Myanma Railways,
Ministry of Transport and Communications,
The Republic of the Union of Myanmar

Data Collection Survey on Maintenance on Rolling-Stock in the Republic of the Union of Myanmar

Final Report

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Abbreviations and Terminology

Abbreviation	Terminology
DEMU	Diesel Electric Multiple Unit
DL	Diesel Locomotive
DRC	Diesel Railway Car (name of the depot in Yangon)
JICA	Japan International Cooperation Agency
JR	Japan Railways
JR Central	Central Japan Railway Company
JR East	East Japan Railway Company
JR Hokkaido	Hokkaido Railway Company
JR Shikoku	Shikoku Railway Company
JR West	West Japan Railway Company
K	Kyat (currency in Myanmar)
LE-Car	Light Economy Car
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MM	Man-Month
MR	Myanma Railways
ODA	Official Development Assistance
OJT	On-the-Job Training
PC	Passenger Coach
RBE	Rail Bus Engine

Exchange rate applied to this report

1 USD	=	105.44 JPY
1 MMK	=	0.08989 JPY

Source: Monthly exchange rate as of August 2016 shown on the JICA website

0 Purpose of this survey

Myanmar's railroad network extends over a total distance of 6,073km (as of March 2015) and all routes are being managed and operated by Myanmar Railways (MR). Those routes are not electrified yet and diesel railcars and diesel locomotives are primarily used. There are 249 Japan-made used rail bus engines (RBE) as of June 2016 that have been introduced since 2003 by the transfer, purchase or any other way from Japan's railway business operators and are supporting Myanmar's passenger transport. Since 1988, MR has spent most of their investment on the railroad sector for the entire Myanmar for the construction of new lines; and the maintenance and renewal of existing routes and equipment have been insufficient. Due to the lack of appropriate maintenance, approximately 40% of the used diesel railcars, introduced from Japan, are currently out of order. Since materials and equipment are insufficient and significantly deteriorated or obsolescent and the maintenance setup at MR is inappropriate and poorly organized, as shown above, 339 derailment and collision accidents occurred in 2012, resulting in a decrease in the service level due to a decreased train travel speed and delays.

On the other hand, the number of railroad passengers is increasing due to the vitalized economy resulting from the democratization. And the traffic congestion is becoming more serious in Yangon owing to the alleviated restriction on the import of automobiles that started in 2011. For those reasons, the enhancement of railroad transport capacity is currently drawing attention. To provide the entire nation with a means of transportation and, at the same time, important infrastructure for the economic development for the future, MR is currently renewing and modernizing the railroad equipment, such as the rolling stock, tracks, civil-engineered structures, and signals, in addition to the improvement in the technical level, including the operation service, maintenance capacity and so forth.

To this day, JICA has been cooperating with them for the construction of railroad traffic network in the country in both hardware and software aspects through the "Project on Improvement of Service and Safety of Railway in Myanmar (technical cooperation project)" (May 2013 through March 2016), "Project for Installation of Operation Control Center System and Safety Equipment (grant aid)" (G/A signed in March 2014), "Yangon-Mandalay Railway Improvement Project (phase 1 (1)) (loan)" (L/A signed in September 2014), "Yangon Circular Railway Line Upgrading Project (loan)" (L/A signed October 2015), and so forth. In the "Yangon-Mandalay Railway Improvement Project" and "Yangon Circular Railway Line Upgrading Project", the procurement of additional diesel railcars is scheduled for the purpose of meeting the demand to accommodate further increasing passengers.

Based on the background shown above, the present investigation conducts information collection and analyses on the current state of the diesel railcars owned by MR, as well as the maintenance technology and maintenance management capabilities for Myanmar's railroad rolling stock sector, and then clarifies the problems that MR faces regarding rolling stock maintenance and studies the solution based on the self helping efforts of MR, for the purpose of studying some possibilities of cooperation on them

1 Rolling stock plan

1.1 Policies, measures and existing programs for the rolling stock plan of Myanma Railways

1.1.1 Rolling stock of Myanma Railways

The rolling stock of Myanma Railways primarily consists of four (4) types of vehicles, including diesel locomotives, freight wagons, passenger coaches, and RBEs (rail bus engines). The RBE is a term used at MR for the used diesel multiple unit that was imported into Myanmar after use in Japan. The types of the vehicles and their photos are shown on Table 1-1-1 and Figure 1-1-1. Figure 1-1-2 shows their ages. For reference, the diesel hydraulic locomotive transmits the rotating force of the engine to the wheels by the use of hydraulic transmission to drive the vehicle and the diesel electric locomotive drives the motor by the electricity generated by the engine generator to drive the vehicle.

Table 1-1-1 Types of vehicles owned by MR (as of March 2016)

Vehicle type	Number of vehicles (Unit: Car)	Remarks
Locomotive	368	Diesel hydraulic locomotives: 124 Diesel electric locomotives: 244
Freight wagon	3,384	
Passenger coach	1,357	
RBE	249	Diesel railcars made in Japan

Source: MR and Survey team

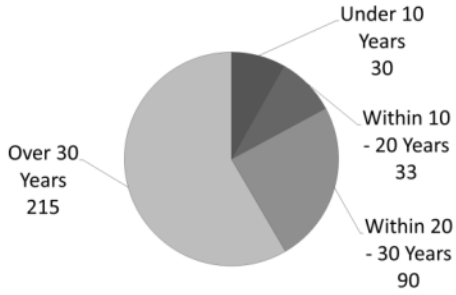
Locomotive

Freight wagon

Passenger coach

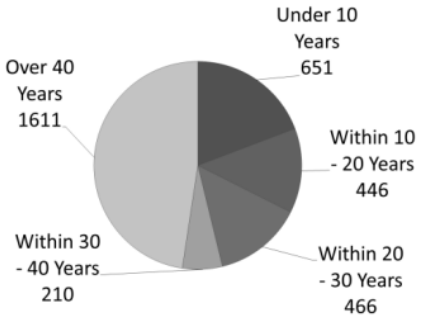
RBE

Figure 1-1-1 Types of vehicles owned by MR

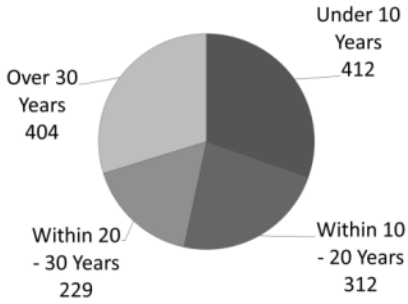


Locomotive (Service life: 30 years)

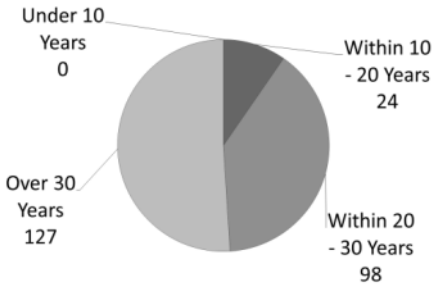
(Unit: Car)



Freight wagon (Service life: 40 years)



Passenger coach (Service life: 30 years)



RBE (Service life: 30 years)

Source: MR and Survey team

Figure 1-1-2 Distribution of vehicle ages by type (as of March 2016)

Figure 1-1-2 shows that many of the vehicles exceed their service lives (normal operable time) regardless of the type. As compared with locomotives and RBEs, passenger coaches and freight wagons have appropriately new and old vehicles and the distribution is less biased. On the other hand, with the locomotives and RBEs, the proportion of vehicles of 20 years or less in age is low. In particular, RBEs were used vehicles at the very beginning, about half of them are more than 30 years old and are generally higher in age than others. Furthermore, while RBEs have been introduced into Myanmar little by little since 2003, only 87 vehicles out of a total of 165 were drivable as of November 2013 as shown on Table 1-1-2, which means only about a half of the vehicles were operative.

Table 1-1-2 Conditions of vehicles owned by MR (as of November 2013)

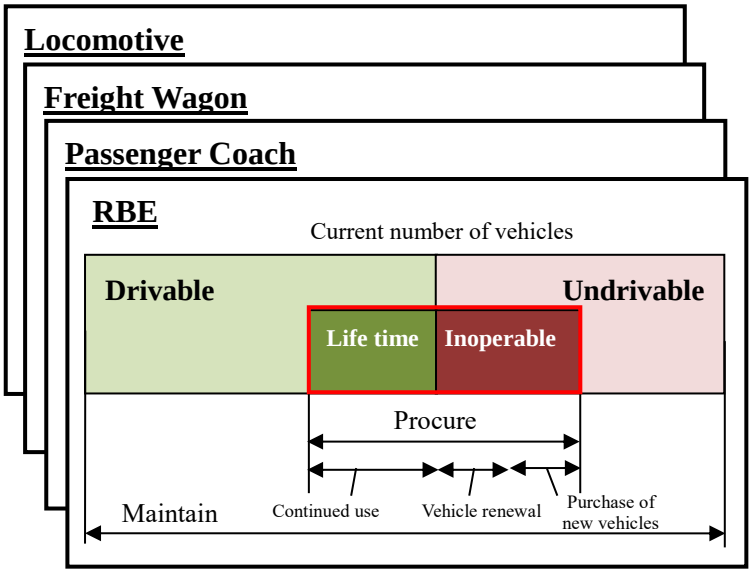
(Unit: Car)

Vehicle type	Total number of vehicles	Drivable	Undrivable	Waiting for deregistration
Locomotive	405	260	145	42
Freight wagon	3,377	2,691	271	253
Passenger coach	1,299	1,123	86	60
RBE	165	87 (52.7%)	78 (47.3%)	0

Source: MR and Survey team

1.1.2 Policies for the rolling stock plan of Myanma Railways

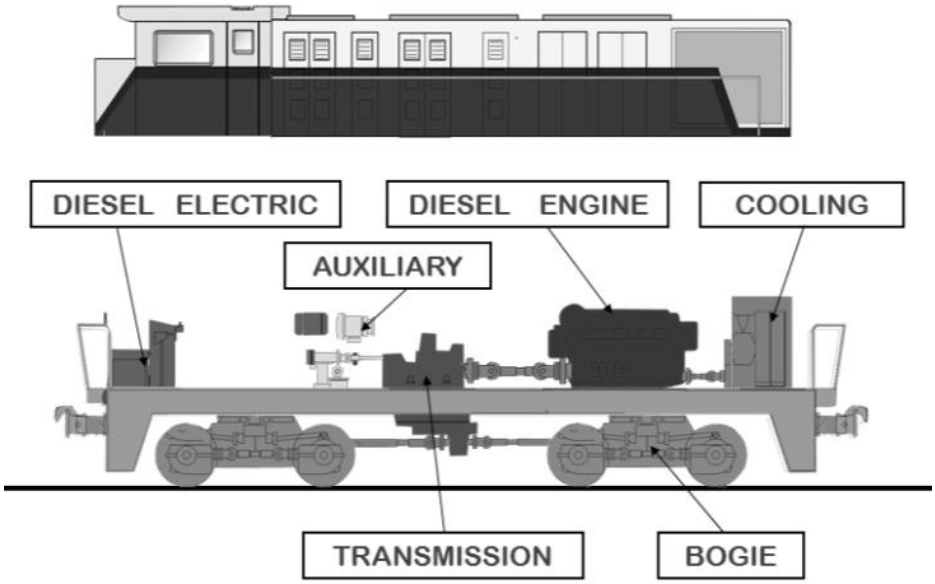
While MR has no middle/long term plan for the procurement of vehicles necessary for the operation of trains, the basic strategy for the vehicles at the Mechanical and Electrical Engineering Department of the MR's Head Office is to maintain the number of vehicles that are currently operating. They develop a plan of procurement of vehicles to make up for those, out of vehicles owned by MR, which exceeded the service life and became inoperable. There are three (3) methods of procuring new vehicles, including the purchase of new vehicles, the renewal of the vehicles and the continued use of the vehicles in excess of the service life (Figure 1-1-3). This strategy of maintaining the currently operating vehicles does not include the idea of procuring the vehicles across the vehicle types and the number of vehicles for each of the vehicle types is simply maintained.



Source: Survey team

Figure 1-1-3 Conceptual representation of the basic strategy of MR's rolling stock plan

The renewal of vehicles consists of repowering or rehabilitation. The repowering is the replacement of the engine and other major drive-related components with new ones and the rehabilitation is the replacement of entire vehicle including the renewal of vehicle interior, not just the drive-related components.



Source: MR's document on the outline of Ywahtaung Workshop

Figure 1-1-4 Construction of a diesel hydraulic locomotive

The selection out of the three (3) measures is significantly affected by the amount of budget approved by the National Assembly. In particular, the purchase of new vehicles is conducted by closing a loan agreement with foreign countries. On the other hand, since the amount of MR budget for the renewal of vehicles is small, those vehicles exceeding the service life still need to be used and, therefore, a lot of failures are occurring due to the effects of obsolescence. For referrence, the service life is generally assumed 30 years for locomotives, 30 years for passenger coaches and 40 years for freight wagons.

1.1.3 Measures and existing programs for the rolling stock plan of Myanma Railways

As the measures for the rolling stock plan, loans are actively used to fund the purchase of new vehicles for the replacement of vehicles exceeding the service life and the following measures are planned.

- Yen loan

Yangon-Mandalay Railway Improvement Project: Introduction of diesel electric multiple units (DEMU)*
-- 24 vehicles in 2020

Yangon Circular Railway Line Upgrading Project: Introduction of diesel electric multiple units (DEMU)
-- 66 vehicles in 2021

* Diesel electric multiple unit (DEMU): A diesel multiple unit that drives the motor by the electricity generated by the engine generator to drive the vehicle.

- Loan from China

Introduction of diesel electric locomotives (DEL) -- 22 vehicles in 2015 - 2016

Introduction of passenger coaches -- 60 vehicles in 2015 - 2016

- Loan from Korea

Introduction of passenger coaches -- 100 vehicles in 2015 - 2016

- Loan from India

Introduction of diesel electric locomotives (DEL)

-- 18 vehicles, time of introduction to be determined (bidding currently in progress)

With RBEs, for the purpose of improving the transport in the urban area of Yangon, the measures of purchasing used vehicles from Japan are carried out making use of MR's limited budget. For the repowering of locomotives, the policy for purchase and replacement of engines is in progress, though the number is limited, by the use of MR's limited budget for replacement.

Table 1-1-3 shows the results of the rolling stock plan for 2015. In reality, despite the execess of the service life, they cannot help using such vehicles without renewal of vehicles and/or replacement with new ones.

Table 1-1-3 Results of the rolling stock plan for 2015

(Unit: Car)

Vehicle type	Locomotive	Freight wagon	Passenger coach	RBE
Total	377	3,395	1,405	234
Deregistered	0	0	0	0
Newly purchased or internally built	18	36	64	74 (used)
Renewed (repowered)	5	0	0	0

Source: MR and Survey team

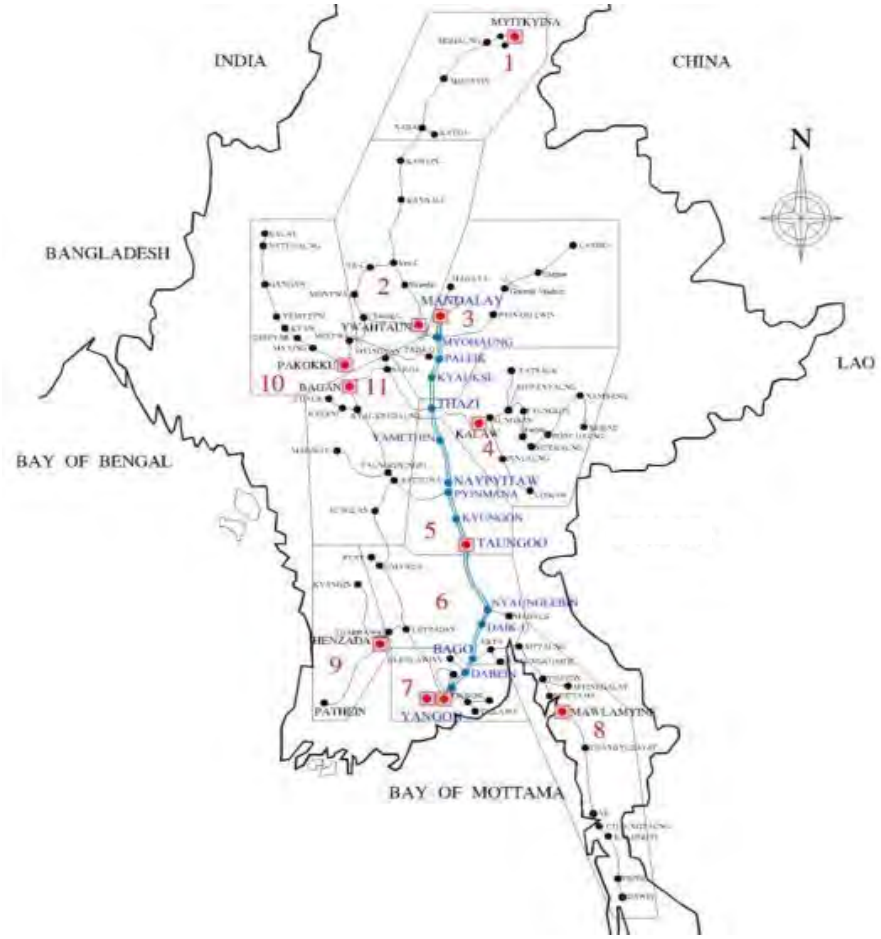
1.2 Setup for the implementation of Myanma Railways' rolling stock plan

Table 1-2-1 shows the major profile of MR and Figure 1-2-1 shows MR's railroad network and organization. As a department responsible for the rolling stock as part of the Head Office, the Mechanical and Electrical Engineering Department develops the plan for the maintenance of the rolling stock and orders. There are two (2) types of major field organizations responsible for the maintenance of vehicles including Workshops and Depots, the former conduct the overhaul of vehicles and the latter the daily maintenance. Workshops are directly controlled by the Head Office and Depots are placed under any of the Divisions that divide the Republic of the Union of Myanmar into eleven (11) regions.

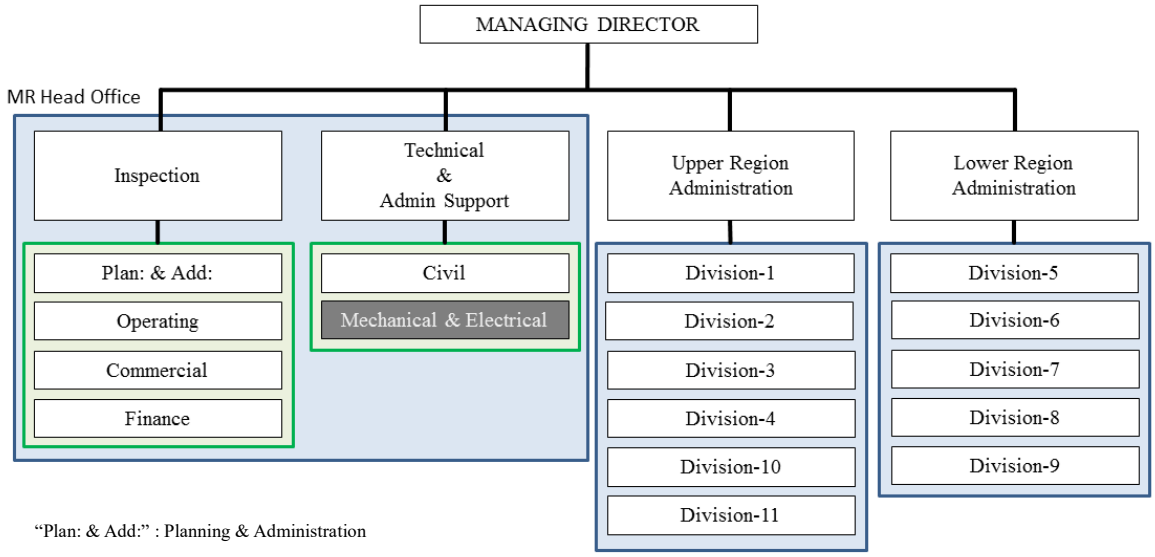
Table 1-2-1 The major profile of MR (as of March 2015)

Number of stations	960
Route length	6,072.5 (km)
Number of staff	20,479
Total number of passengers per year	48.0 (million)
Total number of passenger trains per day	423

Source: MR



MR's railroad network

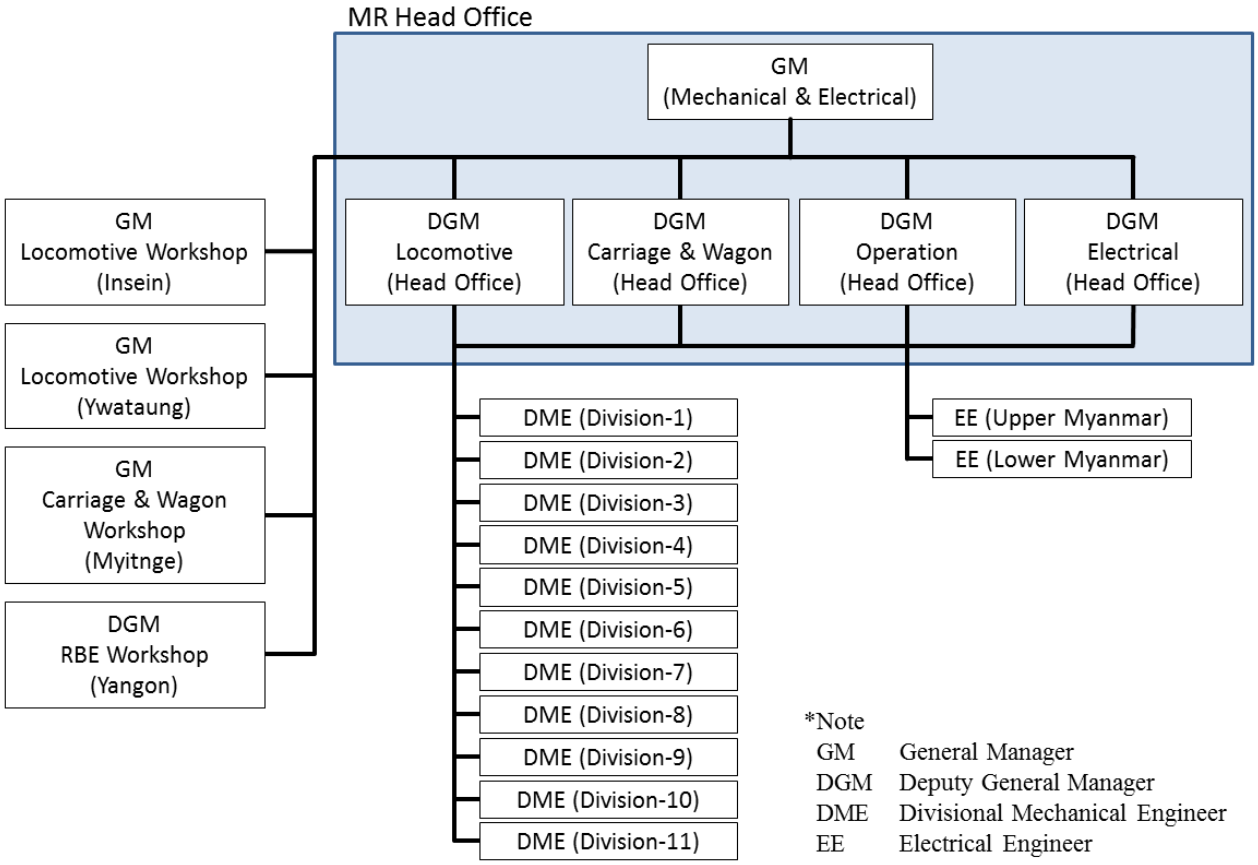


MR's organization

Source: MR and Survey team

Figure 1-2-1 Outline of MR

Figure 1-2-2 shows the organization of the Mechanical and Electrical Engineering Department of the Head Office. Placed under the GM (General Manager), who controls the entire organization, are four DGMs (Deputy General Managers) to control the fields of Locomotive, Carriage & Wagon, Operation, and Electrical. Employees are assigned to each of them to carry out their duties. Actions concerning the workshops that perform the overhaul of vehicles are directly directed by the GM of Mechanical and Electrical Engineering Department to the GMs of Insein Workshop, Ywahtaung Workshop, and Myitnge Workshop and the DGM of RBE Workshop. Since the Depots, which are responsible for the routine maintenance of vehicles, are positioned under the Divisions controlling the individual regions, actions concerning the Depots are directed by the Head Office to the Divisions and then by the Divisions to the Depots.

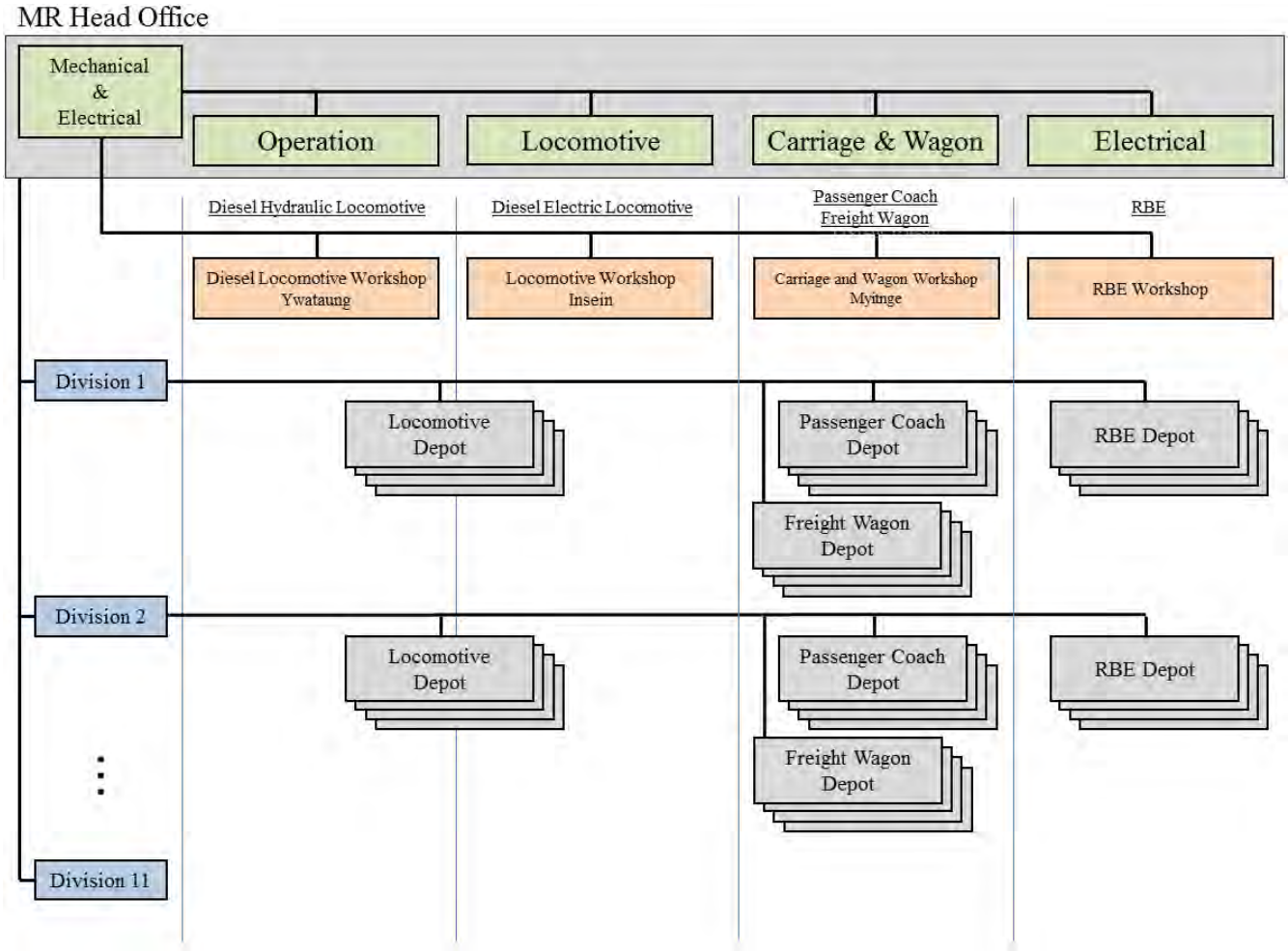


Source: MR and Survey team

Figure 1-2-2 Organization of the MR Head Office's Mechanical and Electrical Engineering Department and relationship with other bodies

Figure 1-2-3 shows the relationships among organizational bodies concerning the management of rolling stock, such as the Head Office, Divisions, Workshops, and Depots. Workshops are divided by the vehicle types, including the diesel hydraulic locomotive, diesel electric locomotive, passenger coach & freight wagon, and RBE. A Depots may be responsible for varying types of vehicles depending on the train set operating on the adjacent routes and may handle multiple vehicle types at times depending on the place. In addition, for each of the vehicle types, the exchange of information and cooperation are made among Head Office's Mechanical and Electrical Engineering Department, Workshops, and Depots.

But, the headcounts and budget for individual organizational bodies or departments are not disclosed.



Source: MR and Survey team

Figure 1-2-3 Organization of MR for the rolling stock management

1.3 Summary of issues on the rolling stock plan and study of proposed improvements

1.3.1 Summary of issues on the procurement policy as part of the rolling stock plan and on the consistency with the long-term plan

Since MR is a national organ, any execution of a large-scale rolling stock plan requires the approval of the National Assembly. At the National Assembly, the approval may be obtained for the plan for the following year and the execution of the plan is conducted in that year. For that reason, the plan may change depending on the administrative policy of the national government. Therefore, MR is not in a position to develop a middle/long-term plan independently on their own. Since the necessary number of vehicles is determined based on the idea of the Mechanical and Electrical Engineering Department providing the vehicles necessary for the operation presented by MR Head Office's Commercial and Marketing Department, there is no clear plan established for the number of vehicles and, therefore, the vehicles become insufficient at times due to unexpected failures of vehicles. They are not procuring or deregistering the vehicles systematically based on future demands and any such factors and do not necessarily have a sufficient capability to develop a rolling stock plan.

In addition, MR takes the policy of relying on loans for the procurement of vehicles and their only long-term plan is the demand prediction-based transportation capacity enhancement measures by the yen loan as part of the "Yangon-Mandalay Railway Improvement Project" and "Yangon Circular Railway Line Upgrading Project". That is because, due to the deficit in the balance of MR, they cannot take the policy of vehicle renewal with the budget of their own and cannot help relying on the loans by foreign aids.

For that reason, in order to develop a rolling stock plan for the improvement of transportation based on the middle/long term demand prediction and to systematically secure budget for assured implementation of the plan, it is necessary to get out of the state of deficit by increasing the revenue and profit through the improvement of convenience and resultant increase in the use of railroad service.

1.3.2 Summary of issues in the rolling stock plan and study of proposed improvements

(1) Current state of the rolling stock plan at MR

The numbers of trains per day operated by MR are as shown on Table 1-3-1. The number of circular trains account for about a half of the MR's total number of trains, indicating the importance of the circular trains to MR.

Table 1-3-1 The number of trains operated by MR (as of January 2016)

Train type		Number of trains (per day)	Remarks
Passenger Train	Express Train	40	
	Mail Train	64	
	Mixed	66	
	Circular Train	225	For Yangon urban area
	Rail Bus	28	For local branch lines
Freight Train		18	
Total		441	

Source: MR and Survey team

Table 1-3-2 shows the number of vehicles by the train type to provide RBEs.

Table 1-3-2 The number of vehicles to provide RBEs (as of June 2016)

Train type	Number of vehicles (Unit: Car)
Express Train	12
Mail Train	30
Circular Train	34
Local Train	10
Total	86

Source: MR and Survey team

And Table 1-3-3 shows the numbers of vehicles deployed by the Mechanical and Electrical Engineering Department to meet that plan.

Table 1-3-3 RBE vehicles actually deployed (as of June 2016)

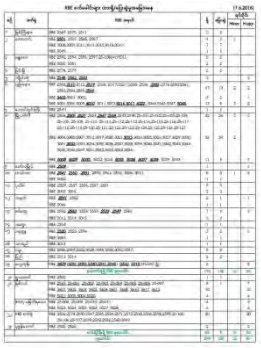
(Unit: Car)

Place of deployment		Total number of vehicles	Vehicles operated	Reserved vehicles	VIP vehicles	Undrivable
Depot	Division 1	3	2	1	0	0
	Division 2	5	4	0	0	1
	Division 3	7	6	1	0	0
	Division 4	4	1	0	0	3
	Division 5	32	12	5	6	9
	Division 6	10	8	1	0	1
	Division 7	103	37	35	4	27
	Division 8	1	0	0	0	1
	Division 9	19	9	4	1	5
	Division 10	4	3	1	0	0
	Division 11	5	4	1	0	0
Workshop		56	0	0	1	55
Total		249	86	49	12	102

Source: MR and Survey team

Table 1-3-3 indicates that the vehicles used for the operation are deployed at Depots, instead of Workshops. It also indicates that reserved vehicles are deployed at individual Depots. Division 7, which controls Yangon suburban area, has Insein DRC Depot. Since those vehicles finished with the overhaul or modification work at RBE Workshop, which is responsible for the overhaul of RBEs, are sent to Insein DRC Depot upon completion and considered to be reserved vehicles, the number of reserved vehicles is large. In addition, many reserved vehicles are deployed in the division which has many vehicles operated in preparation for any unexpected occurrence of inability to drive.

Deploying the vehicles for the train operation is conducted by the procedure shown on Figure 1-3-1.

I. Preparing the train operation schedule	In revising the operation plan, head office prepares a train operation schedule that shows the number of vehicles for each train. 1. Head Office's Commercial and Marketing Department reports the vehicle types and numbers of vehicles in consideration of the "demand", "revenue", and "purpose of train". 2. Based on the report, Head Office's Operating Department judges if the operation is feasible or not. 3. Head Office's Mechanical and Electrical Engineering Department determines if the vehicles are available or not. 4. Head Office's Commercial and Marketing Department develops the train operation schedule.	 Train operation schedule
II. Determining the vehicle deployment	Based on the train operation schedule, Head Office's Mechanical and Electrical Engineering Department determines the destinations of vehicle deployment to suit the conditions of the operation section and to reserve vehicles to respective depots.	 Vehicles deployment table
III. Vehicle operation	Based on the train operation schedule, individual Depots use the vehicles so deployed for the operation of trains.	 Depot operation table

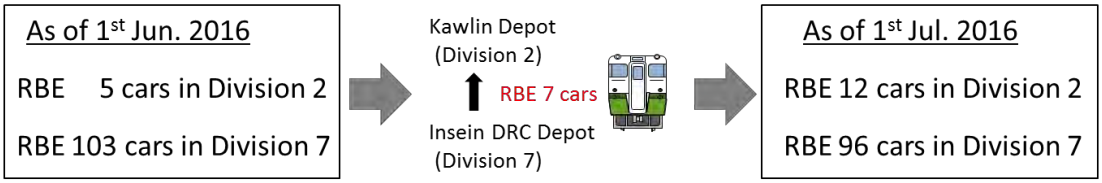
Source: MR and Survey team

Figure 1-3-1 Procedure for deploying vehicles for the operation of trains

The following two (2) points are concretely planned about the future rolling stock plan in terms of RBEs.

- Trains added anew starting July 1, 2016 between Mandalay and Kawlin

  With the total number of vehicles kept unchanged, reserved vehicles are used for the operation with two (2) trains each consisting of three (3) cars. Therefore, as shown on Figure 1-3-2, seven (7) RBEs including one (1) RBE for being reserved will be transfered from Division 7 to Division 2.

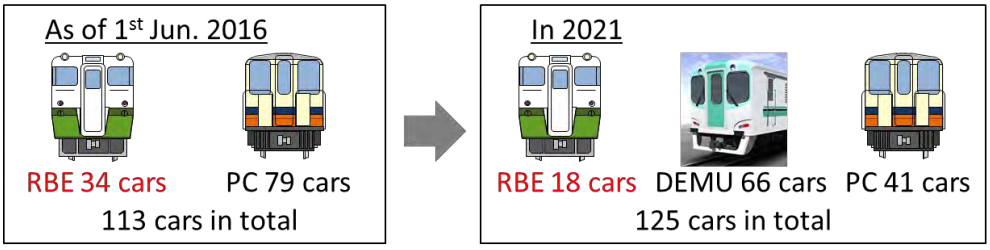


Source: Survey Team

Figure 1-3-2 Conceptual representation of the transfer of vehicles arising from the addition of trains between Mandalay and Kawlin

- DEMU introduced starting 2021 with the implementation of Yangon Circular Railway Line Upgrading Project

  The number of vehicles used for the trains in Yangon urban area (including Yangon Circular Railway and the suburban lines) will be changed as shown on Figure 1-3-3 on the assumption that DEMUs and RBEs will be introduced for all trains on Yangon Circular Railway, which are planned to be operated by 84 cars, and that passenger coachs hauled by locomotives will be introduced for other trains. Then the number of operated RBE vehicles will be decreased by 16.



"PC": Passenger coach

Source: Survey Team

Figure 1-3-3 Conceptual representation of change of the number of vehicles used for the trains in Yangon urban area

As a pre-condition for those actions to be implemented as planned, it is necessary that the RBEs used be maintained in sound conditions at all times. With the measures taken so far, despite any development of a plan in accordance with the number of drivable vehicles, some of the vehicles have been made inoperable at times by unexpected occurrence of vehicle failures, resulting in the suspension of such measures. For that reason, it is important to take measures (enhancement in the maintenance setup, increased service life by

the implementation of repowering work, etc.) for reducing the probability of RBE vehicles becoming undrivable due to any unexpected failure to secure the stably drivable vehicles.

(2) Failure prediction of RBEs

The plan for possession of RBEs is developed based on the conceptual diagram shown on Figure 1-1-3. Based on this concept, the changes in the RBE vehicle conditions are predicted to work out the RBE procurement plan as part of the RBE future plan. When working out the plan, the following preconditions are assumed.

- Assume that the total number of RBE vehicles stays unchanged from that of June 2016. Since the future situations for Japan's used diesel multiple units are unknown, also assume that there will be no import of RBEs.
- Define the proportion of the number of undrivable vehicles against the total number of RBE operating vehicles as the failure rate. The operating vehicles only include vehicles that have actually been used for passenger operation and exclude a total of 33 vehicles, including VIP vehicles, Kiha 183 Series, and vehicles being serviced before the operation.
  (Since Kiha 183 Series vehicles have a high vehicle height, causing accidental contact to some structure on MR's routes, they have not been used for the operation.)
- Assuming that the RBE failure rates for the years elapsed after import stay the same for the future, predict the future vehicle conditions.
- Assume that the necessary number of RBE vehicles for the future is the same as the drivable number of vehicles out of operating vehicles as of June 2016. However, reflect the decrease in the number of necessary RBE vehicles as a result of the introduction of DEMUs by the "Yangon Circular Railway Line Upgrading Project" that is identified in the long-term plan.

By the calculation of the failure rates for the present RBEs for the years elapsed after import based on such conditions, the results are obtained as shown on Table 1-3-4 and Figure 1-3-4. The failure rates worked out include, besides actual failure rates, values smoothed (moving-averaged) for the changes caused by the years elapsed after import. From the table, it is understood that the failure rates increase beyond five (5) years after arrival in Myanmar. It is estimated that the wear or deterioration of some parts make an apparent impact on the failure in such term.

Table 1-3-5 shows the numbers of undrivable vehicles for the future and deficiencies occurring therefrom worked out from the table. According to the results, the RBE vehicles start being deficient in 2017 and, in 2021 when the DEMUs are to be introduced to the Yangon Circular Railway Line, as many as 54 RBE vehicles will be deficient. In that case, trains consisting of a locomotive and passenger coaches need to be left uneliminated and, therefore, the effects of introducing DEMUs by the "Yangon Circular Railway Line Upgrading Project" may become limited.

Table 1-3-4 Current state of the number of RBE vehicles (as of June 2016)

Years elapsed after import	Year of import	Number of operating vehicles (Unit: Car)	Vehicle conditions		Failure rate	
			Drivable (Unit: Car)	Undrivable (Unit: Car)	Actual failure rate	Moving average
Less than 1 year	2016	9	9	0	0%	-
1-2 years	2015	62	58	4	6.5%	-
2-3 years	2014	21	16	5	23.8%	15.1%
3-4 years	2013	0	0	0	0%	15.1%
4-5 years	2012	35	17	18	51.4%	37.6%
5-6 years	2011	11	5	6	54.5%	53.0%
6-7 years	2010	6	2	4	66.7%	57.5%
7-8 years	2009	0	0	0	0%	60.6%
8-9 years	2008	36	14	22	61.1%	63.9%
9-10 years	2007	13	5	8	61.5%	61.3%
10-11 years	2006	10	5	5	50.0%	57.5%
11-12 years	2005	18	3	15	83.3%	65.0%
12-13 years	2004	5	1	4	80.0%	71.1%
13-14 years	2003	1	0	1	100.0%	87.8%
Total		227	135	92		

Source: MR and Survey team

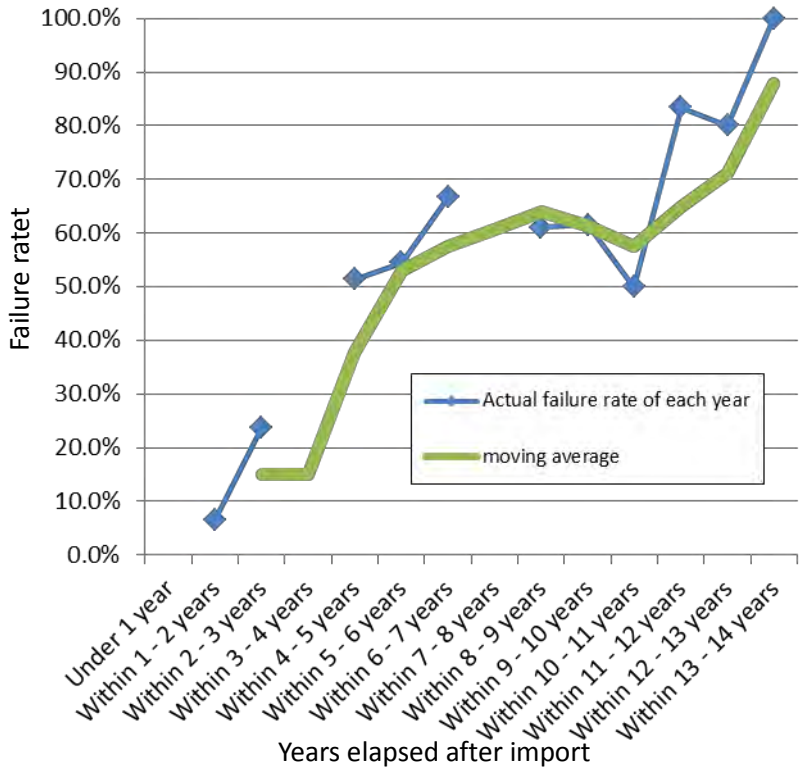


Figure 1-3-4 Actual failure rates of RBEs for years elapsed after import and their moving averages

Table 1-3-5 Predicted numbers of undrivable vehicles and deficient vehicles for the future

(Unit: Car)

Year	Total number of operating vehicles	Number of vehicles required	Number of drivable vehicles	Number of undrivable vehicles	Number of deficient vehicles	Remarks
2016	227	135	135	92	0	Actual number as of Year 2016
2017	227	135	126	101	9	
2018	227	135	115	112	20	
2019	227	135	90	137	45	
2020	227	135	74	153	61	
2021	227	119	65	162	54	By the introduction of DEMUs to Yangon Circular Railway Line, the necessary number of vehicles decreases by 16.
2022	227	119	60	167	59	
2023	227	119	56	171	63	

Source: Survey team

(3) Summary of issues in the plan of RBEs

As stated above, it is predicted, according to Table 1-3-5, that as many as 54 vehicles will become deficient in 2021. In this situation, where deficiency of vehicles is predicted for the future, measures that can be taken by MR will include: [1] Import of used RBEs from Japan, [2] Purchase of new vehicles, [3] Rehabilitation, and [4] Continued use of vehicles currently owned. We compared the measures from the viewpoints of the amount of investment, systematic investment, degree of freedom in determining vehicle specifications, and service life after investment. Table 1-3-6 shows the results.

Table 1-3-6 Comparison of measures against future deficiency of vehicles

Measure	Investment cost	Well-planned investment	Degree of freedom in determining vehicle specifications	Service life after investment
[1] Import of used RBEs from Japan	Small	Not possible	None	Short (approx. 2-5 years)
[2] Purchase of new vehicles	Large	Possible	Large	Long (approx. 30 years)
[3] Rehabilitation	Medium	Possible	Medium	Medium (approx. 10 years)
[4] Continued use of owned vehicles	None	Possible	None	Short (approx. 1-2 years)

Source: Survey team

- Investment cost

  Since “[4] Continued use of owned vehicles” does not involve any additional investment, it is evaluated “None” for the investment. Since “[2] Purchase of new vehicles” makes all components of vehicles new, it is evaluated “Large” for the investment. Since “[3] Rehabilitation” renews some of vehicle parts, it requires less investment than “[2] Purchase of new vehicles”, which involves the purchase of all parts and fabrication of vehicle bodies, although the evaluation depends on the scope of the affected parts. With “[1] Import of used RBEs from Japan”, if the cooperation of railway operators in Japan is obtained, the cost is limited to the transportation of the vehicles. Therefore, the investment will be smaller than with “[3] Rehabilitation”.

- Well-planned investment

  With “[1] Import of used RBEs from Japan”, since the occurrence of used vehicles depends on the rolling stock plan of railway operators in Japan, it will be difficult for MR to systematically secure the necessary number of vehicles. For that reason, we judged “Not possible” for the systematic investment. With all other measures, MR can plan and implement on their own. Therefore, we judged “Possible” for the systematic investment.

- Degree of freedom in determining vehicle specifications

  Specifications of vehicles should be determined by MR based on the needs of the passengers captured on their own. As a result, it will become possible to offer vehicles desired by the passengers and the resultant increase in the number of passengers will be expected. Therefore, the degree of freedom in the determination of vehicle specifications is also an important factor in the confirmation of the effects of investment.

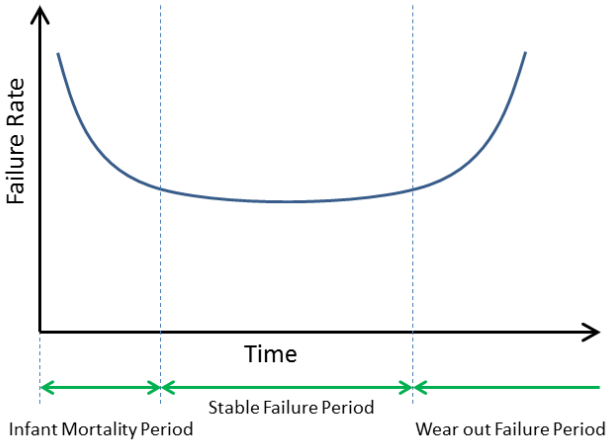
  With “[1] Import of used RBEs from Japan” and “[4] Continued use of owned vehicles”, MR cannot freely determine the specifications. For that reason, they are judged “None” for the degree of freedom. With “[2] Purchase of new vehicles”, since MR can determine the specifications from scratch, the degree of freedom is judged “Large”. Since “[3] Rehabilitation” only partially renews the vehicles, the degree of freedom is lower than with “[2] Purchase of new vehicles”.

- Service life after investment

  It is generally known that, about machines and equipment, the failure rate changes with the elapse of time. The graphical representation of the change in the failure rate looks like a bathtub, as shown on Figure 1-3-5. Hence, it is call a bathtub curve (also known as a failure rate curve). The changes in the failure rate are divided into three periods, including the infant mortality period, stable failure period, and wear-out failure period. In the infant mortality period, the operation is instable at the very beginning as due to the introduction of new technologies and, as the time elapses, the operation becomes stable and the failure rate gradually decreases. In the stable failure period, the operations of

machines and equipment are the most stable and the failure rate stays low at a constant level. In the wear-out failure period, machines and equipment come close to the end of service life and the failure rate gradually increases.

The renewal of machines and equipment has the effect of reversing the elapse of time by renewing the components. It is to bring the machines and equipment in the wear-out failure period back to the stable failure period. For that reason, if the failure rate is tending to increase in the wear-out failure period, it is necessary to plan the renewal of machines and equipment to bring them back to the stable failure period.



Source: Survey team

Figure 1-3-5 Bathtub curve (failure rate curve) for machines and equipment

With RBEs, considering that the vehicle service life is generally about 30 years and that they were more than 20 years old when shipped from Japan, they are considered, at this moment, to be distributed in the latter half of the stable failure period to the first half of the wear-out failure period.

In consideration of the bathtub curve, we made the judgment about their service life. With "[1] Import of used RBEs from Japan", the imported vehicles are more than 20 years old from the time of their fabrication and are distributed in the region from the stable failure period to the wear-out failure period at the time of the import. Therefore, the remaining service life after the introduction to the Republic of the Union of Myanmar is considered short. Actual service life will be 2 years at the shortest and 5 years at the longest. With "[2] Purchase of new vehicles", the service life will be as long as about 30 years. With "[3] Rehabilitation", some of the parts in the wear-out failure period are renewed, it is possible to extend the service life of the relevant parts. But the service life of the vehicle depends on that of the vehicle body and bogies if such vehicle body and bogies are placed out of the scope of the renewal. Therefore, the service life will be shorter than that with "[2] Purchase of new vehicles". Although actual service life will vary depending on the conditions of the vehicle body and bogies, it is considered as being around 10 years. With "[4] Continued use of owned vehicles", since the vehicle is used without doing anything, the service life becomes short, naturally. Actual service life

is considered to be around 1 to 2 years although it depends on the period of use in Japan and that after arrival in Myanmar.

From the comparison shown on Table 1-3-6, for the preventive measures against the future deficiency of vehicles, "[2] Purchase of new vehicles" will be the most effective. To the current MR, however, filling all of the deficient vehicles with new vehicles requires too much investment for the realization. Therefore, "[3] Rehabilitation", which is the second most effective, will be appropriate as a practical measure.

Then, we examine the vehicles to be purchased as new vehicles or to be rehabilitated. Such vehicles are to be selected by comprehensively considering the vehicle age, vehicle conditions, maintainability of vehicle, routes to be used on, and other factors.

- Vehicles age

  In consideration of the trend of change in the vehicle failure rate indicated in the bathtub curve, determine the sequence of renewal by the vehicle age in comparison with the service life of the vehicle.
- Vehicle conditions

  Since, even if the vehicle is aged less, the conditions of the vehicle may vary depending on the using environment, the priority of renewal may be changed based on the vehicle conditions.
- Maintainability of vehicle

  Since, even if a vehicle is good in performance, it may have disadvantages, such as a high maintenance cost, the maintainability may be considered in the determination of the priority of vehicle renewal.
- Routes to be used on

  It is the consideration of the effects of investment on passengers in the judgment. Generally, the routes used by many passengers are given higher priority.

The distribution of weight among the factors varies depending on the thoughts of the railway operator. In case of MR, it is difficult to obtain budget enough to cover all vehicles exceeding the service life. Therefore, considerations must be made to gain the maximum effects with a low investment.

For that reason, as shown in (1), it is desirable to prioritize the investment on vehicles used in Yangon urban area, because a lot of trains are operated there involving a lot of passengers and therefore the consistent transportation can be offered to a lot of passengers.

(4) Study of proposed improvements in the plan of RBEs

Based on the study conducted so far, we propose the following about the rolling stock plan for the future of RBEs.

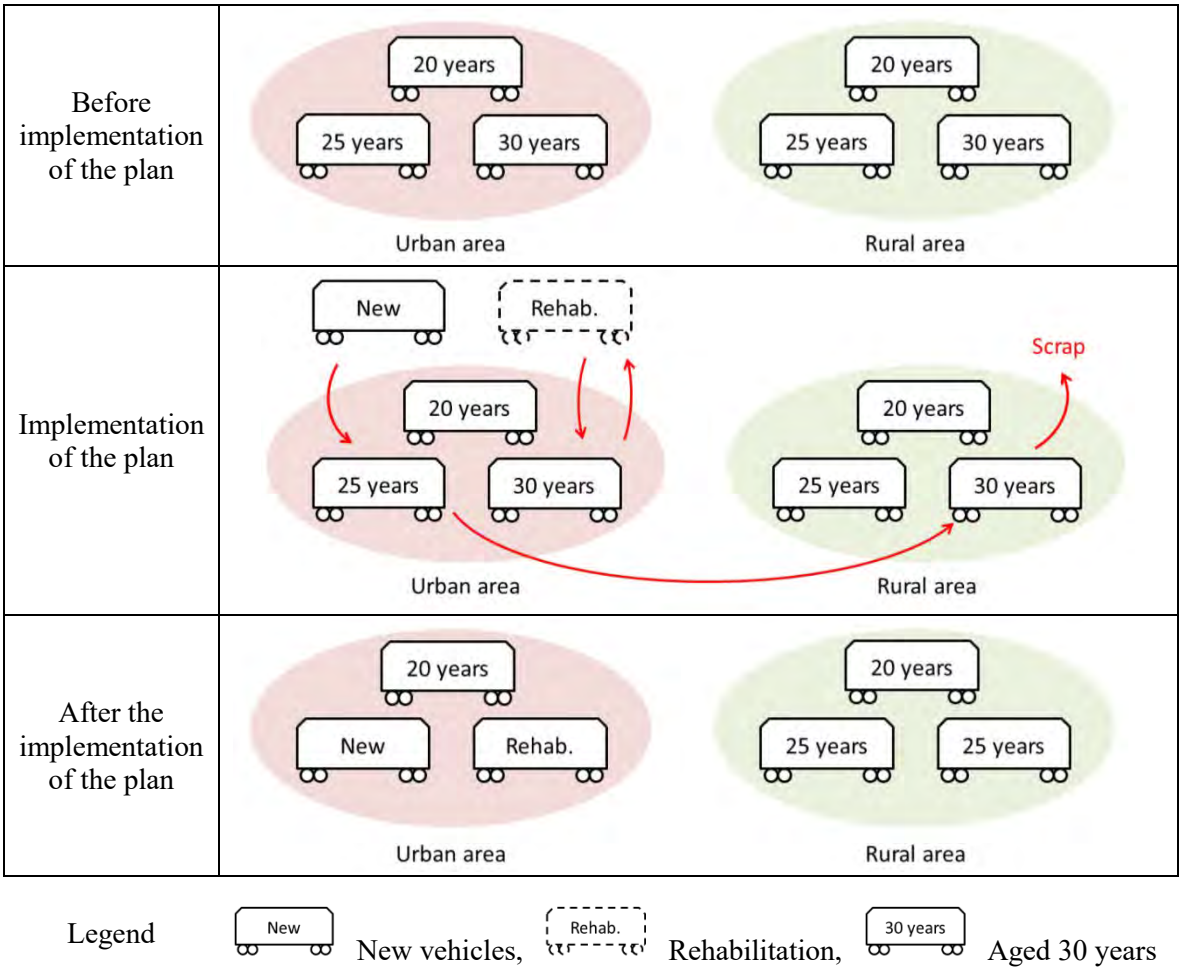
1 By the purchase of new vehicles or rehabilitation of vehicles, increase vehicles that can be used for a long time toward the future to prevent any deficiency in the number of vehicles.

2 Place priority on the deployment of new vehicles or rehabilitated vehicles to Yangon urban area, where there are a lot of passengers.

3 Out of existing vehicles that have been operated in Yangon urban area, use those vehicle on local routes which are relatively less aged, well conditioned and good in maintainability.

4 Deregister those vehicles that exceed the service life and are not in good conditions.

Figure 1-3-6 conceptually illustrate the above-shown rolling stock plan for the future of RBEs. In that way, the conditions of vehicles for the entire MR can be comprehensively improved.



Source: Survey team

Figure 1-3-6 Conceptual representation of the rolling stock plan for the future of RBEs

(5) Summary of issues in the rolling stock plan for Yangon urban area and study of proposed improvements

Based on the study conducted so far, the following proposes the future plan of vehicles for the railway in Yangon urban area.

MR has been working for the improvement of transportation service in order to make the transportation comfortable in Yangon urban area. Concerning the rolling stock, they were operating in the past entirely with trains consisting of a diesel locomotive and passenger coaches. Currently, however, RBEs have been introduced and, as shown on Table 1-3-7, the operation is conducted in Yangon urban area by the use of 6 trains consisting of 5 RBEs and 2 trains consisting of 2 RBEs for a total of 34 RBEs. And they are very popular among the passengers.

Source: MR

Figure 1-3-7 Route map of Yangon urban area

Generally, in the development of railway in the world, a transition occurred from the trains of concentrated traction system to those of distributed traction system to meet the changes in the passenger needs. The former has been used from the the dawn of railroad and the trains used consist of a locomotive and passenger coaches while the latter uses electric cars and/or diesel multiple units that allow large-volume and high-frequency operations. And, with the advancement of technologies, the drive systems have transitioned to those of higher energy efficiency from, for example, the steam engines to internal combustion engines and to electric motors. The railway in Yangon urban area has started to follow that route.

To meet the demands of passengers, MR should work hard for the improvement of transportation service. Therefore, with limited budget, to offer comfortable transportation service to a larger number of passengers, it will be effective to invest on the railway of Yangon urban area that has a large number of passengers.

Table 1-3-7 Basic operation of vehicles belonging to Insein DRC Depot

(As of June 2016)

Operation number	Train set	Major operating section
1,2,3,5,6,7	5-RBE train	Yangon Circular Railway Line
4,8,9,10,11,12,13	1 locomotive + 6 passenger coaches	
R1	1 locomotive + 3 passenger coaches	Branch lines in Yangon suburban area
R2	1 locomotive + 4 passenger coaches	
R3	1 locomotive + 5 passenger coaches	
R4, R5	2-RBE train	
R6	1 locomotive + 4 passenger coaches	
R7	1 locomotive + 2 passenger coaches	

Vehicles used: 12 locomotives, 60 passenger coaches, and 34 RBEs for total of 106 vehicles

Source: Survey team

Concerning the future plan on the railway of Yangon urban area, it is planned that diesel electric multiple units (DEMUs) be introduced as part of "Yangon-Mandalay Railway Improvement Project" and "Yangon Circular Railway Line Upgrading Project" by the use of yen loan from Japan. In particular, a total of 66 DEMUs are to be introduced to Yangon Circular Railway Line starting 2021 for 11 trains comprising 6 vehicles. However, it is not possible to replace all trains of Yangon Circular Railway Line with those of DEMUs and existing RBEs will be used for some of the trains.

From all that, the preconditions for the development of the middle/long-term plan may be summarized as shown below.

- In the future, it is anticipated that RBE vehicles become undrivable due to failures, causing significant shortage in the number of vehicles.
- Replace trains comprising a locomotive and passenger coaches with those of RBEs.
- After the introduction of 66 new DEMU vehicles in 2021, replace RBE trains with those of DEMUs.

Based on all such conditions, the procurement of vehicles for the railway of Yangon urban area in the following way.

- Until the introduction of DEMUs
  - In Yangon urban area, replace vehicles that need to be renewed.
  - Making use of the RBE vehicles obtained by the replacement, replace vehicles that need to be renewed in local areas.
  - Since, in 2018 and beyond, the number RBE vehicles procured reaches 40, exceeding 39 vehicles that are used in Yangon urban area, replace vehicles that need to be renewed in local areas.
- After the introduction of DEMUs

- In Yangon urban area, replace vehicles that need to be renewed.
- Unify the trains of Yangon urban area to the distributed traction type of DEMU vehicles and RBE vehicles.
- Making use of the RBE vehicles obtained by the replacement, replace vehicles that need to be renewed in local areas.

All of the above are summarized as shown on Table 1-3-8 and Table 1-3-9. Table 1-3-8 illustrates a specific rolling stock plan for the procurement of RBE vehicles developed based on the current operation in Yangon urban area that planned in "Yangon Circular Railway Line Upgrading Project". And Table 1-3-9 shows total RBE vehicles for the case of implementing the plan shown on Table 1-3-8.

In this plan, 61 cars of the deficiency because of failure will be compensated until 2020, 34 cars of those will be provided for Yangon urban area. In 2021, the total amount of the compensation from 2016 to 2021 will be 67 cars. If the train consisting of the locomotive and passenger carriages will be abolished in Yangon urban area and replaced by RBE, 40 cars of RBE for replacement will be required. Therefore, 40 cars out of compensated 67 cars will be used in Yangon urban area and rest of 27 cars will be used for local area. In 2021, it is expected the number of the runners of RBE that are available at present will be 68 out of 135 and 68 cars will be used for local area. As a result, the total number of RBE for local area will be 95 considering that 27 cars out of 67 compensated cars.

In this proposed middle/long-term plan, the "Yangon Circular Railway Line Upgrading Project" will complete in 2021, changing the operation system of the Yangon Circular Railway Line and, with the introduction of DEMUs, significantly advancing the transportation service in Yangon urban area. Taking advantage of this opportunity, the trains comprising a locomotive and passenger coaches, which are running in Yangon urban area, are to be replaced to RBEs. By such replacement, switching of trains at the train starting stations and terminals for the purpose of changing the locomotives will not be necessary any more, providing benefits as of improved efficiency.

Table 1-3-8 Middle/long-term plan as proposed for study (Insein DRC Depot)

Item		2017	2018	2019	2020	2021	
Predicted undrivables (RBE-N)		9	20	45	61	54	Cumulative from 2017
Vehicles procured (RBE-S)		9	11	25	16	6	Vehicles to be procured based on Table 1-3-5
Operation number	Train set (as of March 2016)	2017	2018	2019	2020	2021	Major operating route
1	5-RBE train	**RBE-S**	**RBE-S**	**RBE-S**	**RBE-S**	**6 DEMU**	Yangon Circular Railway Line
2	5-RBE train	**4 RBE-S** 1 RBE-N	**RBE-S**	**RBE-S**	**RBE-S**	**6 DEMU**	
3	5-RBE train	RBE-N	**RBE-S**	**RBE-S**	**RBE-S**	**6 DEMU**	
4	1 Loco + 6 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**6 DEMU**	
5	5-RBE train	RBE-N	**RBE-S**	**RBE-S**	**RBE-S**	**6 DEMU**	
6	5-RBE train	RBE-N	RBE-N	**RBE-S**	**RBE-S**	**6 DEMU**	
7	5-RBE train	RBE-N	RBE-N	**RBE-S**	**RBE-S**	**6 DEMU**	
8	1 Loco + 6 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**6 DEMU**	
9	1 Loco + 6 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**6 DEMU**	
10	1 Loco + 6 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**6 DEMU**	
11	1 Loco + 6 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**6 DEMU**	
12	1 Loco + 6 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**6 RBE-S**	
13	1 Loco + 6 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**6 RBE-S**	
(Added)	-	-	-	-	-	**6 RBE-S**	
R1	1 Loco + 3 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**3 RBE-S**	Branch lines in Yangon suburban area
R2	1 Loco + 4 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**4 RBE-S**	
R3	1 Loco + 5 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**5 RBE-S**	
R4	2-RBE-N train	RBE-N	RBE-N	**RBE-S**	**RBE-S**	**2 RBE-S**	
R5	2-RBE-N train	RBE-N	RBE-N	**RBE-S**	**RBE-S**	**2 RBE-S**	
R6	1 Loco + 4 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**4 RBE-S**	
R7	1 Loco + 2 PC	Loco+PC	Loco+PC	Loco+PC	Loco+PC	**2 RBE-S**	
Local	RBE	101 RBE-N	101 RBE-N	**11 RBE-S** 90 RBE-N	**27 RBE-S** 74 RBE-N	**27 RBE-S** 68 RBE-N	Local lines

* Loco: locomotive; PC: passenger coaches;

RBE-N: RBEs owned as of June 2016; RBE-S: RBEs to be procured in 2017 and beyond

* Replaced vehicles are shown in **bold** letters.

* Those vehicles obtained by the replacement are to be used for the replacement of decrepit vehicles in local areas.

Source: MR and Survey team

Table 1-3-9 Numbers of vehicles for the case of the middle/long-term plan implemented

(Unit: Car)

Area	Type of vehicles	As of June 2016	2017	2018	2019	2020	2021
Yangon urban area	Loco	12	12	12	12	12	0
(Insein DRC Depot)	PC	60	60	60	60	60	0
	RBE total	34	34	34	34	34	40
	RBE-N	34	25	14	0	0	0
	RBE-S	0	9	20	34	34	40
	DEMU	0	0	0	0	0	66
Other	RBE total	101	101	101	101	101	79
	RBE-N	101	101	101	90	74	65
	RBE-S	0	0	0	11	27	14
Entire Myanmar	RBE total	135	135	135	135	135	119
	RBE-N	135	126	115	90	74	65
	RBE-S	0	9	20	45	61	54

* Loco: locomotive; PC: passenger coaches;

RBE-N: RBEs owned as of June 2016 RBE-S: RBEs to be procured in 2016 and beyond

Source: MR and Survey team

2 Identification of RBE failure causes

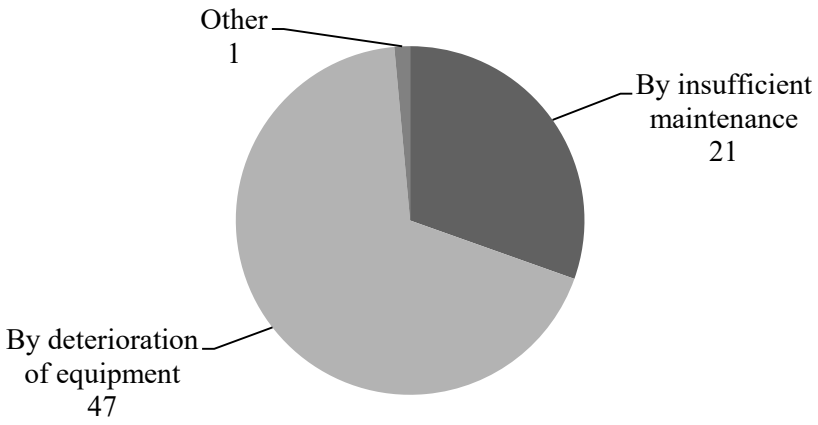
2.1 Classification of RBE failure causes

Using the only data that we could obtain about RBE failures that occurred in the period of August 2013 through July 2014, we analyzed the failure causes.

During that period, a total of 69 failures occurred with RBEs. As a result of the analysis, the failure causes may be classified into two (2) major types.

- Failure caused by insufficient maintenance
- Failure caused by deterioration of equipment

It should be noted that the failure records provided for analysis are mostly the descriptions of vehicle conditions after the occurrence of failures. Therefore, details of non-vehicle factors (railway track conditions, weather, obstacles, etc.) are unknown.



Source: MR and Survey team

Figure 2-1-1 Number of failures by cause

In addition, by the use of the vehicle profile survey and hearing of MR conducted this time, the following causes have been identified.

- Despite the maintenance work conducted, failure occurred due to replacement of mismatching part and/or treatment.
- Collided with something, resulting in the failure of equipment.

2.2 Study of solutions to RBE failures

This section analyzed each of the causes by the use of specific examples. However, since the data that MR owns are about the failed conditions and remedial measures taken alone and are insufficient for the analysis, the analysis include conjecture based on records collected in Japan. The only event that is not attributable to vehicle maintenance, including the deterioration of equipment, is “Collided with something, resulting in the failure of equipment”. Besides that, any non-vehicle factor is unknown.

- Insufficient maintenance
  - Clogged filter caused overheat, resulting in a failure (Figure 2-2-1).
    Filter was insufficiently cleaned.
  - By the wear of engine cylinders, combustion gas leaked, causing a blowby.
    The gap management at the engine cylinders was insufficient.
  - Compressed air blew out from the safety relief valve.
    Pressure regulator failed or was maladjusted.
  - The engine failed to start due to the clogged fuel supply pipe.
    Filter was insufficiently cleaned.

Clogged filter (cause of overheat)
Source: Survey team
Figure 2-2-1 Example of insufficient maintenance

Potential causes of the insufficient maintenance will include: improper inspection system, unclear standards and methods of inspection for the inspection items, insufficient jigs for the maintenance and so forth.

Possible solutions to such causes will be as shown below.

- Re-examine the inspection system.
- Define the inspection standard values.
- Establish the inspection methods.
- Develop jigs for the maintenance.

- Incorrect methods of maintenance
  - The cooling water piping corroded inside the engine and perforated, causing inclusion of water in lubrication oil.

    Cooling water contains no rust inhibitor.
  - The exhaust pipe is kinked, hampering smooth exhaust of gas (Figure 2-2-2).

    The exhaust pipe is defectively mounted.

Kinked exhaust pipe

Source: Survey team

Figure 2-2-2 Example of incorrect maintenance method

Potential causes of incorrect maintenance methods will include: unclear standards and methods of inspection for the inspection items, insufficient procurement of necessary materials due to budget shortage, insufficient training of workers and so forth.

Possible solutions to such causes will be as shown below.

- Define the inspection standard values.
- Establish the inspection methods.
- Obtain budget sufficient for the procurement of materials necessary for the maintenance.
- Enhance the training of workers and the training framework

- Deterioration of equipment
  - The engine intake and exhaust valves cracked and, by the heat of over-combustion, the cylinder head deformed (Figure 2-2-3).

    The service life for the mechanical functions of the intake and exhaust valves and cylinder head is exceeded.
  - The piston connecting rod came off, breaking through the cover (Figure 2-2-3).

    The service life for the mechanical functions of the connecting rod is exceeded.
  - Coupler came off due to a crush of threads.

    Coupler exceeded the wear limit.

Engine intake and exhaust valves broken

Piston connecting rod breaking through the cover after coming off

Source: Survey team

Figure 2-2-3 Examples of deteriorated equipment

Potential causes of the equipment deterioration will include: inappropriate inspection system, unclear standards and methods of inspection for the inspection items, insufficient procurement of necessary parts due to budget shortage, and so forth.

Possible solutions to such causes will be as shown below.

- Re-examine the inspection system.
- Define the inspection standard values.
- Establish the inspection methods.
- Obtain budget for the procurement of parts necessary for the replacement of deteriorated parts.

- Collision of equipment
  - Equipment under the vehicle floor collided with something and deformed (Figure 2-2-4).

Equipment deformed as a result of collision

Source: Survey team

Figure 2-2-4 Example of equipment collision

Collisions into the underfloor equipment of RBE are usually attributable to the presence of obstacles on the track. However, it is also possible that the collision occurred due to the swaying motions of the vehicle caused by bad conditions of MR's railway track, as shown on Figure 2-2-5.

Possible solutions to such causes will be as shown below.

- Enhance the maintenance of railway tracks.

Generally, the events that are not attributable to vehicle maintenance and are highly likely to cause vehicles failures (including accidents) include: derailment by unusual shake of vehicle, derailment by excessive speed at a curve, collision due to violation of signal, etc.

Possible solutions to such causes will be as shown below.

- Enhance the maintenance of railway tracks.
- Enhance the management of curved tracks.
- Enhance the actions against any human error on the handling of signals.

Track conditions (Yangon Circular Railway)

Vehicle significantly swaying

Source: Survey team

Figure 2-2-5 Track conditions of MR

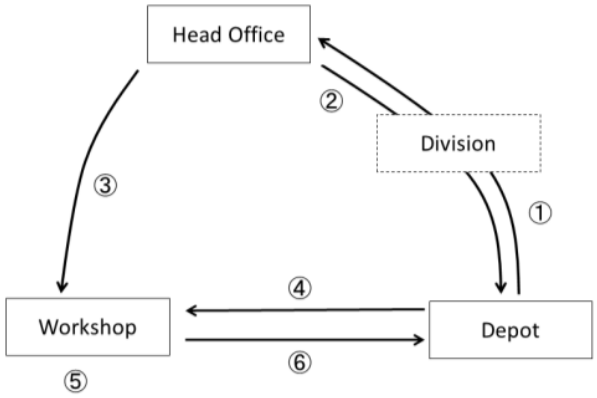
3. Maintenance of RBEs

3.1 Maintenance setup on RBEs

3.1.1 Chain of command

In vehicle-related operations, MR's Head Office gives directions to Workshops and Depots but the Workshops do not directly give directions to Depots. In the case where, for example, a problem has occurred in a Workshop with a vehicle, requiring a large amount of repair cost, the Head Office is supposed to make the decision on the repair and release permission of repair to the Workshop (Figure 3-1-1).

Since, with this chain of command, the repair is performed only after the receipt of direction from the Head Office, the prompt restoration of vehicle cannot be expected, potentially resulting in the reduction in the number of vehicles on trains or suspension of service and causing reduction in passenger service. As a result, the reputation of railway will inevitably be damaged, leading to decrease in the number of passengers and the revenue. Furthermore, since it takes time to restore the vehicle, reserved vehicles must be made available for an extended period of time. For that reason, to ensure a high availability of vehicles, the maintenance setup should be established to allow prompt actions upon any occurrence of vehicles failure.



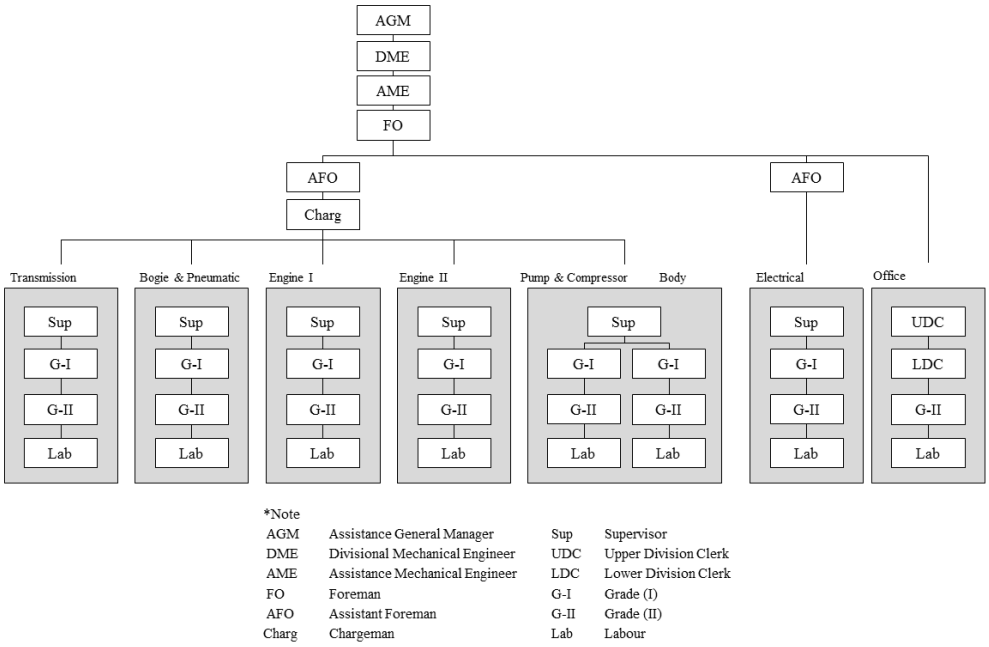
Step	Action
[1]	Report of failure
[2]	Permission to repair
[3]	Direction to repair
[4]	Shipment of failed vehicle
[5]	Repair of failed vehicle
[6]	Return of repaired vehicle (Or sending to other Depot)

Source: Survey team

Figure 3-1-1 Flow from vehicle failure to restoration

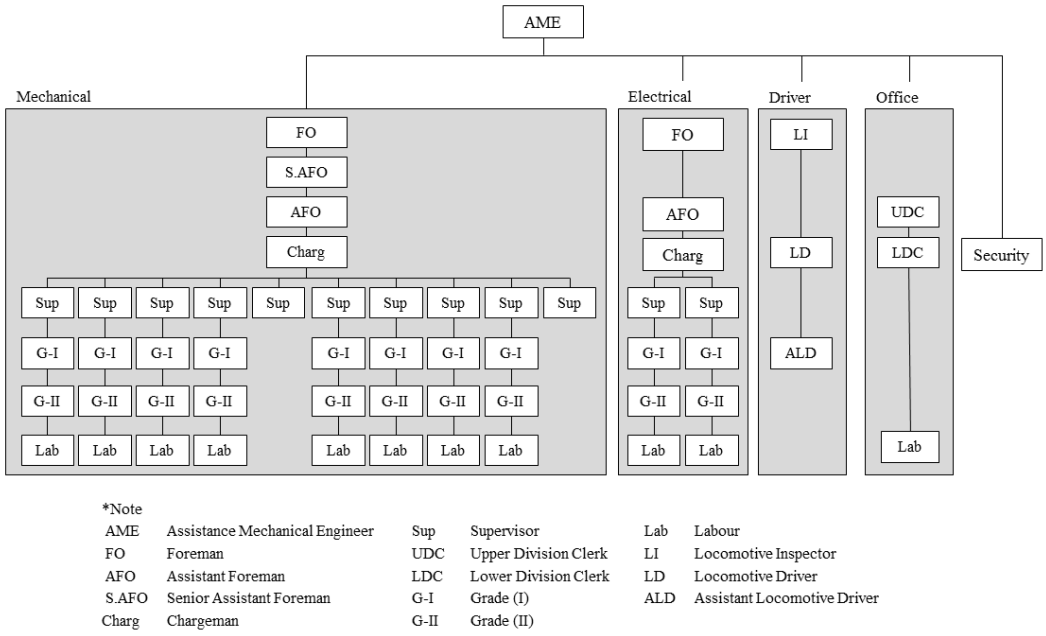
3.1.2 Organization

As examples of Workshop and Depot organizations, Figure 3-1-2 and Figure 3-1-3 show RBE Workshop and Insein DRC Depot, respectively.



Source: MR and Survey team

Figure 3-1-2 RBE Workshop organization chart



Source: MR and Survey team

Figure 3-1-3 Insein DRC Depot organization chart

In both of the organizations, work teams are formed by the type of equipment to work on with their employees assigned. As shown on Figure 3-1-3, “Sup” (Supervisor) controls the work teams “G-I” (Grade(I)), “G-II” (Grade(II)), and “Lab” (Labour) and gives directions to them for the execution of maintenance work.

3.1.3 Budget management

MR is operated by the budget which is approved by the National Assembly. Specific amounts of the budget of the vehicle department are not disclosed. Publicly announced revenues and expenses of MR are as shown on Table 3-1-1. Since MR is operating in the red, it is considered that the budget for the procurement of materials necessary for the maintenance of vehicles is not sufficient.

Table 3-1-1 Revenues and expenses of MR (FY2014)

Category		Amount (million Kyat)	Yen equivalent* (million Yen)
Revenue	Passengers	34,213.29	3,075.43
	Freight	18,509.54	1,663.82
	Other	9,015.86	810.44
Total revenue		61,738.69	5,549.69
Expenses	Operation expenses	97,338.06	8,749.72
	Related expenses	25,787.89	2,318.07
Total cost		123,125.95	11,067.79

* Converted by 1 Kyat = 0.08989 Yen

Source: MR and Survey team

3.1.4 Personnel plan

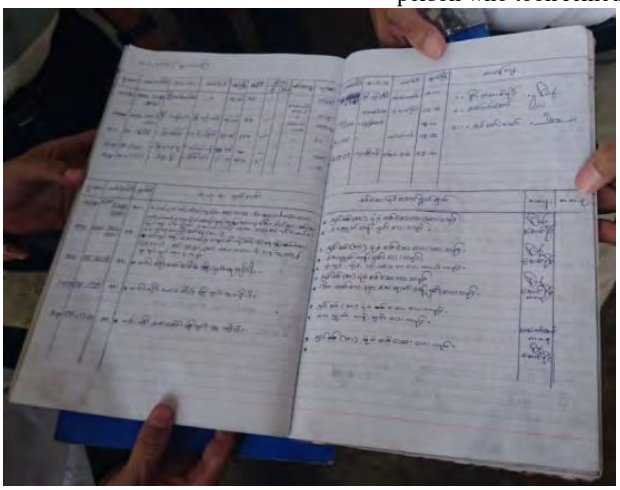
MR has a fixed number of personnel laid down as a standard number for each of the departments and shops. The fixed numbers of personnel and current numbers of employees have not been disclosed. Even if the amount of work is increased, it is difficult to increase the number of workers correspondingly and manage their work because MR is operating in the red and, therefore, hire of new employees is restricted under the national regulations.

3.1.5 Quality control

Concerning the quality control of vehicles in MR, the responsible Workshops and Depots are managing the vehicle operating hours, vehicle conditions, inspection records and so forth by the use of paper-based documents. And any fault that occur during the operation is recorded on another document kept on the vehicle. During inspection after return to the Depot, the records are checked and the fault is repaired as necessary. However, the fault records include no more than phenomena and there is no cause or background information recorded. Furthermore, the inspection records contain the date of inspection and inspection type (M1 - M8) alone and do not indicate any inspection values, cleaning/lubrication actions, or description of repair conducted. For that reason, information is insufficient for the identification of failure causes and the development of solutions, causing problems in the identification of causes and the implementation of corrective measures. We believe, as the first step, it is important to keep in detail the inspection records and fault records for use in the identification of failure causes and development of solutions.

Fault report journal to be kept by the train operator (Kept on vehicle)

Contents of the journal on the left
(From left to right, person reporting the fault, description of the fault, person who took remedial action)



Records of vehicle inspection and repair (Retained at Depot)

Source: Survey team

Figure 3-1-4 Inspection records

3.1.6 Inspection system

The rolling stock of MR consists of four (4) vehicle types, including the locomotive, freight wagon, passenger coach, and RBE and the inspection system varies depending on the vehicle type. The inspection system for RBEs consists of eight (8) types of M1 through M8, as shown on Table 3-1-2, each having the inspection deadline represented in terms of vehicle operating hours.

Table 3-1-2 Inspection system for RBE vehicles

Type	Inspection deadline (operating hours)	Standard work hours	Place of inspection	Major contents of inspection
M1	50 hours	3 hours	Depot	- Inspection of equipment functions - Inspection of equipment conditions - Check of the condition of consumables and their replacement
M2	200 hours	6 hours		
M3	400 hours	8 hours		
M4	800 hours	12 hours		
M5	1,600 hours	16 hours		
M6	3,200 hours	14 days	Workshop (RBE Workshop)	Overhaul of designated equipment
M7	6,400 hours	21 days		
M8	12,800 hours	45 days		

Source: MR and Survey team

M1 through M5 are daily maintenance and M6 through M8 are overhaul. Any of M1 through M5 conducts the lubrication, replacement and replenishment of consumables, inspection of bogie conditions, functional inspection of driving cab, inspection of underfloor equipment, and so forth. Any of M6 through M8 conducts overhaul with underfloor equipment removed, bogie overhaul, recoating of vehicle body, etc. The inspection system for the current M1 through M8 was established at the introduction of RBEs by the copy of inspection system for locomotives.

Since this inspection system was set out based on that for locomotives, the inspection deadline and inspection items may not be set to best suit RBEs. Therefore, inspections necessary to RBEs may not be conducted at an appropriate time, potentially making vehicles undrivable. To maintain a high availability of RBEs, it is necessary to verify and reconstruct the inspection system appropriate for RBEs. In that case, we believe, the trend data for the deterioration and abrasion of individual pieces of equipment need to be collected for an extended period of time and be analyzed.

3.2 Technologies and skills owned for the maintenance of RBEs

Since vehicles are operated during the day, the daily maintenance of vehicles is conducted at night at the Depots. With no reserved vehicles available for the operation while the inspection is underway, the maintenance must be conducted in a limited time window at night.

On the other hand, the overhaul of vehicle is conducted at Workshop with equipment stripped off. Since the inspection takes a maximum period of 45 days, the substitute vehicle for operation during the inspection period is selected and sent to the Depot by the Head Office on an ad hoc basis in consideration of the use of RBEs for the entire MR to minimize the effect on the operation of other trains.

A scene of daily maintenance (M1 through M5)

A scene of overhaul (M6 through M8)

Source: Survey team

Figure 3-2-1 Scenes of vehicles maintenance

Since MR has been conducting the maintenance of locomotives on their own before the introduction of RBEs, they have inspection items and check list established to some extent for the locomotives. For RBE, however, they are not sufficiently established and, therefore, the check list for locomotives is used without modification, as shown on Figure 3-2-2, with respect to the inspection items. As a result, while the inspections are conducted with the driving cab, bogie, and underfloor equipment, no inspection is conducted with the interior of the passenger compartment. In addition, despite the existence of inspection items, there is no reference value provided for the inspection. And since there is no manual available that indicates the methods of inspection, the inspection is no more than the visual observation of the conditions of the equipment and parts. Furthermore, the judgment on the maintenance varies depending on the worker involved, with resultant insufficiency of maintenance.

Myanma Railway
Mechanical & Electrical Department
Instruction for checking RBE Locomotive
M-1 Checking

Running time schedule 8 hours to 50 hours					Time working allowance
No.	Works	To take responsibility	To Supervise	Checking & Recording	Super Supervision
		AA-4/AA-5	AA-3/ Supervisor	A La Hta/ A La Ma	A La Sa Ma-2/ A La Sa Ma-1
a	**Recording notebook for locomotive driving (Loco 6)**				
	To sign by reponsible person after checking & repairing the necessary records of locomotive's drivers	√	√	√	√
b	**Checking Engine Line**				
1	To check for pure oil without water in oil tank and then to fill oil filter	√	√	√	
2	To check the leakgage in oil pipe flow	√	√		
3	To check for the flow of oil from hand pump	√	√		
4	To check for the cover of the oil tank	√			
c	**To check for lubricant line**				

Source: MR

Figure 3-2-2 Example of inspection check list

At Depots, even when there is sufficient time margin to the inspection deadline for M1, the time for the maintenance spared for a single vehicle becomes short because they are conducting the maintenance of all vehicles under their responsibility everyday. As a result, they cannot help decreasing the quality of maintenance.

Take Insein DRC Depot as an example:

- Vehicles for the maintenance (M1 through M5) — Locomotive 11, RBE 39
- Work hours — From 20:00 till 8:00 next morning
- Headcount per work team — Mechanical 4, electrical 1
- Average number of vehicles per work team — Locomotive 2, RBE 10
- Time spared for the maintenance of 5 RBEs — 2 hours

From this, it is inferred that the maintenance is not sufficiently conducted because the time spared for the maintenance of 5 RBEs is short as compared with the standard work hours (16 hours for M5) for the inspection, shown on Table 3-1-2.

Concerning the general use of tools and basic methods of work by the workers on shop floor, they receive a newcomer training, after joining MR, at the training institute of the Ministry of Transport and Communications (former Ministry of Rail Transportation) situated in Meiktila. After that, they are trained at Depots and/or Workshops through OJT by experienced workers. Therefore, they should have a certain level of basic skills.

Knowledge required for the maintenance of vehicles is transferred from Workshops to Depots through technical guidance, because the construction and working principle of various types of equipment are accumulated at Workshops that are responsible for overhauling. At Workshops, they conduct investigations on parts and facilities required for the maintenance and inform the Head Office of any insufficiencies identified in an effort to improve environment for the maintenance.

With RBE vehicles, however, they received little guidance about the vehicle construction and inspection/service procedures and were given only insufficient drawings, specification or other

documentation at the time of import of used vehicles from Japan. Hence, they developed their own standards and work procedures with reference to parts of existing locomotives and heavy construction machines. Therefore, some of such standards and work procedures are inappropriate. And, with some types of equipment, there is no documentation available and so the overhaul is not possible.

3.3 Ability development on maintenance of RBEs

If you are newly hired by MR as a vehicle technician, you will be trained at the training institute in Meiktila for 12 weeks to acquire basic knowledge on all aspects of vehicles as part of newcomer training. Following that, you will be trained by experienced workers at Depots and/or Workshops by OJT to acquire a certain level of basic skills.

In addition, there is a training center for diesel hydraulic locomotives in the Ywahtaung Workshop in Mandalay area, which was founded in 1981 by the German aid. However, since it is intended for the improvement in knowledge and skills on diesel hydraulic locomotives, no effort is being made there for the ability development on the maintenance of RBEs.

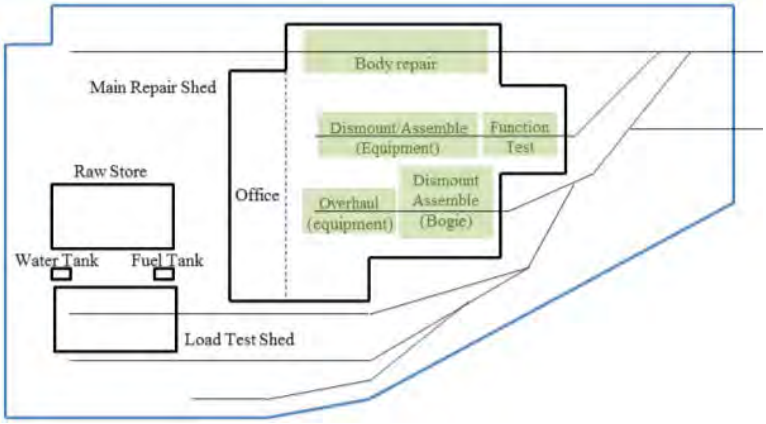
From all of the above, it is necessary to promptly implement the ability development for the enhancement of RBE maintenance setup and the improvement of maintenance skills.

3.4 Facilities & equipment and working procedure for RBEs

- Facilities & equipment of RBE Workshop

Since the RBE Workshop uses the premises and buildings which once were part a Depot for locomotives, the site is small, as shown on Figure 3-4-1, and therefore the number of vehicles that can be maintained at the same time is small. In addition, because of the narrow premises, the RBE Workshop does not have sufficient equipment, such as dynamometer for testing the engine performance and wheel lathe that is essential for the maintenance of bogies, although it does have the equipment for the removal and reinstallation of devices from/to the vehicle body. Such being the case, what is done in the overhauling work is no more than the removal of devices, observation of their conditions, re-installation and functional check. And the performance check is not covered.

Furthermore, since the RBE Workshop is located in the area for the Yangon Central Station redevelopment plan, it needs to be relocated once the redevelopment gets started. On the other hand, it is planned that a Workshop for the maintenance of DEMUs and RBEs be constructed in Ywathagyi around 2023 as part of “Yangon-Mandalay Railway Improvement Project.”



Layout of RBE Workshop

Interior of main repair shed as viewed from the office shown on the left layout

Source: MR and Survey team

Figure 3-4-1 Views of RBE Workshop

At RBE Workshop, the overhaul is conducted in the following procedure (Figure 3-4-2).

1. Incoming inspection

   Start the engine of the vehicle received in the RBE Workshop and check the functions of the vehicle to capture the conditions of the equipment and devices.
2. Application for permission from Head Office

   Apply for the permission of repair from Head Office's Mechanical and Electrical Engineering Department, if the conditions of the equipment are not good.
3. Overhauling

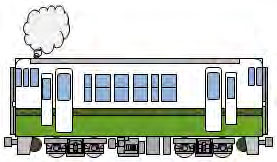
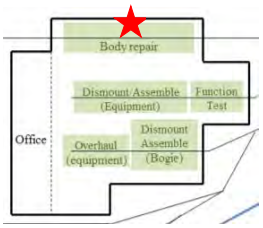
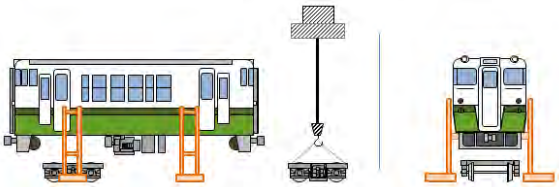
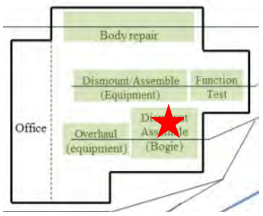
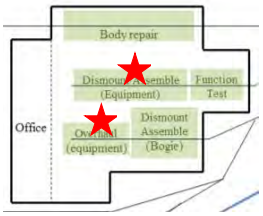
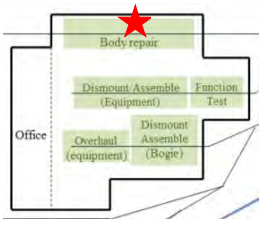
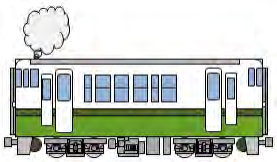
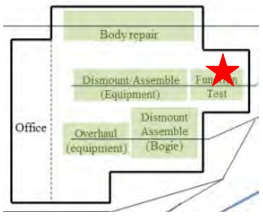
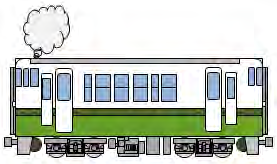
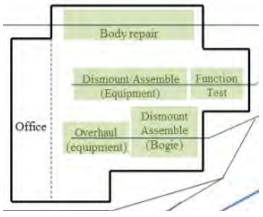
   With the permission of repair received from Head Office, conduct the overhaul of the equipment in question.
4. Maintenance of vehicle body

   Repair and re-coat the vehicle body.
5. Outgoing inspection

   With the vehicle kept in a stopped state, start the engine to inspect the vehicle functions.
6. Trial run

   Trial-run the vehicle on a service line to inspect the vehicle functions.
7. Sending back to where it belongs

   Under the direction of Head Office's Mechanical and Electrical Engineering Department, send the vehicle back to the Depot where the vehicle belongs.

Work to be done	Graphical representation of work	Place of work
1. Incoming inspection		
3a. Overhauling bogies	 Bogies to Insein Workshop	
3b. Overhauling the engine and transmission		
4. Repair and coating of vehicle body		
5. Outgoing inspection		
6. Trial run on service line	 To be conducted between Yangon and Bago	

Source: Survey team

Figure 3-4-2 RBE overhauling process

Considering that those working procedures are carried out in a narrow facility using limited set of equipment and much contrivance, they deserve a certain level of appreciation. Since the construction of a new Ywathagyi Workshop is planned as part of "Yangon-Mandalay Railway Improvement Project" by yen loan, the working procedures need to be developed to suit the new Ywathagyi Workshop.

Shown below are machines and other equipment installed in RBE Workshop.

Table 3-4-1 Machines and other equipment in RBE Workshop

No	Machine name	Quantity (Unit: Set)
1	15 ton overhead crane	1
2	Battery charger	2
3	Nozzle grinding machine	1
4	Injector testing machine	1
5	Compressor test bench	1
6	Compressor	1
7	Welding machine	2
8	Surface grinding machine	1
9	Lathe machine	1
10	Fuel injection pump calibrating machine	1
11	Electric lifting jack	8
12	30 ton hydraulic press	1

Source: MR documents

- Depot for RBEs

The Depot has an almost sufficient level of equipment for the daily maintenance and replacement of faulty devices and equipment (Figure 3-4-3). However, it lacks wheel lathe that is essential for securing the safety of vehicle operation. Although MR is well aware of the necessity of the lathe, it seems that the budget does not allow the installation of the machine. If the wheel shape is found out of the standard, the entire wheel set is to be replaced by the use of a lifting jack.

Maintenance pit and deck

Battery charger

Lifting jack

Crane
(substitute for lifting jack)

Transfer cart
(for mounting/removing underfloor equipment)

Source: Survey team

Figure 3-4-3 Major equipment in the depot for RBEs

The maintenance of equipment is basically conducted by the very Workshop or Depot that uses it. There is no particular section in organizational bodies responsible solely for the maintenance of the facility, and a section responsible for machines does the maintenance of the facility. As compared with Depots, Workshops have many technicians who are able to maintain the equipment of the facility. Therefore, the facility equipment is maintained in good conditions and there will be no adverse effect on the vehicle maintenance work. At Depots, on the other hand, personnel and labor are mostly used up for the maintenance of vehicles and no sufficient maintenance is conducted on the equipment of the facility. As a result, some of the equipment are left in an unusable state.

As in the case of vehicles failure, any failure of equipment of the facility is reported to the Head Office and, with the permission of the Head Office, the arrangement for the repair is made. If the equipment of the facility fails to an inoperable state, the maintenance of vehicles cannot be made any more, leading to a decrease in the number of vehicles available for the operation. For that reason, the equipment of the facility must be kept in a sound state. In the present conditions, however, there are issues of insufficient budget for the maintenance of facility equipment and of insufficient number of technicians assigned for such maintenance.

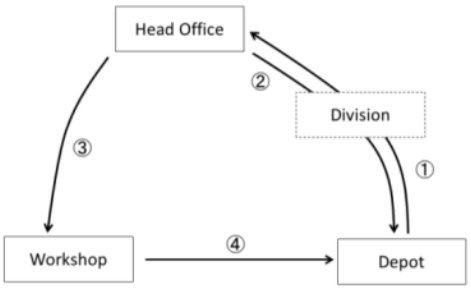
As a middle/long term requirement, MR is hoping for the construction of a new Workshop for RBEs and, in response to that, Ywathagyi Workshop will be constructed around 2023. The functions of the RBE Workshop will be transferred to it.

3.5 Procurement for the part management and maintenance of RBEs

With parts for RBEs, there is no inventory management because the parts are taken from other undrivable RBEs when necessary. Therefore, in any case of unexpected failure of RBE, the vehicle needs to be kept in a state of waiting for repair until the relevant part is obtained from another undrivable RBE. So we think it necessary, as the first step, to manage the inventory of used parts taken from undrivable RBEs in order to systematically keep used parts based on the prediction of parts that are likely to become short. That will shorten the period of waiting for the repair.

Due to the insufficiency of budget, MR does not have sufficient parts necessary for the maintenance of vehicles or for the restoration of failed vehicles and, as a result, cannot conduct a sufficient level of vehicle maintenance. In particular, since engine and transmission parts are costly, if the engine or transmission fails, the parts necessary for the repair may not be procured. There are many vehicles left unrepaired for that reason. At present, owing to the efforts on a shop floor level as those of Depots, parts are taken from undrivable vehicles for use as replacement parts.

Parts for the maintenance of RBEs include: parts periodically replaced at overhaul, parts replaced upon occurrence of vehicle failure, and consumables replaced in daily maintenance. Those parts required at Depots are procured by Workshops and, once made available, sent to the Depots for storage in the warehouse. It should be noted that the purchase costs must be approved by MR's Head Office. Figure 3-5-1 shows the flow of part procurement in case of the occurrence of failure.



Flow	Process
[1]	Report of failure
[2]	Permission to repair
[3]	Direction to repair
[4]	Sending parts

Source: Survey team

Figure 3-5-1 Flow of the procurement of replacement parts in case of vehicle failure

Once the budget is obtained, follow the open bidding when purchasing parts necessary for the maintenance. In the open bidding process, there are two ways of indicating the required part. One is the use of part number and the other is the presentation of a sample part. The purchase of parts is conducted once a year and the parts are delivered to Workshops as divided for each of the vehicle types. Table 3-5-1 shows the flow from the open bidding to delivery.

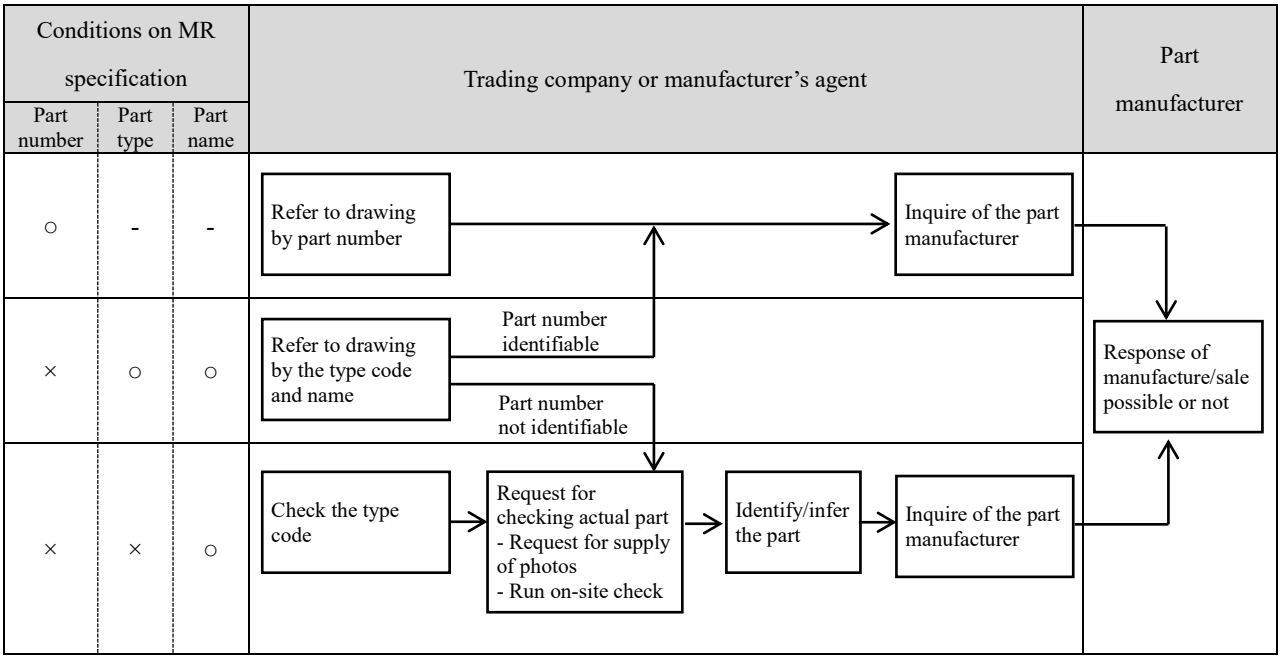
Table 3-5-1 Flow of part purchase from planning to delivery

Step	Part supplier	National Assembly (Committee)	MR			Description of work
			Head Office	Workshop	Depot	
[1]						Workshops to report their part purchase plan
[2]						MR's Head Office to invite to open bidding
[3]						Part suppliers to offer bids (offer engineering specifications and price)
[4]						Contact Workshops for the confirmation of engineering specifications
[5]						Report the compliance or non-compliance with engineering specifications to Head Office
[6]						Report the compliance or non-compliance with engineering specifications to National Assembly (Committee)
[7]						Unseal bids
[8]						MR to negotiate with manufacturers (Check against MR standards, negotiation on time of delivery, etc.)
[9]						Place order for parts from part suppliers
[10]						Part suppliers to delivery parts to Workshops
[11]						Send parts and consumables to Depots

Source: MR and Survey team

Since the budget for the purchase of RBE parts is primarily denominated in the local currency and any budget denominated in foreign currencies will hardly be approved by the National Assembly, the purchase of costly genuine parts from Japan will be very difficult. In addition, while the confirmation of engineering specifications for the part procurement is conducted by Workshops, they do not usually have drawings, bill of materials, specification and any such information on RBEs and so it will be difficult for them to judge if the bid contents comply with the specifications or not. In case of open bidding based on the presentation of sample parts, while the compliance in shape may be judged properly, any judgment of compliance in material will be impossible. As a result, there is a risk of being insufficient in the performance of parts, short in service life of parts, and so forth. Table 3-5-2 illustrates the flow of confirming purchased parts.

Table 3-5-2 Flow of purchased part confirmation



*○: Known, ×: Unknown, -: Known or Unknown, whichever will do

Source: "Investigation on The Railroad Rolling Stock Modernization in Myanmar", Ministry of Land, Infrastructure, Transport and Tourism (2014)

MR's demands are as shown below.

- RBE parts may be procured from the market in Myanmar.
- In the case where the procurement of RBE genuine parts is difficult, low-cost substitute parts that still meet the performance requirements may be procured.

Since many of the RBE parts are made in Japan, many of them are no available from the market in Myanmar. However, if the parts in question are those used in vehicles that are still operated in Japan at present, they should be in circulation in Japan. So it will be possible to purchase them through a contractor in Japan and, through a trading company that can import them to Myanmar, to procure many of the parts. On the other hand, with parts other those used in vehicles that are still operated in Japan, since it is very likely that they are not produced in Japan any more, they should probably be unavailable. In that case, substitute parts need to be found out. But it requires knowledge and costs to determine if the substitute parts satisfy the performance requirements and, therefore, it is likely that the process will not be properly followed. For that reason, we belive it necessary, when renewing parts as for repowering work, to adopt parts that are used and circulated in Japan.

3.6 Issues on the RBE maintenance setup and study of proposed improvements

The issues discussed so far about the maintenance setup may be summarized as shown below.

- Inspection system for RBE is insufficient.
- Reference values and work methods corresponding to the RBE inspection items are unclear.
- There is no linkage between organizational bodies involved in vehicle maintenance.
- The current headcount of MR employees is insufficient.
- The budget is insufficient for the procurement of materials required for the maintenance of vehicles.

With the above-shown issues, we have so far discussed improvements. The proposed improvements for the construction of sustainable maintenance setup may be summarized as shown below.

- Re-examine the current inspection system for RBEs (M1 through M8) through the verification of appropriateness based on data, etc.
- Establish rules, including the reference values and work methods corresponding to the RBE inspection items.
- Improve the technologies and skills as the core of the maintenance of RBEs.
- Concentrate the engineering information on RBEs in Workshops and share it with Depots as necessary.
- Develop maintenance manual on RBEs.
- Develop an appropriate work plan to meet the inspection deadline for RBEs to ensure effective and efficient execution of work.
- Develop the engineering information (bill of materials of the vehicle, etc.) necessary for the procurement of RBE parts.
- Develop the engineering information (drawings, specifications, etc.) necessary for the acceptance in the procurement of RBE parts.

3.7 Effective use of non-governmental resources on the maintenance of RBEs

Work operations currently outsourced from Workshops and Depots are as shown on Table 3-7-1.

Table 3-7-1 MR's outsourced work (as of March 2016)

Organizational body	Outsourced work
RBE Workshop	Vehicle body repair, vehicle body coating, electrical wiring, repair of air conditioner
Insein DRC Depot	Repair of air conditioner

Source: MR and Survey team

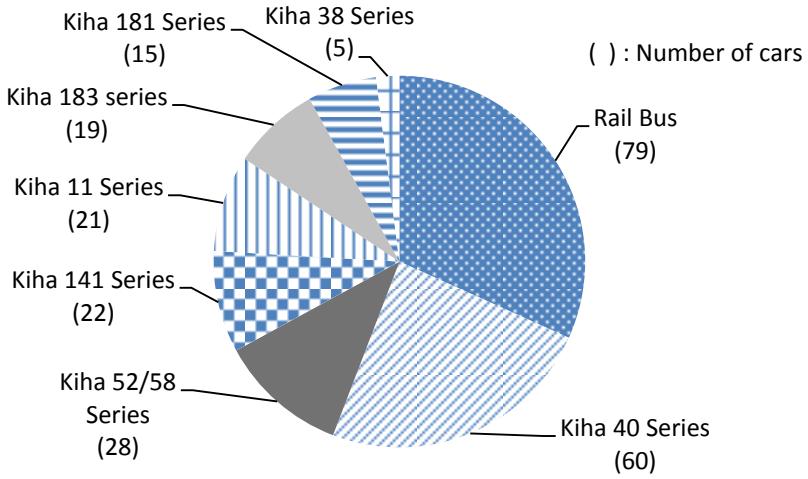
The contents of such outsourced work are not specific to the railway business and similar work exists with the maintenance of buses and other automotive vehicles. Therefore, such work can be performed with common skills. However, the maintenance of bogies and hydraulic transmissions is not outsourced because it requires skills specific to railway vehicles.

The effective use of non-governmental resources is one of the useful measures to solve the deficiency of personnel without increasing the current headcount and to build a setup for accomplishing the planned work. As shown on Table 3-7-1, MR is currently outsourcing some work to make up for the deficiency of workforce. However, work operations requiring skills specific to railway vehicles have not been outsourced so far. That means there is no contractor in Myanmar that has the experience of the maintenance of diesel hydraulic locomotives and/or diesel multiple units. Furthermore, since the maintenance of railway requires peculiar skills as seen from global point of view, the prospective contractors will be limited. As a result, the outsourcing cost is likely to increase. In the selection of the outsourcees, it is necessary to verify the skills they have.

4 Study of maintenance and repowering work necessary for the effective use of RBEs

4.1 Number of RBEs owned and inventory

According to the information obtained from MR, they own a total of 249 RBEs transferred from Japan Railways Group companies and joint public-private companies as of June 7, 2016. The majority is rail bus (79 cars) and Kiha 40 series (60 cars). Among them, a total of 170 vehicles are judged in drivable conditions, the other 79 vehicles are undrivable due to failure. Figure 4-1-1 shows the breakdown and Table 4-1-1 shows the inventory (aggregated data). The detailed data are shown in Appendix



Source: Survey team

Figure 4-1-1 The breakdown of the existing RBEs

Table 4-1-1 The inventory of existing RBEs (aggregated data)

(Unit: Car)

Type	Total number of vehicles	Number of drivable vehicles	Number of undrivable vehicles
Kiha 40 Series	60	57	3
Kiha 11 Series	21	21	0
Kiha 52/58 Series	28	8	20
Kiha 38 Series	5	5	0
Kiha 141 Series	22	22	0
Kiha 181 Series	15	0	15
Kiha 183 Series	19	11	8
Rail Bus	79	46	33
Total	249	170	79

Source: Survey team

4.2 Profile of RBEs and summary of issues for their effective use

- Method of profile survey

In this survey, the target was set to include as many vehicles as possible, regardless of the vehicle conditions, from RBEs imported by MR. In the execution of the survey, since RBEs are deployed in various parts of Myanmar, we visited seven (7) sites of Yangon RBE Workshop, Insein DRC Depot, Naypyitaw Depot, Pyinmana Depot, Myitnge Workshop, Ywahtaung Workshop, and Hinthada Depot, where many are deployed, for the survey of vehicles belonging to the sites. However, many of the vehicles were being used for operation and not accessible during the daytime and, therefore, the survey was primarily conducted with reserved vehicles and those undrivable due to failures. Notwithstanding the above, with vehicles that could be the objects of future modification work, we made a request for the change of operation to conduct the survey during daytime or conducted the survey at night after the end of operation.

Concerning the survey of vehicles conditions, we visually checked, with the vehicles kept in a state of rest, the conditions of vehicle body, bogies and major components primarily for any part that might be a concern for the continued use. And with vehicles that were undrivable due to the presence of failures or any such cause, we asked the MR employees for the causes wherever possible in an effort to leave the records of them.

- Profile investigation of the vehicles and organization of profile data

In the first investigation, we investigated a total of 136 vehicles. Table 4-2-1 shows the breakdown. It should be noted that this table also include 5 vehicles of Kiha 11 Series and 12 of Kiha 40 Series from JR Central, 4 vehicles from JR East, and 9 vehicles of Kiha 40 Series that were transferred from JR East at the end of March 2016. They were not included in the list obtained from MR at the time of investigation. (For further details of the profile, see Appendix.)

Table 4-2-1 Number of RBEs subjected to profile investigation

(Unit: Car)

Type	Number of vehicles
Kiha 40 Series	42
Kiha 11 Series	21
Kiha 52/58 Series	19
Kiha 183 Series	19
Kiha 141 Series	1
Rail bus type	32
RBE converted into passenger coach	2
Total	136

Source: Survey team

The following shows the current conditions for each type.

- Kiha 40 Series

  A total of 60 vehicles were transferred, including 8 from JR Hokkaido, 19 from JR East (including 9 transferred at the end of March 2016), 30 from JR Central, and 3 from JR Shikoku. The 49 vehicles transferred from JR East and JR Central are those transferred in FY 2015 and, therefore, are relatively in good conditions. Out of the remaining 11 vehicles, the 3 vehicles transferred from JR Shikoku, with more than a year passed since they were placed out of operation, are deteriorating on bodies and parts. And the bogies, engines and other major components were removed. Out of 8 vehicle transferred from JR Hokkaido, 5 vehicles that were equipped with air conditioners. But the air conditioners were not working well and were being subjected to the maintenance work. Three (3) other vehicles were being operated without any particular problem.

Source: Survey team

Figure 4-2-1 Photo of the present state of Kiha 40 Series

- Kiha 11 Series

In FY 2015, 21 vehicles were transferred from JR Central. Since little time has passed since the transfer, the conditions are good. However, probably by the effect of the modification to lower the room at the air conditioner mounting part for the purpose of avoiding any interference with the rolling stock gauge, they are suffering a problem of weak air conditioning.

Source: Survey team

Figure 4-2-2 Photo of the present state of Kiha 11 Series

- Kiha 52/58 Series

A total of 32 vehicles were transferred, including 20 from JR East and 12 from JR West. Since 4 of them were converted into passenger coaches, 28 vehicles are remaining on register at present. Although 8 vehicles are still drivable, they are, with their bodies badly corroded, in a barely drivable condition. The remaining 20 vehicles are suffering severe corrosion of their bodies and some of them are warped (buckling) beyond repair. MR is not thinking of repowering such vehicles and is planning to deregister them.

Source: Survey team

Figure 4-2-3 Photos of the present state of Kiha 52/58 Series

- Kiha 183 Series

A total of 19 vehicles were transferred from JR Hokkaido. All vehicles are placed out of operation. Since some vehicles equipped with driving cab have a high roof, a modification work was started to get them within the rolling stock gauge but it is left uncompleted. The rest of the vehicles are in relatively good conditions. But there is no clear plan for their future use and they are left unused.


Source: Survey team

Figure 4-2-4 Photo of the present state of Kiha 183 Series

- Kiha 141 Series

A total of 22 vehicles were transferred from JR Hokkaido. Excluding 2 vehicles that are to be subjected to corrective grinding of wheels, all vehicles are placed in operation. Since many of them are deployed to local Depots and were being used in operation, the investigation was made with only one (1) vehicle. The vehicle was in good conditions and no problem was identified at the moment. But it should be noted that, since its bogies and hydraulic transmission are reuse from a vehicle deregistered when it was registered at JR Hokkaido, it is aged.

Source: Survey team

Figure 4-2-5 Photo of the present state of Kiha 141 Series

- Rail bus type

A total of 85 vehicles were transferred from a total of 13 private railway companies and joint public-private companies. Vehicles types are varied and so the types of major components are varied as well. Among the RBEs, many of them went through many years after having been transferred to MR and those in undrivable state count 39 vehicles, which is close to a half of the total number of vehicles. That is partly because there are a variety of part types. Since it is difficult to obtain the maintenance parts, the vehicles need to be left waiting for repair. Furthermore, since they have been left outdoors unattended for an extended period of time, their body underframes are badly corroded. It was observed that some vehicles could hardly maintain sufficient body strength. Many of the vehicles of a type called LE-car are of a rivet-assembled construction for the purpose of realizing light weight and low cost. Since they are made of thin sheet steel and therefore cannot be repaired by regular arc welding, those suffering significant body corrosion are beyond repair.

Source: Survey team

Figure 4-2-6 Photos of the present state of rail bus

➢ Vehicle converted into passenger coach

Among RBEs introduced to MR, some, primarily those that became unusable due to the failure of major components, were modified into passenger coaches. There are a total of 11 vehicles of that sort, including 1 converted from Kiha 47 Series, 4 from Kiha 52- 58 Series and 6 from rail bus type. With all pieces of equipment removed, excluding brake parts, such vehicles cannot be restored to RBEs any more.

Source: Survey team

Figure 4-2-7 Photo of the present state of former Kiha 58 Series

Table 4-2-2 shows the results of the investigation.

Table 4-2-2 RBEs as classified by type and results of profile investigation

(Unit: Car)

Type	Number of vehicles	RBEs owned by MR: 249 vehicles				Remarks
		Drivable		Undrivable due to failure		
		Unchecked	Investigated		Unchecked	
Kiha 40 Series	60	18	39	3	-	JR Hokkaido 8, JR East 19, JR Central 30, JR Shikoku 3
Kiha 11 Series	21	-	21	-	-	JR Central 21
Kiha 52/58 Series	28	6	2	17	3	JR East 20, JR West 12 (including 4 that were converted to passenger coaches)
Kiha 30 Series	5	5	-	-	-	JR Central 5
Kiha 141 Series	22	21	1	-	-	JR Hokkaido 22
Kiha 181 Series	15	-	-	-	15	JR West 15
Kiha 183 Series	19	-	11	8	-	JR Hokkaido 19
Rail bus	79	29	17	15	18	Joint public-private companies and private railways companies (total of 13 companies)
Total	249	170		79		

Source: Survey team

Table 4-2-3 and Table 4-2-4 shows the results as summarized by major components of engine and hydraulic transmission, respectively.

MR has a great varieties of engines and hydraulic transmissions, including 15 engine types and 24 hydraulic transmission types. It poses a big concern in the execution of maintenance because the maintenance requires the understanding of construction for each of the types and also requires maintenance parts specific to each of them. Furthermore, not a few of the types are not manufactured any more and so some maintenance parts are unavailable at this moment, making any maintenance infeasible. To keep using the vehicles for a long time,it is necessary to narrow down the types to those that can assure the supply of maintenance parts. For that purpose, the implementation of repowering work is required, primarily focusing on the replacement of engines and other major components.

Table 4-2-3 Vehicles owned as summarized by engine type

No	Type	Manufacturer	Number of engines (Unit)	Type of vehicles mounted on
1	DMF13HS	Niigata Engineering	66	Kiha 38 Series, Kiha 141 Series, Rail bus (NT-120D, CR-70, MR-100)
2	DMF13HZ	Niigata Power Systems	32	Kiha 40 Series, Kiha 52/58 Series, Rail bus (MR-100, LE-30)
3	DMF13HZC	Niigata Power Systems	4	Kiha 183 Series
4	DMF15HSA	Niigata Engineering	36	Kiha 40 Series, Kiha 183 Series
5	DMH17	Niigata Engineering	24	Kiha 58 Series
6	DMF18HZ	Niigata Power Systems	4	Kiha 183 Series
7	DML30HSE	Niigata Engineering	10	Kiha 181 Series
8	DML30HSI	Niigata Engineering	13	Kiha 181 Series, Kiha 183 Series
9	DMF11HZ	Komatsu	22	Kiha 52/58 Series, Rail bus (LE-20)
10	SA6D125H-1A	Komatsu	1	Rail bus (IRT355)
11	PE6HT03	Nissan Diesel	6	Rail bus (ISE-1, LE-20)
12	PE6HT03A	Nissan Diesel	40	Rail bus (LE-20, LE-30, NT100)
13	C-DMF14HZ	Cummins	4	Kiha 40 Series
14	C-DMF14HZA	Cummins	21	Kiha 11 Series
15	C-DMF14HZB	Cummins	26	Kiha 40 Series

* Niigata Power Systems is a company that evolved from its predecessor Niigata Engineering

Source: MR and Survey team

Table 4-2-4 Vehicles owned as summarized by hydraulic transmission type

No	Type	Manufacturer	Number of transmissions (Unit)	Type of vehicles mounted on
1	DF115	Niigata Converter	101	Kiha 38 Series, Kiha 52/58 Series, Kiha 141 Series
2	DW4	Niigata Converter	1	Kiha 181 Series
3	DW4C	Niigata Converter	4	Kiha 181 Series
4	DW4D	Niigata Converter	2	Kiha 181 Series
5	DW4E	Niigata Converter	7	Kiha 181 Series
6	DW4F	Niigata Converter	1	Kiha 181 Series
7	DW9A	Niigata Converter	8	Kiha 183 Series
8	DW10	Niigata Converter	22	Kiha 40 Series, Kiha 183 Series
9	C-DW14A	Hitachi Nico Transmission	29	Kiha 40 Series
10	N-DW14B	Hitachi Nico Transmission	5	Kiha 40 Series
11	N-DW14C	Hitachi Nico Transmission	2	Kiha 183 Series
12	C-DW15	Niigata Converter	21	Kiha 11 Series
13	N-DW17	Hitachi Nico Transmission	4	Kiha 183 Series
14	DBR115	Niigata Converter	3	Rail bus (CR-70)
15	TACN-22-1103	Hitachi Nico Transmission	2	Rail bus (LE-20)
16	TACN-22-1103B	Hitachi Nico Transmission	10	Rail bus (LE-20)
17	TACN-22-1103C	Hitachi Nico Transmission	23	Rail bus (LE-20, NT-100, NT-120D, MR-100)
18	TACN-22-1105	Hitachi Nico Transmission	7	Rail bus (MR-100)
19	TACN-22-1105B	Hitachi Nico Transmission	16	Rail bus (MR-100)
20	TACN-22-1108	Hitachi Nico Transmission	4	Rail bus (LE-30)
21	TACN-22-1613A	Hitachi Nico Transmission	5	Rail bus (LE-30)
22	SCR-091A	Shinko Engineering	3	Rail bus (LE-20)
23	SCR-091B-4B	Shinko Engineering	11	Rail bus (LE-20, ISE1)
24	KTF3335A-2A	Komatsu	1	IRT355

* Hitachi Nico Transmission is a company that evolved from its predecessor Niigata Converter

Source: MR and Survey team

4.3 Study of maintenance plan and refurbishment work necessary for the effective use of RBEs

(1) Maintenance plan necessary for the effective use of RBEs

To promote the effective use of RBEs, as we have discussed so far, it is important to enhance the maintenance setup for the purpose of minimizing the occurrence of undrivable vehicles due failures and to implement the maintenance plan based on appropriate inspection system. To that end, it is necessary to seek optimization through the re-examination of systems and rules (organization, budget, personnel, materials, equipment, knowledge and skills, etc.) required for the maintenance of RBEs.

As stated in **1.3.2 (2)**, a deficiency of 54 vehicles in 2021 is predicted as a result of the calculation of the number of drivable vehicles from the predicted future failures of RBEs. In **1.3.2 (3)**, we examined the measures to make up for the deficiency of vehicles. Out of such measures, the purchase of new vehicles is infeasible considering the financial conditions and the purchase of RBEs from Japan cannot be implemented systematically and consistently because it totally depends on the plans of railway operators in Japan. We examine implementation of the repowering work, primarily focusing on the replacement of engines and other major components, for prolonging service life and making maximum use of RBEs.

(2) Selection of candidate vehicles to be subjected to repowering work based on MR's needs

As we asked MR about the vehicles to repowering work, they presented the following demands.

a) Give priority to undrivable vehicles, wherever possible.

b) Unify the equipment types used.

c) Use the specifications that meet the climate of Myanmar.

As stated in**1.3.2 (2)**, demand a) is intended to increase the number of usable vehicles in consideration of the deficiency of vehicles predicted for the future. Demand b), as stated in **4.2**, is intended to facilitate the understanding of the construction of equipment and the procurement of maintenance parts. Demand c) is intended to make the cooling performance of the radiator and the air conditioning performance sufficient to meet the climate of Myanmar, where the temperature exceeds 40 degrees Celsius in the hottest periods, to minimize overheat-related failures and passenger complaints for the deficiency of air conditioning capacity. We think, in addition to the above-shown three (3) demands, vehicles selected should be those that are usable for around 10 years after the repowering.

We considered the selection of candidate vehicles to meet the requirements, while considering the demands of MR. But we believe those vehicles that are undrivable, as shown in a) should be eliminated from the candidates because they have the following problems.

- Vehicle body and parts are significantly corroded and deteriorated

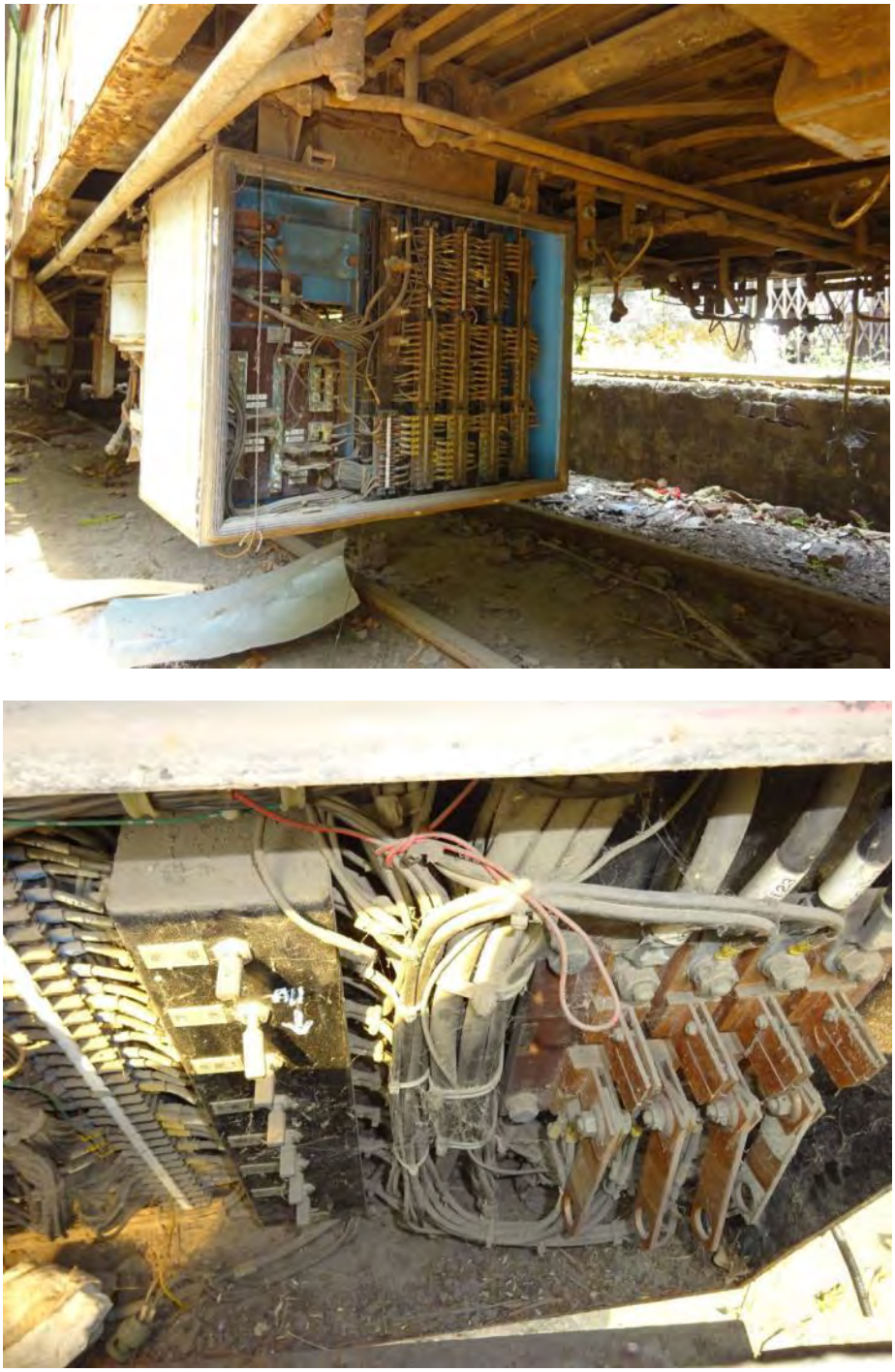
  On not a few of the vehicles, although the vehicle body may look fine apparently on the surface, the development of rust is found when observed from under the floor and the rust easily crumbles and

flakes off when touched with hand. On such vehicles, both outer panels and frameworks are eroded to the depth by rust and any partial cut-off and replacement may accelerate the reduction in strength by the heat of welding. Therefore, it will be difficult to maintain the strength of entire vehicle body. Concerning the underframe, in particular, since it is a critical part for the strength of vehicle body, any such work may cause a warpage (buckling) of the vehicle body by the welding heat, potentially resulting in further reduction in the service life. For that reason, those vehicles with rust on the underframe should be placed out of the object of the repowering work.

Source: Survey team

Figure 4-3-1 Underframe in rusted and perforated state

Having been left outdoors unattended, many of the parts are corroded and/or deteriorated beyond use. Such parts need to be purchased anew. But since the required parts vary depending on the vehicle, they should be procured only after detailed investigation. Some parts may require time for the procurement. That may extend the period for the repowering work and affect the work procedure of other vehicles. And the costs incurred will be enormous. For that reason, such vehicles should be eliminated from the object of repowering work.



Source: Survey team

Figure 4-3-2 Electrical parts eroded by exposure to weather

- There are a lot missing parts other than those to be replaced by the repowering.

  Vehicles that have been placed out of operation for an extended period of time are most likely to be deprived of parts for the repair of other vehicles besides those made unusable by failures. Not a few of them are to be replaced in the repowering work and therefore such parts need to be procured anew. Those parts, like the afore-mentioned corroded and deteriorated parts, involve problems, such as: Detailed investigation is required to identify necessary parts; Takes time for the procurement; Repowering work process will be extended; Costs will become large, etc. For that reason, in our view, they should be eliminated from the object of repowering work.

Source: Survey team

Figure 4-3-3 All relays missing

- A lot of vehicle types

  According to the results of the profile investigation, vehicles placed out of operation for the reason of being undrivable include a lot of rail bus type vehicles. Such vehicles very often vary in not just the body structure but also in the control system and brake system and therefore the specifications of the system must be set to suit individual vehicles besides using the right parts in the replacement. Such modifications require the engineering design and the design should be made by the vehicle manufacturer that is familiar with the original specifications. Since such design requires much time and human efforts and it is predicted that the costs incurred become enormous. Therefore, in our view, such vehicles should be eliminated from the object of repowering work.

From the problems shown above, it is evident that any repowering of undrivable vehicles takes much labor and cost and that the vehicles will not withstand long term of use. Therefore, such vehicles should be eliminated from the object of the work.

The vehicles to be repowered should be free from problems in vehicle body conditions and be equipped with necessary parts. From the results of the profile investigation, most of the vehicles currently drivable are complete with parts that are necessary for the operation and their bodies are basically in good conditions. However, since such vehicles had been deregistered by the railway operators for the reason of being decrepit, the driving-related components should be renewed promptly. Based on all that, we selected the vehicles to meet the following requirements.

- Little deterioration or corrosion is observed on vehicle body and the vehicle will withstand the use of approximately 10 years.
- Major components are becoming aged, requiring early replacement.
- The engine or hydraulic transmission proper is not being manufactured any more and, as a result, the supply of maintenance parts is likely to be terminated.
- A large number of vehicles are included and, therefore, the type unification of engines, hydraulic transmissions and other major components will produce a large effect on the improvement of maintainability.

Through the comparison of the above requirements with the results of the profile investigation, we find it the best to select Kiha 40 Series as the vehicles to be repowered. The following shows the reasons for the selection.

- There is little deterioration or corrosion on the vehicle body. Vehicle body is structured sturdy and without any problem in strength and is likely to withstand about 10 years of use.
- Being more than 35 years old, the engine and hydraulic transmission are decrepit, requiring early replacement.
- The engine and hydraulic transmission are not being manufactured any more and the supply of maintenance parts may be discontinued in the future.
- A total of 60 vehicles are included and, therefore, the type unification of engines, hydraulic transmissions and other major components will produce a large effect on the improvement of maintainability.

However, despite the same vehicle type, the Kiha 40 Series had thirteen (13) variants at the time of manufacturing in the era of JNR and eleven (11) of them are included the vehicles transferred to MR. Furthermore, a variety of modifications had been made to the original specifications at JR Group companies including, for example, replacement of engine and/or hydraulic transmission, installation of air conditioner, and change in the vehicle interior layout. The variants should have been increased even further. If we focus

on the major components alone, there are 4 types of engines and 3 types of hydraulic transmissions. And in the execution of the repowering work, such differences in specifications must be considered for the selection and design.

Table 4-3-1 Specifications of Kiha 40 Series

Driving cab	Passenger door	Type	Class	Destination	Secondary suspension	Deck	Lavatory	Vehicles owned by MR (Unit: Car)
Both sides	Single	Kiha 40 Type	100	Hokkaido	Air	Yes	Yes	2
			500	Cold area				11
			2000	Warm area	Coil	None		8
One side	Double	Kiha 47 Type	0	Warm area	Coil	None	Yes	4
			1000				None	4
			500	Cold area	Air		Yes	1
			1500				None	0
One side	Single	Kiha 48 Type	0	Warm area	Coil	Yes	Yes	0
			1000				None	1
			300	Hokkaido	Air		Yes	3
			1300				None	3
			500	Cold area			Yes	15
			1500				None	9

* The “Class”, or number class, represents one assigned at the time of original manufacture and, with some vehicles, it is changed based on the modifications made to them.

Source: MR and Survey team

As stated in **1.3.2 (2)**, a deficiency of 54 vehicles is considered to occur in 2021, when DEMUs are to be introduced, as a result of calculation of the number of drivable vehicles from the predicted future failures of RBEs. However, while this calculation assumed the absence of future import of RBEs from Japan, it is considered that around four (4) of the deficient vehicles may be covered by the additional import of RBEs from Japan because, in reality, the replacement of decrepit diesel multiple units will still continue on in the future in Japan. In consideration of that, in our view, it will be appropriate to conduct the repowering work on 50 vehicle by 2021.

Based thereupon, we proposed to MR that 50 vehicles of Kiha 40 Series be the objects of the repowering work, because as many as 60 vehicles exist for the Kiha 40 Series, which, in our view, is the best as the object of repowering. However, it was requested by MR to study the inclusion of other types, because limiting the object to Kiha 40 Series alone will cause critical views against MR, for the Series is relatively less aged after the transfer to Myanmar. And, the cost reduction for the entire repowering work was required, as well. As a result of study on the addition of other types, we added five (5) vehicles of LE-30 type that

were transferred from Sanriku Railway and decreased Kiha 40 Series by the same number. Shown below are the reasons for the selection of LE-30.

- It is a type of vehicle, called rail bus, used at joint public-private companies. Its vehicle body is structured relatively sturdy and the vehicles have little deterioration and/or corrosion.
- The engines are considerably aged.
- Unification of types is facilitated because the engine and hydraulic transmission currently installed are of the same types as those to be mounted on Kiha 40 Series by the repowering. And the unification of types is also possible by the replacement of engine alone, with the hydraulic transmission left unchanged. Therefore, by replacing the engine alone, the cost may be reduced.

With Kiha 40 Series, the components as the objects of repowering include engine and transmission decrepit due to deterioration over time and radiator and compressor that are important for maintaining the vehicle functions. All of them are to be replaced with new ones. Out of vehicles of Kiha 40 Series, those transferred from JR East are not currently equipped with air conditioners. For improved comfort inside the vehicle, there is an option to install new air conditioners. With LE-30, for further reduction in costs, only the engine is to be replaced and all other existing components are to be left for continued use.

To summarize the above, the vehicles type, number of vehicles, and components to be replaced for repowering are as shown on Table 4-3-2.

Table 4-3-2 Vehicles type, number of vehicles, and components to be replaced for repowering

	Vehicle type (transferor)	Number of vehicles (Unit: Car)	Component for repowering			
			Engine	Transmission	Radiator	Compressor
*1	Kiha 40 Series (JR East)	18	**New**	**New**	**New**	**New**
2	Kiha 40 Series (JR Central)	27	**New**	**New**	**New**	**New**
3	LE-30 (Sanriku Railway)	5	**New**	Reuse	Reuse	Reuse

"New" ... Replace with new equipment

"Reuse" ... Continue to use existing equipment

*1: There is an option to install new air conditioners.

Source: Survey team

(3) Study of the contents of repowering work

In the implementation of the repowering work, the following components are to be replaced with new ones to attain the target of making the vehicles usable for an approximate period of 10 years. In addition, since it is required to make the specifications appropriate for the climate of Myanmar, the improvement of cooling performance and other actions of that sort are to be implemented at the same time. Typical components currently assumed include the following:

a) Common item for all vehicles for repowering

- Engine DMF13HZ Series

b) Items for Kiha 40 Series

- Hydraulic transmission TACN-22-1600 Series
- Propeller shaft
- Radiator
- Oil cooler
- Charging generator
- Compressor
- Part of piping (oil, water, air), intake & exhaust pipes
- Part of wiring (control line), engine control box, junction box, jumper couplers
- Fittings and vibration-proof rubbers, including engine mount, equipment mount, piping support, etc.

c) Option item for Kiha 40 Series transfered from JR east

- Air conditioner: engine direct drive indoor-mounted distributed type

What were considered in the selection of major components include the results of the profile investigation, ease of maintenance work, availability of maintenance parts and so forth. Shown below are reasons for the selection of respective major components.

[Engine]

DMF13HZ Series is adopted for the engine, because it is of the same type as DMF13HS and DMF13HZ Series that are very often mounted on existing RBEs. By the unification of the engine type, we intend to reduce the work load of maintenance operations and improve the availability of maintenance parts. Engines of this series have a simple construction and MR is confident of their maintenance. In addition, it is the latest type of engine at this moment and is highly reliable.

We heard from MR that the engines made by Niigata Power Systems involve difficulty about the availability of maintenance parts. As we asked about the availability of parts at RBE Workshop, they answered that the three (3) parts of crankshaft, cylinder head, and connecting rod were difficult to procure. Those parts are not to be replaced in ordinary maintenance. It is considered that the necessity of replacement occurred by some cause attributable to the aging of the entire engine. Other parts than those three (3) are currently available and the problem is being eliminated.

[Hydraulic transmission]

As for the hydraulic transmission, new TACN-22-1600 Series is adopted, because it depends on the engine performance and assembly interchangeability to the engine. Although its type name differs, it is of the same series as C-DW15 that is mounted on Kiha 11 Series from JR Central and so the maintenance work and maintenance parts may be commonized. It is the latest type at this moment. It is widely adopted by railway operators in Japan and is reliable.

[Radiator]

The radiator selected should be one with sufficient cooling performance in the hot weather in Myanmar and having a wide clearance between fins to reduce the risk of clogging because sand dust is likely to be sucked up during operation due to the present conditions of the track.

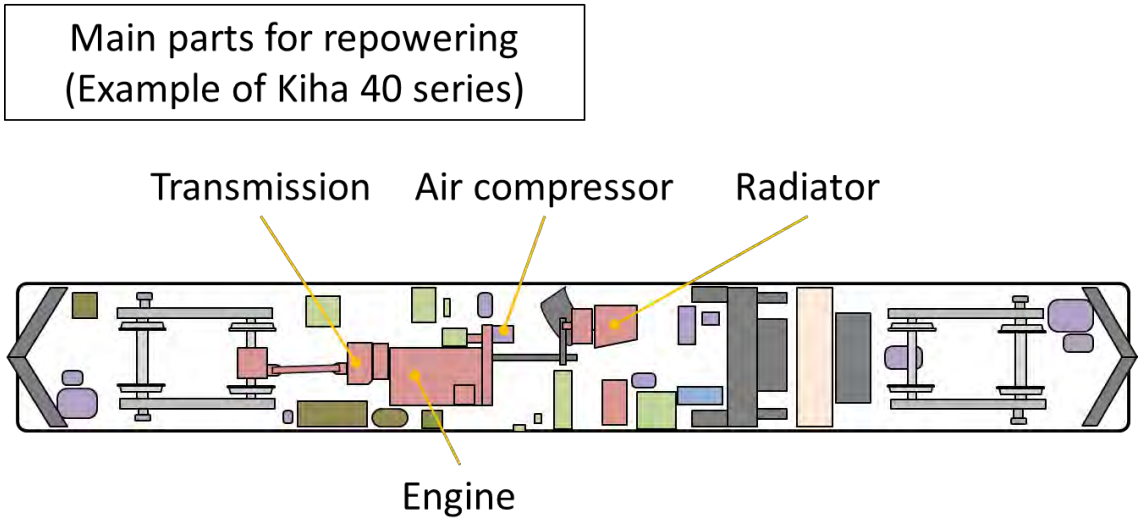
[Compressor]

Type C600 is adopted for the air compressor that generates compressed air as the energy source for air brake and door engine. This type is widely used on existing RBEs. It is simple in construction and has a good maintenance workability. Although its design may be obsolete, it is reliable, commensurately. It can be directly mounted on the DMF13HZ Series engine, which makes the rigging easy.

[Air conditioner]

As for air conditioner, we would propose the engine direct drive system of indoor-mounted distributed type because the modification is easy and the number of parts required is small. With this system, the air conditioning energy (for the compression of refrigerant) is received from the engine used for traveling, the refrigerant is cooled by the condenser installed under the floor, and cool air is blown out through the indoor heat exchanger (evaporator) inside the passenger compartment. MR demands a rooftop-mounted type for the reason that the condenser mounted under the floor tends to collect dust on the filter. However, there is no inspection platform provided at the Depot to get on the rooftop for maintenance and it makes the work difficult. Hence we propose the underfloor-mounted type in consideration of the maintenance workability.

Figure 4-3-4 schematically illustrates the major components as mounted on the vehicle for the case of selecting the above-shown equipment for the repowering.



Source: Survey team

Figure 4-3-4 Schematic view of major components, used for repowering, as mounted on the vehicle

(4) Process of repowering work

Figure 4-3-5 shows the rough process for a single vehicle assumed based on the contents of repowering work we studied.

Work to be done	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week
Removal of equipment and piping	[Rigging 2]							
Ion-working		[Welding 3]			[Welding 1]			
Mounting equipment					[Rigging 3]			
Piping	[Piping 2]				[Piping 2]			
Wiring	[Electrical 2]				[Electrical 2]			
Engine & hydraulic transmission installation							[Rigging 3]	
Functional inspections								[Piping 1] [Electrical 1]

[ ] Indicates a skill type of the worker(s); Number indicates the minimum headcount required.

Source: Survey team

Figure 4-3-5 Proposed basic process of repowering work for a single vehicle

The following describes the contents of respective work to be done.

- Removal of equipment and piping

  Remove unnecessary devices and pipings located under the floor of RBE.

- Ion-working

  Attach fittings to the vehicle by welding for retaining new devices and pipings to be mounted for replacement.

- Mounting equipment

  Mount new devices other than engine and hydraulic transmission.

- Piping

  Mount fuel piping, water piping, air piping and other pipings required.

- Wiring

  Attach wiring necessary for engine control, transmission control, brake control, etc.

- Engine & hydraulic transmission installation

  Mount new engine and hydraulic transmission installation.

- Functional inspections

  Check the functions of equipment related to the work.

The number of workers necessary for the above operations per one car is, as shown on Figure 4-3-5, broken down by the skill as shown below.

Welding workers: 3, piping workers: 2, electrical workers: 2, rigging workers: 3 (total of 10)

(5) Responsibility assignment for repowering work

Table 4-3-3 shows the expected responsibility assignment to MR, a consultant and a contractor for repowering work

The above-shown workers are supposed to be provided by MR. Besides such workers, two (2) technicians from the Japanese manufacturer are required on site during the work period to work, as technical advisors for the execution of work, on the equipment to be installed for repowering . They are necessary to ensure prompt response to any technical trouble that may occur during the repowering work. Besides, they play an important role of providing advice for the quality assurance of the repowering work and for the progress management of the process.

Table 4-3-3 Responsibility assignment for repowering work

	MR	Consultant	Contractor
Tender	X		
Tender assistance		X	
Construction supervision		X	
Preparation of construction document			X
Supply of components for repowering			X
Installation work	X		
Technical advice for installation work			X
Maintenance after installation work	X		
Technical advice for maintenance			X
Supply of spare parts			X

(6) Costs needed for repowering work

Costs described as follow will be needed for the repowering work.

- Costs of equipment and mounting-related parts

  The repowering work currently assumed includes the purchase of engine, hydraulic transmission and other traveling-related major components and the supply of parts necessary for mounting major components. Costs does not include those for the maintenance of bogies and other components not related to travelling, coating of vehicle exterior and interior, and the refurbishment of passenger compartment and driver's cab.

- Spare parts cost

  To ensure consistent operation without any major failure after the completion of the repowering work, the daily maintenance is essential. For that purpose, maintenance parts need to be prepared to meet the daily requirement. In addition, in consideration of any occurrence of a failure on the engine, transmission or such major components that are difficult to repair early, it is recommended that reserved components be kept for such major components. However, since the domestic rules of Myanmar provides that the estimated cost, including that for maintenance parts and reserved components, must be 15% or less of the equipment purchase cost, it is to be kept at a minimum necessary level.

- Equipment and spare parts storage costs

  For the purpose of preventing any loss or theft, it is desired to provide a dedicated storehouse to store the components used for the repowering and parts necessary for the maintenance. While the storehouse is to be installed on the premises of MR, the procurement of the storehouse takes costs. It would be possible to utilize containers, used for transportation, for the storehouses.

- Costs for preparing teaching materials and documentation

  In the execution of the repowering work, teaching materials and documents, such as work manuals and manuals for handling individual components, are indispensable. Such materials and documents are to be developed in Japan, because they can be developed only by Japanese manufacturers that are familiar with the vehicles in question and experienced in the repowering work.

- Technical advisory cost

  As stated above, two (2) technicians from the contractor are required to stay on site during the work period as technical advisors for the execution of work. In addition, the technical advisory from the contractor concerning the whole work at the first installation is required since MR has never executed the repowering installation of Kiha 40 series. The contents of the technical advisory will be the installation works for the engine and transmission as new skills for MR, including welding, piping, rigging, electrical wiring and testing. It is estimated that the first installation at each will take three (3) months because each process is extended by one week.

  It is desired that the vehicles for the technical guidance be decided by the type of vehicles that differ in the content of the repowering work needed. Of the vehicles subjected to the repowering work, Kiha 40 Series, which has different arrangements of underfloor equipment, is divided into three (3) types including:

  - The vehicles with driving cabs on both sides, without air conditioner, transfered from JR East
  - The vehicles with driving cab on one side, without air conditioner, transfered from JR East
  - The vehicles with driving cab on one side, with air conditioner, transfered from JR Central

  Hence, it is desired that the technical guidance be provided with a total of three (3) vehicles, or one vehicle per type.

- Costs for environmental measures

  Asbestos-containing paints were used on railway vehicles that were fabricated before around 1990. Such vehicles include Kiha 40 Series and LE-30 that we selected this time for the work. Asbestos is contained in a paint called underseal that is used for the underfloor and indoor heat insulation. In the repowering, the mounting positions will change from the current due to the changes in the outer dimensions of the engine and other major components. As a result, the underseal needs to be removed from part of underfloor section. Since the removal of asbestos-containing paint requires the prevention

of scatter to external environment, proper measures must be taken to that end, including: Install a dedicated booth enclosure; Have workers operating in the booth wear dust-protective mask and protective clothes, and; Manage the storage of removed wastes. The removal of asbestos-containing paint needs to be conducted by MR's workers under the guidance of a contractor with proper expertise. Hence it takes costs.

That guidance of work is to be conducted for the first three (3) vehicles for a period of approximately two (2) weeks, with three (3) instructors working per vehicle.

- Facility equipment

It depends on the place where the repowering work is conducted, but the execution of the work requires the provision of appropriate facility equipment. Specifically, the work requires a table lifter that has a capacity of lifting up to 5 tons to lift the engine and hydraulic transmission for installation under the floor. Since, as a result of the investigation at the Workshops of MR, it was confirmed that they own such necessary facility equipment, we assume at this moment that no equipment needs to be purchased anew. Additionally, crimping tools are required for electrical wiring connection. But, since the amount involved is small, it should be possible for MR to purchase them.

(7) Study of overall schedule of the repowering work

- Study of overall schedule of the repowering work

The repowering work is assumed to start with five (5) vehicles of LE-30 for which only the engine is to be replaced for repowering. And after the technical guidance for three (3) vehicles at the first installation work of each kind of Kiha 40 Series, the repowering work for the remaining 42 vehicles will start. In the work on the remaining 42 vehicles, the period of the repowering work may be shortened by an increase in the number of lines. Besides, by the concentrated work, the operating efficiency of workers is expected to improve. While increasing the number of lines requires the enhancement of the facility equipment, shifting the process between vehicles makes it possible to efficiently use the facility equipment and to increase the work capacity at the same time. Here we show the results of study on the lines of repowering work. The facility equipment necessary for the work will be discussed at the part "Selection of the site of repowering work".

As we calculated the number of worker, period of work and so forth for the number of lines, the results shown on Table 4-3-4 were obtained.

From this table, you will see that the use of four (4) lines is the most desired in terms of the worker efficiency because the Man-Month for workers is the smallest. For that reason, we propose the use of four (4) lines for the repowering work.

Table 4-3-4 Comparison among different numbers of lines for the repowering work on 42 RBEs

Number of lines	Number of workers (Proposed)	Period of work (approx.)	MM for workers (approx.)
1	12	Approx. 6 years 7 months	Approx. 930 MM
2	19	Approx. 3 years 5 months	Approx. 754 MM
3	27	Approx. 2 years 4 months	Approx. 714 MM
4	34	Approx. 1 year 9 months	Approx. 679 MM
5	41	Approx. 1 year 6 months	Approx. 688 MM

* MM: (number of workers) x (months for work)

Source: Survey team

Based on such results, the overall schedule after the start of the work is assumed as shown on Figure 4-3-6 and the work will be completed after 30 months.

Car Type	Number of vehicles	Year1				Year2				Year3	
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
LE-30	5										
Kiha 40 Series (The first installation work of each kind)	3										
Kiha 40 Series	42										

Source: Survey team

Figure 4-3-6 Overall schedule after the start of the repowering work

- Number of workers for the execution of repowering work

Assuming a work period of 2 months per vehicle and the use of four (4) lines, the minimum headcounts of MR workers are as follows:

Welding workers: 8, piping workers: 9, electrical workers: 9, rigging workers: 8 (total of 34)

As for the technical guidance instructors from a contractor, we estimate that a cumulative total of approximately 78 MM will be necessary in the work period.

Breakdown of 78 MM:

- Technical guidance in the work period (for all 50 vehicles)

... 2 persons x (9 months + 21 months) = 60 MM

- Additional technical guidance in the first work period (only for the first 3 vehicles)

... 2 persons x 9 months = 18 MM

(8) Selection of the site of repowering work

When planning the repowering work, the following are the points for the selection of work site.

- Work space

  Work space can be secured for the execution of repowering work.

  - RBE vehicles may be set stationary for a period of two (2) months.
  - Four (4) RBE vehicles can be subjected to repowering work at the same time for a period of approximately 2 years.
  - Space for the part mounting work must be available around the vehicle that is set stationary
  - The material storage space is available during the work period.

- Facility equipment

  The facility equipment for the repowering work is prepared ready for use.

  - Provided with facility equipment necessary for the fabrication of fittings and jigs related to the installation of components for the repowering.
  - Provided with welding equipment.

- Logistics

  It is easy to transport parts that are used for the repowering.

  - The transport of import parts from Japan is easy.

- Underfloor work

  Technicians are sufficiently skilled for the repowering work.

- Vehicle body work

  Technicians are sufficiently skilled for the repowering work.

Based on all that, we compared the Workshops for the appropriateness as the site of repowering work and Table 4-3-5 summarizes the results.

Table 4-3-5 Comparison among 4 Workshops of Myanma Railways for the execution of repowering work

	Myitnge Workshop	Ywahtaung Workshop	Insein Workshop	RBE Workshop
Work space	A	C	A	C
Facility equipment	A	A	A	B
Logistics	B	B	A	A
Underfloor work	B	A	A	A
Vehicle body work	A	B	B	A
Overall evaluation	Suited	-	Best suited	-

Legend
A: Compatible
B: Involve issues
C: Difficult

Source: Survey team

From the results of comparison shown on Table 4-3-5, Insein Workshop is considered the best suited. The largest factors for the selection of Insein Workshop are the excellence of its facility equipment, excellence

of locational conditions, and skills of underfloor work accumulated as a locomotive workshop. Figure 4-3-7 shows the candidates for the site of setting RBE vehicles during the repowering work, as studied by the Survey Team. As you can see on the figure, Ywahtaung Workshop and RBE Workshop are already engaged in the maintenance and modification work of many vehicles and it would be difficult for them, excluding Insein Workshop and Myitnge Workshop, to secure sufficient space for an extended period of time.

Concerning Myitnge Workshop that is considered the second best, since it is distant from Yangon Port, which is the center of Myanmar's maritime logistics, it has a disadvantage of increased transportation distance within Myanmar. But it is no necessarily a big issue. As seen from the underfloor work skills point of view, it also has an issue that it has no experience in the work of mounting engine and other major components. But the issue may be solved by gathering experienced technicians from other workshops. For the equipment of the facility, the conditions are the same at any workshop as shown on Figure 4-3-8 and Figure 4-3-9.

As a result of the above-shown study, we decided that Insein Workshop is the best for the site of repowering work. If some appropriate measures are taken, however, Myitnge Workshop can also be a good candidate.

Myitnge Workshop
(rigging space of the passenger coach fabrication workshop)

Ywahtaung Workshop
(vehicle body shop)

Insein Workshop
(extension of engine rigging shop)

RBE Workshop
(inside the main repair shed)

Source: Survey team

Figure 4-3-7 Candidate Workshops for the site of repowering work (place for setting the vehicles)

Myitnge Workshop (temporary bogies)

Ywahtaung Workshop (support frame)

Insein Workshop (support frame)

RBE Workshop (lifting jack)

Source: Survey team

Figure 4-3-8 Underfloor work equipment of different Workshops (vehicle body supporting equipment)

Myitnge Workshop

Ywahtaung Workshop

Insein Workshop

RBE Workshop

Source: MR's document on the outline of Insein Workshop, Survey Team

Figure 4-3-9 Equipment of different workshops (machine tool)

5 Suggestions on RBE repowering project

5.1 Study on implementation of RBE repowering

(1) Challenges to be solved and suggestions

As already described, RBEs have some challenges to be solved shown as follows.

- 119 cars of RBE in urban area, including 18 cars for Yangon Circular Railway, will be required even after the introduction of the new type of DEMU.
- In 2021, 54 cars of RBE will become deficient because of failure caused by aging degradation.
- Prediction for used RBE supply from Japan is difficult.
- Additional purchase of DEMU may be difficult because of capital shortfall.

As solutions for them, we suggest securing required RBE by repowering and extension of lifetime.

(2) Necessity, adequacy, and effectiveness of the project

<Necessity>

Because of failures due to aging degradation of RBE, number of the vehicles which cannot run increased rapidly, and it is supposed that continuous purchase of RBE in the future becomes difficult. Therefore, repowering work for about 50 vehicles of RBE becomes necessary until 2021. However, because financial arrangements under MR's own power regarding the repowering work is difficult, it is considered that support by a foreign country becomes necessary.

<Adequacy>

Introduction of the diesel electric multiple unit (DEMU) is planned by support of the Japanese financial cooperation project for the “Yangon-Mandalay Railway Improvement Project” and “Yangon Circular Railway Line Upgrading Project.” However, since RBE still continuously becomes indispensable presence in MR’s urban area transportation and intercity transportation, the support for repowering work of RBE is considered as adequate.

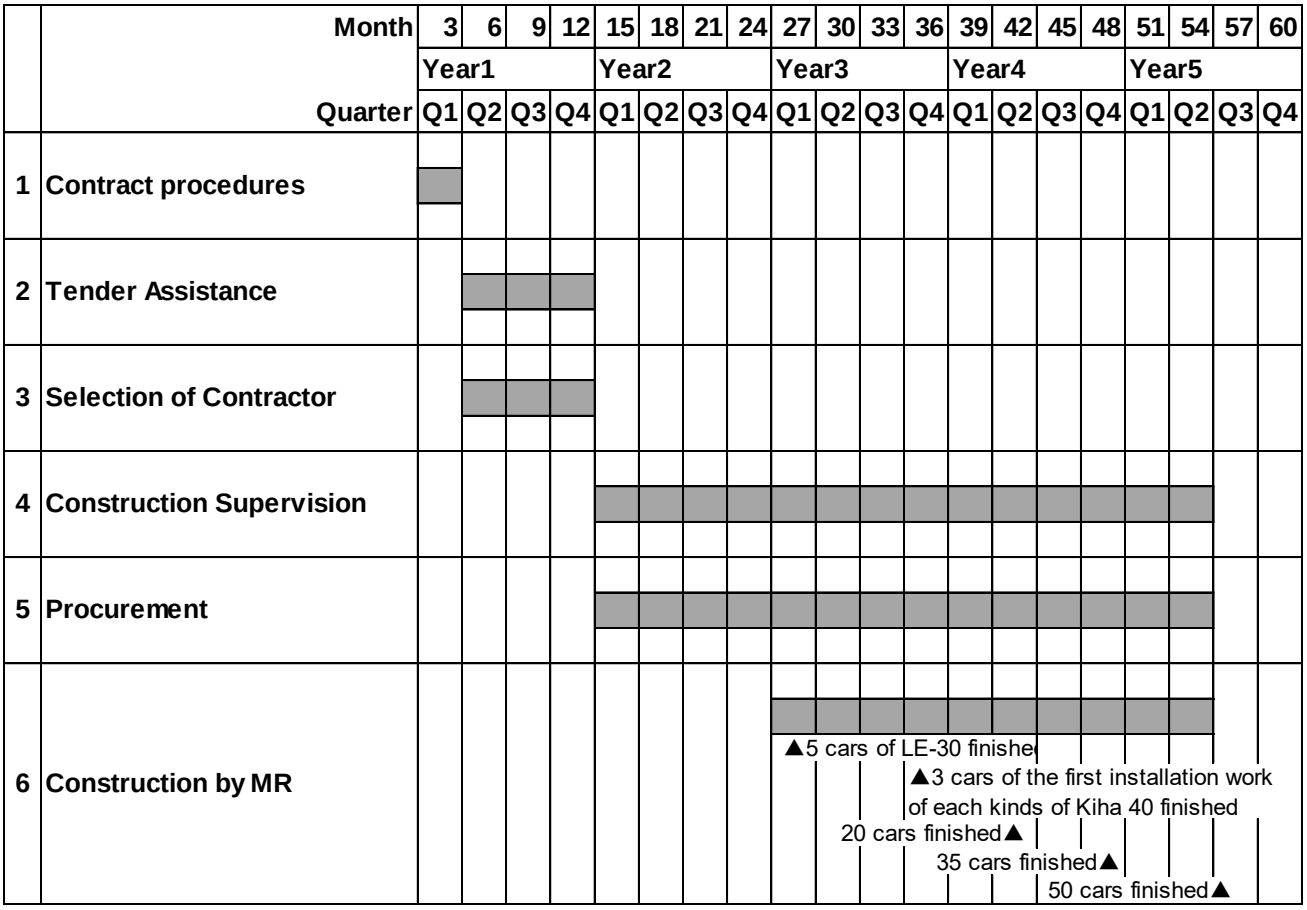
<Effectiveness>

It is considered that the support for repowering work of RBE can prolong the life of RBE for approximately 10 years, and contributes to improve stability of MR’s urban area transportation and intercity transportation. Moreover, since indigenous railway technologies of Japan are indispensable for the repowering work of RBE, it is supposed that utilization of Japanese railway technologies will be promoted and it will become the foothold of introducing Japanese railway technologies, in the future. Furthermore, the 18 vehicles of Kiha 40 Series which are the target of repowering work of RBE are applied to the vehicles of RBE required for the “Yangon Circular Railway Line Upgrading Project,” they also contribute to the “Yangon Circular Railway Line Upgrading Project.” From above-mentioned matters, it is considered

that effectiveness of support regarding the repowering work of RBE is high.

(3) Execution schedule of the project

Figure 5-1-1 shows execution schedule plan of the project. Overall project term including contract procedures and tender assistance is 55 months in total.



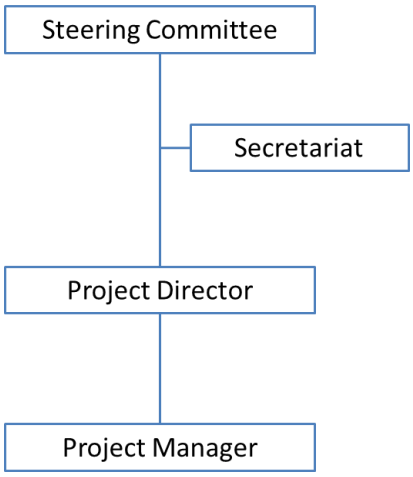
Source: Survey team

Figure 5-1-1 Execution schedule plan of the project

5.2 Study on the implementation system for RBE repowering

(1) Basic study of MR implementation structure for repowering

The repowering installation will be executed by MR and the MR implementation structure for repowering shows Figure 5-2-1.

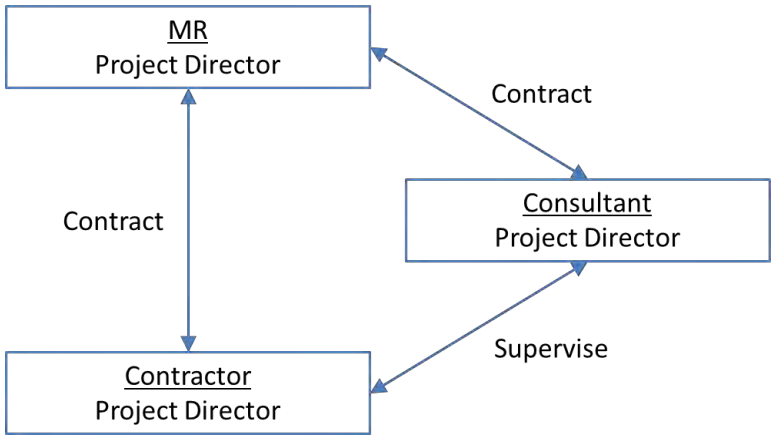


Source: Survey team

Figure 5-2-1 MR implementation structure for repowering

(2) Basic study of project system for repowering

The project system for repowering shows Figure 5-2-2 considering the relationship between the contractor and the consultant for the construction supervision.



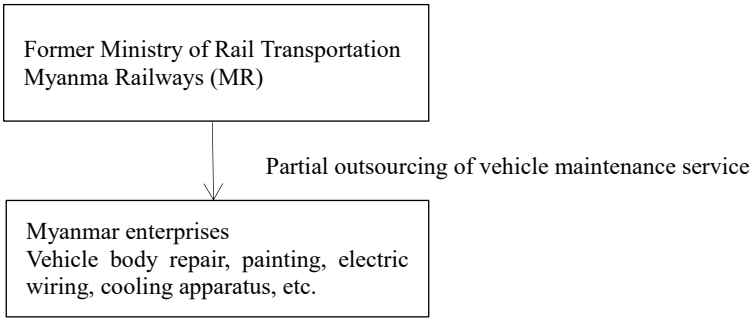
Source: Survey team

Figure 5-2-2 Project system for repowering

(3) Study of introducing power of the private sector for maintenance service after repowering

- MR's present status of utilizing the private sector for vehicle maintenance service

MR is the railway governing structure directly controlled by the former Ministry of Rail Transportation, and since the expenditure is significantly exceeding the revenue, the deficit is indemnified by the government of Myanmar. Presently, outsourcing of vehicle body repair, vehicle body painting, electric wiring, cooling apparatus repair, etc. to the Myanmar's enterprises is performed, regarding the vehicle maintenance of RBE in MR. The reason is that hiring of staff is controlled due to deficit operation of MR, and thus, present number of staff is significantly smaller than the fixed number, in the RBE workshop and Insein DRC Depot. In order to supplement this lack of staff, outsourcing of partial work is performed.

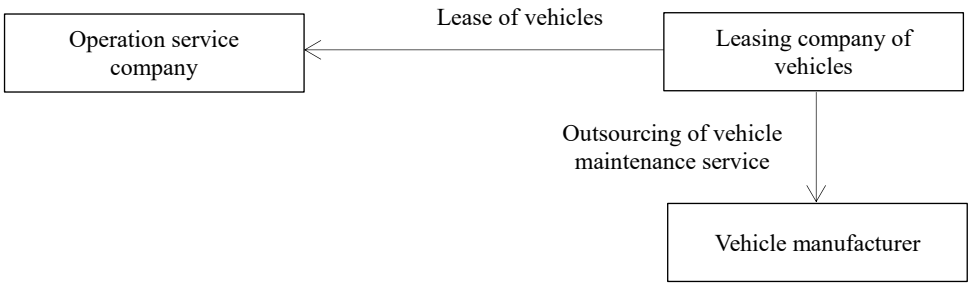


Source: Survey team

Figure 5-2-3 MR's present status of utilizing the private sector for vehicle maintenance service

- Case example of utilizing the private sector for vehicle maintenance service in England

In the intercity transportation of England, vertical separation of the railway has been implemented, and there are case examples where infrastructures are possessed by national enterprises as well as public enterprises, and power of the private sectors is introduced in train operation services. Railway vehicles are possessed by leasing companies of vehicles, and private enterprises which are entrusted with operation services operate the vehicles by leasing them from the leasing companies of vehicles. Regarding the vehicle maintenance service, leasing companies of vehicles are outsourcing to the vehicle manufacturers from which the vehicles were purchased. Therefore, since the costs for vehicle maintenance service are born by the leasing companies of vehicles, the costs are reflected on the lease expense payed by the operation service companies to the leasing companies of vehicles. From the above-mentioned matters, there is a tendency that the costs for vehicle maintenance service become higher than the case where the operation service companies directly entrust vehicle maintenance to the vehicle manufacturers. Furthermore, since the costs for vehicle maintenance service are fixed without being affected by the fluctuation risk of railway fare revenue, the operation service companies take the risk. In these case examples of utilizing the private sector, it is the premise to introduce the lease system of vehicles. However, there is a merit for the operation service companies that the vehicle lease system does not require the money to procure the vehicles.

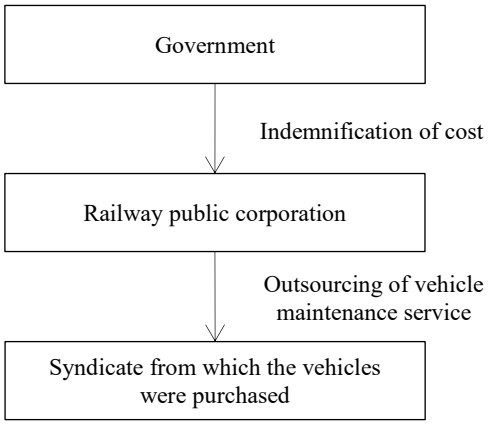


Source: Survey team

Figure 5-2-4 Case example of utilizing the private sector for vehicle maintenance service in England

- Case example of utilizing the private sector for vehicle maintenance service in Thailand

In part of urban area transportation in Thailand, the railway public corporation that performs railway administration possesses vehicles, and it is adopting the system where the vehicle maintenance service is entrusted to the syndicate (combination of enterprises) from which the vehicles were purchased. Therefore, the costs for vehicle maintenance service are born by the railway public corporation that performs railway administration. However, although the costs for vehicle maintenance service are fixed without being affected by the fluctuation risk of railway fare revenue, when revenue and expenditure becomes deficit balance, it is indemnified by the government. Accordingly, the railway public corporation that performs railway administration does not take the risk. In this case, the system of indemnification by the budget of government becomes necessary.



Source: Survey team

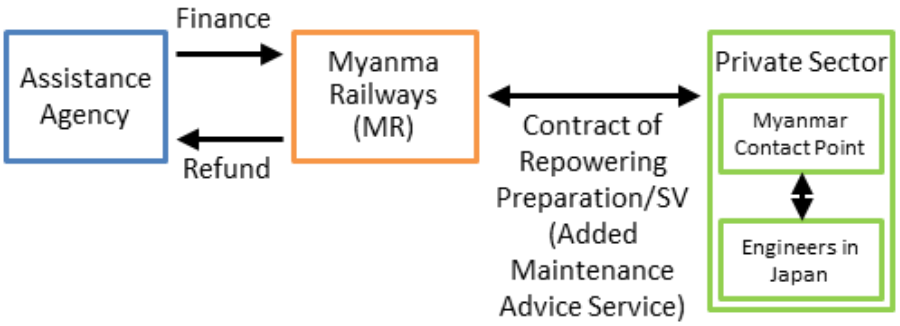
Figure 5-2-5 Case example of utilizing the private sector for vehicle maintenance service in Thailand

(4) Comparison study of implementation organization for repowering and maintenance

A comparison study of implementation organization and working scope was performed with regard to repowering and maintenance for repowered parts. The contents of the proposal are as follows.

- Plan 1: Repowering preparation/supervision & added maintenance advice service

Based on support from an assistance agency, MR will order and make contracts with the private sector about repowering design, parts procurement, and training and supervision. Maintenance advice is also added as an unpaid service. From after termination to semi-overhaul, the contractor will be expected to advise MR about how to take action when problems occur with repowered parts.

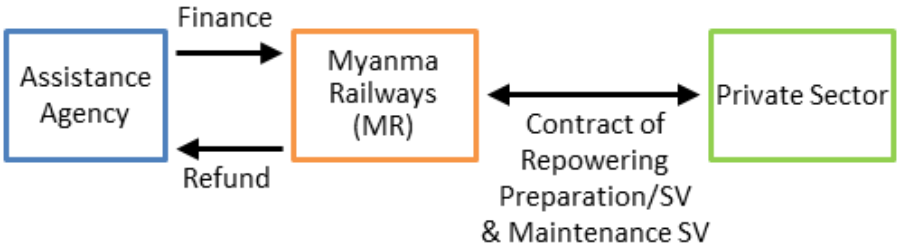


Source: Survey team

Figure 5-2-6 Implementation organization on Plan 1

- Plan 2: Repowering preparation/supervision & maintenance supervision

Based on support from an assistance agency, MR will order and make contracts with the private sector about design, parts procurement, training and supervision of repowering, and supervision of maintenance. Loans will cover payment for the contract period of maintenance supervision. MR will continue on its own budget after termination.



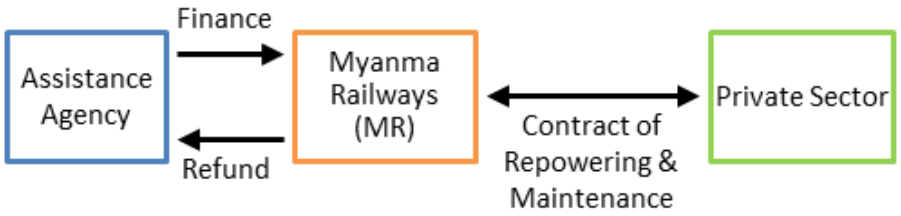
Source: Survey team

Figure 5-2-7 Implementation organization on Plan 2

➢ Plan 3: Repowering work & maintenance work

Based on support from an assistance agency, MR will order and make contracts with the private sector about repowering and maintenance. Loans will cover payment of service fees* during the maintenance contract period. MR will continue on its own budget after termination.

*Service fees: Regarding maintenance services to be paid based on rolling stock operating performance.



Source: Survey team

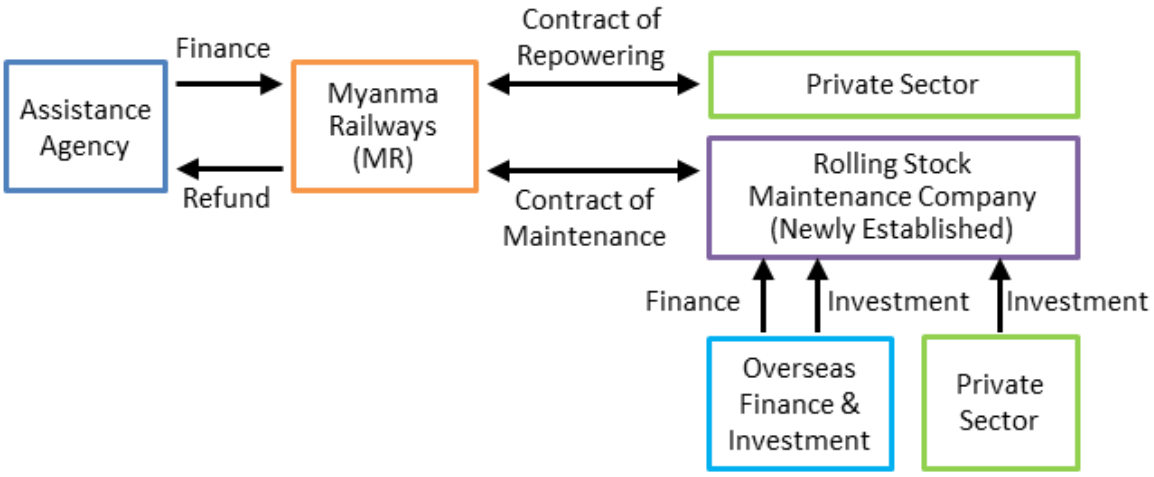
Figure 5-2-8 Implementation organization on Plan 3

➢ Plan 4: Repowering work & maintenance company establishment

Based on support from an assistance agency, MR will order and make contracts with the private sector about repowering, and with a newly established local company about rolling stock maintenance. Loans will cover payment of service fees* during the maintenance contract period. MR will continue on its own budget after termination.

The local company for rolling stock maintenance will be supported through overseas financing and investment.

*Service fees: Regarding maintenance services to be paid based on rolling stock operating performance.



Source: Survey team

Figure 5-2-9 Implementation organization on Plan 4

For each of these plans, the comparison results in terms of advantages and disadvantages, project success, and sustained growth are as follows.

- Plan 1: Repowering preparation/supervision & added maintenance advice service

  In terms of project success, as an advantage, the risks of repowering quality will be mitigated by supervision. As a disadvantage, the risks of repowering process extension will be suppressed by supervision to MR staff, and risk of maintenance quality and process will be depended on MR's skill. (Advisory services can help avoid some risks.)

  In terms of sustained growth, as an advantage, added experience in repower and maintenance will develop some of MR's technical skills. Meanwhile, in cases where maintenance advice is not required, MR will not develop its technical skills by continuing its own style of maintenance.

- Plan 2: Repowering preparation/supervision & maintenance supervision

  In terms of project success, as an advantage, the risks of repowering and maintenance quality will be mitigated by supervision. As a disadvantage, the risks of repowering process extension will be suppressed through supervision of MR staff.

  In terms of sustained growth, as an advantage, MR will work on its own to develop technical skills for repowering and maintenance. There are very high expectations for these effects.

- Plan 3: Repowering work & maintenance work

  In terms of project success, as an advantage, the risks of quality and process will be mitigated for both repowering and maintenance.

  In terms of sustained growth, as a disadvantage, MR's technical skills will not be developed for either repowering or maintenance because the work is provided by the private sector.

- Plan 4: Repowering work & maintenance company establishment

  In terms of project success, as an advantage, the risks of quality and process will be mitigated for both repowering and maintenance.

  In terms of sustained growth, as an advantage, the technical skills of the established local company will be developed. Also, cooperation with the local company will continue when extension and expansion of maintenance works are required in the future. As a disadvantage, maintenance work will be divided between MR and the newly established company. Then, there will be consideration about keeping technicians.

Implementation organization of repowering and maintenance will be planned and determined with consideration to the advantages and disadvantages described above.

6 Suggestions on RBE maintenance technical assistance

6.1 Confirmation of needs for RBE maintenance technical assistance

The technical support regarding maintenance & management of RBE and DEMU has been requested by MR. The survey team studied/investigated the technical support plan considering utilization of Japanese railway technologies based on the tasks with regard to maintenance & management of MR, then consulted with MR, and organized the technical assistance plan, focused on reinforcement of maintenance & management system as well as improvement of skills regarding the maintenance & management of RBE and DEMU.

6.2 Study on the contents of RBE maintenance technical assistance

(1) Background

As part of vehicle modernization of the Myanmar's main line (Yangon - Mandalay) and Yangon Circular Railway Line, the railway improvement project by Japan's ODA has been promoted, and at present, introduction of the new diesel electric multiple unit (DEMU) is under study. In order that the DEMU is smoothly introduced into Myanmar Railways (MR), then subsequent maintenance is surely implemented, and operation at the running level of 100 km/h currently planned is realized, it is necessary to perform technical support required for maintenance & management, and to raise the technical level of MR regarding DEMU, in advance.

Furthermore, as for the "Yangon-Mandalay Railway Improvement Project," introduction of DEMU and construction of the Ywathagyi Workshop for vehicle maintenance which can handle both of DEMU and RBE are planned, in concert with the event that the RBE workshop in charge of overhauling the diesel railcars made in Japan (RBE) is relocated along with the development of areas around the Yangon station. Along with introduction of DEMU and construction of the Ywathagyi Workshop, it is necessary to promote modernization of vehicle maintenance.

On the other hand, diesel railcars made in Japan (RBE) which were used in Japan have been serially imported to MR since 2003, and at present, about 250 vehicles of RBE are registered (as of March 2016). RBE is used for the loop line and suburban railway lines in Yangon, and for important passenger vehicles at each railroad section from local cities. However, because suitable maintenance has not been done, failures continuously occurred within less than several years since imported from Japan, and about 90 vehicles remain seceded from operation due to failures.

In order to improve this situation, it is necessary to implement suitable maintenance at first, not by the

breakdown maintenance system, but by the correct system adapted to RBE (preventive maintenance system). Regarding these matters, the technical support in order to enable them by self-help efforts of MR on its own has been strongly requested by the Myanmar side. (It was expressed at the time when Mr. Than Htay, then-Union Minister for Rail Transportation visited Japan in May 2014, and since then, the request by MR has been continuing.)

For responding to the request, it is indispensable to implement the technical assistance that can promote reinforcement of the maintenance & management system as well as improvement of maintenance & management ability of MR itself toward RBE. This approach is not only directly connected to the technical support for maintenance & management of new-type DEMU which becomes the major passenger vehicle in Myanmar from now on, but also it contributes to solve present problems of RBE.

(2) Challenges to be solved and suggestions

As already described, RBEs have some challenges to be solved shown as follows.

- General enhancement of rolling stock maintenance framework to modernize rolling stock maintenance corresponding to the structure plan for Ywathagyi Workshop associated with the introduction of DEMU
- Improvement of maintenance skills for rolling stock modernization corresponding to the DEMU introduction plan

As solutions for them, we suggest things to do shown as follows.

- Construction of a framework for rolling stock maintenance and management- Enforcement of knowledge and skills about rolling stock maintenance and management
- Organizing of a framework for human resource development regarding maintenance and management

(3) Purpose of the technical support program regarding vehicles

a) “Reinforcement of vehicle maintenance framework” responding to introduction of new-type DEMU and the Ywathagyi Workshop

In order to establish the maintenance framework toward introduction of new-type DEMU in MR, it is necessary to instruct the administration know-how regarding the vehicle maintenance, such as the maintenance (inspection and repair) system, mechanism, rules, organization, budget, etc. In this project, the training course is implemented, with regard to reinforcement of the maintenance framework responding to introduction of new-type DEMU and the Ywathagyi Workshop.

By this training course, the maintenance framework on the premise of preventive maintenance for diesel railcars made in Japan (including new-type DEMU & RBE) is established in MR, and by subsequent self-help efforts of MR, suitable maintenance of diesel railcars made in Japan is implemented, and necessary passenger transportation is secured.

b) “Improvement of vehicle maintenance skills” in preparation for introduction of new-type DEMU

In the training course of “Improvement of vehicle maintenance skills” in preparation for introduction of new-type DEMU, the technical education utilizing actual vehicles is necessary, in addition to the education of basic knowledge for executing the vehicle maintenance work. In the education of basic knowledge, education of the basic vehicle structure and mechanism are educated, aiming at advancement of the smooth introduction of DEMU. In addition, because there are many parts which are common to electric cars, the education regarding the maintenance of electric apparatus is also performed, by using the examples of electric car maintenance performed in Japan. Moreover, since there is also a plan to perform high-speed operation at the running level of 100 km/h in the future, education of the brake system, etc. is also carried out. Furthermore, since the RBE presently introduced has many similar points to the new-type DEMU, the training course is implemented to acquire the series of operation procedures of the daily periodical inspection (daily inspection, regular inspection) and extensive disassembling inspection (important parts inspection, general overhaul) by utilizing the existing RBE, in the practice form.

By above-mentioned series of training courses, base of the maintenance on the premise of preventive maintenance for diesel railcars made in Japan (including new-type DEMU & RBE) is established in MR, and by subsequent self-help efforts of MR, suitable maintenance of diesel railcars made in Japan is implemented, and necessary passenger transportation is secured.

Also, by inviting the human resources who become the core of vehicle maintenance operation in MR, and through real experiences of maintenance work in the Japanese vehicle maintenance workshop, etc., understanding of Japanese maintenance technologies is got to be deepened, and education in Myanmar is complemented.

(4) Operational planning

a) Training course about “Reinforcement of the vehicle maintenance framework”

<u>Training course in Myanmar</u>

- The training course regarding formulation of the maintenance framework (organization, budget, etc.) is implemented, by targeting the manager class of headquarters and worksite of MR.
- The training course regarding formulation of the maintenance system & rules (inspection cycle, inspection items, etc.) is implemented, by targeting the manager class of headquarters and worksite of MR.
- Number of students shall be about 10 members, each time.
- After the training course, MR shall formulate the maintenance framework, maintenance system & rules by itself, and perform follow-up in accordance with the implementation status.

Table 6-2-1 Plan of contents of the training course for "Reinforcement of vehicle maintenance framework" (to be implemented in Myanmar)

Contents
Prior consultation with MR (schedule, contents, place of meeting, etc.)
Training course regarding the formulation of maintenance framework
Training course regarding the formulation of maintenance system & rules
Follow-up after training course and at implementation

Source: Survey team

Training course in Japan

- Training course for real experience of operations with regard to formulation of the maintenance framework is implemented.
- Entire contents shall be as shown in the following Table.

Table 6-2-2 Plan of contents of the training course for "Reinforcement of vehicle maintenance framework" (to be held in Japan)

Contents	Time period	Target of participants
Visit to the headquarters, etc. by the accepted railway business operator	1 month	Staff member of MR (Manager class of headquarters & worksite)
Practical training at a depot		
Practical training at a vehicle maintenance workshop		

Source: Survey team

b) Training course about "Improvement of the vehicle maintenance skills"

Training course in Myanmar

- By using the actual vehicle of RBE as a target, the procedure of main work in the depot, such as daily inspection, regular inspection, improvement of troubleshooting capability, etc. are taught in the practice form. The target of students shall be engineers & technical personnel of the depot, and the number of persons shall be about 10 people, each time.
- By using the actual vehicle of RBE as a target, a series of work procedures (disassembling, maintenance, assembling) in the vehicle maintenance workshop, such as at important parts inspection, general overhaul, etc. are taught in the practice form. The target of students shall be the engineers & technical personnel of the vehicle maintenance workshop, and the number of persons shall be about 10 people, each time.
- Basic construction, mechanism of DEMU, and maintenance of electric apparatus are lectured in the style of education on the desk. The students shall be the engineers & technical personnel, who are probably assigned to the Ywathagyi Workshop in the future, and the number of persons shall be about 30 people, each time.
- After the training course, MR shall perform proficiency training by itself, and follow up depending on

the implementation status.

- The manuals required for each inspection, jigs & tools, and materials that require replacement shall be prepared as educational materials for the training course, based on the actual achievement in Japan.
- When implementing the education, cooperation shall be requested to the respective railway companies.

Table 6-2-3 Plan of contents of the training course for "Improvement of vehicle maintenance skills" (to be implemented in Myanmar)

Contents
Prior consultation with MR (schedule, contents, place of practical training, etc.), investigation about the place of practical training (equipment, tools, etc.)
Training course of daily inspection, regular inspection
Training course of troubleshooting, failure handling
Training course of important parts inspection, general overhaul
Education about basic structure of DEMU, and maintenance of electric apparatus
Follow-up after training course and at implementation

Source: Survey team

Training course in Japan

- As targeted at the railway vehicle engineers & technical personnel who are the core of MR, the training course is held at the vehicle maintenance workshops of railway companies, etc., where maintenance work is experienced.
- Entire contents shall be as shown in the following Table.

Table 6-2-4 Plan of contents of the training course for "Improvement of vehicle maintenance skills" (to be held in Japan)

Contents	Time period	Target of participants
Visit to the headquarters, etc. by the accepted railway business operator	1.5 months	Staff member of MR (in charge of vehicle maintenance)
Practical training at a depot		
Practical training at a vehicle maintenance workshop		

Source: Survey team

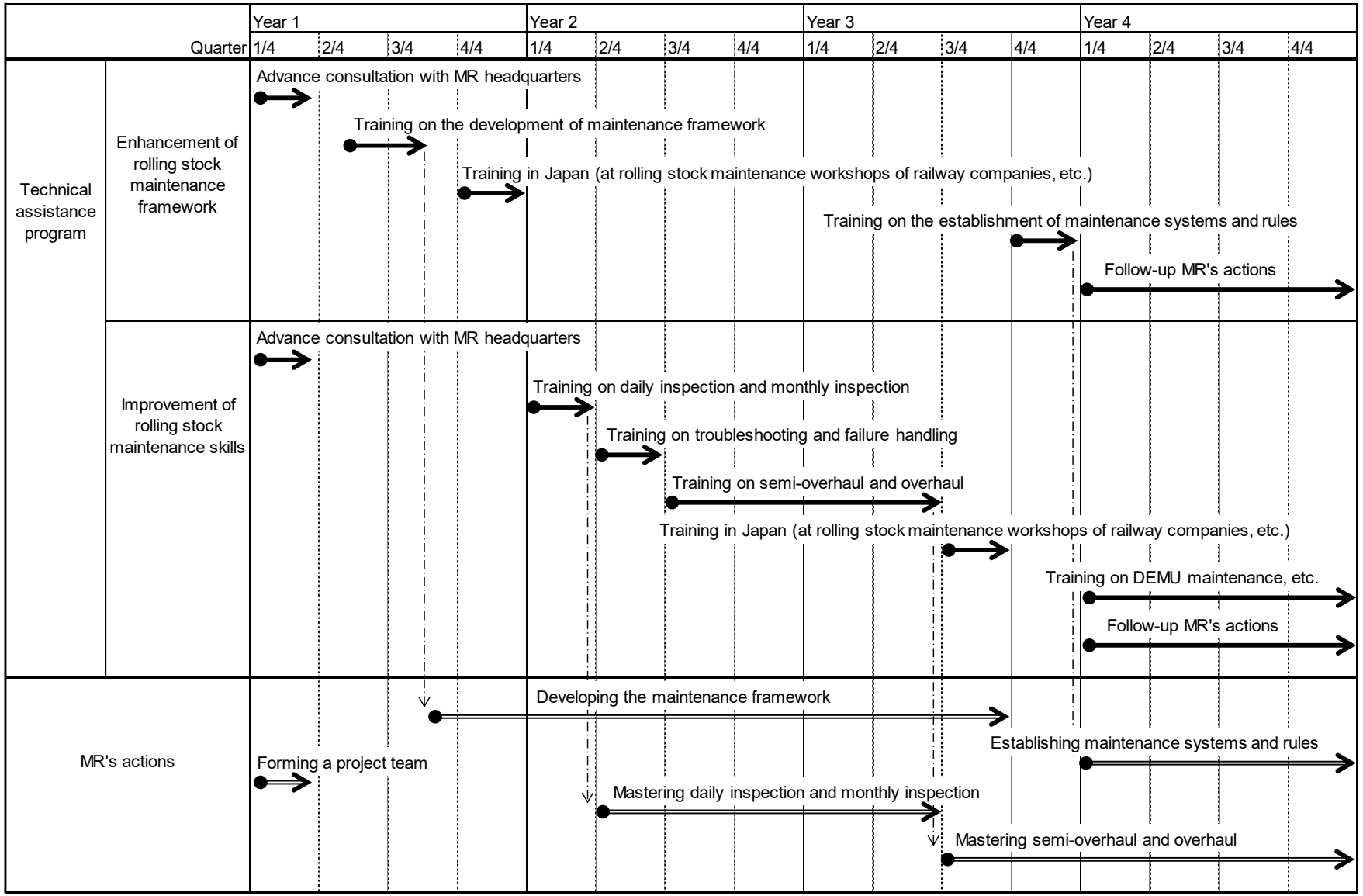
(5) Business management and procurement planning

- In order to implement the above-mentioned technical support, the total business management (including procurement planning) becomes necessary.

(6) Entire schedule

It shall be as shown in Figure 6-2-1.

Entire Schedule of Technical Assistance for Rolling Stock Maintenance in Myanmar



Source: Survey team

Figure 6-2-1 Entire schedule of technical assistance

7 Conclusions and suggestions

7.1 Results of survey and points to consider

In this survey, collection and analysis of the information about the present state and maintenance & management of RBE possessed by MR have been performed. Furthermore, based on the analysis & consultation with MR, and considering utilization of Japanese railway technologies, study of the RBE repowering project and study of the RBE maintenance technical assistance have been performed.

Regarding the RBE repowering project studied in this survey, the plan of RBE repowering including the target and quantities is proposed based on the result of the profile survey of RBE at each MR organization considering the MR request. Moreover, if supply of the second-hand (used) vehicles from Japan which has been currently carried out is continued also in the future, since the purchase price of second-hand vehicles is much lower than the repowering cost, there is a possibility that purchase of the second-hand vehicles may be chosen, even the life is shorter. Anyway, MR shall judge gradually in a careful manner. And the draft plan of the contents, process, location, and MR manpower is developed based on the discussion with MR. The preliminary calculation of the cost of the procurement for repowering is conducted considering the information from the Japanese company that expresses the interest. It is thought that the cost adequacy will be reviewed and examined at the further study such as feasibility study.

Furthermore, regarding the RBE maintenance techinical assistance studied in this survey, technical support for enhancement of the maintenance framework and improvement of knowledge & skills of the RBE & DEMU has been studied. The enhancement of the maintenance framework will contribute significantly to the preparation for new Ywathagyi workshop as the general workshop for RBE and DEMU. In the improvement of knowledge & skills, the knowledge & skills for maintenance of entire field concerning the RBE 250 cars from Japan and DEMU introduced hereafter will be transferred to MR. Moreover, the proposed project is considered so that MR itself will be able to develop the human resources of rolling stock maintenance continuously. However, in order that MR can perform maintenance & management independently even after completion of the technical support, establishment of the framework including budget and manpower in MR is indispensable. Accordingly, when the technical assistance is implemented, confirmation about establishing the framework of these matters in MR becomes important.

In addition, because there is a possibility that a part of this basic written material is used for examination for implementation of the project, it is necessary to continuously pay attention to the handling of information also from now on. Moreover, although consideration has been made so that the misunderstanding as if these results of study are implemented without change, shall not be given to the relevant members of Myanmar Government, it is necessary to pay attention also from now on.

7.2 Suggestions

In MR, RBE is the keystone of urban area transportation and intercity transportation which support economic development of Myanmar, and at the same time, it is the important management resources to promote modernization of railways. Accordingly, it is necessary that MR undertakes the task of improvement for maintenance and management that support operation of the RBE, by its self-help efforts, and that also the Myanmar Government which has the power to make a decision of budget & manpower of MR, understands the importance of maintenance and management of RBE, for railway modernization which are directly connected to economic development of Myanmar.

Furthermore, as the important factors to make a success of the “Yangon-Mandalay Railway Improvement Project” and “Yangon Circular Railway Line Upgrading Project” by Japanese yen credit, maintenance & management of the diesel electric multiple unit (DEMU) which is planned to be newly introduced, and formulation of maintenance framework in the new Ywathagyi Workshop can be mentioned. Thus, it is indispensable for MR to formulate the maintenance & management framework which is sustainable by self-help efforts of MR, until introduction of the diesel electric multiple unit (DEMU), and it is desired that necessary support is appropriately provided from Japan.

Appendix: Profiles of the RBEs

PROFILE of the RBEs (1)

No.	Car No. (Called by MR)	Depot	Car series No. (Called in Japan)	Car No. (Called in Japan)	Owner before transfered	Date of manufacture	Manufacturer
1	RBE-2501	Kawlin	LE-20	LE-21	Nagoya Railroad	1987/08/26	Fuji Heavy Industries
2	RBE-2502	Ywahtaung Workshop	LE-20	LE-22	Nagoya Railroad	1990/05/28	Fuji Heavy Industries
3	RBE-2503	Pyinmana	LE-20	LE-23	Nagoya Railroad	1990/05/28	Fuji Heavy Industries
4	RBE-2504	Insein DRC	LE-20	LE-24	Nagoya Railroad	1990/05/28	Fuji Heavy Industries
5	RBE-2505	Insein DRC	LE-20	LE-25	Nagoya Railroad	1990/05/28	Fuji Heavy Industries
6	RBE-2506	Yangon RBE Workshop	LE-30	LE-31	Nagoya Railroad	1995/02/16	Fuji Heavy Industries
7	RBE-2507	Kawlin	LE-30	LE-32	Nagoya Railroad	1995/02/16	Fuji Heavy Industries
8	RBE-2508	Yangon RBE Workshop	LE-30	LE-33	Nagoya Railroad	1995/02/16	Fuji Heavy Industries
9	RBE-2509	Mawlamyine	LE-30	LE-34	Nagoya Railroad	1995/02/16	Fuji Heavy Industries
10	RBE-2510	Pyinmana	ISE-1	ISE-2	Ise Tetsudo Railway	1987/02/21	Fuji Heavy Industries
11	RBE-2511	Myitkyina	ISE-1	ISE-3	Ise Tetsudo Railway	1987/02/21	Fuji Heavy Industries
12	RBE-2512	Pyinmana	NT-100	NT-100-101	Noto Railway	1987/12/01	Fuji Heavy Industries
13	RBE-2513	Pyinmana	NT-100	NT-100-103	Noto Railway	1987/12/01	Fuji Heavy Industries
14	RBE-2514	Pyinmana	NT-100	NT-100-124	Noto Railway	1991/04/25	Fuji Heavy Industries
15	RBE-2515	Myitnge Workshop	NT-100	NT-100-125	Noto Railway	1991/04/25	Fuji Heavy Industries
16	RBE-2516	Pyinmana	NT-100	NT-100-121	Noto Railway	1991/05/17	Fuji Heavy Industries
17	RBE-2517	Pyinmana	NT-100	NT-100-131	Noto Railway	1991/05/17	Fuji Heavy Industries
18	RBE-2518	Hinthada	NT-100	NT-100-109	Noto Railway	1998/03/04	Fuji Heavy Industries
19	RBE-2519	Pyinmana	NT-100	NT-100-122	Noto Railway	1991/04/25	Fuji Heavy Industries
20	RBE-2520	Pakokku	NT-100	NT-100-106	Noto Railway	1987/12/01	Fuji Heavy Industries
21	RBE-2521	Insein DRC	NT-100	NT-100-112	Noto Railway	1998/03/04	Fuji Heavy Industries
22	RBE-2522	Mahlwagone	NT-100	NT-100-105	Noto Railway	1987/12/01	Fuji Heavy Industries
23	RBE-2523	Pakokku	NT-100	NT-100-133	Noto Railway	1991/05/17	Fuji Heavy Industries
24	RBE-2524	Insein DRC	ISE-1	ISE-4	Ise Tetsudo Railway	1989/12/26	Fuji Heavy Industries
25	RBE-2525	Thayet	LE-20	TH-106	Tenryu Hamanako Railroad	1986/11/27	Fuji Heavy Industries
26	RBE-2526	Thayet	LE-20	TH-211	Tenryu Hamanako Railroad	1987/02/21	Fuji Heavy Industries
27	RBE-2527	Pyinmana	NT-100	NT-100-126	Noto Railway	1991/04/25	Fuji Heavy Industries
28	RBE-2528	Pyinmana	NT-100	NT-100-130	Noto Railway	1991/05/17	Fuji Heavy Industries
29	RBE-2529	Pathein	NT-120D	36-301	Sanriku Railway	1989/**/**	Niigata Engineering
30	RBE-2530	Yangon RBE Workshop	NT-120D	36-401	Sanriku Railway	1989/**/**	Niigata Engineering
31	RBE-2531	Pathein	NT-120D	36-302	Sanriku Railway	1989/**/**	Niigata Engineering
32	RBE-2532	Thayet	NT-120D	36-402	Sanriku Railway	1989/**/**	Niigata Engineering
33	RBE-2533	Sittwe	LE-20	AR201	Amagi Tetsudou	1992/11/23	Fuji Heavy Industries
34	RBE-2534	Yangon RBE Workshop	LE-20	LEDC-63-11	Moka Railway	1988/04/11	Fuji Heavy Industries
35	RBE-2535	Yangon RBE Workshop	LE-20	LEDC-63-1	Moka Railway	1993/04/06	Fuji Heavy Industries
36	RBE-2536	Pyinmana	NT-100	NT-100-132	Noto Railway	1991/05/17	Fuji Heavy Industries
37	RBE-2537	Pathein	LE-20	107	Heisei Chikuho Railway	1989/10/01	Fuji Heavy Industries
38	RBE-2538	Yangon RBE Workshop	LE-20	AR106	Amagi Tetsudou	1989/08/01	Fuji Heavy Industries
39	RBE-2539	Hinthada	CR-70	CR-70-1	Hokkaido Chihoku Kogen Railway	1989/04/29	Niigata Engineering
40	RBE-2540 >> RBT-2540	Yangon RBE Workshop	CR-70	CR-70-2	Hokkaido Chihoku Kogen Railway	1989/04/29	Niigata Engineering
41	RBE-2541	Hinthada	CR-70	CR-70-3	Hokkaido Chihoku Kogen Railway	1989/04/29	Niigata Engineering
42	RBE-2542	Hinthada	MR-100	MR-202	Matsuura Railway	1988/03/02	Niigata Engineering
43	RBE-2543	Insein DRC	MR-100	MR-301	Matsuura Railway	1988/03/28	Niigata Engineering
44	RBE-2544 >> RBT-2544	Yangon RBE Workshop	MR-100	MR-201	Matsuura Railway	1988/03/02	Niigata Engineering
45	RBE-2545 >> RBT-2545	Yangon RBE Workshop	MR-100	MR-203	Matsuura Railway	1988/03/02	Niigata Engineering

PROFILE of the RBEs (1)

No.	Car No. (Called by MR)	Depot	Car series No. (Called in Japan)	Car No. (Called in Japan)	Owner before transfered	Date of manufacture	Manufacturer
46	RBE-2546 >> RBT-2546	Yangon RBE Workshop	MR-100	MR-302	Matsuura Railway	1988/03/28	Niigata Engineering
47	RBE-2547	Pazundaung	MR-100	MR-104	Matsuura Railway	1988/03/02	Niigata Engineering
48	RBE-2548	Kyaingtone	LE-20	104	Heisei Chikuho Railway	1989/10/01	Fuji Heavy Industries
49	RBE-2549	Sittwe	LE-20	108	Heisei Chikuho Railway	1989/10/01	Fuji Heavy Industries
50	RBE-2550	Hinthada	MR-100	MR-204	Matsuura Railway	1988/03/02	Niigata Engineering
51	RBE-2551	Hinthada	MR-100	MR-205	Matsuura Railway	1988/03/02	Niigata Engineering
52	RBE-2552	Sittwe	MR-100	MR-102	Matsuura Railway	1988/03/02	Niigata Engineering
53	RBE-2553	Sittwe	MR-100	MR-103	Matsuura Railway	1988/03/02	Niigata Engineering
54	RBE-2554	Magway	MR-100	MR-123	Matsuura Railway	1991/07/12	Niigata Engineering
55	RBE-2555	Pyinmana	MR-100	MR-124	Matsuura Railway	1991/07/12	Niigata Engineering
56	RBE-2556	Pathein	LE-20	103	Heisei Chikuho Railway	1989/10/01	Fuji Heavy Industries
57	RBE-2557	Pathein	LE-20	202	Heisei Chikuho Railway	1989/10/01	Fuji Heavy Industries
58	RBE-2558	Sittwe	MR-100	MR-105	Matsuura Railway	1988/03/28	Niigata Engineering
59	RBE-2559	Sittwe	MR-100	MR-122	Matsuura Railway	1989/08/12	Niigata Engineering
60	RBE-2560	Thayet	MR-100	MR-101	Matsuura Railway	1988/03/02	Niigata Engineering
61	RBE-2561	Thayet	MR-100	MR-108	Matsuura Railway	1988/03/28	Niigata Engineering
62	RBE-2562	Kyaingtone	LE-20	109	Heisei Chikuho Railway	1989/10/01	Fuji Heavy Industries
63	RBE-2563	Kyaingtone	LE-20	102	Heisei Chikuho Railway	1989/10/01	Fuji Heavy Industries
64	RBE-2564	Hinthada	MR-100	MR-106	Matsuura Railway	1988/03/28	Niigata Engineering
65	RBE-2565	Kawlin	MR-100	MR-107	Matsuura Railway	1988/03/28	Niigata Engineering
66	RBE-2566	Sittwe	MR-100	MR-121	Matsuura Railway	1989/08/12	Niigata Engineering
67	RBE-2567	Yangon RBE Workshop	LE-20	101	Heisei Chikuho Railway	1989/10/01	Fuji Heavy Industries
68	RBE-2568	Insein DRC	LE-20	303	Heisei Chikuho Railway	1989/10/01	Fuji Heavy Industries
69	RBE-2569	Myitkyina	LE-20	230-301	Tarumi Railway	1985/09/20	Fuji Heavy Industries
70	RBE-2570	Myitkyina	LE-20	230-312	Tarumi Railway	1987/09/**	Fuji Heavy Industries
71	RBE-2571	Yangon RBE Workshop	Kiha 47	116	JR Shikoku	1980/07/21	Niigata Engineering
72	RBE-2572	Yangon RBE Workshop	Kiha 47	117	JR Shikoku	1980/07/21	Niigata Engineering
73	RBE-2573 >> RBT-2573	Yangon RBE Workshop	Kiha 47	503	JR Shikoku	1978/07/07	Niigata Engineering
74	RBE-2574	Yangon RBE Workshop	Kiha 47	1087	JR Shikoku	1980/07/26	Fuji Heavy Industries
75	RBE-2575 >> RBT-2575	Yangon RBE Workshop	MR-100	MR-109	Matsuura Railway	1991/**/**	Niigata Engineering
76	RBE-2576	Yangon RBE Workshop	MR-100	MR-110	Matsuura Railway	1991/**/**	Niigata Engineering
77	RBE-2577 >> RBT-2577	Yangon RBE Workshop	MR-100	MR-111	Matsuura Railway	1991/**/**	Niigata Engineering
78	RBE-2578	Myingyan	MR-100	MR-125	Matsuura Railway	1991/**/**	Niigata Engineering
79	RBE-2579	Myingyan	MR-100	MR-126	Matsuura Railway	1991/**/**	Niigata Engineering
80	RBE-2580	Pyinmana	LE-20	Isumi 203	Isumi Railway	1987/**/**	Fuji Heavy Industries
81	RBE-2581	Pyinmana	LE-20	Isumi 207	Isumi Railway	1987/**/**	Fuji Heavy Industries
82	RBE-2582	Thayet	Kiha 141	7	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
83	RBE-2583	Pyinmana	Kiha 141	8	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
84	RBE-2584	Pyinmana	Kiha 141	9	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
85	RBE-2585	Pyinmana	Kiha 141	10	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
86	RBE-2586	Kawlin	Kiha 141	11	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
87	RBE-2587	Ywahtaung Workshop	Kiha 141	12	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
88	RBE-2588	Insein DRC	Kiha 48	301	JR Hokkaido		Niigata Engineering
89	RBE-2589	Insein DRC	Kiha 48	302	JR Hokkaido		Niigata Engineering
90	RBE-2590	Insein DRC	Kiha 48	303	JR Hokkaido		Niigata Engineering

PROFILE of the RBEs (1)

No.	Car No. (Called by MR)	Depot	Car series No. (Called in Japan)	Car No. (Called in Japan)	Owner before transfered	Date of manufacture	Manufacturer
91	RBE-2591	Taungdwingyi	LE-20	Isumi 205	Isumi Railway	1987/**/**	Fuji Heavy Industries
92	RBE-2592	Mandalay	Kiha 141	2	JR Hokkaido		Naebo Workshop (JR Hokkaido)
93	RBE-2593	Hinthada	Kiha 141	3	JR Hokkaido		Naebo Workshop (JR Hokkaido)
94	RBE-2594	Mandalay	Kiha 141	4	JR Hokkaido		Naebo Workshop (JR Hokkaido)
95	RBE-2595	Mandalay	Kiha 141	5	JR Hokkaido		Naebo Workshop (JR Hokkaido)
96	RBE-2596	Pakokku	Kiha 141	6	JR Hokkaido		Naebo Workshop (JR Hokkaido)
97	RBE-2597	Mandalay	Kiha 141	13	JR Hokkaido		Naebo Workshop (JR Hokkaido)
98	RBE-2598	Insein DRC	Kiha 48	1331	JR Hokkaido		Niigata Engineering
99	RBE-2599	Insein DRC	Kiha 48	1332	JR Hokkaido		Niigata Engineering
100	RBE-25100	Insein DRC	Kiha 48	1333	JR Hokkaido		Niigata Engineering
101	RBE-25101	Insein DRC	Kiha 38	2	JR East		Koriyama Workshop (JNR)
102	RBE-25102	Insein DRC	Kiha 38	3	JR East		Omiya Workshop (JNR)
103	RBE-25103	Insein DRC	Kiha 38	4	JR East		Omiya Workshop (JNR)
104	RBE-25104	Insein DRC	Kiha 38	1001	JR East		Nagano Workshop (JNR)
105	RBE-25105	Insein DRC	Kiha 38	1002	JR East		Hatabu Workshop (JNR)
106	RBE-25106	Insein DRC	Kiha 40	334	JR Hokkaido		Niigata Engineering
107	RBE-25107	Insein DRC	Kiha 40	335	JR Hokkaido		Niigata Engineering
108	RBE-25108	Mandalay	LE-20	Isumi 201	Isumi Railway	1987/**/**	Fuji Heavy Industries
109	RBE-25109	Insein DRC	Kiha 40	548	JR East	1979/07/07	Fuji Heavy Industries
110	RBE-25110	Insein DRC	Kiha 40	2024	JR East	1979/06/07	Niigata Engineering
111	RBE-25111	Insein DRC	Kiha 48	501	JR East	1979/06/06	Niigata Engineering
112	RBE-25112	Insein DRC	Kiha 48	553	JR East	1981/12/24	Fuji Heavy Industries
113	RBE-25113	Insein DRC	Kiha 48	1511	JR East	1979/08/24	Fuji Heavy Industries
114	RBE-25114	Insein DRC	Kiha 48	1514	JR East	1979/07/30	Niigata Engineering
115	RBE-25115		Kiha 40	514	JR East	1978/01/10	Fuji Heavy Industries
116	RBE-25116		Kiha 40	562	JR East	1980/02/28	Fuji Heavy Industries
117	RBE-25117		Kiha 48	551	JR East	1981/02/10	Fuji Heavy Industries
118	RBE-25118		Kiha 48	1547	JR East	1981/12/21	Fuji Heavy Industries
119	RBE-25119		Kiha 40	542	JR East	1979/08/21	Niigata Engineering
120	RBE-25120		Kiha 40	549	JR East	1979/07/07	Fuji Heavy Industries
121	RBE-25121		Kiha 40	550	JR East	1979/07/07	Fuji Heavy Industries
122	RBE-25122		Kiha 40	559	JR East	1980/02/28	Fuji Heavy Industries
123	RBE-25123		Kiha 40	578	JR East	1980/12/15	Niigata Engineering
124	RBE-25124		Kiha 40	579	JR East	1980/12/15	Niigata Engineering
125	RBE-25125		Kiha 40	581	JR East	1980/12/15	Niigata Engineering
126	RBE-25126		Kiha 40	2022	JR East	1979/06/07	Niigata Engineering
127	RBE-25127		Kiha 40	2025	JR East	1979/06/07	Niigata Engineering
128	RBE-3001	Pyinmana	LE-30	36-1201	Sanriku Railway	1983/12/06	Niigata Engineering
129	RBE-3002	Pyinmana	LE-30	36-1206	Sanriku Railway	1984/01/12	Niigata Engineering
130	RBE-3003	Pathein	LE-30	36-1106	Sanriku Railway	1984/01/23	Fuji Heavy Industries
131	RBE-3004	Insein DRC	LE-30	36-1103	Sanriku Railway	1983/**/**	Fuji Heavy Industries
132	RBE-3005	Insein DRC	LE-30	36-1107	Sanriku Railway		Fuji Heavy Industries
133	RBE-3006	Insein DRC	Kiha 11	6	JR Central	1998/**/**	Niigata Engineering
134	RBE-3007	Insein DRC	Kiha 11	102	JR Central	1998/**/**	Niigata Engineering
135	RBE-3008	Insein DRC	Kiha 11	103	JR Central	1998/**/**	Niigata Engineering

PROFILE of the RBEs (1)

No.	Car No. (Called by MR)	Depot	Car series No. (Called in Japan)	Car No. (Called in Japan)	Owner before transfered	Date of manufacture	Manufacturer
136	RBE-3009	Insein DRC	Kiha 11	106	JR Central	1998/**/**	Niigata Engineering
137	RBE-3010	Insein DRC	Kiha 11	111	JR Central	1998/**/**	Niigata Engineering
138	RBE-3011	Insein DRC	Kiha 11	112	JR Central	1998/**/**	Niigata Engineering
139	RBE-3012	Insein DRC	Kiha 11	113	JR Central	1998/**/**	Niigata Engineering
140	RBE-3013	Insein DRC	Kiha 11	114	JR Central	1998/**/**	Niigata Engineering
141	RBE-3014	Insein DRC	Kiha 11	115	JR Central	1998/**/**	Niigata Engineering
142	RBE-3015	Insein DRC	Kiha 11	116	JR Central	1998/**/**	Niigata Engineering
143	RBE-3016	Insein DRC	Kiha 11	117	JR Central	1998/**/**	Niigata Engineering
144	RBE-3017	Insein DRC	Kiha 11	118	JR Central	1998/**/**	Niigata Engineering
145	RBE-3018	Insein DRC	Kiha 11	119	JR Central	1998/**/**	Niigata Engineering
146	RBE-3019	Insein DRC	Kiha 11	120	JR Central	1998/**/**	Niigata Engineering
147	RBE-3020	Insein DRC	Kiha 11	121	JR Central	1998/**/**	Niigata Engineering
148	RBE-3021	Insein DRC	Kiha 11	122	JR Central	1998/**/**	Niigata Engineering
149	RBE-3022	Insein DRC	Kiha 47	5001(3)	JR Central	1977/02/**	Niigata Engineering
150	RBE-3023	Insein DRC	Kiha 47	5002(4)	JR Central	1977/02/**	Niigata Engineering
151	RBE-3024	Insein DRC	Kiha 47	6001(1027)	JR Central	1979/01/**	Niigata Engineering
152	RBE-3025	Insein DRC	Kiha 47	6002(1109)	JR Central	1981/07/**	Niigata Engineering
153	RBE-3026	Insein DRC	Kiha 47	6003(1110)	JR Central	1981/**/**	Niigata Engineering
154	RBE-3027	Insein DRC	Kiha 48	3814(531)	JR Central	1980/02/**	Fuji Heavy Industries
155	RBE-3028	Insein DRC	Kiha 48	3816(541)	JR Central		Niigata Engineering
156	RBE-3029	Insein DRC	Kiha 48	5511(528)	JR Central		Fuji Heavy Industries
157	RBE-3030	Insein DRC	Kiha 48	5513(530)	JR Central	1979/12/**	Fuji Heavy Industries
158	RBE-3031	Insein DRC	Kiha 48	5805(513)	JR Central	1979/**/**	Fuji Heavy Industries
159	RBE-3032	Insein DRC	Kiha 48	6803(1517)	JR Central	1979/**/**	Fuji Heavy Industries
160	RBE-3033	Insein DRC	Kiha 48	6813(1530)	JR Central	1980/**/**	Fuji Heavy Industries
161	RBE-3034	Insein DRC	IRT355	IRT355-07	Ibara Railway	1998/**/**	Niigata Engineering
162	RBE-3035		Kiha 11	8	JR Central	1998/**/**	Niigata Engineering
163	RBE-3036		Kiha 11	101	JR Central	1998/**/**	Niigata Engineering
164	RBE-3037		Kiha 11	104	JR Central	1998/**/**	Niigata Engineering
165	RBE-3038		Kiha 11	105	JR Central	1998/**/**	Niigata Engineering
166	RBE-3039		Kiha 11	108	JR Central	1998/**/**	Niigata Engineering
167	RBE-3040		Kiha 40	3005(2058)	JR Central	1980/03/**	Niigata Engineering
168	RBE-3041		Kiha 40	5802(577)	JR Central		
169	RBE-3042		Kiha 40	6307(2111)	JR Central	1981/04/**	Niigata Engineering
170	RBE-3043		Kiha 40	6308(2112)	JR Central	1981/04/**	Niigata Engineering
171	RBE-3044		Kiha 40	6309(2113)	JR Central	1981/04/**	Niigata Engineering
172	RBE-3045		Kiha 40	6312(2131)	JR Central	1981/05/**	Fuji Heavy Industries
173	RBE-3046	Insein DRC	Kiha 48	3815(532)	JR Central	1980/**/**	Fuji Heavy Industries
174	RBE-3047		Kiha 48	5501(509)	JR Central	1979/07/**	Fuji Heavy Industries
175	RBE-3048		Kiha 48	5508(525)	JR Central	1979/12/**	Fuji Heavy Industries
176	RBE-3049	Insein DRC	Kiha 48	5803(511)	JR Central	1979/**/**	Fuji Heavy Industries
177	RBE-3050		Kiha 48	5804(512)	JR Central		
178	RBE-3051		Kiha 48	5806(514)	JR Central		
179	RBE-3052	Insein DRC	Kiha 48	5810(527)	JR Central	1979/12/**	Fuji Heavy Industries
180	RBE-3053	Insein DRC	Kiha 48	6001(1001)	JR Central	1981/**/**	Fuji Heavy Industries

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No.	Car No. (Called by MR)	Depot	Car series No. (Called in Japan)	Car No. (Called in Japan)	Owner before transfered	Date of manufacture	Manufacturer
181	RBE-3054		Kiha 48	6517(1538)	JR Central	1980/06/**	Niigata Engineering
182	RBE-3055		Kiha 48	6808(1525)	JR Central	1979/12/**	Niigata Engineering
183	RBE-3056	Insein DRC	Kiha 48	6814(1531)	JR Central	1980/**/**	Fuji Heavy Industries
184	RBE-3057	Insein DRC	Kiha 48	6815(1536)	JR Central	1980/06/**	Niigata Engineering
185	RBE-3601	Myitnge Workshop	Kiha 58	7211	JR West	1965/11/30	Niigata Engineering
186	RBE-3602	Myitnge Workshop	Kiha 58	647	JR West	1965/05/14	Niigata Engineering
187	RBE-3603	Pyinmana	Kiha 58	1113	JR West	1968/06/20	Niigata Engineering
188	RBE-3604	Myitnge Workshop	Kiha 58	1044	JR West	1967/07/15	Niigata Engineering
189	RBE-3605	Myitnge Workshop	Kiha 58	7209	JR West	1965/06/01	Niigata Engineering
190	RBE-3606	Myitnge Workshop	Kiha 58	1042	JR West	1967/07/10	Niigata Engineering
191	RBE-3607	Myitnge Workshop	Kiha 58	1041	JR West	1967/07/10	Niigata Engineering
192	RBE-3608	Myitnge Workshop	Kiha 58	1045	JR West	1967/07/15	Niigata Engineering
193	RBE-3609	Mahlwagone	Kiha 58	1046	JR West	1967/07/15	Niigata Engineering
194	RBE-3610	Myitnge Workshop	Kiha 58	645	JR West	1965/04/28	Fuji Heavy Industries
195	RBE-3611	Myitnge Workshop	Kiha 58	1128	JR West	1967/07/10	Fuji Heavy Industries
196	RBE-3612	Myitnge Workshop	Kiha 58	1120	JR West	1968/06/25	Fuji Heavy Industries
197	RBE-5001	Pyinmana	Kiha 52	108	JR East	1964/02/14	Niigata Engineering
198	RBE-5002 >> RBT-5002	Yangon RBE Workshop	Kiha 52	109	JR East	1964/02/14	Niigata Engineering
199	RBE-5003 >> RBT-5003	Yangon RBE Workshop	Kiha 52	126	JR East	1965/10/20	Niigata Engineering
200	RBE-5004	Myitnge Workshop	Kiha 52	143	JR East	1966/08/02	Niigata Engineering
201	RBE-5005	Myitnge Workshop	Kiha 52	144	JR East	1966/08/02	Niigata Engineering
202	RBE-5006	Pyinmana	Kiha 52	145	JR East	1966/08/11	Niigata Engineering
203	RBE-5007 >> RBT-5007	Yangon RBE Workshop	Kiha 52	151	JR East	1966/09/26	Niigata Engineering
204	RBE-5008	Insein DRC	Kiha 52	152	JR East	1966/09/26	Niigata Engineering
205	RBE-5009	Pyinmana	Kiha 52	153	JR East	1966/09/26	Niigata Engineering
206	RBE-5010	Pyinmana	Kiha 58	1504	JR East	1968/02/07	Nippon Sharyo
207	RBE-5011	Pyinmana	Kiha 52	110	JR East	1964/02/14	Niigata Engineering
208	RBE-5012	Sittwe	Kiha 52	141	JR East	1966/07/28	Niigata Engineering
209	RBE-5013	Pyinmana	Kiha 52	146	JR East	1966/08/11	Niigata Engineering
210	RBE-5014	Sittwe	Kiha 52	147	JR East	1966/08/11	Niigata Engineering
211	RBE-5015	Sittwe	Kiha 52	148	JR East	1966/08/11	Niigata Engineering
212	RBE-5016	Pyinmana	Kiha 52	149	JR East	1966/09/19	Niigata Engineering
213	RBE-5017	Pyinmana	Kiha 52	154	JR East	1966/11/19	Niigata Engineering
214	RBE-5018	Mahlwagone	Kiha 52	155	JR East	1966/11/19	Niigata Engineering
215	RBE-5019 >> RBT-5019	Yangon RBE Workshop	Kiha 58	1514	JR East	1968/04/26	Fuji Heavy Industries
216	RBE-5020	Myitnge Workshop	Kiha 58	1528	JR East	1968/05/06	Niigata Engineering
217	RBE-5021	Myitnge Workshop	Kiha 182	106	JR Hokkaido	1981/08/21	Niigata Engineering
218	RBE-5022	Pyinmana	Kiha 182	108	JR Hokkaido	1981/09/04	Niigata Engineering
219	RBE-5023	Myitnge Workshop	Kiha 182	1	JR Hokkaido	1981/08/21	Niigata Engineering
220	RBE-5024	Myitnge Workshop	Kiha 182	2	JR Hokkaido	1981/08/21	Niigata Engineering
221	RBE-5025	Myitnge Workshop	Kiha 182	4	JR Hokkaido	1981/08/21	Niigata Engineering
222	RBE-5026	Myitnge Workshop	Kiha 182	5	JR Hokkaido	1981/08/21	Niigata Engineering
223	RBE-5027	Myitnge Workshop	Kiha 182	13	JR Hokkaido	1981/09/18	Niigata Engineering
224	RBE-5028	Myitnge Workshop	Kiha 182	17	JR Hokkaido	1981/08/28	Fuji Heavy Industries
225	RBE-P5029	Insein DRC	Kiha 181	27	JR West	1970/**/**	

PROFILE of the RBEs (1)

No.	Car No. (Called by MR)	Depot	Car series No. (Called in Japan)	Car No. (Called in Japan)	Owner before transfered	Date of manufacture	Manufacturer
226	RBE-P5030	Insein DRC	Kiha 181	45	JR West	1971/**/**	
227	RBE-P5031	Mahlwagone	Kiha 181	47	JR West	1971/**/**	Fuji Heavy Industries
228	RBE-P5032	Insein DRC	Kiha 181	48	JR West	1971/**/**	
229	RBE-P5033	Mahlwagone	Kiha 181	49	JR West	1971/**/**	
230	RBE-5034	Insein DRC	Kiha 180	22	JR West	1969/**/**	
231	RBE-5035	Insein DRC	Kiha 180	36	JR West	1970/**/**	
232	RBE-5036	Insein DRC	Kiha 180	41	JR West	1970/**/**	
233	RBE-5037	Insein DRC	Kiha 180	42	JR West	1970/**/**	
234	RBE-5038	Insein DRC	Kiha 180	45	JR West	1970/**/**	Fuji Heavy Industries
235	RBE-5039	Insein DRC	Kiha 180	48	JR West	1970/**/**	
236	RBE-5040	Mahlwagone	Kiha 180	49	JR West	1970/**/**	
237	RBE-5041	Mahlwagone	Kiha 180	77	JR West	1971/**/**	
238	RBE-5042	Mahlwagone	Kiro 180	4	JR West	1969/**/**	
239	RBE-5043	Insein DRC	Kiro 180	12	JR West	1970/**/**	
240	RBE-5044	Pyinmana	Kiha 142	7	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
241	RBE-5045	Pyinmana	Kiha 142	8	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
242	RBE-5046	Thayet	Kiha 142	9	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
243	RBE-5047	Kawlin	Kiha 142	10	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
244	RBE-5048	Pyinmana	Kiha 142	11	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
245	RBE-5049	Ywahtaung Workshop	Kiha 142	12	JR Hokkaido	1992/**/**	Naebo Workshop (JR Hokkaido)
246	RBE-5050	Mandalay	Kiha 142	2	JR Hokkaido		Naebo Workshop (JR Hokkaido)
247	RBE-5051	Mandalay	Kiha 142	3	JR Hokkaido		Naebo Workshop (JR Hokkaido)
248	RBE-5052	Hinthada	Kiha 142	4	JR Hokkaido		Naebo Workshop (JR Hokkaido)
249	RBE-5053	Pakokku	Kiha 142	13	JR Hokkaido		Naebo Workshop (JR Hokkaido)
250	RBE25001	Myitnge Workshop	Kiha 182	224	JR Hokkaido	1981/09/11	Fuji Heavy Industries
251	RBE25002	Myitnge Workshop	Kiha 182	225	JR Hokkaido	1982/05/28	Niigata Engineering
252	RBE25003	Myitnge Workshop	Kiha 182	226	JR Hokkaido	1982/05/28	Niigata Engineering
253	RBE25004	Myitnge Workshop	Kiha 182	227	JR Hokkaido	1982/05/28	Niigata Engineering
254	RBE25005	Myitnge Workshop	Kiha 184	7	JR Hokkaido	1982/08/27	Niigata Engineering
255	RBE25006	Myitnge Workshop	Kiha 184	2	JR Hokkaido	1981/09/18	Niigata Engineering
256	RBE25007	Myitnge Workshop	Kiha 183	103	JR Hokkaido	1981/09/18	Niigata Engineering
257	RBE25008	Myitnge Workshop	Kiha 183	1	JR Hokkaido	1981/08/21	Niigata Engineering
258	RBE25009	Myitnge Workshop	Kiha 183	2	JR Hokkaido	1981/09/04	Niigata Engineering
259	RBE25010	Myitnge Workshop	Kiha 183	207	JR Hokkaido	1981/09/11	Fuji Heavy Industries
260	RBE25011	Myitnge Workshop	Kiha 183	217	JR Hokkaido	1982/08/20	Fuji Heavy Industries

PROFILE of the RBEs (2)

No.	Car No. (Called by MR)	Date of disuse in Japan	Date of transfer to MR	Engine type	Transmission type	Air conditioner	Condition	Remark
1	RBE-2501	2001/12/26	2003/04/25	Nissan PE6HT03A	SCR-091B-4B	None	Undrivable	
2	RBE-2502	2001/12/26	2003/04/25	Nissan PE6HT03A	SCR-091B-4B	Installed	In operation	VIP
3	RBE-2503	2004/03/31	2004/07/01	Nissan PE6HT03A	SCR-091B-4B	Installed	In operation	VIP
4	RBE-2504	2004/03/31	2004/07/01	Nissan PE6HT03A	SCR-091B-4B	Installed	In operation	VIP, CNG test car
5	RBE-2505	2004/03/31	2004/07/01	Nissan PE6HT03A	SCR-091B-4B	Installed	Undrivable	Disused (2008/03)
6	RBE-2506	2004/03/31	2004/11/29	Nissan PE6HT03A	TACN-22-1108	None	Undrivable	
7	RBE-2507	2004/03/31	2004/11/29	Nissan PE6HT03A	TACN-22-1108	None	In operation	
8	RBE-2508	2004/03/31	2004/11/29	Nissan PE6HT03A	TACN-22-1108	None	Undrivable	
9	RBE-2509	2004/03/31	2004/11/29	Nissan PE6HT03A	TACN-22-1108	None	Undrivable	
10	RBE-2510	2004/12/31	2005/06/22	Nissan PE6HT03	SCR-091B-4B	None	Undrivable	
11	RBE-2511	2004/12/31	2005/06/22	Nissan PE6HT03	SCR-091B-4B	None	In operation	
12	RBE-2512	2005/09/12	2005/11/12	Nissan PE6HT03A	TACN-22-1103C	None	In operation	
13	RBE-2513	2005/09/12	2005/11/12	Nissan PE6HT03A	TACN-22-1103C	None	In operation	
14	RBE-2514	2005/09/12	2005/11/12	Nissan PE6HT03A	TACN-22-1103C	None	In operation	
15	RBE-2515	2005/09/12	2005/11/12	Nissan PE6HT03A	TACN-22-1103C	None	Undrivable	Planned to disuse (Due to an accident)
16	RBE-2516	2005/09/12	2006/02/20	Nissan PE6HT03A	TACN-22-1103C	Installed	In operation	VIP
17	RBE-2517	2005/09/12	2006/02/20	Nissan PE6HT03A	TACN-22-1103C	Installed	In operation	VIP
18	RBE-2518	2005/12/09	2006/02/20	Nissan PE6HT03A	TACN-22-1103C	None	In operation	
19	RBE-2519	2005/12/09	2006/02/20	Nissan PE6HT03A	TACN-22-1103C	None	Undrivable	
20	RBE-2520	2005/12/09	2006/02/20	Nissan PE6HT03A	TACN-22-1103C	None	In operation	
21	RBE-2521	2005/12/09	2006/02/20	Nissan PE6HT03A	TACN-22-1103C	None	Undrivable	Disused due to a flood (2008/03)
22	RBE-2522	2005/12/09	2006/02/20	Nissan PE6HT03A	TACN-22-1103C	None	Undrivable	Engine replaced
23	RBE-2523	2005/12/09	2006/02/20	Nissan PE6HT03A	TACN-22-1103C	None	In operation	
24	RBE-2524	2005/12/31	2006/02/20	Nissan PE6HT03	SCR-091B-4B	Installed	In operation	VIP
25	RBE-2525	2005/12/05	2006/08/07	Nissan PE6HT03	TACN-22-1103	None	Undrivable	
26	RBE-2526	2005/12/05	2006/08/07	Nissan PE6HT03	TACN-22-1103	None	Undrivable	
27	RBE-2527	2005/12/09	2006/08/07	Nissan PE6HT03A	TACN-22-1103C	None	In operation	M8 executed (2016/01/29)
28	RBE-2528	2005/12/09	2006/08/07	Nissan PE6HT03A	TACN-22-1103C	None	In operation	M8 executed (2016/02/29)
29	RBE-2529	2005/12/11	2007/02/19	NIIGATA DMF13HS	TACN-22-1103C	None	In operation	
30	RBE-2530	2005/12/11	2007/02/19	NIIGATA DMF13HS	TACN-22-1103C	None	Undrivable	
31	RBE-2531	2006/02/01	2007/02/19	NIIGATA DMF13HS	TACN-22-1103C	None	In operation	
32	RBE-2532	2006/02/01	2007/02/19	NIIGATA DMF13HS	TACN-22-1103C	None	Undrivable	
33	RBE-2533	2006/12/22	2007/06/09	Nissan PE6HT03A	SCR-091A	None	Undrivable	Planned to disuse
34	RBE-2534	2006/12/09	2007/06/09	KOMATSU DMF11HZ	SCR-091B-4B	None	Undrivable	
35	RBE-2535	2006/12/09	2007/06/09	KOMATSU DMF11HZ	SCR-091B-4B	None	Undrivable	
36	RBE-2536	2006/12/31	2007/06/09	Nissan PE6HT03A	TACN-22-1103C	Installed	In operation	VIP
37	RBE-2537	2007/03/31	2007/06/09	Nissan PE6HT03A	TACN-22-1103C	None	In operation	
38	RBE-2538	2006/12/22	2007/06/09	Nissan PE6HT03	SCR-091B-4B	None	Undrivable	VIP
39	RBE-2539	2006/04/20	2007/10/15	NIIGATA DMF13HS	DBR115	None	Undrivable	
40	RBE-2540 >> RBT-2540	2006/04/20	2007/10/15	NIIGATA DMF13HS	DBR115	None	Undrivable	Converted to passenger coach (2015/08/16)
41	RBE-2541	2006/04/20	2007/10/15	NIIGATA DMF13HS	DBR115	None	Undrivable	
42	RBE-2542	2008/01/27	2008/05/10	NIIGATA DMF13HS	TACN-22-1103C	None	Undrivable	
43	RBE-2543	2008/03/18	2008/05/10	NIIGATA DMF13HZ	TACN-22-1105	None	In operation	Repowered by JITI (2015/03/20)
44	RBE-2544 >> RBT-2544	2008/03/18	2008/05/10	NIIGATA DMF13HS	TACN-22-1105	None	Undrivable	Converted to passenger coach (2015/05/31)
45	RBE-2545 >> RBT-2545	2008/01/27	2008/05/10	NIIGATA DMF13HS	TACN-22-1105	None	Undrivable	Converted to passenger coach (2015/08/16)

PROFILE of the RBEs (2)

No.	Car No. (Called by MR)	Date of disuse in Japan	Date of transfer to MR	Engine type	Transmission type	Air conditioner	Condition	Remark
46	RBE-2546 >> RBT-2546	2008/01/27	2008/05/10	NIIGATA DMF13HS	TACN-22-1105	None	Undrivable	Converted to passenger coach (2015/05/31)
47	RBE-2547	2008/01/27	2008/05/10	NIIGATA DMF13HS	TACN-22-1105	None	Undrivable	
48	RBE-2548	2008/01/27	2008/05/10	Nissan PE6HT03A	TACN-22-1103C	None	Undrivable	Planned to disuse
49	RBE-2549	2008/01/27	2008/05/10	Nissan PE6HT03A	TACN-22-1103C	None	Undrivable	Planned to disuse
50	RBE-2550	2006/11/07	2008/05/10	NIIGATA DMF13HS	TACN-22-1105	None	In operation	
51	RBE-2551	2008/03/18	2008/05/10	NIIGATA DMF13HS	TACN-22-1105	None	Undrivable	
52	RBE-2552	2009/02/08	2008/10/08	NIIGATA DMF13HS	TACN-22-1105B	None	In operation	Planned to disuse
53	RBE-2553	2009/02/08	2008/10/08	NIIGATA DMF13HS	TACN-22-1105B	None	Undrivable	Planned to disuse
54	RBE-2554	2009/02/08	2008/10/08	NIIGATA DMF13HZ	TACN-22-1105B	None	In operation	
55	RBE-2555	2009/02/08	2008/10/08	NIIGATA DMF13HS	TACN-22-1105B	None	Undrivable	
56	RBE-2556	2008/12/20	2008/10/08	Nissan PE6HT03A	TACN-22-1103B	None	In operation	
57	RBE-2557	2008/12/20	2008/10/08	Nissan PE6HT03A	TACN-22-1103B	None	In operation	
58	RBE-2558	2010/01/10	2010/02/28	NIIGATA DMF13HS	TACN-22-1105B	None	In operation	Planned to disuse
59	RBE-2559	2010/01/10	2010/02/28	NIIGATA DMF13HS	TACN-22-1105B	None	In operation	Planned to disuse
60	RBE-2560	2010/01/10	2010/02/28	NIIGATA DMF13HS	TACN-22-1105B	None	Undrivable	
61	RBE-2561	2010/01/10	2010/02/28	NIIGATA DMF13HS	TACN-22-1105B	None	Undrivable	
62	RBE-2562	2009/11/21	2010/02/28	Nissan PE6HT03A	TACN-22-1103B	None	Undrivable	Planned to disuse
63	RBE-2563	2009/11/21	2010/02/28	Nissan PE6HT03A	TACN-22-1103B	None	Undrivable	Planned to disuse
64	RBE-2564	2010/12/26	2011/04/11	NIIGATA DMF13HS	TACN-22-1105B	None	In operation	
65	RBE-2565	2010/12/26	2011/04/11	NIIGATA DMF13HS	TACN-22-1105B	None	In operation	
66	RBE-2566	2010/12/26	2011/04/11	NIIGATA DMF13HS	TACN-22-1105B	None	In operation	Planned to disuse
67	RBE-2567	2009/12/14	2011/04/11	Nissan PE6HT03A	TACN-22-1103B	None	Undrivable	
68	RBE-2568	2010/12/31	2011/04/11	Nissan PE6HT03A	TACN-22-1103B	None	In operation	
69	RBE-2569	2009/04/30	2011/04/11	Nissan PE6HT03A	SCR-091A	None	In operation	
70	RBE-2570	2011/03/20	2011/04/11	Nissan PE6HT03A	SCR-091A	None	In operation	
71	RBE-2571	2010/03/31	2011/04/11	NIIGATA DMF15HSA	DW10	None	Undrivable	
72	RBE-2572	2010/03/31	2011/04/11	NIIGATA DMF15HSA	DW10	None	Undrivable	
73	RBE-2573 >> RBT-2573	2010/03/31	2011/04/11	NIIGATA DMF15HSA	DW10	None	Undrivable	Converted to passenger coach (2015/08/16)
74	RBE-2574	2010/03/31	2011/04/11	NIIGATA DMF15HSA	DW10	None	Undrivable	
75	RBE-2575 >> RBT-2575		2012/12/17	NIIGATA DMF13HS	TACN-22-1105B	None	Undrivable	Converted to passenger coach (2015/05/31)
76	RBE-2576		2012/11/15	NIIGATA DMF13HS	TACN-22-1105B	None	In operation	
77	RBE-2577 >> RBT-2577		2012/11/15	NIIGATA DMF13HS	TACN-22-1105B	None	Undrivable	Converted to passenger coach (2015/05/31)
78	RBE-2578		2012/11/15	NIIGATA DMF13HS	TACN-22-1105B	None	In operation	
79	RBE-2579		2012/11/15	NIIGATA DMF13HS	TACN-22-1105B	None	In operation	
80	RBE-2580		2012/11/15	Nissan PE6HT03A	TACN-22-1103B	Installed	In operation	VIP
81	RBE-2581		2012/11/15	Nissan PE6HT03A	TACN-22-1103B	Installed	In operation	VIP
82	RBE-2582		2012/11/22	NIIGATA DMF13HS	DF115A	None	In operation	
83	RBE-2583		2012/11/22	NIIGATA DMF13HS	DF115A	None	In operation	
84	RBE-2584		2012/11/22	NIIGATA DMF13HS	DF115A	None	In operation	
85	RBE-2585		2012/11/22	NIIGATA DMF13HS	DF115A	None	In operation	
86	RBE-2586		2012/11/22	NIIGATA DMF13HS	DF115A	None	In operation	
87	RBE-2587		2012/11/22	NIIGATA DMF13HS	DF115A	None	In preparation	
88	RBE-2588		2012/11/22	NIIGATA DMF15HSA	DW10	None	In operation	
89	RBE-2589		2012/11/22	NIIGATA DMF15HSA	DW10	None	In operation	
90	RBE-2590		2012/11/22	NIIGATA DMF15HSA	DW10	None	In operation	

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91	RBE-2591	2013/03/31	2014/10/03	Nissan PE6HT03A	TACN-22-1103B	Installed	In operation	
92	RBE-2592	2012/11/14	2014/05/25	NIIGATA DMF13HS	DF115A	None	In operation	
93	RBE-2593	2012/11/14	2014/05/25	NIIGATA DMF13HS	DF115A	None	In operation	
94	RBE-2594	2012/11/22	2014/05/25	NIIGATA DMF13HS	DF115A	None	In operation	
95	RBE-2595	2012/11/22	2014/05/25	NIIGATA DMF13HS	DF115A	None	In operation	
96	RBE-2596	2012/11/22	2014/05/25	NIIGATA DMF13HS	DF115A	None	In operation	
97	RBE-2597	2012/12/05	2014/05/25	NIIGATA DMF13HS	DF115A	None	In operation	
98	RBE-2598	2012/11/14	2014/05/25	NIIGATA DMF13HZ	N-DW14B	Installed	In operation	
99	RBE-2599	2012/11/22	2014/05/25	NIIGATA DMF13HZ	N-DW14B	Installed	In operation	
100	RBE-25100	2012/12/05	2014/05/25	NIIGATA DMF13HZ	N-DW14B	Installed	In operation	
101	RBE-25101	2012/12/20	2014/05/25	NIIGATA DMF13HS	DF115A	Installed	In operation	
102	RBE-25102	2012/12/06	2014/05/25	NIIGATA DMF13HS	DF115A	Installed	In operation	
103	RBE-25103	2012/12/20	2014/05/25	NIIGATA DMF13HS	DF115A	Installed	In operation	
104	RBE-25104	2012/12/06	2014/05/25	NIIGATA DMF13HS	DF115A	Installed	In operation	
105	RBE-25105	2012/12/20	2014/05/25	NIIGATA DMF13HS	DF115A	Installed	In operation	
106	RBE-25106	2012/12/05	2014/05/25	NIIGATA DMF13HZ	N-DW14B	Installed	In operation	
107	RBE-25107	2012/12/05	2014/05/25	NIIGATA DMF13HZ	N-DW14B	Installed	In operation	
108	RBE-25108	2014/03/31	2015/05/12	Nissan PE6HT03A	TACN-22-1103B	Installed	In operation	
109	RBE-25109	2015/07/25	2015/08/20	NIIGATA DMF15HSA	DW10	None	In operation	
110	RBE-25110	2015/07/25	2015/08/20	NIIGATA DMF15HSA	DW10	None	In operation	
111	RBE-25111	2015/07/20	2015/08/20	NIIGATA DMF15HSA	DW10	None	In operation	
112	RBE-25112	2015/07/20	2015/08/20	NIIGATA DMF15HSA	DW10	None	In operation	
113	RBE-25113	2015/07/20	2015/08/20	NIIGATA DMF15HSA	DW10	None	In operation	
114	RBE-25114	2015/07/25	2015/08/20	NIIGATA DMF15HSA	DW10	None	In operation	
115	RBE-25115	2015/09/15	2015/10/22	NIIGATA DMF15HSA	DW10	None	In operation	
116	RBE-25116	2015/09/22	2015/10/22	NIIGATA DMF15HSA	DW10	None	In operation	
117	RBE-25117	2015/09/15	2015/10/22	NIIGATA DMF15HSA	DW10	None	In operation	
118	RBE-25118	2015/09/08	2015/10/22	NIIGATA DMF15HSA	DW10	None	In operation	
119	RBE-25119	2016/02/23	2016/03/**	NIIGATA DMF15HSA	DW10	None	In preparation	
120	RBE-25120	2016/02/17	2016/03/**	NIIGATA DMF15HSA	DW10	None	In preparation	
121	RBE-25121	2016/02/15	2016/03/**	NIIGATA DMF15HSA	DW10	None	In preparation	
122	RBE-25122	2016/02/15	2016/03/**	NIIGATA DMF15HSA	DW10	None	In preparation	
123	RBE-25123	2016/02/17	2016/03/**	NIIGATA DMF15HSA	DW10	None	In preparation	
124	RBE-25124	2016/02/15	2016/03/**	NIIGATA DMF15HSA	DW10	None	In preparation	
125	RBE-25125	2016/02/17	2016/03/**	NIIGATA DMF15HSA	DW10	None	In preparation	
126	RBE-25126	2016/02/23	2016/03/**	NIIGATA DMF15HSA	DW10	None	In preparation	
127	RBE-25127	2016/02/23	2016/03/**	NIIGATA DMF15HSA	DW10	None	In preparation	
128	RBE-3001	2009/03/14	2008/10/08	NIIGATA DMF13HZ	TACN22-1613A	Installed	In operation	
129	RBE-3002	2009/03/14	2008/10/08	NIIGATA DMF13HZ	TACN22-1613A	Installed	In operation	
130	RBE-3003	2009/03/14	2008/10/08	NIIGATA DMF13HZ	TACN22-1613A	Installed	In operation	
131	RBE-3004	2014/03/31	2015/05/12	NIIGATA DMF13HZ	TACN22-1613A	Installed	In operation	
132	RBE-3005	2014/03/31	2015/05/12	NIIGATA DMF13HZ	TACN22-1613A	Installed	In operation	
133	RBE-3006	2015/04/10	2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
134	RBE-3007	2015/04/07	2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
135	RBE-3008	2015/04/07	2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	

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136	RBE-3009		2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
137	RBE-3010	2015/04/10	2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
138	RBE-3011	2015/04/10	2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
139	RBE-3012		2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
140	RBE-3013	2015/04/07	2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
141	RBE-3014		2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
142	RBE-3015	2015/04/07	2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
143	RBE-3016	2015/04/07	2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
144	RBE-3017		2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
145	RBE-3018		2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	Undrivable	
146	RBE-3019		2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
147	RBE-3020		2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
148	RBE-3021	2015/04/07	2015/05/12	Cummins C-DMF14HZA	C-DW15	Installed	In operation	
149	RBE-3022	2015/03/23	2015/05/12	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
150	RBE-3023	2015/03/23	2015/05/12	Cummins C-DMF14HZB	C-DW14A	Installed	Undrivable	
151	RBE-3024	2015/03/23	2015/05/12	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
152	RBE-3025	2015/04/08	2015/05/12	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
153	RBE-3026	2015/04/28	2015/05/12	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
154	RBE-3027	2015/03/23	2015/05/12	Cummins C-DMF14HZ	C-DW14A	Installed	In operation	
155	RBE-3028	2015/04/08	2015/05/12	Cummins C-DMF14HZ	C-DW14A	Installed	In operation	
156	RBE-3029	2015/04/28	2015/05/12	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
157	RBE-3030	2015/03/23	2015/05/12	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
158	RBE-3031	2015/04/03	2015/05/12	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
159	RBE-3032	2015/04/03	2015/05/12	Cummins C-DMF14HZB	C-DW14A	Installed	Undrivable	
160	RBE-3033	2015/04/08	2015/05/12	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
161	RBE-3034	2015/03/02	2015/05/12	KOMATSU SA6D125H-1A	KTF3335A-2A	Installed	In operation	Stainless body
162	RBE-3035	2015/08/06	2015/09/05	Cummins C-DMF14HZA	C-DW15	Installed	Ready to drive	
163	RBE-3036	2015/08/06	2015/09/05	Cummins C-DMF14HZA	C-DW15	Installed	Ready to drive	
164	RBE-3037	2015/08/06	2015/09/05	Cummins C-DMF14HZA	C-DW15	Installed	Ready to drive	
165	RBE-3038	2015/08/06	2015/09/05	Cummins C-DMF14HZA	C-DW15	Installed	Ready to drive	
166	RBE-3039	2015/08/06	2015/09/05	Cummins C-DMF14HZA	C-DW15	Installed	Ready to drive	
167	RBE-3040	2015/07/31	2015/09/05	Cummins C-DMF14HZ	C-DW14A	Installed	Ready to drive	
168	RBE-3041	2015/07/27	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
169	RBE-3042	2015/07/27	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
170	RBE-3043	2015/07/07	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
171	RBE-3044	2015/07/29	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
172	RBE-3045	2015/07/07	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
173	RBE-3046	2015/07/29	2015/09/05	Cummins C-DMF14HZ	C-DW14A	Installed	In operation	
174	RBE-3047	2015/07/07	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
175	RBE-3048	2015/07/07	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
176	RBE-3049	2015/07/27	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	Undrivable	
177	RBE-3050	2015/07/07	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
178	RBE-3051	2015/07/27	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
179	RBE-3052	2015/07/29	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
180	RBE-3053	2015/07/31	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	

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181	RBE-3054	2015/07/29	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
182	RBE-3055	2015/07/27	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
183	RBE-3056	2015/07/31	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
184	RBE-3057	2015/07/29	2015/09/05	Cummins C-DMF14HZB	C-DW14A	Installed	In operation	
185	RBE-3601	2005/03/18	2005/05/22	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
186	RBE-3602	2005/02/18	2005/05/22	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
187	RBE-3603	2005/03/18	2005/05/03	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
188	RBE-3604	2005/01/19	2005/02/27	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
189	RBE-3605	2005/03/18	2005/05/03	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
190	RBE-3606	2005/03/18	2005/05/22	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
191	RBE-3607	2005/01/19	2005/02/27	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
192	RBE-3608	2005/01/19	2005/02/27	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
193	RBE-3609	2005/01/19	2005/02/27	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
194	RBE-3610	2005/02/18	2005/05/10	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
195	RBE-3611	2005/02/18	2005/05/10	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
196	RBE-3612	2005/02/18	2005/05/10	DMH17 X 2	DF115A X 2	None	Undrivable	Planned to disuse
197	RBE-5001	2007/09/09	2007/10/15	KOMATSU DMF11HZ X 2	DF115A X 2	None	In operation	
198	RBE-5002 >> RBT-5002	2007/09/09	2007/10/15	KOMATSU DMF11HZ X 2	DF115A X 2	None	Undrivable	Converted to passenger coach
199	RBE-5003 >> RBT-5003	2007/12/02	2008/02/22	KOMATSU DMF11HZ X 2	DF115A X 2	None	Undrivable	Converted to passenger coach
200	RBE-5004	2007/12/02	2008/02/22	NIIGATA DMF13HZ X 2	DF115A X 2	None	Undrivable	Planned to disuse
201	RBE-5005	2007/12/09	2008/02/22	KOMATSU DMF11HZ X 2	DF115A X 2	None	Undrivable	Planned to disuse
202	RBE-5006	2007/12/09	2008/02/22	KOMATSU DMF11HZ X 2	DF115A X 2	None	In operation	
203	RBE-5007 >> RBT-5007	2007/12/09	2008/02/22	NIIGATA DMF13HZ X 2	DF115A X 2	None	Undrivable	Converted to passenger coach (2015/05/31)
204	RBE-5008	2007/12/09	2008/02/22	NIIGATA DMF13HZ X 2	DF115A X 2	None	Undrivable	
205	RBE-5009	2007/12/09	2008/02/22	KOMATSU DMF11HZ X 2	DF115A X 2	None	In operation	
206	RBE-5010	2007/12/02	2008/02/21	KOMATSU DMF11HZ X 2	DF115A X 2	None	Undrivable	
207	RBE-5011	2007/12/02	2008/02/29	KOMATSU DMF11HZ X 2	DF115A X 2	None	In operation	
208	RBE-5012	2007/12/02	2008/02/29	KOMATSU DMF11HZ X 2	DF115A X 2	None	In operation	Planned to disuse
209	RBE-5013	2007/12/09	2008/02/29	NIIGATA DMF13HZ X 2	DF115A X 2	None	In operation	
210	RBE-5014	2007/12/09	2008/02/29	KOMATSU DMF11HZ X 2	DF115A X 2	None	In operation	Planned to disuse
211	RBE-5015	2007/12/09	2008/02/29	NIIGATA DMF13HZ X 2	DF115A X 2	None	In operation	Planned to disuse
212	RBE-5016	2007/12/02	2008/02/29	NIIGATA DMF13HZ X 2	DF115A X 2	None	Undrivable	
213	RBE-5017	2007/12/09	2008/02/29	NIIGATA DMF13HZ X 2	DF115A X 2	None	Undrivable	
214	RBE-5018	2007/12/09	2008/02/29	NIIGATA DMF13HZ X 2	DF115A X 2	None	Undrivable	
215	RBE-5019 >> RBT-5019	2007/12/02	2008/02/21	NIIGATA DMF13HZ X 2	DF115A X 2	None	Undrivable	Converted to passenger coach (2015/08/16)
216	RBE-5020	2007/12/02	2008/02/21	NIIGATA DMF13HZ X 2	DF115A X 2	None	Undrivable	Planned to disuse
217	RBE-5021	2008/03/17	2010/10/09	NIIGATA DML30HSI	DW9A	Installed	Undrivable	
218	RBE-5022	2008/03/17	2010/10/09	NIIGATA DML30HSI	DW9A	Installed	Undrivable	
219	RBE-5023	2010/03/24	2010/12/18	NIIGATA DML30HSI	DW9A	Installed	In preparation	
220	RBE-5024	2010/03/24	2010/12/18	NIIGATA DML30HSI	DW9A	Installed	In preparation	
221	RBE-5025	2010/03/24	2010/12/18	NIIGATA DML30HSI	DW9A	Installed	In preparation	
222	RBE-5026	2010/03/24	2010/12/18	NIIGATA DML30HSI	DW9A	Installed	In preparation	
223	RBE-5027	2010/03/24	2010/12/18	NIIGATA DML30HSI	DW9A	Installed	In preparation	
224	RBE-5028	2010/03/24	2010/12/18	NIIGATA DML30HSI	DW9A	Installed	In preparation	
225	RBE-P5029	2012/02/08	2012/04/04	NIIGATA DML30HSE, DMF15HSG	DW4E	Installed	Undrivable	

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No.	Car No. (Called by MR)	Date of disuse in Japan	Date of transfer to MR	Engine type	Transmission type	Air conditioner	Condition	Remark
226	RBE-P5030	2012/02/08	2012/04/04	NIIGATA DML30HSE, DMF15HSG	DW4D	Installed	Undrivable	
227	RBE-P5031	2012/02/08	2012/04/04	NIIGATA DML30HSE, DMF15HSG	DW4E	Installed	Undrivable	
228	RBE-P5032	2012/02/08	2012/04/04	NIIGATA DML30HSE, DMF15HSG	DW4C	Installed	Undrivable	
229	RBE-P5033	2012/02/08	2012/04/04	NIIGATA DML30HSE, DMF15HSG	DW4E	Installed	Undrivable	
230	RBE-5034	2012/02/08	2012/04/04	NIIGATA DML30HSE	DW4C	Installed	Undrivable	
231	RBE-5035	2012/02/08	2012/04/04	NIIGATA DML30HSI	DW4F	Installed	Undrivable	
232	RBE-5036	2012/02/08	2012/04/04	NIIGATA DML30HSE	DW4E	Installed	Undrivable	
233	RBE-5037	2012/02/08	2012/04/04	NIIGATA DML30HSE	DW4	Installed	Undrivable	
234	RBE-5038	2012/02/08	2012/04/04	NIIGATA DML30HSI	DW4D	Installed	Undrivable	
235	RBE-5039	2012/02/08	2012/04/04	NIIGATA DML30HSE	DW4E	Installed	Undrivable	
236	RBE-5040	2012/02/08	2012/04/04	NIIGATA DML30HSI	DW4E	Installed	Undrivable	
237	RBE-5041	2012/02/08	2012/04/04	NIIGATA DML30HSE	DW4E	Installed	Undrivable	
238	RBE-5042	2012/02/08	2012/04/04	NIIGATA DML30HSI	DW4C	Installed	Undrivable	
239	RBE-5043	2012/02/08	2012/04/04	NIIGATA DML30HSI	DW4C	Installed	Undrivable	
240	RBE-5044		2012/11/22	NIIGATA DMF13HS X 2	DF115A X 2	None	In operation	Converted from 50 Series passenger coach to diesel car
241	RBE-5045		2012/11/22	NIIGATA DMF13HS X 2	DF115A X 2	None	In operation	
242	RBE-5046		2012/11/22	NIIGATA DMF13HS X 2	DF115A X 2	None	In operation	
243	RBE-5047		2012/11/22	NIIGATA DMF13HS X 2	DF115A X 2	None	In operation	
244	RBE-5048		2012/11/22	NIIGATA DMF13HS X 2	DF115A X 2	None	In operation	
245	RBE-5049		2012/11/22	NIIGATA DMF13HS X 2	DF115A X 2	None	In preparation	
246	RBE-5050	2012/11/14	2014/05/25	NIIGATA DMF13HS X 2	DF115A X 2	None	In operation	
247	RBE-5051	2012/11/14	2014/05/25	NIIGATA DMF13HS X 2	DF115A X 2	None	In operation	
248	RBE-5052	2012/11/22	2014/05/25	NIIGATA DMF13HS X 2	DF115A X 2	None	In operation	
249	RBE-5053	2012/12/05	2014/05/25	NIIGATA DMF13HS X 2	DF115A X 2	None	In operation	
250	RBE25001	2008/03/17	2009/10/10	NIIGATA DMF18HZ	N-DW17	Installed	Undrivable	Former RBE25101
251	RBE25002	2008/03/17	2009/10/10	NIIGATA DMF18HZ	N-DW17	Installed	Undrivable	Former RBE25102
252	RBE25003	2008/03/17	2009/10/10	NIIGATA DMF18HZ	N-DW17	Installed	Undrivable	Former RBE25103
253	RBE25004	2008/03/17	2009/10/10	NIIGATA DMF18HZ	N-DW17	Installed	Undrivable	Former RBE25104
254	RBE25005	2008/03/17	2009/10/10	NIIGATA DMF15HSA X 2	DW10	Installed	Undrivable	Former RBE25105
255	RBE25006	2008/03/17	2009/10/10	NIIGATA DMF15HSA X 2	DW10	Installed	Undrivable	Former RBE25106
256	RBE25007	2010/03/24	2010/12/18	NIIGATA DMF15HSA X 2	DW10	Installed	In preparation	Former RBE25201
257	RBE25008	2010/03/24	2010/12/18	NIIGATA DMF15HSA X 2	DW10	Installed	In preparation	Former RBE25108
258	RBE25009	2010/03/24	2010/12/18	NIIGATA DMF15HSA X 2	DW10	Installed	In preparation	Former RBE25109
259	RBE25010	2010/03/24	2010/12/18	NIIGATA DMF13HZC X 2	N-DW14C	Installed	In preparation	Former RBE25110
260	RBE25011	2010/03/24	2010/12/18	NIIGATA DMF13HZC X 2	N-DW14C	Installed	In preparation	Former RBE25111

CONDITION of the RBEs (1)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Car body						Cab					Under floor					Pipe			Wire		
		Good in appearance	Underframe corroded	Beginning of corrosion	Deformed	Built by rivets	Difficult to repair	Good in appearance	Corroded	Deteriorated	Roof removed	Unexamined	Good in appearance	Deformed	Corroded	Greasy	Covers removed	Good in appearance	Corroded	Deformed	Good in appearance	Deteriorated	Dis-connected
1	RBE-2501																						
2	RBE-2502	X				X	X					X	X					X			X		
3	RBE-2503	X				X	X					X	X					X			X		
4	RBE-2504				X	X	X					X						X			X		
5	RBE-2505		X			X	X								X				X			X	
6	RBE-2506		X			X	X								X				X			X	
7	RBE-2507																						
8	RBE-2508																						
9	RBE-2509																						
10	RBE-2510		X			X	X							X					X				
11	RBE-2511																						
12	RBE-2512																						
13	RBE-2513																						
14	RBE-2514																						
15	RBE-2515				X		X							X						X			
16	RBE-2516			X				X					X					X			X		
17	RBE-2517	X										X						X			X		
18	RBE-2518			X				X					X		X				X		X		
19	RBE-2519		X				X	X					X		X				X				
20	RBE-2520																						
21	RBE-2521		X		X		X																
22	RBE-2522		X				X								X				X				
23	RBE-2523																						
24	RBE-2524		X				X								X				X				
25	RBE-2525																						
26	RBE-2526																						
27	RBE-2527			X				X					X					X			X		
28	RBE-2528			X				X					X					X			X		
29	RBE-2529																						
30	RBE-2530		X				X	X					X		X				X		X		
31	RBE-2531																						
32	RBE-2532																						
33	RBE-2533																						
34	RBE-2534		X				X					X			X				X			X	
35	RBE-2535		X				X					X								X		X	
36	RBE-2536	X						X					X					X			X		
37	RBE-2537																						
38	RBE-2538		X				X								X				X			X	
39	RBE-2539		X				X								X				X			X	
40	RBE-2540 >> RBT-2540																						
41	RBE-2541		X				X								X				X			X	
42	RBE-2542		X				X								X				X				
43	RBE-2543	X						X					X					X			X		
44	RBE-2544 >> RBT-2544																						
45	RBE-2545 >> RBT-2545																						

CONDITION of the RBEs (1)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Car body						Cab					Under floor					Pipe			Wire		
		Good in appearance	Underframe corroded	Beginning of corrosion	Deformed	Built by rivets	Difficult to repair	Good in appearance	Corroded	Deteriorated	Roof removed	Unexamined	Good in appearance	Deformed	Corroded	Greasy	Covers removed	Good in appearance	Corroded	Deformed	Good in appearance	Deteriorated	Dis-connected
46	RBE-2546 >> RBT-2546																						
47	RBE-2547		X					X					X		X				X		X		
48	RBE-2548																						
49	RBE-2549																						
50	RBE-2550																						
51	RBE-2551		X				X								X				X			X	
52	RBE-2552																						
53	RBE-2553																						
54	RBE-2554																						
55	RBE-2555		X				X								X				X			X	
56	RBE-2556																						
57	RBE-2557																						
58	RBE-2558																						
59	RBE-2559																						
60	RBE-2560																						
61	RBE-2561																						
62	RBE-2562																						
63	RBE-2563																						
64	RBE-2564																						
65	RBE-2565																						
66	RBE-2566																						
67	RBE-2567		X				X							X				X				X	
68	RBE-2568		X				X	X										X			X		
69	RBE-2569																						
70	RBE-2570																						
71	RBE-2571	X						X					X					X			X		
72	RBE-2572	X						X					X					X				X	
73	RBE-2573 >> RBT-2573																						
74	RBE-2574				X		X	X						X				X			X		
75	RBE-2575 >> RBT-2575																						
76	RBE-2576		X				X	X					X					X			X		
77	RBE-2577 >> RBT-2577																						
78	RBE-2578																						
79	RBE-2579																						
80	RBE-2580					X	X					X	X					X			X		
81	RBE-2581					X	X					X	X					X			X		
82	RBE-2582																						
83	RBE-2583																						
84	RBE-2584																						
85	RBE-2585																						
86	RBE-2586																						
87	RBE-2587	X						X					X					X			X		
88	RBE-2588	X						X					X					X			X		
89	RBE-2589	X						X					X					X			X		
90	RBE-2590	X						X					X					X			X		

CONDITION of the RBEs (1)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Car body						Cab					Under floor					Pipe			Wire		
		Good in appearance	Underframe corroded	Beginning of corrosion	Deformed	Built by rivets	Difficult to repair	Good in appearance	Corroded	Deteriorated	Roof removed	Unexamined	Good in appearance	Deformed	Corroded	Greasy	Covers removed	Good in appearance	Corroded	Deformed	Good in appearance	Deteriorated	Dis-connected
91	RBE-2591																						
92	RBE-2592																						
93	RBE-2593																						
94	RBE-2594																						
95	RBE-2595																						
96	RBE-2596																						
97	RBE-2597																						
98	RBE-2598	X						X								X		X			X		
99	RBE-2599			X				X					X					X			X		
100	RBE-25100			X								X	X					X			X		
101	RBE-25101																						
102	RBE-25102																						
103	RBE-25103																						
104	RBE-25104																						
105	RBE-25105																						
106	RBE-25106	X						X					X					X			X		
107	RBE-25107	X										X	X					X			X		
108	RBE-25108																						
109	RBE-25109	X										X	X					X			X		
110	RBE-25110	X						X					X					X			X		
111	RBE-25111	X						X					X					X			X		
112	RBE-25112	X						X					X					X			X		
113	RBE-25113	X						X					X					X			X		
114	RBE-25114	X						X					X					X			X		
115	RBE-25115	X						X					X					X			X		
116	RBE-25116	X						X					X					X			X		
117	RBE-25117	X						X					X					X			X		
118	RBE-25118	X						X					X					X			X		
119	RBE-25119	X										X	X					X			X		
120	RBE-25120	X										X	X					X			X		
121	RBE-25121	X										X	X					X			X		
122	RBE-25122	X										X	X					X			X		
123	RBE-25123	X										X	X					X			X		
124	RBE-25124	X										X	X					X			X		
125	RBE-25125	X										X	X					X			X		
126	RBE-25126	X										X	X					X			X		
127	RBE-25127	X										X	X					X			X		
128	RBE-3001	X						X					X					X			X		
129	RBE-3002																						
130	RBE-3003																						
131	RBE-3004	X						X					X					X			X		
132	RBE-3005	X						X					X					X			X		
133	RBE-3006	X										X	X					X			X		
134	RBE-3007	X										X	X					X			X		
135	RBE-3008	X						X					X					X			X		

CONDITION of the RBEs (1)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Car body						Cab					Under floor					Pipe			Wire		
		Good in appearance	Underframe corroded	Beginning of corrosion	Deformed	Built by rivets	Difficult to repair	Good in appearance	Corroded	Deteriorated	Roof removed	Unexamined	Good in appearance	Deformed	Corroded	Greasy	Covers removed	Good in appearance	Corroded	Deformed	Good in appearance	Deteriorated	Dis-connected
136	RBE-3009	X										X	X					X			X		
137	RBE-3010	X										X	X					X			X		
138	RBE-3011	X										X	X					X			X		
139	RBE-3012	X										X	X					X			X		
140	RBE-3013	X										X	X					X			X		
141	RBE-3014	X										X	X					X			X		
142	RBE-3015	X										X	X					X			X		
143	RBE-3016	X						X					X					X			X		
144	RBE-3017	X										X	X					X			X		
145	RBE-3018	X										X	X					X			X		
146	RBE-3019	X						X					X					X			X		
147	RBE-3020	X										X	X					X			X		
148	RBE-3021	X						X					X					X			X		
149	RBE-3022			X				X					X					X			X		
150	RBE-3023			X				X					X		X				X		X		
151	RBE-3024																						
152	RBE-3025																						
153	RBE-3026	X						X					X					X			X		
154	RBE-3027																						
155	RBE-3028	X						X					X					X			X		
156	RBE-3029																						
157	RBE-3030			X				X					X					X			X		
158	RBE-3031			X				X					X					X			X		
159	RBE-3032	X						X					X					X			X		
160	RBE-3033	X						X					X					X			X		
161	RBE-3034	X										X	X					X			X		
162	RBE-3035	X										X	X					X			X		
163	RBE-3036	X										X	X					X			X		
164	RBE-3037	X										X	X					X			X		
165	RBE-3038	X										X	X					X			X		
166	RBE-3039	X										X	X					X			X		
167	RBE-3040	X						X					X					X			X		
168	RBE-3041																						
169	RBE-3042																						
170	RBE-3043																						
171	RBE-3044																						
172	RBE-3045																						
173	RBE-3046																						
174	RBE-3047	X						X					X					X			X		
175	RBE-3048																						
176	RBE-3049	X						X					X					X			X		
177	RBE-3050																						
178	RBE-3051																						
179	RBE-3052																						
180	RBE-3053																						

CONDITION of the RBEs (1)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Car body						Cab					Under floor					Pipe			Wire		
		Good in appearance	Underframe corroded	Beginning of corrosion	Deformed	Built by rivets	Difficult to repair	Good in appearance	Corroded	Deteriorated	Roof removed	Unexamined	Good in appearance	Deformed	Corroded	Greasy	Covers removed	Good in appearance	Corroded	Deformed	Good in appearance	Deteriorated	Dis-connected
181	RBE-3054																						
182	RBE-3055																						
183	RBE-3056																						
184	RBE-3057	X						X					X					X			X		
185	RBE-3601		X		X		X								X				X			X	
186	RBE-3602		X		X		X								X				X			X	
187	RBE-3603			X								X											
188	RBE-3604		X		X		X								X				X			X	
189	RBE-3605		X		X		X								X				X			X	
190	RBE-3606		X		X		X								X				X			X	
191	RBE-3607		X		X		X					X			X				X			X	
192	RBE-3608		X		X		X								X				X			X	
193	RBE-3609																						
194	RBE-3610		X		X		X								X				X			X	
195	RBE-3611		X		X		X								X				X			X	
196	RBE-3612		X		X		X								X				X			X	
197	RBE-5001	X						X						X									
198	RBE-5002 >> RBT-5002																						
199	RBE-5003 >> RBT-5003																						
200	RBE-5004			X										X	X				X			X	
201	RBE-5005		X				X							X	X				X			X	
202	RBE-5006																						
203	RBE-5007 >> RBT-5007																						
204	RBE-5008		X				X			X					X				X			X	
205	RBE-5009																						
206	RBE-5010	X						X										X			X		
207	RBE-5011	X										X	X					X			X		
208	RBE-5012																						
209	RBE-5013			X						X				X	X				X			X	
210	RBE-5014																						
211	RBE-5015																						
212	RBE-5016		X				X			X				X					X			X	
213	RBE-5017			X											X			X				X	
214	RBE-5018			X				X							X				X			X	
215	RBE-5019 >> RBT-5019																						
216	RBE-5020			X					X								X	X				X	
217	RBE-5021			X								X		X				X					X
218	RBE-5022			X				X					X					X			X		
219	RBE-5023			X								X					X	X			X		
220	RBE-5024			X								X					X	X			X		
221	RBE-5025			X								X	X					X			X		
222	RBE-5026			X								X	X					X			X		
223	RBE-5027			X								X	X					X					X
224	RBE-5028			X								X	X					X					X
225	RBE-P5029																						

CONDITION of the RBEs (1)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Car body						Cab					Under floor					Pipe			Wire		
		Good in appearance	Underframe corroded	Beginning of corrosion	Deformed	Built by rivets	Difficult to repair	Good in appearance	Corroded	Deteriorated	Roof removed	Unexamined	Good in appearance	Deformed	Corroded	Greasy	Covers removed	Good in appearance	Corroded	Deformed	Good in appearance	Deteriorated	Dis-connected
226	RBE-P5030																						
227	RBE-P5031			X				X					X					X			X		
228	RBE-P5032																						
229	RBE-P5033																						
230	RBE-5034																						
231	RBE-5035																						
232	RBE-5036																						
233	RBE-5037																						
234	RBE-5038																						
235	RBE-5039																						
236	RBE-5040																						
237	RBE-5041			X				X					X					X			X		
238	RBE-5042																						
239	RBE-5043																						
240	RBE-5044																						
241	RBE-5045																						
242	RBE-5046																						
243	RBE-5047																						
244	RBE-5048																						
245	RBE-5049																						
246	RBE-5050																						
247	RBE-5051																						
248	RBE-5052																						
249	RBE-5053																						
250	RBE25001			X								X						X			X		
251	RBE25002			X								X	X					X			X		
252	RBE25003			X								X	X					X			X		
253	RBE25004			X								X	X					X			X		
254	RBE25005			X								X						X			X		
255	RBE25006			X								X		X				X			X		
256	RBE25007			X				X						X				X			X		
257	RBE25008			X					X		X				X				X			X	
258	RBE25009			X					X		X		X					X			X		
259	RBE25010			X					X		X		X					X			X		
260	RBE25011			X							X		X					X			X		

CONDITION of the RBEs (2)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Engine			Transmission		Bogie				Removed equipment											
		Good in appearance	Blow-by	Corroded	Good in appearance	Corroded	Good in appearance	Corroded	Deteriorated	In preparation	Engine	Trans-mission	Radiator	Propeller shaft	Compressor	Engine controller	Relay	Coupler	Driving bogie	Trailing bogie	Axle box	Air cleaner
1	RBE-2501																					
2	RBE-2502	X			X		X															
3	RBE-2503	X			X		X															
4	RBE-2504	X					X					X	X									
5	RBE-2505										X						X	X				
6	RBE-2506										X	X	X				X					
7	RBE-2507																					
8	RBE-2508																					
9	RBE-2509																					
10	RBE-2510		X																			
11	RBE-2511																					
12	RBE-2512																					
13	RBE-2513																					
14	RBE-2514																					
15	RBE-2515			X		X																
16	RBE-2516	X			X		X															
17	RBE-2517	X			X		X															
18	RBE-2518	X			X		X															
19	RBE-2519							X			X											
20	RBE-2520																					
21	RBE-2521										X							X	X			
22	RBE-2522			X								X						X				
23	RBE-2523																					
24	RBE-2524								X													
25	RBE-2525																					
26	RBE-2526																					
27	RBE-2527	X			X		X															
28	RBE-2528	X			X		X															
29	RBE-2529																					
30	RBE-2530	X			X		X										X		X			
31	RBE-2531																					
32	RBE-2532																					
33	RBE-2533																					
34	RBE-2534					X					X											
35	RBE-2535	X			X		X															
36	RBE-2536	X			X		X															
37	RBE-2537																					
38	RBE-2538										X	X	X					X		X		
39	RBE-2539					X		X			X											
40	RBE-2540 >> RBT-2540																					
41	RBE-2541		X																		X	
42	RBE-2542							X			X				X							
43	RBE-2543	X			X		X															
44	RBE-2544 >> RBT-2544																					
45	RBE-2545 >> RBT-2545																					

CONDITION of the RBEs (2)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Engine			Transmission		Bogie				Removed equipment												
		Good in appearance	Blow-by	Corroded	Good in appearance	Corroded	Good in appearance	Corroded	Deteriorated	In preparation	Engine	Trans-mission	Radiator	Propeller shaft	Compressor	Engine controller	Relay	Coupler	Driving bogie	Trailing bogie	Axle box	Air cleaner
46	RBE-2546 >> RBT-2546																					
47	RBE-2547	X			X		X															
48	RBE-2548																					
49	RBE-2549																					
50	RBE-2550																					
51	RBE-2551		X				X					X	X									
52	RBE-2552																					
53	RBE-2553																					
54	RBE-2554																					
55	RBE-2555										X	X	X		X		X					
56	RBE-2556																					
57	RBE-2557																					
58	RBE-2558																					
59	RBE-2559																					
60	RBE-2560																					
61	RBE-2561																					
62	RBE-2562																					
63	RBE-2563																					
64	RBE-2564																					
65	RBE-2565																					
66	RBE-2566																					
67	RBE-2567		X				X					X										
68	RBE-2568	X			X		X															X
69	RBE-2569																					
70	RBE-2570																					
71	RBE-2571	X			X															X		
72	RBE-2572	X			X		X								X							
73	RBE-2573 >> RBT-2573																					
74	RBE-2574	X					X					X										
75	RBE-2575 >> RBT-2575																					
76	RBE-2576	X			X		X															
77	RBE-2577 >> RBT-2577																					
78	RBE-2578																					
79	RBE-2579																					
80	RBE-2580	X			X		X															
81	RBE-2581	X			X		X															
82	RBE-2582																					
83	RBE-2583																					
84	RBE-2584																					
85	RBE-2585																					
86	RBE-2586																					
87	RBE-2587	X			X				X													
88	RBE-2588	X			X		X															
89	RBE-2589	X			X		X															
90	RBE-2590	X			X		X															

CONDITION of the RBEs (2)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Engine			Transmission		Bogie				Removed equipment											
		Good in appearance	Blow-by	Corroded	Good in appearance	Corroded	Good in appearance	Corroded	Deteriorated	In preparation	Engine	Trans-mission	Radiator	Propeller shaft	Compressor	Engine controller	Relay	Coupler	Driving bogie	Trailing bogie	Axle box	Air cleaner
91	RBE-2591																					
92	RBE-2592																					
93	RBE-2593																					
94	RBE-2594																					
95	RBE-2595																					
96	RBE-2596																					
97	RBE-2597																					
98	RBE-2598	X			X		X															
99	RBE-2599	X			X		X															
100	RBE-25100	X			X		X															
101	RBE-25101																					
102	RBE-25102																					
103	RBE-25103																					
104	RBE-25104																					
105	RBE-25105																					
106	RBE-25106	X			X		X															
107	RBE-25107	X			X		X															
108	RBE-25108																					
109	RBE-25109				X		X															
110	RBE-25110				X		X															
111	RBE-25111				X		X															
112	RBE-25112				X		X															
113	RBE-25113				X		X															
114	RBE-25114				X		X															
115	RBE-25115				X		X															
116	RBE-25116				X		X															
117	RBE-25117				X		X															
118	RBE-25118				X		X															
119	RBE-25119				X					X												
120	RBE-25120				X					X												
121	RBE-25121				X					X												
122	RBE-25122				X					X												
123	RBE-25123				X					X												
124	RBE-25124				X					X												
125	RBE-25125				X					X												
126	RBE-25126				X					X												
127	RBE-25127				X					X												
128	RBE-3001	X			X		X															
129	RBE-3002																					
130	RBE-3003																					
131	RBE-3004	X			X		X															
132	RBE-3005	X			X		X															
133	RBE-3006	X			X		X															
134	RBE-3007	X			X		X															
135	RBE-3008	X			X		X															

CONDITION of the RBEs (2)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Engine			Transmission		Bogie				Removed equipment												
		Good in appearance	Blow-by	Corroded	Good in appearance	Corroded	Good in appearance	Corroded	Deteriorated	In preparation	Engine	Trans-mission	Radiator	Propeller shaft	Compressor	Engine controller	Relay	Coupler	Driving bogie	Trailing bogie	Axle box	Air cleaner
136	RBE-3009	X			X		X															
137	RBE-3010	X			X		X															
138	RBE-3011	X			X		X															
139	RBE-3012	X			X		X															
140	RBE-3013	X			X		X															
141	RBE-3014	X			X		X															
142	RBE-3015	X			X		X															
143	RBE-3016	X			X		X															
144	RBE-3017	X			X		X															
145	RBE-3018	X			X		X															
146	RBE-3019	X			X		X															
147	RBE-3020	X			X		X															
148	RBE-3021	X			X		X															
149	RBE-3022	X			X		X															
150	RBE-3023	X			X		X															
151	RBE-3024																					
152	RBE-3025																					
153	RBE-3026	X			X		X															
154	RBE-3027																					
155	RBE-3028	X			X		X															
156	RBE-3029																					
157	RBE-3030	X			X		X															
158	RBE-3031	X			X		X															
159	RBE-3032	X			X		X															
160	RBE-3033	X			X		X															
161	RBE-3034	X			X		X															
162	RBE-3035	X			X		X															
163	RBE-3036	X			X		X															
164	RBE-3037	X			X		X															
165	RBE-3038	X			X		X															
166	RBE-3039	X			X		X															
167	RBE-3040	X			X		X															
168	RBE-3041																					
169	RBE-3042																					
170	RBE-3043																					
171	RBE-3044																					
172	RBE-3045																					
173	RBE-3046																					
174	RBE-3047	X			X		X															
175	RBE-3048																					
176	RBE-3049	X			X		X															
177	RBE-3050																					
178	RBE-3051																					
179	RBE-3052																					
180	RBE-3053																					

CONDITION of the RBEs (2)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Engine			Transmission		Bogie				Removed equipment											
		Good in appearance	Blow-by	Corroded	Good in appearance	Corroded	Good in appearance	Corroded	Deteriorated	In preparation	Engine	Trans-mission	Radiator	Propeller shaft	Compressor	Engine controller	Relay	Coupler	Driving bogie	Trailing bogie	Axle box	Air cleaner
181	RBE-3054																					
182	RBE-3055																					
183	RBE-3056																					
184	RBE-3057	X			X		X															
185	RBE-3601			X		X		X														
186	RBE-3602			X		X		X														
187	RBE-3603										X	X							X	X		
188	RBE-3604			X		X		X														
189	RBE-3605			X		X		X														
190	RBE-3606			X		X		X														
191	RBE-3607							X			X	X	X		X		X					
192	RBE-3608			X		X		X														
193	RBE-3609																					
194	RBE-3610			X		X		X														
195	RBE-3611			X		X		X														
196	RBE-3612			X		X		X														
197	RBE-5001										X	X										
198	RBE-5002 >> RBT-5002																					
199	RBE-5003 >> RBT-5003																					
200	RBE-5004		X		X															X		
201	RBE-5005										X	X	X		X							
202	RBE-5006																					
203	RBE-5007 >> RBT-5007																					
204	RBE-5008					X	X				X											
205	RBE-5009																					
206	RBE-5010						X				X	X	X		X							
207	RBE-5011	X			X		X															
208	RBE-5012																					
209	RBE-5013	X			X														X			
210	RBE-5014																					
211	RBE-5015																					
212	RBE-5016				X						X											
213	RBE-5017	X			X		X															
214	RBE-5018	X			X		X															
215	RBE-5019 >> RBT-5019																					
216	RBE-5020										X	X										
217	RBE-5021	X			X		X															
218	RBE-5022		X		X		X															
219	RBE-5023	X			X		X									X						
220	RBE-5024	X			X		X									X						
221	RBE-5025						X				X	X										
222	RBE-5026						X				X	X										
223	RBE-5027	X			X		X															
224	RBE-5028	X			X		X															
225	RBE-P5029																					

CONDITION of the RBEs (2)

X Applicable Cars that were not examined or were converted to passenger coachs

No.	Car No. (Called by MR)	Engine			Transmission		Bogie				Removed equipment											
		Good in appearance	Blow-by	Corroded	Good in appearance	Corroded	Good in appearance	Corroded	Deteriorated	In preparation	Engine	Trans-mission	Radiator	Propeller shaft	Compressor	Engine controller	Relay	Coupler	Driving bogie	Trailing bogie	Axle box	Air cleaner
226	RBE-P5030																					
227	RBE-P5031	X			X		X															
228	RBE-P5032																					
229	RBE-P5033																					
230	RBE-5034																					
231	RBE-5035																					
232	RBE-5036																					
233	RBE-5037																					
234	RBE-5038																					
235	RBE-5039																					
236	RBE-5040																					
237	RBE-5041	X			X		X															
238	RBE-5042																					
239	RBE-5043																					
240	RBE-5044																					
241	RBE-5045																					
242	RBE-5046																					
243	RBE-5047																					
244	RBE-5048																					
245	RBE-5049																					
246	RBE-5050																					
247	RBE-5051																					
248	RBE-5052																					
249	RBE-5053																					
250	RBE25001	X			X		X							X			X					
251	RBE25002	X			X		X															
252	RBE25003	X			X		X															
253	RBE25004	X			X		X															
254	RBE25005	X			X		X						X									
255	RBE25006		X		X		X															
256	RBE25007		X		X		X															
257	RBE25008			X		X		X								X						
258	RBE25009						X				X	X										
259	RBE25010	X			X		X															
260	RBE25011	X			X		X															