Republic of the Union of Myanmar
Ministry of Electric Power (MOEP)

Project for Capacity Development of Power Transmission and Distribution Systems in the Republic of the Union of Myanmar (Phase II)

Project Completion Report

February 2023

Japan International Cooperation Agency (JICA)

Tokyo Electric Power Services Co., Ltd. (TEPSCO)

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Abbreviations Table

AE	:	Assistant Engineer
AD	:	Assistant Director
AIS	:	Air Insulated Switchgear
AMI	:	Advanced Meter Infrastructure
AMR	:	Automatic Meter Reading
ASEAN	:	Association of South-East Asian Nations
CDM	:	Civil Disobedience Movement
CE	:	Chief Engineer
CRMS	:	Customer Relationship Management System
CT	:	Current transformer
CT	:	Current Transformer
DAS		Distribution Automation System
DC	:	Direct Current
DD	:	Deputy Director
DEPP	:	Department of Electric Power Planning
DGM	:	Deputy General Manager
DMS	:	Data Management System
DPTSC	:	Department of Power Transmission and System Control
DT	:	Distribution Transformer
EE	:	Executive Engineer
EPGE		Electric Power Generation Enterprise
ESE	:	Electricity Supply Enterprise
GIS	:	Gas Insulated Switchgear
GM	:	General Manager
GPS	:	Global Positioning System
IT	:	Information Technology
JCC	:	Joint Coordinating Committee
JICA	:	Japan International Cooperation Agency
KPI	:	Key Performance Indicator
LAN	:	Local Area Network
LV	:	Low Voltage
MDMC	:	Multi Divided Multi Connected
MESC	:	Mandalay Electricity Supply Corporation
MOEP	:	Ministry of Electric Power
MSDP	:	Myanmar Sustainable Development Plan
MTS	:	Mixed Technology Switchgear
MV	:	Medium Voltage

O&M	:	Operation & Maintenance
ODA	:	Official Development Assistance
OH	:	Over Head
PDCA	:	Plan-Do-Check-Action (Cycle)
PDM	:	Project Design Matrix
PJ	:	Project
R/D	:	Record of Discussion
SAE	:	Sub Assistant Engineer
SAIDI	:	System Average Interruption Duration Index
SAIFI	:	System Average Interruption Frequency Index
SCADA	:	Supervisory Control And Data Acquisition
SDGs	:	Sustainable Development Goals
SE	:	Superintendent Engineer
SOP	:	Standard Operating Procedure
TEPCO	:	Tokyo Electric Power Company
TOT	:	Training Of Trainers
UG	:	Underground
VCB	:	Vacuum Circuit Breaker
VT	:	Voltage Transformer
WG	:	Working Group
YESC	:	Yangon Electricity Supply Corporation

1. Project Overview

1.1. Project Background and Objectives

1.1.1. Project Background and Objectives

The demand for electric power in the Republic of the Union of Myanmar (hereinafter called Myanmar) has been growing rapidly due to recent development and investment. Electricity demand has increased the most during the hot season (March to May), with the maximum demand reaching about 3,075 MW (Mid-May 2017) in 2017. In addition, according to the power master plan "Electric Power Development Program Preparation Survey", which JICA helped formulate, it is expected to increase to 4,531 MW (high case) in 2020, and the electric power supply capacity is planned to increase accordingly.

However, despite plans to increase electricity supply in response to the strong demand, the upgrading and improvement of power distribution facilities have been delayed. The transmission and distribution loss rate in FY 2014 was 20% (World Bank), which is still at a high level compared to other ASEAN countries. The transmission and distribution loss rates in the Yangon and Mandalay regions, the first- and second-largest commercial cities in Myanmar, were high at 15.41% (Yangon Region) and 14.70% (Mandalay Region) as of FY 2017. Power distribution substations continue to have high load ratios, and the load ratios are expected to exceed 100% by 2022. Even if new power plants and transmission lines are built to meet the demand for electric power, the stable supply of electricity will be hampered by distribution losses and the shutdown of substations. Therefore, improving the capacity for transmission and distribution technology is an urgent issue, along with improving and reinforcing distribution facilities in line with the expansion of power plants and transmission lines.

JICA provides support for the development of power distribution networks through the ODA loan projects "Regional Development Project for Poverty Reduction Phase I", "Regional Development Project for Poverty Reduction Phase II", "Power Distribution Improvement Project in Yangon Phase I", and "Power Distribution System Improvement Project in Major Cities". It also aids the development of power transmission networks through "National Power Transmission Network Development Project Phase I" and "National Power Transmission Network Development Project Phase II".

However, the Ministry of Electricity and Energy (hereinafter, MOEP) has not implemented engineer capacity development programs for the development, operation, and maintenance of transmission and distribution networks with a systematic plan, coherent system, or suitable training facilities, and has not sufficiently standardized technical standards or specifications for the development, maintenance, and management of facilities.

In light of the above, the Government of Myanmar requested Japan to provide technical cooperation on the "Project for Capacity Development of Power Transmission and Distribution Systems" (hereinafter, the Project) to strengthen the capacity of engineers engaged in the planning, construction, operation, and maintenance of the transmission and distribution network. JICA

reached a basic agreement on the framework of the project with the Government of Myanmar through the Record of Discussion (R/D) in January 2016, and started the project in July 2016.

The purpose of this project is to improve the capacity of personnel engaged in the development, operation, maintenance, and management of power transmission and distribution systems, and to contribute to the improvement of the reliability, efficiency, and energy access for the power supply by establishing a framework for human resource development plans related to power transmission and distribution system technology under MOEP, developing training programs, and establishing a PDCA (Plan-Do-Check-Action) cycle for training implementation and training systems.

The first phase of the Project, Phase I, was carried out from July 2016 to December 2018.

In the second phase of this Project, Phase II, human resource development plans related to power transmission and distribution system technology, development of training programs, implementation of training, and construction of a PDCA cycle for the training system is to be carried out.

1.1.2. Objectives and Prospective Outputs

(1) Overall goal

Efficiency and reliability of electric power supply and energy access is improved through the reinforcement and improvement of power supply infrastructure in Myanmar.

(2) Project purpose

Capacity for engineers and technicians engaged in the Transmission and Distribution system is strengthened.

(3) Expected Results

Output 1: A framework for human resource development planning is developed.

Output 2: Training programs are developed and implemented.

Output 3: The PDCA (Plan-Do-Check-Action) cycle of the training system is established and implemented.

1.1.3. Project Implementation Period

May 2019 to December 2022 (approximately 44 months)

1.1.4. Project Implementation Area

Nay Pyi Taw (Main Project Sites) and other related areas

1.1.5. Related Organizations

Ministry of Electric Power (MOEP)

✧ Coordination with related departments
- Department of Electric Power Planning (DEPP)

✧ Relevant departments in charge of implementation
- Department of Power Transmission and System Control (DPTSC)

- Electricity Supply Enterprise (ESE)
- Yangon Electricity Supply Corporation (YESC)
- Mandalay Electricity Supply Corporation (MESC)

1.1.6. Revision of PDM

(1) Overall Goal

In preparation for the latter half of Phase II, target values for distribution loss rate and SAIFI/SAIDI, which are objectively verifiable indicators for the overall goal, were considered.

For the first indicator, distribution loss rate, based on the facts that an approximately 50% reduction of distribution loss was achieved in low-voltage systems where new transformers were installed in Phase I relating with the system improvement projects, and the distribution loss rate for the whole distribution system was 14% as of 2018, the target value for 2024 was set as 12%, on the condition that the power supply coverage by one transformer becomes smaller.

Table 1-1 Distribution loss rates before and after installation of transformers in Phase I

Location	Capacity (New Installation) JICA DTs	LV Network Loss (%)	
		Before	After
Tat Kone	100kVA	18.5%	7.2%
Taung Gyi	25kVA	17%	8.3%
Taung Gyi	50kVA	18%	10%

(Source: ESE, 2019)

[First Objectively Verifiable Indicator for the Overall Goal]

Original: Distribution loss of 17% in 2016 will be decreased to xx% by 2024.

Revised: Distribution loss of 17% in 2016 will be decreased to 12% by 2024.

For the other indicator, SAIFI/SAIDI, through which the effectiveness of the Project can be evaluated quantitatively, it is necessary to have a firm grasp of the baseline and analyses of accident records for multiple years in order to set meaningful values.

Since it is essential for field engineers to understand problems with the distribution system and take appropriate measures based on analysis to manage and improve reliability, data management activities are carried out to establish operations such as data collection, analysis, and countermeasure planning in Phase II.

In consideration of the above situation, the second indicator is revised as follows:

[Second Objective Indicator for the Overall Goal]

Original:

✧ Total number (xx) and duration (xx minutes per fault) of faults in distribution system in Myanmar in 2018 will be decreased to less than (xx) by 2024.

Revised:

✧ Reliability management work, which is essential to SAIFI/SAIDI analysis for reliability improvement, starts in all distribution offices by 2024.

(2) Project Purpose

There are four indicators for the Project purpose. Two of these are SAIFI/SAIDI, and distribution loss rate for the pilot sites where transformers were installed in Phase I. Although the data management activities are carried out in Phase II as described above, these two indicators are revised as follows to meet the activities.

[Objectively Verifiable Indicators for the Project Purpose]

Original:

✧ More than 2 pilot sites reduce the total number and duration of faults (minutes per fault) to more than the target value.

✧ More than 2 pilot sites reduce distribution losses to more than the target value.

Revised:

✧ Effective work process in fault data management for power distribution reliability improvement is introduced at 6 pilot sites.

✧ Action plan to expand the effective work process is created and this process has begun to be adopted at the regional offices.

1.2. Impact of Novel Coronavirus (COVID-19)

1.2.1. Postponement of Overseas Travel

Due to the spread of COVID-19, overseas business trips were suspended at the beginning of March 2020, and the 2nd Training (scheduled from 9th January to 8th April 2020 for three (3) months at the MOEP Training Center in Nay Pyi Taw) was suspended. The training continued until 18th March 2020 and lectures on distribution planning, distribution design, distribution construction & safety, and distribution O&M were completed but those on transmission lines and substations remained uncompleted.

Since the spread of COVID-19 continued and the risk of infection increased and both by Government of Myanmar and Japan, there were several restrictions for travelling outside country, all overseas business trips related to the Project were prohibited and postponed. After October 2020, some business trips - mainly in Southeast Asian countries, including Myanmar - resumed, but the activities for this Project in Myanmar (other than the wrap-up trip) have not resumed since 1st February 2021.

1.2.2. Remote Activities

In order to proceed with the Project's activities under the above-mentioned situation as far as possible, the training that was suspended was conducted online, using a web conferencing tool, from July to August 2020. Various considerations, such as a comparison of web conferencing tools, checking of the internet environment at the site, and how to manage the training, were made before conducting the training.

After that, the implementation method for the Project activities amid the COVID-19 situation was discussed at the 2nd JCC, held on 24th November 2020, and it was agreed that the next (3rd) training, SOP preparation and data management should be implemented online.

The JICA Experts asked MOEP to feed back their comments on the draft practical textbooks and suggested holding online workshops for SOP preparation and data management. After that, the online workshops for SOP preparation and data management were resumed in June 2022, and held six times until November 2022, and a follow-up workshop was held in December 2022.

1.2.3. Extension of Project Period

As mentioned above, Project activities, including the dispatching of JICA Experts, could not be implemented as planned due to COVID-19 and the change in situation. Implementation of the three Workshops in Japan scheduled for FY 2020 also appeared problematic. As implementation of all the activities during the present Project period was difficult, an approximately 1-year extension of the Project period (until December 2020) was agreed in the 2nd JCC. The extended overall schedule was assumed to be as follows, but since there is no prospect of resuming normal activities, it has been decided not to extend the Project period beyond December 2022.

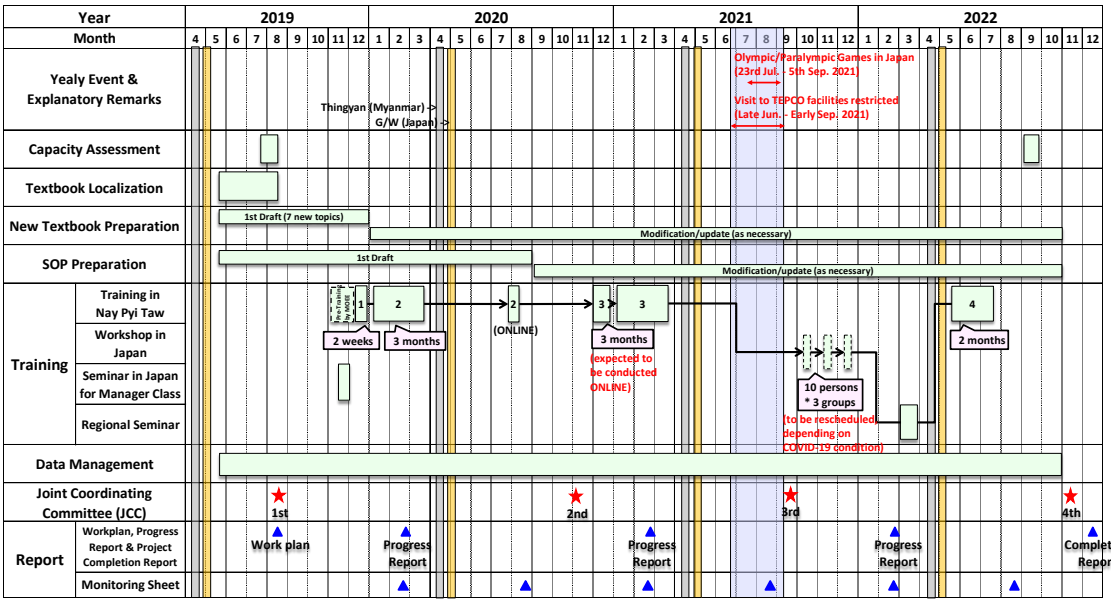


Figure 1-1 Extended Overall Schedule

2. Activities

2.1. Project Input

The major inputs from the Japanese and Myanmar sides in Phase II are listed below.

2.1.1. Japanese Side

(1) Experts

Assigned Experts	Number of members	Number of dispatches
1. Leader / Training System (PDCA)	1	6
2. Sub-Leader / Training System (PDCA)	1	1
3. Distribution Expert (Planning)	1	4
4. Distribution Expert (Design)	1	2
5. Distribution Exert (Construction Management)	1	7
6. Distribution Expert (Construction Technique)	1	3
7. Distribution Expert (Safety)	1	1
8. Distribution Expert (O&M)	1	4
9. Transmission Line Expert	1	3
10. Substation Expert	1	6
11. Substation Expert (O&M)	1	0
12. HRD Planning/Organizational Structure Expert	1	3
13. Data Management Expert	1	5

(2) Training and Seminars

Titles	Places	Main Training/Seminar Items	Period
1st Intensive Training	Myanmar	- Distribution Planning and Design (Phase 1 Review) - Distribution construction (same as above) - Distribution O&M (same as above) - Transmission (same as above) - Substation (same as above)	16 Dec 2019 – 24 Dec 2019 (about 2weeks)
2nd Intensive Training	Myanmar	- Distribution planning (facility planning and load management, etc.) - Distribution design (pole strength calculation and voltage drop calculation, etc.) - Distribution construction and safety (construction supervision, construction methods and safety management, etc.) - Distribution O&M (power quality management, reliability indicators, equipment maintenance concepts, etc.)	9 Jan 2020 – 18 Mar 2020 (about 70 days)
	Online	- Transmission line (transmission facility design) - Substation (control system and basics of various tests for substation)	27 Jul 2020 – 14 Aug 2020 (about 3weeks)
Seminar on Training System for Managers	Japan	- Human resource development policies, target achievement mechanisms, and its related facilities at Japanese electric power company - Observation of power quality improvement and maintenance technologies in Japan	12 Nov 2019 – 21 Nov 2019 (10 days)

(3) Other

✧ Local costs associated with conducting raining (meal for trainer candidates, venue and transportation for online training)

2.1.2. Myanmar Side

(1) Counterpart Personnel

Activities	Department	Number of members
Trainer Candidates	DEPP	1
	DPTSC	3
	ESE	15
	YESC	6
	MESC	5
Phase 1 Textbook Localization WG	DEPP	4
	DPTSC	4
	ESE	15
	YESC	4
	MESC	3
New Textbook Preparation WG	DEPP	0
	DPTSC	5
	ESE	9
	YESC	8
	MESC	7
Data Management WG	DEPP	1
	DPTSC	1
	ESE	2
	YESC	2
	MESC	2
	EPGE	1
SOP Preparation	DPTSC	2
	ESE	1
	YESC	1
	MESC	1
Subtotal by Department	DEPP	6
	DPTSC	15
	ESE	42
	YESC	21
	MESC	18
	EPGE	1
Total		103

(2) Other

✧ Office space and equipment, training lecture rooms, local costs (daily allowance and accommodation for trainer candidates)

2.2. Establishment of the Project Implementation System

2.2.1. Joint Coordination Committee (JCC)

The JCC determines the project policy. JCC meetings were to be held once a year with the same members as in the first phase, and the JCC was to continue to manage the Project in the second phase.

Table 2-1 JCC Member List

Myanmar side	
Chairperson	Permanent Secretary, MOEE
Directors	Director General of DEPP
	Director General of DPTSC
	Managing Director of ESE
	Chief Executive Officer of YESC
	Chief Executive Officer of MESC
Administration	Deputy Director General and Director of DEPP
Members	Representatives of DEPP, DPTSC, ESE, YESC and MESC
Japanese side	
Members	JICA Experts
	Representative(s) of JICA Myanmar Office
	Other concerned member(s) of JICA

The 1st JCC meeting was held in August 2019 to reconfirm the overall concept for the Project, the schedule for Phase II, the Project Design Matrix (PDM) and monitoring methods, and the progress in activities from the start of Phase II to the 1st JCC meeting. Details of each activity will be described later.

2.2.2. Phase I Textbook Localization Working Group

The Working Group (WG) was established to localize the textbooks prepared in Phase I based on Japanese laws and technical guidelines, putting them into a language that can be used in Myanmar (localization). The WG is composed of five (5) Sub-WGs for each theme, consisting of the Phase I members of MOEP and Phase II members of the JICA Expert group.

Table 2-2 Phase I Textbooks Localization WG Members

		Name & Organization (boldface: Leader)	
MOEE side	[Group 1] Distribution Planning and Design	**U Soe Ko Ko Aung, DEPP**	U Myo Min Aung, ESE
		U Aung Tun, ESE	U Bo Bo, ESE
		U Naung Win Htoo, DPTSC	Daw Phyo Thiri Aung, YESC
	[Group 2] Distribution Construction Works and Safety Technologies	**U Aung Zaw Myint, MESC**	U San Myo Aung, ESE
		U Si Thu Aung, ESE	U Zaw Htike, MESC
		U Min Thiha, ESE	Daw Yi Mon Aye, DEPP
	[Group 3] Distribution O&M	**U Aung Tun Lin, YESC**	U Khun Saw Naung Htwe, ESE
		U Naing Lin, ESE	U Kyaw Kyaw, MESC
		U Lin Ko Ko, ESE	U Kyaw Soe Lin, YESC
	[Group 4] Tranmission Line	**U Than Naing Lin, DPTSC**	U Win Kyaw, DPTSC
		U Myint Oo, ESE	Daw Kyawe Kyawe Hlaing, YESC
		U San Yu Maw, ESE	Daw Shwe Yee Win, ESE
	[Group 5] Substation	**U Win Min Tun, ESE**	U Myo Thant Zin, DEPP
		U Than Htike Oo, ESE	Daw Soe Yupar Thein, DPTSC
		U Zaw Zaw Htet, ESE	Dr. Tay Zar Lin, DEPP
JICA side	Distribution Planning Expert, Distribution Design Expert, Distribution Construction Management Expert, Distribution Construction Technique Expert, Distribution Safety Expert, Distribution O&M Expert, Transmission Line Expert, Substation Expert		

2.2.3. New Textbook Preparation WG

The new WG was established to write the New Topic Textbooks on 7 new topics not covered in Phase I, based on a request by MOEP. The WG consists of seven Sub-WGs for each topic, with a mixed composition of MOEP and JICA members from the start, based on experience from the establishment of the Phase I textbooks, which required the revision work mentioned in 2.2.2. MOEP members with a wealth of work experience and technical knowledge were selected from related departments in MOEP. In addition, as a result of discussions with DEPP, this WG also dealt with textbooks on practical topics (practical textbooks).

The WG members as of November 2020 were as follows:

Table 2-3 Members of the New Textbook Preparation WG (as of November 2020)

		Name & Organization (boldface: Leader)	
MOEE side	[Group 1] Underground Distribution System	**U Zaw Lin Tun, YESC**	U Zaw Tun, MESC
		Daw Than Than Aye, ESE	U Zay Yar Oo, YESC
	[Group 2] Earthing System	**U Than Naing Lin, DPTSC**	U Maung Maung Khaing, ESE
		U Aung Min Thein, YESC	U Ye Lwin Oo, MESC
	[Group 3] Substation Control /Automation System	**U Aung Sithu Win, DPTSC**	U Aung Myo Zaw, DPTSC
		U Win Naing Oo, MESC	U Myo Kyaw Swe, YESC
	[Group 4] Live Line Works for Distribution Transformer and Low Voltage Line	**U Thant Zin, ESE**	U Myat Min Soe, ESE
		U Nyein Tun, YESC	U Tun Lin Aung, MESC
	[Group 5] AMR, AMI and Smart Metering System	**U Aung Kyaw Htoo, ESE**	U Min Thu Win, DPTSC
		U Sai Aung Ye Kyaw, ESE	U Zay Yar Oo, YESC
		U Aung Kyaw Myo, MESC	
	[Group 6] Testing and Commissioning of Substation Equipment	**U Tun Tun Win, DPTSC**	U Than Htike Oo, ESE
		U Ye Naung, YESC	U Nyein Chan Kyaw, MESC
	[Group 7] Distribution Management System	**U Aung Kyaw Lin, MESC**	U Aung Than, ESE
		U Myo Aung San, ESE	Daw Thin Thin Hlaing, YESC
		U Phyo Wai Lin, ESE	
JICA side	Distribution Planning Expert, Distribution O&M Expert, Distribution Design Expert, Distribution Construction Management Expert, Distribution Construction Technique Expert, Distribution Safety Expert, Transmission Line Expert, Substation Expert		

2.2.4. Data Management WG

In order to establish and disseminate methods for data management in MOEP, the WG was founded to advance data management activities centering on SAIFI and SAIDI, which are evaluation indices not only for this project but also for the Myanmar Sustainable Development Plan (MSDP). The members were selected from the MOEP side to lead the necessary data collection, and some of them from ESE and MESC changed. The WG members as of November 2020 were as follows:

Table 2-4 Members of the Data Management WG (as of November 2020)

	Name & Organization	
MOEE side	U Zaw Zaw Htet, ESE	Dr. Kyaut Kyaut Hlaing, ESE
	Daw Thin Thin Hlaing, YESC	U Htet Min Aung, YESC
	Daw Moe Thun Htwe, DEPP	U Than Zaw Oo, MESC
	Daw Htet Htet Win, DPTSC	U Phyo Min Aung, MESC
	Daw Zin Mar Htay, EPGE	
JICA side	Distribution Planning Expert, Distribution O&M Expert, Distribution Construction Management Expert, Data Management Expert	

Subsequently, there was a change of members on the MOEP side when the online workshop resumed in June 2022, and the members are shown in the table below.

Table 2-5 Members of the Data Management WG (after June2022)

	Name & Organization	
MOEE side	Daw Ye, DEPP	Daw Htet Htet Win, DPTSC
	Daw Zin Mar Htay, EPGE	Daw Su Hlaing Phyo, ESE
	Daw May Oo Khin, ESE	Daw Thin Thin Hlaing, YESC
	Daw Myat Thiri Mon, YESC	Daw Ye Htet Hmue, MESC
	Daw Aung Myo, MESC	
JICA side	Distribution Planning Expert, Distribution O&M Expert, Distribution Construction Management Expert, Data Management Expert	

2.2.5. System for Preparing Standard Operating Procedures (SOP)

The CEs and GMs of each related department were selected as persons in charge of the preparation of the SOP to discuss each item. Although ESE, YESC and MESC were initially seen as the target, all related departments were involved in the end since the DPTSC expressed its desire to join. As of November 2020, the following persons were appointed from each related department. The persons in charge from ESE, YESC and MESC changed from the previous time.

Table 2-6 Contact Points for Each Department Involved in the Preparation of SOPs

(as of November 2020)

	Name	Organization
MOEE side	U Than Naing Lin, Deputy Director U Tun Tun Win, Deputy Director	DPTSC
	U Naing Win, Superintendent Engineer	ESE
	Daw Khin Lay Nwe, Deputy General Manager U Aung Kyaw Moe, Superintendent Engineer	YESC
	U Hlaing Hlaing Oo, Deputy General Manager	MESC
JICA side	Mr. Satoshi KOBAYASHI, Team Leader Mr. Keisuke YANAGIUCHI, Dist. Expert (for Dist. system related items) Mr. Junichi ARAKAWA, Trans. Expert (for T/L related items) Mr. Masanobu KAMINAGA, Subs. Expert (for S/S related items)	JICA Expert Team

Since then, the number of JICA experts increased according to the SOP topics, and there was also a change in the MOEP side members when the online workshop resumed in June 2022, resulting in the members shown in the table below.

Table 2-7 Contact Points for Each Department Involved in the Preparation of SOPs

(after June 2022)

	Name	Organization
MOEE side	U Than Naing Lin, Deputy Director U Tun Tun Win, Deputy Director	DPTSC
	U Naing Win, Superintendent Engineer	ESE
	U Aung Zaw Oo, Deputy General Manager	YESC
	U Ko Ko Naing, Deputy General Manager	MESC
JICA side	Mr. Satoshi KOBAYSHI, Team Leader Mr. Akira NIIZUMA, Dist. Expert Mr. Toshiya MINEJIMA, Dist. Expert Mr. Masaki IWAMA, Dist. Expert Mr. Masanobu KAMINAGA, Subs. Expert Mr. Yukikazu SUZUKI, Subs Expert Mr. Junichi ARAKAWA, Trans. Expert	JICA Expert Team

2.2.6. Trainer Candidates

At the start of Phase II, 28 members from MOEP were appointed as trainer candidates. Following this, the 1st Training in Nay Pyi Taw was held in December 2019 after two more members were added. The 2nd Training in Nay Pyi Taw was also held for the following 30 trainer candidates from January 2020 after one replacement.

Table 2-8 List of Trainer Candidates

Name	Designation	
	Position	Organization
Daw Sandar Win	Staff officer	DEPP
Daw Zar Ni Aung	Assistant Engineer	DPTSC
U Pai Soe Thu	Sub Assistant Engineer	
Daw Thin Thin Oo	Sub Assistant Engineer	
U Hla Min Thaung	Assistant Engineer	ESE
U Yan Naing Soe	Assistant Engineer	
U Lynn Lynn Oo	Assistant Engineer	
U Arkar Htet Paing Swe	Executive Engineer	
U Nay Lin Aung	Assistant Engineer	
U Myo Zaw Htut	Assistant Engineer	
U Aung Aung	Assistant Engineer	
U Thaw Zin Htoo	Sub Assistant Engineer	
U Van Boi Lyan	Sub Assistant Engineer	
U Thiha Aung	Sub Assistant Engineer	
Daw Ni Ni San	Sub Assistant Engineer	
U Lin Tun Oo	Sub Assistant Engineer	
U Than Tun	Sub Assistant Engineer	
U Kyaw Myo Htet	Sub Assistant Engineer	
Daw Ingyin Khaing	Sub Assistant Engineer	
Daw Myat Mon Yee	Manager	YESC
U Htet Min Aung	Assistant Manager	
Daw Hsu Myat Thaung	Sub Assistant Engineer	
Daw Moht Moht	Sub Assistant Engineer	
Daw Thwe Thwe Soe	Assistant Manager	
Daw Win Lae Thu	Sub Assistant Engineer	
U Aung Zaw Lin	Assistant Manager	MESC
U Ye Lin Ko Ko	Assistant Manager	
Daw Thi Han Htun	Assistant Manager	
U Kyaw Thura Ko	Assistant Manager	
Daw Su Myat Lwin	Assistant Manager	

2.3. Capacity Assessment

2.3.1. Purpose of Capacity Assessment

The capacity assessment is conducted to confirm the following:

- ✧ To confirm the capacity of the trainer candidates in transmission and distribution system technology
- ✧ To decide the implementation policy for the Project
- ✧ To monitor changes in the ability of the instructor candidates
- ✧ To measure the impact of the Project on the trainer candidates' transmission and distribution system technology capacity

2.3.2. Method of Implementation

The assessment is conducted via a questionnaire (test) and interviews to ascertain the capacity of all instructor candidates. The details of the procedure are shown below.

- ✧ Questionnaire (test)

  Basic knowledge in the five fields of this Project, and ability related to the knowledge necessary for practical work are measured in the tests.
- ✧ Interview

  Measures capacity elements which are difficult to assess through questionnaires, such as motivation for human resource development, lecture style as a trainer, communication skills, English ability, etc.

2.3.3. Implementation Schedule

The capacity assessment is conducted at defined stages: at the start of the Project, during the Project, and at the end of the Project.

- ✧ Start of the Project

  Understand the strengths and weaknesses of each trainer candidate, and determine the content and method of trainer-training programs for this Project. At the same time, decide the direction of the Project.
- ✧ During the Project

  Ascertain the understanding levels for each trainer-training lecture via tests, and reflect this in subsequent trainer-training programs.
- ✧ End of the Project

  Measure the impact on the capacity of trainer candidates through the Project

2.3.4. Project Start Assessment (June-August 2019)

2.3.4.1. Implementation Status

The questionnaire was delivered by e-mail to all the trainer candidates and collected by e-mail. The interviews were conducted according to the schedule shown in Table 2-9.

Table 2-9 Interview Schedule

Interviewee (number of candidates)	Date	Venue
Trainer candidates of DEPP (1)	24th July	Training Center
Trainer candidates of DPTSC (3)	24th July	Training Center
Trainer candidates of ESE (15)	25th & 26th July	Training Center or ESE HQ
Trainer candidates of MESC (5)	29th July	MESC HQ
Trainer candidates of YESC (4)	1st August	YESC HQ

MSEC (July 29, 2019)

YESC (August 2, 2019)

Figure 2-1 Interviews with Prospective Instructors for Capacity Assessment

2.3.4.2. Assessment Results

✧ Composition of trainer candidates

More than 80% of the trainer candidates have less than 10 years of work experience in MOEP, and they are a relatively young group in the technical field. Currently, about 70% of the trainer candidates are in charge of distribution O&M at branches and township offices, 24% are in charge of the management of distribution substations, and the remaining 7% are in charge of HV transmission work in DPTSC.

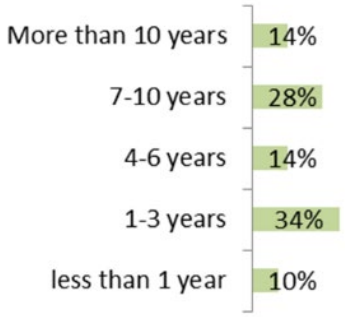


Figure 2-2 Length of work in MOEP

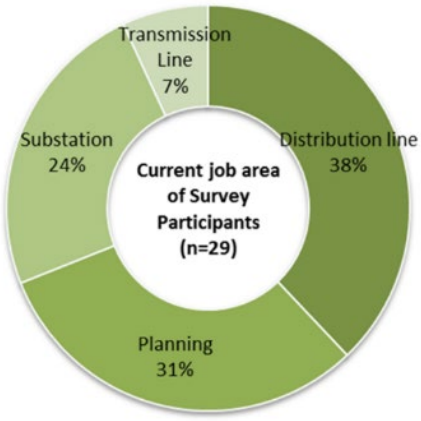


Figure 2-3 Current work in MOEP

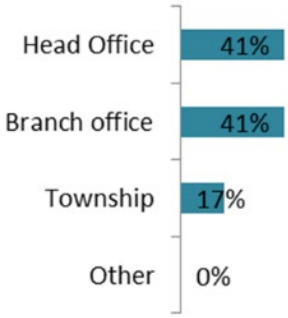


Figure 2-4 Workplace in MOEP

✧ Results of the questionnaire for instructor candidates

The general characteristics of the trainer candidates were observed to be as follows. The results have been summarized to recognize trainer candidates.

The trainer candidates' results on the questionnaire were tabulated individually and by subject to understand the characteristics of each trainer candidate and their current knowledge level. In this report, individual data is omitted, but an aggregated sample is shown in Figure 2-5.

[General]

✧ Characteristics of trainer candidates

- Have basic knowledge related to transmission and distribution, but have problems applying it in practice.
- Unfamiliar with technical calculations such as power loss and voltage drop, which are the basis of system planning and design.

✧ Points for trainer candidate training

- The training shall include repeated grid system calculation practice to master it.
- To ensure stable power supply, the training shall include lectures related to system regulations, such as system voltage management.

[Construction and safety]

- ✧ Characteristics of trainer candidates
  - Have basic knowledge related to distribution line construction.
  - Understand the basics of safety management in maintenance and construction work.
- ✧ Points for trainer candidate training
  - Focus on points to check in construction work.
  - Focus on concrete safety measures and actions to maintain safety.
  - Lecture on Japanese safety regulations.

[Distribution O&M]

- ✧ Characteristics of trainer candidates
  - Have basic knowledge on the causes of transmission faults, fault point investigation, and restorations.
  - Not enough experience on distribution line inspection and maintenance.
  - Have knowledge on key performance indicators, such as SAIDI and SAIFI, but need to know more on the details of measurement.
- ✧ Points for trainer candidate training
  - Focus on preventive maintenance.
  - SAIDI and SAIFI measurement training through real measurement work.

[EHV transmission line]

- ✧ Characteristics of trainer candidates
  - Don’t have experience on EHV facilities (almost all are from distribution companies)
- ✧ Points for trainer candidate training
  - The training shall start from the basics of EHV facilities.
  - Repeated calculation training shall be included to enhance practical capacity.
  - Case studies using real site problems shall be used for easy understanding by the trainer candidates who are from distribution companies.

[Substation]

- ✧ Characteristics of trainer candidates
  - Not enough knowledge on the physical theory related to substation O&M.
  - Not enough knowledge on substation facility specifications.
  - Not enough knowledge on the testing of substation facilities.
  - Not good at calculations for physical phenomena related to substation O&M.
- ✧ Points for trainer candidate training
  - The training shall include explanations about physical phenomena related to substation O&M.
  - Repeated calculation training shall be included to enhance practical capacity.

Figure 2-5 Samples of Tabulated Individual Data

[Results of interviews]

- ✧ Characteristics of trainer candidates
  - Strong motivation to learn in the Project.
  - Have hopes to actively utilize the knowledge gained from the Project.
  - Interested in training next generation as trainers, but they do not want to become a full-time trainer.
  - Not good at English.
- ✧ Points for trainer candidate training
  - The HRD system shall consider the fact that trainers can undertake their classes in parallel with their O&M work.
  - A Burmese interpreter must be assigned to the trainer candidate training to enhance their understanding of lectures.

2.4. Phase I Textbook Localization

2.4.1. Activities (overall)

2.4.1.1. 1st Workshop (May 2019)

Since MOEP members had already been working on the localization of the Phase I textbooks since the end of Phase I, each Sub-WG confirmed the contents jointly with JICA Experts. JICA Experts provided advice and held technical question-and-answer sessions on the contents, and discussed how to proceed with the localization work and an overview of the final product.

Group Discussion (Sub-WG 1)

Group Discussion (Sub-WG 5)

Sharing the Results of Group Discussion by each Sub-WG

Sharing the Results of Group Discussion by each Sub-WG

Figure 2-6 1st Phase I Textbook Localization Workshop

2.4.1.2. 2nd Workshop (August 2019)

After the first workshop, the JICA Experts reviewed the contents of the localized Textbooks in Japan and returned comments and advice to MOEP members. At the second workshop, MOEP members confirmed the revisions made based on the comments and advice, and worked together to revise the remaining parts. Final drafts of the revised textbooks were then prepared.

Group Discussion (Sub-WG 2)

Group Discussion (Sub-WG 5)

Overall Discussion

Figure 2-7 2nd Phase I Textbook Localization Workshop

2.5. New Textbook Preparation

2.5.1. Activities (overall)

2.5.1.1. 1st Workshop (August 2019)

MOEP and JICA Experts launched a WG to jointly prepare seven new textbooks. In this WG, all WG members first confirmed how to proceed with the preparation work in the first workshop. Each WG member was respectively assigned to the seven Sub-WGs and items to be described in the new textbooks were discussed based on the Table of Contents prepared by the JICA Experts. The contents of the new textbooks were compiled by combining proposals from the JICA Experts with opinions and requests from MOEP members.

Group Discussion (Sub-WG 2)

Group Discussion (Sub-WG 6)

Explanation by JICA Experts

Wrap-up

Wrap-up

Figure 2-8 1st New Textbook Preparation Workshop

In addition to the new textbooks, it was also decided that practical textbooks should be prepared for each field, as follows.

- ✧ Power distribution: planning, design, construction safety, maintenance, grid interconnection guidelines for distributed generators, strength calculation examples
- ✧ Substation: Lightning protection and protection relays for substations
- ✧ Transmission: Construction supervision for transmission lines

2.5.1.2. 2nd Workshop (September to October 2019)

New topic textbooks were drafted by JICA Experts following the first workshop, and shared with MOEP members. In the second workshop, each Sub-WG discussed the contents of each textbook drafted, and MOEP members and JICA Experts in the Sub-WGs clarified the necessary amendments and modification schedule. Subsequently, at the 1st JCC, at the request of MOEP, the first edition of the new topic textbook was to be prepared by October 2019, and the textbooks were revised and updated mainly by the JICA Experts based on the comments and additional requests from MOEP members submitted at the workshop.

Group Discussion (Sub-WG 2)

Group Discussion (Sub-WG 5)

Group Discussion (Sub-WG 6)

Group Discussion (Sub-WG 7)

Figure 2-9 2nd New Textbook Preparation Workshop

2.5.1.3. 3rd Workshop (December 2019)

The new topic textbooks were completed and submitted to MOEP at the end of October 2019, following mail-based revisions and updates by both MOEP members and JICA Experts. It should be noted that this first edition is a provisional edition, and the contents are to be updated and modified during the Project. The third workshop was held at the Sub-WG level, and the contents were reviewed after the submission of the first edition was confirmed.

2.5.2. Discussion Content and Concerns about 7 New Textbooks

2.5.2.1. Underground Distribution System

The textbook for underground distribution systems provides an overview of underground facilities, items to be considered to promote underground distribution system development (planning, design, construction, etc.), and other technical information. The textbook also shows development methodologies aimed at reducing size and cost per the actual situation at the target areas, using information on Japanese underground distribution development methodologies as references. The information is considered to be helpful for the future development of underground systems in Myanmar.

A large amount of technical information regarding underground cable engineering was requested to be added to the new textbook by the working group members. The following is the information added in the textbook.

- ✧ Cable jointing technologies
- ✧ Information about XLPE cables
- ✧ Cable capacity calculation in various situations
- ✧ Cable testing items before installation
- ✧ Cable installation methods
- ✧ Cable inspection methods

The contents of the textbook cover a wide area of technical information regarding underground distribution system development; however, based on the discussions among working group members, additional technical information could be added if it seems necessary.

2.5.2.2. Earthing System

The earthing systems textbook states specific technologies, construction methods and other examples applied in Japan. A wide range of information, including general concepts of earthing systems, distribution earthing designs, earthing construction methods, and earthing designs in substations, is covered by this text.

Since a working group member from Myanmar requested that technical information about earthing design in substations be added to the textbook, the textbook summarizes concrete methods such as calculations for substation earthing design and neutral earthing methods. The major items are as follows:

- ✧ General concept of earthing design (examples in Japan)
- ✧ Earthing construction methods in substations
- ✧ Neutral earthing method for power lines
- ✧ Protection measurement for electric devices

- ✧ Protection against surge voltage
- ✧ Earthing methods for distribution equipment
- ✧ Construction methods for distribution lines

It is assumed that the textbook covers general, required knowledge on earthing design and construction.

If more information is needed, the necessary information will be added to the textbook upon a request from a working group member.

2.5.2.3. Substation Control/Automation Systems

The hardware and software used in the substation control system are described, focusing on the basic technologies that are commonly used in various countries around the world. In addition, easy understanding is promoted by including actual examples in Myanmar provided by WG members. Specifically, the equipment and configuration diagrams used in Myanmar, provided by WG members, were reflected in the textbook. In order to promote understanding of the wiring concept between devices and the method of verifying proper wiring by testing, actual connection diagram examples were inserted into the textbook. In addition, in order to insert pictures of control devices in a substation in Myanmar into the text, pictures of the equipment in the 220kV Nay Pyi Taw substation control room adjacent to the training center were taken and added to the textbook.

When the text was used in the second training, items to be added/changed/corrected were discovered and reflected in the textbook.

2.5.2.4. Live Line Work for Distribution Transformer and Low Voltage Lines

The textbook on live-line work for distribution facility construction covers the knowledge, techniques, and construction methods necessary for safe working when carrying out repair work on live-lines for overhead power distribution.

In addition, this textbook covers the protective equipment and tools necessary to carry out live-line work, and summarizes the basic items related to this work.

- ✧ Necessity of live-line work
- ✧ Information about electrical shocks
- ✧ Cases of electrical shock and prevention measures
- ✧ Types and specifications of protective tools and equipment
- ✧ Inspection of protective tools and equipment before use and how to handle them
- ✧ Equipment for pole climbing in live-line work
- ✧ Tools for live-line work
- ✧ Method of pole climbing with full harness-type safety belt
- ✧ Attaching of protection devices or covers during live-line work

✧ Certification system for live-line work

This textbook touches on the background to the introduction of live-line work in Japan and explains that it is a means to efficiently carry out construction work at distribution facilities, the amount of which is increasing with economic development.

Currently, in Myanmar, there are no opportunities for work to be carried out on live lines at distribution facilities, but it will be helpful in the future when considering various construction methods, depending on the circumstances on the Myanmar side.

This textbook will be referred to in the lectures on distribution construction and safety.

2.5.2.5. AMR, AMI and Smart Metering Systems

For the AMR (Automatic Meter Reading) and AMI (Advanced Meter Infrastructure, including smart meters) textbook, the contents focus on AMI while touching on the development history of AMR as a predecessor of AMI. The textbook describes the three main components of AMI:

✧ Meters or terminals of systems, namely AMI smart meters
✧ Central units such as servers that control systems, connect with other systems and store data
✧ Networks that transmit data between the central units and the meters

AMI is famous for its potentially innovative influence on the life of a country's residents, so the textbook highlighted a few examples of social changes seen in some countries or regions where the system has already been implemented. Some experiences related to the launch of AMI were also shared in the textbook, and international specifications on meters, servers and networks were summarized as typical references, in response to a request from the Myanmar side.

AMI could offer large-scale innovation in the field of smart cities by connecting to other adjacent systems. It also could bring business process reinventions in distribution planning, design, construction and O&M (operation and maintenance) through integration with DA (Distribution Automation) or distribution SCADA. Not only implementation of AMI but also adding an effective and customer-oriented peak-cut tariff to the lineups of power utilities' offerings to consumers, by utilizing detailed data on consumption via AMI, are essential in order to realize the peak leveling that all utilities should aim at.

The AMI textbook might be revised, if needed, in accordance with the progress in AMR or AMI projects that are said to be ongoing in Myanmar.

2.5.2.6. Testing and Commissioning of Substation Equipment

For various tests related to substation equipment, the purpose of each test is clarified and the test methods are concretely described in the textbook to promote understanding of the necessity

of the test, the physical meaning, and the effect on the prevention of accidents, etc.

Photographs and connection diagrams of the test equipment actually used in Myanmar and the test work provided by the WG members were adopted as the text. In addition, missing drawings were created by JICA experts and inserted into the text. These materials contributed to easy understanding of the test methods.

In addition, the WG members provided a Testing Procedure created by the Myanmar side, and part of it was reflected in the textbook so as to comply with the Myanmar procedure.

2.5.2.7. Distribution Management Systems

DMS (Distribution Management System) has a variety of definitions, from a mere computer-aided business support machine to an administrative or management scheme for the whole distribution business.

Considering the uncertainties around the meaning of DMS, the textbook first provides an overview of the status of distribution digitalization at Japanese firms.

It should provide trainees in Myanmar with the opportunity to understand the essence of business advancements in every category, from distribution planning, via design and construction to operation and maintenance.

The contents include distribution automation (DA) as a well-known and successful system.

The author has attempted to not only describe essential functions of the relevant system or digital equipment, but to stress the importance of implementing digitalization, which would bring considerable advantages in efficiency and effectiveness for distribution operations.

This means that the aim of business advancements through digitalization should be to gain a higher degree of customer satisfaction, rather than boosting productivity.

Therefore, deployment of CRMS (Customer Relationship Management System), which allows all staff in all business sections or bodies to access integrated data for the purpose of understanding and sharing the needs of customers, is crucial.

Furthermore, integration between computer-aided business administration systems and DA is explained as a recent topic in the distribution field.

This would enable distribution companies to add advanced business schemes to their existing ones and to acquire the ability to deal with potential challenges, especially through connection to AMI (Advanced Meter Infrastructure).

It is considered that the textbook, which refers to Japanese experiences, would be more useful and practical to engineers in Myanmar by considering the status of local distribution businesses, and by reflecting the goals and targets of the nation or Myanmar's society.

2.5.3. Discussion Content and Concerns about Practical Textbooks

2.5.3.1. Distribution Planning

The practical textbook for distribution planning is drafted based on the basic contents for distribution planning training in a Japanese power utility. It provides information on the "Multi

Divided Multi Connected (MDMC) Medium Voltage (MV) grid system configuration" and "DAS (Distribution Automation System)", which contribute to distribution reliability improvement measures in Japan, and "the introduction of distribution work systematization in Japanese power utilities" as a work efficiency improvement measure and "PJ evaluation method", in addition to basic content on distribution planning.

Furthermore, measures for loss reduction methods in distribution systems are also provided.

The contents of the current version of practical texts for distribution planning are as follows:

- ✧ Outline of Distribution Planning
- ✧ Distribution Systems
- ✧ Distribution Facility Planning
- ✧ Load Management
- ✧ Budgetary Management (with overview of Japanese experience)
- ✧ Distribution Work Systematization (Japanese experience only)
- ✧ Economic and Financial Evaluation Methods for a Project
- ✧ Distribution Automation Systems (DAS) (Japanese experience only)
- ✧ Underground Planning (Japanese experience only)
- ✧ Distribution System Loss Reduction Methods

Although information related to distribution planning work is covered, the JICA experts will continue to make additions and corrections where possible in response to requests from the Myanmar side.

2.5.3.2. Distribution Design

The practical textbook on distribution design describes the basic flow for distribution design, specific design procedures for each piece of distribution equipment, technical calculations and so on. It also refers to concrete design formulas applied in Japan. The major contents are as below:

- ✧ Outline of distribution design
- ✧ Design for electric poles
- ✧ Design for electric wires
- ✧ Design for distribution switches
- ✧ Design for service wires
- ✧ Design to protect against lightning strikes
- ✧ Design for specific equipment
- ✧ Distribution loss
- ✧ Underground distribution design

2.5.3.3. Distribution Construction and Safety

The textbook on distribution construction and safety covers information from the standpoint of construction work management (electric utility) and from the standpoint of technical knowledge on construction work provided by the construction company.

It also explains the safety activities needed to implement construction work. It focuses on how safety is important while engaging in construction work.

This textbook shows the safety efforts taken in Japan and what kind of approach electric utilities and construction companies are taking to ensure safety, and focuses on the information being considered a reference in Myanmar.

When undertaking construction work, it is essential to have not only knowledge and techniques regarding the work itself but also an understanding of the areas of planning and design, so this textbook covers fundamental knowledge in planning and design with some case references as well.

This textbook covers the following.

- ✧ Outline of Distribution Construction Work (Daily work management, Construction work management, Inspection Safety management, etc.)
- ✧ Construction work methods for distribution facilities
- ✧ Roles and responsibilities of work site supervisor
- ✧ Risk assessment methods
- ✧ Countermeasures for accidents at work
- ✧ Construction work site patrols
- ✧ Advanced construction methods (direct and in-direct live-line work)
- ✧ Distribution line design and construction case studies
- ✧ Practical safety check sheet for power distribution facility construction work

Although the textbook itself incorporates the practical ideas and knowledge applied in Japan, when using it, lecturers are to keep in mind how the ideas and knowledge will be taken into account in Myanmar in practical terms, by employing their understanding of the situation regarding construction work and safety management in Myanmar.

This textbook also covers sample formats which could be considered for use in Myanmar for construction management work and safety activities. How these could be used is also to be explained in lectures.

2.5.3.4. Distribution O&M

This textbook was developed to deal with the basics of distribution operation and maintenance (O&M). The importance of consistent and systematic approaches for power reliability improvement is stressed in the textbook, as O&M stands on the very downstream side of the entire distribution business flow, which leads to a tendency for passive methodologies and attitudes when trying to improve SAIDI and SAIFI.

The textbook also explains that it is essential for distribution companies to implant the Plan-Do-Check-Action cycle in their businesses, because the comprehensive involvement of all related sections is vital for realizing reliability, and acquiring information from feedback loops is crucial for continuous improvement.

As is well known, major indices in the technical field that distribution companies should prioritize in their operations are SAIDI and SAIFI for reliability, and loss rate for efficiency. The textbook, though specific to O&M work, explains not only reliability but also efficiency, reflecting the author's wish to help readers in Myanmar acquire knowledge with a broad perspective.

Information technologies that are exponentially developing and expanding globally could bring both innovation and evolution to distribution O&M business. A few examples in the field were put into the textbook, and the importance of always being keen to acquire such cutting-edge technologies is stressed, because advanced technologies could be too critical to be ignored in order to innovate in distribution O&M.

The main contents of the textbook on distribution operation and maintenance are shown below.

- ✧ Outline of Distribution O&M Business
- ✧ Power Quality Indices – Voltage, Current, Power Factor, Imbalance, Disturbances, etc.
- ✧ Power Quality Management
- ✧ Voltage Management – Voltage Regulation and Voltage Management Measures
- ✧ Voltage dip, Flickering, Power Factor Management and Ferranti Effect
- ✧ Harmonics – History, Causes, Regulation and Compatibility
- ✧ Adverse effects on distribution network caused by Distributed Generators
- ✧ Power Reliability Indices – SAIDI and SAIFI
- ✧ Protection Systems
- ✧ Power Disruptions – Causes of Outage Events and Reasons for Lengthy Power Interruptions
- ✧ Approach to improve SAIDI and SAIFI
- ✧ Methodologies for Network Maintenance
- ✧ Time-Based Maintenance and Condition-Based Maintenance
- ✧ Visual Checks and Diagnostics – Points to Check, Limit Samples and Repetition Period
- ✧ Relevant Indices – Loss Rate and Catalog for Loss Reduction Measures
- ✧ Digitalization in the Distribution O&M Business – Trends and Features

2.5.3.5. Transmission Line

In Phase 1, the focus was on rudimentary design and maintenance for power transmission, but this time it was taken a step further. Specifically, in the design of insulation, insulators, steel towers, conductors and ground wires, basic information leading to detailed design and simple calculation exercises were incorporated as appropriate so that theoretical and numerical understanding can be deepened.

For the maintenance of power transmission facilities, checkpoints are included in the patrol and inspection methods based on experience in Japan to provide concrete explanations.

The textbook also includes documents necessary for the maintenance of transmission facilities, natural phenomena related to the equipment, and obstacles and countermeasures that occur as a result.

2.5.3.6. Substation

For substations, a practical textbook focusing on the following actual work procedures and management methods was created.

- ✧ Substation design procedures (including underground substations)
- ✧ Substation construction procedures
- ✧ Substation data/records management
- ✧ Substation safety management
- ✧ Substation accidents/problem response

It also explains physical phenomena that occur at substations, with the aim that the reader will acquire knowledge that will help in their actual work.

- ✧ Theory of occurrence for abnormal phenomena (overvoltage, negative sequence current, harmonics, resonance phenomenon, etc.)

Trends in protection and control technology used for power grid and substation equipment are explained, so that engineers in Myanmar can study the introduction of the technology in the future.

- ✧ Auto-reclosing method
- ✧ Overload protection control
- ✧ Lightning countermeasures
- ✧ Trends in protection relay systems

The first draft was prepared with the above information and submitted to DEPP on September 30, 2020 to request confirmation of the content. At the 2nd JCC, it was confirmed that the comments were being fed back as they were under review at the relevant departments within DEPP.

Since this textbook deals with practical content, the JICA experts would like to consider additions and corrections according to the actual situation on the Myanmar side. In terms of the revision method, the actual situation should be discussed in the training and the discussion points should be reflected in the textbook.

2.5.4. Suggestions

For the textbooks for the seven new topics, the first edition was planned to be used for the training, with necessary updates added based on the feedback from the trainer candidates. However, no updates to the textbooks have been made because the training could not be held. For the practical textbooks, the drafts were submitted to MOEP at the end of September 2020 and were scheduled to be revised before the 3rd Training based on comments from MOEP after their review, but there was no feedback from MOEP.

These textbooks need to be updated according to the electric power facilities to be introduced, as well as actual operations in MOEP. Therefore, it is suggested that the textbooks should be reviewed on a continuous basis and utilized for the training of trainer candidates and young engineers after completion of the Project.

2.6. Data Management

2.6.1. Activities (overall)

2.6.1.1. 1st Workshop (June 2019)

First of all, the importance of implementing and deploying a Distribution Management System in the distribution field in Myanmar was shared with the Myanmar side in order to improve and enhance the efficiency and effectiveness of each distribution company – namely, YESC, MESC and ESE. TEPCO Power Grid's DMS was also explained to the Myanmar engineers as an example of streamlining business processes.

For the Data Management Workshop, both sides agreed to focus on data relevant to SAIDI and SAIFI, which would be essential for improving the reliability of distribution networks in Myanmar.

The JICA Experts and Myanmar engineers came to the agreement that the conditions for selecting a candidate pilot project from each company for gathering SAIDI and SAIFI data be discussed in the next workshop, which would be held in August 2019.

2.6.1.2. 2nd Workshop (August 2019)

Items of data to be collected in the event of a power disruption in the distribution network owned and operated by TEPCO Power Grid were explained to the Myanmar side by the JICA Experts. The three distribution companies determined to start collecting and storing data on power failure events in accordance with the methodologies of TEPCO Power Grid.

Each of the three firms agreed to choose a pilot project site of its own for data-gathering and to commence recording actual events of power interruptions immediately.

2.6.1.3. 3rd Workshop (September 2019)

Reports on the information gathered on power failure events at distribution companies revealed

the two significant aspects described below.

(1) The causes of power disruptions for nearly half of the events could not be found.

(2) Incidents of electricity unavailability lasting over 4 hours have sometimes been observed, and this would actually never be regarded as exceptional.

As for the former, the JICA Experts stressed the importance of clarifying the cause of failure in every event and asked the Myanmar engineers to strive not to leave any case as 'Unknown'. As for the latter, case studies on shortening failure durations in such an event were to be conducted by each company, providing information on actual events that had continued for as long as 4 hours or more at the next workshop. Procedures for collecting information in accordance with TEPCO Power Grid's scheme were also reaffirmed in order to comprehensively analyze power failures.

Both sides came to the mutual understanding that data collection be conducted continuously and preparations for the case studies mentioned above be carried out in advance of the next workshop. A work plan for developing manuals on data management would also be discussed then.

Overall explanation of the 2nd WS
(August 13, 2019)

Group discussion

Figure 2-10 Data Management Workshop

2.6.1.4. 4th Workshop (March 2020)

In this workshop, the working group confirmed how each distribution company had collected data on power failure events, using the same method as that of the 3rd workshop.

The JICA experts stressed the two points all members should remember in working group activities. These are:

(1) Data on every single event should be gathered.

(2) Data gathering should be carried out following TEPCO's methodologies.

Both sides exchanged experiences and information for conducting data collection in a more appropriate manner, which would result in the standardization of data management activities with the required quality.

2.6.1.5. 5th Workshop (1st online) (January 2021)

(1) The latest information on the WG's activities, including the content discussed at the JCC held on 24th November 2020, was shared.
   (i) The current situation, in which every single outage event is being recorded appropriately in TEPCO's format, was reported on by Myanmar side.
   (ii) Power disruption data for the years 2019 and 2020 is ready for analysis.
   (iii) Development of a 'plan-list' for reliability improvement work was explained by the JICA team as a new activity.

(2) A very basic scheme for the plan-list was explained by the JICA team and agreed upon in the WG.
   (i) The list would consist of not only disruption causes and typical countermeasures, but also expected effects and required budget for SAIDI/SAIFI improvement.
   (ii) The content of the main parts of the list would be primarily drafted by the JICA team, while the details or information on local affairs vital for their effectiveness and usefulness would be added by the Myanmar side.

(3) The below next steps for each side were confirmed:
   (i) Comprehensive data on 2019 and 2020 would be provided to the JICA team.
   (ii) The JICA team would then demonstrate the methodology for analyzing outage data.
   (iii) The JICA team would provide tentative chapters and overviews for the plan-list.

Incidental Information:

(a) The period for recording outage events in Myanmar is from Jan. to Dec., while the fiscal year runs from 1st Oct. until 30th Sep. of the next year.
(b) Data that covers from Jan. to July of 2019 are not in TEPCO's format. They are undergoing data conversion.

2.6.1.6. 2nd Online Workshop (July 2022)

The 2nd workshop was held online on 14th July, 2022, around one and a half years after the previous one. In order to fill in gaps in information, the agenda was set as follows.

(1) Share the latest information on the WG's activities.
(2) Confirm what we should do for the next WS.
(3) Reconfirm the objectives for data management implementation in distribution operations, especially the reliability improvement program.
(4) Understand the definition of SAIDI and SAIFI and the points for analyzing the indices

The JICA team asked the three companies on the Myanmar side to kindly provide all recorded data on power failure events, whether already sent to the Japanese side or not.

2.6.1.7. 3rd Online Workshop (August 2022)

The 3rd workshop was held online on 24th August, 2022.

The Reliability Improvement Plan was explained in the context of the overall business flow for SAIDI & SAIFI improvement through enforcing data management. The points were:

(1) Data Analysis
Gather and analyze data on power failure events and mobilizations.
Target promising causes or shortages for SAIDI and SAIFI improvement from insights gained from the data.

(2) Improvement Measure List
List candidate measures to address the aforementioned causes or shortages in order to mitigate poor reliability.
Consider budget, required time or resources, side effects and additional effects comprehensively.

(3) Priority
Prioritize items to be implemented among the many candidate plans by considering the company's vision.

(4) Implementation
Conduct authorized work for power reliability improvement in an effective and timely manner.

(5) Review
Check effects expressed from every measure planned and carried out for improving indices, and feed the lessons learned back into further activities, if any.

As for data analysis, the lesson that one-sided views are to be avoided was lectured upon using a case study on underground cable failure analysis. When attempting to reduce the amount of outages caused by, for example, underground cable systems, there exist many possible causes, such as:

31. Inappropriate manufacturing
32. Inappropriate construction
33. Inappropriate maintenance
34. Overloading
54. Flooding
62. Construction site

(The number at the top of each cause corresponds to the code used in the data set scheme of the outage management system utilized by Tokyo Electric Power Company.)

Each cause is related to a different business unit that has responsibility for it, and also different measure(s) to tackle.

2.6.1.8. 4th Online Workshop (September 2022)

The 4th workshop was held online on 15th September, 2022.

Comments from the JICA experts on the power failure event records submitted (especially from YESC) were shared among participants. When recording the number of affected customers, it might be useful to distinguish big customers, such as factories sited in Special Industrial Zones, from ordinary households in cases where detailed consideration is required. It is also strongly recommended to take appropriate measures to enable easy sorting of the event records by terms such as 'planned/unplanned', 'MV/LV' or 'HV/GEN', in order to focus on unplanned disruptions originating in the distribution system.

In addition, each item of work nominated for the reliability improvement program (namely, 'List of Plans') was studied considering the status on the Myanmar side. YESC, which represents the Myanmar side, will conduct further investigations to gain information on some promising areas of work.

2.6.1.9. 5th Online Workshop (October 2022)

The 5th workshop was held online on 10th October, 2022.

For the 'Reliability Plan for Pilot Lines' submitted by YESC, both sides agreed the following.

<Lightning> Unit costs (per mile) of newly-installed grounding wires and lightning arresters are to be presented.

<Salty environment> Information on present insulators is to be described.

<Aging> Current situation regarding regular inspections focused on DTs is to be clarified, such as intervals of check work and costs for inspection. The unit cost of replacing DTs of typical output is to be presented.

The JICA experts commented as follows on the outage data submitted by the three companies.

Primary and Secondary causes are essential information for data analysis that help formulate appropriate plans for reliability improvement. Utilizing the various functions of MS Excel is useful for proper data recording and calculation. This might help to detect data loss or mis-inputs. The number of total customers might need to be revised in some cases, in view of the definition of SAIDI and SAIFI.

2.6.1.10. 6th Online Workshop (November 2022)

The 6th workshop was held online on 21st November, 2022.

For the presentation to be held at the 7th December session, JICA experts stressed the importance of having a broad vision when planning, such as focusing not only on reliability but on other essential factors of loss rate or power quality indices. The Myanmar side determined the person to give a presentation from each company, and declared that it would start preparations for the presentation.

The draft version was to be explained in the next WS on 30th November.

2.6.2. Data Collection/Analysis Status at Pilot Sites

As described in 2.5.1., data collection is in progress and ongoing according to reports from the Myanmar side.

Data analysis would be expected to start soon, under the condition that the 2019 and 2020 data, referred to in 2.5.1., are deemed available for analyzing power failure event data.

2.6.3. Capacity Development

Capacity development was estimated to be properly carried out based on the progress of related activities.

The three targets for the activities of the Data Management WS are:

(1) Implementing data collection referring to the dataset utilized by Tokyo Electric Power Company
(2) Analyzing the data gathered in order to set targets for improving SAIDI & SAIFI
(3) Developing a 'List of Plans', which abridges various measures to reduce outages in the distribution network

Items (1) and (3) are almost accomplished while (2) has not yet been carried out because of a lack of data on causes, which is expected to be addressed in 'Future Plans'.

2.6.4. Concerns

Generally speaking, all participants from the Myanmar side appear to be highly skilled, keen to identify and resolve problems and committed to improving and developing their business, which suggests no concerns about achieving successful results for this working group's activities.

Here, two small concerns that could potentially affect data collection will be summarized.

(1) As previously mentioned, identifying the proper and precise cause of every single power failure accident is essential in data collecting. It is crucial to avoid choosing 'unknown' as a cause as much as possible, and select the best-fit cause from the list of failures.
    For this, a sufficient number of appropriately trained and skilled resources should be stationed at proper offices.
(2) Combined power failures, though they may occur rarely, cause power outages across wider areas. Furthermore, locating faults and identifying causes in such cases would not generally be easy to conduct.
    Data collection on even combined failures should be carried out completely, as the norm. Further organizational or systematic support for this might be necessary due to the status of the relevant businesses.

2.6.5. Suggestions

The comprehensive work flow for the systematic improvement of power reliability is summarized as follows.

✧ data gathering

- ✧ data analysis and target setting
- ✧ development of effective planning
- ✧ timely implementation
- ✧ feeding back of effects

Implementation of the loop would also bring the PDCA cycle to the relevant offices in charge of improving SAIDI and SAIFI.

2.7. Development of Standard Operating Procedures (SOP)

2.7.1. Activities (overall)

Based on the results of the discussion with DEPP, the SOPs were to be prepared through technical discussions between the JICA Expert Team and each implementation-related department directly, without setting up WGs. The JICA Expert Team then visited each implementation-related department to hold discussions.

2.7.1.1. 1st Discussion (July 30 - August 14, 2019)

Prior to the 1st discussion, part of the existing SOPs was shared by each related department in order for the JICA Expert Team to confirm what the SOPs were like. ESE, YESC and MESC provided non-technical information on administrative procedures with regard to power supply (installation of meters and transformers), and DPTSC provided non-technical information on internal work allocation.

Therefore, the utilization status of existing SOPs, the purpose of creating SOPs, and the related needs were first confirmed individually with each department involved in the activities.

Discussion with ESE (August 14, 2019)

Discussion with YESC (August 2, 2019)

Figure 2-11 Discussions on the 1st SOP

Discussion with MESC (July 30, 2019)

Discussion with DPTSC (August 14, 2019)

Figure 2-11 Discussions on the 1st SOP

The status of the existing SOPs and related needs vary depending on the implementation-related department. Hence, the SOPs to be prepared in this Project should be items which are greatly needed, and they are to be prioritized by considering their importance, urgency, frequency of use, etc. The technical know-how and experience the JICA Expert Team has should also be utilized in the SOPs. Based on the ideas described above, it was agreed that the following SOPs will be developed.

Table 2-10 SOP List

	SOP ITEM	Organization in charge
1	Operation & Maintenance of AIS Substation	ESE
2	Operation & Maintenance of GIS Substation	MESC
3	Distribution System Operation with SCADA	MESC
4	Safety Management for engineers/technicians	YESC
5	Maintenance of LV and MV distribution equipment (Tr. & Line, etc.)	YESC
6	Underground distribution system development	YESC
7	Quality Control for substation construction (including check list)	DPTSC
8	Quality Control for transmission line construction (including check list)	DPTSC

2.7.1.2. 2nd Discussion (October 31 - November 5, 2019)

The 2nd discussion was held separately with each department involved in the activities. Since the structure and content of the SOPs had not been determined on the MOEP side, the JICA Expert Team proposed their basic structure and the information to be included in each SOP selected. Following this, and by adding some content requests from the MOEP side, the JICA Expert Team prepared the first draft of the SOPs selected.

In terms of quality control for transmission line construction work, the SOP draft was shared with DPTSC prior to other SOPs.


Figure 2-12 Discussion on SOP


Figure 2-12 Discussion on SOP

2.7.1.3. 3rd Discussion (December 18 - December 24, 2019)

The JICA Expert team discussed the respective draft SOPs with ESE and DPTSC.

Since these SOPs are being promoted as MOEP common documents, the drafts are shared among other related departments through the responsible departments, and then comments are to be collected widely.

2.7.1.4. 1st Online Workshop (January 12 - 21, 2021)

Because overseas business trips remained suspended due to COVID-19 and the change in situation, topic-based workshops were planned to localize the draft SOPs online. The online workshops enabled not only the organization in charge of the topic but also other organizations to participate in the discussion and to share information/progress at the same time. The first workshops were held as follows:

Table 2-11 Schedule of 1st Online Workshop

Date	Subject
12 Jan. 2021	SOP Topic 1 (Operation & Maintenance of AIS Substation)
	SOP Topic 2 (Operation & Maintenance of GIS Substation)
14 Jan. 2021	SOP Topic 3 (Distribution System Operation with SCADA)
	SOP Topic 7 (Quality Control for Substation Construction)
19 Jan. 2021	SOP Topic 5 (Maintenance of LV & MV Distribution Line)
	SOP Topic 6 (Underground Distribution System Development)
21 Jan. 2021	SOP Topic 4 (Safety Management for Engineers/Technicians)
	SOP Topic 8 (Quality Control for Transmission Line Construction)

Consequently, all the related organizations participated in the workshops for each topic.

Table 2-12 Workshop Participant List

Name	Position	Organization	No. of Topic							
			1	2	3	4	5	6	7	8
U Tun Tun Win	DD	DPTSC	@	@	@	@	@	@	@	@
U Than Naing Lin	DD		@	@						@
U Myo Min Tun	DD									@
U Naing Win	SE	ESE	@	@						
U Phyo Wai Linn	AE				@	@	@	@	@	@
Daw Than Than Aye	EE							@		
Daw Khin Lay Nwe	GM	YESC	@	@	@	@	@	@	@	@
U Aung Kyaw Moe	DGM		@	@	@	@	@	@	@	@
U Thein Soe	AGM		@	@	@	@	@	@	@	@
U Zaw Lin Tun	AGM							@		
U Hlaing Hlaing Oo	GM	MESC	@	@	@	@	@	@	@	@
U Nanda Kyaw	DGM		@	@	@	@	@	@	@	@
Daw Zin Mar Win	AM		@	@	@	@	@	@	@	@
Daw Moe Thuzar Htwe	AD	DEPP	@	@						
Daw Chaw Thanda Soe	AD									@

@: participated / Gray hatching: organization in charge

2.7.1.5. 2nd-6th Online Workshops (June - November 2022)

In February 2021, immediately after the first online workshop in January 2021, the change in situation occurred and the online workshop had to be cancelled. Since then, the situation in Myanmar has been closely monitored, and in June 2022, when it was confirmed that MOEP was ready to take action, the online workshop resumed for the first time in approximately one year and five months in preparation for the completion of the SOPs. The dates of each workshop are as follows. The number of workshops held was six, including the one held in 2021, and follow-

ups were conducted by e-mail or other means as necessary.

Table 2-13 Dates of the 2nd-6th Online Workshops

Topic	Workshop No.	Date
SOP Topic 1 (Operation & Maintenance of AIS Substation)	2nd workshop	June 14th, 2022
	3rd workshop	July 25th 2022
	4th workshop	August 16th 2022
	5th workshop	October 4th 2022
	6th workshop	November 8th 2022
SOP Topic 2 (Operation & Maintenance of GIS Substation)	2nd workshop	June 14th, 2022
	3rd workshop	July 25th 2022
	4th workshop	August 16th 2022
	5th workshop	October 4th 2022
	6th workshop	November 8th 2022
SOP Topic 3 (Distribution System Operation with SCADA)	2nd workshop	June 21st, 2022
	3rd workshop	August 2nd 2022
	4th workshop	September 13rd 2022
	5th workshop	October 18th 2022
	6th workshop	November 22nd 2022
SOP Topic 4 (Safety Management for Engineers/Technicians)	2nd workshop	July 11st, 2022
	3rd workshop	September 12nd 2022
	4th workshop	October 5th 2022
	5th workshop	October 18th 2022
	6th workshop	November 22nd 2022
SOP Topic 5 (Maintenance of LV & MV Distribution Line)	2nd workshop	July 11st, 2022
	3rd workshop	September 12nd 2022
	4th workshop	October 5th 2022
	5th workshop	October 18th 2022
	6th workshop	November 22nd 2022
SOP Topic 6 (Underground Distribution System Development)	2nd workshop	July 16th, 2022
	3rd workshop	July 21st 2022
	4th workshop	August 30th 2022
	5th workshop	October 6th 2022
	6th workshop	November 10th 2022
SOP Topic 7 (Quality Control for Substation Construction)	2nd workshop	June 14th, 2022
	3rd workshop	July 25th 2022
	4th workshop	August 16th 2022
	5th workshop	October 4th 2022
	6th workshop	November 8th 2022
SOP Topic 8 (Quality Control for Transmission Line Construction)	2nd workshop	June 16th, 2022
	3rd workshop	July 21st 2022
	4th workshop	August 23rd 2022
	5th workshop	October 27th 2022
	6th workshop	December 2nd 2022

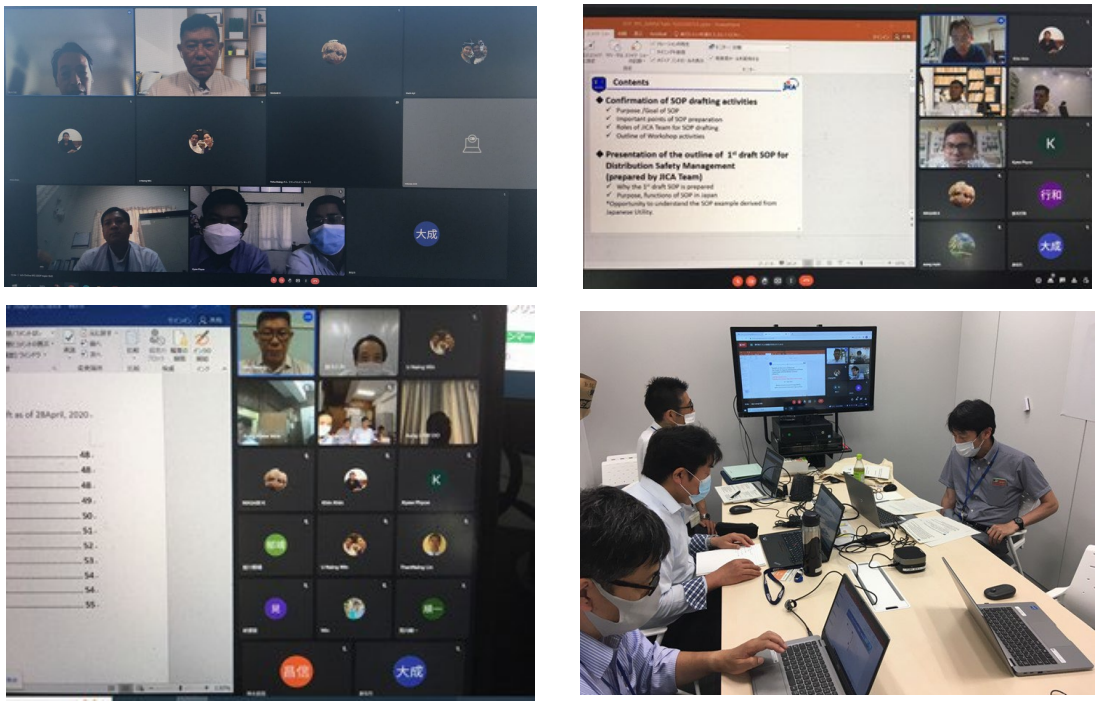


Figure 2-13 the 2nd-6th Online Workshops

2.7.1.6. 7th Follow-up Workshops (November- December 2022)

As mentioned above, a total of six online workshops were held in the preparation of the SOPs, following the on-site consultations. In addition to that, follow-up workshops were held to review the presentation materials for presenting the draft SOPs to MOEP management. As travel to Myanmar became possible near the end of the Project period, face-to-face workshops were held on topics that were feasible at that time. The follow-up workshops were conducted as follows.

Table 2-14 Dates of the 7th Follow-up Workshops

Topic	Date	Place
SOP Topic 4 (Safety Management for Engineers/Technicians) Data Management	November 30th 2022	Online
SOP Topic 8 (Quality Control for Transmission Line Construction)	December 2nd 2022	Online
SOP Topic 3 (Distribution System Operation with SCADA) SOP Topic 5 (Maintenance of LV & MV Distribution Line) SOP Topic 6 (Underground Distribution System Development)	December 16th 2022	YESC Meeting Room at Yangon
SOP Topic 1 (Operation & Maintenance of AIS Substation) SOP Topic 2 (Operation & Maintenance of GIS Substation) SOP Topic 7 (Quality Control for Substation Construction)	December 19th 2022	MOEP Training Center at Nay Pyi Taw

Figure 2-14 the 7th Follow-up Workshop at YESC

Figure 2-15 the 7th Follow-up Workshop at MOEP Training Center

2.7.1.7. Presentation on Standard Operating Procedure & Data Management

Presentations were made by representatives of each topic in order to explain the SOPs created and the results of the data management working group to MOEP. The presentations were held face-to-face in Nay Pyi Taw, but also streamed so that they could be attended online. The presenters for each topic are as follows.

Table 2-15 Presenters for SOPs & Data Management Presentations

Presentation on Standard Operating Procedure & Data Management		
Date & Place : 20th December, 2022 @ PARKROYAL HOTEL Nay Pyi Taw		
SOP Topic 1	U Naing Win,	ESE
SOP Topic 2	U Kyaw Phyoe Win	MESC
SOP Topic 3	U Kyaw Phyoe Win	MESC
SOP Topic 4	U Thiha Hlaing	YESC
SOP Topic 5	U Pyae Hein Win	YESC
SOP Topic 6	U Zaw Linn Htun	YESC
SOP Topic 7	U Tun Tun Win	DPTSC
SOP Topic 8	U Than Naing Lin	DPTSC
Data Management	Daw Thin Thin Hlaing	YESC
	Daw Su Hlaing Phyo	ESE
	U Kyaw Phyoe Win	MESC

SOP Topic 1

SOP Topic 2&3, Data Management

Topic 4

SOP Topic 5

SOP Topic 6

SOP Topic 7

SOP Topic 8

Data Management

Data Management

Figure 2-16 Presentation on SOPs& Data Management

2.7.2. Discussion Content for each SOP Item, Issues of Concern and Suggestions

2.7.2.1. Operation and Maintenance of AIS Substation

A draft version of the SOP for the O&M of AIS substations was prepared with reference to the Japanese operations manual for the patrol and inspection of substation facilities.

However, MOEP's actual facilities and O&M management system were different from those in Japan.

It was important to draw out actual conditions, opinions, and requests from MOEP and reflect them in the SOP through workshops so that a realistic, MOEP version of the SOP could be completed.

When the SOP was first prepared, discussions were held twice with ESE, which proposed the preparation of the SOP. After that, a workshop involving ESE, YESC, MESC, and DPTSC was set up to reflect the opinions of MOEP as a whole.

Therefore, we proposed a questionnaire covering all contents of the draft SOP so that it could reflect MOEP's intentions, and utilized it with MOEP's endorsement.

The content discussed at the workshop was maintained as a discussion list, and the status of its reflection in the SOPs was also shared.

The workshop was led by ESE and involved all MOEP members in the compilation of opinions.

1st Online Workshop (January 12, 2021)

[Discussions]

At the first online workshop, in which all relevant departments within MOEP participated, the following things were explained with an outline of the SOP:

- ✧ The current SOP was created with reference to Japanese operating procedures.
- ✧ The procedures and figures in the current SOP need to be modified to suit the actual situation in Myanmar.

From the next WS, the participants agreed to modify each item according to the actual situation in Myanmar. The JICA experts were to distribute a table describing the contents of the discussion in advance and the Myanmar side would prepare comments and information

per the table by the next WS.

2nd Online Workshop (June 14, 2022)

Since the WS was being held again after a break of a year and a half, it was agreed that the SOP preparation work would resume from the beginning.

[Discussions]

- ✧ A draft version of the SOP prepared with reference to the Japanese manual was shared, and the outline and structure of the SOP were explained.
- ✧ Participants discussed the workshop schedule for the completion of the MOEP version of the SOP.
- ✧ Participants agreed on the points to be discussed at each workshop.

[Proposals]

- ✧ A draft version of the SOP was proposed.
- ✧ It was suggested that a questionnaire covering the contents of the SOP be used.

[Future recommendations]

- ✧ Clarify the items that should be reflected in the SOP according to the actual situation on the MOEP side.

3rd Online Workshop (July 25, 2022)

[Discussions]

- ✧ It was agreed to add to the SOP the dry-type equipment used on the MOEP side, in addition to the oil-filled current transformer (CT).
- ✧ It was agreed to add the capacity calculation method for the nickel cadmium type battery used on the MOEP side, in addition to that for the lead-acid battery.
- ✧ It was agreed to add an example of the battery capacity calculation procedure to the SOP so that MOEP engineers can calculate the battery capacity themselves by referring to the SOP.

[Proposals]

- ✧ The MOEP side should review the draft SOPs before the next workshop and propose necessary modifications at the next WS.

[Future recommendations]

- ✧ Since the draft version of the SOP has been prepared only for Japanese practices, it is important to continue the revision work according to the actual condition of the facilities on the MOEP side, as discussed in this WS.

4th Online Workshop (August 16, 2022)

[Discussions]

- ✧ The definition of the life (cycle) of storage batteries as a characteristic of them was confirmed and it was discussed whether the definition was suitable or not for use in Myanmar's environment.

[Proposals]

- ✧ In conjunction with the addition of the nickel-cadmium storage battery capacity calculation method, it was proposed to add a calculation method for the case of lithium-ion batteries, which are more likely to be used.
- ✧ In conjunction with the addition of the storage battery capacity calculation example, it was proposed to add an example for calculating the capacity of a battery charger.

[Future recommendations]

- ✧ Check SOP items from the viewpoint of whether the current work process needs to be changed according to the SOP.
- ✧ Check SOP items from the viewpoint of whether the SOP needs to be modified to fit the current work process

5th Online Workshop (October 4, 2022)

[Discussions]

- ✧ The definition of storage battery life (cycles) was reviewed and shared.

[Proposals]

- ✧ It was suggested that the workflow for "Patrol Operations" and "Inspection Operations" be explained and added to the SOP.

[Future recommendations]

- ✧ Report the results of the workflow review, review the latest draft version of the SOP, and summarize opinions.

6th Online Workshop (November 8, 2022)

[Discussions]

- ✧ Agreed to finalize comments by ESE after explaining the latest draft version of the SOP.
- ✧ It was confirmed that the SOP would be revised and shared on the MOEP side by the follow-up workshop, to be held face-to-face.

[Proposals]

- ✧ It was suggested that any questions or confirmations throughout the entire SOP be summarized in advance if they were expected to be discussed during the face-to-face follow-up.

[Future recommendations]

- ✧ Since MOEP needs to review and revise the completed MOEP version of the SOP as appropriate, it is necessary to establish a work system to manage the SOP periodically.

7th Online Workshop (December 19, 2022)

[Discussions]

- ✧ The latest draft version of the SOP was explained and it was agreed to finalize the revisions.
- ✧ The revisions in the department names in the workflow were confirmed.
- ✧ The additional descriptions of the part device names on each facility were presented and

confirmed.

✧ It was confirmed that the term "LR", used in the description of transformer inspection items, should be modified to "LTC".

[Proposals]

✧ Added descriptions and explanations of two gas circuit breaker arc extinguishing methods.

✧ Added description of the outline drawing of the vacuum circuit breaker and a photograph of the vacuum measuring device.

[Future recommendations]

✧ It would be beneficial to continuously improve the SOP to identify the root causes of abnormalities and share countermeasures for such abnormalities and other problems found during inspections, in order to move forward to the next step.

2.7.2.2. Operation and Maintenance of GIS Substation

A draft version of the SOP for the O&M of GIS substations was prepared with reference to the Japanese operations manual for the patrol and inspection of substation facilities.

However, MOEP's actual facilities and their O&M management system were different from those in Japan.

It was important to draw out actual conditions, opinions, and requests from MOEP and reflect them in the SOP through workshops so that a realistic, MOEP version of the SOP could be completed.

Therefore, we proposed a questionnaire covering all contents of the draft SOP so that it could reflect MOEP's intentions, and utilized it with MOEP's endorsement.

The content discussed at the workshop was maintained as a discussion list, and the status of its reflection in the SOPs was also shared.

The workshop was led by MESC and involved all MOEP members in the compilation of opinions.

1st Online Workshop (January 12, 2021)

[Discussions]

Before holding the online WS, the discussion on the SOP was conducted only with MESC, which was the entity proposing to establish the SOP for GIS substations. At the first online workshop, in which all relevant departments within MOEP participated, the following things were explained with an outline of the SOP:

✧ The current SOP was created with reference to Japanese operating procedures.

✧ The procedures and figures in the current SOP need to be modified to suit the actual situation in Myanmar.

From the next WS, the participants agreed to modify each item according to the actual situation in Myanmar. The JICA experts were to distribute a table describing the contents of the discussion in advance and the Myanmar side would prepare comments and information according to the table by the next WS.

Since the leader, MESC, had no experience in GIS and it was difficult to provide information that can be reflected in the SOP, the modification work was to proceed while drawing out the actual situation in Myanmar from the experience of DPTSC and YESC.

2nd Online Workshop (June 14, 2022)

[Discussions]

- ✧ A draft version of the SOP prepared with reference to the Japanese manual was shared, and the outline and structure of the SOP were explained.
- ✧ Participants discussed the workshop schedule for the completion of the MOEP version of the SOP.
- ✧ Participants agreed on the points to be discussed at each workshop.

[Proposals]

- ✧ A draft version of the SOP was proposed.
- ✧ It was suggested that a questionnaire covering the contents of the SOP be used.

[Future recommendations]

- ✧ Clarify the items that should be reflected in the SOP according to the actual situation on the MOEP side.
- ✧

3rd Online Workshop (July 25, 2022)

[Discussions]

- ✧ Opinions on the SOP's Chapter 1 "Purpose" through 3.2 "Inspection Services" in Chapter 3 were exchanged per the MOEP side's response regarding the draft version of the SOP.

[Proposals]

- ✧ The MOEP side should review the draft SOPs before the next workshop and propose necessary modifications at the next WS.

[Future recommendations]

- ✧ Since the draft version of the SOP has been prepared only for Japanese practices, it is important to continue the revision work according to the actual condition of the facilities on the MOEP side, as discussed in this WS.

4th Online Workshop (August 16, 2022)

[Discussions]

- ✧ Opinions on the SOP's Chapters 3.3 "Control Operations" through 3.5 "Field Work Precautions" in Chapter 3 were exchanged per the MOEP side's response to the draft version of the SOP.

[Proposals]

- ✧ The MOEP side should review the draft SOPs before the next workshop and propose necessary modifications at the next WS.

[Future recommendations]

- ✧ Check SOP items from the viewpoint of whether the current work process needs to be

changed by the SOP.

- ✧ Check SOP items from the viewpoint of whether the SOP needs to be modified to fit the current work process.

5th Online Workshop (October 4, 2022)

[Discussions]

- ✧ It was confirmed that the draft SOP does not include any equipment other than GIS, but that the SOP for Topic 1, AIS Substation, should be referenced as needed.

[Proposals]

- ✧ It was suggested that the workflow for "Patrol Operations" and "Inspection Operations" be explained and added to the SOP.

[Future recommendations]

- ✧ Report the results of the workflow review, review the latest draft version of the SOP, and summarize opinions.

6th Online Workshop (November 8, 2022)

[Discussions]

- ✧ After explaining the latest draft version of the SOP, participants agreed to finalize comments on the SOP.
- ✧ It was confirmed that the SOP should be revised and the revised SOP be shared by the MOEP side by the follow-up Workshop, to be held face-to-face.

[Proposals]

- ✧ It was suggested that any questions or confirmations throughout the entire SOP be summarized in advance if they were expected to be discussed during the face-to-face follow-up.

[Future recommendations]

- ✧ Since MOEP needs to review and revise the completed MOEP version of the SOP as appropriate, it is necessary to establish a work system to manage the SOP periodically.

7th Online Workshop (December 19, 2022)

[Discussions]

- ✧ It was agreed to add the 33kV Semi-GIS equipment used at MOEP to the SOP.
- ✧ It was confirmed that the circuit breaker used in the 33kV Semi-GIS is a vacuum circuit breaker and should be excluded from the gas control table in the SOP.
- ✧ It was agreed to adopt MOEP's idea for the notation of workflow.

[Proposals]

- ✧ A photo of the gas leak measuring device actually used for 33kV semi-GIS in MOEP was provided, and it was proposed and agreed to replace the photo with a photo illustrating the external diagnostic techniques section.

[Future recommendations]

- ✧ It is possible to identify most abnormalities in SF6 gas-insulated equipment by conducting gas leak checks and dissolved gas analysis tests. It would be good to promote the training of engineers to handle the equipment.

2.7.2.3. Distribution System Operation with SCADA

The JICA team prepared the draft SOP (sample) related to distribution system operation with SCADA based on the distribution line and substation operation manual used in a Japanese electric utility. In the first workshop, the policy for the initiative was confirmed among the parties concerned in order to proceed with the SOP drafting work. At the same time, the contents of the draft SOP prepared by the JICA team were explained to the participants in order for them to understand it. In addition, the work of the Myanmar side WG members was confirmed. In the 2nd to 6th workshops, the actual operations for distribution systems in Myanmar were discussed for each item of the draft SOP, and efforts were made to ensure that this SOP satisfies the following items.

- ✧ Documenting the existing operation policy developed on the Myanmar side.
- ✧ This SOP should contribute to the capacity building of practitioners in Myanmar.
- ✧ The Myanmar side must be able to update the SOP by themselves in the future.

[Issues/Concerns]

- ✧ It seems that the assumptions on various abnormal situations regarding distribution systems, and the education and training for them, have not been sufficiently conducted.
- ✧ There is concern about how the contents of this SOP will be reflected in in-house training in Myanmar.
- ✧ ESE, YESC, and MESC might have their own operational policies due to differences in regional realities and the level of progress in facility formation, but the details regarding these differences were not clear. Therefore, it is necessary to continue to closely monitor how the SOP developed this time will be handled within each company.

[Points to note]

- ✧ The SOP prepared this time defines the operational policy for distribution systems. The Myanmar side is expected to continuously develop the workflow for each operation case.
- ✧ It is necessary to update the operation rules in accordance with the progress of SCADA system implementation. Therefore, after the implementation of the SCADA, the Myanmar side should not leave it up to the manufacturers, but be actively involved to ensure that SOPs are updated appropriately.

2.7.2.4. Safety Management for Engineers/Technicians

Based on the agreement with the Myanmar side, draft SOP, which focused on safety in distribution construction, was prepared and shared with the Myanmar side, with the aim of

developing their own SOP on distribution safety management. The draft referred to operation manuals by the distribution department of a Japanese power utility, and quoted general content such as basics and principals on safety.

As reference, in the first workshop of this SOP subproject, the JICA experts first explained the business flow of distribution construction typically seen in Japanese industry, and came to the conclusion that there exists no significant difference in business style between the two nations. This was followed by a briefing on the contents of the draft SOP.

The essence of the relevant manuals by the safety management department of the Japanese firm was added to the original draft SOP in response to a request from the Myanmar side.

Localization of the draft SOP was completed on the Myanmar side for the purpose of developing SOP of their own, by reflecting the status of local industry. The resulting document was, naturally, in compliance with related laws and regulations on safety stated by the central or local government.

[Issues/Concerns]

- ✧ The contents of the localized SOP - especially the rules and regulations, training resources and quantitative standards - could be ineffective in pursuing safety if the SOP did not appropriately reflect the realities of the workforce, equipment or organizations in Myanmar.

[Points to note]

- ✧ Differences in many aspects, such as the safety legal system, business flow, machines and equipment, and safety consciousness, between Japan and Myanmar should be recognized and considered in developing local SOP.
- ✧ Not only SOP-based work but capacity building, and well-trained resources with appropriate equipment are necessary for safety and quality.
- ✧ Sharing information on disasters in a timely manner, warning each other when a potentially risky practice is observed, and the repetition of safety training are essential for effectively reducing fatal accidents, many of which take place repeatedly.
- ✧ Cleaning up work sites and putting them in order are deemed a steady approach to ensure safety, even if this looks like a detour to the goal. This is endorsed by experience from many cases in which disorderly construction premises tend to experience accidents.

2.7.2.5. Maintenance of LV and MV Distribution Equipment

The SOP drafting activity for “maintenance of LV, MV distribution equipment” provides the content extracted for pole and DT (Distribution Transformer), which account for a large amount of equipment among distribution facilities composed of various equipment, as the first localization target. The information references examples of basic content from the “Distribution Material Preventive Maintenance Manual” of a Japanese power utility.

At the first (1st) WS, the JICA experts confirmed the policy for proceeding with SOP localization work in the future among related parties. The JICA experts explained the relation of laws and regulations, content, limit (photo) sample materials and the SOP update policy following

implementation in order to promote detailed understanding of the 1st draft SOP provided. Further, in order to promote future localization work by the Myanmar team based on “a draft of the SOP for maintenance for LV and MV distribution equipment” which was provided by JICA experts, the JICA experts confirmed the WG leader of the Myanmar team and the work plan for the future.

The maintenance and operation methods for distribution facilities in Myanmar are different from those in Japan. In terms of the numerical values for standards, which were provided as Japanese checking/inspection examples, the JICA experts also explained and emphasized that the contents of the 1st draft SOP cannot be adopted in Myanmar, because the numerical values are based on the conclusions from evaluating the relation between strength and deterioration of equipment in a Japanese power utility.

In addition, the JICA experts decided to provide basic content for "measurement", "on-site attendance and protection" and "repair," explained at the 1st workshop on the SOP, since the Myanmar team requested their provision for localization work based on information used by a Japanese power utility.

In the 2nd workshop, the contents of the 1st workshop were re-lectured upon. The 3rd workshop covered the concept of preventive maintenance; in the 4th and 5th workshops, the progress of localization work was confirmed; and in the 6th workshop, the SOP improvement and revision activities for the future were introduced.

In the next step of the SOP localization work to be performed by the Myanmar team, there is a need for confirmation and verification of matters such as laws and standards, maintenance methods, limit (photograph) sample materials and numerical standards in Myanmar.

[Issues/Concerns]

- ✧ With regard to the numerical standards for pole and DT maintenance, it is unclear whether the Myanmar team will perform the technical verification and localize it based on the conclusion of the technical verification.
- ✧ It is necessary to work on the basis of some kind of verification by the Myanmar team when creating limit (photo) sample materials.
- ✧ Establishment of local versions of SOPs at related power distribution companies.
- ✧ Local establishment of SOP improvement and revision activities.

[Points to note]

- ✧ Confirmation of unclear points on the SOP content provided by the JICA experts and promoting understanding of basic SOP content.
- ✧ Encouraging reports about confirmation status on related laws and standards, work operation procedures, work personnel and their roles in Myanmar, and supporting them so that the information is reflected in the SOP after localization work.
- ✧ Providing support for the task of updating the limit sample (photo) materials.
- ✧ Since there is no technical basis for numerical standard examples of poles and DTs for equipment with Myanmar specifications, and it is assumed that it will be difficult to determine the Myanmar standards at an early stage, the JICA experts should confirm with

the Myanmar team about their handling policy and obtain agreement.

- ✧ After the end of the Project, it is necessary for the Myanmar team to update the SOP contents as appropriate by itself, and it is also necessary to additionally enhance the contents concerning distribution equipment and related procedures that were not provided this time.
- ✧ In this Project, the JICA experts requested the active participation of the Myanmar team from the first stage of localization work on the information for poles and DT, and provided support for basic capacity building.

2.7.2.6. Underground Distribution System Development

The purpose of the draft SOP for underground distribution system development is to promote underground distribution systems in Myanmar. The draft SOP was prepared by the JICA team referring to the guidelines for underground distribution system development in Japan as an example, focusing on the planning, implementation and promotion methods. In the 1st Workshop, the JICA team explained the 1st draft SOP to the working group members. During the workshop, the aim of this SOP and how it is to be used were confirmed and basic ideas on SOP content shared among working group members. It was also explained that since the 1st draft SOP is based on Japanese practices, it needs to be modified to fit Myanmar's situation. Working group members understand that the SOP is designed to be used in Myanmar continuously and active involvement of the Myanmar side is essential because it must be established, revised, updated or modified by themselves. In the 2nd to 6th workshops, we confirmed the relevant laws and regulations, standards, and business operation methods in Myanmar, being mindful of the actual conditions related to the formation process for the underground distribution system in Myanmar for each item of the draft SOP. In addition, efforts were made to ensure that this SOP meets the following items.

- ✧ Documenting the existing business operation methods developed on the Myanmar side.
- ✧ This SOP should contribute to the capacity building of practitioners in Myanmar.
- ✧ The Myanmar side must be able to update the SOP by themselves in the future.

[Issues/Concerns]

- ✧ In urban areas where electricity demand is growing rapidly, it is expected that the undergrounding of distribution facilities will proceed at a different speed than in the past. Therefore, there is concern about whether the training of engineers familiar with the construction of underground distribution facilities will proceed in a planned manner.

[Points to note]

- ✧ As the undergrounding of power distribution facilities continues to expand in urban areas, the importance of load relief for healthy sections in the event of a facility accident is expected to increase. However, the current configuration of underground power distribution systems does not seem to take the above points into sufficient consideration. Therefore, we hope that this point will be discussed in the standardization of system configurations in the future.

✧ In addition, distribution substations will be included while accepting the growing demand for electricity. Therefore, it is necessary to work more closely with DPTSC than ever before, especially in urban areas.

2.7.2.7. Quality Control for Substation Construction

A draft version of the SOP for quality control of substation construction was prepared with reference to the Japanese design manual for substation facilities.

However, MOEP's actual facilities and their O&M management system were different from those in Japan.

It was important to draw out actual conditions, opinions, and requests from MOEP and reflect them in the SOP through workshops so that a realistic, MOEP version of the SOP could be completed.

Therefore, we proposed a questionnaire covering all contents of the draft SOP so that it could reflect MOEP's intentions, and utilized it with MOEP's endorsement.

The content discussed at the workshop was maintained as a discussion list, and the status of its reflection in the SOPs was also shared.

The workshop was led by DPTSC and involved all MOEP members in the compilation of opinions.

1st Online Workshop (January 14, 2021)

[Discussions]

At the first online workshop, in which all relevant departments within MOEP participated, the following things were explained with an outline of the SOP:

✧ The current SOP was created with reference to Japanese design procedures.

✧ The procedures and figures in the current SOP need to be modified to suit the actual situation in Myanmar.

From the next WS, the participants agreed to modify each item according to the actual situation in Myanmar. JICA experts requested DPTSC to provide a workflow chart that matches the current situation in Myanmar by the next meeting, and the JICA experts would also distribute a table describing the contents of the discussion in advance, with the Myanmar side preparing comments and information according to the table by the next WS.

The leader, DPTSC, is actively reviewing the SOP, and JICA experts can expect further active involvement.

2nd Online Workshop (June 14, 2022)

[Discussions]

✧ A draft version of the SOP prepared with reference to the Japanese manual was shared, and the outline and structure of the SOP were explained.

✧ Participants discussed the workshop schedule for the completion of the MOEP version of the SOP.

✧ Participants agreed on the points to be discussed at each workshop.
- Add description of power cable connections and overhead line connections to transformers
- Create and explain descriptive material on tablets and keys
- Add design items specific to unmanned substations, especially substation automation systems

[Proposals]

✧ A draft version of the SOP was proposed.

✧ It was suggested that a questionnaire covering the contents of the SOP be used.

[Future recommendations]

✧ Clarify the items that should be reflected in the SOP according to the actual situation on the MOEP side.

3rd Online Workshop (July 25, 2022)

[Discussions]

✧ It was agreed to consider the following requests from the MOEP side.
- Add items on the commissioning test for substations
- Add transmission line protection relay function
- Add example patterns, like double bus bar, to the bus bar design arrangement
- Add the layout design for new remote monitoring and control equipment in the section on unmanned design
- It was also agreed that MOEP should confirm the actual status of the workflow.

[Proposals]

✧ Items required for the unmanned substation design study were proposed.

✧ Materials regarding tablets and keys were provided and explained.

[Future recommendations]

✧ Since the draft version of the SOP is being prepared only for Japanese practices, it is important to continue the revision process conforming to the business reality on the MOEP side, as discussed at this WS.

4th Online Workshop (August 16, 2022)

[Discussions]

✧ Agreed to provide information on safety valve testing of circuit breakers among the inspection items of the commissioning test.

✧ Agreed to add the solid grounding method, which is mainly used in Myanmar, to the neutral grounding method.

✧ Agreed to add a calculation method to estimate the capacity of DC battery chargers and to add examples of capacity calculations for DC chargers and storage batteries.

✧ Agreed to add an example of capacity calculation for an auxiliary circuit.

✧ Agreed to add information on the selection method for control cables.

✧ Agreed to delete the section on compressed air systems and add information on MTS (Mixed Technology Switchgear) instead.

[Proposals]

✧ Items on commutation testing of substations were proposed.

[Future recommendations]

✧ Check SOP items from the viewpoint of whether the current work process needs to be changed according to the SOP.

✧ Check SOP items from the viewpoint of whether there is a need to modify the SOP to fit the current work process.

5th Online Workshop (October 4, 2022)

[Discussions]

✧ It was agreed that the workflow that was under consideration on the MOEP side did not require any modification.

✧ It was agreed that applicable conditions for the installation of bus bar protection relays, such as voltage and GIS, should be considered.

✧ It was agreed to provide information on examples of standard circuit breaker trip circuit duplication.

[Proposals]

✧ An additional item on control cable selection was proposed. In addition, a formula for calculating the allowable length of control cables was provided so that the MOEP side can also calculate the allowable length.

✧ An item on MTS (Mixed Technology Switchgear) information was compiled and proposed.

✧ Provided information on safety valve testing of circuit breakers as one of the commissioning test items.

✧ Proposed additional items on transmission line protection relay function.

[Future recommendations]

✧ A list of overhead line connection materials, etc., is a reference document in itself. It is important not only to put everything in the SOP but also to have a variety of dedicated materials.

6th Online Workshop (November 8, 2022)

[Discussions]

✧ It was agreed that the protection and control circuit connection diagram would be revised and reflected by the MOEP side.

✧ It was agreed that the voltage classifications of the applicable conditions for bus bar protection relays and the voltage classifications of the list of transmission line protection relays will be corrected to match the actual situation on the MOEP side.

[Proposals]

✧ Capacity calculation methods and calculation examples for storage batteries, DC battery

chargers, and household transformers were proposed.

- ✧ Proposed application conditions for bus bar protection relays.
- ✧ Proposed a standard diagram regarding the redundancy of circuit breaker trip circuits.
- ✧ Suggested that any questions or points to be confirmed throughout the entire work process be summarized in advance if MOEP wants to discuss them in the follow-up face-to-face meeting.

[Future recommendations]

- ✧ Since the completed MOEP version of the SOP needs to be reviewed and revised as appropriate, it is necessary to establish a work system to manage the SOP periodically.

7th Online Workshop (December 19, 2022)

[Discussions]

- ✧ The latest draft version of the SOP was explained and it was agreed to finalize the revision items.

[Proposals]

- ✧ Although not reflected in the SOP at this time, the JICA experts provided and explained a form that can be used as a reference for the future development of materials for overhead wire connection materials.

[Future recommendations]

- ✧ Since substation design involves many items that must be considered and decided upon, it is important to improve the SOP. It would be preferable that the SOP include what the design staff should check as they work.

2.7.2.8. Quality Control for Transmission Line Construction

In response to a strong request from the Myanmar side (DPTSC), we provided support for the preparation of SOPs for construction supervision, construction inspection reports, and checklists for transmission line construction.

In assisting the preparation, the structure and content of Japan's SOP were referred to, and drafts were presented for the below four items. Based on these, several workshops were held to explain and discuss mainly the points that should be reviewed, and the finalization was made by the Myanmar side.

Japan's inspection standard values were presented as examples of specific construction inspection standard values. However, during the discussion, it was explained that these standard values were rather strict in accordance with the high quality of construction in Japan. This was understood and incorporated into the final SOP.

The types of construction inspections are shown in a list as standard examples in Japan, but in this work, the guidebooks were divided into three main categories (Tower foundations, Tower erection, and Wire stringing).

In the future, it is hoped that SOPs or guidebooks for other categories, such as material inspections, OPGW inspections, and completion inspections, will be considered and prepared by

the Myanmar side themselves.

(1) Quality control for transmission line construction work

This is the basis of construction management for construction work in general and consists of the purpose of construction management work, construction management system, responsibilities and authorities, construction supervision, quality control, etc.

Responsibilities and authorities were reviewed to suit the actual situation in Myanmar, but the final SOP was made generally based on the contents of the draft.

(2) Inspection guidebook and checklist for tower foundations

A draft of the inspection system, inspection method, inspection items, inspection standards, and inspection checklist at the tower foundation construction stage was presented based on examples in Japan and other countries, but the final SOP was made generally based on the contents of the draft.

(3) Inspection guidebook and checklist for tower erection

Drafts of inspection methods, inspection items, inspection items, inspection standards and inspection checklists at the tower assembly stage were presented based on examples in Japan and other countries, but the final SOP was made generally based on the contents of the draft.

However, since the types of bolts and nuts used are based on Japanese standards, it is recommended that they should be reviewed in accordance with the bolts and nuts standards used in Myanmar.

(4) Inspection guidebook and checklist for wire stringing

Drafts of inspection methods, inspection items, inspection standards and inspection checklists for the electric wire installation stage were presented based on examples in Japan and other countries, but the final SOP was made generally based on the contents of the draft.

It was requested to present sample data for some of the inspection record forms as part of the writing method. In addition, since there was a question about how to measure the slackness of electric wires, we introduced a standard measurement method and gained understanding on this.

Construction of transmission lines is currently underway in Myanmar, and the SOP prepared this time should be used to supervise construction on-site. As a result, if there is anything that should be improved, we hope the SOP will be revised appropriately.

2.7.3. Suggestion for Use of SOP

Draft SOPs for MOEP were prepared with reference to the relevant operation procedures of a Japanese power utility. These SOPs will aid operational efficiency, as well as the standardization of technology. It is suggested that the SOPs be translated into Burmese as appropriate, be posted on the intranet, etc. for information sharing, and be positioned as official documents and utilized in MOEP. In common with the textbooks, SOPs need to be updated according to the facilities to be introduced in the future and actual operations. Therefore, it is also suggested that departments mainly in charge of each SOP are determined, and the SOPs be reviewed on a continuous basis after completion of the Project.

2.8. Self-Learning

2.8.1. Preparation of Materials

Self-learning materials for each subject were created and provided to the trainer candidates so that they could continue to strengthen their capabilities even while the training was suspended. Preparatory content was created for subjects in which training had not been completed (i.e., transmission lines and substations), and reviews/exercises were created for distribution planning, distribution design, distribution construction and safety, and distribution O&M, in which training had been completed.

2.8.2. Status of Implementation

Prior to the online 2nd Training scheduled for July and August 2020, the self-learning materials for substations and transmission lines were provided from the end of June 2020. The materials for other subjects were then provided in series, around every two weeks, from September 2020.

Table 2-16 Implementation Status for Self-Learning

Subject	Date Distributed	No. of Submission	Implementation Rate
Substation	June 23, 2020	23	76.7%
Transmission Line	July 1, 2020	4	13.3%
Distribution Planning	September 28, 2020	10	33.3%
Distribution Design	October 9, 2020	8	26.7%
Distribution Construction & Safety	November 11, 2020	9	30.0%
Distribution O&M	November 28, 2020	10	33.3%

The implementation rate for substations, which was the first subject, exceeded 70%, but after that the rates were as low as about 30%. Some trainees said that they couldn't spare time for the self-learning materials due to their normal work, and it seems that the low implementation rate may have been affected by the work environment of each trainee. Therefore, these self-learning materials will be reviewed in the training but will not be added to the evaluation of each trainee.

2.9. Policy Meeting

2.9.1. Kick-off Meeting

A kick-off meeting was held on May 21, 2019 to discuss the project structure and overall schedule.

Figure 2-17 Kick-off Meeting (May 21, 2019)

2.9.2. 1st Joint Coordination Committee (JCC)

The 1st JCC was held on August 19, 2019, and the overall schedule, PDM, and monitoring sheet for Phase II were confirmed, as well as the progress of each activity after the start of the Project. One of the activities, localization of Phase I textbook, has been completed, and the revised textbook was approved by MOEP before pre-training by MOEP-certified trainers in December 2019.

Figure 2-18 1st JCC (August 20, 2019)


Figure 2-18 1st JCC (August 20, 2019)

2.9.3. 2nd JCC

Prior to the 2nd JCC, a working-level pre-meeting was held online on 20th November 2020 and the agenda for the JCC was confirmed, and details of proposals such as extension of the Project period, revision of the PDM and pilot introductions of system/equipment for transmission and distribution systems were discussed. The method for proceeding with the preparation of the textbooks and the SOPs was discussed, and the progress of data management activities and action plans for training systems, which could not be covered in the JCC due to time constraints, were reported on by the MOEP side.

Table 2-17 Working-level Pre-meeting Participant List

Organization	Name (Position)
DEPP	U Saw Si Thu Hlaing (Dir), U Myo Lwin Nyein (DD), U Bhone Myint Kyaw (SAE)
DPTSC	U Tun Tun Win (DD), U Myo Min Tun (DD)
ESE	U Thant Zin (DCE), U Naing Win (SE), Daw Kyaut Kyaut Hlaing (AE)
YESC	Daw Khin Lay New (DGM), Daw Yee Mon Mon (DGM), U Aung Kyaw Moe (AGM), U Thein Soe (Mg), Daw Thin Thin Hlaing (Mg), U Zaw Lin Tun (Mg), U Myo Kyaw Swe (Mg), U Zayar Oo (Mg), U Aung Min Thein (AM), U Nyein Tun (AM), Dr. Thwe Thwe Soe (AM), Daw Win Lae Thu (SAM)
MESC	U Hlaing Hlaing Oo (DM), U Nanda kyaw (AGM), U Aung Kyaw Myo (AGM) Daw Zin Mar win (AM)
JICA Team	Mr. Kobayashi, Mr. Akimoto, Mr. Kaminaga, Mr. Minejima, Mr. Arakawa, Mr. Yanagiuchi, Mr. Minagawa, Mr. Shoriki Daw Khin Yatanar Tun, U Win Naing (Interpreter)

After that, the discussion content was confirmed within MOEP and the proposed content for the 2nd JCC on 24th November 2020 was agreed upon.

2.10. Training

At the start of Phase II, the three-month training was scheduled to be held twice, but there was an additional request from the MOEP side at the kick-off meeting, and a two-week training program for reviewing Phase I in December 2019, and a two-month training program were added in the first half of 2021, resulting in a total of four training sessions. However, due to COVID-19 and the change in situation, only two training sessions were held.

Training by JICA Experts was conducted with a focus on interactive lectures, including exercises and Q&A sessions.

2.10.1. Pre-Training by MOEP (First half of December 2019)

For two weeks from November 25 to December 6, 2019, MOEP-certified trainers who were certified in Phase I provided pre-training on the basic and theoretical contents of Phase I.


Figure 2-19 Pre-Training by MOEP

2.10.2. 1st Training in Nay Pyi Taw (Latter half of December 2019)

Following the pre-training conducted by the MOEP-certified trainers, key points were extracted from the Phase I textbook revised by the JICA Experts and implemented for approximately two weeks from December 16 to December 24, 2019, in accordance with the 1st Training Program.

Figure 2-20 1st Training in Nay Pyi Taw

2.10.3. 2nd Training in Nay Pyi Taw (From January 9, 2020 onward)

As of February 3, 2020, training on distribution planning and distribution design was conducted according to the 2nd Training Program. The lectures on power distribution planning and design were based on the newly prepared draft practical textbooks and lecture materials prepared by the JICA Experts.

After that, training on distribution construction & safety, and distribution O&M was conducted continuously until March 18, 2020, but the training was suspended due to COVID-19 and the training on transmission lines and substations remained unimplemented.

Figure 2-21 2nd Training in Nay Pyi Taw

Since the prohibition of overseas business trips continued, the training was conducted online, connecting the JICA Experts' office in Tokyo and a conference room at the PARKROYAL Hotel in Nay Pyi Taw, which is equipped with high speed internet, instead of MOEP's Training Center.

Figure 2-22 2nd Training Online

2.10.3.1. Details for each Training Theme

(1) Distribution planning

(a) Contents

The lecture for distribution planning based on the distribution planning practical text is as follows:

- ✧ Outline of Distribution Planning
- ✧ Distribution Systems
- ✧ Distribution Facility Planning
- ✧ Load Management
- ✧ Budgetary Management (with overview of Japanese experience)
- ✧ Distribution Work Systematization (Japanese experience only)
- ✧ Economic and Financial Evaluation Methods in the Project

(b) Initiatives

- ✧ The JICA experts tried to stimulate the trainees to comment on aspects common to Myanmar and Japan, such as facility formation methods and supply voltage criteria, during the lecture, so that all trainees could actively participate in it.
- ✧ The MDMC MV distribution system and the work systematization are technologies developed in Japan, but the JICA experts lectured on these because such information may help in the formation of electric power facilities, improvement of reliability, and

improvement of operational efficiency in Myanmar in the future.

- ✧ The SAIFI and SAIDI calculation method and the planning method for the MDMC MV distribution system are important in distribution planning training, so JICA experts made exercise practices for review, and explained and utilized them after lecturing on this content.
- ✧ To deepen understanding of the harmonic wave and flicker phenomena, the JICA experts performed simple voltage wave simulations using Microsoft Excel.
- ✧ The JICA experts emphasized that localization work for the practical textbook must be conducted in Myanmar, since the content of the practical textbook used in the lecture refers to distribution planning work in a Japanese power utility.

(c) Progress of capacity development

- ✧ The average score in the midterm examination on the final day of the distribution planning lectures was 60.3 out of 100 points; the normal distribution was 13.6 points. One (1) half of the participants' scores exceeded 60%, so the JICA experts judged that the understanding of almost all participants was advanced (27 participants out of 30 (90.0%) were in the -1σ (46.7 point) range).

(d) Concerns

- ✧ The results of the midterm examination of a few participants (3 persons) were below the average score of -1σ (46.7 points), and so the JICA experts should proceed with the next lectures by determining whether the lecture contents are incomprehensible or the English comprehension ability is too low for the examination.
- ✧ Because of the COVID-19 pandemic, web lectures will be performed in the future, and it is necessary to pay attention to remote communication and understanding with participants.

(e) Points to consider for next training

- ✧ As time has passed since the last lecture, the JICA experts will set aside time to review the content of the previous lecture.
- ✧ Take more time to practice the key content and deepen understanding of the lecture content.
- ✧ Make trainees aware of the task of localizing practical texts and motivate them to focus on the lecture.

(2) Distribution design

(a) Contents

- ✧ Basic procedure for distribution design
- ✧ Load calculation for electric poles, including those on the pole foundation
- ✧ Sag calculation, including separation wire design

- ✧ Transformer load/operating-rate calculation
- ✧ Voltage drop calculation, loss calculation

(b) Initiatives

Since the electric systems of Myanmar and Japan differ considerably, we try to make the lecture more flexible so that it can be applicable to the case in Myanmar. The lecture includes various exercise calculations for trainer candidates to solve on their own to facilitate understanding. In addition to a technology lecture course on design, the attitude toward design work and how to conduct this with examples from Japan are delivered to motivate attendees in the lecture.

(c) Progress of capacity development

The average exam score at the end of the lecture was equivalent to 71 points, and more than two-thirds of examinees obtained a score exceeding 70 points. These results show that the majority understand the meaning of distribution design in the lecture, and have learned how to derive correct answers and how to use them.

(d) Concerns

Due to differences in the electric systems of Myanmar and Japan, there are dozens of issues that need to be addressed in order to apply Japanese methods in Myanmar. It is necessary to comprehend and analyze the technology used in Japan, then enable its use by adjusting it according to the situation in Myanmar.

(e) Points to consider for next training

The lecture should try to focus on what is required according to the results of previous exams, in order to expedite capacity development.

Try to help trainer candidates consider how to take the knowledge they learn from lectures back to their workplace and how to utilize it in their fields.

(3) Distribution construction and safety

(a) Lecture contents

- ✧ Construction work management (roles of electric utility, point of management, etc.)
- ✧ Importance of coordination and scheduling among various areas of distribution construction work
- ✧ Construction work methods for distribution facilities
- ✧ Outline of equipment and tools for construction work
- ✧ Live-line work methods and safety equipment
- ✧ Basic points of safety management
- ✧ Construction work for underground distribution facilities

(b) Initiatives

Since the procurement and process for distribution construction work are completely different between Japan and Myanmar, the lecture itself is based on the ideas in Japan, but we have taken care to get the trainer candidates interested as much as possible.

Videos about construction work were shown in lectures so the trainer candidates can deepen their understanding of the details of distribution work.

Distribution construction techniques have been developed and improved over many years through trial and error. Lectures focus not only on work techniques but also the process of improvement or development to determine better work methods, so that engineers who engage in construction work can think of better methods.

The current awareness of safety differs greatly between Myanmar and Japan. Therefore, based on the idea that ensuring safety must be shared by everyone, lectures have been given so they can boost individual awareness regarding safety.

Opportunities to handle protective tools and equipment were given in the lectures so that trainer candidates can recognize their good points, quality, etc. Some trainer candidates used the protective equipment and tried sample work to experience an actual (mock) work scenario.

Actions to prevent accidents were explained in the lecture about construction work methods with special vehicles and equipment. The lecture offered the opportunity to think about safety measures when using various equipment or materials.

(c) Progress of capacity development

- ✧ Upon conducting an examination based on the lecture content in the training, the average score was about 80 points (standard deviation 8.2), and it can be said that the lecture content is well understood as a whole.
- ✧ The importance of grasping and recognizing the design content for construction work is well understood.
- ✧ Since the lecture on safety focused on boosting safety awareness in distribution construction work, it is thought that an awareness of the “safety first” principle has been obtained. It is also expected that trainer candidates will spread broadly the awareness of “safety first” in their country.
- ✧ Many opportunities for trainer candidates to speak were given in the lecture, so the lecture was not just one way.

(d) Concerns

Since the procedures for distribution line work and procurement work in Japan are different from those in Myanmar, the technical knowledge and know-how which the JICA Team can provide will not be directly useful to line work in Myanmar. Therefore, it is necessary to proceed with lectures showing the difference between both countries and indicating the possibility of Japanese methods being incorporated in Myanmar’s system.

Due to the nature of the topics about distribution construction and safety, demonstrations and close communication are important ways to give lectures. If the lecture is conducted remotely due to the COVID-19 problem, there is a big concern that knowledge and know-how may not be conveyed smoothly.

(e) Points to consider for next training

The contents of the lecture cover technical knowledge and know-how obtained over many years in Japan and basically fit the Japanese method of approach. Lectures emphasize that the trainer candidates should recognize the difference in each country's methods and allow them to think how they can incorporate knowledge from other countries.

Lectures aim to not only impart knowledge but also provide opportunities for the students to think how they can incorporate what they have learnt into their work.

Lectures aim to raise safety awareness, even if the trainer candidates do not have opportunities to directly engage in construction work.

(4) Distribution O&M

(a) Contents

A lecture on distribution operation and maintenance was carried out. The contents of the lecture, corresponding to the chapters of the aforementioned textbook on distribution O&M, were as follows:

- ✧ Outline of Distribution O&M Business
- ✧ Power Quality Indices – Voltage, Current, Power Factor, Imbalance, Disturbances, etc.
- ✧ Power Quality Management
- ✧ Voltage Management – Voltage Regulation and Voltage Management Measures
- ✧ Voltage dip, Flickering, Power Factor Management and Ferranti Effect
- ✧ Harmonics – History, Causes, Regulation and Compatibility
- ✧ Adverse effects on distribution network caused by introducing Distributed Generators
- ✧ Power Reliability Indices – SAIDI and SAIFI
- ✧ Protection Systems
- ✧ Power Disruptions – Causes of Outage Events and Reasons for lengthy power interruptions
- ✧ Approach to improve SAIDI & SAIFI
- ✧ Methodologies for Network Maintenance
- ✧ Time-Based Maintenance and Condition-Based Maintenance
- ✧ Visual Checks and Diagnostics – Points to Check, Limit Samples and Repetition Period
- ✧ Relevant Indices – Loss Rate and Catalog for loss reduction measures

(b) Initiatives

The lecturer made the below efforts in order to provide useful and practical lectures on distribution operation and maintenance to trainees.

- ✧ To make the lecture as interactive as possible: At the beginning of every lesson, the lecturer encouraged trainees to explain issues or the situation in Myanmar for each topic in the lesson, which not only boosted interaction between the lecturer and the trainees but also provided the lecturer with essential information on lots of technical problems in Myanmar.
- ✧ Confirming trainees' understanding of the essence of the lecture during sessions by asking them how well they understood the lectures, plus welcoming questions from trainees at any time, even if the questions might be very far from the topic of the lecture.
- ✧ Providing trainees with a wide understanding of technical issues by explaining not only theories of electrical engineering but also socio-economic approaches that should be taken into consideration in solving certain technical problems.
- ✧ Explaining relevant phenomena in an integrated manner, not individually, in order to promote trainees' understanding. An example is for voltage management, with power factor control as one of the main measures for management, and over-compensated reactive power and its undesirable enhancement of harmonics, which were included together and explained in combination.
- ✧ Providing case studies on various topics regarding distribution systems to capture trainees' interest.
- ✧ Reviewing the contents of the lecture held the previous day by preparing MS PowerPoint material that summarized what was taught and stressed.
- ✧ Encouraging trainees to participate in the class in any form, such as through questions, comments, opinions or stating their impressions. The lecturer praised those who raised their hands and spoke, whatever their comment was, in order to cultivate a feeling of participation and to make the lecture more effective and attractive.

(c) Progress of capacity development

- ✧ The average score in the test held in the final timeslot in the lecture was about 56 points. Fewer questions on calculations in the O&M field than other parts of lectures might be one of the causes for the lower average points in comparison with other parts of lectures.
- ✧ A few trainees appear to have poor understanding on per unit methods or concepts of real and imaginary parts, which are essential knowledge in power engineering. Those trainees are strongly recommended to be taught the basics thoroughly and appropriately.

(d) Concerns

Follow-up work for the trainees described above is strongly recommended to be individually planned and carried out.

(e) Points to keep in mind for the next training

- ✧ Topics that many of the trainees seemed to have insufficient understanding of would be selected for further study in the next lectures, by considering in detail the results of the tests held last March.
- ✧ Some of what the technical agenda trainees are interested in would be picked up in the coming session in response to their requests expressed in the survey carried out at the end of the last lecture.

(5) Transmission Line

(a) Contents

- ✧ Insulation design (Designing of clearance, etc.)
- ✧ Insulator design (Designing the number of insulators, etc.)
- ✧ Tower design (load applied to the tower, etc.)
- ✧ Foundation design (load applied to the foundation, etc.)
- ✧ Wire/ground wire design (allowable current calculation, sag calculation, etc.)

(b) Initiatives

Of the above-mentioned transmission line designs, in order to encourage the formation of detailed designs, understanding was promoted by explaining the basic matters, and was implemented via exercises. In addition, photographs and charts not included in the text were carefully explained using supplementary materials.

(c) Progress of capacity development

Since the comprehension test was just after the lecture, the average score was high and it seems that understanding was about 80%.

In order for participants to become a training instructor in the future, it is necessary to improve their degree of understanding by repeatedly reviewing the details by themselves, through preparations such as seminars.

(d) Concerns

Nothing in particular.

(e) Points to keep in mind for the next training

Next time, since the content features front-line site information such as patrols and inspections, the JICA experts would like to proceed by giving actual examples with photographs etc., to the extent possible.

(6) Substation

(a) Contents

Training was conducted focusing on the basic contents of the following two themes.

Basics of Substation Control Systems

- ✧ Purpose and definition
- ✧ Development history
- ✧ Hardware overview
- ✧ Software overview
- ✧ Types and processing of data
- ✧ Wiring
- ✧ Communication method and procedure (protocol)
- ✧ Operation and maintenance
- ✧ Security (data, communications, operational authority)
- ✧ Interlock circuit
- ✧ DC power supply

Basics of various tests at substations

- ✧ Purpose and definition
- ✧ Outline of tests by equipment type (transformer, circuit breaker, CT, VT, bushing, protection control device, power cable, etc.)
- ✧ Insulation test theory and practice
- ✧ Safety equipment
- ✧ Maintenance tests
- ✧ Site acceptance tests and commissioning tests during construction

(b) Initiatives

Prior to the training, each participant was instructed to study the textbook in advance and asked to identify and report any questions that arose during their study. The questions submitted were summarized and answered during the training to eliminate concerns and improve understanding.

Since substation control systems in Japan have many special specifications when viewed from a global perspective, the training content focused on systems used as standards overseas and international standards.

In addition, the recent trend of international standard IEC 61850, as well as the configuration of a LAN-based system using station buses, process buses and merging units, were also explained in detail.

(c) Progress of capacity development

Based on the results of the comprehension test, it is judged that the trainees acquired about 80% of the basic knowledge immediately after the training, but the percentage of trainees who understand the content well enough to teach others as instructors may be lower than this

percentage.

However, in the second half of the Project, there will be an opportunity to act as an instructor at a regional seminar, and it is hoped that the advance preparation required for this will improve competence, as prior reviews and further studies are essential to fulfilling the responsibilities of an instructor.

(d) Concerns

Nothing in particular.

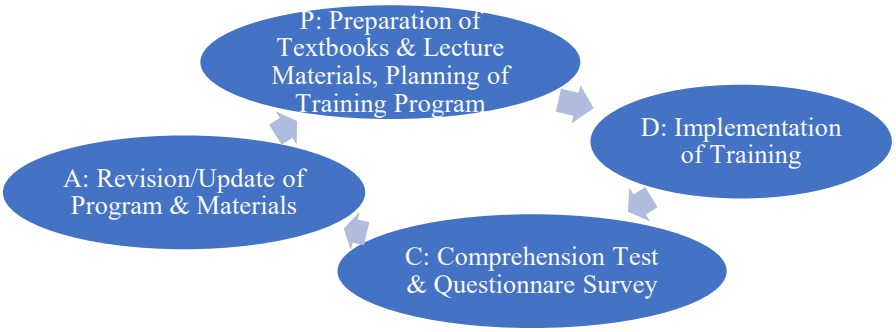
(e) Points to keep in mind for the next training

As far as possible, JICA experts will prepare materials that are easy to understand visually, such as videos, photos and diagrams.

In the next training, the content will be more practical, so the JICA experts would like to ask questions and confirm the actual situation in Myanmar during the lecture, and explain the situation with a comparison with Japan, in order to promote understanding.

2.10.3.2. PDCA cycle for Training

From the 2nd Training, examinations to check the trainees' depth of understanding and questionnaire surveys to check contents and lecture strategies were conducted. Not only the results of the exams but also feedback on the lectures were shared with the JICA experts in charge to make the next training better in consideration of the trainees' level of understanding, requests on content to be included and so on. The 3rd and 4th training sessions could not be held due to COVID-19 and the current situation, but the textbooks and lecture materials are expected to be updated in the same manner and utilized by the MOEP-certified trainers after completion of the Project. This sequential circulation will help organize training tools for the implementation of self-sustaining training.



2.10.4. 3rd Training & 4th Training

After the relaxation of restrictions for domestic travel in Myanmar, the 3rd Training was planned to be conducted online per the 3rd Training Program from 15th February 2021, but was cancelled

due to the change in situation that occurred on 1st February 2021. Moreover, the 4th Training also could not be held.

2.11. Training in Japan

2.11.1. Seminar on Training System for Managers in Japan (November 2019)

In order to strengthen human resource development (HRD) in MOEP, a seminar was held for senior officials in charge of human resource development at MOEP. The seminar focused on explanations of HRD activities at TEPCO, a Japanese power company, such as its HRD policy, targets, and strategies for achieving targets, as well as visits to HRD-related facilities.

Since MOEP aims to improve power quality and O&M knowledge/skills, TEPCO's efforts to improve power quality and maintenance technology were also included.

Prior to the seminar in Japan, the participants organized a list of issues related to HRD in their workplaces.

On the last day of the seminar in Japan, action plans for improving HRD after returning to Myanmar were considered based on what had been learned during the seminar.

(1) Schedule

Pre-training: October 30, 2019

Training in Japan: November 11, 2019 - November 21, 2019 (11 days)

Date	Seminar	Place
11 Nov.	Depart from Nay Pyi Taw	
12 Nov.	Arrive in Tokyo	
13 Nov.	AM: Briefing meeting PM: Quality control at C-GIS manufacturer	JICA HQ TOSHIBA
14 Nov.	AM: TEPCO overview and O&M for power quality PM: HRD implementation on-site (branch office) Inspection of DAS, emergency restoration tools and equipment, and underground substation	TEPCO HQ TEPCO Tokyo Branch Office
15 Nov.	AM: HRD system in power utility PM: Inspection of facilities at training center Presentation of action plan from participants	TEPCO Training Center
18 Nov.	All day: Safety management training in TEPCO	TEPCO Safety Thinking and Activity Center
19 Nov.	AM: Quality control at concrete pole manufacturer PM: HRD at contractor	Nippon Concrete Industries Co., Ltd. Kandenko
20 Nov.	AM: Quality control in TEPCO distribution expertise PM: Presentation on action plan/wrap-up ceremony	TEPCO Eng. Center JICA HQ
21 Nov.	Depart from Tokyo, Arrive at Nay Pyi Taw	

(2) Participants

The following 10 managers from MOEP participated.

Name	Position	Company
U Htay Naing	Director	DEPP
U Myo Lwin Nyein	Deputy Director	DEPP
U Tun Win	Deputy Director	DPTSC
U Kyaw Min Tun	Deputy Director	DPTSC
U Thant Zin	Supervisor Engineer	ESE
U Tun Wanna	Supervisor Engineer	ESE
U Tin Thant Zaw	Assistant General Manager	YESC
U Naing Win	Assistant General Manager	YESC
Daw Su Sabal Aung	Assistant General Manager	MESC
Daw Zar Zar Ohn	Assistant General Manager	MESC

(3) Pre-seminar

In order to enhance the effectiveness of the seminar, the following pre-seminar was conducted before the seminar in Japan.

At the same time, the participants presented a summary of HRD issues at their workplaces, and JICA Experts and participants exchanged opinions on these.

Time	Details of implementation
10: 00 - 10: 30	Object and aims of the seminar Seminar schedule in Japan
10: 30 - 11: 00	Overview of TEPCO Organizational structure of TEPCO Power Grid, Inc.
11: 00 - 12: 00	Outline of distribution facilities and O&M in TEPCO
13: 00 - 14: 00	HRD Policy in TEPCO HRD for young employees and Skill certification system HRD implementation system
14: 00 - 14: 30	TEPCO's Training Center
14: 30 - 15: 00	Quick restoration system and special training
15: 00 - 16: 30	Presentation and discussion on each action plan

Figure 2-23 Schedule for Pre-Training

(4) Main contents of the seminar in Japan

✧ HRD at TEPCO

- Objectives of HRD
- HRD Policy
- HRD Objectives and HRD Programs (development of young employees, development

of specialists, maintenance and improvement of O&M skills)
- Training of young employees and skill certification system
- HRD Manuals (Standard Operation Procedures - SOP)
- Overview of specific training content (training for new employees, training for skill certifications, skill competition games)
- Operation and management at training center and annual schedule for training center
- Inspection of training facilities

Figure 2-24 Training for HRD in TEPCO

✧ Safety training at TEPCO

In the capacity assessment of the trainer candidates, there was a strong need for on-site safety education. TEPCO also provided special training to eliminate injuries and fatalities at workplaces and work sites. The participants took TEPCO's safety training through TEPCO's training.

The main contents of the safety training are as follows.
- TEPCO's policy and measures for safety education
- Operational and training results of safety training facilities
- Concept of Accident Risk
- Database and utilization of accident case histories
- Inspection of training methods through actual safety training (raising employee

awareness of safety through case studies, experiencing and recognizing human error, and raising awareness through risk experience)

- Latest training methods and lectures
- Inspection of safety training facilities

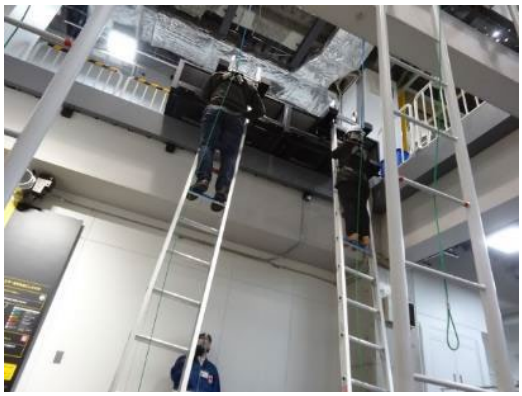


Figure 2-25 Training on Safety Education

✧ TEPCO's quality control

- Reduce accident risk by analyzing and managing information on defects and electrical accidents (data management)
- Training on the aggregation and analysis of electrical accident information at branch offices
- Improvement of facility quality through investigation and testing of power facilities to identify causes of problems and control them
- Training on preventive maintenance by ascertaining the remaining life of equipment
- Quality assurance for equipment purchased through type tests of power facilities
- Inspection of actual type test
- Training on disaster restoration efforts at the head office and branch offices
- Preparations for quick restoration from disasters (preparations at head office and branch offices)

Figure 2-26 Training on Quality Control

(5) Outcomes of Seminar and Action Plans

On December 19, 2019, the participants shared what they learned at the seminar with MOEP senior management. The following points were presented.

- Awareness of the need for comprehensive and systematic training in MOEP
- Realizing that human resource development is the key to strengthening MOEP's organizational capabilities
- Raising Awareness and Knowledge of Safety and Safety Education

Draft action plans for HRD prepared in Japan by two groups were also presented at the report meeting.

The action plans of each group are outlined below.

Group 1	Introduction of a comprehensive training system and training content in MOEP Leader: U Htay Naing (Director of DEPP) Outline of Implementation - MOEP's human resource development policy formulation - Development of HRD systems in MOEP - Setting MOEP's HRD Objectives - Regular/annual training program establishment - Textbook preparation for training - Securing budgets for HRD
Group 2	Study on the use of JICA-prepared textbooks and lecturers Leader U Thant Zin (Deputy Chief Engineer of ESE) Outline of Implementation - Setting Training Targets - Development of training plans - Review of Phase II Textbook

Figure2-27 Report Meeting on Action Plan


Figure 2-27 Report Meeting on Action Plans

2.12. Equipment Procurement Plan

2.12.1. Status of Phase I Procurement Equipment

In Phase I, power distribution training equipment was installed at the MOEP training center in Nay Pyi Taw, and training equipment such as safety equipment was introduced. In addition, transformers and SOGs were installed at the pilot site in order to confirm the effects of loss reduction and failure reduction, learned during the first phase of training, at an actual site.

The installation status of the first phase's equipment procurement (transformers and SOG) as of the end of January 2021 is as follows:

Table 2-18 Installation Status of Phase I Procurement Equipment (Transformer)

Organization	Township	District	Type of Transformer	Capacity	Voltage	Status
ESE	Tatkon	Nay Pyi Taw	Three Phase	100kVA×1	11/0.4kV	Installed
	Pyinmana	Pyinmana	Single Phase	25kVA×1 50kVA×1	11/0.23kV	Installed
	Pathein	Pathein	Single Phase	25kVA×1 50kVA×1	11/0.23kV	Installed
	Taunggyi	Taunggyi	Single Phase	25kVA×1 50kVA×1	11/0.23kV	Installed
	Magway	Magway	Single Phase	25kVA×1 50kVA×1	11/0.23kV	Installed
YESC	Dala	Yangon	Three Phase	200kVA×3	11-6.6/ 0.4 kV	Installed
MESC	Kyauk-padaung	Nyaung Oo	Three Phase	100kVA×2	11/0.4kV	Installed
			Single Phase	25kVA×1 50kVA×1	11/0.23kV	Installed

Table 2-19 Installation Status of Phase 1 Procurement Equipment (SOG)

Organization	Township	District	Type of Switch	No.	Status
ESE	Tatkon	Nay Pyi Taw	SOG	1	Installed
MESC	Kyaukpadaung	Nyaung Oo	SOG	1	Installed

2.12.2. System and Equipment Procurement in Phase II

2.12.2.1. Objective

11-kV line switchgears and small-capacity pole-mounted transformers were introduced and the trainees deepened their understanding of their effectiveness for distribution loss reduction and power outage range reduction through the appropriate separation of a fault point, etc. In order to enhance the trainees' capacity to achieve the Project's purpose, the additional introduction of a system and equipment for improving power supply reliability and efficiency, and related training, were planned for Phase II, but this could not be conducted due to COVID-19 and the change in situation. The table below shows the original plan.

Because most of the trainees are engineers engaged in operation and maintenance for transmission and distribution systems on site, we planned for the system and equipment to focus on operation & maintenance and safety, as shown below.

Table 2-20 List of Equipment to Be Procured in Phase II

Equipment Planned	Outline of Plan & Expected Effectiveness	Training Content
Transmission line fault point locator system	Pilot installation for a high frequency fault transmission line around Nay Pyi Taw (to be discussed with DPTSC) [Effectiveness] - Quick detection and restoration of transmission line fault points - Implementation of recurrence prevention measures based on fault causal analyses (reduction of electrical faults)	Principles of fault point location, supervision of installation work, operation procedure, parameter setting, fault point location, fault data analysis and measures for fault reduction, etc.
Pulse charging ground fault detector	Conducting demonstration at MOEP Training Center (to be determined where to deploy) [Effectiveness] - Efficient and quick distribution line fault point detection and shortening of power outage times (reliability improvement)	Principles of fault point location, demonstration of fault detection, ensuring safe work, etc.
Aerial Work Platform	Conducting demonstration at MOEP Training Center (to be determined where to deploy) [Effectiveness] - Improvement in high-place work efficiency for distribution lines and shortening of power outage times (reliability improvement) - Enhancement of safety in high-place work for distribution lines	Work preparations such as parking, outrigger operation and grounding, operation of bucket including boom and winch, etc.

In addition to the above equipment, demonstrations on the indirect live-line method using specialized tools, and underground fault point detection and exploration of buried cable positions using a fault location device called “T2LUPIN” were planned by bringing JICA Expert Team-owned tools and devices to Myanmar.

2.12.2.2. Equipment Selection and Bidding Method

(1) Transmission line fault point locator system

The equipment shall be as specified in the specifications.

(2) Ground Fault Detector

The JICA team would like to procure equipment manufactured by Nippon Kouatsu Electric Co., Ltd. (hereinafter referred as NKE) under a free contract for the following various reasons.

- ✧ Only Japanese manufacturers manufacture equipment that injects pulse voltages to the distribution line where a ground fault has occurred and detects the current flowing into the ground fault point with an antenna with a built-in directional current transformer (CT).
- ✧ The equipment is made in Japan, and is used by Japanese power utilities, so its long-term usage stability and maintainability have been confirmed.
- ✧ It is possible to provide support for on-site work by deploying the same type of equipment as that procured by the yen loans, since it is directly connected to the on-site work of the power distribution corporation.
- ✧ The power source of NKE's impulse generator is DC 12V, which is equivalent to an in-vehicle battery, and it is lightweight (about 30 kg) and compact, which is advantageous in terms of portability.
- ✧ Among Japanese companies that manufacture equipment with similar functions, only NKE has a manufacturing and sales base in Myanmar. It has know-how related to imports and exports in Myanmar, and after-sales service following product delivery is readily available.
- ✧ Since the fault point location method for overhead lines (OH) in Myanmar relies on visual inspections of a faulty distribution line's parts, by introducing the equipment, which is widely used by Japanese electric power utilities, and giving lectures by JICA experts, fault point location work methods in Myanmar will be streamlined and the time spent locating faults will be significantly shortened, which will contribute greatly to reducing outage durations.
- ✧ This equipment can also be adopted to identify a fault section on underground (UG) lines.
- ✧ In the future, Myanmar engineers will be able to handle the work themselves, which will contribute to the diffusion of such equipment.
- ✧ Under the above circumstances, this equipment has the potential to become the de facto standard in Myanmar.

(3) Aerial Work Platform (Track Mounted Type and Insulated Type)

The JICA team would like to procure equipment manufactured by AICHI CORPORATION

(hereinafter referred as AICHI) under a free contract for the following various reasons.

- ✧ AICHI's Aerial Work Platform was adopted by "JICA's Partnership with the Japanese Private Sector" in 2014 and its effectiveness has been confirmed in developing countries. It will be effective in activities to improve reliability and work safety by improving work efficiency in this Project.
- ✧ The equipment is specified based on "Active utilization of products and technologies surveyed and demonstrated in "JICA's Partnership with the Japanese Private Sector" for ODA projects (policy formulation)" (JICA (OS) No. 11-24001).
- ✧ The equipment is made in Japan, and is used by Japanese power utilities, so its long-term usage stability and maintainability have been confirmed.
- ✧ It is possible to provide support for on-site work by deploying the same type of equipment as that procured by the yen loans, since it is directly connected to the on-site work of the power distribution corporation.
- ✧ With aerial work platforms made in Japan, fine adjustment of the position of the bucket on which the worker rides and adjustment of the movement speed can be easily achieved by adjusting the operation lever, and safety functions such as an automatic horizontal level holding function for buckets and a rollover prevention function for aerial work platforms are also substantial.
- ✧ The bucket of the aerial work platform (track mounted type and insulated type) is fully insulated and this specification helps reduce electric shock incidents.
- ✧ AICHI can deliver right-hand drive vehicles and aerial work platforms on the left side (sidewalk side) of the bucket storage position in a completed state, so they are compatible in Myanmar.
- ✧ Since an import/export handling agency office for AICHI products exists in Myanmar, it has know-how on the import/export business and can provide after-sales service relatively easily, even after delivery.
- ✧ The aerial work platform made by AICHI has the highest reach of bucket floor surface (16.5 m) among Japanese products, and may be used more widely in distribution work in Myanmar.
- ✧ AICHI aerial work platforms are widely used by Japanese electric power companies, and by purchasing this aerial work platform, JICA experts who are proficient in handling aerial work platforms can give lectures.
- ✧ In the future, Myanmar engineers will be able to handle the work themselves, which will contribute to the diffusion of such equipment.

2.12.2.3. Procurement Period

(1) Transmission line fault point locator system

Approximately 11 months after the contract is signed (delivery deadline scheduled for February 2022)

(2) Ground Fault Detector

Around six (6) months after the contract

(3) Aerial Work Platform (Track Mounted Type and Insulated Type)

Around ten (10) months after the contract

2.12.2.4. Equipment Overview

(1) Transmission line fault point locator system

When a transmission line fault occurs, a fault surge is generated. The fault surge comes to the substations at both ends at different times, measured by GPS. The F/L server calculates the fault location based on the surge's arrival time difference at the substations. The system consists mainly of receiving devices installed at both ends of transmission lines at facilities such as substations, servers that store the data received, and computers that display the fault location point.

(2) Ground Fault Detector

This equipment is uniquely used in Japan. It injects impulse voltages for a fault distribution line and detects the current flowing into the ground fault point with an antenna with a built-in directional CT, and determines the direction of the fault point easily and quickly. Since it is small and lightweight and the accident point identification time is short, it is expected to help reduce outage times and improve reliability.

(3) Aerial Work Platform (Track Mounted Type and Insulated Type)

This equipment makes it easy for workers to move up and down during construction and maintenance work for distribution lines, and helps reduce fatigue by stabilizing the working posture, improving work efficiency, and preventing falling incidents. Furthermore, the bucket part of insulated-type equipment is fully insulated, which also helps prevent electric shock incidents. Additionally, with aerial work platforms made in Japan, fine adjustment of the bucket position and adjustment of the movement speed can be easily achieved by adjusting the operation lever, and safety functions such as the automatic horizontal holding function of the bucket floor and the rollover prevention function of the aerial work platform can also be utilized.

2.12.2.5. Manufacturer Designation Justification

Refer to Exhibit 1.

2.12.2.6. Equipment Specifications

(1) Transmission line fault point locator system

Refer to Exhibit 2-1.

(2) Ground fault detector

Refer to Exhibit 2-2.

(3) Aerial work platform

Refer to Exhibit 2-3.

2.13. Human Resource Development

2.13.1. Existing Skill Classification System in MOEP

2.13.1.1. Technical Staff Categories in MOEP

MOEP has two types of technical staff categories in their system. One is for engineers and the other is for technicians. The differences for each are as follows:

- ✧ Engineers

  Engineers are those who have graduated from university and have passed the Assistant Engineer (AE) test conducted by MOEP. In the future, there is a possibility of their becoming a chief engineer, general manager, etc.

- ✧ Technicians

  Basically, they have graduated from high school or vocational school, and have been hired by MOEP after working as interns. They work according to instructions from the AE. There is a possibility of promotion to the equivalent SE level.

2.13.1.2. Skill Classification in MOEP

MOEP has skill classifications for both engineers and technicians. Work responsibilities are allocated to each skill level.

The general skill classification and promotion path are described in Figure 2-28 and Figure 2-29.

For both engineers and technicians, tests and interviews for promotion to the next level are conducted to confirm their technical skill.

A Sub-Assistant Engineer (SAE) is regarded as an intern and working as one is not an essential requirement for becoming an AE.

There is a general understanding in MOEP that “Skill worker 1” is equivalent to the SE.

✓ Skill class and its rank-up are linked with promotion
✓ Promotion and its salary are managed by each D-Co.

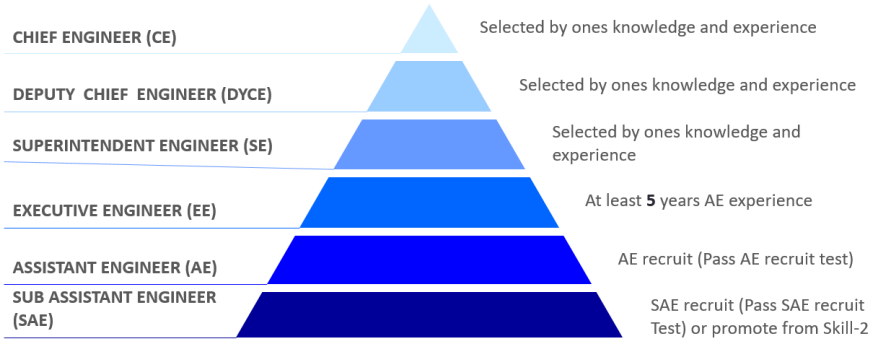


Figure 2-28 General Structure and Promotion Path for Engineers

✓ Skill class and its rank-up are linked with promotion
✓ Promotion and its salary are managed by each D-Co.

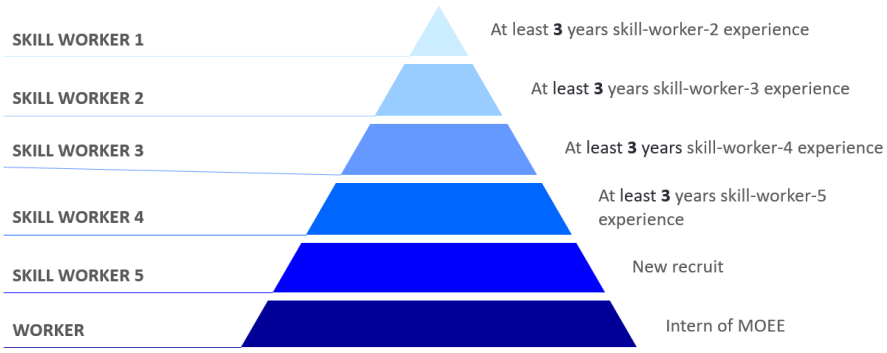


Figure 2-29 General Structure and Promotion Path for Technicians

2.13.1.3. General Organization in Distribution Company

Figure 2-30 shows the general organization chart in a distribution company on the technical side.

Work/OJT training instructions are undertaken by the upper engineers in the chart.

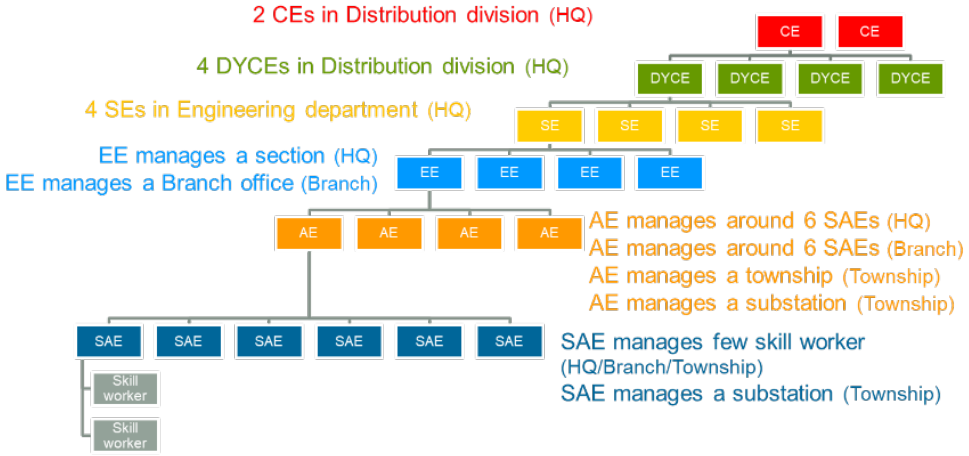


Figure 2-30 General Organization Chart in Distribution Company

2.13.2. Existing Training Planning in MOEP

The training planning and implementation are under the charge of DEPP and distribution companies.

At this moment, HRD policies do not exist at the company. There are few annual training programs in MOEP. Some training programs are implemented via orders from the deputy minister and DEPP management. Table 2-21 shows the training confirmed by interviewing MOEP.

Basic technical training is held by each distribution company, and this is mainly classroom training (Off-JT).

In addition to this, technical training is voluntarily implemented in various places by devoted AEs.

Table 2-21 Existing Training programs in MOEP (from interview)

Main body	Training course	Frequency	Type of training
MOEP/ DEPP	Basic pre-service course (General)	Annual	Off-JT
	Basic civil service officer (General)		
	Basic Jr. civil/clerical service officer (General)		
	Refresher course of each division (Technical)		
	Office supervisor enhancement (General)		
	Management course middle level (General)		
	Management course senior level (General)		
	Management course executive level (General)		
	IT course (Technical)	Irregular	
Distribution Co.	Office proficiency (Office)	Annual	
	Public relation (Office)		
	Village lighting (Office)		
	Mobile industrial (Office)		
	Basic English (General)		
	Sub-assistant engineer course (Technical)		
	Basic electrical work (Technical)		
	Substation O&M work (Technical)		
AE, etc.	O&M works (Technical)	Irregular	OJT/Off-JT

2.13.3. Harmonization of New Training Program with Existing Training System

The Project pursues the enhancement of technical training using the output generated by it, such as textbooks, SOP books and trainers certified in this Project.

Special care shall be taken in harmonization work regarding the existing MOEP system described above, to enhance the existing strong motivation of the younger generation to learn.

The JICA team works with two action plans implemented by MOEP management members who have attended the seminar in Japan.

The harmonization plan for the new training program involves allocating the training course to the existing MOEP training program. The details of each course are going to be established through negotiations with MOEP and each distribution engineer.

Through the interviews with trainer candidates, it was noted that the younger generation welcomes the written certificate of training, and most of them are motivated by getting it as proof of their related knowledge.

Issuing certificate plans is also under consideration to enhance the motivation for training among the younger generation.

The draft plan is as follows:

[Draft harmonization of new training program]

- ✧ Create training courses using the textbook created in the Project along with MOEP's requirements
- ✧ Allocate the training courses into existing MOEP training schedule
- ✧ Establish the procedure for issuing training certificates

A rough illustration of the allocation is given in Figure 2-31.

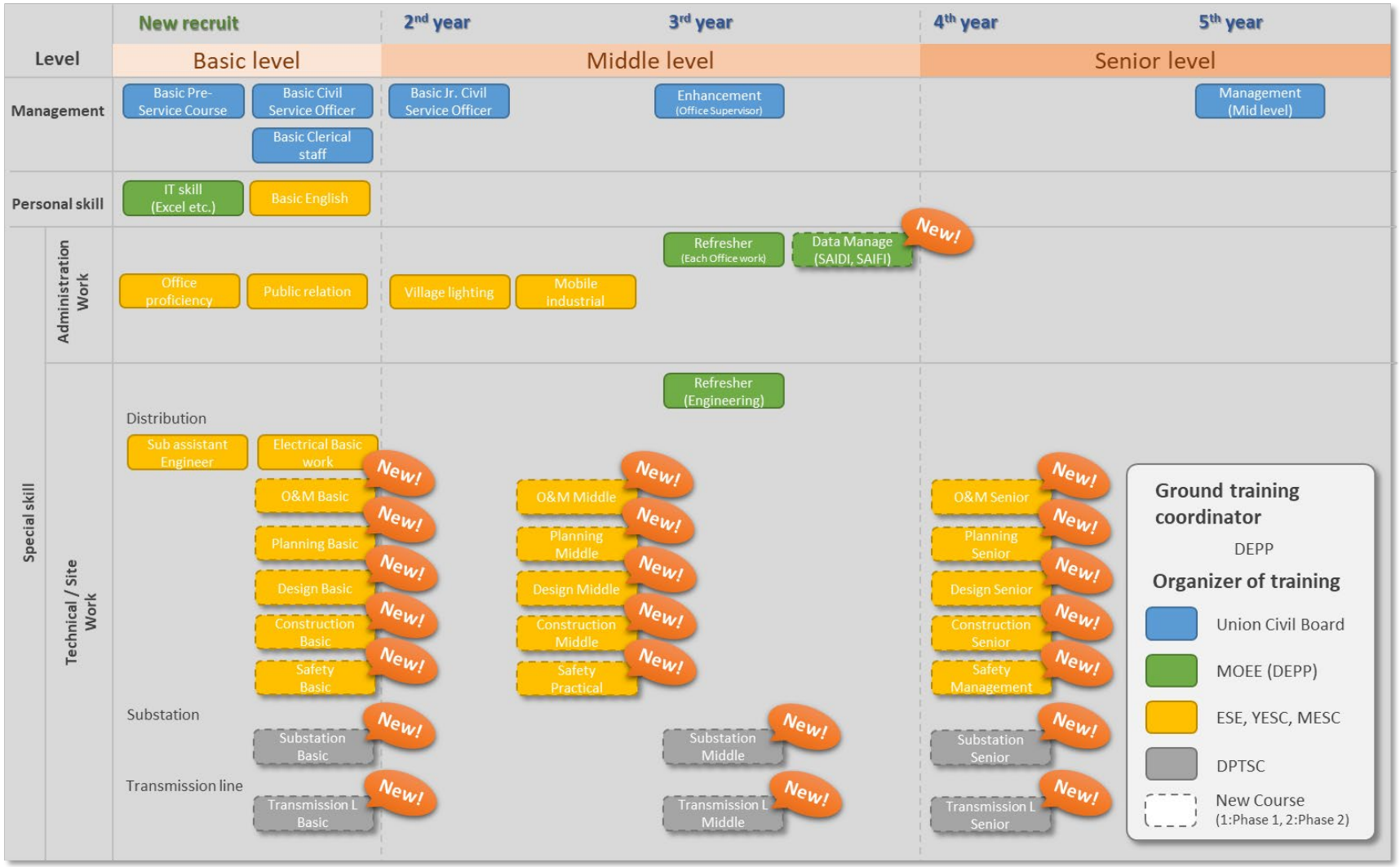


Figure 2-31 Rough Illustration of Training Course Allocation

2.13.4. Management of Training Course

The training management in Japan uses a “training diary” to help the younger generation train on their own. The JICA team introduces this diary and discusses with MOEP whether it fits the MOEP culture or not.

Sample images of the “Training diary” in Japan are given in Figure 2-32.

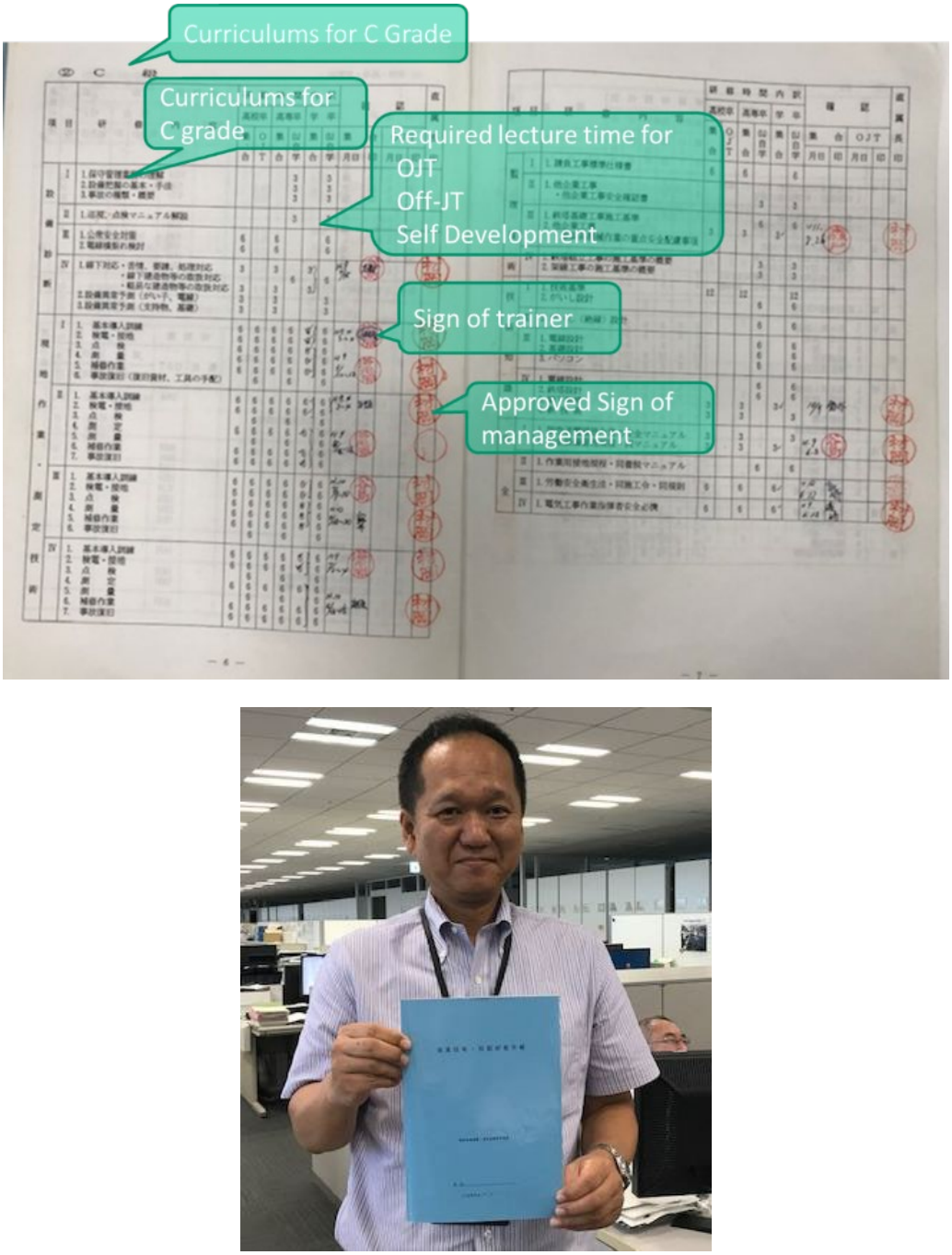


Figure 2-32 Sample Images of “Training diary” in Japan

2.13.5. Progress of the Action Plans after Seminar in Japan

The seminar for managers was held in Japan in November 2019. The participants established two action plans from two teams.

The action plans are as follows:

Action Plan 1: Action Plans on Training System on the Project for Capacity Development of Power Transmission and Distribution Systems

Action Plan 2: Training Program Using JICA Textbooks

[Report on the seminar in Japan] 19th Dec. 2019

The report meeting was held in MOEP with DDG in attendance. Discussions about actions were held in the meeting.

Figure 2-33 Report Meeting on the Seminar in Japan

2.13.6. Concerns and Suggestions

MOEP has recognized the issues regarding the training system, and how to utilize the training center. According to the management's action plans above and interviews with MOEP, they are willing to improve the training environment for the next generation.

Generally, requirements/needs regarding training should reflect work sites. The JICA team has carefully tried to identify on-site requirements and include them in the training course, using textbooks established in the Project.

The idea of this Project is based on the "Training of Trainers (TOT)" scheme. The JICA team trained trainer candidates during the Project. The draft training strategy in MOEE is shown in Figure 2-34.

Some training courses are to be held in the training center to for reasons of efficiency and uniformity, and some courses are to be held at each DISCO.

The training center has just been established and there are no administration staff there. Some training is apparently being undertaken there at the moment. Thus, it is better that the number of training courses be limited at the first stage, with this number being gradually expanded along

with experience.

The suggestion from the team is to make a time-based medium term training strategy like Figure 2-34.

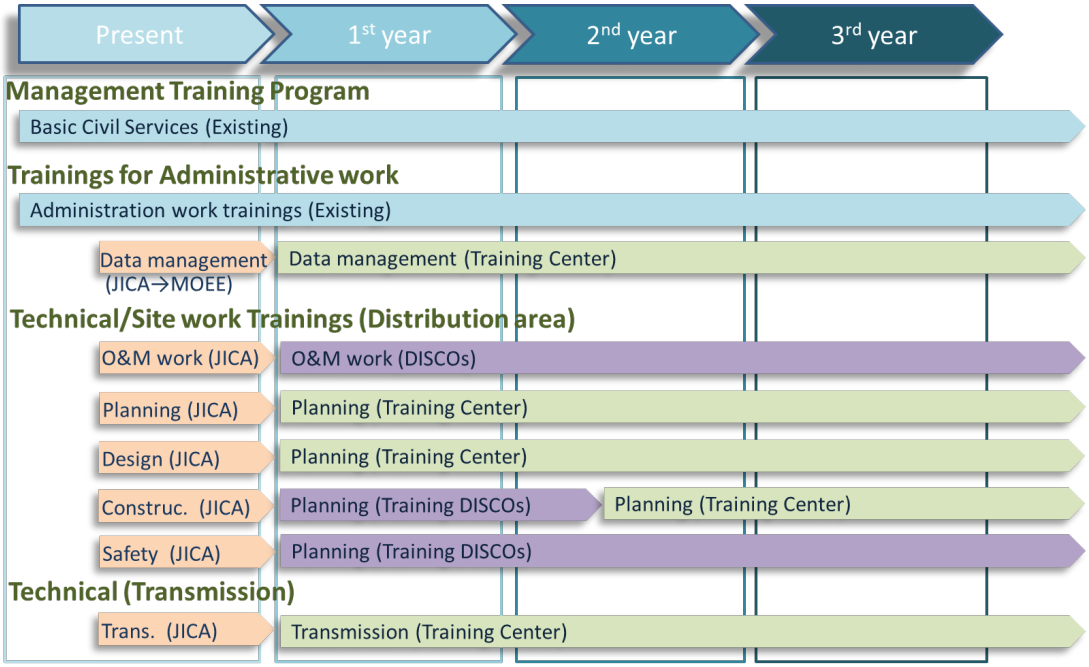


Figure 2-34 Draft Training Strategy in MOEE

From Japanese power company experience, training courses should be modified and improved year by year along with a site's requirements. The implementation of training and modification of training require an implementation body to drive such activities.

To solve this issue, a training committee system has been introduced in Japanese utilities. Draft ideas for the PDCA cycle and training committee are shown in Figure 2-35 and Figure 2-36.

The team suggests the establishment of a training committee to implement training and the PDCA cycle.

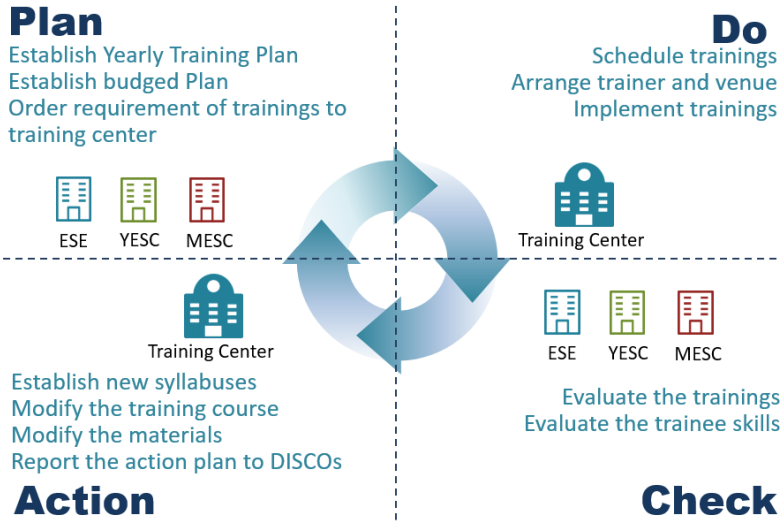


Figure 2-35 Draft PDCA cycle for Training in MOEP

Figure 2-36 Draft Idea of Training Committee in MOEP

The matching of training needs and training courses might improve the autonomy of MOEP staff in terms of training, and autonomy improves the motivation of staff.

3. Issues, Initiatives and Lessons Learned concerning Management and Implementation of the Project

(1) Coordination Process on the Myanmar side

In this Project, DEPP served as MOEP's contact point and DPTSC, ESE, YESC, and MESC participated as trainer candidates and WG members, so it was necessary to coordinate various activities with DEPP in advance. In Phase II, instead of assigning Myanmar experts as in Phase I, a local coordinator living in Nay Pyi Taw was hired, who contacted and responded to inquiries from trainer candidates and WG members on behalf of DEPP, thereby facilitating communication with the MOEP side. In particular, Phase II of the Project was greatly affected by COVID-19 and the change in situation, and there was a long period of time when travel was not possible, but even in such a situation, some activities, such as intensive training and workshops, could be carried out remotely.

(2) Preparation of Training Textbooks and SOPs

Based on the lessons learned from Phase I, the preparation policies and contents of various documents, such as textbooks and SOPs, were agreed upon with MOEP from the beginning of the Project. This enabled the project to proceed smoothly without any mid-term changes in direction. It was essential that both the training textbooks and SOPs be created in accordance with the facilities and operations in Myanmar. Through the workshops, participants were encouraged to develop a sense of ownership in updating and utilizing the documents autonomously, even after the Project was completed.

(3) Selection of Trainer Candidates

Initially, the training of trainer candidates was envisioned with the PDCA series from Phase I, but 30 new trainer candidates with relatively little work experience were selected by MOEP. Since some of them had difficulty understanding the training content in English, lectures were given in Japanese, with a Burmese interpreter, with attention paid to covering the basic content. In addition, some candidates did not receive trainer candidate explanations and did not wish to be trainers. It is recommended that trainer candidates be selected after sharing the objectives in advance.

(4) Self-Learning

As described in the section 2.8, self-learning materials were prepared and provided for each subject so that the trainer candidates could continue to strengthen their skills even during the overseas travel restricted period, and the self-learning was positioned as a self-development program in consideration of trainer candidates' normal work at each workplace. The content of the self-learning was designed as preparation for, or review of, the intensive training, which we believe led to a deeper understanding of the lecture content. Nevertheless, since the implementation rate was limited to about 30%, this rate could have been increased by explaining the purpose in more detail and having each trainer candidate understand the significance of the program. Regardless, the development of young engineers and technicians will lead to improved

work efficiency and quality in the workplace as a whole, so a certain understanding of human resource development is necessary at each workplace.

(5) Human Resource Development Plan

As of the beginning of Phase II, MOEP management expressed the view that the establishment of the human resource development plan (training system) had been completed in Phase I, so direct involvement in Phase II became difficult. On the other hand, at the seminar held in Japan for managers, the participants understood the advantages of the systematic training system at Japanese electric power companies, and action plans for improving the training system in MOEP were drafted. The systematic training system is being promoted at the working level, and it is expected that MOEP will implement these action plans in the future.

(6) Japanese Language Lessons

During the intensive training in Nay Pyi Taw, JICA experts and the Japanese-Burmese interpreter taught Japanese to trainees who are expressed an interest in the language after the lectures every Monday, Wednesday, and Thursday. This was requested by some trainer candidates, and we believe that it provided an opportunity for close communication between the JICA Experts and trainees, as well as between trainees, and motivated them to work toward the workshops in Japan scheduled after the 2nd training in Nay Pyi Taw.

4. Achievement of Project Purpose

4.1. Overall Goal and Project Purpose

4.1.1. Outline of Project Indicators

The indicators to check the degree of achievement of the Overall Goal and Project Purpose were partially changed from those set in the Phase I at the second JCC held on November 20, 2020, to align with the activities of Phase II. The following indicators were set.

Items	Indicators
Overall Goal	- Distribution losses in the whole of Myanmar - Establishment of data management work for power supply reliability management
Project Purpose	- Number of training sessions conducted by certified trainers - Number of work accidents at distribution line work sites - Introduction of data management processes at pilot sites and their application in each region

4.1.2. Achievement of the Overall Goal and Project Purpose

In common with both the Overall Goal and the Project Purpose, the distribution losses at the time of Phase II could not be quantitatively evaluated because the contact policy forced us to refrain from official contact after February 1, 2021.

Regarding the establishment of data management processes for power supply reliability management operations, the working group prepared a draft reliability improvement plan covering each distribution utility, although the plan has not yet been applied and established in each region.

In terms of training by certified trainers, although trainers could not be certified in Phase II, one training session was held for Phase II trainer candidates by the Phase I-certified trainers. In addition, Phase I-certified trainers are now serving as lecturers in Mandalay and other regions, and it is expected that certified trainers will continue to train their successors.

In order to reduce distribution losses, capital investment is required for boosting distribution line voltage, splitting MV distribution line loads, proper placement of MV/LV transformers (load balancing by repositioning transformers and introducing small capacity transformers), and lowering losses from MV/LV transformers (introducing amorphous transformers), etc. In Myanmar, where the electrification rate reached around 50% by 2019 due to the development of the power distribution network (according to the completion report for JICA's "Project Study on the Efficiency of Electricity Use through Visualization Technology in Myanmar," January 2021), large-scale renovation of existing facilities will be necessary in addition to the implementation of such measures for new facilities. Since this Project is not directly related to the reinforcement of power facilities or reduction of distribution losses, but rather to the capacity development of

MOEP engineers, it is difficult to state the prospects of achieving the Overall Goal due to the effects of the Project. However, just as Phase I confirmed the effect of loss reduction as a result of load shedding by installing small-capacity transformers, Phase II also incorporated the concept of distribution facility planning and design for distribution loss reduction in the draft practical textbooks. Through continuous implementation by MOEP of the training for engineers based on these textbooks after the Project is completed, human resources with the necessary technical knowledge to achieve the Overall Goal will be developed, and will provide the basis for promoting the effects of the Project.

The capacity development of MOEP engineers implemented through this Project is effective for the construction and maintenance of sound power supply infrastructure and high quality power supply, but reinforcement and improvement of power supply infrastructure including Japanese ODA loan projects such as "Power Distribution System improvement Project in Yangon Phase I" is essential for accomplishment of the Overall Goal, and development of a strategy for loss reduction and systematic capital investment in MOEP is desired.

4.2. Achievement Status for each Project Output

The achievement statuses for each project output are as follows.

4.2.1. Achievement Status for Output 1

Table 4-1 shows the achievement status for "Output 1: A framework for human resource development planning is developed."

Table 4-1 Indicators and Achievement Status for Output 1

Indicator	Achievement Status
(1) More than one recommendation for improvements in financial and institutional challenges is applied in MOEP.	- Action plan to upgrade the training system and conduct comprehensive training in MOEP was proposed. (Action Plan in Group 1)
(2) More than one recommendation for improvements in technical challenges of T&D system, including standardization, is applied in MOEP.	- Draft standard operating procedures (SOPs) for eight (8) technical items concerning T&D systems were prepared.
(3) Human resource development plan/policy proposed.	- Action plan to create training programs for less experienced engineers was proposed. (Action Plan in Group 2)

4.2.2. Achievement Status for Output 2

Table 4-2 shows the achievement status for “Output 2: Training programs are developed and implemented.”

Table 4-2 Indicators and Achievement Status for Output 2

Indicator	Achievement Status
(1) More than one training program is authorized.	- Due to the impact of COVID-19 and the change in situation, the regional seminars for engineers could not be held.
(2) Syllabi, curricula and textbooks for training are prepared (more than one each).	- Phase I textbooks were localized and authorized. - First versions of new textbooks for seven (7) topics were prepared and authorized. - Practical textbooks for six (6) themes were drafted.
(3) Training of trainers ("TOT") is implemented more than once.	- 1st training in Nay Pyi Taw was conducted. - 2nd training in Nay Pyi Taw was conducted partially online.
(4) Attendance rate of each trainer candidate reaches at least 95%.	- Average attendance rate for 1st and 2nd training was more than 98%.
(5) Each trainer candidate is certified as a trainer for at least one theme (30 trainers certified).	- Due to the impact of COVID-19 and the change in situation, the training was interrupted and not a single trainer could be certified.
(6) Authorized trainer's accreditation system.	- No change from Phase I.
(7) Necessary equipment and materials for training introduced.	- Additional procurement of equipment and devices for training was planned but called off.
(8) At least one textbook related to technical standardization activities is prepared.	- Draft standard operating procedures (SOPs) for eight (8) technical items concerning T&D systems were prepared.

4.2.3. Achievement Status for Output 3

Table 4-3 shows the achievement status for “Output 3: The PDCA (Plan-Do-Check-Action) cycle of the training system is established and implemented.

Table 4-3 Indicators and Achievement for Output 3

Indicator	Achievement Status
(1) At least one time of evaluation for training.	- Due to the impact of COVID-19 and the change in situation, this could not be implemented. - For the 2nd Training, examinations were conducted and results were evaluated.
(2) At least one time of feedback for next training plan.	- Due to the impact of COVID-19 and the change in situation, this could not be implemented. - For the 3rd Training, the program was planned based on the results of the examinations for the 2nd Training.
(3) Continuous practice of PDCA.	- Due to the impact of COVID-19 and the change in situation, training stopped mid-course and continuous practice of PDCA could not be implemented.

4.3. Project Evaluation

Joint monitoring with MOEP using Monitoring Sheets was conducted periodically. At the end of the Project, based on the results of the monitoring, Phase II (May 2019 - December 2022) was evaluated in accordance with the five criteria set by the DAC (Development Assistance Committee), which are relevance, effectiveness, impact, efficiency, and sustainability as per the following. The evaluation should take into account external factors such as the overseas travel restrictions due to COVID-19 from March 2020, and the change in situation that occurred in February 2021, which subsequently forced the holding of low-key activities after that and which had big influence on each project activities and its outcomes.

4.3.1. Relevance

Since there has been no change in the direction of Myanmar's development policies and initiatives, and the Project is a continuation from Phase I, it is evaluated to be "high" in terms of relevance.

4.3.2. Effectiveness

Due to the reasons mentioned above, training in Nay Pyi Taw and training in Japan, which were the main activities for this Project, could not be implemented, and many of the activities related to Output 2 and Output 3 have not been accomplished. Therefore, the effectiveness of the Project is evaluated to be “low”; however, we believe that the Project has produced a certain level of effectiveness, considering the following points, despite the external factors.

✧ The training textbooks and SOPs were created as tools that can be updated by MOEP in the

future for use in human resource development and operational efficiency.

- ✧ The data management activities deepened understanding of data collection and analysis of the causes of accidents, which are vital for improving power supply reliability.

4.3.3. Impact

As mentioned above, the training for 30 trainer candidates which was the main activity for the Project was interrupted and the trainers were not certified, so the impact is evaluated to be "low." Nevertheless, it is assumed that the presentation by MOEP members on SOP preparation and data management to the management of MOEP had a certain impact on future dissemination and development within MOEP.

4.3.4. Efficiency

Although it is difficult to evaluate efficiency due to the large discrepancy between the original plan and actual results caused by the external factors mentioned above, we believe that some degree of efficiency was secured through the following online efforts, even though activities were limited.

- ✧ Following in position of travel restrictions due to the impact of COVID-19, online training was considered at a relatively early stage, and the second intensive training, which had been suspended, was completed.
- ✧ Workshops on SOP preparation and data management were conducted online.

4.3.5. Sustainability

As for Phase II, the training of trainers was interrupted and did not lead to trainer certification, so the sustainability must be evaluated as "low," but the Project as a whole, including Phase I, is considered to have generated sustainability for the following reasons.

- ✧ Training was provided to trainer candidates in Phase II by the trainers certified in Phase I. Furthermore, they have provided training as trainers in their respective regions.
- ✧ The Phase I-certified trainers became members of the textbook preparation-related WG in Phase II, and were involved in the Phase I textbooks' localization and new textbook preparation.

Although training textbooks were prepared as a human resource development tool in this project, a follow-up to the establishment of a systematic training system was not implemented due to the contact policy amid the current situation after the change in situation. Establishment of a trainer certification system and the securing of a budget would be essential elements for sustainable human resource development in the future.

5. Recommendations for Future Cooperation

In light of the fact that the activities during Phase II were limited and only partial results were achieved due to the change in situation in Myanmar, it is considered that the following items would be prospective technical assistance themes in the future.

(1) Implementation of Technical/Operational Standardization

It is recommended that guidelines and/or manuals which provide common standards for each operation at DPTSC, ESE, YESC and MESC (which are responsible for power transmission and distribution) be developed in order for MOEP to efficiently realize high-quality power supply throughout Myanmar. The eight (8) draft SOPs developed in Phase II, should be disseminated to engineers and technicians in each organization after they are authorized as official documents in MOEP. Therefore, it is recommended to establish systems for sharing and updating these documents within MOEP in a timely manner. It is also recommended that SOPs for other technical/operational items be created sequentially to proceed with standardization.

(2) Implementation of Data Management

Through the data management activities in Phase II, understanding of the workflow for data collection related to power supply reliability improvement focusing on SAIFI/SAIDI has progressed, and we expect implementation of data collection at each site of ESE, YESC, and MESC independently. However, the activities have not yet led to the implementation of data analysis work, and determination of accidents' causes requires the deployment of personnel with a certain level of technical expertise at the sites. Therefore, further technical assistance and system planning for the introduction and establishment of a data management system to improve the accuracy and efficiency of power distribution operations and to accurately ascertain the baseline for the entire country of Myanmar would be effective.

(3) System Introduction and Technical Assistance on Power System Planning for Power Supply Reliability Improvement

In Myanmar, in addition to planned power outages due to electricity shortages, power outage accidents occur frequently, and once a power outage occurs, restoration takes a long time. The transmission line fault point locator system and the pulse charging ground fault detector which were planned to be procured as training equipment in Phase II, as well as the distribution grid configuration such as multi-divided and multi-connected, and distribution automation system introduced in the lecture, will help reduce the duration of power outages and improve operational efficiency. The introduction of these systems and technical assistance for system planning/design methods will be effective in improving supply reliability.

(4) Development of distribution system interconnection conditions to promote renewable energy

In the midst of the global trend toward carbon neutrality, Myanmar has not yet developed standards for connecting renewable energy sources to distribution systems. Furthermore,

commercial facilities and industrial consumers in urban areas are utilizing diesel generators as backup power sources to cope with planned power outages. Under these circumstances, connection of distributed renewable energy sources to the distribution systems is vital in order to promote carbon neutrality in power sources, and the introduction of renewable energy sources will be an effective measure to address power supply shortages. Therefore, it is recommended to develop distribution system interconnection conditions for promoting renewable energy.