{0.5\ C\ V^2}{2.5\ V^2 - 400\ V + 40000\ \log_e(1 + 0.01\ V)}$$

$$f_m' = \frac{CV}{5\ V - 400\ \log_e(1 + 0.01)}$$

where,

f_m : Mean friction coefficient -- use for the calculation of brake distance.

f_m': Mean friction coefficient -- use for the calculation of braking time.

V : Initial braking speed km/hr

C : Coefficient by weather, Fair = 0.42
Rain = 0.30
Normal = 0.32

iii) Braking distance

$$S = \frac{Vt_1}{3.6} + \frac{KV}{\frac{P_t}{W_t} f_m + r_m \pm r_g + r_c}$$

where,

S : Braking distance m.

V : Initial speed of braking km/hr.

t_1: Idle running time sec.

P_t: Total brake shoe pressure kg

W_t: Total train weight t

r_m: Mean running resistance kg/t

r_g: Resistance on inclined track kg/t

r_c: Curve resistance kg/t

K : Constant, 4.17 for normal train, diesel multiple unit, 4.29 for electric multiple unit

iv) Braking time

$$t = t_1 + \frac{AV}{\frac{P_t}{W_t} f_m' + r_m \pm r_g + r_c}$$

where,

t : Braking time

A : Constant, 30 for normal train, diesel multiple unit
30.9 for electric multiple unit

(Note) Braking as well as power running is an important performance of the locomotive.

4. Loading Dimensions

Sentences within the frame at the last part of this paragraph shall be deleted.

(Note) Structures shall be kept to run any car which is kept within the Loading Gabarit shown in S.M. 3100 B.

6. Diesel Engine

(1) Specification of the diesel engine shall be requested in accordance with international standard form. International forms are such as UIC 623, etc.

(Note) To make study and comparison of characteristics of the diesel engines.

(2) The clause to read as "The engine will be required to pass country of origin test" shall be revised to request to pass international specification. International specification is for example UIC 623.

The test results for the above shall also be requested.

(Note) To make study and comparison of the characteristics of the engines.

(3) It should preferably be requested to submit the calculation sheet of derating, e.g. the calculations to obtain maximum useful service output from the international certified type rating.

(Note) To clarify the basis of derating.

(4) Revolutional speed of the engine should preferably not to be limited to 1050 rpm or lower.

Also it is preferable that super-charged engine is used.

(Note) The use of super-charged engine is the worldwide tendency of rolling stock diesel engine, which is becomming more and more smaller weighted per HP adopting higher supercharging and engine speed.

Data of various diesel engines are attached for the reference.

Table Typical Diesel Engines for Locomotives in the World

Countries	Manufacturers	Model	Super-charger	Inter-cooler	Continuous output	Continuous speed	BMEP	Piston speed	Weight (dry)	Dimensions widthxlengthxheight (mm)
Japan	SHINKO NIIGATA DAIHATSU	DML61ZB	Yes	Yes	1,500 HP	1,500 rpm	14.3 kg/cm^2	10.33 m/s	6,500 kg	1,880x2,768x1,833
Germany	MTU	12V652TB11	Yes	Yes	1,840 PS	1,500 rpm	14.1 kg/cm^2	11.5 m/s	5,820 kg	1,600x2,408x2,240
France	SEMT	12PA4V18°VG	Yes	Yes	2,000 HP	1,500 rpm	17.6 kg/cm^2	10.5 m/s	5,620 kg	1,450x2,539x1,863
Britain	PAXMAN	12YJCL	Yes	Yes	1,500 MP	1,500 rpm	11.8 kg/cm^2	10.8 m/s	5,080 kg	1,335x2,060x2,010
	EE	8RKXT	Yes	No	1,400 HP	900 rpm	11.5 kg/cm^2	9.2 m/s	13,100 kg	1,680x4,280x2,390
U.S.A.	GM	12-645E	No	No	1,500 HP	900 rpm	6.6 kg/cm^2	7.63 m/s	11,340 kg	1,651x4,470x2,260
	GE	FDL-8	Yes	Yes	1,970 HP	1,050 rpm	19.6 kg/cm^2	9.35 m/s	12,247 kg	1,727x3,251x2,184
	ALCO	6-251F	Yes	Yes	1,520 HP	1,100 rpm	18.95 kg/cm^2	9.78 m/s	11,204 kg	1,651x3,912x2,261
	CATERPILLAR	D-399TA	Yes	Yes	1,300 HP	1,300 rpm	14.2 kg/cm^2	8.80 m/s	6,804 kg	1,689.6x3,259.8x2,001.3
	CUMMINS	KTA-2300L	Yes	Yes	1,200 BHP	2,100 rpm	197 PSI	11.1 m/s	3,632 kg	1,256.5x2,186x1,677.5

(5) Although it is stated that "The engine shall develop its nominal power at all locomotive speeds.", this shall be amended to read as "Engine output shall be able to utilize efficiently in widest possible speed range of the locomotive".

(Note) Engine full power cannot be developed in the low speed range and high speed range, because of the voltage and current characteristics of the alternator.

The power at the starting is also determined by the adhesion.

(6) The word "turbo-blower" should preferably be amended to read as "turbo-charger".

(Note) To comply with ISO/DIS 2710-1976.

Internationally specified wording should preferably be regarded as much as possible.

(7) It is preferable to obtain the chemical properties of engine cooling water used by ER. An example of its form is attached hereto.

(Note) Characteristic of water may affect cooling water system and related equipments.

Items of Water Investigation

Item	Unit	Remarks
Appearance		Color, Odor, Floating Matter, Sediment
PH		
Electric conductivity	μ℧/cm	
M-alkalinity (C_aCO_3)	ppm	
Total hardness (C_aCO_3)	ppm	
C_a hardness (C_aCO_3)	ppm	
M_g hardness (C_aCO_3)	ppm	
Soluble evaporation residual	ppm	
Cl ion	ppm	
C_a ion	ppm	
M_g ion	ppm	
Total F_e ion	ppm	
Cu ion	ppm	
SiO_2 ion	ppm	
SO_4 ion	ppm	
Resistivity	Ω - cm	

(8) Four-stroke cycle engine should preferably be added as an alternative type of diesel engine.

(Note) Although 4-stroke engine and 2-stroke engine have their merits and demerits, 4-stroke cycle engine should also be considered to adopt at the view point of fuel consumption.

	4-stroke cycle	2-stroke cycle
Merits	1. High thermal efficiency is obtained because of sure scavenging, volumetric eff., high compression resulting to smaller fuel consumption. 2. Easy start, smooth low speed operation, long cylinder life because of cooling combustion chamber during the whole scavenging stroke.	1. 1.2 to 1.5 times of output is obtainable with the same weight and volume, resulting to cheaper cost. 2. Valve mechanism is simpler results in smaller noise.
Demerits	1. Mechanism of suction & exhaust valves and related parts becomes more complicate, and results more noise. 2. Because of one combustion stroke for two revolutions, resulting larger torque fractuation and increases size and weight of the engine for the same HP output.	1. Because of insufficient scavenging action, air feed pump is required. 2. Fuel consumption is larger than that of 4-stroke cycle, because of more fresh air blow-off. Two-stroke cycle consumes 10% more fuel than 4-stroke engine in the case of 1600 HP

7. Fuel Oil and Fuel Filter

Specification M. 170-1971, Gas Oil for Diesel Locomotive was examined to find that sulphur content is specified to 1.5 max., which seems high. It is desirable that diesel fuel oil with less sulpher content will be used, which should be limitted to 1.0% max.

(Note) Comparison with fuel oils from various country is shown in Appendix 4 for reference.

11. Control and Cab Arrangement

(1) Standard drawing of driver's cab arrangements should preferably be prepared, and the drawing should explain movements of the hands and feet of the operator as well as the habits related. For example, left side of the pedal is for sanding device, the right side is for vigilance control, handle of the master controller rotates around a vertical shaft, power running is obtained when the handle is pulled toward the driver, etc.

(Note) For standardized driving operation. Different operations with different types may lead to the accidents.

(2) It shall be clearly stated that A.T.C., V.H.F. units be procured by E.R., and the mounting and adjustments of the instruments will also be made by E.R.

(Note) To clear the liability for the charges for A.T.C. and V.H.F. units and the charge of their installation to locomotive and adjustment, and also the responsibility for these instruments.

(3) Following title should preferably be entered in page 14 right column, between second and third lines:
"Power source for A.T.C. and V.H.F. units"

(Note) The contents thereafter shall clearly be separated with that of V.H.F. Units mentioned.

(4) Allowance of the voltage supplying to A.T.C., V.H.F. units shall clearly be stated.

For example, it should preferably be expressed as 24 V ± 2.4 V or 24 V ± 10%.

(Note) The value is necessary for the selection and design of battery and its charger.

16. Superstructure

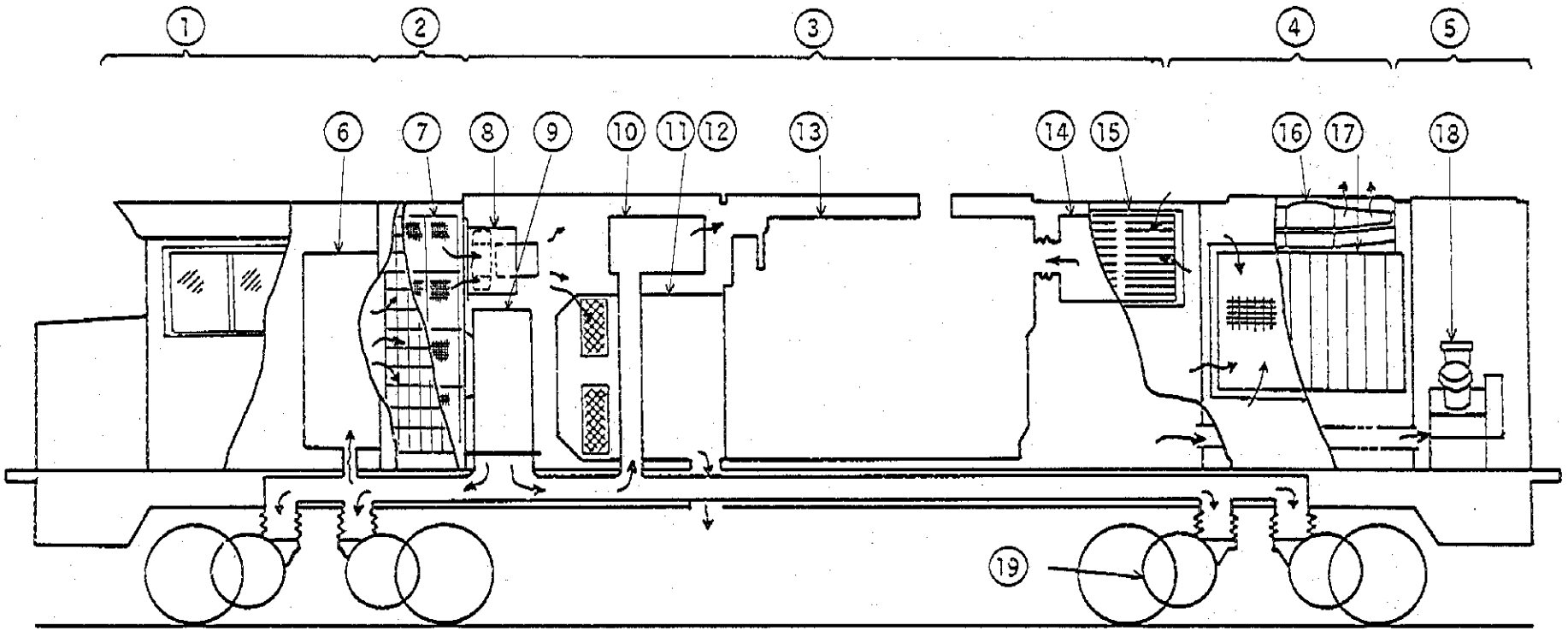
What is specified in chapter 16 that "because of the condition with much sand and dust, appropriate pressurizing device shall be installed to the engine room and ventilation system to the operator's cabin may better be amended to read as "because of the condition with much sand and dust, a proper device shall be installed to pressurize the engine room, control machine room, air compressor room, etc., to the pressure of about the range of 30 to 50 mm water column, and the driver's cabin shall be installed with ventilating device."

According to Egyptian climate it is experienced to have adequate filtration consisting of at least two stages.

(Note) This will help to keep the engine room and the control cabinet free from sand and dust.

An example of the pressurizing system for DEL is attached for reference.

For the application of this system, special attention should be made for the sealing of doors.



Air Filtering Scheme

1. Cab
2. Air Filter Compartment
3. Engine Compartment
4. Cooling Room
5. Machine Room
6. Control Cabinet
7. Panel Type Air Filter
8. Pressurize Fan-Motor
9. Traction Motor Blower
10. Main Rectifier
11. Main Alternator
12. Auxiliary Generator
13. Diesel Engine
14. Oil Bath Type Air Filter
15. Inertia Type Air Filter
16. Radiator Fan
17. Radiator Core
18. Air Compressor
19. Traction Motor

32. Traction Motor

(1) Insulation class is not mentioned. Class H shall be specified.

(2) Specified as "GM Model D77 or GE Model 752 or equal" should preferably be deleted.

(Note) Specification for the bid shall be free from a certain manufacturer's name. As the style of specification, the explanation shall be similar to that of paragraph 31 "Main Alternator".

33. Auxiliary Electric Machines

Specified as "An A.C. auxiliary generator similar to those presently in use on E.R. is required." shall be deleted.

(Note) The required output of the generator may depend upon the driving system of the auxiliary machines of the locomotive.

38. Lighting

Head light and horn should preferably be dual systems.

(Note) To continue operation even when any one of those fails.

49. Material & 50. Workmanship

Specified as "locomotives manufactured in U.S.A." or "the U.S. locomotive manufacturers" shall be deleted.

(Note) Specification for the bid should preferably be free from a certain manufacture of a certain country.

For materials also, more ERSs shall be quoted in this specification, and those which lacking of ERS shall be specified with international specifications, national specifications or those similar to them such as UIC, AAR, BS, etc.

52. Testing

Items of the final test of Diesel Locomotive should be standerdized.

(Note) To make inspections reasonable.

JIS E 4044-1967, General Rules for the Inspection of Diesel Locomotive on Completion of Construction is attached in Appendix 1 for your reference.

4. THIRD CLASS BOGIE CARRIAGES (SPEC. NO. 998)

1. Type

Stress calculation sheets for the car body should preferably be requested to the contractor.

(Note) Lack of the strength of the main parts of the car body may affect the life of the passenger car, and the strength of the car body shall be confirmed.

3. Leading Dimensions

(1) Tare weight shall be specified in the leading dimensions. Tare weight of the car is the weight of the car without loading any of crews, passengers, or freight and baggage, and also not including water, tools, etc. The value of the tare weight shall not be more than 42 tons.

(Note) The tare weight has close relationship with the weight reduction of the rolling stock, which has large effects on the operation improvement in the administration.

(2) Weight under fully crowded passengers shall be entered in the leading dimensions. The total car weight with fully crowded passengers shall not be more than that of Max. axle load.

(Note) The value is necessary for the planning and designing in the strength of the parts, performance of the rolling stock, etc.

5. General Design of Body

(1) Although it is specified that the outer body sheeting should not be less than 14 S.W.G. (2.0 mm) thick, and the roof sheet should not be less than 16 S.W.G. (1.6 mm), superior atmospheric corrosion resisting steel sheet of 1.6 mm or thicker for the outer body sheet, and 1.2 mm or thicker of the same material should preferably be specified.

(Note) The reduction of weight and improvement of corrosion resistance are expected.

(2) Although it is stipulated that "aluminum alloy may be used for roof sheet", aluminum alloy should preferably not be used.

(Note) It is possible that galvanic corrosion may yield at the joint of aluminum alloy and steel plate.

(3) The gangway is specified to be a bellow-type, however, a flange interconnection type specified in UIC should preferably be adopted.

(Note) The flange interconnection type is easy for maintenance, has longer service life, and can make body longer for the same length between couplings.

(4) Compressive end load should preferably be specified to be considered with the under-frame. The value of the load should preferably be based on UIC specification.

(Note) Sufficient car body strength is necessary, to keep the body from large failure in case of collision.

(5) Camber of the car body may be specified.

The specification should preferably be made as "the car body shall not have negative camber even under maximum load".

(Note) Even when the car body will be deformed by loading, under floor equipments and car ends shall not interfere the rolling stock gauge.

(6) Structure of underframe ends should preferably be considered in space and strength so that automatic couplers can be equipped in the future.

(Note) Modification work of the car body will become minimum in the future adoption of automatic coupler.

6. Insulation

(1) Glass wool should preferably be specified with bulk specific gravity. Specified value of the bulk specific gravity should preferably be 0.15 to 0.19 g/cm^3.

(Note) Bulk specific gravity is necessary to be specified to secure the performance of heat insulation and the effect of sound absorption.

(2) Insulation under the floor can be the spray of either bituminous anti-corrosive paint or asbestos.

(Note) Bituminous anti-corrosive paint is superior in adhesiveness, water resistivity, performance of heat and noise insulation.

Data of this material is shown in the following.
(JRS 66099 - IE - 15AR6A)

Bituminous Anti-corrosive Insulation Paint

1. Scope This standard specifies about the bituminous anti-corrosive insulation paint (hereinafter is called as paint).

2. Material The paint mainly consists of bituminous substance, synthetic resin, pigment and filler.

3. Quality The paint is pasty status, and shall conform to the following requirements.

Status in the container		shall be uniform without lumps
Specific gravity ($^{20}/_{20°C}$)		1.1 or less
Workability		Work shall be smooth with a spray gun or a pallet.
Drying time	Touch hard	one hour or less at 20°C ± 1°C
	Half set	20 hours or less at 20°C ± 1°C
Flex resistance		shall bear to the bending of 50 mm dia.
Resistance to impact		no crack nor peeling by impact of plumb
Resistance to boiling water		No softening, wrinkle, peeling or blister when immersed in boiling water for 30 m.
Resistance to salt water		No blister, crack, peeling or corrosion after immersed in 5% salt water for 96 h.
Heating residue (%)		55 or more
Heat conductivity ($^{50°C \pm 5°C}_{K\ cal/mh°C}$)		0.2 or less

7. Interior Finishing

Specification of the surface of interior panel as "PLASTIC" or "FORMICA" should be amended as "Melamine Resin Decorative Laminate".

8. Floors

(1) Keystone plate should preferably be amended to superior atmospheric corrosion resisting steel of rolled convex or trapezoidal section of the plate thickness of 1.2 mm or more, instead of 16 S.W.G. (1.6 mm) dovetail as specified.

(Note) Weight reduction, quality improvements of welded portion and increased corrosion resistance are expected.

(2) Floor compound should preferably be amended to epoxy resin flooring compound for rolling stock, instead of the trade name "INDUROLEUM" or "DECOLIT" as specified.

(Note) Epoxy resin flooring compound for rolling stock is superior in water resistance and wear one, protects steel plate from corrosion, and advantageous for reduction of car weight.

9. Seats and Tables

Material for the surface of the table should preferably be melamine plastic, instead of trade name "PLASTIC" or "FORMICA" as specified.

(Note) It is desirable to specify material by common name to allow selection from wide range of good material from performance and economical point of view.

10. Doors

Entrance door may be considered to be operated automatically.

(Note) Automatic doors are quite effective for the safety of passengers.

Compressed air for brake system is desirable to use for the operation of automatic doors.

14. Lavatories

A whole lavatory may be made from F.R.P.

(Note) Prevention of corrosion, keeping good appearance and reduction of cost can be attained. The above specified F.R.P. does not require any special strength and may not cause any problem. However, taking the account of Egyptian circumstances the provision of F.R.P. of a whole lavatory is applicable only to the case of foreign supplies.

18. Water Tanks

Galvanised steel is specified for the material of water tank, however, F.R.P. product may also be used.

In this case, care is invited to its strength and rigidity.

(Note) F.R.P. product is superior from the view point of preventing corrosion, reducing weight and keeping hygiene condition.

19. Fire Extinguishers

Although foam type fire extinguishers are specified, powder type fire extinguishers should preferably be adopted.

(Note) Even with passenger car, electric fire can be considered, foam type fire extinguisher is ineffective for electric fire.

21. Underframe

(1) Sole bars should preferably be allowed to use light gauge steel, not to limit the material only to rolled steel channel.

(Note) This amendment allows light weight design.

(2) Considering future modification for adopting automatic coupler, center beams should preferably be designed to provide adequate structure which transfers coupler force between the end beam and the bolster beam.

(Note) It is to make modification work of the car body as small as possible, in future adopting automatic coupler.

22. Bogies

(1) Bogie frame should preferably be fabricated by using pressed steel plate, and welded by union-melt method (The contractor is invited to submit the design he suggests, which he thinks, can meet E.R.'s requirements, and the E.R. has the right to ask for modifying).

(2) Stress calculation sheet of the bogie should also preferably be requested to the contractor.

(Note) Improvement of the strength and reliability of the bogie and its weight reduction are expected.

(3) Spring constant of spring gear and damping coefficient of hydraulic-dampers to be used in the bogie shall be informed by the contractor.

(Note) Because characteristics of the spring gear and the hydraulic-damper of the bogie markedly affect the comfortability of the passengers, these characteristics are necessary to be checked.

(4) The contractor should preferably be requested to ask for the approval for the characteristics, analysis, coating process of cushion rubber used in the bogie. Otherwise, material specification for cushion rubber should preferably be prepared.

(Note) Service life of cushion rubber depends much on the material and surface coating process.

23. Wheels

(1) Press-in pressure is specified as 70 to 90 tons, however this value shall be amended to 4 to 6 tons/cm.

(Note) The pressure shall be determined in consideration of the shape of the wheel, because the press-in force depends on the shape, and minimum 4 tons/cm is necessary to prevent loosing of wheel center or wheel to axle.

(2) Although rape oil is solely specified to be applied when pressing the wheels on, any of the following lubricants should preferably be used:

Rape oil,
White lead or white zinc with rape oil,
White lead or white zinc with boiled oil,
Tallow.

(Note) The above listed lubricants are widely used internationally, there is no reason to limit only for rape oil.

(3) Although wheel with tyre is specified, solid rolled wheel should preferably be adopted.

(Note) Wheels with tyre are being replaced with solid rolled wheel world-widely as well as in Japan, for passenger cars, electric rail-cars and diesel rail-cars. In Japan, solid rolled wheels have been used since 1952, and the replacement to solid rolled wheel is extended even to the wheels for repair as well as those for the new cars.

The merits of the solid rolled wheel are as follows:

1. Safety of the traffic is secured, because chances of tyre loosing or cracking were eliminated, and thus satisfied the most important requirement of traffic.

2. By solid rolled wheel, weight of one wheel becomes about 10 kg less than wheel with tyre. The solid rolled wheel can rationally make lighter design, because it does not require the portion corresponding to the rim of the wheel with tyre, and also not necessary to pay attention to the shrinkage fitting stress. The reduction of the wheel weight reduces non-suspended weight and improves riding quality accordingly. The reduction of weight may result in the economy of power consumption and maintenance cost.

3. Maintenance is easy. In the case of wheel with tyre, removing tyre by gas cutting, correction turning of outer diameter of the wheel center and that of inner diameter of the tyre are necessary, and also additional works of shrinkage fit and caulking are necessary, however the solid rolled wheel can easily be removed with a wheel press, and the replacement can be completed with only finishing inner diameter of the wheel boss.

4. Initial cost will become cheaper in future. Basically speaking, solid rolled wheel is cheaper than wheel with tyre, considering all material, working and other costs.

5. Service life is longer. Tyres are quite difficult to be heat treated, because of their configuration and high shrinkage stress, however, solid rolled wheels can easily be heat treated at their wheel treads to increase their wear resistance. This allows longer service life, and reduce out-of-operation time for wheel replacement.

28. Bearing Springs

Standard coupler heights under tare condition shall be 1105 mm, and preferably with the tolerance of ± 5 mm. Difference of the heights of the front and rear couplers shall also be limitted to within 10 mm. (The value coincides with the recommendation of UIC.) As the load condition, the fully crowded passenger condition specified in the clause 3 of this specification shall be applied, and the center height of the draft gear will be 1066 mm or higher under this condition.

(Note) Bending force may act upon the draft gear if the difference between the heights of neighboring car couplers is large.

29. Brake and Brake Compartment

As for the pin material, induction-hardened steel should preferably be considered as well as case-hardened steel.

(Note) Induction hardened pin is superior in the phase of quality control of hardness, and world-wide experiences on its application are sufficiently available taking the consideration the bush is harder.

31. Material

Products of the material manufacturers which are not registered to E.R. Department should preferably be used, if the contractor obtains approval of E.R.

(Note) New technology can be introduced.

33. Testing

Detailed specification shall be given for the inspection of car after assembly. For your reference, details of inspection are shown in APPENDIX-2.

(Note) Reasonable tests and inspections will be performed by specifying the details of inspection to improve quality.

34. Painting

Polyurethane resin paint may be applied to the outer body sheet.

(Note) Polyurethane resin paint is superior in durability, and is in a tendency to be used more widely all over the world. J.N.R. is also continuing long term tests with good results.

37. Inspection at Works

Details of stage inspection shall be specified. For your reference, details of stage inspection are shown in APPENDIX -3.

(Note) Reasonable inspection can be performed by specifying stage inspection.

5. COMMON MATERIALS AND PARTS

Specification NO. M2-1970

1. Quality of Material

Oxygen process may be added as "the best quality steel made by the open hearth, electric furnace or oxygen processes."

(Note) Quality of steel from oxygen process has come to be by no means inferior to the steel from open-hearth and electric furnace, on account of the recent technical advances. Moreover the steel from oxygen process become very popular worldwidely because of its merit of high productivity and low cost, and is in the tendency to be adopted in the specifications of wheel-set of various countries.

2. Workmanship

When the axle is manufactured direct from the ingot, the average sectional area ratio shall be 4 or larger, and when it is manufactured from the ingot through billet, the ratio of average sectional area of the original ingot and that of axle shall be 8 or larger.

(Note) The above description was added, because ingots became more larger recently, and the cases of being forged from ingots through billets are increasing, by the reason that good forging can be expected with larger forging ratio.

The measurement of the forging ratio was made with average sectional area in consideration of modern quality control.

Specification NO. M4-1964

1. Quality of Material

(1) Oxygen process may be added as "the best quality steel made by the open hearth, electric furnace or oxygen processes."

(Note) Quality of steel from oxygen process has come to by no means be inferior to the steel from open-hearth and electric furnace, on account of the recent technical advances. Moreover the steel from oxygen process become very popular worldwidely because of its merit of high productivity and low cost, and is in the tendency to be adopted in the specifications of wheel-set of various countries.

(2) The two types of materials should preferably be unified as follows:

	Class	C	Si	Mn	P	S
(Original)	A	0.72-0.85	0.15-0.35	0.50-0.90	$\leqq$ 0.05	$\leqq$ 0.05
	B	0.62-0.75	0.15-0.35	0.60-0.90	$\leqq$ 0.05	$\leqq$ 0.05
(Preferable)		0.60-0.75	0.15-0.35	0.50 0.90	$\leqq$ 0.05	$\leqq$ 0.05

(provided, P + S $\leqq$ 0.09)

(Note) Various properties are requested for tyres, and many materials can be considered to fulfill the requirements of tensile strengh only, however, standing on the view that some range of contents should preferably be specified for the good wear resistance or other properties, range of carbon between 0.60 and 0.75% shall be adhered in consideration of tensile strength and thermal crack resistance.(The classification, A and B, by type of rolling stock could remain unchanged.)

3. Rolling Tolerance

Dimensional tolerance should preferably be specified on drawing, and with the value of JRS.

(Note) It is adequate to indicate dimensional tolerance on the drawing, because tolerances are strongly dependent on the size of wheel as completed, width, configuration and operating conditions, and inadequate to determine with a standard. The value of JRS may be used.

UIC specification is requesting balancing test for wheels, which may affect vibration or other phenomena when large unbalance exists, as wheels are high speed rolling bodies.

Therefore, dimensional tolerance of rims and bosses (strictly expressed, variation of thickness) are controlled in Japan including Shinkansen which is running at very high speed, and this method resulted in very good operation even without performing balancing test; this control method is quite recommendable.

8. Tensile Test

Physical properties should preferably be changed as follows:

(Original)

Class	A	B
Tensile Strength (kg/mm^2)	88-97	78-88
Elongation (%)	≧ 11 ∿ ≧ 9	≧ 13 ∿ ≧ 11
Hardness (HB)	265-300	≧ 235

(Amendment)

Class	A	B
Tensile Strength (kg/mm^2)	88-103	78-93
Elongation (%)	≧ 11 ∿ ≧ 8	≧ 13 ∿ ≧ 10
Hardness (HB)	(244-288)	(217-260)

(Note) 1. Too narrow allowable dispersion of tensile strength may practically lead to specify the products of special manufactures; and the value was changed to have the range of 15 kg/mm^2. In case of heat treatment also, range of about 15 kg/mm^2 is technologically required from the metallurgical quality control point of view.

2. Although it is not desirable to specify both surface hardness and tensile strength, because these relation varies with the mass (size of the products); if it should be specified, current specified relation is not in a proper relation and the amendment may be proposed as above.

9. Ultrasonic Test

All tyres should be submitted to the ultrasonic test. And the AAR specification for wheels should preferably be adopted.

(Note) Wheel and tyre are of high cabron steel and apt to yield flake defects, which are desirable to be checked internally. Ultrasonic test is adequate for the purpose by its superiority and simplicity; and the use of it is recommended.

As for the process, current procedure of AAR is thought to be adequate, and recommended. Further, if ultrasonic test is specified, macrostructure inspection is not necessary to be specified.

Specification NO. M6-1962

1. Quality of Material

(1) The requirement that "be made from the highest quality of steel made from best selected material by the acid or basic open hearth, crucible or electric furnace processes" should preferably be amended as "be manufactured from steel of good quality made from killed ingots".

(Note) Because the steel shall be guaranteed of necessary quality, therefore quality of material of the steel was specified.

(2) Oil quenching should preferably be specified as well as water quenching. Materials should preferably be of the follows:
Water hardening steel

%

Type	C	Si	Mn	P	S
Carbon steel	0.45-0.65	$\leqq$ 0.30	0.60-0.80	$\leqq$ 0.05	$\leqq$ 0.05
Silicon-manganese steel	0.40-0.55	1.50-1.85	0.50-0.75	$\leqq$ 0.05	$\leqq$ 0.05

Oil quenching steel

%

Type	C	Si	Mn	P	S	Cr	B
Plain carbon steel SUP 3	0.75-0.90	0.15-0.35	0.30-0.60	≦0.035	≦0.035	-	-
Silicon-manganese steel SUP 6	0.55-0.65	1.50-1,80	0.70-1.00	≦0.035	≦0.035	-	-
Manganese-chrome steel SUP 9	0.50-0.60	0.15-0.35	0.65-0.95	≦0.035	≦0.035	0.65-0.95	-
" SUP 9A	0.55-0.65	0.15-0.35	0.70-1.00	≦0.035	≦0.035	0.70-1.00	-
Boron steel SUP 11A	0.55-0.65	0.15-0.35	0.70-1.00	≦0.035	≦0.035	0.70-1.00	≦0.0005

Each steel shall not include more than 0.30% Cu as inpurities

(Note) Oil quenching has certain advantage of good cooling performance resulting in less quenching crack, quenching deformation and uneven quenching; therefore oil quenching is recommendable to be applied upon establishing clear application condition in consideration of present status of ER. Workshop facilities such as oil baths should be installed.

7. Compression Tests (Assembled Spring)

(1) The sentence to read as "All springs shall be tested by being deflected by a quick acting scrag before the buckle is put on to an amount equal to $L^2/900 \cdot t$, where---" should preferably be amended to use permanent set testing machine of JRS and JIS specification. Amended sentence should be as follows:

"Test load shall be such value to produce surface stress of 70 kg/mm^2 for the carbon steel spring, and 90 kg/mm^2 for the alloy steel spring. Test load shall be calculated by the following equation,

For the case of $1/n<80$: $$P = \frac{n \times b \times t^2}{5.5(1 - 0.6_e)} \cdot \sigma$$

For the case of $1/n \geqq 80$: $$P = \frac{n \times b \times t^2}{5.3.1} \cdot \sigma$$

where,
- 2P: Load on the spring (kg)
- σ : Surface stress of the spring (kg/mm^2)
- t : Plate thickness (mm)
- b : Width of the plate (mm)
- 2·1: Span of the specified weight (mm)
- 2·e: Width of spring buckle (mm)
- n : Number of spring leaf

(Note) Test load of $L^2/900 \cdot t$ is applicable for carbon spring however alloy steel springs shall be more deflected because of its high strength. Therefore, the test shall be performed with the stress as specified in JRS and JIS.

(2) The portion of the specification to read as "The free camber shall not exceed that specified by more than 3 mm or 2 per cent ------" should preferably be amended to effect as "Establish allowance to the camber under specified loaded condition or the height of the spring at that time, and the free camber or free height may be given as reference figure."

The allowances are as follows:

(i) Allowance of the camber under the specified load,

±(2.5 mm + 2.5% of the planned deflection (mm) under specified load) mm,
where the figure will be round-up to 0.5 mm.

(ii) Allowance of the height under the specified load,

±(4 mm + 2.5% of the planned deflection (mm) under specified load) mm,
where the figure will be round-up to 0.5 mm.

(Note) Control of spring characteristics by the allowance to the camber or height under specified load is more effective to the control of the parallelness of the bogie.

8. Buckles

Manufacturing method of buckles should be preferably as follows:

Locomotive and tender	Seamless
Others	One point welding, Welding at two points or less. (Upper or upper & lower face of the buckle)

(Note) To clarify the manufacturing process to secure the strength and quality of the buckle.

Specification NO. M7-1968

1. Quality of Material

(1) The requirement of current specification that "The spring shall be manufactured from the highest quality of steel made from the best selected material by the acid or basic open hearth, crucible, or electric furnace processes" should preferably be amended as "The spring shall be manufactured by good quality steel made from killed ingot".

(Note) Because the steel shall be guaranteed of necessary quality, therefore quality of the steel was specified.

(2) Boron steel should preferably be added to the specification.

Steel	C	Si	Mn	P	S	Cr	B
Plain carbon steel	0.9-1.2	≦0.30	0.45-0.75	≦0.05	≦0.05	-	-
Silicon-Manganese steel	0.50-0.60 (1) 0.60-0.70 (2)	1.40-1.90	0.70-1.00	≦0.05	≦0.05	-	-
Manganese-chrome steel	0.50-0.60	0.15-0.35	0.65-0.95	≦0.035	≦0.035	0.65-0.95	-
Boron steel SUP 11A	0.55-0.65	0.15-0.35	0.70-1.00	≦0.035	≦0.035	0.70-1.00	≦0.0005

Cu as inpurity shall not be more than 0.3%.

(Note) Hardenability must be considered for large wire diameter.

3. Manufacture

Dimensional tolerance of rolled bars as specified:

(mm)

Wire dia.	Tolerance
d<12.5	+0.3 0
12.5≦d<25	+0.4 0
25≦d	+0.6 0

should preferably be amended to be similar to JRS (same with JIS), and as follows:

(mm)

Wire dia.	Tolerance
12≦d≦15	± 0.25
16≦d≦20	± 0.30
21≦d≦32	± 0.40
34≦d≦45	± 0.50
46≦d≦70	± 0.70
75≦d≦80	± 1.00

(Note) JRS (same as JIS) specified tolerance is sufficient for the control of the wire performance, and the control of the spring constant shall separately be specified on the drawing.

5. Compression Test

(1) The paragraph should preferably be supplemented with the sentence as "Spring characteristics shall be measured after normal test load was once added."

(Note) Spring characteristics shall be measured under stable conditions.

(2) The sentence "The free height shall then not exceed that specified by more than 3.0 mm or 1 1/4 per cent, -----" should preferably be amended to express the tolerance of the spring height and spring constant as follows:

1. Measurement of the spring constant shall be specified by two loading points which lie between 30% and 70% of the total deformation, and tolerance of 5% shall be specified when so required, otherwise 10% tolerance will be allowed.

2. Tolerance of the spring height shall be measured by the heights under specified loads, and the tolerance will be given by the following equation:
   Height under specified load =
   $\pm$(1.5 + 0.03·(planned deflection under specified load))mm.
   where minimum value is limited to $\pm$0.01 x free height.
   The free height here is only a reference figure.

3. When no tolerance of spring constant and the height under specified load is specified, tolerance for the free height shall be $\pm$1.5%.

(Note) Spring constant and spring height are the important factors for the running performance of the bogie, and they shall be controlled severely.

6. Workmanship

(1) The sentences in this paragraph "A plug gauge 1.5 mm less than the specified inside diameter shall pass through the spring. If required, the outside diameter----------over 140 mm diameter and all volute springs" should preferably be amended as "The tolerance for inner and outer diameter of the helical spring shall be in accordance with the instruction given

by the drawing. Also the paragraph shall be supplemented with the sentence "The portion of the spring related only with installation shall be checked with the gauges".

(Note) Because those dimensions are intimately related with the structures of bogie, detailed specification shall be given with each drawing, instead of uniformly stated.

(2) What is specified to the last of the paragraph that "In the case of volute springs the coils must not touch one another even when the springs are compressed height home" should preferably be amended as "Coils of a constant pitch compression spring shall not touch each other when 80% of the total deflection are pressed, except both ends."

(Note) Generally coils of compression type spring are partially contact under the compression of more than 80% of the height home.

7. Heat Treatment

After the sentence of "All springs shall be correctly hardened and tempered. However the heat treatment should be stated," a sentence as "Surface hardness of the spring after tempering shall be between HB 352 and 415 (diameter of the indentation between 3.25 and 3.00 mm)" shall preferably be supplemented.

(Note) To specify the range of the hardness.

Specification NO. M9A-1963

1. Quality of Material

Oxygen process may be added as "the best quality steel made by the open hearth, electric furnace or oxygen processes."

(Note) Quality of steel from oxygen process has come to be by no means inferior to the steel from open hearth and electric furnace, on account of the recent technical advances. Moreover, steel from oxygen process become very popular worldwidely because of its merit of high productivity and low cost, and is in the tendency to be adopted in the specifications of wheel-set of various countries.

2. Freedom from Defects

Dimensional tolerances should preferably be specified on drawings. Those tolerances should preferably be expressed by JRS.

(Note) Requirements on wheels depend much on various forms and service conditions applicable, therefore, it is more reasonable to specify in detail dimensional tolerances on the drawing to be adequate to configuration than to specify uniformly on a specification.

7. Tensile Test

Mechanical test requirement should preferably be amended from the current requirement of:

Class	Tensile strength (kg/mm^2)	Elongation (%)
Wheel center	52 - 63	22≦ - 15≦

to the following values:

Class	Tensile strength (kg/mm^2)	Elongation (%)
Wheel center	52 - 67	22≦ - 12≦

(Note) To narrow allowable dispersion of tensile strength may practically lead to specify the products of special manufactures; and the value was changed to have the range of 15 kg/mm^2. Also, in case of heat treatment, range of about 15 kg/mm^2 is technologically required from the metallurgical quality control point of view.

For reference following specifications are quoted:

Specification	allowable limit
ERS	7.9 - 8.4 (kg/mm^2)
JRS	20
BS	10.8 - 11.1
UIC	12 - 15
AAR	15 §

§ Hardness range was converted into tensile strength

Specification NO. M9B-1960

1. Quality of Material

(1) Oxygen process material may be added as "The ingot shall be made by the open hearth, electric furnace or oxygen processes ---"

(Note) Quality of steel from oxygen process has come to by no means inferior to the steel from open hearth and electric furnace, on account of the recent technical advances. Moreover steel from oxygen process become very popular worldwidely because of its merit of high productivity and low cost, and is in the tendency to be adopted in the specifications of wheel-set of various countries.

(2) Values of carbon, silicon and manganese shall also be specified: current specification,

Class	P.S.
C	≦0.06
D	Acid & Electric. ≦0.05 Basic ≦0.06
E	≦0.05

shall be amended to,

Class	C	Si	Mn	P	S
C.D.E.	0.60 - 0.75	0.15 - 0.35	0.50 - 0.90	≦0.05	≦0.05

(Note) The current E.R. specification specifies chemical analysis of tyre, but not to wheel. In the case of wheel and tyre, wear resistance and crack resistance are requested as well as mechanical properties.

A variety of materials can be considered to satisfy only mechanical properties, however it is not desirable to make large variations of wear resistance or crack resistance between wheels, so the range of chemical properties are considered to be established to some extent.

To secure necessary mechanical property, use of high carbon steel is desirable to obtain higher tensile strength and satisfactory wear resistance economically. However, too high carbon composition reduces fracture toughness and lead to easy crack of wheel during braking.

Above composition is the proper value obtained from the long experience in Japan. Among many materials to satisfy required tensile strength, carbon content of 0.60 to 0.75% was selected to satisfy thermal crack resistance.

Maximum value of P and S was determined to be 0.05%, because it is irrational to select different value with the melting method and the value of 0.06 is too high.

2. Freedom from Defects

Dimensional tolerances should preferably be specified on drawings. Those tolerances should preferably be expressed by JRS.

(Note) Dimensional tolerances are inadequate to be expressed generally by specification, but shall be specified on the drawing, because they are strongly affected by the size, width and service conditions of wheel set. And the dimensional tolerance shall not only be applied to the plate thickness but also be applied to all major part dimensions. Value of JRS may be applied.

UIC specification is requesting balancing test for wheels, which may produce vibration or other phenomena when large unbalance exists, as wheels are high speed rolling bodies.

Therefore, dimensional tolerance of rims and bosses (strictly expressed, variation of thickness) are controlled in Japan including Shinkansen which is running at very high speed, and this method resulted in very good operation even without performing balancing test; this control method is quite recommendable.

6. Falling Weight or Deflection Test

Falling test may be performed as necessary when agreed upon between supplier and user, instead of performing it as a routine test.

(Note) Although mechanical properties and hardness indicate the property of the component consisting the products, however, it does not guarantee the strength of the products including its configuration. Therefore checking of durability of the product by adding external force on final article may have somewhat the meaning.

However, external force added by the falling test does not always coincide with the external force acts under service, in nature and direction, etc. Specifications for falling test are quite different by the countries in the method, specified value and calculation methods, and the physical meaning of the falling test is not clear.

Therefore the test may be performed only for the reference. As for the restriction of internal defects, ultrasonic test is superior and simpler, and this method can be applied for each article. According to the above consideration, the test shall not be requested as mandately, and the ultrasonic inspection should be more important.

7. Tensile Test

Mechanical test requirement should preferably be amended from the current requirement of:

Class	Tensile strength (kg/mm^2)	Elongation (%)
C	78.74 - 86.62	$13\leqq$ - $11\leqq$
D	88.19 - 97.64	$10\leqq$ - $8\leqq$
E	99.22 - 108.67	$10\leqq$ - $8\leqq$

to the following values:

Class	Tensile strength (kg/mm^2)	Elongation (%)
C	78 - 93	$13\leqq$ - $10\leqq$
D	88 - 103	$11\leqq$ - $8\leqq$
E	98 - 113	$10\leqq$ - $7\leqq$

(Note) Too narrow allowable dispersion of tensile strength may practically lead to specify the products of special manufactures; and the value was changed to have the range of 15 kg/mm^2. Also, in case of heat treatment, range of about 15 kg/mm^2 is technologically required from the metallurgical quality control point of view.

For reference following specifications are quoted:

Specification	allowable limit
ERS	7.9 - 8.4 (kg/mm^2)
JRS	20
BS	10.8 - 11.1
UIC	12 - 15
AAR	15 §

§ Hardness range was converted into tensile strength

8. Ultrasonic Test

All wheels should be submitted to the ultrasonic test. And the AAR specification for wheels should preferably be adopted.

(Note) Wheel and tyre are of high carbon steel and apt to yield flake defects, which are desirable to be checked internally. Ultrasonic test is adequate for the purpose by its superiority and simplicity; and the use of it is recommended.

As for the process, current procedure of AAR is thought to be adequate, and recommended. Further, if ultrasonic test is specified, macrostructure inspection is not necessary to be specified.

Specification NO. M10-1959

8. Testing

The administration should preferably specify any of the following inspections if necessary.

(1) Radiographic penetration test

(2) Fluorescent liquid penetrant test

(3) Ultrasonic testing

(4) Magnetic particle inspection

(Note) Improvement of quality is expected by performing of these inspections. Japanese Industrial Standard clearly specifies the same requirement as above.

Specification No. M13-1960 and M14-1955

3. Chemical Composition

"The P and S contents shall be agreed upon between the administration and the contractor." shall be added to the specification.

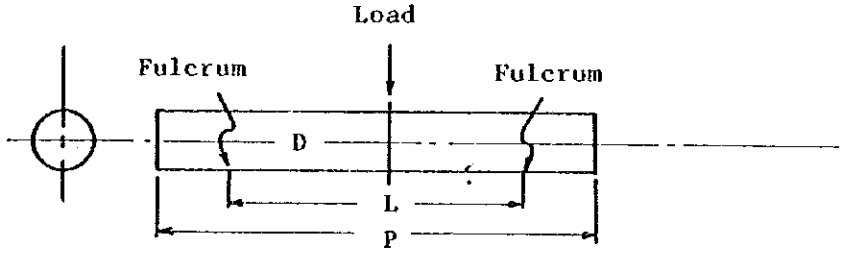
(Note) Contents of P and S which specially affect the quality of the casting are desirable to be specified by agreements.

7. Dimension of Test Bar

(A) Transverse test bars

Only one diameter for the transverse test piece is given, however several types should preferably be established.

The types are as follows:



in mm

Type of test piece	Diameter D	Tolerance of Dia.	Fulcrum gauge L	Length P
A	13	± 1.0	200	About 300
B	20	± 1.0	300	About 350
C	30	± 1.5	450	About 500
D	45	± 2.0	600	About 650

(Note) The diameter of the test piece are desirable to be as near as possible to the thickness of the main members. JIS classifies into 4 types in similar manner as above.

8. Mechanical Test

The specification should preferably be supplemented so that hardness test can be performed if necessary.

(Note) Specification of hardness might be necessary by application. JIS also specifies hardness tests.

Specification No. M106-1975

Tolerance

Although the tolerance of glass is specified to be ± 0.4 mm for thickness, and ± 0.5 mm for length and width, tolerances should preferably be specified taking into consideration of thickness, length and width.

For example, the value of the tolerance shall be as follows:

in mm

Thickness	Dimensional Tolerance	
	Thickness	Width & Length
1.9	± 0.2	± 1.5
3	± 0.3	
5		± 2.0

(Note) Productivity of glass assembly may be increased.

JRS (JIS) adopts different tolerance for different thickness, width and length.

SHEET GLASS FOR ROLLING STOCK

JRS 67103-1E

1. Scope

This specification stipulates for the glass applicable to windows, doors, etc., of rolling stock.

2. Dimentional Tolerance

2.1 Dimensional tolerance of plate glass shall be as shown in the following table 1:

Table 1

in mm

Type		Thickness	Tolerance	
			Thickness	Width, Length
Sheet Glass	S 1.9	1.9	± 0.2	± 1.5
	S 3	3	± 0.3	
	S 5	5		± 2.0
	S 6	6		
Polished Plate Glass	P 3	3	+ 0.5 - 0.4	± 1.5
	P 5	5		± 2.0
	P 6	6		
	(P 8)	8	+ 1.0	± 2.5
	(P 12)	12	- 0.9	± 3.0
Ground Sheet Glass	G 3	3	± 0.3	± 1.5
	G 5	5		± 2.0
	G 6	6		

3. Manufacturing Process

3.1 Sheet glass is plate glass manufactured by mechanical drawing method, etc., with a fire-smoothed surface.

3.2 Polished plate glass shall be made from rough plate prepared by roll-out process or equivalent, and be polished both sides, or manufactured by floating process.

3.3 Ground sheet glass shall be sheet glass, one side is delustered by sand grinding, sand blasting, corrosion, or other proper methods.

4. Quality

4.1 Quality of sheet glass shall be as following.

(1) Bubble, Flaw, Inclusion, Knot

(a) Number of the defects shown in the table 2 shall be not more than three in the center part ④ and five at the margin part ⑥ for an arbitrary taken 30 cm square.

(b) Glass shall be free from defects larger than maximum allowable length.

(c) Defects smaller than minimum specified may be allowed, however, collection of such defects shall not affects transparency.

Table 2

in mm

Types of defects		Defects	
Bubble ①		Center ④ Margin ⑥	5.0 or more and less than 15.0
Flaw	Heavy Flaw ②	Center ④ Margin ⑥	5.0 or more and less than 15.0
	Medium Flaw ②	Center ④ Margin ⑥	10.0 or more and less than 30.0
	Light Flaw ②	Shall be free from such as impede practical use.	
Inclusion ③		0.5 or more and less than 1.5	
knot		0.5 or more and less than 3.0	

(2). Wave, Code: No conspicuous figure by observing from 60 degree direction.

(3). Speck: No such defect as impede actual use exists.

(4). Warp: 0.5% or less.

(5). Chip, Flare: None of their length and width shall be larger than nominal thickness. However, those do not affect usage may be allowed.

(6). Flaw: Nothing allowable.

(7). Defect in edge: Those does not impede actual use may be allowed.

Note: ① Bubble include white bubble.

② The flaws easily caught by a finger nail is assigned as "Heavy flaw", those difficult to be caught by a finger nail as "Medium flaw", those cannot see as "Light flaw".

③ Inclusion includes colored bubble.

④ "Center" is the area surrounded by the oval of which both axis are 2/3 of the each side of the plate glass.

⑤ "Edge" is the portion of the glass within 25 mm from the side.

⑥ "Margin" is the portion other than "Center" and "Edge."

4.2 Quality of polished plate glass shall be as following.

(1) Bubble, Broken bubble, Flaw, Inclusion, Knot

(a) Number of defects shown in the Table 3 shall be not more than three in the center part ④ and five at the margin part ⑥, for an arbitrary taken 30 cm square.

(b) Glass shall be free from defects larger than maximum allowable length.

(c) Defects smaller than minimum specified may be allowed, however, collection of such defects shall not affects transparency.

Table 3

in mm

Types of defects		Defects	
Bubble ①		Center ④	1.0 or more and less than 3.0
		Margin ⑥	1.0 or more and less than 5.0
Broken bubble		Center ④	0.5 or more and less than 1.5
		Margin ⑥	0.5 or more and less than 2.5
Flaw	Heavy Flaw ②	Center ④	5.0 or more and less than 10.0
		Margin ⑥	5.0 or more and less than 20.0
	Medium Flaw	Center ④	10.0 or more and less than
		Margin ⑥	30.0
	Light Flaw ②	Shall be free from such as impede practical use.	
Inclusion ③		0.5 or more and less than 1.5	
Knot		0.5 or more and less than 3.0	

(2). Wave: Objects within 5 m from the glass shall not seen deformed when seeing through 45 deg. angle.

(3). Short Finish: Small spot may be allowed.

(4). Ream: Nothing conspicuous shall be in the center ④ and nothing larger than 100 mm in total length in the margin ⑥.

(5). Warp: 0.3% or less

(6). Edge, Chipping: None of their length and width shall be larger than nominal thickness. However, those do not affect usage may be allowed.

(7). Crack: Nothing allowable.

(8). Defect in edge: Those does not impede actual use may be allowed.

4.3 Ground sheet glass

No place shall be remained unfrozen where objects can be clearly seen through the ground surface. Warp shall be less than 1.0%, and the

glass shall be free from bubbles, inclusion, knots, edge, chippings and cracks which may affect usage.

5. Packing and Marking: The products shall be packed with proper buffer material in a box, on which name of the products, their dimension, manufacturer's name or its abbreviation, and the number of panes contained in a box shall be indicated.

Tolerance

Definite criteria for the quality should preferably be established.

The standard shall be as following:
Quality of sheet glass shall be as follows:

(1) Bubble, Flaw, Inclusion, Knot

(a) Number of the defects shown in the table shall be not more than three in the center part and five at the surrounding for an arbitrarily taken 30 cm square.

(b) Glass shall be free from defects larger than maximum allowable length shown in the table 4.

(c) Defects smaller than minimum specified may be allowed, however, collection of such defects shall not affects transparency.

Table 4

in mm

Types of defects		Defects	
Bubble		Center Surrounding	5.0 or more and less than 15.0
Flaw	Heavy Flaw	Center Surrounding	5.0 or more and less than 15.0
	Medium Flaw	Center Surrounding	10.0 or more and less than 30.0
	Light Flaw	Shall be free from such as impede practical use.	
Inclusion		0.5 or more and less than 1.5	
Knot		0.5 or more and less than 3.0	

(2). Code, Wave: To be free from recognizable ones on the surface of the sheet glass when observed at an angle of 60 degrees with its surface.

(3). Speck: No such defect as impede actual use exists.

(4). Warp: Within 0.5%.

(5). Chip, Flare: None of their length and width shall be larger than nominal thickness. However, those chips and flares which do not affect usage may be allowed.

(6). Flaw: Nothing allowable.

(7). Defect in periphery: Unless impede actual service, it may be allowed.

(note) Improvement of quality is expected by introducing the above mentioned criteria.