JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

MINISTRY OF INDUSTRY, MINES AND ENERGY(MIME)
KINGDOM OF CAMBODIA

No. 2

THE STUDY FOR ESTABLISHMENT OF ELECTRIC POWER TECHNICAL STANDARDS AND GUIDELINES IN KINGDOM OF CAMBODIA

FINAL REPORT

MAIN REPORT

Vol. I

ELECTRIC POWER TECHNICAL STANDARDS

FEBRUARY 2004

ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO-JAPAN

CHUBU ELECTRIC POWER CO.,INC.
NAGOYA-JAPAN

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THE ROYAL GOVERNMENT OF CAMBODIA
MINISTRY OF INDUSTRY, MINES AND ENERGY

ELECTRIC POWER TECHNICAL STANDARDS

OF

THE KINGDOM OF CAMBODIA

(Draft)

January 31, 2004

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Abbreviation

1. EAC

   "EAC" means Electricity Authority of Cambodia.

2. IEC

   "IEC" means International Electrotechnical Commission.

3. ISO

   "ISO" means International Organization for Standardization.

4. RTU

   "RTU" is abbreviation of "Remote Terminal Unit" for SCADA system installed at the electric power facilities for monitoring the operation/fault states and control

5. SCADA

   "SCADA" is abbreviation of "Supervisory Control and Data Acquisition".

CONTENTS

CHAPTER 1 General Provisions

Paragraph 1: Definitions

Clause 1: Definitions

1. Dam

"Dam" means a general term of embankments, including its foundations and affiliated facilities such as spillways, installed to store flowing water or divert it to intakes for power generation.

2. Draw-in Conduit System

"Draw-in Conduit System" means a installation method for underground lines that cables are installed in conduits.

3. Electrical Line

"Electrical Line" means one of electric power facilities to supply electricity, which connect to power stations, substations, switching stations and user's sites, including lines, protective devises and switchgears.

4 Electric Power Facility

"Electric Power Facility" means Generating Facilities, Substations, Switching Stations, Electrical Lines, and dispatching centers, including equipment, buildings, dam, waterways, fuel storageyards, ash disposal areas, etc.

5. Electrical Equipment

"Electrical Equipment" means electrical-charged facilities.

6. Generating Facilities

"Generating Facilities" means one of electric power facilities to generate electricity.

7. High-Voltage Line

"High-voltage Line" means an electrical line of voltage higher than 35kV

8. House Wiring

"House wiring" means user's electrical equipment like wiring or devices installed in houses or buildings etc for the purpose of using electricity. And that doesn't include electrical equipment installed in places like power generation, substation that aren't user's facilities.

9. Indoor Electrical Appliances

"Indoor electrical appliances" means low-voltage incandescent lamps, discharge lamps, and household and business electrical appliances installed indoors.

10. Insulated Conductor

"Insulated Conductor" means a cross-linked polyethylene (XLPE) insulated conductor for the medium-voltage lines and XLPE insulated conductor or a polyvinyl chloride (PVC) insulated conductor for the low-voltage line, according to the substance of the covering insulator.

11. Joint Use

"Joint Use" means a condition that electrical lines and communication lines two or more owners are installed at a supporting structure.

12. Licensee

"Licensee" means a power service supplier who has been issued a license by the EAC.

13. Low-Voltage Line

"Low-voltage Line" means an electrical line of its voltage is no more than 600V.

14. Medium-Voltage Line

"Medium-voltage Line" means an electrical line of its voltage is more than 600V, and is no more than 35kV.

15. National Grid

"National Grid" means the high voltage backbone system of interconnected transmission lines, substations and related facilities for the purpose of conveyance of bulk power.

16. Reservoir

"Reservoir" means stored water impounded by one or more dams or surrounding ground. It also means land on which water is impounded to the largest water storage.

17. Service Connection

"Service Connection" means two or more insulated electrical conductors which provide, or are intended to provide, an electrical link between Low-voltage Line and a connected User's site.

18. Side by Side Use

"Side by Side Use" means a condition that electrical lines and communication lines of one owner are installed at a supporting structure.

19. Substation

"Substation" means electric power facilities to transform the voltage, which includes transformers, lightning arresters, circuit breakers, disconnection switches, potential devices, current transformers, bus bars, protective relay system for Electrical Lines and equipment and devices RTU for SCADA system, telecommunication facilities, etc.

20. Supporting Structure

"Supporting structure" means a structure to support electrical line, such as wooden poles, iron poles, reinforced concrete poles and steel towers.

21. Switching Station

"Switching Station" means electric power facilities to change-over the electrical lines which includes disconnecting switches, circuit breakers, bus-bars, protective relay system, RTU for SCADA system, etc.

22. The Technical Standards

"The Technical Standards" means The Electric Power Technical Standards in Cambodia.

23. User's Site

"User's Site" means a place at which machines, apparatus and devices for using electricity are installed.

24. Waterway

"Waterway" means a general term of channels and auxiliaries including gates and valves that take flowing water, convey it to hydro-turbines, and discharge it into a river and so on for power generation. "Waterway" is generally composed of intakes, forebays (settling basins), headraces, head tanks or surge tanks, penstocks, tailraces, outlets, and other facilities.

Paragraph 2: Purpose, Applied Area and Enforcement

Clause 2: Purpose

1. To specify the technical, design, or operational criteria of Electrical Power Facility, House Wiring and Electrical Appliance,

2. To ensure that the basic rules for supply electricity are fair and non-discriminatory for all Consumers of the same category, and

3. To maintain the technical standards (levels) of Electrical Power Facility, House Wiring and Electrical Appliance installed in Cambodia

Clause 3: *Applied Area*

All electrical power facilities, house wiring and electrical appliances, except the following facilities, shall be in accordance with the Technical Standards.

1. Electrical equipment installed in airplanes, vessels, trains and vehicles

2. Electrical equipment lower than 30V AC/DC which has not been connected to the electric facilities of 30V or more

3. Communication facilities other than the communication facilities for power system operation

Clause 4: *Enforcement*

4-1 General

All the persons who are related to electric power supply, electrical works, use of electricity, manufacturing electric power facilities, trading of the facilities shall strictly follow to the Technical Standards. The Technical Standards will not exempt any concerned conditions stipulated in the clauses of the other law and ordinance even thought the matters not stipulated in the Technical Standards.

4-2 Attention to be paid for Power Project

1. In planning of electric power projects, the feasibility studies shall be made in view of long term vision on technically, economically and financially viable, and socially acceptable.

2. In design, manufacturing, assembling and procurement of power facilities, the facilities shall be operated with the designated performance for a long time. Therefore, enough attentions shall be paid in selection of the materials, safety factors, easy operation, assembling/dismantling during O&M.

3. In installation of the electric power facilities, equipment and construction of the facilities, enough attentions in selection of the materials, construction management during the construction work, shall be paid.

4. In operation and maintenance of the electric power facilities, enough attentions for maintaining the required performance of the power facilities for long time and to protect the environment in the surrounding areas, shall be paid.

5. In closing the electric power facilities, enough attentions to the environmental and social issues after closing the facilities, shall be paid.

4-3 Licensees of power utilities shall employ qualified electrical engineers for supervision of the power facilities.

4-4 Electrical works, such as house wiring, cable connection, installation of electrical equipment, shall be made by qualified electricians. The works shall be made in accordance with the Technical Standards.

Clause 5: Provisional Clause

1 The existing electric power facilities that is not harmful to human beings could be operated by the time of its renewal or replacement.

2 The existing electrical power facilities harmful to human beings shall be modified within two years to be satisfactory with the requirement of the Technical Standards.

3. The 4-3 and 4-4 of Clause 4 of the Technical Standards are only effective after establishment and issuance of the licenses of the Qualified Electrician and a Qualified Electrical Engineers for supervision of the power facilities, respectively.

Paragraph 3: Quality of Electric Power

Clause 6: Voltage

6-1 Standard Voltage

AC voltage shall be as follows below.

Classification of voltage	*Range of Nominal Voltage*	*Nominal Voltage*	*Highest Voltage*
Low Voltage	600V or less	220/380V	–
Mediun Voltage	More than 600V 35kV or less	22kV	24kV
High Voltage	More than 35kV	115kV	123kV
		230kV	245kV

6-2 Variation of voltages

The AC voltage at power supply points shall be maintained to the value according to the nominal system voltage in accordance with the following table;

Nominal System Voltage	***Value to be maintained***
220 V	Between 207 V and 244 V
380 V	Between 360 V and 424V

Clause 7: Frequency

The rated frequency is 50 Hz. The variation of the frequency shall be between 49.5Hz and 50.5Hz.

Clause 8: Continuous Power Supply

1 Electric power supply shall be made continuously in accordance with the Regulation of General Conditions of Supply Electricity in the Kingdom of Cambodia.

2 In case of power interruption, power system failure or loss of power, all electric power licensees shall make possible effort to secure the normal conditions for continuous power supply.

Paragraph 4: Prevention of Electric Power Disasters

Clause 9: Prevention of Electric Power Disasters

The electrical equipment shall be installed not to cause electrical shock, fire and other accidents.

Clause 10: Prevention of Accidents Caused by Electric Power Facilities

The electric power facilities shall be installed with proper measures for operators not to touch their moving parts, hot parts and other dangerous parts, and not to fall from them, accidentally.

Clause 11: Safety of Third Persons

1. Appropriate measures shall be taken to prevent third persons from entering into compounds of power plants, substations and switching stations.
2. Appropriate measures shall be taken to prevent third persons from climbing supporting structures of overhead electrical lines.

Clause 12: Prevention of Failures of Electric Power Facilities from Natural Disasters

Proper measures shall be taken for preventing failures of electric power facilities from anticipated natural disasters such as floods, lightning, earthquakes, and strong winds.

Paragraph 5: Prevention of Electric Power Outage

Clause 13: Prevention of Electric Power Outage

1. When any generating facilities are in serious fault, the generating facility shall be disconnected from the power system so that the effect of the fault on the system can be minimal and possibly the system could be operated, continuously.

2. When a power system fault is happened during generating by any of the generating facilities, the generating facility shall be disconnected from the system immediately, then the generator shall be continuously running with no-load to wait for the recovering the system fault.

3. When a power system fault is happened on electrical lines, the power cut areas shall be minimized by disconnecting the troubled parts or other proper methods as much as possible.

Paragraph 6: Preservation of Environment

Clause 14 Compliance with the Environmental Standards

To prevent the Environmental pollution, the electric power facilities shall be in accordance with the environmental laws and regulations in Cambodia.

CHAPTER 2 Technical Standards of Electric Power Facilities

Paragraph 1: General

Clause 15: Applicable Standards

Electrical Power Facility, House Wiring and Electrical Appliance shall be followed to the Technical Standards. In case the matter not stipulated in the Technical Standards, IEC Standards shall be applied. If it is not in IEC standards, then ISO Standards shall be applied. If it is not in ISO Standards, internationally recognized standards shall be applied subject to the approval of EAC.

Clause 16: Life of Electrical Power Facility

1. Electrical power facilities shall be durable for a long time usage with efficient and stable operation.
2. Taking design of the electrical power facilities, selection of the materials, assembling and installation of the equipment into consideration, suitable safety factors against foreseeable stresses, such as thermal stress, mechanical stress, insulation strength, shall be considered.
3. To secure the power supply for a long time, necessary drawings, installation records, technical manuals, instruction manuals, operation records necessary for the proper maintenance works on the electrical equipment shall be provided.

Clause 17: Grounding

1. Grounding or other appropriate measures shall be provided for Electrical Equipment to prevent electric shock, danger to human bodies, fire, and other impediments to objects.
2. Grounding for Electrical Equipment shall be installed to make current safely and securely flow to the ground.

Clause 18: Connection of Conductors

Conductors shall be connected as following methods;

1. Conductors shall be connected firmly and the resistance of conductors shall not increase.

2. The insulating capacity of cables and insulated conductors shall not decrease.

3. The electrochemical corrosion shall not occur by connecting conductors of different kind of materials.

Clause 19: Communication System

To secure the power supply, necessary communication system shall be provided.

Clause 20: Accuracy of Power Meters

Power meters shall be accurate, fair and equitable power meters. The accuracy of Meter shall be generally as follows:

1. Electro-magnetic mechanical power meter

Classification of customer	*Class
High-voltage customers	0.5
Medium-voltage customers	1.0
Low-voltage customers	2.0

*In accordance with IEC

2. Electronic power meter

Classification of customer	*Class
High-voltage customers	1.0
Medium-voltage customers	1.0
Low-voltage customers	2.0

*In accordance with IEC

Paragraph 2: Generating Facilities (Thermal Power)

Clause 21: Boiler and its Accessories

21-1 Materials for Boiler and its Accessories

Regarding vessels and tubes which belong to the boiler, dependent superheater and steam storage vessel and its accessories, the parts which are subject to an internal pressure higher than 0kg/cm2 (hereinafter, referred to as pressure parts) shall be made of the materials which have enough mechanical strength and chemical stability under the maximum working pressure and temperature.

21-2 Structure of Boiler and its Accessories

The pressure parts of the vessels and tubes which belong to the boiler shall have enough safety margin against the maximum stress under the maximum working pressure or temperature condition.

In this case, the stress shall not be exceeded from the allowable stress of the material.

21-3 Safety Valves

Vessels and tubes which belong to the boiler which will be able to be overpressure shall be equipped with safety valve in order to release the pressure.

21-4 Feed Water System

1. The feed water system shall be able to avoid the thermal damage on the boiler during the maximum evaporating condition.

2. In order to avoid the abnormal condition on the boiler feed water system, the boiler shall be equipped with the standby feed water system.

21-5 Shutoff of Steam and Feed Water

1. The steam outlet of the boiler shall be able to be shutoff the steam.

2. The feed water inlet of the boiler shall be able to be shutoff automatically and firmly.

21-6 Drain off Device For Boiler

In case of circulation boiler, the drain-off device shall be equipped which protect deposit and to maintain the water level.

21-7 *Monitor and Alarm System*

Boiler and its accessories shall be equipped with the monitoring system to monitor the running condition and the alarm system to protect from the damage of the boiler and its accessories.

Clause 22: Steam Turbine and its Accessories

22-1 Materials for Steam Turbine and its Accessories

Regarding cylinders, vessels and tubes which belong to the steam turbine and its accessories, the pressure parts shall be made of the materials which have enough mechanical strength and chemical stability under the maximum working pressure and temperature.

22-2 Structure of Steam Turbine and Its Accessories

1. A steam turbine shall have enough mechanical strength for the structure even when it is operated at a speed which the steam turbine reaches when the emergency governor is actuated.

2. A steam turbine shall have enough mechanical strength for the structure against the maximum amplitude value of vibration produced on the major bearings and shaft.

3. Bearings of steam turbine shall have the construction to be able to support the load stably during operation and not to be arisen it's abnormal wear and deformation, and overheat.

4. The critical speed of steam turbine and/or combined with generator or rotor on the same shaft shall not be in the speed between the minimum speed of governor and the maximum available speed of emergency governor. However, it will be exempted if it will be arranged the enough countermeasure against the vibration of critical speed during operation of turbine.

5. The pressure parts and its accessories which belong to steam turbine shall have enough safety margin against the maximum stress under the maximum working pressure and temperature. In this case, the stress shall not be exceeded from the allowable stress of the material.

22-3 Governor

A steam turbine shall be equipped with a device to adjust automatically the steam entering into the steam turbine in order to prevent its speed and output from fluctuating continuously even in case of a change in load condition. The device to adjust the steam entering into the steam turbine automatically shall have an ability to keep the turbine speed after the interruption of the rated load below the speed at which the emergency governor is actuated.

22-4 Emergency Stop and Alarm Devices

1. A steam turbine shall be equipped with an alarming device that functions to alarm when the amplitude value of vibrations was detected beyond the allowable level during the turbine operation.

2. In order to avoid the occurrence of harm from overspeed or other abnormal conditions during steam turbine operation, steam turbine shall be equipped with a device which interrupts the inflow of steam automatically and a manual emergency stop device. When the above emergency stop device is actuated, the emergency stop alarm shall be energized.

22-5 Overpressure Protection Device

Steam turbine and its accessories which will be able to be overpressure shall be equipped with an overpressure protection device in order to release the pressure.

22-6 Monitor and Alarm System

A steam turbine and its accessories shall be equipped with the necessary monitoring system to monitor the operating condition and necessary alarm system to prevent from the damages of steam turbine and its accessories during the operation.

Clause 23: Gas Turbine and its Accessories

23-1 Materials for Gas Turbine and its Accessories

Regarding cylinders, vessels and tubes which belong to the gas turbine and its accessories, the pressure parts shall be made of the materials which have enough mechanical strength and chemical stability under the maximum working pressure and temperature.

23-2 *Structure of Gas Turbine and its Accessories*

1. A gas turbine shall have enough mechanical strength for the structure even when it is operated at a speed which the gas turbine reaches when the emergency governor is actuated.

2. A gas turbine shall have enough mechanical strength for the structure against the maximum amplitude value of vibration produced on the major bearings and shaft.

3. Bearings of gas turbine shall have the construction to be able to support the load stably during operation and not to be arisen it's abnormal wear and deformation, and overheat.

4. The critical speed of gas turbine and/or combined with generator or rotor on the same shaft shall not be in the speed between the minimum speed of governor and the maximum available speed of emergency governor. However, it will be exempted if it will be arranged the enough countermeasure against the vibration of critical speed during operation of turbine.

5. The pressure parts and its accessories which belong to gas turbine shall have enough safety margin against the maximum stress under the maximum working pressure and temperature. In this case, the stress shall not be exceeded from the allowable stress of the material

23-3 Governor

A gas turbine shall be equipped with a device to adjust automatically the energy entering into the gas turbine in order to prevent its speed and output from fluctuating continuously even in case of a change in load condition. The device to adjust the energy entering into the gas turbine automatically shall have an ability to keep the turbine speed after the interruption of the rated load below the speed at which the emergency governor is actuated.

23-4 Emergency Stop and Alarm Device

1. A gas turbine shall be equipped an alarming device that functions to alarm when the amplitude value of vibrations was detected beyond the allowable level during the gas turbine operation.

2. In order to avoid the occurrence of harm from overspeed or other abnormal conditions during gas turbine operation, gas turbine shall be equipped with a device which interrupts the inflow of gas automatically and a manual emergency stop device. When the above emergency stop device is actuated, the emergency stop alarm shall be energized.

23-5 Overpressure Prevention Device

Gas turbine and its accessories which will be able to be overpressure shall be equipped with an overpressure protection device in order to release the pressure.

23-6 Monitor and Alarm System

A gas turbine and its accessories shall be equipped with the necessary monitoring system to monitor the operating condition and the necessary alarming system to prevent the damages of gas turbine and its accessories during the operation.

Clause 24: *Internal Combustion Engine (reciprocating engine) and its Accessories*

24-1 Material for Internal Combustion Engine and its Accessories

Regarding cylinders, vessels and tubes which belong to the internal combustion engine and its accessories, the pressure parts shall made of the materials which have enough mechanical strength and chemical stability under the maximum working pressure and temperature.

24-2 Structure of Internal Combustion Engine and its Accessories

1. An internal combustion engine shall have enough mechanical strength even when it is operated at a speed which the internal combustion engine reaches when the emergency governor is actuated.

2. Bearings of the engine shall have the structure to be able to support the load stably during operation and not to be arisen it's abnormal wear and deformation, and overheat.

3 The pressure parts and its accessories which belong to the engine shall have enough safety margin against the maximum stress under the maximum working pressure and temperature. In this case, the stress shall not be exceeded from the allowable stress of the material.

24-3 *Governor*

An engine shall be equipped with a device to adjust automatically the energy entering into an engine in order to prevent its speed and output from fluctuating continuously even in case of a change in load condition.

24-4 Emergency Stop Device

In order to avoid the occurrence of harm from overspeed or other abnormal conditions during the engine operation, the engine shall be equipped with a device which interrupts the inflow of fuel automatically and a manual emergency stop device. When the above emergency stop device is actuated, the emergency stop alarm shall be energized.

24-5 Overpressure prevention Device

An engine and its accessories which will be able to be overpressure shall be equipped with an overpressure protection device in order to release the pressure.

24-6 Monitoring and Alarming System

An engine shall be equipped with the necessary monitoring system to monitor the operating condition and the necessary alarming system to prevent the damages of the engine and its accessories during the operation.

Clause 25: Gas-turbine Combined Cycle and its Accessories

Gas Turbine Combined Cycle and its Accessories shall be designed, manufactured constructed and operated in accordance with the above Clause 21, 22 and 23.

Paragraph 3: Generating Facilities (Hydroelectric Power)

Clause 26: Dams, Waterways, Powerhouses and Other Facilities

26-1 Prevention of Overflow from Non-overflow Sections of Dams

Every dam shall be equipped on or near its body with a spillway capable of safe and secure discharge of an inflow design flood, and every dam body shall have an adequate freeboard, in order to prevent overflow of water from non-overflow sections of the dam for dam safety.

26-2 *Dam Stability*

1. Dam bodies shall be stable for sliding, overturning, and have required strength and durability for dam stability. Fill dam bodies shall be stable for sliding, and have required strength and durability for dam stability.

2. Dam foundations and the contact areas between the dam body and its foundations shall be stable for sliding, and have the required strength for dam stability.

26-3 Prevention of Seepage Failure of Dams

1. Dam foundations shall have required water-tightness and seepage failure shall not occur in dam foundations.

2. Dam bodies shall have required water-tightness. Excessive uplifts shall not occur under concrete dam bodies. Seepage failure shall not occur in fill dam bodies.

3. Seepage failure shall not occur at the contact areas between a dam body and its foundations.

26-4 Prevention of Serious Deformations and Cracks of Dams

1. Dam foundations shall have a required bearing capacity.

2. Serious cracks shall not occur in concrete dam bodies.

3. Fill dam bodies shall be embanked with adequate materials in order to prevent serious settlement and cracks.

26-5 Prevention of Failure of Waterways

1. Waterways shall be structurally stable for anticipated loads, and not be damaged by disasters such as a landslide and a flood.

2. Waterways shall be able to safely and securely discharge and control a design plant discharge, and be hydraulically stable.

26-6 Prevention of Failure and Damage of Powerhouses and Other Facilities

Structures related to hydroelectric power civil engineering facilities such as powerhouses, maintenance roads, and temporary facilities for construction works shall be stable for anticipated loads, and not suffer failure and damage due to a landslide and a flood.

Clause 27 *Prevention of Damage caused by Hydroelectric Power Plant*

27-1 Prevention of Damage to Reservoirs and Ground around Reservoirs

1. Reservoirs shall not cause harmful water leakage to the surrounding ground, seepage failure of the ground, and large-scale landslides.

2. Proper measures shall be taken if submergences of properties such as houses and buildings may occur at upstream areas of a reservoir due to rises in water level caused by the reservoir sedimentation.

27-2 Prevention of Damage to Downstream Areas of Dams and those of Outlets

1. Damage due to discharge from a dam to the downstream area under conditions of floods shall not increase in comparison with the damage of no dam existence.

2. Proper measures shall be taken if damage to humans or properties, and impacts on the surrounding environment and so on may occur at the downstream areas due to discharge from dams.

3. Proper measures shall be taken if a rapid change in water level at downstream area of an outlet due to discharge from a hydroelectric power plant may cause damage to the downstream area.

Clause 28 Hydraulic Turbines and Generators

28-1 Prevention of Damage to Hydraulic Turbines

1. Hydraulic turbines shall not be remarkably damaged by driftwood, floating debris, or sediment that flows into hydraulic turbines.

2. Vibrations that may damage hydraulic turbines shall not occur.

3. Cavitation erosion that may damage hydraulic turbines shall not occur.

28-2 Equipment to Quickly Shut off the Inflow of Water

Hydraulic turbines or waterways shall be equipped in principle with facilities that can quickly shut off the inflow of water into the turbines.

28-3 Mechanical Strength of Hydraulic Turbines and Generators

1. Hydraulic turbines shall withstand the maximum water pressure in case the load is rejected.

2. Hydraulic turbines and generators shall withstand the maximum speed in case the load is rejected.

3. Generators shall withstand the mechanical shock caused by short-circuit current.

28-4 Thermal Strength of Hydraulic Turbines and Generators

Hydraulic turbines and generators shall withstand the heat generated by hydraulic turbines and generators under normal operations.

28-5 Protective Devices for Hydraulic Turbines and Generators

Hydraulic turbines and generators shall be equipped with devices to break the generators from the electrical circuits and to stop the hydraulic turbines automatically in case any abnormality that may cause significant damage and/or make serious trouble to the supply of electricity occurs.

Paragraph 4: Generating Facilities (Others)

Clause 29: Renewable Energy, Portable Generators and Small Hydro Generations

As to renewable energy generating facilities including photovoltaic generation, wind power, bio-mass or bio-gas generation, portable generators and small hydropower generation including micro-hydro generation, the Technical Standards shall also applicable. However, some of the conditions of the clauses stipulated in the Technical Standards which may be hard to apply to such generating facilities in their special features of the facilities and/or the circumstances may be relaxation of the conditions by application from the prospective owner with the reasons if it is judged reasonable.

Clause 30: Pumped Storage Generating Facilities

The Technical Standards shall be applicable to the generating facilities. Since the Technical Standards are not enough for the generating facilities, an additional version of the Technical Standards on the generating facilities will be issued by the time when it is needed.

Paragraph 5: Transmission and Distribution Facilities (Common)

Clause 31: Property of Conductors

1. The conductor of transmission and distribution facilities shall be cables, insulated conductors or bare conductors. Bare conductors shall not be used for low-voltage lines.
2. Cables and insulated conductors shall have sufficient insulation capacity appropriate for the conditions of the applied voltage.

Clause 32: Prevention of Climbing on Supporting Structures

As for supporting structures of electrical lines, following measures shall be taken to prevent danger of third persons.

1. Any metal steps of supporting structures shall not be installed at the height of 1.8m or below from the ground.
2. Warning signs to make third persons recognize danger shall be installed at each supporting structure.
3. As for high-voltage lines, appropriate devices shall be installed at all legs of supporting structures to prevent third persons from climbing the supporting structures. However, in case that the supporting structures are located at places where third persons hardly approach such as in the mountains or the supporting structures are surrounded by fences or walls with appropriate height, this article shall not be applicable.

Clause 33: Safety Factor of Bare Conductors and Ground Wires of Overhead Electrical Lines

As for tensile strength of conductors and ground wires for overhead electrical lines except for cables, the safety factor shall be not less than 2.5.

Clause 34: Side by Side Use and Joint Use of Electrical Lines or Communication Lines

34-1 High-Voltage Lines, Medium-Voltage Lines and Low-Voltage Lines

Side by side use and joint use of electrical lines shall be done by following methods.

1. When a high-voltage line and a medium-voltage line are installed at the same supporting structure, the medium-voltage line shall be installed under the high-voltage line and on separate cross arms.

2. When a medium-voltage line and a low-voltage line are installed at the same supporting structure, the low-voltage line shall be installed under the medium-voltage line and on separate cross arms.

3. No low-voltage line shall be installed at the same supporting structure where a high-voltage line is installed.

34-2 Electrical Lines and Communication Lines

Side by side use and joint use of electrical lines and communication lines shall be done by following methods. If communication lines are optical fibers and they are united to electrical lines or ground wires, this may not be applicable.

1. When a medium-voltage or a low-voltage line and a communication line are installed on the same supporting structure, the medium-voltage or the low-voltage line shall be installed above the communication line and on separate cross arms.

2. No communication line shall be installed at the same supporting structure where a high-voltage line is installed.

Clause 35: Underground Lines

35-1 Cables shall be applied for underground electrical lines.

35-2 In case that underground lines are installed with draw-in conduit system, tubes shall withstand the pressure of vehicles and other heavy objects.

35-3 In case that underground lines are installed with a direct burial system, they shall be installed in accordance with following methods.

1. Installation of proper plates above the underground lines or other proper measures shall be taken to protect the underground lines against mechanical shocks.

2. The installed position of underground facilities shall be no less than 1.2 m in depth at a place where there is a danger of receiving pressure from vehicles or other objects, and no less than 0.6 m at other place.

Clause 36: Protection against Over-current

Protection equipment against over-current shall be installed at the appropriate places of electrical circuits to prevent electrical equipment from over-heating due to excessive current and not to cause fire.

Clause 37: Protection against Ground Faults

Protection equipment against ground faults or other appropriate measures shall be provided to prevent damage of electrical equipment, electrical shock and fire.

Clause 38: SCADA System for Load Dispatching Center

1. RTU for SCADA System shall be installed in electric power facilities so that the state of the National Grid could be monitored and control of the Power Facilities could be made at the Dispatching Center.
2. Necessary telecommunication system shall be installed among Dispatching Center and electric power facilities. As the redundancy, at least two different telecommunication systems shall be required for the National Grid.

Clause 39: Classification of Grounding for Electrical Lines.

The types of grounding, the places to be applied, installation conditions, resistance value to earth at distribution line shall be in the following table;

Kinds of groundings

Grounding type	*Application*	*Installation conditions*	*Resistance to earth (Ω)*
System grounding	MV/LV transformer	Low-voltage neutral conductor of TT or TN grounding type	Value prescribed for Class B grounding work
Safety grounding	Exposed conductive parts(*1)	For high-voltage lines(*2)	Value prescribed for Class A grounding work
		For medium-voltage	
		For low-voltage exceeding 300 V	Value prescribed for Class C grounding work
		For low-voltage not exceeding 300 V	Value prescribed for Class D grounding work
Arrester grounding	Surge arrester	For medium-voltage	Value prescribed for Class A grounding work

*(*1) "Exposed conductive parts" refers to parts such as steel stands, metal case or the like of apparatus installed in the electrical circuit.*

*(*2) Groundings for high-voltage substations and switching stations shall be individually designed, depending on the short-circuit capacity.*

Class A-Class D resistance value to earth shall be equal to or less than the value given in the following table.

Classification of grounding work	*Resistance to earth*	*Conditions for easement of resistance value*
Class A	10Ω or less	
Class B	10Ω or less (When $\frac{230}{I^{*1}}$ is less than 10, resistance to earth shall be the value of $\frac{230}{I^{*1}}$ or less.)	In cases where voltage to earth of a low-voltage electrical circuit exceeds 230V due to power contact between the medium-voltage electrical circuit and the low-voltage electrical circuit of the transformer, when an earth leakage breaker that cuts off the electrical circuit within 1 second is installed, $\frac{600}{I^{*1}}$ Ω or less. When $\frac{230}{I^{*1}}$ becomes less than 5Ω, it shall not be necessary to obtain resistance less than 5Ω.
Class C	10Ω or less	In the case where grounding arises in a low-voltage electrical circuit, when an earth leakage breaker that acts within 0.5 seconds is installed, the resistance value shall be 500Ω or less.
Class D	100Ω or less	In the case where grounding arises in a low-voltage electrical circuit, when an earth leakage breaker that acts within 0.5 seconds is installed, the resistance value shall be 500Ω or less.

**1 Single-line earth fault current*

Paragraph 6: Transmission and Distribution Facilities (High Voltage)

Clause 40: Design of Supporting Structures of Overhead High-voltage Lines

1. Supporting structures of overhead lines shall be designed, taking into account the following loads.

Kinds of Loads

Type of Load	*Contents*
Vertical loads	Weight of the supporting structure
	Weight of the conductors and the ground wires and the accessories supported by the supporting structure
	Weight of the insulator strings and the fittings supported by the supporting structure
	A vertical component of the maximum tension of the guy wires supporting the supporting structure, if any
Horizontal transverse loads	Wind pressure of the supporting structure under the maximum wind velocity
	Wind pressure of the conductors and the ground wires supported by the supporting structure under the maximum wind velocity
	Wind pressure of the insulator strings and the fittings supported by the supporting structure
	A horizontal transverse component of the maximum tension of the conductors and the ground wires supported by the supporting structure and the guy wires supporting the supporting structure, if any
Horizontal longitudinal loads	Wind pressure of the supporting structure under the maximum wind velocity
	A horizontal longitudinal component of the unbalanced maximum tension of the conductors and the ground wires supported by the supporting structure and the maximum tension of the guy wires supporting the supporting structure, if any

2. Supporting structures and foundations of overhead high-voltage lines shall be designed in consideration of the value of wind pressure based on the assumed maximum wind velocity in Cambodia.

3. Supporting structures and foundations of overhead high-voltage lines shall be designed so that those withstand the maximum loads, in consideration of appropriate safety factors.

4. In cases that overhead high-voltage lines are installed at places on the worst conditions such as inside river areas, windy areas, and so on, the supporting structures and the foundations shall be designed to withstand such the severe conditions.

Clause 41: Safety Factor of Fittings for Conductors and/or Ground Wires of Overhead High-voltage Lines

Safety factor for the tensile strength (the maximum tensile strength, breaking strength) of fittings of conductors and ground wires for overhead high-voltage lines shall be 2.5 or more.

Clause 42: Protection against Lightning for Overhead High-voltage Lines

The following measures shall be taken for overhead high-voltage lines to decrease the number of electrical faults, and to protect equipment from damage by the faults.

1. Installation of ground wires for overhead high-voltage lines
2. Installation of arcing horns for both ends of insulator assemblies of overhead high-voltage lines
3. Installation of armor rods to wrap conductors by a clamp of suspension insulator assemblies of overhead high-voltage lines

Clause 43: Bare Conductors of Overhead High-voltage Lines

1. Vibration Dampers

   An appropriate type and number of dampers shall be installed to prevent fatigue of bare conductors and ground wires for overhead high-voltage lines due to their aeolian vibration.

2. Connection

   In case that bare conductors and ground wires are jointed with each other or with insulated conductors or cables, the connection shall conform to the following requirements in addition to the Clause 18.

   (1) Bare conductors and ground wires shall be connected with compression type sleeves or compression type devices.

   (2) Tensile strength of connection of bare conductors and ground wires shall be 95 % or more of the tensile strength of the connected bare conductors and ground wires. However, this requirement shall not be applied to cases where the maximum tension to be designed is

substantially smaller than the ultimate strength of the bare conductors and ground wires such as jumper conductors, the end span to substations and others.

Clause 44: Clearance among Bare Conductors and Supporting Structures of Overhead High-voltage Lines

1. Clearance among bare conductors and supporting structures, arms, guy wires and/or pole braces of overhead high-voltage lines shall be as follows. The clearances shall be secured, in any cases of the maximum swing of conductors under the maximum wind velocity to be designed, as follows;

Nominal Voltage	*Clearance*
115kV	No less than 0.70m
230kV	No less than 1.45m

2. Clearance among ground wires and the nearest conductor in the same span shall be larger at any points in the span than the clearance of the supporting points at the both sides of the span.

Clause 45: Height of Overhead High-voltage Lines

Height of conductors of overhead high-voltage lines shall be as follows.

1. Height in urban areas

Height of conductors of overhead high-voltage lines in urban areas shall be no less than the value by adding 0.06 m for every 10kV over 35kV to 6.5m, and rounding up to the nearest whole number.

2. Height in areas where third persons hardly approach

Height of conductors of overhead high-voltage lines in areas where third persons hardly approach shall be no less than the value by adding 0.06 m for every 10kV over 35kV to 5.5m, and rounding up to the nearest whole number.

3. Height over roads and/or railways

Height of conductors of overhead high-voltage lines crossing over roads and/or railways shall be no less than the value by adding 0.06 m for every 10kV over 35kV to 13m, and rounding up to the nearest whole number.

4. Height over rivers and/or seas

Height of conductors of overhead high-voltage lines crossing rivers and/or seas shall be as follows.

At places with no craft passage	At places with vessel passage
From the highest water level	From the highest point of vessels on the highest water level(*1)
No less than the value by adding 0.06 m for every 10kV over 35kV to 5.5m, and rounding up to the nearest whole number	No less than the value by adding 0.06 m for every 10kV over 35kV to 3m, and rounding up to the nearest whole number

*(*1) The highest point of vessels shall be decided taking into account the future possibility.*

5. All the heights described above shall be secured in any cases of the maximum sagging of conductors in the maximum temperature to be designed.

Clause 46: Clearance among Overhead High-voltage Lines and Other Facilities or Trees

Clearance among each conductor of overhead high-voltage lines and other facilities or trees shall be as follows;

1. Clearance to other facilities

Clearance among each conductor of overhead high-voltage lines and other facilities shall be no less than the value by adding 0 06 m for every 10kV over 35kV to 3m, and rounding up to the nearest whole number.

2. Clearance to trees

Clearance among each conductor of overhead high-voltage lines and trees shall be no less than the value by adding 0 06 m for every 10kV over 35kV to 2m, and rounding up to the nearest whole number.

3. The clearances described above shall be secured in any cases of the maximum sagging of conductors in the maximum temperature and/or the maximum swing of conductors under the maximum wind velocity to be designed.

Clause 47: Prevention of Danger and Interference due to Electrostatic Induction and Electromagnetic Induction

47-1 Electrostatic Induction

High-voltage lines shall be installed to prevent danger of human bodies and/or

interference on communication lines installed near the high-voltage lines caused by electrostatic induction, taking appropriate measures including following items 1, 2 and Clause 34 into consideration.

1. The electrical field, which is caused by overhead high-voltage lines, at 1 m above the ground surface shall be 3kV/m or less, except for overhead high-voltage lines in the places where third persons seem to hardly approach such as in the mountains, in farming land and so on.

2. Conductive materials on the surface of the buildings under overhead high-voltage lines shall be grounded with the Class D in accordance with Clause 39.

47-2 Electromagnetic Induction

High-voltage lines shall be installed to prevent danger of human bodies and/or interference on communication lines caused by electromagnetic induction on the low voltage lines and/or communication lines installed near the high-voltage lines, taking appropriate measures including Clause 39.

Clause 48: Surge Arresters

Surge arresters shall be installed at the appropriate places of Electrical Lines.

Paragraph 7: Transmission and Distribution Facilities (Medium and Low Voltage)

Clause 49: Supporting Structures

49-1 *Safety Factor of Foundation of Supporting Structures*

1. The safety factor of foundation of supporting structure for low-voltage lines shall be 2 or more to the wind load.

2. The safety factor of foundation of supporting structure for medium-voltage lines shall be 2 or more to the load prescribed in Clause 39.

3. If wooden poles, iron-poles and iron-reinforced concrete poles are installed at other than soft ground in accordance with the following table, this clause may not be applicable.

	Design load of supporting structure	*Length of Poles*	*Setting depth*	*Span*
Wooden pole	———	15m or less	1/6 of overall length or more	Medium-voltage lines in urban area: No more than 75m Others: No more than 150m.
		More than 15m, and 16m or less	2.5m or more	
Iron pole	———	15m or less	1/6 of overall length or more	
		More than 15m, and 16m or less	2.5m or more	
Iron-reinforced concrete pole	6.5kN or less	15m or less	1/6 of overall length or more	
		More than 15m, and 16m or less	2.5m or more	
		More than 16m, and 20m or less	2.8m or more	

49-2 Strength of Iron-reinforced Concrete Pole

1. Iron-reinforced concrete pole for low-voltage lines shall have the strength to withstand the wind load.

2. Iron-reinforced concrete pole for medium-voltage lines shall have the strength to withstand the load prescribed in Clause 39.

3. Iron-reinforced concrete pole shall withstand 2 times the strength of design load.

Clause 50: Overhead Lines

50-1 Cables for Overhead Lines

1. When cables are used for overhead lines, the cables shall be installed not to be inflicted the tensile strength using messenger wires or other appropriate measures. The messenger wires shall be installed in accordance with the provision of Clause 41.

2. When cables are installed along a building or another object, the cables shall be supported not to be damaged by contacting the building or the object.

50-2 Connecting Methods of Overhead Conductors

The tensile strength of the conductors shall not be reduced by 20% or more, when electric conductors are connected. If the tension working on the conductors is distinctly smaller than the general tensile strength of conductors this may not apply.

50-3 Branching of Overhead Lines

Branching of overhead lines shall be made at the supporting point of the lines. If branching shall be done not to inflict tension to conductor at the branch point, this may not be applicable.

Clause 51: Mechanical Strength of Insulators

The insulator to support medium-voltage line shall be installed in such a manner that it has sufficient strength to attain a safety factor of 2.5 or more based on the assumption that the following loads are exerted to the insulators..

1. For the insulators to anchor lines, the load is the assumed maximum tension of the lines.
2. For the insulators to support lines, the load is the horizontal lateral load or vertical load exerted perpendicular to the axis of the insulators.

Clause 52: MV/LV Transformers

MV/LV transformers including medium-voltage conductors other than cables, shall be installed not to be in danger of electrical shock in either manner of following method.

1. MV/LV transformers shall be installed in an exclusive cabin that is locked.
2. MV/LV transformers shall be installed at the height of 5.0m or more above the ground in order that persons do not touch them easily.
3. Appropriate fences shall be installed around the MV/LV transformers in order that persons do not touch them easily and warning signs to indicate the danger are displayed. Otherwise MV/LV transformers of which charged parts are not exposed shall be installed for persons not to touch them easily.

Clause 53: Protective Devices

53-1 Installation of Medium-Voltage Over Current Circuit Breakers

1. On a Medium-voltage Lines, an over current circuit breaker shall be installed at the outgoing point of a substation or similar location and on the primary side of a transformer.
2. Over current breakers for a short circuit protection shall have the ability to break the short circuit current that pass the breakers.

53-2 Installation of Medium-Voltage Ground Fault Circuit Breakers

A ground fault breaker that breaks circuit automatically when an earth fault happens in the lines shall be installed at an outgoing point of substation or similar locations.

53-3 Installation of Surge Arresters

To prevent electrical equipment from being damaged by lightning, surge arresters shall be installed at the places of lines stating below or their surrounding areas. If electric power facilities will not be damaged by lightning, this may not be applicable.

1. A lead-out of overhead line from power station, substation, and equivalent places.
2. The connecting point of overhead medium-voltage lines with a main transformer.

Clause 54: Height of Overhead Lines

The height of overhead lines shall be no less than the values in the following table;

(Unit: m)

	Low-voltage	*Medium-voltage*		
		Urban area		*Other area*
		Cable	*Others*	
Crossing a road	6.5	8.0	8.0	6.5
Others	5.5	5.5	6.5	5.5

Clause 55: Clearance between Overhead Lines and Other Objects

Minimum clearance between a line and another object shall be the values in the following table;

(Unit: m)

				Low-voltage	*Medium-voltage*
Structures of buildings	Upside adjacency	With the possibility for persons to climb on	Bare conductor	-	3.0
			Insulated conductor	2.0	2.5
			Cable	1.0	1.2
		Others	Bare conductor	-	3.0
			Insulated conductor	1.2	1.5
			Cable	0.4	0.5
	Lateral and downside adjacency		Bare conductor	-	3.0
			Insulated conductor	1.2	1.5
			Cable	0.4	0.5
Plants			Bare conductor	-	2.0
			Insulated conductor	Shall not contact directly	
			Cable	Shall not contact directly	

Clause 56: Adjacency and Crossing of Overhead Lines

56-1 Plural Medium-Voltage Lines

When a medium-voltage line is installed adjoining or crossing another medium-voltage line, the clearance between the two medium-voltage lines shall be 2.0m or more. If one is a cable and the other is a cable or an insulated conductor, the clearance shall be 0.5m or more.

56-2 Medium-Voltage Lines and Low-Voltage Lines

When a medium-voltage line and a low-voltage line are installed with adjoining or crossing each other, they shall be installed in the manner of following method.

1. The medium-voltage line shall not be installed under the low-voltage lines. If the medium-voltage line keeps the horizontal clearance of 3.0m or more with the low-voltage line, and the low-voltage line does not come in contact with the medium-voltage line when the support structure of the low-voltage line collapses, this may not be applicable.

2. The clearance between the medium-voltage line and the low-voltage line shall be 0.5m or more when the medium-voltage line is a cable, 1.0m or more when it is a insulated conductor, and 2.0m or more when it is a bare conductor.

3. The medium-voltage line shall not be crossed under the low-voltage line. If the medium-voltage line is a cable and the clearance between the medium-voltage line and the low-voltage line is 0.5m or more, this may not be applicable.

56-3 Plural Low-Voltage Lines

When a low-voltage line is installed adjoining or crossing other low-voltage lines, the clearance between the two low-voltage lines shall be 0.6m or more. When one is a cable and the other is a cable or an insulated conductor, the clearance shall be 0.3m or more.

56-4 Medium-Voltage Lines and Communication Lines

When a medium-voltage line is installed adjoining or crossing a communication line, the medium-voltage line shall be installed in the manner of following methods.

1. The medium-voltage line shall not be installed under the communication line. If the medium-voltage line keeps the horizontal clearance of 3.0m or more with the communication line, and the communication line does not

come in contact with the medium-voltage line when the support structure of the low-voltage line collapses, this may not be applicable.

2. The clearance between the medium-voltage line and the communication line shall be 0.5m or more when the medium-voltage is a cable, 1.0m or more when it is an insulated conductor, and 2.0m or more when it is a bare conductor.

3. The medium-voltage line shall not be crossed under the communication line. If the medium-voltage line is a cable and the clearance between the medium-voltage line and the communication line is 0.5m or more, this may not be applicable.

56-5 Low-Voltage Lines and Communication Lines

When a low-voltage line is installed adjoining or crossing a communication line, the low-voltage line shall be installed in the manner of following method.

1. The low-voltage line shall not be crossed under the communication line. If other methods are not technically realistic, this may not be applicable

2. The clearance between the low-voltage line and the communication line shall be 0.3m or more when the low-voltage is a cable, and 0.6m or more when it is a insulated conductor.

Paragraph 8: House Wiring

Clause 57: Insulation

The insulation resistance between conductors of low-voltage wiring and between the electrical circuit and ground shall be no less than the value given in the following table with respect to the nominal circuit voltage for each section into which the electrical circuit can be divided by switching devices or overcurrent circuit breakers.

If insulation resistance measurement is difficult, it is sufficient to keep the leak current 1 mA or less.

Nominal circuit voltage [V]	*Test voltage d c. [V]*	*Minimum of Insulation resistance [MΩ]*
500 V or less	500	More than 0.5
Over 500 V	1,000	More than 1.0

Clause 58: Grounding

Grounding shall be installed according to Clause 39.

Clause 59: Protection against Overcurrent

Devices to protect against Overcurrent shall be installed according to Clause 35.

Clause 60: Protection against Ground Fault

On an electrical circuit to supply electricity to low-voltage equipment and devices enclosed with a metal case and installed at a place where there is the danger of persons easily touching it, a device shall be installed to interrupt the circuit automatically when a ground fault occurs in the electrical circuit.
However, such a device need not be installed if the situation is under one of the following:

1. If the equipment and devices are installed in a dry place.
2. If the equipment and devices are covered with rubber, synthetic resin or other insulating material.
3. In the case of supplying electricity to emergency lighting equipment etc of which could impair ensured public safety.

Clause 61: Indoor Wiring

61-1 Restriction of bare conductor

Bare conductor shall not be used for indoor wiring.

61-2 Sign of indoor wiring

The color of sign for neutral conductor shall be black or blue. And the color of sign for protective conductor shall be green, or green with white or yellow.

Clause 62: Indoor Wiring Utensil

Indoor wiring utensils attached to the indoor electrical circuits shall be installed as follows:

1. No live parts shall be exposed.

   The above shall not apply to a place prepared to block out any person other than the operator.

2. The utensil shall be connected fast and electrically safely by screw fastening or the like. In addition, no mechanical tension shall act on the connection point.

3. The indoor wiring shall contain protective grounding conductors beforehand to ensure the grounding of electric equipment.

Clause 63: Installation Methods of Indoor Electrical Appliances

Indoor electrical appliances shall be installed as follows:

1. No live parts of electrical household appliances shall be exposed.

2. No live parts of low-voltage business electrical appliances shall be exposed.

   However the above shall not apply appliances that are used with some live part inevitably exposed and the case that these are installed in a place made inaccessible for any person other than the operator.

3. If the indoor electric appliance is connected to an electrical conductor, an electrical conductor shall be connected fast and electrically perfect. In addition, no mechanical tension shall act on the connection point.

Clause 64: Indoor Wiring for Adjacency and Crossing

The low-voltage indoor wiring shall be installed in such a manner so as not to contact a telecommunication conductor, water supply pipe, gas pipe or other similar object.

Clause 65: Outdoor Installation at user's site

65-1 Overhead low-voltage service drop lines

1. Height from ground

The height from the ground surface shall be no less than 4 m, and no less than 6.5 m for road crossing.

2. Clearance to other objects

A low-voltage overhead service drop line shall be installed according to Clause 55. For a building in which a low-voltage overhead service drop line is directly installed, or if it is technically difficult to install such facilities according Clause 55, A low-voltage overhead service drop line shall be installed in such a manner that a person cannot reach it even if he or she stretches out his/her hand from a window, corridor, or a passage where person can ordinarily access.

65-2 Other outdoor Installation at user's site

The wire or cable shall be in a conduit if people have possibility of touching them.

Outlets shall be waterproof type if they have possibility of taking rainwater.

A protective device shall be installed if it is considered danger.