

**PROJECT ON IMPROVEMENT OF SERVICE AND
SAFETY OF RAILWAY IN MYANMAR
PROJECT FINAL REPORT**

March 2016

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JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO., LTD
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Preface

“Project on the Improvement of Service and Safety of Railway in Myanmar” by Japan International Cooperation Agency (JICA) has been implemented by the consortium (JICA Expert Team) consisting of three companies, Japan International Consultants for Transportation Co., Ltd., Oriental Consultants Global Co., Ltd., and Sumitomo Corporation since May 2013 addressing the issues regarding Myanmar Railways (MR) where railway facilities are aging and where there were 651 serious accidents in fiscal 2011 such as derailment, collision, etc. The project consists of two components.

- (1) Based on accident and low service level analysis, recommendation on technical standards relating to administrative and maintenance aspect and drawing up railway facilities improvement plan to improve service and safety level
- (2) Technology transfer of track maintenance technology to improve the level of service and safety through implementation of the Pilot Project

Regarding the first component of the project, its site activity was completed in March 2015 as initially scheduled. As for the second component, track maintenance work was scheduled to be implemented until May 2014 with 30 engineers from MR but it was decided to extend the completion of the project as long as possible, based on the request by MR, while the track maintenance work was conducted with 30 engineers, who were replaced approximately every month. In addition, upon a request in writing from the Myanmar side dated 28th January, 2015 to continue the site training of track maintenance work, the project term was further extended, with additional track maintenance work and bridge maintenance/management training. The site activity was completed in February 2016. During the period, the Japan side ordered additional equipment twice and conducted the training of railway management and track maintenance work in Japan while communicating closely with the Myanmar side.

The JICA Expert Team sincerely thanks our counterpart, Myanmar Railways, the Ministry of Rail Transportation, the Institution for Transport Policy Studies for providing track maintenance materials for the project implementation, and other cooperating organizations including the Embassy of Japan in Myanmar and JICA's Myanmar Office for their support for the smooth implementation of the project.

This Project Final Report presents the major activities throughout the term of this project.

We hope that this report will contribute to the improvement of the safety and service level of MR and to the enhancement of friendly relations between Myanmar and Japan.

March, 2016

Leader of JICA Expert Team
Nobuyuki MATSUO

Project on Improvement of Service and Safety of Railway in Myanmar

Project Final Report

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Abbreviation

AE	• • •	Assistant Engineer
AGM	• • •	Assistant General Manager
CITC	• • •	Ministry of Rail Transportation Central Institute of Transport and Communication
DE	• • •	Divisional Engineer
DGM	• • •	Deputy General Manager
EE	• • •	Executive Engineer
EDCF	• • •	Economic Development Cooperation Fund (Korea)
ESCAP	• • •	Economic and Social Commission for Asia and the Pacific (United Nations)
GM	• • •	General Manager
GIZ	• • •	Deutsche Gesellschaft für Internationale Zusammenarbeit (Germany)
GTZ	• • •	Deutsche Gesellschaft für Technische Zusammenarbeit (Germany)
JCC	• • •	Joint Coordinate Committee
JIC	• • •	Japan International Consultants for Transportation Co., Ltd.
JICA	• • •	Japan International Cooperation Agency
JRE	• • •	East Japan Railway Company
JRF	• • •	Japan Freight Railway Company
JITI	• • •	Japan International Transport Institute
MLIT	• • •	Ministry of Land, Infrastructure, Transport and Tourism
MOC	• • •	Ministry of Construction
MORT	• • •	Ministry of Rail Transportation
MR	• • •	Ministry of Rail Transportation Myanmar Railways
O&M	• • •	Operation and Maintenance
ODA	• • •	Official Development Assistance
OJT	• • •	On the Job Training
PWI	• • •	Permanent Way Inspector
RGC	• • •	Rail Gang Car
RTTC	• • •	Railways Technical Training Centre

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Chapter1 Project Summary

1-1 Project Background

In recent years, MR and Ministry of Rail Transportation have come to recognize the importance of maintenance/repair of existing lines. In the past, however, MR invested more than a half of the budget in the construction of new railway lines, with only a small portion appropriated for the renewal of existing facilities and equipment. As a result, MR is now has crucial subjects how to recover the deteriorated safety level and passenger services. In concrete terms, facilities and equipment have extremely superannuated and machines, tools and materials are running short. Maintenance, and management have not been implemented appropriately in the past. As a matter of fact, 118 accidents including derailment and collision having occurred in fiscal 2011 in the Yangon–Mandalay section. There are a number of problems in the section, such as delays of train operation, lowered train speed and worsened ride comfort.

1-1-1 Circumstances Regarding Safety of MR

According to the data of MR, the status of the safety of train operation is as follows. From 2011 through 2012, 118 accidents occurred in the 620.4 km-long Yangon–Mandalay section, of which those attributed to tracks, rolling stock and others accounted for 50, 29 and 21%, respectively.

1-1-2 Circumstances Regarding Service of MR

There are a number of factors that govern the service level, such as train speed, punctuality, comfort (ride comfort, cleanliness in the passenger room) and fare and charge. The scheduled speed between Yangon and Mandalay is as low as 39 km/h, with train speed limited at various points. The on-time operation rate of express passenger trains in the same section is as low as 41% during the past three years, with trains delayed 59% by improper track conditions and 22% by malfunction of rolling stock. This means that train delay is caused mostly by deteriorated tracks. Furthermore, trains vibrate excessively and passenger rooms are not clean. MR is required to eliminate these drawbacks and improve passenger services.

1-2 Circumstances Having Led to the Project

With the above facts in the background, the government of Myanmar requested the government of Japan to implement a project of technical cooperation, namely “The Project on Improvement of Service and Safety of Railway.” Based on this request, JICA delegated a detailed project planning study team in October 2012 and surveyed the present status of the railways around Yangon and in the suburbs of Naypyidaw and also had the consultations with MR.

According to the Record of Discussion (hereinafter referred to as R/D) signed on March 25, 2013, between President of MR and General Manager, JICA office in Myanmar, agreement was reached upon the detailed contents of the Project and cooperation of JICA to be extended thereto.

1-3 Purpose of the Project

Administration and maintenance ability is improved for the enhancement of service and safety of Myanmar Railways.



(1) Track settlement into road bed



(2) Lack of ballast, track irregularity



(3) Yangon central station (rainy season)



(4) Bridge (rainy season)

Photo 1-1 Situations of MR's facilities (before this project)

Chapter2 Basic Plan of Project Implementation

2-1 Overall Goal and Project Purpose

Overall goal and Project purpose of this Project and expected outputs are as follows.

Overall goal and Project purpose	
1	Service and safety level of Myanmar Railways is improved (Overall goal)
2	Administration and maintenance ability is improved for the enhancement of service and safety of Myanmar Railways (Project purpose)



Expected outputs	
Output1	Based on accident analysis, issues are clarified for the enhancement of service and safety in the administration and maintenance process, and the improvement plan is drawn.
Output2	Technical Transfer of Track Maintenance Technology to improve the level of Service and Safety through implementation of the Pilot Project

2-2 Implementation Plan

Implementation plans which accomplish the project purpose are as follows.

Implementation plan for Output1	
To survey current situations of track, rolling stock, signal and telecommunication, and operation, and to establish system for collecting information in these various areas above.	
To promote familiarization on the investigation and analysis method of accident cause based on the comprehensive factors of track, rolling stock, signal and telecommunication, and operation.	
To conduct the investigation and analysis mentioned above with due consideration on hardware (facilities, equipment), and software (operational and maintenance standards, human errors etc.)	
To provide recommendation based on the above analysis on necessary technical standards relating to operational and maintenance aspects to improve service and safety level	
To draw up the improvement plan of railway facilities through discussion with the “Working Group of service and safety improvement”	

Implementation plan for Output2
To draw up technology transfer plan of track maintenance through OJT in the Pilot Section.
According to the technology transfer plan above, to procure the necessary equipment and materials.
To conduct track maintenance (inspection, planning, work) jointly with MR staff, making use of the equipment and the materials.
To summarize points to be improved obtained during track maintenance operation mentioned above, and to feed back to the successive measures.
To revise the track maintenance manual based on the feedback above.
To conduct seminars, training for technical improvement of the track maintenance

2-3 Project Section

The site is located between Yangon and Bago in the Yangon suburban area. At the beginning, technology transfer of track maintenance started for 30 trainees in the Pilot Section of 20km located in the section between Yangon and Bago. But, the various situations relating to technology transfer have been changed. MR hoped to make many trainees to receive workshop of track maintenance rather than the length of Pilot Section. In order to implement the training efficiently, trainings were sometimes repeated in the same place, and also on Dagon or Thilawa line near Toegyaunggale Sta, and Yangon Sta.

In this regard, JICA Expert Team consulted with MR about various matters including the suitable change of the length of the Pilot Section.

On 6th April, 2015, Minutes of Meetings for the Amendment to the record of discussions on the Project on improvement of service and safety of Railway in Myanmar in the republic of the union of Myanmar Between Myanma Railways Ministry of Rail Transport and Japan International Cooperation Agency, hereinafter MOM, had been signed between Chief Representative of JICA Myanmar Office and Managing Director of MR. Based on MOM, Thilawa line has been added on pilot section for technology transfer of track maintenance. And pilot bridges also have been done on project site for bridge maintenance training.

As a result, accumulated number of trainees amounts to 574.

2-4 Flow Chart of Project Implementation

The flow chart of the project implementation (Initial Plan) is shown in Fig 2-1.

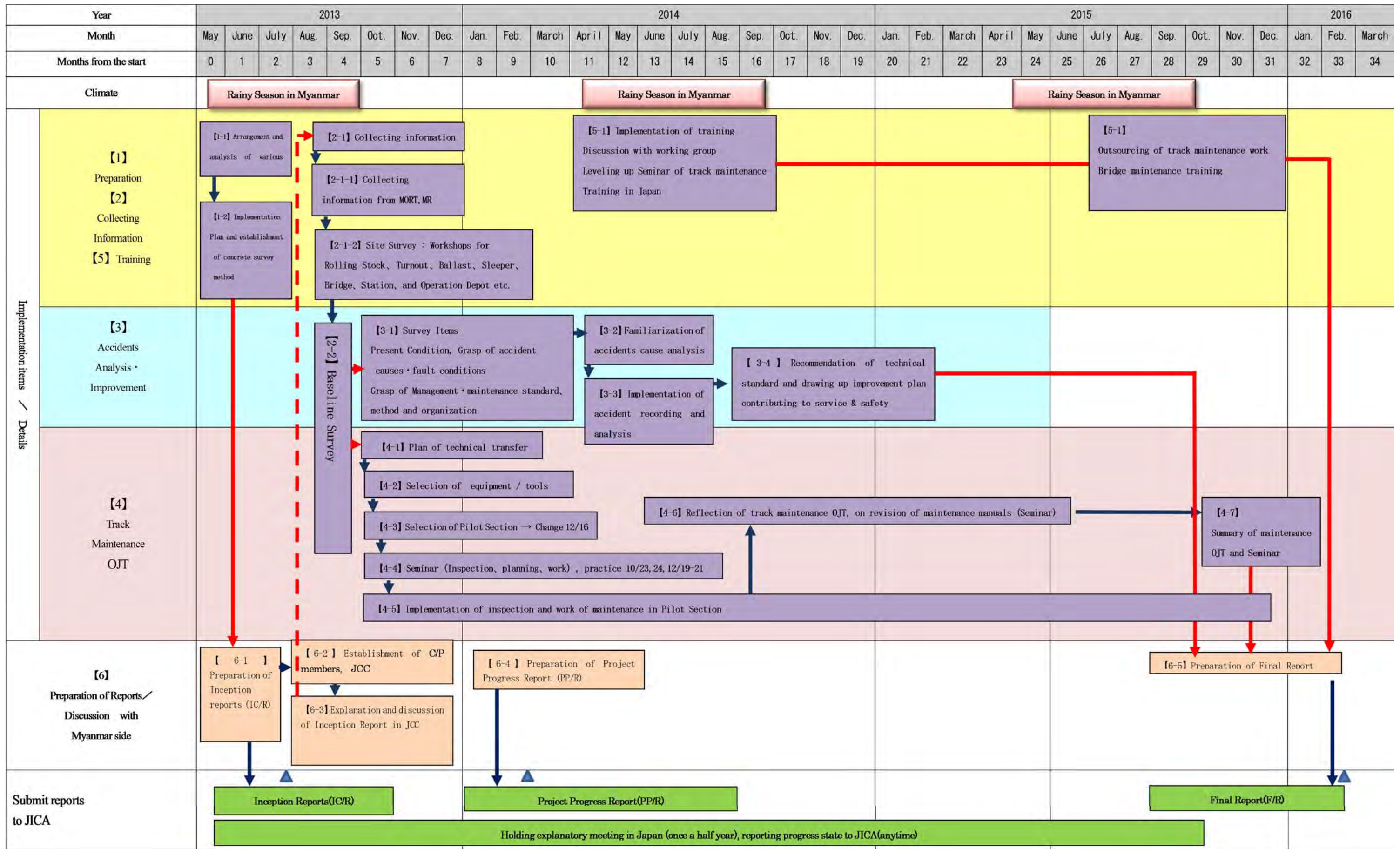


Fig 2-1 Project Implementation

Chapter3 Project implementation Organization

3-1 Structure of Project Implementation Organization

Based on R/D, a project implementation Organization was organized as shown in Fig 3-1.

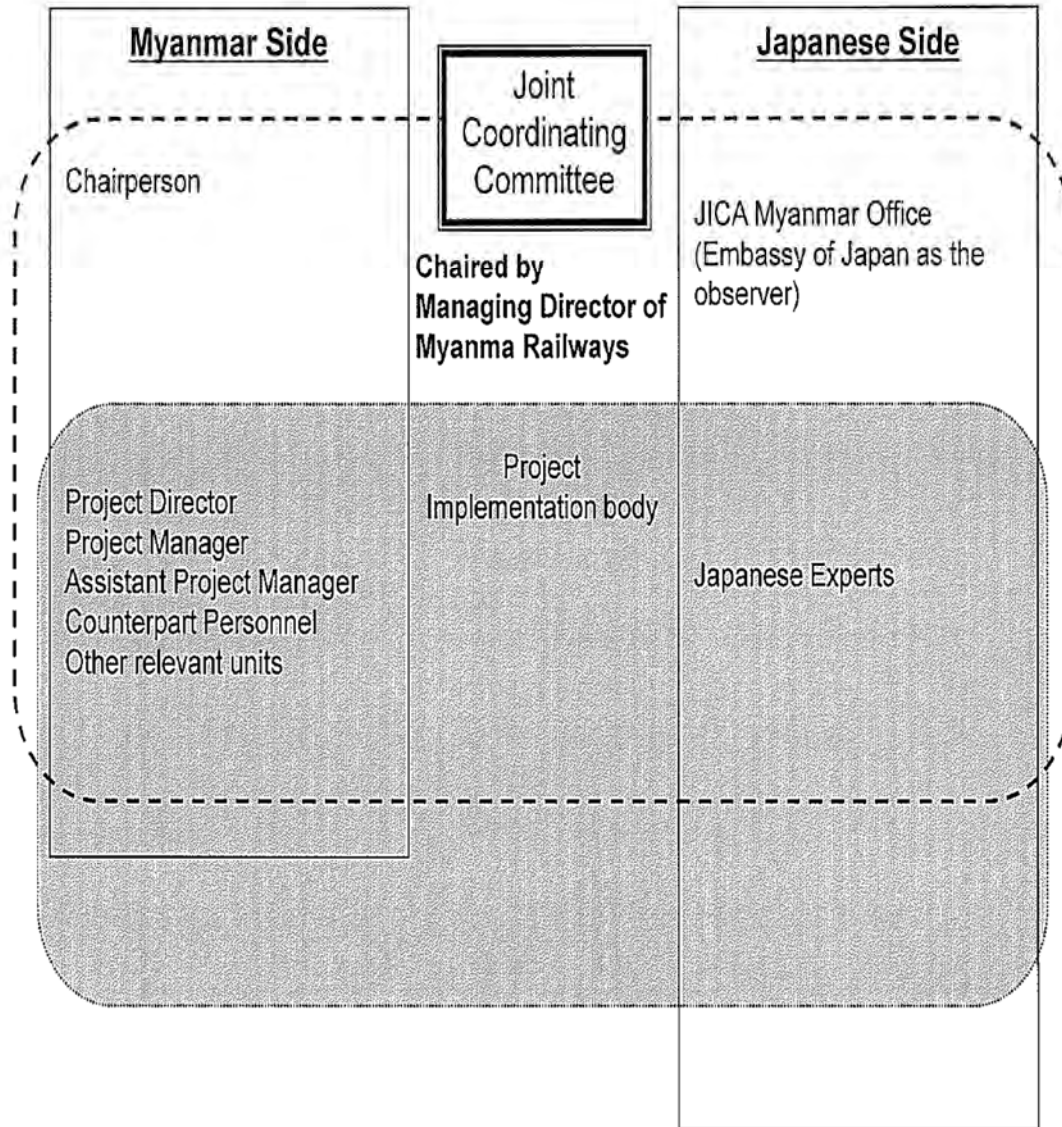


Fig. 3-1: Structure of project implementation Organization

This project is promoted as a scheme of “technical cooperation”. Implementation organization consists of (1) Myanmar Railways (MR) supported by the Ministry of Rail Transportation on the Myanmar side and (2) JICA and a tripartite consortium (JICA Expert Team) composed of Japan International Consultants for Transportation Co., Ltd. , Oriental Consultants Global Co., Ltd. (former Oriental Consultants Co., Ltd.), and Sumitomo Corporation on the Japanese side. Further it should be mentioned that Japan International Transport Institute had donated the hand tie tampers and other 3 items to MR in order to support the implementation of this project. To ensure smooth implementation of the whole project, the Joint Coordinating Committee (JCC) was established as explained later in the section 3-4.

3-2 Implementation Body on the Myanmar side

MR plays a central role on the Myanmar side. To correspond to Japanese experts, a Counterpart Team was organized for this project. Project Director commands the general affairs and implementation of the project, while Project Manager manages the projects and directs technical affairs. (Table 3-1)

During the implementation of the Project, several experts locating at MR Headquarters at Nay Pyi Taw were added to the Counterpart Team, as shown below, so that the analysis of accidents, low service level and discussion of countermeasures could be effectively executed under the cooperation of MR experts and JICA experts. Although some of the members of the counterpart Team were changed due to various reasons, the final member of the counterpart Team are shown in Table 3.1. Further it should be noted that based on MOM, the counterpart members of Outsourcing of track maintenance work and bridge maintenance were added to the counterpart Team.

- Track maintenance U Than Htay, DGM(Civil)
- Signaling and telecommunications U Han Nyant, AGM(S&T)
- Rolling Stock U Thet Lwin, DGM (Rolling stock)
- Operation U Htiay Myint Aung, DGM (Operation)
- Structure U Tin Win, DGM(Civil)

3-3 Implementation Body on the Japan side

The JICA experts selected from the above tripartite consortium guide/advise the personnel on the Myanmar side and offer recommendations where necessary for the project. See Table 3-1 for the list of the JICA expert members.

Japan International Consultants for Transportation Co. Ltd., is a general railway consulting company for the overseas railways established in November 2011 by major Japan Railway companies and private railway companies, and played a role of the leader company of JICA Expert Team. It implemented this project with full support from Japan Railway companies. With respect to the track maintenance works, it was implemented with cooperation from Japan Railway Track Consultants Co.,Ltd, which is a leading consulting company specialized for track maintenance.

During the implementation of the Project, the following replacement of Japanese experts was made due to justified or inevitable circumstances.

- Project Director (Leader) : from Sadaaki KURODA to Nobuyuki MATSUO (since 27th May, 2015)
- Project Manager (Deputy Leader) :from Nobuyuki MATSUO to Mitsuru TAKAMI (since 27th May, 2015)
- Track maintenance(1) :from Kazuhiko MURAO to Masato WAKATSUKI (since 23rd October, 2013) from Masato WAKATSUKI to Hideo FUJIWARA (5th February, 2015) from Hideo FUJIWARA to Osamu HAGA (29th May, 2015)
- Track maintenance(2): from Hisayoshi MITSUI to Keiichi KOBAYASHI (since 8th October,2015)
- Track maintenance(3): from Shigenori TANAKA to Makoto TOYA (since 8th October,2015)
- Track maintenance(4):from Takashi ITO to Hisashi KOMATSU (since 8th October,2015)
- Procurement of Equipment & Materials: from Yuichi TANIGUCHI to Tsuyoshi NAKAMURA (since 1st August, 2014), from Tsuyoshi NAKAMURA to Tomohiro AIZUKI (2nd July, 2015)
- Signaling & Telecommunications : from Kiichi TAKEMURA to Ryuhei MITANI (25th October, 2013)

- Train Operation : from Hideharu IGARASHI to Shunji MORIHARA (since 19th September, 2014)
- Structure : from Kiyoshi MIYAMOTO to Mitsuru TAKAMI (since 14th November, 2014)

3-3-1 Alternation of Leader/ Deputy Leader of JICA Expert Team

Based on MOM, the project period was extended. Then mainly technology transfer of track maintenance and bridge maintenance was decided to be implemented during the extended period of this project. Former leader, Dr. Sadaaki KURODA had been in charge of the project as a whole, and particularly the project implementation of safety and service level improvement (the project for the output1). The project implementation for the output 1 had already completed on May, 2015 as initially planned. After completion of the project for the output1, it was considered that Mr. Nobuyuki MATSUO, the former deputy leader who had been in charge of civil engineering works generally, could be a leader for efficient and sufficient project implementation. Then, the leader of JICA Expert Team has been changed from Dr. Sadaaki KURODA to Mr. Nobuyuki MATSUO. According to this change, Deputy leader of JICA Expert Team has been changed from Mr. Nobuyuki MATSUO to Mr. Mitsuru TAKAMI, who has been in charge of Structure.

3-4 Establishment of Joint Coordinating Committee (JCC) and Its Functions

JCC is the committee to confirm the progress of the Project, discuss important matters and make decisions for the better implementation of the Project. The role of JCC is shown as below

- To discuss the yearly project implementation plan described under the scheme determined based on R/D, and approve it
- To evaluate the outputs and total progresses of the yearly project implementation plan
- To approve the necessary items regarding to project output smoothly
- To discuss / study the several major problems appeared in the project implementation

Managing Director of MR is the chairperson of the JCC. The members are listed in Table 3-2. On Myanmar side U Saw Valentine, General Manager (Technical & Admin. Support) was changed to U Aung Win in Dec.2014 and U Aung Win, General Manager (Mechanical & Electrical) was replaced by U Win Oo in Dec.2014. Corresponding to the replacement of Japanese experts as mentioned in the section 3-3, the JCC members on Japanese side were replaced. Originally JCC was planned to be held at least twice a year and when necessary arises. However on the request of Myanmar side, it is planned to be held around once every 3 months.

Table 3-1 “Member of Administrative and Counterpart Personnel”

Field	Myanma Railways	Japanese Side (JICA Expert Team)
Project Director	U Aung Win (U Saw Valentine) / GM (Technical & Admin. Support)	Nobuyuki MATUO (Sadaaki KURODA) /Leader
Project Manager	U Tin Soe / GM Manager(Civil) U Saw Valentine/ Advisor	Mitsuru TAKAMI (Nobuyuki MATUO) /Deputy Leader
Railway Policy/ OM Improvement	U Kyaw Kyaw Myo /AGM (Passenger)	Hiroshi KOMATSU
Track Maintenance	U Than Htay/ DGM (Civil) U Tin Myint (U Maung Maung Than)/ AGM (Civil) U Min Aung /AE (Civil)	Osamu HAGA (Sadaaki KURODA, Kiyoshi MIYAMOTO) (Kazuhiko MURAO, Masato WAKATSUKI, Hideo FUJIWARA)
		Keiichi KOBAYASHI (Hisayoshi MITSUO) Makoto TOYA (Shigenori TANAKA) Hisashi KOMATSU (Takashi ITO) Masahiro OSANAI
Signaling & Telecommunications	U Khin Maung Thein/ DGM (S&T) (U Myint Lwin, AE (S&T), U Han Nyunt, AGM (S&T))	Ryuhei MITANI (Kiichi TAKEMURA)
Rolling Stock	U Win Oo/ GM (Rolling Stock) (U San Myint/ Train operation, U Thet Lwin/ DGM(Rolling Stock))	Makoto ISHIKAWA
Train Operation	U Htay Myint Aung/ DGM (operation) (U Zaw Pe Sein/ Divisional Traffic Manager)	Shunji MORIHARA (Hideharu IGARASHI)
Structure	U Tin Win/ DGM (Civil)	Mitsuru TAKAMI (Kiyoshi MIYAMOTO)
Procurement of Equipment & Materials	U Khin Maung Than (U Win Htein) / DGM(Supply)	Tomohiro AIZUKI (Yuichi TANIGUCHI, Tsuyoshi NAKAMURA)
Outsourcing of track maintenance work	U Maung Maung Than/ DGM (Civil)	Nobuyuki MATUO
Bridge maintenance training	U Maung Maung Than/ DGM (Civil)	Mitsuru TAKAMI
Policy Advisor	Mitsuo HIGASHI	

Table 3-2 JCC Personnel

Chairman U Thurein Win Managing Director of Myanmar Railways			
Myanmar Side		Japanese Side	
Name	Position (Major)	Name	Position (Major)
U Aung Win (U Saw Valentine)	GM (Technical & Admin support)	Nobuyuki MATUO (Sadaaki KURODA)	Leader of Japanese Expert Team (Track maintenance/ Maintenance planning)
U Myint Wai	GM (Operation)	Mitsuru TAKAMI (Nobuyuki MATSUO)	Deputy Leader (Earth Roadbed)
U Saw Valentine	Advisor	Hiroshi KOMATSU	Railway Administration and Management Expert
U Tin Soe	Project Manager, GM (Civil)	Tomohiro AIZUKI	Procurement of Equipment and Materials Expert
U Than Htay	Assistant Project Manager, DGM (Civil)	Ryuhei MITANI	Signalling and Telecommunications Expert
U Khin Maung Thein	Assistant Project Manager, DGM (Signalling & Telecommunications)	Makoto ISHIKAWA	Rolling Stock Expert
U Min Aung	Counterpart Personnel, AE (Civil)	Osamu HAGA	Track Maintenance Expert
U Myint Lwin	Counterpart Personnel, AE (Signalling & Telecommunications)	Shunji MORIHARA	Operation Expert
Daw Thi Thi Nwe	AGM (Finance)	Mitsuo HIGASHI	Railway Management Advisor
Htaung Sian Kan	DGM (Admin)		Representative of JICA
			Representative of Embassy of Japan : Observer

In this project, nine JCCs were held in total at Nay Pyi Taw on the following dates. The reports and minutes of meetings of the respective JCCs are attached as the appendix.

Kick off meeting	28 th June, 2013		
1 st JCC	28 th August, 2013	2 nd JCC	27 th February, 2014
3 rd JCC	29 th May, 2014	4 th JCC	29 th September, 2014
5 th JCC	19 th December, 2014	6 th JCC	13 th March, 2015
7 th JCC	17 th July, 2015	8 th JCC	28 th October, 2015
9 th JCC	29 th January, 2016		

3-5 Establishment of Working Group for Service and Safety Improvement

In the Record of Discussion(R/D) agreed between Managing Director of MR, U Thurein Win and Chief Representative, Myanmar office of JICA, on May 28th 2013, Appendix 1, II .OUTLINE of the Project, 5.Activities(1-5) reads as follows: [To draw the improvement plan of railway facilities through discussion with Working Group for Service and Safety Improvement(tentative name)]

In this regards, MR and JICA Expert Team have established Working Group as shown in Table 3-3. Although the members of the Working Group were partly changed along with the progress of the project, the members indicated in Table 3-3 are those who substantially participated in the discussion for drawing up the improvement plan of railway facilities.

Table 3-3 “Member of Working Group for Service and Safety Improvement”

Field	Myanma Railways	Japanese Side (JICA Expert Team)
Project Director	U Saw Valentine, General Manager (Technical & Admin. Support)	Sadaaki KURODA (Leader)
Project Manager	U Tin Soe, General Manager(Civil)	Nobuyuki MATUO (Deputy Leader)
Railway Policy/ OM Improvement	U Kyaw Kyaw Myo AGM (Passenger)	Hiroshi KOMATSU
Track maintenance	U Than Htay, DGM (Civil)	Masato WAKATSUKI Kiyoshi MIYAMOTO
Signalling & Telecommunications	U Han Nyunt, AGM (S&T)	Ryuhei MITANI
Rolling Stock	U Thet Lwin, DGM (Rolling Stock)	Makoto ISHIKAWA
Train Operation	U Htay Myint Aung, DGM (Operating)	Shunji MORIHARA
Structure	U Tin Win, DGM (Civil)	Mitsuru TAKAMI (Coordination)

Chapter4 Final Reporting of the Project

4-1 Recommendation of Technical Standard Relating to Administrative and Maintenance Aspect and Drawing up Railway Facilities Improvement plan to Improve Service and Safety Level

4-1-1 Preparation of a Working Plan

The Project is completed as scheduled in Table 4-1.

Table 4-1 Table of working plan schedule

Subject	F Year	2013												2014												2015					Note
	Month	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5					
	Past Month	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24					
3.1.1 Survey of the present status and Establishment of an organization to																															
3.1.2 Guidance and familiarization of the analyzing technique of the causes (1) Safety 1) Compilation of text books 2) Studying and learning with text books 3) Summarization of accident (Workshop) (2) Services level 1) Compilation of text books 2) Studying and learning with text books 3) Summarization of cause analysis and countermeasures (Workshop)																															
3.1.3 Recommendation on technical standards for service level and safety (1) Proposal (2) Summarizing																															
3.1.4 Drawing up short-, medium- and long-term railway improvement (1) Proposal (2) Summarizing																															
Education/training in Japan																															
Discussion on the report/JCC																													[Remark]		
Submission of the report (JICA)																													IC/R Inception Report PR Progress Report PPR Project Progress Report DPPR Draft Project Progress Report DFR Draft Final Report FR Final Report		

4-1-2 Survey of the Present Status and Establishment of Organization to Collect Information

- With respect to an organization to collect information, the counterpart team was established as shown in Table 3.1 of this Report.
- Collection of relevant information relating to train operation and rolling stock. Two experts visited MR headquarters and three rolling stocks workshops for facts finding in August and September, 2013.
- Present status of safety and service level of MR

Based on the answers to the Questionnaire from the JICA expert team to MR, the paper “Present Situation of Safety and Service Level of MR” was prepared, which is attached as Appendix 8-1 (p.A-8-2-57-p.A-8-2-68) of the Progress Report March 2014.

4-1-3 Guidance and Familiarization of the Analyzing Technique of the Causes of Accidents and Low Service Level

(1) Training Program of Cause Analysis of Accidents/ Low Service Level and Establishment of Countermeasures

Training program, of which purpose is to guide MR staff and to make them be familiarized about the technique to analyze the cause of accident and low service level, and establishment of countermeasures, was held from Feb. 10 to Feb. 28, 2014 jointly by the MR and JICA in the meeting room of MR Headquarters.

19 experts (originally 20, but one expert was absent) of manager level (Track maintenance, Civil works, Signaling, Rolling stocks and Train Operation) of Divisions or Head office of MR participated in the training program.

The whole training program consists of three parts. The first part is class room lecture of the text book prepared by JICA experts. The second one is workshop. The third one is training of vibration measurement of rolling stock.

Further it should be mentioned that interview survey to investigate the customer’s satisfaction level of MR’s passenger transport was conducted following the training program.

Class room lecture of the text book was held from Feb.11 to Feb. 21 between 9:00 – 12:00 in the morning. Workshop was held from Feb. 11 to Feb.26, mainly between 14:00 – 16:00 in the afternoon. Training of rolling stock vibration measurement was implemented from Feb. 27 to Feb. 28.

(2) Class Room Lecture of Text book

JICA experts explained, based on the text book, about the past accidents and countermeasures in the world mainly in Japan (for examples, derailment, train collision, level crossing, natural disaster and so on), and introduced the measures for improvement of the service level (for examples, increasing train speed, punctuality, riding comfort abilities, train protections and so on).

There were various discussions between JICA lecturers and MR participants. Major advices to MR by JICA experts based on the discussion are summarized in the Progress Report (p.A-8-3-6-p.A-8-3-17) submitted to 3rd JCC held in May, 2014.

(3) Workshops

1) Items Selected for Presentation by MR Experts

The purpose of the workshop is to make MR experts be familiarized with analysis of causes of accidents and low service levels and establishment of countermeasures through making MR staff themselves analyze the causes of actual accidents or low service levels of MR and making themselves establish suitable countermeasures.

In this regard, 25 items relating to accidents and low service levels (train delay and speed restrictions) were selected from the actual MR's events in 2012/ 2013, and MR experts by themselves tried to analyze the causes and to establish the appropriate countermeasures.

2) Discussion between MR Experts and JICA Experts on Presentation by MR Experts

For each presentation of MR experts, JICA experts made comments on method of cause analysis and establishment of countermeasures presented by MR experts. JICA experts also presented advices to MR regarding major issues identified through discussion in the workshop.

These comments and advices were prepared for each of all presentations which are classified according to kinds of items for presentation.

Summary and details of them are given in Appendix 2-1 (p.A-8-3-49- p.A-8-3-56) of Progress Report, May 2014.

(4) Comments of Training Program by MR Participants

In order to find out the major response of MR experts to the Training Program (the lectures by JICA experts and Workshop), the following four questions were asked to each MR participant.

Question 1 According to your opinion, what information/ matters/ Japanese examples were especially useful for improvement of safety and service level of MR?

Question 2 Are there any other information/ matters/ Japanese experiences you would like to know more?

Question 3 Do you think the way/ method by which JICA expert team organized the workshop was satisfactory to you?

Question 4 Do you have any advice how to improve the way/ method of workshop?

The answers to each question by MR participants are shown in Table2.4 (p.A-8-3-17) of the Progress Report, May 2014.

(5) Training for Measurement of Train Vibration

In order to make MR experts familiarize how to apply the vibration measurement of train to control of track maintenance and improvement of vehicle performance, JICA experts instructed measurement and analysis of actual Train Vibrations on Feb. 27, and 28th. Trainings were implemented by using the device [Digital Vibration Measurement Device W0031]. Trainings included 1) how to use the device to measure the vibration and how to analyses the measured data, 2) measurement of actual MR's express train, and 3) analysis of the measured data.

The details of the training of measurement of train vibration are presented in [Vibration Measurement Report] included as a part of the Progress Report, May 2014.

(6) Investigation of Customer's Satisfaction Level of MR Passenger Transport

In order to investigate customer's satisfaction level of MR passenger transport, interview survey was conducted on March 4 to 7 2014, between Yangon Station and Nay Pyi Taw Station on Yangon-Mandalay Trunk Line.

Myanmar Railway passengers were targeted excluding foreign travelers, and they were interviewed on the running trains. In case of a group trip, only one passenger of the group was interviewed.

3 kinds of train and class, "Express Upper", "Express Ordinary" and "Local", were targeted and at least 120 passengers were sampled for each train kind/class.

For interviewing, a questionnaire consisting of 20 questions was prepared.

Subjective Evaluation items (Q1~16) were scored and the difference of evaluation by Train kind and passenger class was analyzed. The survey items (Q17~20) were for investigating the fundamental properties of passengers such as gender, age, purpose of travel and occupation.

The boarding sections of passengers were plotted on the graph for each train.

The details of the interview survey and the result of the analysis of the answers to the questionnaire are summarized in the Progress Report (p.A-8-3-25-p.A-8-3-39), May 2014.

The analysis results were evaluated by a four-stage assessment (Very dissatisfied, Dissatisfied, Slightly dissatisfied and No comment) and the degree of satisfaction with MR's passenger service was found to be low overall. This kind of interview survey had never been conducted by MR in the past and the JICA Expert Team suggested that MR conduct periodical surveys like this. In addition, the JICA Expert Team also suggested that MR should humbly accept the finding that passengers are dissatisfied, and prioritize improving passenger service.

4-1-4 Recommendation on Technical Standards Relating to Administrative and Maintenance Aspect to Improve the Service Level and Safety

(1) Introduction

The training program and workshop for familiarization of cause analysis of accidents and low service level and for conducting these cause analysis and establishing counter measures together with MR experts were held from Feb. 10 to 28, 2014 at Nay Pyi Taw. In this training program and workshop, major technical standards of MR relating to safety and service level in the field of track, rolling stock, signal/telecommunication, train operation and structure, were discussed between MR experts and JICA experts. Taking this opportunity, JICA Experts collected the relevant major technical standards relating to safety and service level in the respective engineering fields.

JICA Expert Team made reviews on these collected technical standards and proposed recommendations on these technical standards as shown in Appendix I [Report of Proposals of Recommendation on Technical Standards of MR and Short-, Medium-, and Long Term Railway Facilities Plan] (Herein after referred to as "Report of Proposals") (p.A-8-4-29- p.A-8-4-187) attached

to Progress Report September 2014 (4th JCC).

(2) Some Major Technical Standards Having Been Reviewed by JICA Experts

They are listed in the Following Table 4-2.

Table 4-2 List of Technical Standards/ Regulations Reviewed by JICA Experts

A--Rolling stock	
1	Diesel Electric Locomotives and Diesel Hydraulic Locomotives Maintenance Instruction Schedule
2	Diesel Electric Locomotives and Diesel Hydraulic Locomotives Maintenance Instruction Schedule (Electrical)
3	Examination and repair of C & W stock
4	Technical Specifications for 1200 Horse Power Diesel Hydraulic Locomotive
5	Technical Specifications for Meter Gauge 1200/2000 Horse Power for Hillsection Diesel Electric Locomotives for Plain Section
6	Technical Specifications for Meter Gauge 2000 Horse Power Diesel Electric Locomotives
7	Technical Specifications for In-Service Diesel Electric Locomotives
8	Technical Specifications for YDM4 Class Locomotive (1000mm Gauge)
9	Technical Specifications for Meter Gauge 2000HP Diesel Electric Locomotives
10	General Technical Specifications for Meter Gauge Bogie Passenger Coaches
11	General Technical Specifications for Meter Gauge Bogie Freight Wagons
12	General Technical Specification for Design, Supply and Domestic Manufacturing of Meter Gauge Bogie
13	General Technical Specifications for Meter Gauge Bogie Passenger Coaches Type BDTEZ
14	Technical Specifications for Meter Gauge Bogie Ballasted Hopper Wagons
15	Particular Technical Specification for Meter Gauge Four-Axle Bogie Well Wagon for Container
16	Technical Specification for Meter Gauge Bogie Day Upper Class Passenger Coach
17	Technical Specification for Meter Gauge Bogie Covered Wagon Type - GBHV
18	Technical Specification for Meter Gauge Bogie Sugarcane Cum Material Wagon Type - SMBV
19	Technical Specification for Meter Gauge Bogie Material Wagon Type - MBHV
B--Track	
1	Manual of the Engineering Department Chapter IV Permanent Way I (material, tool, theory)
2	Manual of the Engineering Department Chapter V Permanent Way II (construction, and maintenance)
3	Track Specification
4	Manual of the Engineering Department Chapter XXII Technical Appendices
5	Manual of the Engineering Department Chapter IX Miscellaneous
C--Structures, Building, Station Machinery, Safety Precaution	
1	Manual of the Engineering Department Chapter XII Safety Precaution
2	Manual of the Engineering Department Chapter VI Bridges
3	Manual of the Engineering Department Chapter III Formation
D--Signalling and Telecommunications	
1	TRAIN SIGNALLING INSTRUCTIONS for the Double and Single Lines by Electric Block Instruments and by Telegraph or Telephone
2	Manual of the Engineering Department-Chapter VIII-Signal and Tele-communication No.1
3	General Rules for all open lines of railway in Burma Parts I&II together with the subsidiary rules
E--Train Operation	
1	General Rules for all open lines of railway in Burma Parts I&II together with the subsidiary rules
2	Chapter I Preliminary
3	Chapter II Signals
4	Chapter III working of Trains General
5	Chapter IV Accidents
6	Chapter XIII The Following Trains System

(3) Details of the major recommendations/comments on Technical Standards.

The details of the recommendations/comments are presented in the Appendix 1, [Report of Proposals] (p.A-8-4-29- p.A-8-4-187) attached to Progress Report, September 2014. Report of Proposal was submitted to the workshop and discussed by the members of Working Group for Service and Safety Improvement. Summary of discussion for these recommendations are presented in Appendix-2 [Summary of Discussion in the Workshop for Recommendation on Technical Standards and for Drawing up Short-, Medium-, and Long-term Railway Facilities Improvement Plan]

(p.A-8-5-189-p.A-8-5-194) attached to Progress Report Dec. 2014. Later a set of Questions relating to the Workshop were sent to JICA experts. The answers prepared by JICA experts are attached as Appendix 8-1 of Progress Report (p.A-8-5-27-p.A-8-5-187) , March 2015 (6th JCC).

(4) Revision of the Report of Proposal

The Report of Proposal was revised as required according to the discussion mentioned in 4.1.4-3 above, and Revised Report is attached to the Progress Report, Dec. 2014 as Appendix-1 [Revised Report of Proposal of Recommendation on Technical Standard of MR and Short-, Medium-, and Long- Term Railway Facilities Improvement Plan] (p.A-8-5-27-p.A-8-5-187).

(5) Summarizing Workshop

Revision of the report of Proposals was very limited, so JICA Experts made several presentations relating to improvement of service and safety of MR in addition to explanation of Revised Report of Proposals. The agenda and timetable are as shown in the following Table 4.1.3 and 4.1.4.

Table 4-3 Agenda

1. Explanation of Revision of the Last Report of Proposals
2. Railway Development in Japan
3. Running Performance of Rolling Stock
4. Supervision of Construction Work
5. Maintenance Work for Civil Engineering Railway Structure
6. Supplementary Lecture on ATS etc.

Table 4-4 Timetable

Month / Day	Dec 15	Dec 16	Dec 17	Dec 18	Dec 19
Day of the Week	Mon	Tue	Wed	Thu	Fri
Morning	9:30-12:00 Explanation of Revised Report of Proposal by Dr. S. Kuroda, Mr. M. Takami.	9:30-12:00 Lecture No.2 Running Performance of Rolling Stock by Mr. M. Ishikawa	9:30-12:00 Lecture No.4 Maintenance Work for Civil Engineering Railway Structure by Mr. M. Takami	9:30-12:00 General Discussion	5 th JCC
Afternoon	13:30-15:30 Lecture No.1 Railway Development in Japan by Dr. S.Kuroda	13:30-15:30 Lecture No.3 Supervision of Construction Work by Mr. N. Matsuo	13:30- Lecture No.5 Supplementary Lecture on ATS etc. by Mr. R. Mitani		

Summary of discussion made during summarized workshop is attached as Appendix 8-2 (p.A-8-6-129-p.A-8-6-141) of Progress Report, March 2015.

4-1-5 Drawing Up of Short-, Medium-, and Long-Term Railway Facilities Improvement Plan

(1) The Principles for Drawing up Short-, Medium-, and Long-Term Railway Facilities Improvement Plan

In drawing up short-, medium-, and long-term railway facilities improvement plan (hereinafter referred to as RFIP) from the viewpoint of upgrading safety and service of MR, the following principles are adopted,

- RFIP focuses on the rehabilitation and modernization of the existing lines.
- Railway facilities plan relating to new line construction and improvement of international transport will be excluded.
- RFIP will focus on improvement of facilities relating to upgrading safety and service, but exclude the improvement of facilities relating to economic development of the area along the lines, railway business expansion, or revenue increase such as development of ICD, freight yard, connection to sea ports.
- The railway projects proposed by Myanmar Development Cooperation Forum which took place on Jan.19 and 20, 2013 will be duly taken into consideration.
- “Survey Program for National Transport Development Plan in the Republic of the Union of the Myanmar” prepared by JICA (June 2014) will be duly taken into consideration.

(2) Proposal of Short-, Medium-, and Long-Term Railway Facilities Improvement Plan

In drawing up RFIP, the principles described in 4-1-5 (1), Introduction have been duly taken into consideration. Further the following preconditions or policies have been assumed.

- In MR railway network, Yangon – Mandalay line and Yangon Transit System (Circular line + Danyingon ~ Hlawga+ Mahlwagon ~ Ywathagyi+ Thilawa line) have been defined as “Most Important Lines”.
- Mandalay – Myitkyna line, Yangon – Pyay line, Yangon-Pathein line and Yangon – Dawei line have been defined as “the Next Important Lines”.
- All other lines have been defined as “Other Lines”.
- As indicated in the Inception Report,

Short term corresponds to	2015 – 2018
Medium term corresponds to	2018 – 2025
Long term corresponds to	2025 – 2045

(3) Short-, Medium-, and Long-Term Railway Facilities Improvement Plan

Details of improvement plans are explained in Appendix 1 [Report of Proposal] (p.A-8-4-29-p.A-8-4-187) attached to Progress Report September, 2014. The Report of Proposal was submitted to the workshop and discussed by the member of working group for Service and Safety

Improvement.

Summary of discussion for the proposed plan is presented in Appendix-2 [Summary of Discussion in the Workshop for Recommendation on Technical Standards and for Drawing up Short-, Medium-, and Long-term Railway Facilities Improvement Plan] (p.A-8-5-189-p.A-8-5-194) attached to Progress Report Dec. 2014.

(4) Revision of the Report of Proposal

The Report of Proposal was revised as required according to the discussion mentioned in 4.1.5-2 above, and Revised Report is attached to the Progress Report, Dec. 2014 as Appendix-1 [Revised Report of Proposal of Recommendation on Technical Standard of MR and Short-, Medium-, and Long- Term Railway Facilities Improvement Plan] (p.A-8-5-27-p.A-8-5-187).

(5) Summarizing Workshop

Revision of the Report of Proposals was very limited, so the agenda and timetable of summarizing workshop was the same as those for Recommendation on Technical Standards.

Summary of discussion made during summarized workshop is attached as Appendix 8-2 (p.A-8-6-129-p.A-8-6-141) of Progress Report, March 2015.

4-1-6 Education/ Training in Japan

Schedule of training in Japan was proposed by JICA Expert Team to MR in August, 2014, which MR reviewed and agreed with on the condition that Railway Museum is desirable to be included.

As a result, the schedule of training in Japan was finalized as shown in Table 4-5. The 11 participants as shown in Table 4-6 were nominated by MR.

Details of the training in Japan are summarized in Appendix 3 [Workshop Report of the Institutional Management Improvement Course in Japan] (p.A-8-5-195- p.A-8-5-207) attached to Progress Report, Dec. 2014

Table4-5 Schedule of Training in Japan (Institutional Management Improvement Course)

No.	Date	Time	Lecture/ Visit	Content	Lecturer	Location of Training	Stay at
1	Oct. 19 (Sun)	6:50 ~		arrival at Narita			JICA Tokyo
2	Oct. 20 (Mon.)	9:00 ~ 14:00	Lecture	Program Orientation	JIC/JICA	JICA Tokyo	JICA Tokyo
		14:00 ~ 15:30	Lecture	Outline of Railway Transport in Japan	MLIT	JICA Tokyo	
		15:30 ~ 17:00	Lecture	Outline of JR East	JIC	JICA Tokyo	
3	Oct. 21 (Tue)	9:30 ~ 10:00	Lecture	Orientation	JIC	JICA Tokyo	JICA Tokyo
		10:00 ~ 12:00	Lecture	Outline of railway development in Japan	JIC	JICA Tokyo	
		13:00 ~ 15:00	Lecture	Management & technology of JRE to ensure safe railway transport	JIC	JICA Tokyo	
		15:00 ~ 17:00	Lecture	Management and technology of JRE to ensure comfortable/ convenient railway transport	JIC	JICA Tokyo	
4	Oct. 22 (Wed)	7:30 ~ 10:00	trip	Tokyo - Shinshirakawa - Training Center			JICA Tokyo
		10:00 ~ 11:30	Lecture	Outline of staff training of JRE	JEPS	JRE Training Center	
		11:30 ~ 12:00	Visit	Museum of railway accident	JEPS	JRE Training Center	
		12:00 ~ 15:00	trip	Shinshirakawa-Tokyo			
		15:00 ~ 17:00	Visit	Tokyo monorail	Tokyo monorail	Hamamatsu-cho	
		17:00 ~ 18:00	Trip				
5	Oct. 23 (Thur)	9:00 ~ 10:00	trip	(Tokyo - Keiyo Line)			JICA Tokyo
		10:00 ~ 14:00	Visit	High speed Track Inspection Car (East-i)	JRE, NSG	Keiyo Line	
		14:00 ~ 15:00	trip	Tokyo- Omiya			
		13:00 ~ 16:00	Visit	Railway museum	JIC	Omiya	
		16:00 ~ 17:00	trip				
6	Oct. 24 (Fri)	8:30 ~ 9:30	Trip	Tokyo - Kunitachi			JICA Tokyo
		9:30 ~ 12:00	Visit	Railway Technical Research Institute RTRI	RTRI	Kunitachi	
		12:00 ~ 13:30	trip	Kunitachi - Tokyo freight terminal			
		13:30 ~ 17:00	Visit	Tokyo Freight terminal	JRF	Shinagawa	
		17:00 ~ 18:00	trip				
7	Oct. 25 (Sat)		Holiday	Free			JICA Tokyo
8	Oct. 26 (Sun)		Holiday	Free			JICA Tokyo
9	Oct. 27 (Mon)	7:00 ~ 12:00		Free			Akita
		13:00 ~ 14:00	Lecture	Outline of Akita Branch Office	JRE	Akita Branch office	
		14:00 ~ 15:30	Visit	Akita General Training Center (AGTC)	JRE	AGTC	
		15:30 ~ 17:30	Visit	Riding train on Oga line	JIC	Akita Branch office	
10	Oct. 28 (Tue)	9:30 ~ 12:30	Visit	Akita General Rolling Stock Center (AGRSC)	JRE	AGRSC	Akita
		13:30 ~ 15:00	Visit	Akita rolling Stock Center (ARSC)	JRE	ARSC	
		15:00 ~ 16:30	Visit	Train Control Center	JRE	Akita Branch office	
		16:30 ~ 17:00	Lecture	follow-up orientation	JIC	AGTC	
11	Oct. 29 (Wed)	9:30 ~ 11:00	Visit	Akita Track maintenance Technical Center (ATMTC)	JRE	ATMTC	Akita
		12:30 ~ 13:00	Trip	Akita - Oga Line			
		13:00 ~ 15:00	Visit	Oga line	JRE/JIC	Oga Line	
		15:00 ~ 18:00	Lecture	Natural Disaster Prevention system	JIC	Oiwake Traing Center	
12	Oct. 30 (Thur)	9:00 ~ 10:00	Lecture	Akita Station in General	JRE	Akita Station	JICA Tokyo
		10:00 ~ 12:00	Visit	Various Station Facilities	JRE	Akita Station	
		13:00 ~ 14:00	Visit	Non-Railway Business Station Plaza etc.	JRE	Akita Station	
		14:00 ~ 18:00	trip	Akita - Tokyo			
13	Oct. 31 (Fri)	9:30 ~ 11:00	Lecture	Question and Answers	JIC	JICA Tokyo	JICA Tokyo
		11:00 ~ 17:00	Presentation and Wrap up	Opinion/ comments on Training Program by MR trainees. Wrap up meeting	JIC/JICA		
14	Nov. 1 (Sat)	11:00		Leave Narita			

JEPS = JR East Personnel Service, RTRI = Railway Technical Research Institute

Table 4-6 The List of Trainees for Institutional Management Improvement Course

No	Name	Rank
1	U Win Naing	Deputy General Manager (Carriage)
2	U Htay Myint Aung	Deputy General Manager (Operation)
3	Daw Kyi Kyi Nwe	Assistant General Manager (Finance)
4	U Lwan Thu	Executive Engineer (Civil)
5	U Maung Maung Tin	Manager (Supply)
6	U Aung Chan Myint	Manager (Commercial)
7	U Myint Lwin	Executive Engineer (Communication)
8	U Aung Wai Soe	Assistant Manager (Inspection)
9	Daw Khin May Than	Assistant Manager (plan & News)
10	U Nyo Aung	Assistant Engineer (Electric)
11	U Aung Myint	Assistant Manager (Planning)

4-2 Technology Transfer of Track Maintenance Technology to Improve the Level of Service and Safety through Implementation of the Pilot Project

4-2-1 Drawing Up a Plan for Technology Transfer

The system of track maintenance work currently in practice in Myanmar is a version of the old-fashioned system implemented in the past in Japan. Through this Project, track maintenance workers of MR shall receive education/training of basic track maintenance works, while aiming at a mechanized maintenance system to use large-scale maintenance machines in the future. This means a conversion from the current gang system to a larger sized maintenance depot system or a re-construction of maintenance system. Bearing in mind this long-term vision, JICA Expert Team implemented a plan for technology transfer focused on the track maintenance OJT.

See Table 4-7 for the planning and result of technology transfer.

4-2-2 Procurement of the Required Equipment/ Tools

Table 4-8 (1st time) and Table 4-9 (2nd time) summarizes the required equipment / tools, which were procured by the Japan side are shown. These equipment and tools were delivered to MR as shown in Attached File 6 (p. A-6-2 - p. A-6-8).

The role of MR staff in track maintenance work is roughly classified into site foreman (PWI, MR staff of supervisor class) and workers (Labor, MR staff of skilled labor class). During OJT track maintenance, the methods of handling measuring equipment were mainly instructed to the former, while the methods of handling machines and instruments for work were instructed to the latter; the methods of handling measuring instruments were intensively instructed to both. MR trainees often broke machines during training because of their inexperience with the machines. For example, in one case a motor burned out due to the rotating blade of the rail piercing machine hitting the rail continuously. Based on these cases, long-term in-service methods without breakage and methods of handling breakage such as the aforementioned case were instructed with priority. The JICA Expert Team taught maintenance and minor repair techniques to enable them to perform work at the site routinely, as well as techniques to perform large-scale maintenance at MR factory, etc., in view of the availability of materials at MR.

In this project, a series of track maintenance work, including inspection of rails by using supplied equipment and detection and repair of damaged locations, was instructed. The ability to perform track maintenance work was largely improved by using the equipment supplied by this project compared to MR's work performed by a small number of workers in the past.

Table 4-8 List of the required equipment / tools (1st time)

No.	Item	Unit	Manufacturer
1	Analog standard gauge	5	KANEKO CO., LTD.
2	Instrument detection for track	5	GIDOU GIKEN
3	Measuring instrument for rail wearing depth	2	HARADA SEISAKUSYO
4	Gap gauge	5	TRSUKO NAKAYAMA CO., LTD.
5	Taper gauge	5	KANEKO CO., LTD.
6	Thermometer for rail	5	KANEKO CO., LTD.
7	Square for rail	5	KANEKO CO., LTD.
8	Trackmaster	1	KANEKO CO., LTD.
9	Measuring instrument for train swing	1	SHINYEI TECHNOLOGY CO.,LTD
10	Cloth measuring tape (30 m)	5	YAMAYO SOKUTEKI CO., LTD.
11	Steel measuring tape (30 m)	5	YAMAYO SOKUTEKI CO., LTD.
12	Square	5	TETUYU KOGYO CO., LTD
13	Slate pencil , Chalk	4	NIHON HAKUBOKU KOGYO CO., LTD.
14	Tie tamper	1	SHIBAURA ELRTEC CORPORATIO

No.	Item	Unit	Manufacturer
15	Beater	18	ISHI TEKOU CO., LTD
16	Shovel	18	TONBO KOGYO CO.,LTD.
17	Bar	35	ISHI TEKOU CO., LTD
18	Spike hammer	13	ISHI TEKOU CO., LTD
19	Panpuller	18	HOSEN KIKI SEIBI CO.,LTD
20	Jack for rail	40	NICH CO., LTD.
21	Equipment for ballast tamping	5	HITACHI KENKI KAMINO CO., LTD.
22	Generator	1	SHIBAURA ELRTEC CORPORATIO
23	Generator	5	HONDA MOTOR CO., LTD.
24	Shovel	9	TONBO KOGYO CO.,LTD.
25	Dump shovel	9	KATOU SEISAKUSYO CO., LTD.
26	Shovel with blade divided into multiple	9	KATOU SEISAKUSYO CO., LTD.
27	Hoe with blade like nail of wild goose	9	KYOUWA CO., LTD.
28	Hand screen	15	IRIE KOUGYO CO., LTD.
29	Hoe with blade of triangle	9	IRIE KOUGYO CO., LTD.
30	Wooden maul	9	KONDO KASHIZAI MOKOUSYO CO., LTD.
31	Basket made by bamboo or plastic	9	SEKISUI KAGAKU KOGYO CO., LTD.
32	Jack traverser	10	TOKO SANGYO CO., LTD.
33	Rail sawing machine	3	TETUYU KOGYO CO., LTD
34	Rail boring machine	3	KOBORI TEKOUSYO CO., LTD.
35	Core cutter	10	KOBORI TEKOUSYO CO., LTD.
36	Rail bending machine	1	RIKEN KIKI CO., LTD.
37	Rail joint expandor	1	TETUYU KOGYO CO., LTD
38	Sleeper replacing machine	1	HOSEN KIKI SEIBI CO.,LTD
39	Rail carrying machine	9	YOSHIKE KAKEN KIKI CO., LTD.
40	Rail carrying tongs	9	YOSHIKE KAKEN KIKI CO., LTD.
41	Shovel	18	TONBO KOGYO CO.,LTD.
42	Single open ended spanner	9	ISHI TEKOU CO., LTD
43	Chisel	5	ISHI TEKOU CO., LTD
44	Rail fork	5	NICH CO., LTD.
45	Disc grinder	5	HITACHI KOUKI HANBAI CO., LTD.
46	Power wrench	5	MAKITA CO., LTD.

No.	Item	Unit	Manufacturer
47	Low joint maintenance machine	1	L. GEISMAR
48	Spanner for joint bolt	9	IJIMA KIKOU CO., LTD.
49	Rail grinding machine	1	YOSHIKE KAKEN KIKI CO., LTD.
50	Swager for back bolt	1	NIPPON POP RIVETS AND FASTENERS LTD
51	Hydraulic lining machine	5	TETUYU KOGYO CO., LTD
52	Low roller	7	HOSEN KIKI SEIBI CO.,LTD
53	Chisel with handle	3	ISHI TEKOU CO., LTD
54	Spanner for bed plate / rail brace	7	IRIE KOUGYO CO., LTD.
55	Adz	9	ISHI TEKOU CO., LTD
56	Hand hammmar	9	TORASUKO NAKAYAMA CO., LTD.
57	Spanner for huck bolt	9	IJIMA KIKOU CO., LTD.
58	Engine Drilling Machine	13	NIKOU TANAKA ENJINYARING CO., LTD.
59	Drill 22mm	13	NIKOU TANAKA ENJINYARING CO., LTD.
60	Gouge	9	KAKURI SANGYO
61	Electric saw	5	HITACHI KOUKI HANBAI CO., LTD.
62	Boring machine	3	MAKITA CO., LTD.
63	Sleeper carrying tongs	9	KATOU SEISAKUSYO CO., LTD.
64	Pad remover	9	ORUHA CO., LTD.
65	Light track trolley	5	YOSHIKE KAKEN KIKI CO., LTD.
66	Gas cutting machine	2	YAMATO SANGYO CO.,LTD
67	Rail lifting machine	3	TOKO SANGYO CO., LTD.
68	Spanner	2	TOPU KOGYO CO., LTD.
69	Track jack	9	TETUYU KOGYO CO., LTD>
70	Low elasticity pad	20	NIHON ESURAITO CO., LTD.
71	Track shim	20	TETUDOU YOUHIN CO., LTD.
72	Huck bolt	40	KONDO TEC CO., LTD.
73	Brushcutter	4	HONDA MOTOR CO., LTD.
74	Chip cutter for Brushcutter	4	HONDA MOTOR CO., LTD.

Table 4-9 List of the required equipment / tool (2nd time)

No.	Item	Unit	Manufacturer
1	Analog standard gauge G=1000	8	KANEKO CO.,LTD.
2	Instrument detection for track	8	KIDOUGIKEN
3	Tie tamper	8	SHIBAURA ELRTEC CORPORATION
4	Generator	8	SHIBAURA ELRTEC CORPORATION
5	Equipment for ballast tamping	8	HITACHI KENKI KAMINO CO., LTD.
6	Basket made by bamboo or plastic	40	SEKISUI KAGAKU KOGYO CO., LTD.
7	Light track trolley 1ton G=1000	8	YOSHIKE KAKEN KIKI CO., LTD.
8	Rail lifting machine	10	TOKO SANGYO CO.,LTD
9	Jack for rail	48	NICH CO., LTD.

4-2-3 Selection of Pilot Section

In the 46.5 mile section (74.8 km long) between Yangon and Bago, JICA Expert Team implemented track maintenance as a means of technical transfer in the approximately 20 km-long Pilot Section. Japanese side proposed pilot section 1 and 2 at the 1st JCC, August, 2013. This reason was that there are many kinds of structure in pilot section 1, and as a result of train vibration test, vibration value was big in pilot section 2. After a while, Myanmar side proposed new section and changing how to train (change trainees every 1 month). So concept of pilot section disappeared and JICA Expert Team implemented training around Toggyaungglae station repeatedly.

In addition, BS75 rail was replaced by 50N rail in the section between 14 km 200 mm and 15 km 400 mm, and this section was improved intensively by OJT track maintenance in order to make it suitable for the Running Confirmation Test.

4-2-4 Implementation of Track Maintenance (Inspection, Planning, Work and Control)

(1) Compilation of Text Book

To use for classroom education and practical training, JICA Expert Team compiled a text book in three parts, each covering the fields of (1) safety of work, (2) track maintenance work and (3) track inspection. JICA Expert Team implemented practical training and maintenance work based on this text book and compile, (1) standards and (2) manuals, for track maintenance work, after modifying, adding or deleting contents of the text book based on review of track maintenance training. JICA Expert Team compiled text of Myanmar language to make trainees understand.

(2) Classroom Education and Practices (Seminars)

Before implementing actual track maintenance work, JICA Expert Team had seminars on the particulars related to track maintenance such as inspection, planning and work for the workers. (23rd October, 2013) This was the first classroom education and an important step to assess the level of

local staff, which significantly contributed to the work progress control in the future.

Before starting the maintenance work, JICA Expert Team performed practical training on track maintenance (inspection and work) on non-commercial tracks. (Some are commercial tracks. 24th October, 2013) As safety is one of the most important concerns for track maintenance workers, JICA Expert Team also educate them on safety in practicing track maintenance work, with (1) wearing safety vest and other protective equipment and (2) deployment of security guards (train watchmen) subject to prior negotiation with MR. However, JICA Expert Team proposed at least wearing protective shoes, helmets and safety vests.

After arriving equipment from Japan, JICA Expert Team hold seminar about new equipment and how to jack up rail and level flat for the workers (19th -21st December, 2013).

JICA Expert Team held small seminar about using trackmaster and analog standard gauge at Nay Pyi Taw (24th February, 2015) and Yangon(25th February, 2015).

During implementing track maintenance, JICA Expert Team changed how to implement workshop. So every time of first day for new trainees, JICA Expert Team held workshop of safety education, how to use tie tamper and survey.

(3) Implementation of inspection, planning and work in the Pilot Section

For this education/training, in principle, JICA Expert Team used the intervals between trains during the daytime except long work such as changing rail. JICA Expert Team tackled with track inspection and maintenance work from 1) to 10) and show outline of work.

- 1) Ballast compacting work (use of hand tie-tampers)
 - ① Inspection of track irregularities and conditions
 - ② Correction of track irregularities
- 2) Ballast sieving
 - ① Inspection of ballast
 - ② Execution of work
- 3) Rail renewal work
 - ① Inspection of rail
 - ② Rail renewal work (Change BS75, Big scale change to 50N accompanied with changing PC sleepers)
- 4) Rail joint work (rework on rail clearance (rail joint clearance), correction of rail joint depression)
 - ① Inspection of rail joint
 - ② Clearance correcting work
 - ③ Fail joint correcting work
- 5) Track realignment work
 - ① Inspection of track deformation (Inspection of track displacement)
 - ② Irregular alignment correcting work (Correcting work of straight line and curve line)
- 6) Turnout maintenance work
 - ① Inspection of turnout
 - ② Repair and renewal of turnouts

7) Inspection and maintenance of bridge sections

- ① Inspection
- ② Maintenance work(Changing bridge sleepers, adjustment of level, hook bolt, installation of bond timber, safety countermeasure of prevention from falling down)

8) Correction of track gauge

- ① Inspection

9) Improvement of formation

- ① Inspection of ballast and roadbed
- ② Maintenance of roadbed (Countermeasure of mud pumping, how to do)

10) Supervision and evaluation of track condition (Test for running confirmation)

JICA Expert Team were planning welding of rail on of item at first. But the condition of welding materials was not good condition and quantity of completion was neither. Therefore, JICA Expert Team planned countermeasure of rail junction immediately and specialized in junction work. JICA Expert Team supplied design of the fish plate which has been improved its rigidity with heat-treated bolt and prototype.

4-2-5 Education/Training in Myanmar

Trainees of MR change every month. It is shown divisions of trainee and members till now (Table 4-10). JICA Expert Team has educated 574 trainees who are belonging to all divisions in Myanma Railways.

Table 4-10 Divisions of trainee and numbers till now

No	From	To	Division	Number
1	25.10.2013	12.5.2014	(7)Yangon (6)Bago	24 6
2	13.5.2014	12.6.2014	(7)Yangon (5)Taunggu (8)Mawlamying (9)Hinthada	15 6 4 5
3	13.6.2014	12.7.2014	(7)Yangon (2)Ywataung (3)Mandalay (10)Pakauku	10 8 8 7
4	13.7.2014	12.8.2014	(7)Yangon (1)Myitgyinar (4)Kalaw (11)Bagan	10 6 7 7
5	13.8.2014	12.9.2014	(7)Yangon (5)Taunggu (8)Mawlamying (9)Hinthada	10 6 6 8
6	13.9.2014	10.10.2014	(7)Yangon (2)Ywataung (3)Mandalay (6)Bago	10 6 6 8
7	13.10.2014	12.11.2014	(7)Yangon (9)Hinthada (8)Mawlamying (5)Taunggu	10 7 7 6
8	13.11.2014	11.12.2014	(7)Yangon (2)Ywataung (3)Mandalay (10)Pakauku	10 8 9 7
9	9.1.2015	6.2.2015	(7)Yangon (4)Kalaw (9)Hinthada (11)Bagan	10 7 7 7
10	9.2.2015	4.3.2015	(7)Yangon (1)Myitgyinar (6)Insein (10)Pakauku	10 6 7 7

No	From	To	Division	Number
11	9.3.2015	8.4.2015	(7)Yangon (4)Kalaw (5)Taungu (11)Bagan	10 6 7 7
12	27.4.2015	22.5.2015	(7)Yangon (1)Myitgyinar (5)Taungu (8)Mawlamying	10 5 7 7
13	25.5.2015	19.6.2015	(7)Yangon (2)Ywahtaung (3)Mandalay (10)Pakauku	10 6 7 7
14	22.6.2015	17.7.2015	(7)Yangon (4)Kalaw (6)Pyon tan sar (11)Bagan	10 6 7 7
15	23.7.2015	21.8.2015	(7)Yangon (8)Mawlamying (9)Hinthada (10)Pakauku	10 6 7 7
16	24.8.2015	18.9.2015	(7)Yangon (1)Myitgyinar (3)Mandalay (6)Bago	10 6 7 6
17	21.9.2015	16.10.2015	(7)Yangon (2)Ywahtaung (4)Kalaw (11)Bagan	10 6 7 7
18	19.10.2015	17.11.2015	(7)Yangon (1)Myitgyinar (5)Taunggu (9)Hintada	10 6 7 7
19	30.11.2015	29.12.2015	(7)Yangon (3)Nehtoegy (6)Nyaunglaypin (8)Zinkyete	10 6 6 6
Total (Total number of people)				574

4-2-6 Education/ Training in Japan

JICA Expert Team hold workshop about track maintenance in Japan twice. First workshop was from 9th June to 20th June, 2014. Second workshop was from 23rd June to 4th July, 2014. 22 participants as shown in Table 4-11 were nominated by MR. The curriculum was shown in Table 4-12.

JICA Expert Team requested cooperation from JRE and Japan Railway Track Consultants. Contents of this workshop were lectures and practical track maintenance. Details are described in Appendix 3 “Workshop Report” (p.A-8-4-193-p.A-8-4-202) of the 4th JCC, September 2014.

Table 4-11 The list of Trainees for track maintenance

(1) 1st Group (from 9th June to 20th June, 2014)

No.	Name	Affiliation	Position Title
1	U Ye Htut	Nay Pyi Taw	Assistant Engineer (Civil)
2	U Kyaw Lwin	Division(3)	Assistant Engineer (Civil)
3	U Saw Naing	Division(3)	Permanent Way Inspector (1)
4	U Aung Swe	Division(6)	Permanent Way Inspector (1)
5	U Han Tin Soe	Division(8)	Permanent Way Inspector (1)
6	U Win Nyunt	CITC	Permanent Way Inspector (2)
7	U San Yu	Division(1)	Permanent Way Inspector (2)
8	U Chit Ko Ko	Division(2)	Permanent Way Inspector (2)
9	U Than Naing	Division(3)	Permanent Way Inspector (2)
10	U Aung Thein Win	Division(6)	Permanent Way Inspector (2)
11	U San Naing	Division(6)	Permanent Way Inspector (2)

(2) 2nd Group (from 23rd June to 4th July, 2014.)

No.	Name	Affiliation	Position Title
1	U Soe Myint Aung	Division(4)	Assistant Engineer (Civil)
2	U Aye Nyeub Swe	Division(3)	Assistant Engineer (Civil)
3	U Han Thein	Division(11)	Permanent Way Inspector (1)
4	U Kyaw Thu Ya	Katha-Bahmo Project	Permanent Way Inspector (1)
5	U Moe Kyaw Aung	Yangon-Pathein Project	Permanent Way Inspector (2)
6	U Kyaw Htet Zaw	Division(6)	Permanent Way Inspector (2)
7	U Aye Min Aung	Division(11)	Permanent Way Inspector (2)
8	U Kyaw Tun Linn	Division(2)	Permanent Way Inspector (2)
9	U Aung Aung	Division(5)	Permanent Way Inspector (2)
10	U Hla Htay Win	Division(4)	Permanent Way Inspector (2)
11	U Thaug Tun Aye	Division(5)	Permanent Way Inspector (3)

Table 4-12 Curriculum of track maintenance

No.	Content	Type	Time (h)	Lectures
1	Summary of Japanese Track maintenance Technology and present state of track in Myanma	Lecture	1:00	NSG
2	Technology standards and Rules of Track Maintenance	Lecture	3:00	NSG
3	Tamping Machine and Ballast Regulator	Lecture	1:30	Kotsu transport Construction & Engineering Corporation
4	Turnout (Structure , inspection . Maintenance)	Lecture	3:00	NSG
5	Past Train Accident caused by Track Conditions and its Countermeasure	Lecture	2:00	JIC
6	Track structure and Track work , Track material	Lecture	6:30	NSG
7	Track material (Rail , Fastening , Sleeper , Turnout)	Lecture	2:30	NSG
8	Tokyo Operation Control Center	Visit	2:00	JRE
9	Tokyo Rail Center (Factory welding , Long Rail wagon)	Visit	2:30	JRE
10	Turnout Factory	Visit	3:00	SUMIHATSU
11	Sleeper Factory	Visit	2:30	ABE NIKKO KOGYO
12	Ballast Factory	Visit	2:00	Seeds
13	JRE General Education Center Museum of the History of Railway Accidents	Visit	2:00	JEPS
14	Tamping Machine and Ballast Regulator	Practice	2:30	Kotsu transport Construction & Engineering Corporation
15	Track inspection , Track maintenance work	Practice	4:00	NSG
16	Replacement of Rail and Sleeper , Adjustment of joint gaps	Practice	7:00	NSG
17	Question and answer Review and presentation	Lecture	3:00	NSG , JIC

JRE: East Japan Railway Company , JEPS:JR-East Personnel Service , NSG: Japan Railway Track Consultants

4-2-7 Summarization of the Points of Improvement and Reflecting them in the Track Maintenance Manuals/ Standards

The standard related to MR track maintenance work is based on the rules and standards of India, namely the EU, and the standard related to materials is based on technology from China. When reviewing the technical standard of MR, it was found that the contents of MR's technical standard were simple and not systematic. Only a part of the calculation method for rail joint gap management was the same as Japan's, but numeric values required for track maintenance/management such as regulations on maintenance criteria, etc. are not covered. Therefore, MR engineers have to search for the information that is missing in the standard by referring to other countries over the Internet, etc. Namely, there are many parts where MR's existing technical standard is unsatisfactory and it is difficult to perform proper track management. A few examples of measures to improve MR's technical standard are as follows:

- Inspection means (patrol, small trolley, vehicle and locomotive) are written under "Inspection Method" in the Technical Standard, but concrete inspection methods and management values are lacking.
- Periodical inspection and comparison with previous data are written under "Train Vibration Test" in the Technical Standard, but key control values are not given.

Therefore, the JICA Expert Team prepared a track maintenance work manual with MR by considering the working system at site, work conditions, natural conditions such as the weather, etc. This manual was prepared based on the Japanese technical standard. However, it was hard to use the standard as it is because the equipment to be used and working conditions are different. Therefore, photos taken during the site survey, the order of work corresponding to the site and equipment usage were included in the manual to make it easier for MR staff to use. In addition, the manual was translated into Burmese to assist MR staff. The manual consists of three parts, Work, Safety and Inspection. A reference guide was also distributed to site supervisor class trainees in addition to the manual.

In addition, management values and working methods in the manual are based on the Japanese ones and are given for reference; the JICA Expert Team instructed MR to review and revise the manual by itself for further continuous development of MR's techniques. DGN (Civil Engineering) of MR said that the technical standard will be revised based on the manual recommended by this project.

4-2-8 Final Summarization and Seminars

JICA Expert Team held seminar gathering concerns engaged in track maintenance on the occasion of ending track maintenance from 2nd to 5th in February 2016. JICA Expert Team tried to eliminate unknown thing and Q and A session were conducted actively. This was the last step that MR staff maintain by themselves. JICA Expert Team hope MR staff expand to all parts of the country. Unclear points regarding all matters related to track maintenance work were resolved specifically for turnouts, rail joint measures, curve control, long welded rail control and higher speeds in future. JICA Expert Team tried to eliminate unknown thing and Q and A session were conducted actively.

4-3 Bridge Maintenance Training

Bridge maintenance training are decided to be carried out in this project based on MOM. Almost half of MR's bridges are constructed by the British Commonwealth of Nations, the former suzerain state, and the design and maintenance concept has not been succeeded to the present MR fully. Additionally, bridges have been generally thought as maintenance- free structure because of less maintenance work compared with track. According to these reasons, the present MR has insufficient bridge maintenance technology. Then MR bridges have been deteriorated for long years in the same way as the track.

In this context, bridge maintenance training was planned and carried out after having grasped to present technology level of MR through the survey of the existing bridge maintenance of MR.

4-3-1 Survey of the Existing Bridge Maintenance of MR.

(1) Outline of MR Bridges

The number of bridges of MR are shown in Table 4-13. MR's railway lines can be divided into 2 groups, one has been constructed in 71 years of British rule (from 1877 to 1948), the others have been constructed in 67 years after independence of Burma (since 1948). Then, after 1989, when the name of nation changed from "Union of Burma" to "Republic of the Union of Myanmar", approximately 100km route length has been constructed every year. Moreover, after 2015, the route length will be extended by 561km additionally. It should be noted that the difference between the route length and the track length, during the period from 1988 to 2011, are big because Yangon- Mandalay line double track construction had been carried out. And, some traffic road bridges are maintained by MR.

Table 4-13 MR's Rout length, Track length, Stations and Bridges

Construction Year	Route length (km)	Track length (km)	Stations (Nos)	Bridges (Nos)
1877—1948	2,851.31	4134.45	385	5,084
1948—1988	330.61	363.67	102	5,66
1988—2011	2,622.90	3,116.32	428	5,872
2011—2015	402.82	432.64	45	577
Total	6,207.64	8,047.08	960	12,099

Source Fact about Myanma Railways (2015)

(2) MR Bridge Maintenance Implementation Body

Table4-14 shows the organization of Civil Engineering Department which is in charge of bridge maintenance, and Table4-15 shows position titles of Civil Engineering Department. This department maintains not only bridge, but also track (permanent way), structures such as tunnel, earth structure, drainage, building and etc., and machinery. Each division is stationed by Divisional Engineer, Assistant Engineer, and relevant Inspector, and Division(1) - (11) maintain track and structure, Bridge Division does bridge, Mechanical Division does machinery. As Divisional engineers of Division(3) Mandalay and Division (7) Yangon, Assistant General Manager class managers are assigned.

Table4-14 MR Organization of Civil Engineering Department

Head Office		
	Chief Engineer	General Manager
	Track	Deputy General Manager Assistant General Manager Executive Engineer Assistant Engineer
	Store	
	Work	
	Bridge	
	Planning	
	Mechanical Work	
	Budget	
	Project	
Division (1) ~ (11)		
Bridge Division		
Mechanical Division		

Table4-15 MR's position title regarding to Civil Engineering Department

Class	Position title	Remarks
1	General Manager	Chief Engineer
2	Deputy General Manager	
3	Assistant General Manager	Divisional Engineer (3), (7)
4	Executive Engineer	Divisional Engineer (except above), Project engineer
5	Assistant Engineer	
6	Sub Assistant Engineer (1)	Permanent Way Inspector (1), (2), (3), and (4) Work Inspector (1), (2), (3), and (4) Bridge Inspector (1), (2), (3), and (4)
7	Sub Assistant Engineer (2)	
8	Sub Assistant Engineer (3)	
9	Sub Assistant Engineer (4)	
10	Supervisor	
11	Skill Worker	
12	General Worker	

(3) Mahalwagon Bridge Depot

There is a bridge depot in Mahalwagon near Yangon under the direct management of MR. Bridge Division is placed there, and manufactures new bridges, and repairs old bridges. It can manufacture steel deck plate girders of the maximum length of 90ft, steel through Truss girders, and Pre-stressed concrete girders (hereinafter, "PC girder") of the maximum length of 100ft, and other steel products such as station building frames, inspection hummers and so on.

Mahlwagon Bridge Depot was established in 1965, and steel girders had been manufactured there. Since 1977, PC girders have been manufactured there. Manufactured girders are used for new line construction works or replacement of the existing girders. In these years, MR tends to use PC girder

because of its economy, material availability, durable life and easy maintenance compared with the steel girder. Under these circumstances, deteriorated steel girders are replaced with PC girders. The number of replacement is approximately 50. Facilities of the bridge depot are old, and the method of connecting steel members is riveting.

There are many Personal Computers, which are used for drawing up or stocking documents of inspection and documents of design. But most of the old drawings and documents have been lost



(1) Office building



(2) Truck



(3) Inside view of the Bridge Depot



(4) Rivetting work

Photo 4-1 Mahalwagon Bridge Depot

(4) Internal rules

With regard to MR bridge maintenance, Manual of the Engineering Department Chapter IV Bridges (hereinafter, “internal rule”) is issued, and several roles and inspection according to each class of engineer are defined. Here, the longest span of inspection is defined as 1 year. On the other hand, Indian Railways Bridge Manual is also applied to MR maintenance work partially, and the longest span of inspection is defined as 5 years. But, these internal rules are not fully applied to MR maintenance work because of insufficient human resources, and insufficient budget.

According to the result of the interview with MR, bridge maintenance work is likely to be carried out by its following rules. The organization for bridge inspection is different depending on the bridge

length. Bridges longer than 60ft is inspected by Bridge Division engineer (Bridge inspector), Bridges shorter than 60ft is inspected by Each Division engineer(Work inspector / Permanent way inspector). The bridges shorter than 60ft which judged were “defect”, are inspected by bridge inspectors again. These inspection results are reported to Chief Engineer, and bridges needing repair are repaired /improved or replaced after budgeting. Here, bridges less than 60ft is likely to be replaced, and bridges over 60ft is likely to be repaired.

Aside from the above, some bridges used both for railway and road traffic are maintained by Ministry of Construction (hereinafter, MOC) .

(5) Major Problems of MR bridge Maintenance

MR bridge maintenance is considered to have the following problems.

- Because of replacing many existing bridges and expensing much budget, the countermeasure works for deteriorated bridges are implemented in slow progress for its total volume.
- Because of slow progress of countermeasures, there are many bridges which seem to be under the execution of the temporary countermeasure. These bridges have no major problems for safety train operation in the present situation, but after modernization (increasing number of train and its speed), those may disrupt safety train operation.
- Because of the existence of the various inspection organizations, the condition of all MR bridge are not grasped. Especially, PWIs are mainly in charge of track maintenance, and they seems not to be able to inspect the bridges sufficiently.
- Because of insufficient bridge maintenance technology, bridges with large deterioration are replaced with new one only based on the result of the visual inspection. However, even if bridges have large deterioration, it can be considered to be safe for train operation in case of using sufficient maintenance technology.

4-3-2 Bridge Maintenance Training Plan

(1) Training Outline

Considering the survey results, this training aims for improving MR bridge maintenance technology of superstructure mainly through seminar and on-site training. Considering MR modernization, this training is implemented with the following 2 purposes:

- 1) MR engineer can consider several alternatives for suitable maintenance of bridge, namely not only replacement, but also other ways based on suitable inspection, judgement, countermeasure.
- 2) In order to change the corrective maintenance system to the preventive maintenance system, MR engineer can record the deterioration situation and the prediction of the future deterioration progress through suitable inspection.

Bridge maintenance training was planned to be divided into 4 phase, and to be implemented at the actual MR bridges in the field. In the Phase1, MR trainees would learn the basic technology of bridge maintenance by training guided by JICA Expert Team. In the Phase2, MR would apply the technology, which they learned in Phase1, to the actual work by themselves, and JICA Expert Team sometimes would follow them up in the training at the site. In Phase3, for making their technology and

knowledge advance, JICA Expert Team would hold a seminar for advanced bridge maintenance technology. At the end, Phase4, JICA Expert Team would evaluate MR trainee's achievement, and summarize the problems of MR bridge maintenance to be tackled with.

The numbers of trainees are limited to under 10, and the trainees should be selected from among the responsible engineers in Head Office, Bridge Inspectors, and Work inspectors. Here, the training outline was proposed to MR from JICA Expert Team at the 7th JCC and approved..

(2) Textbook

Before training, in order to be used for the whole phase, a text book was compiled referring to 「Modern Inspection and Maintenance Procedures for Railway Structures」(1990, Economic and Social Commission for Asia and the Pacific : ESCAP) and 「Tetsudou Shisetsu Gijutsu Hattatu Shi」 (1994, Japan Railway Civil Engineering Association) . It was attached to the Progress Report of 8th JCC Appendix 2 (p.A-8-8-62-p.A-8-8-130).

(3) Implementation Body

Bridge maintenance training was provided by Japanese bridge experts mainly from JICA experts and Bridge Maintenance Consultants Cooperation (hereinafter BMC), which is the secondary contracted company with JICA. BMC has a rich experience for training Japanese railway company's bridge maintenance engineers such as JR-east, and has a rich know-how for maintaining bridges.

(4) Equipment and Tools

Bridge maintenance training was carried out with the followings equipment and tools. These equipment were prepared by JICA Expert Team and BMC

- 1) Safety Equipment : Helmet, safety vest, safety boots.
- 2) Inspection Tools : Inspection hammer, inspection mirror, convex, wrench, easy-measuring distance machine, wire brush, measuring tape, spray, white marker, easy- stress measuring machine, digital camera, level book, crack scale.

4-3-3 Implementation Report (Phase1)

Table4-16 shows the curriculum of Phase1, Table 4-17 shows the trainees of Phase 1 . It can be thought that present MR technology level and its surrounding circumstances may be similar to Japanese 1950s' one. Therefore, In this Phase1, JICA Expert Team delivered lectures about history of Japanese Railway Bridge Maintenance Technology development, present maintenance technology, and preventive maintenance. Further JICA Expert team provided the trainees with training at the site in order to learn necessary technology for modernization. Trainings at the site were carried out at 10 bridges consisting of 3 bridges (Gokteik Viaduct、 Inwa Bridge、 Sittaung Bridge, which MR are anxious for maintaining) and 7 pilot bridges.

Table 4-16 Phase1 Curriculum

DD/MM	Training	Place
27 th July	Orientation, Lecture (History of bridge maintenance in JPN, Present bridge maintenance)	Mahalwagon
28 th July	Lecture (Bridge chart and BMC system) Site visit (DG:No.21, DG:No.9)	Mahalwagon Yangon – Bago
29 th July	Site visit(TT:No.32U, TG:No.32D)	Yangon – Bago
30 th July	Site visit(TT:No.13U&D,DG:No13D)	Yangon – Bago
31 st July	Day off	
1 st August	Day off	
2 nd August	Pre-survey (Steel trestle: Gokteik viaduct)	Shan State
3 rd August	Site visit (Steel trestle: Gokteik viaduct)	Shan State
4 th August	Site visit (TT: Inwa Bridge)	Sagaing
5 th August	Lecture (site visit result 1)	Mahalwagon
6 th August	Site visit (TT: Sittaung Bridge)	Sittaung
7 th August	Lecture (Site visit result 2 and repairing plan)	Mahalwagon
8 th August	Orientation (BMC measurement system rental)	Mahalwagon
9 th August	Day off	
10 th August	Site visit (PC and Composite Structure: Insein Rail over Bridge), Extra (Nyaung Don Bridge)	Insein
11 th August	Lecture (Site visit review, Stress Ratio theory, Water way control, Painting, Record, etc), Orientation	Mahalwagon

Table 4-17 Phase1 MR Trainees

No	Name	Affiliation	Position Titele
1	U Zaw Min Oo	Yangon – Mandalay Railway Improvement Project(JICA) Phase 1	Executive Engineer (Civil)
2	U Tin Moe	Yangon – Pathain Railway Project	Assistant Engineer
3	U Than Lwin	Minbu-Ann-Sittwe Railway Project	Work Inspector(1)
4	U Than Swe	Division(7) Yangon	Work Inspector(2)
5	U Maung Chit	Bridge Division (Mahalwagon)	Bridge Inspector(2)
6	U Kyaw Swar Htay	Division(6) Bago	Work Inspector(2)
7	U Tun Tun Win	Bridge Division (Mahalwagon)	Bridge Inspector(2)

Table 4-18 shows the major deformation, countermeasures and effective proposed measures for ten bridges where on-site training was carried out. Here, MR was particularly interested in three bridges, Gokteik Viaduct, Inwa Bridge and Sittaung Bridge, which are long bridges exceeding 600 m in length. The seven other bridges are pilot bridges. At the on-site training, we trained MR focusing on inspection methods and points of observation, determination methods and recording methods according to the respective structure of the ten bridges in order to teach what should be performed during bridge inspections. In addition, prediction of future deformation and reviewing countermeasures were taught, while considering the surrounding environment at the site. An overview of the ten bridges obtained through the training follows:

Points of concern for MR regarding three bridges are: “Whether the bridge beam which dropped during a war in the past and was recovered is sound or not” and “Large swinging of trains”. MR maintains the three bridges by painting them every three years and conducting frequent inspections, however, they are concerned about their effectiveness. Therefore, a performance comparison of healthy bridge beams and the doubtful ones was conducted with stress measurement by using equipment brought by BMC and the deformation behavior of the bridges was measured by camera. Abnormal values were not found within the measured range. It is considered that the method of maintenance management performed by MR was adequate since large defects were not found visually, provided train operation is conducted under the current situation (kinds of train, frequency, and speed). The possibility of increasing the speed at the three bridges by repainting was difficult to determine by the survey this time; it is desirable to conduct detailed tests to determine the replacement of corroded railroad sleepers, and railroad sleeper fixing by hook bolts.

As for the other seven bridges, there was serious deformation of Bridge No. 13 (1) and Bridge No. 21 which requires urgent measures, and deformation was found on Bridge No. 9, Bridge No. 13 (2) and Bridge No. 32 which require scheduled measures to be taken. Countermeasures for the deformation were proposed by the Japanese side. The deformation on Bridge No. 13 (1) and Bridge No. 13 (2) was large cracks on the main beam. The size of redundancy on Bridge No. 13 (1) was visually confirmed but the crack on Bridge No. 13 (2) was small. We determined that urgency is low because abnormal values were not found upon measuring the stress on a small crack.

In spite of the existence of serious deformation, proper countermeasures were not taken for the bridges (Bridge No. 9 and Bridge No. 21) which were inspected by other than bridge inspectors. There is a large crack in the beam of Bridge No. 21 and the main beam of Bridge No. 9 is severely corroded. In addition, MR has not resolved the major deformation such as cracks on Bridge No. 13 (1) and Bridge No. 13 (2), or derailment marks on vertical and horizontal members of Bridge No. 32. The inability to detect the seriousness of deformation and countermeasures, and the current situation in which train operation is not affected by the deformation, might have caused MR’s inaction.

Table4-18 Phase1 the result of on-site training

Bridge name (kind of structure)	major deterioration	counter measure	advanced measure
Gokteik Viaduct (Deck truss girder and Trestle)	deterioration on floor plate	Around bearing clearing, Usual MR maintenance, Detail inspection when repaint	Replacement of rotted sleeper Fixing sleeper by hook bolt
Inwa Bridge (Through truss girder)	deterioration on floor beam, rivet relaxing on bracing	Around bearing clearing, Usual MR maintenance, Detail inspection when repaint	Monitoring concrete surface under the traffic road, Replacement of rotted sleeper Fixing sleeper by hook bolt
Sittaung Bridge (Through truss girder)	Additional stringer's rivet relaxing	Around bearing clearing, Usual MR maintenance, Detail inspection when repaint	Removing extra sleeper, Monitoring concrete surface under the traffic road,
No.9 Bridge (Deck plate girder)	Main girder corrosion, Sleeper support	Cleaning , Repainting, Remove wooden sleeper	Replace the corroded lower flange of main girder
No.13 Bridge (1) (Deck plate girder)	Crack on welded attached plate	Monitoring	Remove existing plate and attach new plate with hi-tension bolt
No.13 Bridge (2) (Through truss girder)	Crack on web of stringer	Plate attaching with hi tension bolt	At first installing stop hole
No.21 Bridge (Deck plate girder)	Crack on pier	Temporary repairing, Zonal plate wrapping, monitoring	Reconstruction pier
No.32 Bridge (Through truss girder)	Damage of train derailment	Monitoring, especially stringer end	Replace damaged member
No.32 Bridge (Through plate girder)	Corrosion on cross beam	Monitoring, especially stringer end	Attaching plate, lateral replace
Insein rail over bridge (PC girder)	Additional mortar on surface	Monitoring	Remove mortar which has closed crack



(1) No9 Bridge



(2)No13 Bridge(2)



(3)Gokteik Viaduct



(4) Inwa Bridge

Photo 4-2 On-site training

Japanese railways are a safe and stable transportation system, which was achieved by analyzing the causes of accidents and disasters in the past and a long succession of countermeasures. There are many common characteristics between Japanese railways post WWII before modernization and the current MR. The current MR situation is similar to Japan's in the 1950s in terms of the economic and social situation in Myanmar. The bridge maintenance/management techniques in Japan shifted from breakdown maintenance (repair after breakage) to preventive maintenance (repair before breakage). Lectures were conducted on the approach to modernizing bridge maintenance/management techniques in Japan and an overview of current inspection for reference as a future guideline to MR. In addition, the accumulation of information related to bridges such as inspection data is essential for preventive maintenance. Lectures were also provided on the data wrapping-up method with bridge charts (bridge guard cards) in Japan as an example. The training contents at site and countermeasures were reviewed during the lectures, with follow-up to deepen the knowledge.

The trainees from MR paid close attention to every move that the Japanese engineers made at site, listened to their words, and were enthusiastic to learn the techniques. In addition, they were positive to put what they had learned into practice immediately. For example, when the Japanese engineers clean

around supporting points before inspection as a matter of course, it is not only effective to detect deformation but also to suppress the progression of corrosion at the supporting points, thus helping to prolong bridge life. Once the trainees understood the importance of cleaning, they took the initiative by themselves without hesitating to get dirty. When they were taught how to make site record field notes, they prepared the notes on a PC the next day and all of them brought their notes with them to the site. Trainees reported to the vice minister of MORT on October 21, 2015. The report included what had been taught aurally by the Japanese side at the site in detail.

During Phase1, it had become clear that the former MR engineer, U Myat Lin, had compiled a text book referring to Japanese maintenance technology that Japanese experts taught MR engineers through ESCAP program in 1990 (Fig. 4-1). Here, the text book compiled, in 2014 by U Myat Lin who was then the vice principal of CITC was used for training of MR bridge maintenance engineers.

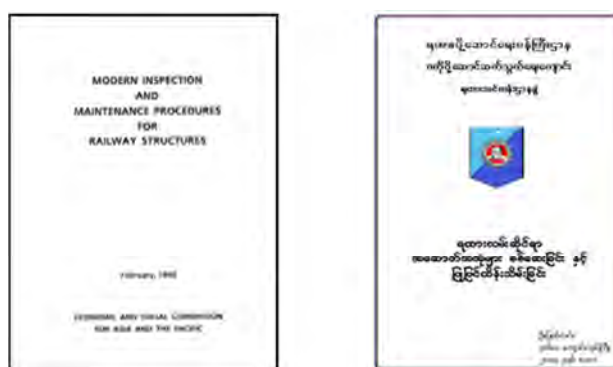


Fig.4-1 Bridge maintenance text (ESCAP and Myanmar)

4-3-4 Implementation Report (Phase2)

In Phase2, it consisted of 2 parts. One part is aiming that MR engineers, by themselves, would apply the bridge maintenance technology which they learned in the phase1 to their actual bridge maintenance work from August (after phase1) to November (before phase4). and another is aiming that JICA Expert Team would follow MR engineer up through 4days on-site training.

(1) What MR Implemented in Phase 2

In Phase 2, MR had repaired No9 Bridge, No13 Bridge(1), No13 Bridge(2), and No21 Bridge and No32 Bridge were to be provided in the near future. Here, MR made a document report describing the situation of repairing work to JICA Expert Team. Especially, MR trainees had repaired No13 Bridge not only according to the repairing plan that JICA Expert Team suggested, but also according to their original additional countermeasure such as shown in Fig. 4-2. MR attached support member between lower flange of stringer and lower flange of floor beam in order to decrease the stress acting there to cause the crack. Although, MR could execute repairing based on the drawings that JICA expert Team provided, there are some following items to be improved as shown in Photo 4-3.

- Repairing with welding for old rivet girders which are not suitable for welding
- Hi-tension bolts are fastened not by machine but by manpower without necessary torque

- Attaching plate without removing paint coat of each attaching surface of steel plate and girder
- Temporary support had not be placed on the bottom of stiffener of main girder.

MR hadn't implemented inspection in Phase2, however, they compiled 2 inspection manuals of Myanmar language that JICA Expert Team taught in Phase1. Those were about "Stress measurement and study fatigue" and "Stress Ratio of Steel girder".

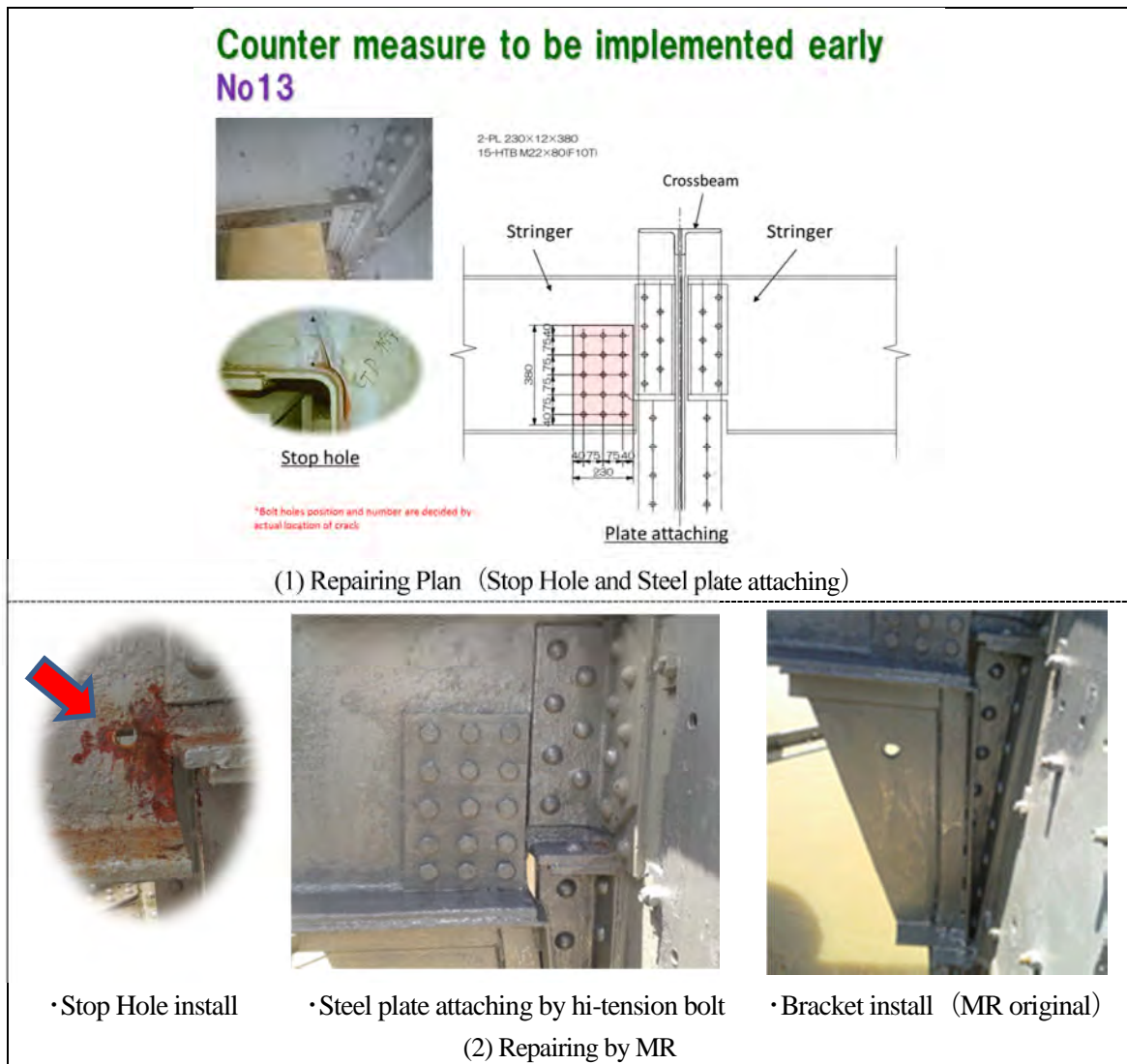


Fig. 4.2 Repairing of No13 Bridge(2)



- Repairing report
- Manuals for stress measurement, fatigue
- Stress Ratio method manual

Fig. 4-3 Documents made by MR trainee



Photo 4-3 Phase2 Repairing by MR trainee

(2) JICA Expert Team Follow up

The intermediate follow-up curriculum of Phase 2, list of trainees who participated in Phase 2, and an overview of the follow-up are shown in Table 4-19, Table 4-20 and Photo 4-4, respectively. The follow-up was conducted by Mr. Takami of the JICA Expert Team. The bridges visited in Phase 1 were visited again for follow-up inspection because the trainees did not inspect them in Phase 2.

At Bridge No. 21, inspection training was conducted on the bridge columns by getting down to the riverbed since the water level was lower than during the previous training. Also, the areas repaired by MR were inspected.

Stress measurement training by using equipment was conducted at Bridge No. 32. The measurement was made by passing two trains in service and four maneuver vehicles (Rail Gang Car (RGC)) for maintenance at the time.

Table4-19 Phase2 follow-up curriculum

DD/MM	Training	Place
5 th October	Preparation, No.9 Bridge	Mahalwagon
6 th October	No.21 Bridge, No13 Bridge (1) and (2),No.9 Bridge	Yangon – Bago
7 th October	No.32 Bridge (Inspection and measurement training),	Yangon – Bago
8 th October	Follow up for stress analyzation and fatigue	Yangon – Bago

Table4-20 Phase2 MR trainees

No	Name	Affiliation	Position Title
1	U Zaw Min Oo	Yangon – Mandalay Railway Improvement Project(JICA) Phase 1	Executive Engineer (Civil)
2	U Than Swe	Division(7) Yangon	Work Inspector(2)
3	U Sein Myint	Bridge Division (Mahalwagon)	Bridge Inspector(2)
4	U Maung Chit	Bridge Division (Mahalwagon)	Bridge Inspector(2)
5	U Han Sein	Division(6) Bago	Work Inspector(2)
6	U Tun Tun Win	Bridge Division (Mahalwagon)	Bridge Inspector(2)
7	U Aung Win Myint	Division(2) Ywahtaung	Work Inspector(3)



(1) Stress measure training (No32 Bridge)

(2) Closing visual inspection (No21 Bridge pier)

Photo 4-4 Follow up (Phase)

4-3-5 Implementation Report (Phase3)

The seminar on bridge maintenance/management was conducted at the training center of MR's head office on the 1st and 2nd of October, 2015. The themes were selected through discussion with MR aiming to deepen knowledge of bridge maintenance and management. A lecture and Q&A session on each theme, "Water Way Control" and "Stress Ratio Method", were held respectively for one day each. The participants are listed in Table 4-21.

The theme "Water Way Control (River Control)" was requested by the MR side. Every rainy season, railway tracks are broken by bridges being washed out and bank collapse due to rainfall disaster, etc.,

and MR has a tough time to deal with them. At the seminar, the lecture focused on case studies in Japan aiming to improve the techniques of water way control. Specifically, the lecture explained the basic knowledge and theory of river control, the mechanism of and countermeasures for scouring disaster, regulations of the River Act (Japan), river inspection method, and train operation restriction method. Many questions related to countermeasures such as predicting the scope of scouring, the range of construction work as a countermeasure, etc. were raised by MR.

The theme “Stress Ratio Method (Existing Stress Ratio)” was requested by the Japan side. The frequency and speed of train operation will be increased with modernization in the future, but MR engineers need a scientific method of assessing the deformation status of steel bridges to determine whether the existing steel bridges can cope with the changes. Therefore, a method for evaluating deformation and proof strength was taught by taking deck plate girders, which are widely used on MR’s bridges, as an example. In addition, a list of stresses occurring in beams due to live load for all vehicles in the future was prepared by using the BMC system. With this list, complicated live load calculations are eliminated and MR can evaluate the proof strength and beam status more easily. It is considered that MR fully understood through the completion of the procedure manual regarding the existing stress ratio calculation in Burmese based on the contents of this lecture.

Table 4-21 Phase 3 MR participants

No	Name	Affiliation	Position Title
1	U Aung win Myint	Division(2)Ywahtaung	Work Inspector (3)
2	U Maung Maung Chit	Bridge Division (Mahalwagon)	Bridge Inspector(2)
3	U Kyaw Swar Htay	Division(6)Letpadan	Work Inspector (3)
4	U Tun Tun Win	Bridge Division (Mahalwagon)	Bridge Inspector(2)
5	U Thein Sue Oo	Head office	General worker
6	U Thet Htwe Oo	Kabaung Bridge Project	Work Inspector (1)
7	Ma Thida Kheing	Division(4)Kalaw	Supervisor
8	Ma Htwe Nge	Division(4)Kalaw	Supervisor
9	U Han Sein	Division(6)Bago	Work Inspector (2)
10	Ms. San Win Maw	Divion(5)Taungoo	Supervisor
11	U Win Myint	Division(2)Ywahtaung	Work Inspector (3)
12	U Than Lwin	Division(1)Moenyin	Work Inspector (1)
13	U Zaw Min Oo	Yangon – Mandalay Railway Improvement Project(JICA) Phase 1	Executive Engineer
14	U Zaw Ye Myint	Head office	Assistant Engineer
15	U Zaw Ko Lutt	Division(3)Mandalay	Supervisor
16	U Aung Phyo Wai	NayPyiTaw Project	Work Inspector (1)
17	U Aung Kyaw Nyunt	Division(5)Pyinmana	Work Inspector (1)
18	U Than Lwin	Sittwe Project	Bridge Inspector(1)
19	U Kyaw Lwin Oo	Division(8)Thanbyuzayet	PWI(1)
20	U Zaw Naing Lin	Division(6)Phaungtawthi	PWI(3)



Photo 4-5 Seminar (Phase3)

4-3-6 Implementation Report (Phase4)

As for Phase 4, the contents of the curriculum and trainees are shown in Table 4-22 and Table 4-23, respectively. Since Phase 4 is the final finishing phase, knowledge required for further improvement of maintenance and management techniques was increased through in-service training and seminars. The instruction was conducted by Mr. Takami of the JICA Expert Team and Mr. Kumon, an expert from BMC.

In Phase 4, lectures on “PC girder maintenance summary” and “Fatigue crack” were given at the request of MR. Currently, PC beams are widely used by MR, and lectures regarding the mechanism of deformation, inspection methods and repair methods were given based on case examples in Japan. As for fatigue cracking, it was taught repeatedly in Phases 1 to 3, however, it was taught again in order to deepen understanding by introducing various case examples in Japan.

During the on-site training in Phase 4, the trainees took a site tour to observe the replacement of corroded railroad sleepers which are commonly seen at many bridges. The replacement work is a part of the track maintenance training for the OJT track maintenance project, and taught MR trainees countermeasures for corroded track sleepers, construction procedures and points to note. In addition, trainees reconfirmed the repair status of Bridge No. 13 (1) and (2), and Bridge No. 9 was reconfirmed.

Since MR is not familiar with inspection, general inspection training was carried out. In this training, trainees inspected one section (Mahalwagon–Hnizigon) on the Yangon–Mandalay main line, and determined and measured the deformation found at site by visually inspecting the soundness of all bridges while reviewing the theory learned during Phases 1 to 3 through the case studies. In addition, inspection training on Myogwin Bridge was conducted, since MR is concerned about this bridge which was damaged in the war in the past.

During the closing workshop, we gave recommendations regarding the current situation and modernization of MR at each stage of the preventive maintenance cycle (inspection, diagnosis, repair plan and construction) and taught the attitude required by in-house engineers. We also gave recommendations regarding assessing the entire bridge status and prioritization, securing budget required for maintenance management, modernization of tools and facilities, strengthening the

maintenance management of bridges shorter than 60 ft and promoting disaster prevention work as the components required for modernization. Finally, we handed a certificate to each trainee.

Table 4-22 Phase4 Curriculum

DD/MM	Training	Place
11 th November	Orientation, Briefing, Lecture (PC girder maintenance summary), MR report of phase2	Mahalwagon
12 th November	Working site visit of exchange sleeper on bridge Site visit (No13 bridge (1) and (2), No9 bridge)	Togyaungglae, Mahalwagon
13 th November	General inspection training between Mahalwagon to Hnizigon, short review for general inspection	Mahalwagon- Hnizigon
14 th -15 th November	Day off	
16 th November	Site Visit (Myogwin Bridge)	Hintada
17 th November	Lecture (Review of Phase 4, Fatigue crack), Closing workshop	Mahalwagon

Table 4-23 Phase4 MR Trainees

No	Name	Affiliation	Position Title
1	U Zaw Min Oo	Yangon – Mandalay Railway Improvement Project(JICA) Phase 1	Executive Engineer (Civil)
2	U Thein Htway Oo	Head Office Civil Department	Assistant Engineer
3	U Than Lwin	Sittwe project	Bridge Inspector(1)
4	U Than Swe	Division(7) Yangon	Work Inspector(2)
5	U Maung Chit	Girder Depot (Yangon)	Bridge Inspector(2)
6	U Aung Win Myint	Division(2) Ywahtaung	Work Inspector(3)
7	U Tun Tun Win	Girder Depot (Yangon)	Bridge Inspector(2)
8	U Sein Myint	Girder Depot (Yangon)	Bridge Inspector(2)
9	U Han Sein	Division(6) Bago	Work Inspector(2)

A loose bolt was found after inspection at a location repaired by MR. It is considered that the cause was the interposition of manual construction work and paint film as pointed during Phase 2. Frequent inspection and bolt retightening were recommended since the loosening occurred during the first 2 months after repair.

Myogwin Bridge is an iron draw-type bridge over 100 years old, crossing the Irrawaddy River. The bridge lost its function as a draw-up bridge during the war and has been used as a road bridge by placing sleepers without gaps after the war. Cars pass on the track even now. Since the bridge columns are high due to the 10 m water depth of the river, the bridge columns swing largely even when cars are passing. We recommended that a separate detailed survey is required for vibration assessment since there was no time or tools for conducting the test during the survey this time. Although the beam itself has no problem, it was recommended that the beam should be inspected thoroughly at the time of

track sleeper replacement and that measures to prevent corrosion should be taken.

During the overall inspection training, five bridges in the Mahalwagon–Hnizigon section were inspected. All of the bridges have deformation and a countermeasure policy was recommended at site. Especially, on Bridge No. 10, the upper side beam had dropped due to rivet breakage and there was severe vibration when trains passed, threatening running safety when train speed is increased. After a detailed inspection, it was judged that the rivets were loose and had fallen due to repetitive passing loads over the years, since the track sleepers on the bridge hit the head of the rivets connecting the side beam and main beam. We recommended urgent retightening.

In addition, at the concrete overbridge in the section, there was deformation such as cracks on the lower surface of the floor slab compared to the state at the time of construction. Such deformation was considered to be caused by the increasing live load. Since the overall inspection is based on visual inspection, we recommended observing the surface in detail by using a ladder and specifying the cause separately for the detailed survey.

The status of Bridge No. 8 was the worst in the section. Half of the bridge column is submerged in salty water during the rainy season and corrosion is severe. When mud attached to the beam was removed, pitting corrosion on the radial plate from the edge of the beam to the central part was found. The base material of the beam was severely corroded, and rust was laminated in layers and exfoliated. We urged MR to take immediate measures, and MR replaced the beam with a new one as a tentative solution in January 2016. However, since the situation of the beam dipping into the salty water remained, countermeasures such as structural change, river bed dredging, etc. are necessary.

On January 27, 2016, a special lecture was held for 40 bridge engineers of MR on railway disaster prevention technology by Project Professor Makoto Shimamura of the School of Engineering, the University of Tokyo, at the training center of MR's head office.



(1) Myokwin Bridge



(2) No.10 Bridge



(3) Rail over bridge



(4) No.8 Bridge

Photo 4-6 General inspection training (Phase4)

4-3-7 Review the Bridge Maintenance Training

Through the training, MR trainees were always watching carefully for JICA Expert action, be earnest to learn more bridge maintenance technology, act same as JICA Expert Team action. JICA Expert Team and BMC appreciate MR trainee attitude. After complete of Phase4 training, MR trainee's comments were collected. Major comment are shown as followings.

- A trainee could learn new technology and remind forgot technology.
- Before training, a trainee considered bridge needs no maintenance, and when it will be deteriorated, it should be replaced new one.
- After training a trainee comes into think that inspection and repairing are best way for maintain bridge.
- A trainee could learn necessary technology in detail through repeated study the theory and implementation.
- A trainee could learn the progress of bridge deterioration and how to maintain them.
- A trainee could learn the major inspection item, inspection method, and calculation.

4-4 Others

4-4-1 Cooperation and Assistance by the Government of the Counties other than Japan in the Field of Railways

The assistance of funds and conditions of loans and other matters regarding the assistance (ODA) extended by the governments of the countries other than Japan in the field of railway are from China, India Yugoslavia and Republic of Korea. The details are described in main text , “2.3.1 Official Development Aid by the Government (As of 2013) (p.A-8-5-19)” of Project Progress Report, December 2014.

4-4-2 Existing Situations and Issues to be Improved of RTTC and CITC

(1) Visit of RTTC and CITC by JICA Expert Team

JICA Expert Team consisting of Kuroda (Leader), Ishikawa (rolling stock expert), Morihara (Train Operation expert), Mitani (Signalling & Telecom. expert) and Takami (Civil Engineering Structure expert) visited CITC at Meiktila on Dec. 22nd 2014 and RTTC at Ywataung on Dec 23rd, 2014., and surveyed the existing situations of those educational institutes to identify the major issues to be improved, which will become the basis of future cooperation by advanced railways.

(2) RTTC

The existing situations are described in detail in the Appendix 8-3, “Existing situations of RTTC and the Answers to the Questionnaire (p.A-8-6-143 –p.A-8-6-161)” of Progress Report, March 2015.

Major issues to be improved are described below. (It should be noted that RTTC is the training institute for upgrading the technical skills of the staff working for diesel locomotives)

1) RTTC was established with the cooperation of GTZ of Germany, and mainly machineries for training, preparation of curriculum, training of teachers were offered by GTZ. The RTTC started the training activities in 1981. Installation of machineries for training was executed about 30 years ago, so they should be modernized. Now GTZ is under consideration for upgrading the RTTC, but not yet decided. It is recommended that RTTC should be upgraded with due consideration on modernization of MR.

2) Further the following can be mentioned for consideration.

a) Facility

Dormitory of RTTC consists of one large room and very old. It is recommended to divide the one large room into small units for several number of trainees so that their privacy can be secured and they can study individually at the night time.

b) Equipments/ Machineries

When a new system is introduced, a mockup for the new system shall also be provided to make trainees to be familiarized with the system.

Mockup shall also have a function to simulate the failure of locomotives intentionally and trainees should find out how the failures have happened and learn the procedure to repair them.

(3) CITC

The existing situations are described in Appendix 8-4 "Existing Situations of CITC" in Progress Report, March 2015. Future upgrading plan by CITC and some recommendations by JICA experts for modernizing CITC are given below.

1) Future Upgrading Plan of CITC.

The CITC has the future upgrading plan as shown below.

- To conduct more training courses annually.
- To review and upgrade the training curriculums using currently in the courses.
- To collect the skilled instructors and training aids to be more effective for the training courses.
- To cultivate the technical know-how instructors.
- To promote trainer of the training program (ToT)
- To implement the effective training courses by upgrading the existing personnel strength.
- To promote the scholarship program domestic and foreign countries for the instructors will be extended for the sake of receiving advance teaching techniques and applying effectively in real life situation.

2) Reviewing and Upgrading the Training Curriculums

- In line with the modern technologies, some of the subjects have been reviewed and submitted. The submitted subjects are upgraded in cooperation with Myanmar Railways (MR).
- Some of the case study and research paper are requiring more attractive and practical Lectures, classrooms and practice facilities to motivate the trainees are necessary.
- Recruitment of excellent new expert and engineers will be trained in near future due to the development of Myanmar market oriented economy.
- To aspire the teaching and training aids to be more effective for the training courses (Table 4-24).
- To cultivate the technical know-how instructors.
- To implement the effective training courses by upgrading the existing personnel strength.
- To cooperate with donor partner just like JICA.

Table4-24 Requirements of the CITC for Training Aids

No	Description	Qty
1	Desktop Computer Class Room 40 Sets, Furniture Fully Equipped Accessories	40- Nos
2	Locomotive Driving Simulator(Full Cab)	1-Nos
3	Multimedia Class Room PC 30 Sets+ Furniture + Fully equipped Audio,Video Accessories	30-Nos
4	Training for Automotive Vehicles (Saloon,Wagon, Van)	7-Nos
5	Digital Ultrasonic Flaw Dector	1-Nos
6	On Board Diagnosis, Machines Fully Equipped and Accessories	1-Nos

3) Some Recommendations by JICA Experts

a) Track

Now MR is going to modernize Yangon – Mandalay line and Yangon Circular line, and is required to introduce the new technologies such as long-welded rail, application of large scale track maintenance machines, track maintenance to cope with the train speed up to 100km/h.

In this regard, lectures relating to these new technologies, and training equipments for trainees to be trained for these new technologies, in the laboratories and on the practical training track, should be provided.

b) Rolling stock

When a new system is introduced, a mockup for the new system shall also be provided to make trainees to be familiarized with the system.

Mockup shall also have a function to simulate the failure of locomotives intentionally and trainees should find out how the failures have happened and learn the procedure to repair them.

c) Signalling & Telecom.

- It can be praised to hand over the text used in training to a student after the completion of training. This practice should be continued.
- The practice to take notes of the contents of the lectures and other important things taught should be tried to be established in CITC. This practice should also be applied to the field workers. In this regard, CITC is advised to deliver memo notebooks to the trainees.
- Training course of signaling for Junior Engineers is also necessary. Further, it's necessary to establish a curriculum for dealing with every equipment including Interlocking.
- Signal equipment and train protection system are used only in the railway. CITC is advised to issue qualification for the persons who completed the training for these equipments.

- Electronic Interlocking will be introduced to MR from now on. It is necessary to understand its operation mechanism by training. It is also necessary to understand the operation mechanism of Relay Interlocking by training. Understanding the operation mechanism of these equipments will contribute to life prolongation of these equipment.
- All signal training equipments in CITC are of old types. However, these old types are still used on local railway lines. Then CITC should repair these old type training equipments so that they can be used as training equipment.
- The electric switch machine and the track circuit should be installed in CITC as signal practical training equipments. The maintenance of the electric switch machine and the track circuit becomes very important for MR after its modernization. The training of these equipments should be fully provided..
- Many construction laborers are needed for modernization projects of MR by Japanese ODA and Grant aid. CITC is advised to give relevant trainings to these construction laborers.

d) Train Operation

We inspected "CITC", and the comments on points that we are concerned about in comparison with the present conditions of the education institutes of the Japanese railway company are given in Table4-25.

Table4-25 Items should be improved of CITC

	Points which we are concerned about	Comment
1	The area of trainee's desk is small because it is a simple table top mounted on the chair.	In the training center of Japan, the trainee places a textbook, a reference book and a notebook on a desk and while referring to each of them, he listens to the lectures.
2	The inside of the classroom is dark.	The visual information that a person can recognize decreases in the dark. In Japan, necessary illumination corresponding to kinds of work is specified by a law.

	Points which we are concerned about	Comment
3	Most lectures were conducted in classroom style, where the instructor wrote on the blackboard and the trainees took notes.	<p>As for the demerit of the lecture method to write lecture contents on the blackboard, the following is thought about.</p> <ul style="list-style-type: none"> ▪ Loss of the time when a teacher writes them on the blackboard ▪ When letters are small or dirty, trainees are hard to read ▪ Fear of wrong letters or omitted letters <p>In Japan, a teacher often prepares lecture contents in large size characters in advance and displays them in front of trainees in the classroom. The above-mentioned demerits can be canceled by doing so, and efficient and effective lectures become possible.</p>
4	Operating equipment such as signal control panels is prepared but most of them are for display and not used for training.	In Japan, many railway companies install apparatuses handled on-site in the training center and utilize them for handling skill education.
5	All teachers of the skill education are on-site leaders.	Some Japanese railway company educates trainees not only about the knowledge but also about the operation skill in the training center. The trainees can learn knowledge and the operation skill of the constant level by doing so. Further the burden of on-site leaders can be reduced.
6	The passing standards of the knowledge test is more than 50%.	<p>Some Japanese railway company makes passing standard a little more severe for ensuring train operation safety.</p> <p>When a trainee becomes unacceptable in the reexamination, he is made to leave from the training center in consideration of his unfitness.</p>

	Points which we are concerned about	Comment
7	Each on-site leader judges the passing of the operation skill test of the trainees, but there is not the clear passing standard.	Some Japanese railway company establishes the passing standard of the skill test clearly for evaluating a trainee. A fair skill evaluation is made possible by doing so and what parts of a training course a trainee cannot yet understand can be made clear. In addition, the uniform evaluation is possible even if an evaluator is changed.
8	It cannot be said that quantity of the meal is enough.	Some Japanese railway company evaluates meals as very important in developing the health and the energy of the trainees. Therefore the company offers meals to trainees in consideration of a nourishment aspect and quantity.

e) Civil Engineering Structure

- There are no training courses for maintenance of civil engineering structures except bridge. They should be established for maintenance of tunnels, earth structure and other civil engineering structures.
- For the bridge maintenance course, trainees should learn several types of bridges, such as concrete bridge, and steel bridges. But these trainings are not held in any places including CITC, Mahlwagon bridge depot, and the field. These training courses should be held at least in one place.
- In the CITC, there are some track equipments for training. A bridge, “Baily pin” structure, is installed on the practical training line. But this structure is a minor type on operating line of MR. Then it is considered that training using such a type would not be effective. It should be replaced with other ones that are major type of bridges in MR, such as Deck girder.
- It is advised to install necessary equipments for practical training of bridge maintenance in CITC.

4-4-3 Outsourcing of Track Maintenance Work

This was added at R/D signed on 6th April. We held meeting or discussion about outsourcing once a month. Contents are as below.

① **Current Situation in Myanmar Railways**

Survey of outsourcing of track maintenance work in Myanmar Railways

② **Introduce of Japanese experience**

In Japan, the outsourcing of track maintenance has changed. At the same time, organization changes, too. (Ref. next page)

③ **Discussing about outsourcing of track maintenance**

Based on (1) and (2), MR and we share basic stance of outsourcing of track maintenance. .

④ **Mixing opinion of Myanmar and Japan**

MR and we take good opinion for the future.

⑤ **Proposal of procedure of outsourcing track maintenance work by Myanmar style**

Make proposal of procedure of outsourcing track maintenance work for MR.

⑥ **Seminar or presentation by Experts**

We held presentation about track maintenance.

JICA Expert Team made a report and power point about outsourcing of track maintenance. Its outline is as shown in Table4-26.

Table 4-26 Outsourcing of track maintenance outline

1. Background
2. Hearing investigation from Myanmar Railways
3. Precondition toward outsourcing of track maintenance
4. Example of Japan
5. Outsourcing of track maintenance for Myanmar Railways
6. Conclusion

Myanmar Railways has already begun a part of outsourcing. But this outsourcing is different from Japanese transition. In case of MR, one of purpose of outsourcing is fair work because staff have some jobs. At this style, cost will increase and profits will get worse as the company.

In case of Japan, railway companies have tackled with trimming down the organization and leveling work throughout a year at the same time outsourcing. So we must consider cost reduction.

At present, example of Japan may be only reference. In the future, when MR changes to privatization or most important target is to improve profit, we think example of Japanese outsourcing of track maintenance will be helpful. See Attachment 10 “Final Report on the Outsourcing of Track Maintenance Work (p. A-10-1 – p. A-10-20)” for details.

4-4-4 Sanitary system on Rolling Stock

There were many requests from MR about sanitary system on rolling stock. In order to reply the request from MR, JICA Expert Team held a seminar at MR Training Center in nay Pyi Taw on 30th September,2015. Mr. Ishikawa introduced Japanese sanitary system and transition on rolling stock in the morning. He explained each type of sanitary system in detail and had a question and answer session in the afternoon. Many contents were discussed about equipment or cost in the Q and A session. There were many opinions that which type was suitable for MR.



Photo 4-7 Seminar of sanitary system on Rolling Stock

4-4-5 Public Relations (Japan and Myanmar)

In order to emphasize that the project is supported by Japan, we placed the JICA logo on the maintenance tools at the OJT track maintenance work, and hoisted a large signboard indicating an outline of the project near the training site. Members of the JICA Expert Team actively submitted articles to specialty journals and published the contents of the project. In addition, the team accepted interviews with various media outlets, mainly the International Development Journal, during the project period. The results of PR activities for the project are shown on Table 4-28.

Table 4-28: Major publicity results of the project

Date	Type	Name	Comment
February, 2014	Japanese Journal	International Development Journal	OJT track maintenance work
February, 2014	Japanese Journal	Association Journal, Japan Railway Civil Engineering Association	Matsuo
February, 2014	Japanese Journal	Japan Railway Engineer's Association Journal	Takami, Komatsu
June, 2014	Japanese TV	Fuji TV (June 13)	OJT track maintenance work
July, 2014	Japanese Journal	International Development Journal	OJT track maintenance work
September, 2014	Japanese Journal	International Development Journal	Accident analysis, training in Japan (track)
December, 2014	Japanese TV	NHK (December 6)	OJT track maintenance work
December, 2014	Japanese Journal	International Development Journal	Training in Japan (Institutional Management Improvement)
November, 2015	Japanese TV	NHK (November 21)	OJT track maintenance work
January, 2016	Japanese TV	TV Tokyo (January 18)	OJT track maintenance work
January, 2015	Japanese Journal	JREA's English-language journal "Japanese Railway Engineering"	Komatsu, Takami
August, 2015	Japanese Newspaper	Nikkei (August 22)	OJT track maintenance work
September, 2015	Japanese Journal	International Development Journal	maintenance/management training
September, 2015	Japanese Journal	The Japan Railway Civil Engineering Association	Takami
February, 2016	Japanese Journal	Japan Society of Civil Engineers	Matsuo

In addition, the project was reported by the media in both Japan and Myanmar.

Chapter5 Major issues to be tackled with, good schemes for better implementation, lessons obtained through implementation

5-1 Recommendation of Technical Standards Relating to Administrative and Maintenance Aspect and Drawing up Railway Facilities Improvement Plan to Improve Service and Safety Level

To implement the project more effectively, the Counterpart Team and Working Group for Service and Safety Improvement were strengthened by including both the MR experts stationed at Yangon, and those stationed at Nay Pyi Taw as shown in Tables 4.1 and 4.3.

With respect to guidance and familiarization of the technique to analysis the present status and causes of accidents and poor services, the Training program and the Workshop were programmed and implemented as described in the section 5.1.3. Through implementation of the training program and the workshop, the following have been found out to be the items for recommendation.

- Repetition of the training program and the workshop so that MR experts could be more familiarized with the relevant techniques.
- In analyzing the causes of accidents/ low service levels by MR experts, theoretical analysis seems to be insufficient. In this regard, a small research unit consisting of a few selected able experts in the field of track, civil engineering structures, rolling stock and signaling/ telecom is recommended to be established, and these experts should be trained so that they can execute theoretical analysis of the causes of accidents/ low services.
- Strengthening of educational institutes.

In MR, there are currently two educational institutes: RTTC located at Ywataung Locomotive Workshop for upgrading the technical skills of locomotive maintenance staff and CITC belonging to Ministry of Rail Transportation and located at Meiktila for upgrading engineering staff in the fields of track, rolling stock, operation and signaling/ telecom.

The training facilities/ equipments in these Institutes are sometimes out-of-date and insufficient. These Institutes should be modernized to cope with the coming modernization of MR.

With respect to recommendation on Technical Standards of MR relating to administrative and maintenance aspect to improve service level and safety, relevant recommendations were proposed by JICA experts as described. Through the process of proposing these recommendation, the following were found out to be major issues and relevant suggestions.

- Many ones of the current Technical Standards of MR are out of date, not well organized systematically and very simple, They should be updated, systematically organized deleting duplications, and adequately detailed.
- In this regard, technical cooperation for updating and revising Technical Standards of MR could be a meaningful one in the coming years.

With regard to drawing up short-, medium-, and long-term railway facilities improvement plan, it is described.

Through implementation of this activity, the following have been considered to be some meaningful suggestions by JICA Experts.

In view of the budget constraint, in drawing up the plan, railway lines to be improved should be prioritized from the socio-economic and political viewpoints.

Regarding giving priority to the lines from the viewpoint of socio-economy, “The survey program for the national transport development plan in the Republic of the Union of Myanmar” prepared by JICA (June, 2014) should be adequately referred to.

5.2 Technology Transfer of Track Maintenance Technology to Improve the Level of Service and Safety through Implementation of the Pilot Project

By reviewing the approximately two and a half years of track maintenance work with MR, we listed the problems to be solved, improved points, lessons learned, etc. as follows:

- JICA Expert Team prepared various work plans to accommodate the delays in the arrival of the equipment from Japan and provision of facilities (ballast and sleepers) from MR.
- The training site was moved to near Toggyaungglae railway station in order to provide instruction on special sections such as track branch parts, bridges, curves, etc. to the trainees who were replaced every month from May 2014.
- In some cases the work did not proceed as scheduled due to unpunctual train operation. For this reason, we had to work while confirming train delays by communicating with the nearby station.
- It was hard to draw up the work plan while taking into consideration weather conditions such as squalls in the rainy season and sudden temperature rises in the dry season.
- Since there were not enough routes to the work site except the station yard, we drew up the work plan allowing sufficient time because conveying equipment and moving to the work site takes a long time in many places.
- Sometimes, work was interrupted due to unscheduled locomotive switching at the station yard.
- The equipment used for OJT track maintenance tends to wear out as it is used, and there is a high risk of breakdown because MR is not familiar with handling it. Therefore, the JICA Expert Team instructed MR on repair methods using techniques and materials available locally.
- The JICA Expert Team distributed protective equipment such as helmets to all trainees. Some protective shoes broke after one month due to their poor quality and some trainees damaged them due to lack of familiarity. Instruction was given focusing on safety through OJT track maintenance, particularly on the modernization of MR in the future (train speed, traffic frequency and increased train weight).
- MR’s trainees, who handle simple devices such as beaters, etc., are highly skilled because they have performed manual work on the track where trains are passing often.
- JICA Expert Team delivered a set of equipment necessary for minimum track maintenance work such as tie tampers, rail jacks, etc. to each MR district through equipment provision in 2015 for trainees from other districts trained in Yangon, to help them remember what they had learned.
- It is important to maintain railway track by MR continuously providing equipment. MR should reorganize its organization and change awareness of purchasing new equipment.
- · Due to the shortage of workers, currently MR is unable to implement the necessary track maintenance work. The shortage is caused by the rapidly increasing salaries for construction workers

in fields other than railways such as building construction and harsh working conditions for railway workers. Higher wages and better labor conditions would be effective countermeasures, but this is difficult because of insufficient budget of MR. Therefore, MR began to outsource a part of track maintenance work but it is not fully effective and actually increases costs. Without reforming the organization and reviewing operations while outsourcing, there will be no solution. All operations, with the head office as the center, need to be reviewed.

- As for human resource development, it is important to train core engineers (in-house engineers) in MR. This is because MR requires technical skills itself, even if outsourcing gets underway. So, it is important to develop core engineers as a part of the future plan for human resource development. It is also important that the core engineers pass on their skills and knowledge to the next generation of engineers. MR's head office must actively lead the human resource development effort.

5-3 Bridge Maintenance Training

- In order to improve adaptability of technique which JICA Expert Team taught to MR in short training term, 7 number of pilot bridges were selected from those which are typical structural bridges in MR.
- In order to make MR deeply understanding, training curriculum was carried out in the repeated cycle lecture(pre-study) – training (implementation) – lecture (review) for each technology. It was defined that training of Phase1 and 2 are aimed for train basic technology, Phase3 and 4 are done for advanced technology.
- JICA Expert Team understood the current status of bridge maintenance management by MR by locating our base at Mahalwagon Bridge Depot, because it has access to the pilot bridge and much information related to bridge maintenance management.
- In order to keep contact in the term of absence of JICA Expert Team, contact person are chosen from MR trainee and inform the activities to JICA Expert Team weekly.
- The MR bridge maintenance management system is insufficient and is operated by corrective maintenance (scrap and build type). A systematic maintenance management system needs to be built and a standard needs to be formed to improve the current situation. As a first step, we informed MR of the necessity of bridge maintenance management during the project. Namely, the necessity of preventive maintenance and methods (inspection and repair before failure) were instructed repeatedly since faster bridge deterioration associated with the modernization of MR (higher speed, frequent operation and increasing weight of trains) will make it difficult to secure working hours.
- MR is preparing a bridge maintenance management ledger by using a personal computer but lacks the information required for maintenance management. The JICA Expert Team instructed the addition of necessary information based on the above.
- MR wrapped up the contents of the training in the report in Burmese language and submitted it to the vice minister of MORT, to spread what had been learned through the training. MR was able to obtain the budget for implementing the repair method recommended by the JICA Expert Team in Phase 1 in the department and implemented repair construction work. This voluntary assistance by MR enabled training on repair methods to be conducted under the project.
- MR engineers who are engaging in bridge maintenance management are also undertaking

construction/repair work. In addition, they do not receive sufficient training on bridge maintenance management and skills differ greatly among individuals. This situation is similar to that before the modernization of Japan National Railways and the situation of Japan in the 1950s is a useful reference.

- Bridge maintenance management work is not sufficiently implemented since MR engineers who are engaging in bridge maintenance management are also undertaking construction work and there are insufficient workers. In addition, “No particular issues in bridge status” is the goal of maintenance management work, and thus the incentive for operation is falling. GM also understands the problem that inspections are inadequate. It is desirable to modernize the tools for bridge maintenance management and to allocate budget appropriately in order to improve the incentives for bridge maintenance management. Therefore, we tried to improve the incentives for bridge maintenance management by bringing in the necessary basic tools for bridge maintenance work from Japan.

Chapter6 Extent of achievement of target

6-1 Recommendation of Technical Standards Relating to Administrative and Maintenance Aspect and Drawing up Railway Facilities Improvement Plan to Improve Service and Safety Level

This project is the project of technology transfer and consists of two subprojects: namely

- (1) Recommendation of technical standards relating to administrative and maintenance aspect and drawing up railway facilities improvement plan to improve service and safety level
- (2) Technology transfer of track maintenance technology to improve the level of service and safety through implementation of the Pilot Project

In this section, extent of achievement of target of the subproject (1) above will be described.

This subproject consists of the following shown in Table 6-1.

Table 6-1 Contents of Subproject (1)

<ol style="list-style-type: none">1. Preparation of working plan2. Survey of the present status and establishment of an organization to collect information3. Guidance and familiarization of the analyzing technique of the causes of accidents and low service level, and establishment of countermeasures.4. Investigation of customer's Satisfaction Level of MR passenger transport5. Recommendation on technical standards for service and safety6. Drawing up short-, medium-, and long-term railway facilities improvement plans.7. Education/training in Japan

These all items were implemented as scheduled in Table 4-1 in this regard, the target of this subproject can be said to be almost achieved. However it should be noted that complete achievement of technology transfer takes time and needs continuous efforts by MR staff and continuous cooperation between MR staff and Japanese railway experts.

6-2 Technology Transfer of Track Maintenance Technology to Improve the Level of Service and Safety through Implementation of the Pilot Project

In this section, extent of achievement of target of the subproject (2) of 6-1 above will be described. This subproject consists of the following shown in Table 6-2.

Table 6-2 Contents of Subproject (2)

1.	Drawing up a technical transfer plan
2.	Procurement of the required equipment / tools
3.	Selection of Pilot Section
4.	Implementation of track maintenance work (inspection, planning, work, control)
5.	Education/training
6.	Summarization of the points of improvement and reflecting them in the track maintenance manuals/ standards
7.	Final summarization and seminars

(1) Drawing up a Technical Transfer Plan

The Project initially started with the plan to perform technology transfer for track maintenance in the pilot section of 20 km between Yangon and Bago. The plan was significantly changed later following MR's request for training as many people as possible instead of maintaining the 20 km section. Even though the plan was greatly changed, the fact that a total of 574 MR engineers received training has major implications and it is considered that the goal was accomplished.

(2) Procurement of the Required Equipment / Tools

After the equipment was selected initially, it took time for procedures, ordering, etc., and the equipment from Japan arrived about half a year after the project commenced. The equipment was immediately used in the training thereafter. Ordering and procedures for additional equipment after extension of the time for completion arrived in Myanmar as scheduled and the equipment was delivered to the Myanmar side. Accordingly, it is considered that the goal was accomplished.

(3) Selection of Pilot Section

Written in (1) (The concept of the pilot section was dropped, and the target was changed to the number of people.)

(4) Implementation of Track Maintenance Work (Inspection, Planning, Work, Control)

Track maintenance work accounted for a large part of the project; it took about two and a half years and produced significant results. It is considered that the goal was accomplished sufficiently.

(5) Education/ Training

Training on track maintenance in Japan was implemented twice and a total of 22 people were dispatched.

(6) Summarization of the Points of Improvement and Reflecting them in the Track Maintenance Manuals/ Standards

Technical transfer of track maintenance work was implemented by using Myanmar's materials before the materials arrived from Japan. The current status and problems of track maintenance work in Myanmar

were clarified, and reflected in later work by adding them to the Work Manual (based on the Japanese work standard). The manual is very effective because it is distributed to the whole of Myanmar.

(7) Final Summarization and Seminars

The final seminar was held at Nay Pyi Taw and Yangon after the completion of the final JCC.

These all items were implemented as scheduled in Table 4-7. In this regard, the target of this subproject can be said to be almost achieved. At first, pilot section was preceded others. But we changed plan and it was big effect to educate staffs belonging to all divisions in MR. Upgrading of track maintenance in all divisions was planned by this. In the beginning, there was no plan of test running. But we conducted test running and could educate how to increase speed safely against speed up in the future to Myanmar Railways. We think that our project contributed big effect of safety and service.

6-3 Bridge Maintenance Training

Bridge maintenance training has been carried out through the implementation Phase 1 to Phase 4 in form July to November 2016. Hereby, it is thought that the item described on MOM, to conduct lecture(s) in Myanmar on outline of maintenance of bridges, had been completed and the expected output of this training approved on 7th JCC, technical capability is improved through bridge maintenance to improve the level of service and safety, had been achieved. MR had thought that bridge maintenance management and continued usage was not needed after construction until something broke, but this training showed MR engineers the necessity of bridge maintenance management. Better performance than initially expected was accomplished since repair techniques could be taught in the bridge maintenance management training in addition to inspection techniques thanks to voluntary assistance by MR. Other accomplishments are as follows:

- MR trainees had insufficient skills in bridge maintenance management but can now conduct inspections by themselves thanks to this training.
- Although MR had records related to bridge maintenance management, the pattern and entry items were not unified and differences among individuals were large. However, the trainees understood the items that must be recorded for maintenance management and could create effective records following this training.
- MR trainees were able to identify the points to be observed for maintenance management on each bridge (limited to those bridges having the same structure as the one covered by this training).
- MR trainees learned quantitative bridge maintenance management techniques such as fatigue analysis, and calculation of existing stress ratio of steel structures by using necessary devices (limited to those bridges having the same structure as the one covered by this training).
- MR trainees understood the contents of this training, reflecting the actual condition of MR, and prepared a manual in the Burmese language to spread the contents of the training to other bridge maintenance management engineers.
- MR trainees learned new repair methods through the training with the JICA Expert Team, although it is limited to the techniques provided by this training.

Chapter7 Recommendation Addressed to Achievement of Overall Goal

7-1 Recommendation of Technical Standards Relating to Administrative and Maintenance Aspect and Drawing up Railway Facilities Improvement Plan to Improve Service and Safety Level

The following are the items, the pursuit of the implementation of which will contribute to further upgrading the safety and service level of MR.

- Repetition of the training program and workshop similar to those provided by the Project, to further promote the relevant technology transfer
- Updating and revising the current Technical Standards so as to match the technical development and modernization of MR.
- .Modernization of Training Institutes, RTTC and CITC, with respect to training facilities/equipments, curriculum etc.
- Establishment of a research unit by which fundamental theoretical analysis of track structure, and rolling stock such as calculation of stress, deformation, vibration, and fundamental measurements of technical data such as vibration, stress, deformation, relevant forces, temperature are implemented.
- Establishing the priority of each railway line from the socio-economic point of views, with due consideration on the recommendation of “The survey program for the national transport development plan in the Republic of the Union of Myanmar” prepared by JICA (June 2014), and implementing the modernization of each line step by step based on the established priorities.

So it is hoped that MR staff try to continue expanding and deepening the relevant knowledge and experiences of Japanese railways introduced by JICA experts in this sub project.

Further it is hoped that technical cooperation between MR staff and Japanese railways experts will be continued through the projects of modernization of Yangon- Mandalay line and Yangon circular line, etc. and taking advantage of the opportunity of these cooperation, technology transfer of this subproject should be further deepened and promoted.

7-2 Technology Transfer of Track Maintenance Technology to Improve the Level of Service and Safety through Implementation of the Pilot Project

The following are the items, the pursuit of the implementation of which will contribute to further upgrading the safety and service level of MR.

- We supplied additional equipment. We decided number of equipment to distribute to all divisions. Especially, tie tamper and rail jack are frequently used and they are important for track maintenance. All trainees went back to their hometown. We think that track condition will be improved if they use additional equipment and implement track maintenance certainly.
- It is important that staffs who didn't receive workshop and new employees should be taught by trainees who received workshop. To tell and pass technique to the next generation are very important through training center and training on site in Myanma Railways.
- Myanma railways is proceeding outsourcing of track maintenance partly. If outsourcing is proceeding, it is important to keep resources who are well known track maintenance in Myanma Railways. They are what is called in-house engineer. Safety and service level will be kept by them.
- Unlike construction work and improvement work, track maintenance management cannot identify if a certain period of time has passed. For this reason, it is necessary to follow up for a certain period of time after the project is completed to ensure that the techniques transferred by this project are utilized at a more senior level.
- The track maintenance techniques of MR are similar to those of Japan in the late 1960s. Meanwhile, steps need to be taken to transfer technology (basic knowledge and theory) since MR is requesting 21st-century track maintenance techniques which are two generations ahead. Accordingly, the project involved training fresh recruits, but it is

necessary to give additional training after selecting which system, techniques and skills should be instructed.

- Whether based on modernization measures in the future or not, MR asked many questions regarding speed improvement and expressed a strong interest. Considerable training would be needed to raise the speed (60 km/h) confirmed in the running test of this project. Specifically, it is necessary to provide training on track theory and structures to ensure safety and ride quality in case of higher speeds (compared to existing techniques of India), structure and maintenance methods for track branch parts, speeding up and improvement of curves, maintenance system (existing system acceptable, what should be improved, actual methods), and track management after speeding up (method, procedures, inspection, equipment used, and concepts of track maintenance work).
- The project mainly focused on training fresh recruits, and the basic technology of track engineering was transferred. However, the training should be given to track engineers who have a great deal of experience, proper skills and theory, and who can understand the superiority compared with other countries, to achieve the above-mentioned goal of MR.

We have educated total 574 trainees in this project. Myanmar Railway will conduct big scale improvement project such as 7-1. They will play very important role on site. They need to devote themselves to their studies and new technique which will introduce to Myanmar Railways.

7-3 Bridge Maintenance Training

The following are the items, the pursuit of the implementation of which will contribute to further upgrading the safety and service level of MR.

(1) MR Should Grasp the Present Situation of All Bridges and Priority Level of Repairing by Following Ways to Know the Total Amount of Necessary Bridge Repairing.

- MR should inspect bridges and judge its soundness in the suitable inspection cycle.
- Bridge Inspector and Work Inspector should instruct Permanent Way Inspector for implementing suitable bridge inspection.
- Priority level should be done considering its cause of deterioration, counter measure, soundness, and grade of track (section).

(2) Necessary Budgeting for Repairing

- Making year on year repairing plans for high prioritized bridges to ensure train safety, and budgeting them
- Most authorities excepted civil department recognizes that bridge is no necessary of maintenance, bridge engineer should explain the necessity of bridge maintenance showing the result of inspection.

(3) Modernization of Necessary Equipment and Tools

- Because of man powered work, the fastened bolts had loosened after 2 months since repaired in this training. For improving repairing work, following equipment and tools should be prepared.
- Hi-tension bolt, stress measurement machine, displacement measurement machine, strain gauge, bolt fastening machine, grinder, drilling machine for steel girder, impact test equipment, inspection ladder for site, and vehicle with lift.

(4) Strengthen the Maintenance for Short Bridges which Span are Under 60ft

- Once bridges under 60ft are deteriorated condition which threat train safety, MR would replace the old bridge to new one. So far, only under the present train operation, it is easy to make working time to replace. However, after modernization of MR, increasing speed

and number of train, and of repairing necessary bridges, it would be hard to make working time.

- Deteriorated bridges under 60ft should not be only replaced, but repaired partially to make bridge life longer.
- Repairing partially, it would do effect budget, such as budget for replacing one bridges can repair 10 bridges.

(5) Improving Disaster Prevention Work

- Most of MR bridges are threatened by salt damage, water way, scouring, and increasing live load effect and so on. To prevent train operation from these disasters, it should be done disaster prevention work after grasping priority level.
- MR should make effort to continue talking with Administrative authority of river to prevent water way disaster.
- MR should grasping the changing of surrounding environment of water way by comprehensive inspection.

(6) Improvement of Technology of Supervisor, Skill Worker, and General Worker

- In this training is aimed to train the engineer whose position title is over than inspector class. However, Because of secondary deterioration on where MR repaired in this training, It should be improved the technology level of supervisor, skill worker, and general worker that are working on site mainly.
- MR should modernize equipment and tools, and make effort to train these class engineers.

(7) Others

- Improve technical skills of MR through continuous technical training and technological exchange.
- Perform streamlining of the technical standard group (streamlining of design and maintenance management standards and preparation of a handbook for maintenance/repair).

After words

As stipulated in R/D, the Project consists of two components:

- (1) Based on accident and low service level analysis, recommendation on technical standards relating to administrative and maintenance aspect and drawing up railway facilities improvement plan to improve service and safety level
- (2) Technology transfer of track maintenance technology to improve the level of service and safety through implementation of the Pilot Project

We would like to express our sincere thanks to MR for their kind and earnest cooperation for execution of the Project, and sincerely hope that the execution of the Project has contributed to the improvement of safety and service level of MR.

March, 2016

Leader of JICA Expert Team

Nobuyuki MATSUO

Appendix

1. PDM (Project Design Matrix).....	A-1-1
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10. About outsourcing of track maintenance Final Report.....	A-10-1

Appendix-1 PDM

1.1 Latest version

The original PDM is given as Annex 1 of Record of Discussion (R/D) signed on March 25, 2013 between the Managing Director of MR and General Manager of JICA Office in Myanmar.

It was modified two times. One is as given in Table 6.1 of Chapter 6 of the Inception Report, which is shown in 1.2. And the other is shown in 1.3

1.2 Essence of 1st modification of original PDM in Inception Report

Essence of modification is given in below.

Mainly the description of 「Objectively Verifiable Indicators」 and 「Means of Verification」 corresponding to 「Overall Goal」 and 「Project Purpose」 are modified. The modified descriptions are shown in Table 6-1. The reasons for modification are given as follows.

(1) Overall Goal : Objectively Verifiable Indicators

① Number of annual accidents

Because (a) the Pilot Section is rather short, only 20km, accordingly rehabilitation of track is limited in length, (b) the rehabilitation/modernization of various railway facilities on the Yangon-Mandalay line is not made clear, accordingly it may be difficult to show how much the accidents caused by the deteriorated railway facilities can be reduced, and (c) number of accidents fluctuates considerably year to year mainly due to weather conditions, quantitative expression for reduction of accidents is avoided.

② 「Reduction of Number of Limited Speed Locations」, 「Improvement of Journey Speed」, 「Improvement of Punctuality of Train Operation」

Without the modernization of signaling systems, it may be difficult to raise the train speed, while ensuring the train operation safety. Accordingly 「Reduction of Number of Limited Speed Locations」, 「Improvement of Journey Speed」, and 「Improvement of Punctuality of Train Operation」 are adopted as evaluation items, and also quantitative expressions are avoided.

(2) 「Overall Goal : Means of Verification」,

「Project purpose : Objectively Verifiable Indicators」, 「Project Purpose : Means of Verification」

The meanings are not changed, but the description is modified as given in Table 6-1.

(3) Others : Counterpart Training in Japan

Number of trainees is increased.

- Railway Institutional Management Improvement : 11persons × 2weeks
- Track Maintenance : 11persons × 2 × 2weeks

Table 6-1 Modification of PDM (Inception Report)			
Project Design Matrix		Annex 1 PDM	
The Project on Improvement of Service and Safety of Railway		Project Implementation Period : 2013 to 2015	
Excuting Agency:Myanma Railway(MR) ,Ministry of Rail Transportation		Project Site: Yangon	(24months)
Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Service and safety level of Myanma Railways is improved.	①Number of annual accidents on Yangon-Mandalay line decreases compared with the present and past records. ②Number of speed restricted locations on Yangon-Mandalay line decreases compared with their present number. ③Journey speed on Yangon-Mandalay line increases compared with the present journey speed. ④Punctuality of express passenger trains on Yangon-Mandalay line is improved compared with the present situation. ⑤Satisfaction level of clients is enhanced. ⑥Number of passenger	-Statistics on safety -Reporting of accidents cause analysis and discussion of countermeasures are executed. -Statistics on operation -Interview/questionnaires to clients -Statistics on operation	
Project Purpose Administration and maintenance ability is improved for the enhancement of service and safety of Myanma Railways.	①Accident cause analysis and countermeasures to prevent the similar accidents, and means to improve service levels are established and executed ,and inherited by MR ②Administrative and managerial capacity of track maintenance is improved and improved level is kept by MR	-Reflection on organization,management/ operation rules,facilities renewal plans -Utilization,modification of administration management manuals -Actual results of maintenance execution, such as the record of maintenance	-Administration staff members are not relocated drastically -Technical staff members are not relocated drastically
Output			
1. Issues are clarified for the enhancement of service and safety in the administration and maintenance process, and the improvement plan is drawn.	1-1 System for collecting information of track, rolling stock, signal and communication, and operation is established. 1-2 Safety issues are listed based on the investigation and analysis of cause of accident. 1-3 Service issues are listed. 1-4 Service and safety improvement plan is drawn so as to tackle the issues.	1-1 Related management document(s) of System for collecting information 1-2 Listed issues 1-3 Listed issues 1-4 Service and safety improvement plan	-The Government support to the Myanma Railways, especially financial support is secured.
2. Technical capability is improved through emergency track maintenance to improve the level of service and safety.	2-1 Technical transfers are made effectively at each measure (targeted numbers of technical staff 30 persons). 2-2 Working manual of emergency track maintenance is prepared. 2-3 Proper equipment and materials are procured both qualitatively and quantitatively. 2-4 Counterpart personnel acquired necessary proficiency through seminars(3 times), trainings(3 times) for technical improvement on the rail maintenance and others.	2-1 Record of technical transfers 2-2 Set of Working manual 2-3 Inventory list of equipment and materials 2-4 Record of seminar and training	

Table 6-1 (continued) (Inception Report)

Annex 1

Activities	Input		Preconditions
	(Japanese side)	(Myanmar side)	
<p>1. Preparation of Railway Service and Safety Improvement Plan</p> <p>1-1 To conduct current situation survey regarding track, rolling stock, signal and communication, and operation, and establish system for collecting information.</p> <p>1-2 To promote familiarization on the investigation and analysis method of accident cause based on the comprehensive factors of track, rolling stock, signal and communication, and operation.</p> <p>1-3 To conduct the investigation and analysis mentioned above.</p> <p>1-4 To provide recommendation based on above analysis on necessary technical standards to improve service and safety level.</p> <p>1-5 To draw the improvement plan of railway facilities through discussion with the "Working Group for service and safety improvement(tentative name) "</p>	<p>1. Dispatch of Japanese Experts</p> <p>Fields of Experts(several person)</p> <p>-Railway OM improvement</p> <p>-Technical Standards</p> <p>-Track Maintenance</p> <p>-Procurement of Equipment and Materials/Project Coordination</p> <p>2.Counterpart training in Japan</p> <p>-Railway Institutional Management Improvement: 11person × 2weeks</p> <p>-Track Maintenance: 22person (11p × 2 × 2weeks)</p> <p>3.Equipment</p> <p>Necessary handy equipment of emergency track maintenance, such as Tie Tamper.</p> <p>4.Expense</p> <p>-For research, travelling, training, the other activities for Japanese experts</p>	<p>1. Assignment of Counterpart</p> <p>-Project Director: 1person</p> <p>-Project Manager: 1person</p> <p>-Railway Polocy/OM Improvement: 1person</p> <p>-Rail Maintenance: 1person</p> <p>-Procurement of Equipment and Materials: 1person</p> <p>-Others: As appropriate</p> <p>2.Provision of facilities for the Project implementation:</p> <p>-Project office (in the Myanmar Railways, Lower Myanma Regional Office)</p> <p>-Working tools and furniture for Project Office</p> <p>-Internet connection in the Project office</p> <p>3.Joint Coordination Committee(JCC)</p> <p>-Establishment of JCC</p> <p>4. Expense</p> <p>-Local cost for personnel</p> <p>-Cost for office rent and quipment.</p> <p>-Expense for the pilot project,such as gravels,sleepers,rail materials and others.</p> <p>-Other expenses: For research,travelling,training,the other activities for counterpart personnel</p> <p>5.Others</p> <p>-Status guarantees of Japanese experts, ID card for access into the Myanma Railways properties.</p> <p>-Access to the necessary statistical data and related information</p> <p>-Other necessary local cost</p>	<p>Natural Disaster does not hit the railway facilities fatally.</p>
<p>2. Enhancement of Technical Capabilities of Track Maintenance</p> <p>2-1 To draw the technology transfer plan.</p> <p>2-2 To procure the necessary equipment and materials.</p> <p>2-3 To conduct emergency track maintenance.</p> <p>2-4 To summarize betterment point(s) obtained during emergency track maintenance operation, and to feedback to the successive measures.</p> <p>2-5 To draw the working manual of emergency track maintenance.</p> <p>2-6 To conduct seminars, trainings for technical improvement on the rail maintenance and others.</p>			

1.3 2nd modification of PDM in final JCC

After terminating this project, this project effect will have been to be evaluated in some years later. For evaluating this project effect, over goal's objectively verifiable indicators should be few items.

There were 6 indicators in over goal's objectively verifiable indicators. Then, JICA Expert Team and MR discussed for reviewing the PDM to expecting most effectively and efficiently capture project performance in Final JCC. As a result, PDM has been summarized as below table and the number has been changed 6 to 3 numbers. The 3 indicators are as below.

- Number of annual accidents on Yangon-Mandalay line decreases compared with the present and past records
- Journey speed on Yangon-Mandalay line increases compared with the present journey speed
- Punctuality of express passenger trains on Yangon-Mandalay line is improved compared with the present situation

Table A-1-1 Summary of PDM Modification

Narrative Summary	Objectively Verifiable Indicators		
	PDM _{ver1}	PDM _{ver2}	PDM _e
	R/D (March 2013)	Inception Report (August 2013)	Final JCC (January 2016)
Overall Goal			
Service and safety level of Myanmar Railways is improved	① Number of annual accidents on Yangon-Mandalay line decreased 20% from 2011-2012's 118 cases	① Number of annual accidents on Yangon-Mandalay line decreases compared with the present and past records	[no change]
	② Average sanction speed on Yangon-Mandalay line increased 10% from 2011-2012 average (number of 2011-2012 average sanction speed to be set later)	② Number of speed restricted locations on Yangon-Mandalay line decreases compared with their present number	[dropped]
		③ Journey speed on Yangon-Mandalay line increases compared with the present journey speed	[no change]
		④ Punctuality of express passenger trains on Yangon-Mandalay line is improved compared with the present situation	[no change]
	③ Satisfaction level of clients is enhanced	⑤ Satisfaction level of clients is enhanced	[dropped]
		⑥ Number of passenger	[dropped]

Appendix-2 Flow Chart of Project Implementation

As shown in Fig.2.1 of the main text.

Appendix-3 Detailed Implementation Plan

As shown in Paragraph 4-1-1, and Paragraph 4-2-1 of the main text.

Appendix-5 Records of Training in Japan

1. Railway Institutional Management

It is reported in the section 4-1-6 of this report, and its detail is reported in Appendix-3 of 5th JCC's Project Progress Report.

2. Track Maintenance

It is reported in the section 4-2-6 of this report, and its detail is reported in Appendix-3 of 4th JCC's Project Progress Report.

* All JCC report is attached as appendix-8 in this report.

Appendix-6 Records of Procurement of required equipment/tools

As shown in Paragraph 4-2-2 of the main text.

These equipment and tools were donated to MR with attached letters.



Ref. No. : JICA (MY) 2-10006

Date : 10 February 2016

Mr. Nobuyuki MATSUO
Leader
JICA Expert Team

Subject: Acknowledgement for receipt of two letters from Myanmar Railways on Delivery Certificate for the equipment supplied under the "Project on Improvement of Service and Safety of Railway in Myanmar"

Dear Mr. Nobuyuki MATSUO,

First and foremost, I would like to express my sincere appreciation to you and your team for your kind cooperation and support rendered to the "Project on Improvement of Service and Safety of Railway in Myanmar".

With reference to your letter dated February 5th, 2016, I would like to acknowledge for receipt of two letters from Myanmar Railways with Reference **Letter No. 005-Planning 2015 dated 1 June 2015** and **No. 005-Planning/2015 dated 29 January 2015**.

Yours sincerely,

Keiichiro NAKAZAWA
Chief Representative
JICA Myanmar Office

■ JICA Expert Team

No. 348, Corner of Merchant St., & Theinbyu St.,
Lower Myanmar Administrative Office,
Myanmar Railways Botahtaung Township, Yangon, Myanmar
Tel: +95-1-298630

Date. 5th February, 2016

Keiichiro NAKAZAWA
Chief Representative
Japan International Cooperation Agency
Myanmar Office

Subject: Delivery Certificate for the equipment Supplied under The Project on Improvement of
Service and Safety of Railway in Myanmar

Dear Sir,

We would like to express our appreciation to Japan International Cooperation Agency (JICA) for
the Project on Improvement of Service and Safety of Railway in Myanmar.


In this project, we had handed over properly equipment to Myanma Railways. We hereby would
like to submit (2) letters of delivery certificate from Myanma Railways as attached to JICA
Myanmar Office.(2) letters are No.005-Planning-2015 (1st June,2015) and No.005-Planning/2015
(29th January, 2016) .

I would like you to arrange "Receive letter" for our team.

We will be happy if I could receive a letter from you for the confirmation of receiving the (2) letters
from Myanma Railways

Thank you so much for your kindly cooperation.

Sincerely yours,



Nobuyuki MATSUO
Leader
JICA Expert Team



THE REPUBLIC OF THE UNION OF MYANMAR
MINISTRY OF RAIL TRANSPORTATION
MYANMA RAILWAYS
NAYPYITAW

TELEPHONE - **067 - 77000**

FAX NO. - **067 - 77016**

No. 005 – Planning - 2015

Date. 1st June, 2015

To

JICA Expert Team for

The Project on Improvement of Service and Safety of Railway in Myanmar

Address: No.348, Corner of Merchant St., and Theinbyu St.,
Lower Myanmar Administrative Office, Myanma Railways,
Botahtaung Township, Yangon Myanmar.

Office Tel: +95 – 1 – 298630

Attn: Mr. Hiroshi KOMATSU, Railway Administration and Management Expert

Subject; **Delivery Certificate for the Equipment Supplied under The Project on Improvement of Service and Safety of Railway in Myanmar**

Dear Sirs,

With regard to the captioned subject, we, Myanma Railways, hereby confirm the completion of the delivery of the Equipment listed in the attachment 1, which is supplied under the Project on Improvement of Service and Safety of Railway in Myanmar.

With Best Regards,

for Managing Director

Aung Win

General Manager (Technical & Admin)

Myanma Railways

Attachment 1: Equipment List
for the Project on Improvement of Service and Safety of Railway in Myanmar

No.	Item No.	Item name	Total supplied
1	1	Rail joint expandor	1
2	2	Sleeper replacing machine	1
3	3	Gas cutting machine	2
4	4	Rail lifting machine	3
5	5	Track master	1
6	6	Measuring instrument for train swing	1
7	7	Swager for back bolt	1
8	8	Analog standard gauge	5
9	9	Instrument detection for track	5
10	10	Measuring instrument for rail wearing depth	2
11	11	Gap gauge	5
12	12	Taper gauge	5
13	13	Thermometer for rail	5
14	14	Squar for rail	5
15	15	Cloth measuring tape (30M)	5
16	16	Steel measuring tape (30M)	5
17	17	Squar	5
18	18	Slate pencil, Chalk	4
19	19	Tie tamper	1
20	20	Beater	18
21	21	Shovel	18
22	22	Bar	35
23	23	Spike hammer	13
24	24	Panpuller	18
25	25	Jack for rail	40
26	26	Equipment for ballast tamping	5
27	27	Generator	1
28	28	Generator	5
29	29	Shovel	9
30	30	Dump Shovel	9
31	31	Shovel with blade divided into multiple	9
32	32	Hoe with blade like nail of wild goose	9
33	33	Hand screen	15
34	34	Hoe with blade of traiangle	9
35	35	Wooden maul	9
36	36	Basket made by bamboo or plastic	9
37	37	Jack traverser	10
38	38	Rail sawing machine	3
39	39-1	Rail boring machine	3
40	39-2	Core cutter	10
41	40	Rail bending machine	1
42	41	Rail carrying machine	9
43	42	Rail carrying tongs	9

No.	Item No.	Item name	Total supplied
44	43	Shovel (Square)	18
45		Shovel (Round)	
46	44	Single open ended spanner (41 size)	9
47	45	Chisel	5
48	46	Rail fork	5
49	47	Disc grinder	5
50	48	Power wrench	5
51	49	Low joint maintenance machine	1
52	50	Spanner for joint bolt 41 size	9
53	51	Rail grinding machine	1
54	52	Hydraulic lining machine	5
55	53	Low roller	7
56	54	Chisel with handle	3
57	55	Spanner for bed plate /rail brace	7
58	56	Adz	9
59	57	Hand hammer	9
60	58	Spanner for huck bolt (30 size) 30size	9
61	59	Engine drilling machine	13
62	60	Drill 22 mm	13
63	61	Gouge	9
64	62	Electric saw	5
65	63	Boring machine	3
66	64	Sleeper carrying tongs	9
67	65	Pad remover	9
68	66	Light track trolley	5
69	67	Spanner	2
70	68	Track Jack	9
71	69-1	Brush cutter	4
72	69-2	Chip cutter for brush cutter	4
73	70	Low elasticity pad	20
74	71	Track Shim	20
75	72	Huck bolt	40



THE REPUBLIC OF THE UNION OF MYANMAR
MINISTRY OF RAIL TRANSPORTATION
MYANMA RAILWAYS
NAYPYITAW

TELEPHONE - 067 - 77000

FAX NO. - 067 - 77016

NO. 005-Planning/2015

Date : 29 January, 2016

To

JICA Expert Team for
The Project on Improvement of Service and Safety of Railway in Myanmar
Address: No. 348, Corner of Merchant St., and Theinbyu St.,
Lower Myanmar Administrative Office, Myanma Railways,
Botahtaung Township, Yangon, Myanmar
Office Tel: +95-1-298630

Attention: Mr. Hiroshi KOMATSU, Railway Administration and Management Expert

Subject: Delivery Certificate for the Equipment Supplied under The Project on Improvement
of Service and Safety of Railway in Myanmar

Dear Sirs,

With regard to the captioned subject, we, Myanma Railways, hereby confirm the completion of the delivery of the Equipment listed in the attachment 1, which is supplied under the Project on Improvement of Service of Railway in Myanmar.

With Best Regards,

for Managing Director
Aung Win
General Manager (Technical & Admin)
Myanma Railways

Attachment 1: Equipment List

For the Project on Improvement of Service and Safety of Railway in Myanmar

No.	Item Name	Total supplied
1	Analog standard gauge G=1000	8
2	Instrument detection for track	8
3	Tie tamper	8
4	Generator	8
5	Equipment for ballast tamping	8
6	Basket made by bamboo or plastic	40
7	Light track trolley 1ton G=1000	8
8	Rail lifting machine	10
9	Jack for rail	48

Appendix-7 Minutes of Discussion of whole JCC

- Appendix-7-1

Minutes of Discussion 1st JCC for “The Project on Improvement of Service and Safety of Railway in Myanmar,

- Appendix-7-2

Minutes of Discussion 2nd JCC for “The Project on Improvement of Service and Safety of Railway in Myanmar, 5th March, 2014

- Appendix-7-3

Minutes of Discussion 3rd JCC for “The Project on Improvement of Service and Safety of Railway in Myanmar, 3rd June, 2014

- Appendix-7-4

Minutes of Discussion 4th JCC for “The Project on Improvement of Service and Safety of Railway in Myanmar, 2nd October, 2014

- Appendix-7-5

Minutes of Discussion 5th JCC for “The Project on Improvement of Service and Safety of Railway in Myanmar, 24th December, 2014

- Appendix-7-6

Minutes of Discussion 6th JCC for “The Project on Improvement of Service and Safety of Railway in Myanmar, 6th March, 2015

- Appendix-7-7

Minutes of Discussion 7th JCC for “The Project on Improvement of Service and Safety of Railway in Myanmar, 17th July, 2015

- Appendix-7-8

Minutes of Discussion 8th JCC for “The Project on Improvement of Service and Safety of Railway in Myanmar, 29th October, 2015

- Appendix-7-9

Minutes of Discussion 9th JCC for “The Project on Improvement of Service and Safety of Railway in Myanmar, 29th January, 2016

Minutes of Discussion

1st JCC for " The Project on Improvement of Service and Safety of Railway in Myanmar"

- 1. DATE** 28 August, 2013 10:00am~12:00am
- 2. PLACE** Meeting Room of Myanmar Railway Head Quarter
- 3. ATTENDANTS**

3.1 Myanmar side

Myanmar Railways

GM (Inspection)	Mr. Ba Myint
GM (Operating)	Mr. Myint Wai
Deputy GM (Mechanical)	Mr. Thet Lwin
Deputy GM (Goods)	Mr. Thura Aung Myo Myint
Deputy GM (Civil)	Mr. Maung Maung Thwin
Deputy GM (Planning)	Mr. Htaung Sian Kan

3.2 Japan side

JICA Transportation and ICT Division 1

Transportation and ICT Group

Economic Infrastructure Department Mr. K. Imia (Adviser), Mr. T. Chokki

JICA Southeast Asia Division 4

Southeast Asia and Pacific Department Mr. T. Kon (Adviser), Mr. A. Fukuyama

JICA Myanmar-Office Mr. M. Morikawa (Project Formulation Adviser)

JICA Expert Team Dr. S. Kuroda (Leader: Track maintenance),

Mr. N. Matsuo (Sub-leader: Maintenance Planning),

Mr. H. Komatsu (Operation maintenance),

Mr. Y. Taniguchi (Procurement of equipment and material),

Mr. K. Miyamoto (Track maintenance 2),

Mr. Ishikawa (Rolling Stock),

Mr. H. Igarashi (Train Operation),

Mr. M. Takami (Coordination),

JICA Railway management

Adviser Mr. M. Higashi

Observer JICA Study Team (MYT-PLAN) Mr. J. Shibata (Project Manager),

Mr. I. Numata (Train Operation)

Sumitomo Corporation Asia Pte. Ltd. Nay Pyi Taw Office

Mr. M. Yamato (General Manager)

Interpreter

Mr. Ye Tun Oo

- 4. SUBJECT** Explanation and Discussion of Inception Report(IC/R)
- 5. HANDOUTS** Inception Report(IC/R)
Power Point document for explaining Inception Report
Three kinds of letters
- JICA Expert Team Schedule until October
 - Selection of the Pilot Section
 - Additional Questionnaire
- List of members of JICA Expert Team with face photos

6. GREETINGS BY JICA

Before the start of explanation and discussion of IC/R, Mr.Chokki of JICA Headquarters gave an opening address and at the same time delivered the following comment and request for the Project.

- (1). This Project is not a Yen loan project, but a technical cooperation project aiming at technology transfer.
- (2). We should be grateful, if MR could kindly arrange smooth import of related equipments/tools from Japan, and prepare track materials such as rail, ballast etc., necessary for track maintenance OJT in proper timing.

7. MAJOR SUBJECTS

7.1 Presentation of IC/R

IC/R was presented and explained by Dr.Kuroda, leader of JICA Expert Team, and it was accepted by MR in principle.

7.2 The following three letters were explained by Dr.Kuroda.

- (1) The letter proposing the Pilot Section and requesting confirmation of it by MR
- (2) The letter describing the working schedule of JICA experts in August, September and October and requesting the arrangements necessary for JICA experts activities.
- (3) The letter requesting provision of relevant information requested by the additional Questionnaire.

7.3 Major Points of discussion

- (1) MR : ① MR will be responsible for clearance of necessary equipments/tools to be provided by Japan side for the Project.
- : ② MR has already prepared necessary track materials to be used for on-the-job training of track maintenance. JICA experts should make checking the ballast whether right size or not before start the project.
- : ③ Working schedule of JICA experts in August, September and October has already been confirmed. MR will suitably deal with it.
- (2) MR : When was the vibration of vehicle running on the proposed Pilot Section measured?
- JICA Expert : It was measured in March, 2013.

MR : In the period from March to August, any specific renewal work has not been executed, accordingly the measurement in March does not raise any specific problems.

- (3) MR: JICA Expert Team is proposing the Pilot Section, and is requesting MR to confirm the proposal. Are there any possibilities to modify the proposal?

JICA Expert: Pilot Section is selected with due consideration on the kinds of track maintenance work technology to be transferred to MR staff. Difference of opinions between MR and JICA Expert Team, if any, can be adjusted in the first week of September, during which preparatory work such as driving in the posts is carried out.

MR: We would like to have the discussion in the first week of September on the location of the Pilot Section. JICA experts and MR staff will survey the proposed Pilot section together using the rail car.

JICA Expert: At that time, please check the size of ballast.

JICA Expert: Please provide us with the specification of ballast.

MR: We will do.

(4) MR: Does proposed Pilot Section include both the up line and the down line?

JICA Expert: It includes both lines.

(5) MR: How many trainees will be involved in job training of pilot project?

JICA Expert: Members of gangs are planned to be trained:

Number of trainees will be about 30. With respect to details, we would like to discuss with MR. We are also planning to make use of the training center of MR.

(6) MR: Is welding work technology included in the kinds of maintenance work to be transferred to MR staff? We would like to get training of welding technology.

JICA Expert: Yes, it is included. Thermit welding is used by MR, so if the quality of Thermit welding used by MR has some problems, we will investigate the problems and make recommendations.

(7) MR: In the period of 1st week of September during which discussion on the location of the Pilot Section will be held, we would like to request JICA experts to examine the equipments/tools possessed by MR gangs.

JICA Expert: Yes, we do. As one countermeasure to improve rail joint portion, we would like to propose one design of fishplate of rail joint.

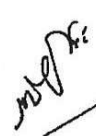
(8) MR: With respect to equipments/tools to be imported from Japan, tax and import license fee exemptions can be assured. Schedule of technology transfer of track maintenance has already been informed to the relevant track maintenance organizations. The answers to the Additional Questionnaire are being prepared and will be completed soon.

(9) MR: Which rail will be used in the pilot project, new or existing rails?


JICA Expert: It will be confirmed while implement the project.

Sept 5, 2013

Nay Pyi Taw



U Thurein Win
Managing Director
Myanma Railways



Dr. S. Kuroda
Leader of JICA Expert Team

Minutes of Discussion

2nd JCC for "The Project on Improvement of Service and Safety of Railway in Myanmar"

1. DATE 27 February, 2014 10:00~12:30am
2. PLACE Meeting Room of Myanmar Railways Headquarters
3. ATTENDANTS
- 3.1 Myanmar side
- | | |
|--|--------------------|
| Managing Director | U.Thurein Win |
| General Manager(Technical&Admin.Support) | U.Saw Valentine |
| General Manager(Civil) | U.Tin Soe |
| General Manager(Mechanical and Electrical) | U.Aung Win |
| Deputy General Manager(Planning) | U.Htaung Shan Khan |
| Deputy General Manager(Civil) | U.Than Htay |
| Deputy General Manager(Finance) | Daw.Thi Thi Nwe |
| Railway Policy Advisor | Mr.M.Higashi |
- 3.2 Japan side
- JICA Transportation and ICT Division 1
Transportation and ICT group
Economic Infrastructure Department Mr.T.Chokki
- JICA Expert Team Dr. S.Kuroda(Leader:Track maintenance),
Mr. N.Matsuo(Sub-leader:Maintenance planning),
Mr. H.Komatsu(Operation maintenance),
Mr. Y.Taniguchi(Procurement of equipment and material),
Mr. K.Miyamoto(Track maintenance),
Mr.R. Mitani(Signal&telecom)
Mr. M.Ishikawa(Rolling Stock),
Mr. H.Igarashi(Train Operation),
- Observer Sumitomo Corporation Mr.M.Yamato (General Manager)
- Interpreter Mr. Ye Tun Oo
- 4.SUBJECT Explanation and discussion of Progress Report
- 5.HANDOUTS (1). Progress Report(PR)
Power Point Document of PR for explanation
(2.)Text Book for Training Program of Cause Analysis of Accidents/Low Service Level and Establishment of Countermeasures

- 8: -
SK

- (3) Article in the Journal of Japan Railway Civil Engineering Association introducing "The Project on Improvement of Service and Safety of Railway in Myanmar"
- (4) Photo List of Members of JICA Expert Team (The newest version)

6. OPENING GREETING

6.1 U. Thurein Win, Managing Director, Chairman of JCC

- At the beginning of the last year, in the top meeting between Myanmar and Japan, the Japanese Government agreed upon the cooperation with the Myanmar Government in the field of railway transport. Since then, Yen loan projects, free aid projects, and technical cooperation projects have been planned and programmed.

Technical cooperation of "the Project on improvement of Service and Safety of Railways in Myanmar" is the first realized technical cooperation in the field of railways.

This Project was initiated according to ROD agreed upon between MR and JICA in March 2013.

According to this Project, the following various cooperations have been promoted.

- * 74 items, 610 quantities of track maintenance equipments/tools have been provided to MR.
- * 11 track maintenance related staff of MR have been trained for two weeks recently in Japan.
- * 20 officers of MR have been trained in the training program focused on accidents analysis, and safety and service level improvement.
- * At present, track maintenance training is being executed with the use of modern Japanese track maintenance equipments/tools in the section between Thingangyun and Ledaunggan.

On the Myanmar side, we are making every efforts in the smooth acquisition of visas for JICA experts, in exemption of import tax for track maintenance equipments/tools imported from Japan to Myanmar country, provision of working offices in Nay Pyi Taw and Yangon for JICA experts, and so on.

In the first JCC, we could have active and fruitful exchange of views regarding the smooth execution of the Project. It is sincerely hoped that in the 2nd JCC, we could have active and substantial discussion in the same way as in the first JCC.

Last but not the least, we ,MR, express the sincere appreciation to JICA experts for their cooperation with MR in improvement of safety and service level of MR.

6.2 Mr.Chokki , JICA Headquarters

It is our pleasure that the whole track maintenance equipments/tools offered by JICA have arrived at the Pilot Project site.

In this regard, we, JICA ,appreciate very much MR for their efforts in smooth import of these equipments/tools .With the arrival of these equipments/tools, full-dress track maintenance training will be executed soon.

It is our pleasure to inform our MR colleagues that the activities of technology transfer of track maintenance in the Pilot Section have been introduced in an article of a well-known journal of railway engineering in Japan.

Today, in the 2nd JCC,JICA expert team will present the Progress Report describing the status of the progress of the Project.

We should be grateful, if JCC members could kindly examine the Progress Report and provide the various advices for smooth and effective execution of the Project.

7. Presentation of Progress Report

Progress Report was explained by Dr.S.Kuroda, Leader of JICA Expert Team, and Mr.N. Matuso, Deputy Leader of JICA Expert Team, and it was accepted in principle.

8. Major Points of Discussion

- (1) MR: ① Track maintenance is very important for safe train operation. However, MR is in shortage of skilled track maintenance staff.
Measurement of track conditions by instruments is very important. We expect JICA experts to train the young MR staff with respect to measurement of track conditions with use of measurement tools.
- ② MR have 200 sets of tie-tampers although their performances are not good. Is it possible to make use of them with the suitable modification such as replacement of parts?
- ③ "Finger pointing and confirmation" is a splendid method for ensuring the precise work.
- ④ We are very happy that JICA provided us with a train vibration measuring device. Is it possible to evaluate the track conditions between Nay Pyi Taw and Mandalay by measuring the vibration of

train with this device? If we could find the locations of bad track conditions by vibration measurement, we can efficiently repair the track.

- ⑤ In reviewing the track maintenance manual, kindly discuss with MR staff concerned, so that the revision could be made with due consideration on MR's practical situations.

JICA Expert: With respect to ② above, it may not be practical to use MR tie-tampers with replacement of parts. We have been informed that MR have 10 sets of tie-tampers similar to Japanese ones. We would like to propose a plan to suitably combine these 10 MR tie-tampers and JICA tie-tampers for track tamping.

Regarding ④ above, we would try to comply with the request. However, kindly inform us of your request of measurement one week in advance. With respect to ⑤ above, we would try to comply with your request.

- (2) MR: MR needs vehicles to comply well with the track condition. MR's vehicles have frequent failures and there are many problems with respect to bogies etc. Kindly teach us what kinds of vehicles MR should have. MR is now planning to purchase new DEMUs. Kindly advise us what types of suspension should these DEMUs have. In the Yangon – Mandalay line, there are 400 vehicles, and MR have to replace 3200 pieces of spring coils every year, namely replacement of 8 spring coils per vehicle per year. It means that $\frac{1}{4}$ of 32 spring coils installed in one vehicle are replaced every year. It is a very bad situation. MR would like to find out suitable spring coils to comply with the track condition.

JICA Mr.Chokki: The Project is the technology transfer project focused on track maintenance technology and improvement of safety and service level through the accidents/ low service level analysis. With respect to cooperation with MR in the field of rolling stock, JICA would like to do it by other separate projects. However, provision of relevant information can be made through rolling stock engineer of the Team, through Text Book used in the Training Programme, etc.

- (3) MR: Regarding the cost of this Project, whether it should be or should not be



put in the Myanmar Railways budget .

JICA Mr.Chokki : This questions will be answered after getting the idea from JICA Headquarters in Tokyo.

(4) MR: How MTTs and tie-tampers can be used properly?

JICA Expert: MTTs are used in the track maintenance of the long section. Tie-tampers are used for the tamping of turnouts or for spot maintenance.

(5) MR: What kinds of trainees should be selected for October training in Japan?

JICA Expert: We are now training 20 middle class management experts (such as divisional officials) of track, train operation, rolling stock and signaling & telecom in the "Training Program of Cause Analysis of Accidents/Low Service Level and Establishment of Countermeasures." MR officers of the similar levels are recommended for training in Japan. One DGM level senior management officer is advised to be included in the trainees as a leader.

(6) MR: In case of measurement of train vibration, not only the track conditions but also vehicle conditions will have effect on magnitude of vibrations.

Accordingly good conditioned vehicle should be selected for measurement of train vibration.

JICA Expert: We agree with the opinion. We are now measuring the train vibration to confirm the effect of track maintenance once per two weeks. We are trying to chose the similar vehicles for measurement of vibration.

9. JICA Mr.Chokki's comments:

① With respect to ballast supply for track maintenance, we appreciate very much MR for their efforts in supplying the required amount of ballast with proper timing.

We should be grateful if MR could kindly continue the proper and timely supply of ballast so that the track maintenance training could be executed smoothly.

② With respect to working hours for training in the season after the middle of March and allowances for overwork of MR staff.

In the season after the middle of March. It becomes very hot in the Yangon Area. The government and the media warn that the people

should not be outside their houses from 10 A.M. to 4 P.M. ,if going out is not necessary.

With the condition of this situation, in order to keep the health of workers in good conditions, we are planning to set the working hours from 7 A.M. to 11 A.M., instead of the current working hours from 8 A.M. to 12 A.M.

The MR workers participating in the training program must do the other maintenance work of duty in the evening or at night, in addition to the work for training.

This situation puts a big burden on them. We should be grateful if MR could kindly consider some suitable allowances for the trainees to comply with their overwork.

MR: We will consider the matter suitably.

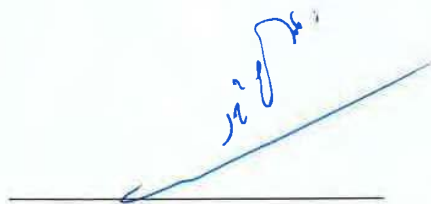
10. Closing speech by the Chairman

It is a pleasure that there have been many substantial exchange of views on various matters in this JCC.

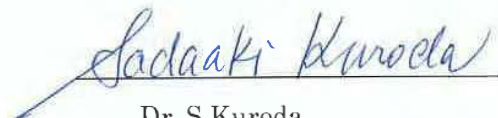
From now on, MR would like to continue their efforts in cooperating with the Project as much as possible.

March 5, 2014

Nay Pyi Taw



U Thurein Win
Managing Director
Myanma Railways



Dr. S.Kuroda
Leader of JICA Expert Team

Minutes of Discussion

3rd JCC for "Project on Improvement of Service and Safety of Railways in Myanmar"

- 1. Date and time** 29 May 2014 9:30~12:30
- 2. Place** Meeting Room of Myanmar Railways Headquarters

3. Attendants

3.1 Myanmar side

Myanma Railway

U Thurein Win	(Managing Director)
U Saw Valentine	(General Manager –Technical & Admin Support)
U Myint Wai	(General Manager –Operation)
U Tin Soe	(General Manager –Civil)
U Aung Win	(General Manager –Mechanical & Electrical)
U Ba Myint	(General Manager –Inspection)
U Aung Myint Hlaing	(Deputy General Manager –Passenger)
U Htaung Sian Kan	(Deputy General Manager –Planning)
U Than Htay	(Deputy General Manager –Civil)
Daw Thi Thi Nwe	(Deputy General Manager –Finance)

3.2 Japanese Side

JICA Myanmar Office	Mr. Win KoKo (Program Assistant)
JICA Expert Team	Dr. S. Kuroda (Leader: Track Maintenance)
	Mr. N. Matsuo (Deputy Leader: Maintenance Planning)
Observer	Mr. M. Yamato (General Manager: Nay Pyi Taw Office Sumitomo Corporation)
Interpreter	Mr. Kyaw Soe Thu

4. Subject: Explanation and Discussion of Progress Report

5. Handouts

- (1) Progress Report (PR) (JICA Expert Team)
- (2) Power Point Document of PR for explanation (JICA Expert Team)
- (3) Report for Technical Transfer Training in Yangon –Bago Line Pilot Project by JICA (Civil Engineering Dept. Myanmar Railways)

6. Opening Speech by U Thurein Win, Managing Director, Chairman of JCC

The Pilot Section was selected in the last September, and since then the track maintenance training

has been implemented under the cooperation of JICA.

The 1st and the 2nd JCC were held in August 2013 and in February 2014 respectively, and now we are going to hold the 3rd JCC.

It is our pleasure that two groups of eleven members each are going to visit Japan for track maintenance training.

We would like to express our gratitude to JICA and JICA Expert Team for their assistance in recommendation on technical standards and drawing up railway facilities improvement plan based on cause analysis of accidents/low service level, and in technology transfer of track maintenance.

7. Greeting by Dr. Kuroda, Leader of JICA Expert Team

I must report with regret that Mr. A. Sanjo, senior representative of JICA Myanmar Office cannot attend the Meeting due to some inevitable reason, although he was scheduled to attend the Meeting.

If MR has some specific requests to JICA, they will be recorded in the minutes of the Meeting and will be reported to JICA.

On this opportunity, we, JICA Expert Team would like to express their appreciation to U Thurein Win, Managing Director and the officials concerned for their assistance extended to the Team.

8. Presentation of Progress Report

Progress Report was presented by Dr. S. Kuroda, Leader of JICA Expert Team and Mr. N.Matsuo, Deputy Leader of JICA Expert Team.

9. Presentation of Report for Technical Transfer Training In Yangon —Bago Rail Line Pilot Project by JICA

The Report was presented by U Tin Soe, General Manager (Civil). In the presentation, U Tin Soe made the following requests to JICA.

*Kindly continue the train vibration measurement by the measurement device on Yangon —Mandalay line (the up line of Yangon —Pyinmana section has already been measured).

*Kindly arrange so that Dr. Osanai visits Myanmar more often to give training of track maintenance to MR staff concerned.

10. Major Points of Discussion

- (1)MR:**
- ①Measurement of track irregularities by inspection device is very significant. Supplying track with ballast of specified volume is also important. We are now supplying the track between Yangon and Pyinmana with the ballast of 280000 m³/ year in these two years.
 - ②We would like to request JICA to provide us with training of maintenance of long welded rail track.
 - ③Kindly explain the meaning of unification of level crossings.

④ What is the opinion of JICA Expert Team about the size of ballast of MR?

JICA Expert:

***With respect to ② above.**

It will be reported to JICA.

***With respect to ③ above.**

It means that several small size level crossings locating close to each other are unified to one level crossing which will be equipped with sufficient protection devices.

***With respect to ④ above**

The maximum ballast size specified by MR standards is larger than that by JR standards. It can be observed that stones larger than the maximum size specified by MR standards are used in the track. Generally the excessively large stones are difficult to be filled under the sleeper.

Further it can be observed that grain size distribution of ballast is not well controlled by MR. If the various sizes of stones are appropriately mixed, the settlement characteristics of the track will be improved. We will later submit the size distribution standards of JR Group together with the comparison with that of MR.

(2). MR: ① JICA has already provided us with one train vibration measuring device.

Kindly provide MR with one more train vibration measurement device

② By the presentation of JICA expert, it can be well understood that there are many issues regarding braking system and spring coil system. Kindly provide us with training of rolling stock maintenance.

③ How should MR improve vibration system of the truck, in order to improve riding comfort?

④ Continuous braking system is designed for vehicles, accordingly the sentence on the 5th line from the bottom on page 13 of PPT should be replaced by the following sentence.

“The vehicle should be fully equipped so that.....”

Should MR replace vacuum braking system with compressed air braking system?

⑤ Thermit welding can be executed while it is raining?

⑥ Kindly provide us with training on cause analysis of accidents and low service level and establishment of countermeasures for MR officials in the various fields including civil, track, rolling stock, operation, signal/telecom.

JICA Expert:

***With respect to ①&② above.**

They will be reported to JICA.

***With respect to ③ above.**

Damper system should be improved. More details will be explained later after consultation with the rolling stock expert of our Team.

***With respect to ④ above.**

Continuous braking system is arranged for vehicles in design. However, continuous brake is actually not working in the vehicles. In case continuous brake is not working, brake distance of the train will become long, and train speed cannot be raised so much.

In case of vacuum braking system, the maximum braking force is only one atmospheric pressure, accordingly the brake distance of the train equipped with vacuum braking system becomes longer than that of the train equipped with compressed air pressure braking system. Compressed air braking system should be adopted for increasing train speed.

***With respect to ⑤ above.**

Thermit welding should not be executed while it is raining.

***With respect to ⑥ above.**

It will be reported to JICA.

(3).MR:① Please explain the JR rule about train speed slow down during the track maintenance work.

② There occur many accidents on illegal level crossings. What should we do?

We would like to know more about level crossing accidents prevention. We will ask the questions by e-mail. Kindly answer the questions.

JICA Expert:

***With respect to ① above.**

In JR, the time during which trains are operated and the time during which track maintenance works are carried out are separated from each other. The kinds of track maintenance works which will be carried out while trains run, but accompanied by train speed slow down are limited to specific preparatory works specified by the regulation.

***With respect to ② above.**

In case some illegal level crossing are necessitated by the neighborhood residents, they should be leveled up to the legal ones, and should be equipped with appropriate protection devices. In case the ones are not so much necessitated by the neighborhood residents, they should be abolished.

If you have some questions about level crossing issues, please send us your questions by e-mail. We would like to try to answer your questions as much as possible.

11. A list of requests to JICA made by MR during the discussion are given as follows.

*Kindly continue the train vibration measurement by measurement devices on Yangon–Mandalay line.

(The up line of Yangon–Pinyinmana section has already been measured)

*Kindly arrange so that Dr. Osanai visits Myanmar more often to give training of track maintenance to MR staff concerned.



*Kindly provide MR staff concerned with training of maintenance of long welded rail track.

*Kindly provide MR with one more train vibration measurement device.

*Kindly provide MR staff concerned with training of rolling stock maintenance.

*Kindly provide training of cause analysis of accidents and low service level, and establishment of countermeasures to MR officials in the fields of civil ,track, rolling stock, signal/telecom and operation.

12. Closing speech by U Thurein Win, Managing Director, Chairman.

I appreciate the attendants on the 3rd JCC meeting for their earnest discussion. MR would like to do its best in cooperating with the Project.

In case JICA has some specific requests regarding implementation of the Project, kindly inform us of these, which MR would try to comply with as much as possible.

June 3, 2014

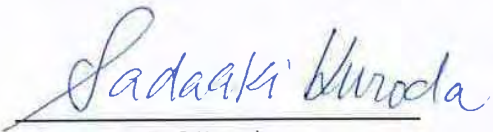
Nay Pyi Taw



UThurein Win

Managing Director

Myanma Railways



Dr.S.Kuroda

Leader of JICA Expert Team

