Comparison of Electric Power Technical Standards and Policy Making for Technical Cooperation

Final Report

March 2006

Japan International Cooperation Agency
Economic Development Department

[Preface]

For economic growth in developing countries, the development of electric power infrastructure is essential. Therefore, Japan and other industrialized countries assist in power infrastructure improvement and expansion through the development of power resources and rural electrification. Through these activities, the increase in electrification ratio and improvement in power quality can lead to broad-ranging economic progress in developing countries. Also, in connection with the global trend of power market deregulation, , the introduction of international investments, such as IPP, is encouraged in developing countries.

In this environment, a considerable number of industrialized countries are involved in the development of power infrastructure in developing countries. However, surprisingly few countries posses their own electric power technical standards. As the number of electric power facilities increases, the frequency of operational problems also increases due to the diversity of specifications associated with the equipment connected to the same network system. Additionally, the absence of technical standards also leads to low-reliability and danger in electric power facilities, especially in old facilities and facilities of small-scale utilities, and often results in accidents involving electrocution.

Japan International Cooperation Agency (JICA) promotes several technical cooperation projects for development of technical standards in developing countries, in order to mitigate these problems. The development of technical standards, the preparation of related laws and regulations and capacity building of engineers have all been implemented in Laos and Cambodia. Furthermore, the requirements for the development of technical standards have expanded in other developing countries and the expectations for Japanese assistance is high.

However, technical standards differ according to the purpose and facilities involved. . Therefore, technical standards vary internationally and Japanese standards cannot be considered globally consistent. In this regard, it is useful for JICA to draw lessons from the projects in Laos and Cambodia and to analyze the conditions of technical standards in Japan, other industrialized countries and Southeast and Southwest Asian countries from their establishment, when JICA carries out further technical cooperation regarding the development of electrical power technical standards. This research study is proposed to examine a variety of different systems and organize them into a guideline of comparisons and suggestions for effective technical cooperation.

This report includes clarification of the definitions concerning technical standards, findings from investigation and analysis regarding technical standards and laws in Japan, leading industrial countries as well as China, the safety system in Southeast and Southwest Asia, and lessons from the projects in Laos and Cambodia. This report also outlines suggestions regarding promotion of effective technical cooperation by JICA.

This study was commissioned by JICA and implemented by Chubu Electric Power Co., Inc.. However, the contents of the report are based on the investigation and the analysis of the study team involved and does not necessarily represented the views of JICA.

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Definition of Terms

	Terms	Explanation
1	Technical Standards	This means how to do (methods and idea in general) to achieve the target from the aspect of safety of electrical equipment. Here in after, Ministerial ordinance should be described as "Technical Standards (Ministerial Ordinance)" to distinguish from general technical standards. Please refer in detail chapter 2.
2	Technical Standards（Minister ordinance）	Prescribed technical standards as ministerial ordinance (Ex. for electrical facility, for thermal power plant, for hydro power plant, etc.)
3	Electrical Facility Technical Standards（Minister ordinance）	Abbreviation of "Technical standards for electrical facility (Ministerial Ordinance)" in Technical Standards.
4	Thermal Power Plant Technical Standards（Minister ordinance）	Abbreviation of "Technical standards for thermal power plant (Ministerial Ordinance)" in Technical Standards.
5	Standards	This prescribes specification of equipment, test methods and procedure. Ex. IEC, ANSI, BS, DIN and so on. Please refer in detail chapter 2.
6	Code	A series of industry provision in general to achieve some target. This should be distinguished form technical standards or standards.
7	Safety System	This means regulation conducted by governmental regulatory body or measure conducted by firm to keep safety of electrical facility, work, operation. Ex. Entry Inspection, Submit Report and so on.

Abbreviation

	Abbreviation	Explanation
1	AFNOR	**Association Francaise de Normalisation** Body which prescribe industry standards in France
2	ANSI	**American National Standards Institution** Body which prescribe industry standards in US
3	AS	**Australia Standards** Industry Standards which is prescribed by SAI in Australia
4	BSI	**British Standards Institution** Body which prescribe industry standards in U.K.
5	CENELEC	**European Committee for Electrotechnical Standardization** Electrical industry standards in European Standards
6	DIN	**Deutsches Institut fur Noumung** Body which prescribe industry standards in Germany
7	DTI	**Department of Trading and Industry** Regulatory body of government for trade and industry and also electrical utility.
8	EDF	**Electricite de Francaise** Precursor is French Electric Corporation owned by government established in 1946. EDF was privatized (holding company) in 2004, this lead to present condition.
9	ENA	**Energy Network Association** Industrial body of transmission company in U.K.. ENA was established as body of transmission section after deregulation. Precursor is EA which is industry body of electrical utility.
10	GOST	**Gosudarstvennyj Komitet Standartov Ministrov** Industry Standards which is prescribed by S.S.R.R.(Old Soviet National Standards) .
11	IEC	**International Electrotechnical Commission** This was established to promote unification and international harmony for electrical standards.
12	IEEE	**Institute of Electrical and Electronics Engineers** This was established in 1884 and now is the biggest association of electrical engineer in the world. About 150 counties.
13	ISO	**International Standardizing Organization** This was established to promote unification and international harmony for except electrical standards.
14	JEAC	**Japan Electric Association Code** This is voluntary and industry standards and was established to complement" Technical Standards (ministerial ordinance)" .JESC：Japan Electrotechnical Standards and Code Committee.
15	JIS	**Japanese Industrial Standards** This was established by government based on Industry Standardization Law
16	NEC	**National Electrical Code** This is the code which should be complied in electrical work by electrician. This was established by NFPE and approved by ANSI. The object is customer's facilities in general.

17	NESC	**National Electrical Safety Code** This was established by IEEE to protect public safety from the hazard caused by electrical equipment and facility installed and approved by ANSI. The object is facilities for business.
18	NF	**Normalisation de Francaise** Industry Standards which is prescribed by AFNOR in France.
19	NFPA	**National Fire Protection Association** This is Non-profit international organization to provide information concerning the safety of electricity and fire.
20	NZS	**New Zealand Standards** Industry Standards which is prescribed by SANZ in New Zealand.
21	OSHA	**Occupational Safety health Administration** This is the one of the authorities of DOL(Department of Labor) in US and the body which prescribes relative law from the view point of occupational safety and healthy. The representative law is OSH Act (Occupational Safety and Health Act).
22	SAI	**Standard Australia International** Body which prescribes industry standards in Australia.
23	SANZ	**Standard Association of New Zealand** Body which prescribe industry standards in New Zealand.
24	UTE	**Union Technique de Electricite** Body which prescribes the code concerning electrical engineering(generator, transmission, distribution, equipment), and also is charge in prescribe NF standards.
25	VDE	**Verbamd Deutscher Elektrotechniker** Body which prescribes electrical industry standards in Germany to maintain safety . The lower organization of DIN.
26	VDN	**Verbamd Deutscher Netzbetreiber** Industrial body of transmission company in Germany. The lower organization of DEW(Verband der Elektrizitätswirtschaft).

1 Introduction

1.1 Background of the Project

The electric power sector has seen the move of market liberalization as a global trend. As a step of power sources development plan, many developing countries have performed structural reforms attempting to attract foreign capital, such as IPP investments. To facilitate the entry of foreign companies, it is indispensable to put into place a set of electrical technical standards (hereinafter referred to as "technical standards"). A technical standard generally refers to a prescribed standard that has binding authority over electrical facilities and their operation and maintenance. Due to the differences between different country's standards, it is necessary for a foreign power company to tenaciously adhere to the technical standards of the target country, from the safety point of view. On the other hand, it has been viewed with suspicion as common cases that in many developing countries there are no technical standards at all in the first place, or they have become obsolete even if there are. In such occasions, foreign power companies have to apply either international standards or individual standards. Owing to power companies applying different technical standards, there are high risks of problems occurring on system connection, which in turn lead to power supply interruption.

Under such circumstances, it has become necessary in recent years for developing countries to draw up a set of new technical standards or to renew the outdated ones. JICA is also underway in implementing or going to implement three technical cooperation projects:

- The Project on Electric Power Technical Standard Promotion in Lao P.D.R. (2005/01～2008/01)
- Project for Capacity and Institutional Building of the Electric Sector in Cambodia (2004/09～2007/09)
- Viet Nam's Technical Standard for Electric Facilities [Tentative Name] (2006/06～, under preparation for implementation)

Apart from the aforementioned projects, JICA has engaged in and already finished other two ones.

- The Project on Electric Power Technical Standard Promotion in Lao P.D.R. (2000/05～2003/04)
- The Study for Establishment for Electric Power Technical Standards and Guideline in Cambodia (2002/11～2004/03)

In light of the big future needs to conduct technical cooperation in developing countries, it is necessary for JICA to get enough knowledge accumulated in this field and get it put in order. At present, technical cooperation activities are carried out based on Japan's technical standards. However, it is not indispensable that Japan's technical standards be based upon, and it is necessary to perform a thorough technical analysis on what be based upon for technical cooperation. Furthermore, it is still necessary to verify past cooperation cases and extract good lessons.

This project is implemented Based on the aforementioned background.

1.2 Objectives of This Research Project

The objectives of this project are as follows:

a) Compare technical standards internationally and systematically sort out the outlines and characteristics of technical standards with a focus on developed countries;
b) Extract lessons from past cooperation projects and derive suggestions on effective approaches for forming healthy technical cooperation projects in future.

1.3 Project Outline

The project outline is shown as follows. Refer to Figure.1.3.1 for the overall work flow.

1.3.1 First Domestic Study

(1) Investigation and Analysis on Japan's Technical Standards

To provide a measuring rod for investigation on developed countries and Southeast and Southwest Asian countries, we have sorted out and analyzed Japan's statutory framework and safety management system associated with technical standards (ministerial ordinances).

(2) Investigation and Analysis on China's Technical Standards

To make clear China's technical standard statuses, the statutes that give them binding authority and the safety management system, we have collected data through literature search, internet search and telephone interview, and then summarized and analyzed the data collected.

(3) Investigation and Analysis on Technical Standard Aid Projects Carried Out by JICA

We have sorted out and analyzed the technical standard formulation aid projects carried out by JICA in Cambodia and Laos, and provided advices for future implementation of technical standard formulation aid projects.

(4) Investigation on Southeast and Southwest Asian Countries

We have engaged in investigation on and analysis of whether a set of technical standard has been laid down and how they are used in Southeast and Southwest Asian countries.

(5) Analysis on Outlines and Characteristics of International and National Standards

We have analyzed the outlines and characteristics of developed countries' national standards that hold a strong influence in developing countries.

1.3.2 Site Investigation

(1) Engage in Investigation on Technical Standards in Developed Countries

We have engaged in investigation on the statutory framework of technical standards and safety management systems for electrical facilities in the US, United Kingdom, Germany, France and Australia.

(2) Sort out and Analyze Technical Standards on International Inter-connection

Take the inter-connection within Europe Union as an example, we have sorted out and analyzed the outline of technical standards and their operating statuses in each country.

1.3.3 Second Domestic Study

(1) Sort Out Main Issues Associated with Technical Standards

We have sorted out main issues to be discussed with counterparts of host countries in which technical standards are to be formulated.

(2) Propose Effective Approaches for Technical Standard Formulation Aid Projects And Advices for Technical Cooperation

We have proposed the effective approaches and advices for the technical standard formulation aid projects and technical cooperation.

(3) Guideline Development

We have developed a practical guideline that includes the necessary knowledge, points of view, points of concern useful to JICA and those who are to be involved in the technical standard projects.

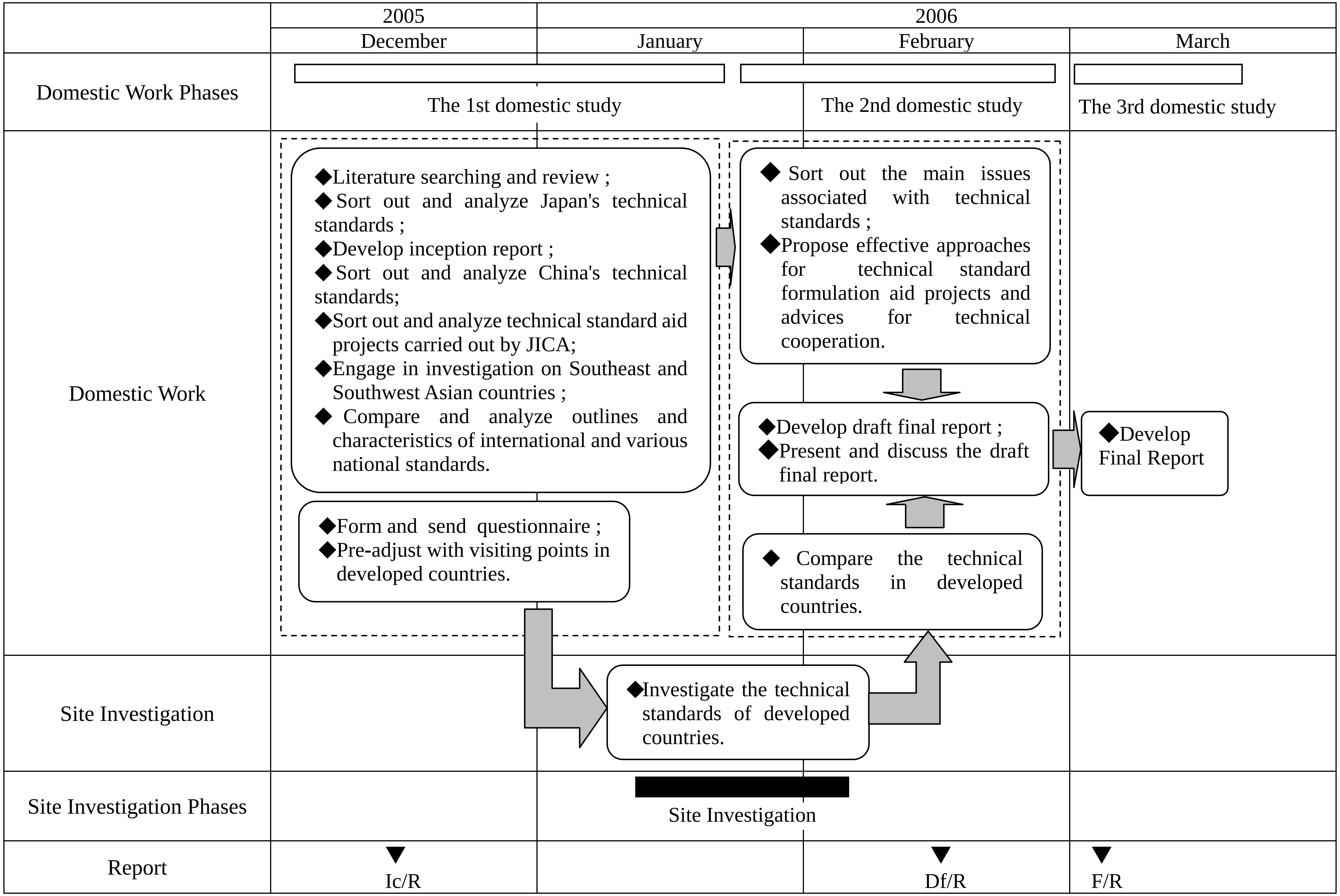


Figure.1.3.1 Overall Work Flow

1.4 Destinations for Site Investigation

Table 1.4.1 shows the list of agencies and companies visited for site investigation.

Table 1.4.1 Agencies/Companies for Site Investigation

Destination Country	Agency/Company	Visiting List
US	Regulatory Agency	・Occupation Healthy and Safety Agency（OHSA） ・International Brotherhood of Electrical Workers ・Georgia Public Utility Commission ・New Jersey Board of Public Utility
	Power Company	・Edison Electric Institute（EEI） ・GEORGIA POWER ・Orange & Rockland
	Standard Constitution Agency	・Institute of Electrical and Electronics Engineers（IEEE）
United Kingdom	Regulatory Agency	・Department of Trade and Industry（DTI）
	Power Company	・Energy Network Association（ENA） ・National Grid ・EDF Energy ・United Utilities
Germany	Regulatory Agency	・Ministry of Industry and Technology
	Power Company	・RWE ・EoN ・Network Association（VDN）
	Other (Inspection Agency)	・TÜV Rheinland
France	Power Company	・EDF
	Standard Constitution Agency	・Electric Engineering Association（UTE）
Belgium	Power Company	・ERURELECTRIC
	Standard Constitution Agency	・Europe Network Operator Institute（UCTE）
Australia	Regulatory Agency	・Essential Services Commission Victoria（ESCV） ・Department of Energy, Utilities and Sustainability（DEUS） ・Australia Energy Regulator（AER） ・Australia Energy Market Commission（AEMC）
	Power Company	・Powercor, Australia ・Energy Australia ・TransGrid, Australia ・Delta Electricity, Australia
	Other	・National Electricity Market Management Company（NEMMCO）

1.5 Investigation Team

Table 1.5.1 shows the team members and their assignments.

Table1.5.1 Team Members and Assignments

MEMBER	ASSIGNMENT
Keiji Shiraki	Team Leader/ Development of guideline
Noboru Yumoto	Technical Standard Analysis 1 (organizations; laws)
Kazuaki Ishikawa	Technical Standard Analysis 2 (transmission and distribution facilities)
Toshiomi Sahara	Technical Standard Analysis 3 (consumer installations)
Takao Kutsukake	Technical Standard Analysis 4 (generating facilities; system inter-connection)
Guobin Wang	Technical Standard Analysis 5 (Southeast Asia; Southwest Asia; China)

2 The definition of "Technical Standards"

In Japan, "Electric Power Technical Standards" corresponds to "Technical Standard for Electrical Equipment", the ministerial (Ministry of Economy, Trade and Industry) ordinance, which is used as a proper noun. The reason is that the ordinances cover the standards concerning electric power equipment broadly and the role of the ordinances is as primary standards of electric power equipment. However, strictly speaking, standards for voltage/frequency or for the environment regulated according to Electric Power Industry Law are also technical standards of electric power. The ordinances are not sole technical standards. "Technical Standards" correspond to a very wide range of regulations according to their purpose and object. Therefore, the meaning of "Technical Standards" should be defined clearly before proceeding to project suggestions.

"Technical Standards" usually means "KIJYUN" and "KIKAKU". "KIJYUN" and "KIKAKU" may be confused with each other, so they should be clearly defined to accurately distinguish "Technical Standards". ("KIKAKU" and "KIJYUN" are Japanese words. Both are translated into English as "standards". Therefore we use these Japanese words to make highlight differences here and later in this chapter.)

2.1 Categorizing "KIJYUN" and "KIKAKU"

Each meaning of "KIJYUN" and "KIKAKU" is as follows.

"KIKAKU": This is established based on agreement and approved by an official organization with the aim of achieving adequate order (Ref. " IEC/ISO Guidebook"). This idea is universal. "KIKAKU" is categorized General, Products and Methods.

- General: Here it is defining Term, Symbol, Unit and so on, which are common.
- Products: Here it is defining the shape, size, material, quality and performance.
- Methods: Here it is defining the methods of test, analysis, inspection and work.

We should understand that "KIKAKU" usually prescribes Products and Methods. However, "KIKAKU" has a unique system in each country, so this situation differs in some cases. Especially in Japan, JIS (Japanese Industry Standards), that is Japanese "KIKAKU", is specifies Products, and does not have any parts in common part with "KIJUN". "KIKAKU" of each country (Ex. BS, DIN) is mentioned in detail in section 2.4.1.

"KIJYUN": This prescribes design and installation methods of facilities or structures. That is to say, prescribes the methods, how or what to do, to achieve the targets. (Especially, safety of not only each type of equipment but also all through the transmission and distribution facility system, including the methods of installation and connection, which are very important. This is because transmission and distribution facilities are composed of several products, such as tower, conductor, transformer etc.)

That is to say, "KIKAKU" and "KIJYUN" don't mean different parts, they have a common part, that is Methods.

Figure 2.1.1 and Figure 2.1.2 show portions of "KIKAKU" and "KIJYUN".

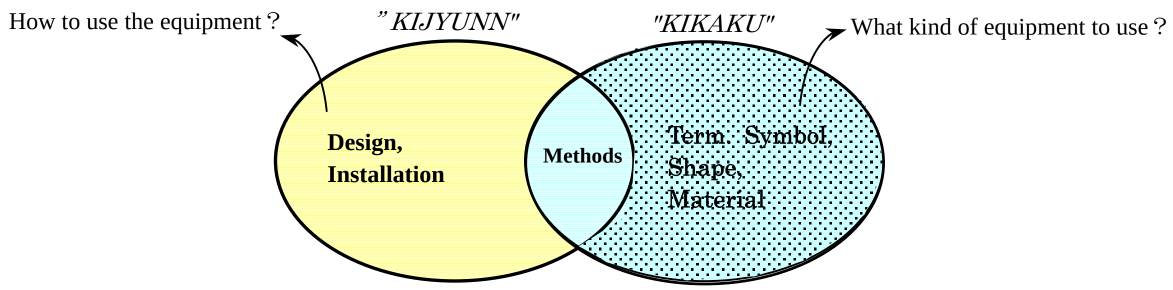


Figure 2.1.1 Concept of "KIKAKU" and "KIJYUN".

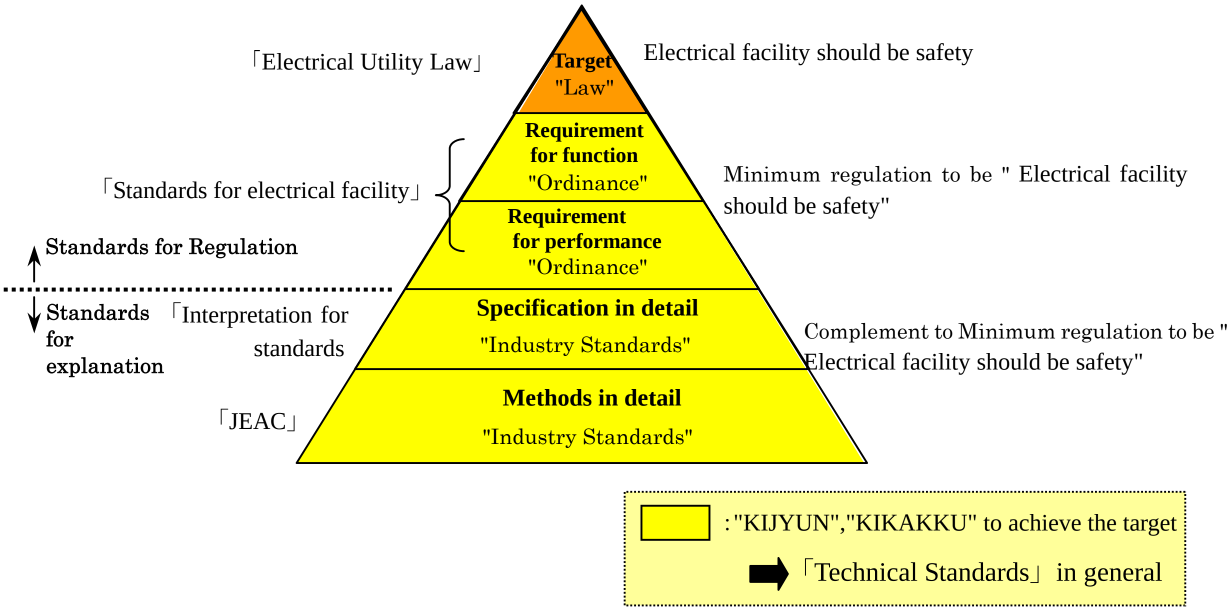
Organization of establishiment	Legal obligation	"KIJYUN","KIKAKU"（Standards)	
		"KIJYUN" for installation of facility	Standards for electrical equipment
State	Yes	Standards for electrical facility	
	Non	Interpretation of standards	
			Japan Industry Standards（JIS）

Figure 2.1.2 Portions of "KIKAKU" and "KIJYUN" (Example in Japan)

As shown in Figure.2.1.1, "KIJYUN" doesn't contain specifications of equipment. These ideas are assumed knowledge in this research report.

2.2 Meaning of "Technical Standards"

Figure 2.2.1 shows the Japanese system of electric power technical standards as an example, and explain the meaning of "KIJYUN" in detail. In this case, standards aiming to achieve a target prescribed in the Electric Power Industry Law, take priority. These standards mean "Technical Standards" in general.



【Reference】Law relative to standards of electrical facility (In the case of Japan)

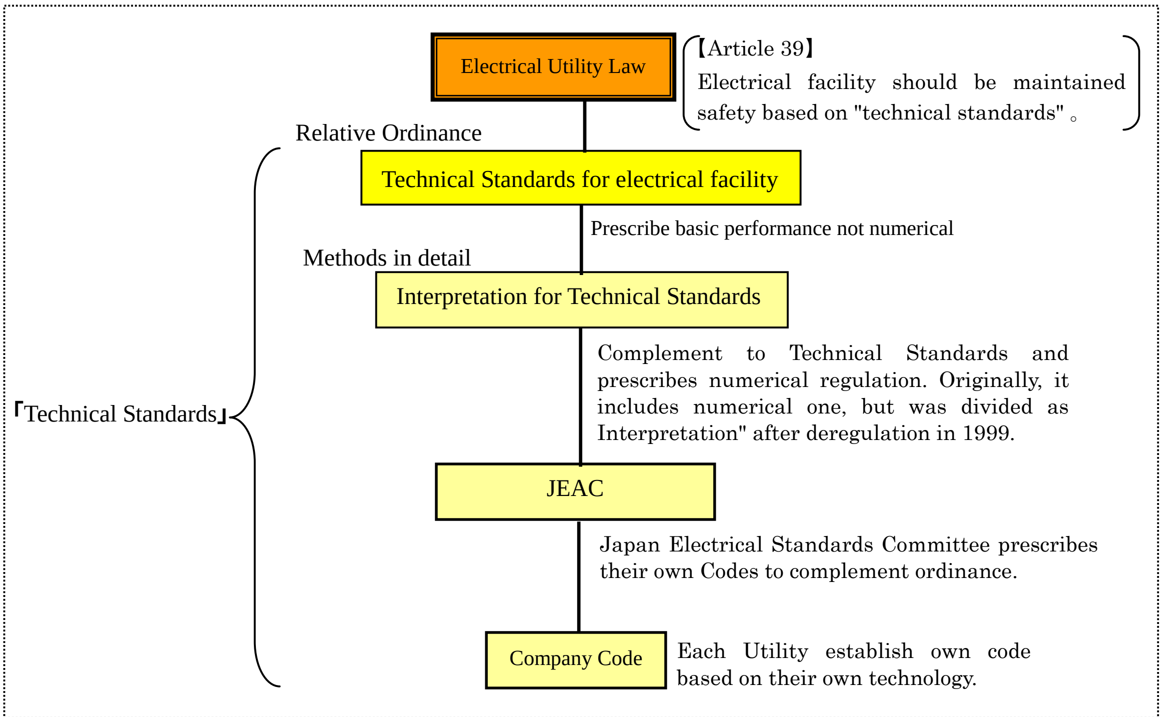


Figure 2.2.1 System of Technical Standards for Electrical Facility (In the case of Japan)

The system shown in Figure 2.2.1 is example of standards aiming to secure safety of electric facilities (that is public safety). In the case where the aim is secure safety of workers, the technical standards correspond to Occupation Safety & Healthy Law. The Technical Standards differ according to the purpose, but the idea that the standards aim to achieve a the target, the meaning of "Technical Standards" in general is common.

2.3 What is "Technical Standards" in Technical Cooperation

The dotted part in Figure 2.1.1 shows equipment specification and is unified with international "KIKAKU", that is IEC (International Electrotechnical Commission). Considering this situation, establishment of new national "KIKAKU" is not logical. Therefore in this report, we define this part, excepting that "KIJYUN" corresponds to "Technical Standards" in Technical Aid Program. However we should point out that "Technical Standards" correspond to several kinds of standards according to their purpose and object. "Technical Standards" refer to international or national standards if necessary.

2.4 "KIKAKU" System

Figure 2.4.1 shows the rank of "KIKAKU". Here "KIKAKU" are standards for equipment.

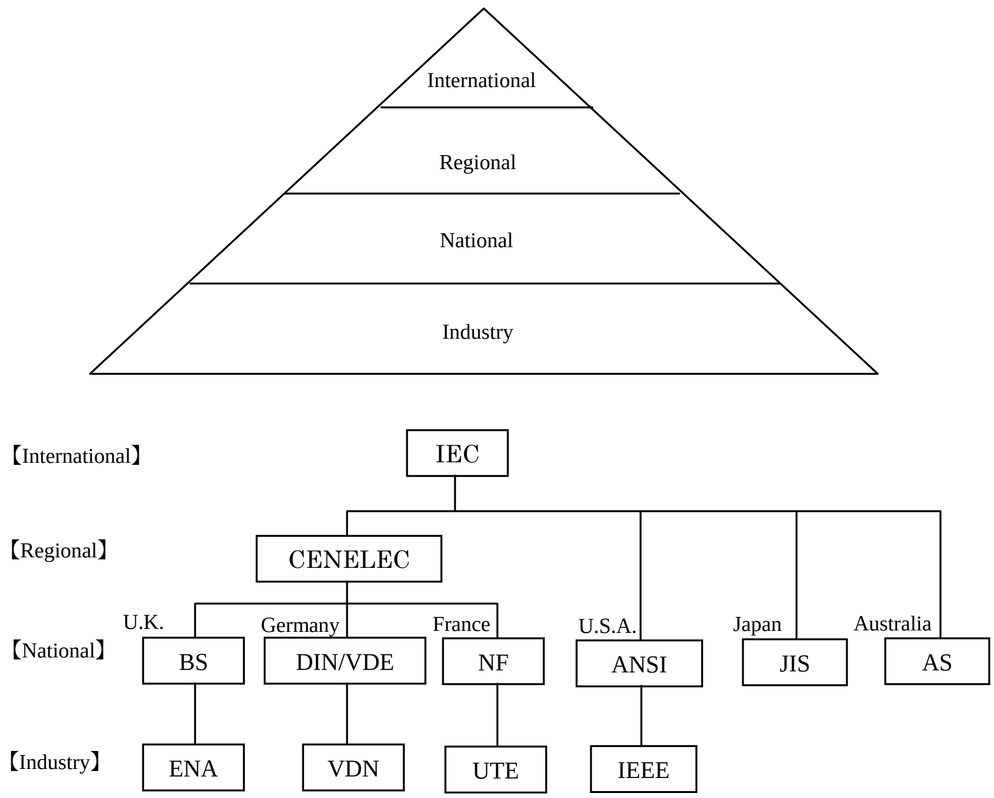


Figure 2.4.1 System of "KIKAKU"

The world's highest ranking standards are the international standards, IEC (International Electrotechnical Commission) standards, concerning electrical engineering. International standards gained their importance, though the need for unified standards in Europe, and therefore establishment of unified standards (European standards) became a matter of great urgency in CENELEC (European Committee for Electrotechnical Standardization) to institute the unitary market in Europe.

At this time, ISO (International Standards Organization) and CEN (European Committee for Standardization) concluded the Vienna agreement concerning technical assistant in the establishment of the standards. Together, IEC and CENELEC concluded the Dresden agreement of in electrical standards. Under these agreements, IEC established its position as the basic standardization. Unified standards are matched with IEC automatically by Dresden Agreement, so Europe is the leading area as unification of standards has proceeded aggressively. Standards for equipment are unified with international standards gradually and worldwide. It follows that is more rational for a developing country that has the ability to adopt international standards, do so, rather than establish new national standards for equipment.

2.4.1 Foreign Standards

(1) IEC

IEC (International Electro-technical Commission) is the authoritative international organization on standards related to electrical engineering. It was established to reach mutual agreement on standardization of electrical equipment standards. There are fifty industrialized countries that are members of IEC. Recently, some developing countries, such as Indonesia, Philippines, Pakistan, Malaysia, and Thailand in Asia have become members of IEC. Industry Associations, consumer groups, government, and several engineering association have joined the IEC committee as interested parties.

(2) CENELEC

CENELEC (European Committee for Electro-Technical Standardization) was established to establish voluntary electrical standards. CENELEC also aims to remove trade barriers, to create new markets and to support in formulating Europe's economic areas.

Under the Dresden agreement, European standards are established based on IEC. CENELEC members are 28 countries in Europe, including 8 countries in East Europe.

(3) BS

BS (British Standards) is the leading set of standards of the world. BSI (British Standards Institution) has a long history, in which 2001 was the centenary of foundation. BS is established with the aim of being applied worldwide, and covers several areas including terms, methods, specifications, installation and so on. Industry Association, consumer group, government, several engineering associations joined BS committee as interested parties. BSI members exceed 19,000. The attached document #2 shows the catalogue of BS.

(4) VDE

VDE (Verbamd Deutscher Elektrotechniker) was established by DKE (Deutsche Kommission Elektrotechnik) according to the contract based on Energy Economic Law. Manufacturers, Electric Power Companies, Government, joined the DKE committee. Therefore, consensus on several aspects can be reached easily. VDE contains not only equipment specifications but also standards on facility installation and inspection. Energy Economic Law confers legal binding force on VDE standards. Attached document #3 shows the catalogue of VDE.

(5) NF

NF (Normalisation de Francaise) is approved by AFNOR, a government organization. Staff members in charge of standards are assigned to AFNOR from the relevant ministry.

AFNOR doesn't establish any standards, it only approves standards prepared by the body that is in charge of establishing standards. The organization for electric engineering standards is UTE (Electric Engineering Association), which is France's largest organization in this field, and the second one is UNM (Mechanical Engineering Association). NF is referred to as legally binding standards by the ministerial ordinance.

(6) ANSI

The role of ANSI (American National Standards Institution) is not to establish standards but to formulate consensus on standards among qualified standards establishment bodies. Industry Associations, consumer groups, government and several engineering associations have joined the ANSI committee as interested parties. The membership consists of 850 companies, 35 governmental organization and more than 300 related parties.

(7) AS

AS (Australia Standards), is the national standards body of Australia, and covers all industry fields. SAI (Standard Australia Institution) establish AS. SAI is a non-profit corporate body formed to manage AS. Standards established by SAI are not legally binding standards. SAI make efforts to gather wide consensus widely in several industries.

2.4.2 Establishment and Revision of Standards

Procedure of establishment and revision of standards are similar in every country. Figure.2.4.2 shows BS procedure as a typical example. The procedure is divided into six sections.

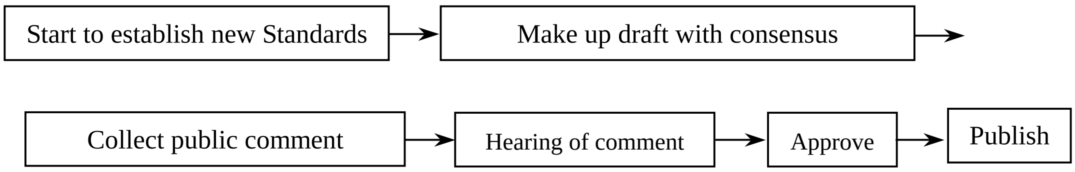


Figure 2.4.2 Procedure of Establishment and Revision of Standards

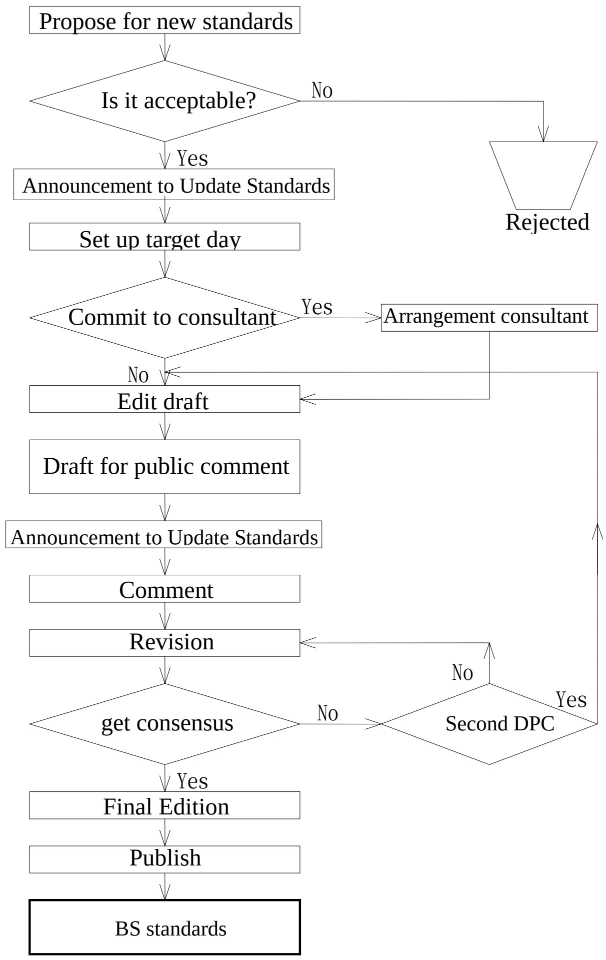


Figure 2.4.3 Procedure of Establish BS Standards in detail

2.4.3 GOST

Socialist countries in Asia, such as Vietnam, adopt GOST as national standards. GOST are the standards established in the former Soviet Union. GOST was established in 1917. At that time, the government recognized the importance of standards. GOST covers symbols, equipment character, management, safety and so on. GOSSTANDART, which is in charge of establishing GOST, is composed of a scientist, researcher and expert.

New "Technical Regulation Law" came into effect on Dec.15, 2005. This Law was the first step of reforming the Russian standards system. GOST-R was established as the newly altered version of GOST according to the above Law. GOST-R adopt international standards.

2.5 Regional Standardization Organization

International trade improved after World War Ⅱ, and WTO was established to remove the trade barrier under GATT round. However, free trade areas were established in the related economic and cultural areas. Establishment of regional standardization organizations follows associated free trade areas. In Southeast Asia and Southwest Asia, regional standardization and internationalization are proceeding as follows.

Table 2.5.1 Regional Standardization Organizations in Asia

Region	Organization	Member	Situation
Southeast Asia	ASEAN/Consulting Committee on standards and quality	Main County in South East Asia	Adoption ISO and IEC
Southwest Asia	South Asia Association for Regional Cooperation	India, Pakistan, Sri Lanka, Nepal, Bhutan	It doesn't establish regional standards

3 Safety System of Electrical Equipment in Japan

3.1 Electrical Utility System

In the context of the public utility businesses changing dramatically worldwide, the electrical utilities have been moving toward deregulation since around 1990. In Japan, the deregulation of electrical utilities has been promoted "to realize electricity prices as low as the world standard by allowing new entrants from outside of the existing general electrical utility companies and exercising market principles." After the amendments of Electrical Utility Law in 1995 and 2000, which allowed Independent Power Producers (IPP) and Power Producers and Suppliers (PPS) to enter the electricity generation business, and liberalized the electricity retail business for large demand customers, Japanese electrical utilities have drastically changed in the last decade. The following diagram shows the current (as of Mar. 2006) electrical utilities in Japan.

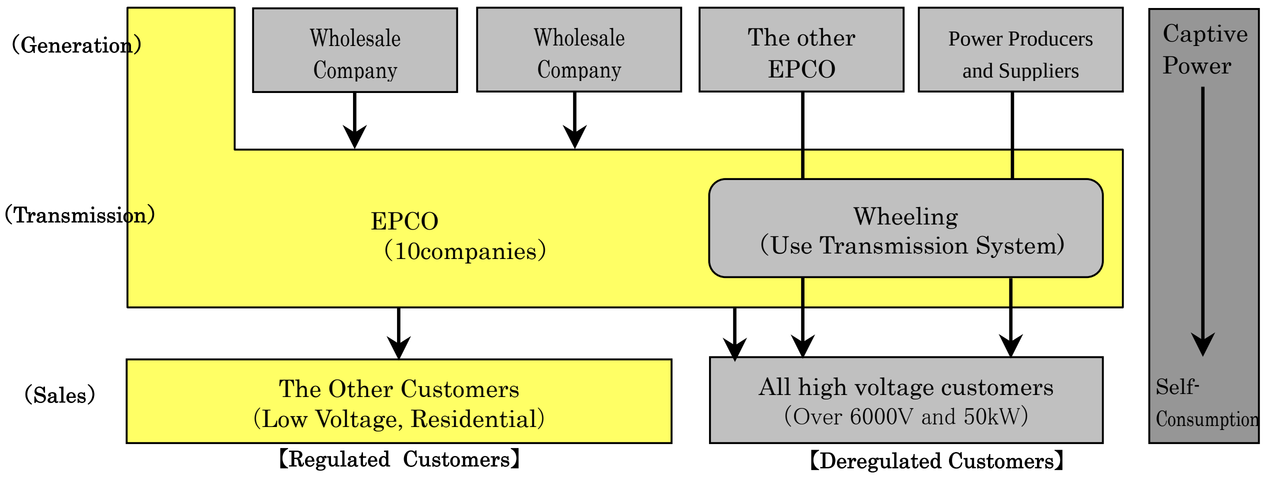


Figure 3.1.1 Electrical Utility System (Mar. 2006)

Electrical utility companies (10 companies) have remained vertically integrated although there are new entrants into the generation and retail businesses. However, new operation rules for transmission sections have been introduced to secure neutrality and transparency of wheeling.

As of Mar. 2006, the electric retail business has been liberalized up to the high voltage (greater than 6000V and 50kW) customer level. Liberalization for other customers is to be discussed after 2007.

3.2 Laws and Regulations on Safety of Electrical Equipment

3.2.1 Progression of the Safety Regulation Law

There is a long history associated with the electric power industry safety regulation in Japan. Originally, this regulation was an order of local government and then became a safety regulation law promulgated by national government. The contents changed from being focused on new project approval to detailed regulations concerning safety when the "Regulatory law of electric power industry" came into force in 1911. After that, it was divided into two categories, "Electric Utility Industry Law" and "Electrical Work Regulations" in 1931. So independent safety regulations were established to ensure safety of persons in charge of electrical equipment and have existed ever since. At present, the organization responsible for safety is established according to the Ministry of Economy, Trade and Industry ordinance that define technical standards on electrical equipment.

(1) Safety Organization in the Early Stages

The specific regulations for electric power industry regarding safety were orders consisting of 15 clauses promulgated by the metropolitan police department on Aug. 8th, 1908 and originally imposed on TEPCO's predecessor. Construction licensing, inspection and the distance between wires and communication wires or roofs of houses were stipulated in these regulations. Applications for installation of lights on sidewalks were basically submitted to the Tokyo Metropolitan Government, however activities involving roads was a matter for metropolitan police department. Therefore, the metropolitan police department had an intimate involvement in this issue at that time.

(2) Safety Regulations Enforced by Local Government

A fire of unknown cause, which burned down the Imperial Diet House in 1991, prompted discussion for establishing the Electrical Utility Law. As an electricity leakage was suspected to be the cause, this increased awareness regarding the danger of electricity and drove the electrical utilities into a corner. Regulations covering electricity business and electrical engineering in general were required, so "Regulatory law of electric power industry" was established as a law to regulate the electric power industry in the same year. It was the first time that central government was able to regulate the electric power industry with this regulation. This regulation not only enabled securing of electric safety but also made a significant contribution to reconfirming the regulatory procedures conducted by local governments. .

(3) Safety Regulation through Centralization of Administrative Power

The 3rd ministry ordinance (enforced in 1891) passed by the communication department prescribed that any regulation set by a local government governor would also require agreement from the Minister of the communication department. This ordinance contributed to enhance regulation because applications from of the electric power industry significantly increased due to an electric power demand increase. Furthermore, the "Regulation for extra high voltage lines management" which includes regulations restricting construction under power lines, was promulgated on Dec. 21st, 1907. This was the first safety regulation for transmission lines which were not conventional overhead distribution lines

(4) The Birth of the Electric Work Regulation

In 1911, the existing regulation, "Regulatory law of electric power industry", was divided into two parts, "Electric Utility Industry Law" (enforced on Mar.29th) and "Electrical Work Regulations" (enforced on Sep.5th), and hence establishing laws specifically focused on electric power industry regulation and safety regulation respectively. With respect to the "Electric Utility Industry Law", articles governing rights of land possession, land entrance and tree trimming under power lines were newly specified. However, the "Electrical Work Regulations" were established by combining the regulation covering extra high voltage equipment with the "Regulatory law of electric power industry" and the original regulation was modified significantly.

(5) The Movement to the Voluntary Safety Organization

The current electric power industry law came into force in 1965. This law was revised considerably, twice, in 2000 and 1995. The aim of these revisions was deregulation in the electric power industry. Strictly speaking, the revisions were made to allow IPPs to enter the generation division and to advance liberalization of retail for large-scale customers. Other than these business deregulations, the revision in 2000 deregulated safety and voluntary safety by electric power utilities was defined as a principle of the safety organization.

As mentioned earlier, the safety regulation law has been amended considerably. In particular, revision and division of and between public and private roles and rationalization of regulations within these categories have been made to ensure safety, while adapting to the prevailing conditions in terms of social needs, innovations in technology and the practical performance of voluntary safety by electric power utilities.

3.2.2 Role of the Electrical Utility Law

The Electrical Utility Law regulates the management of electrical utility companies to ensure public safety and environmental protection as well as customers' welfare. It regulates two main areas, "business regulation" and "safety regulation", which the Technical Standards are based on.

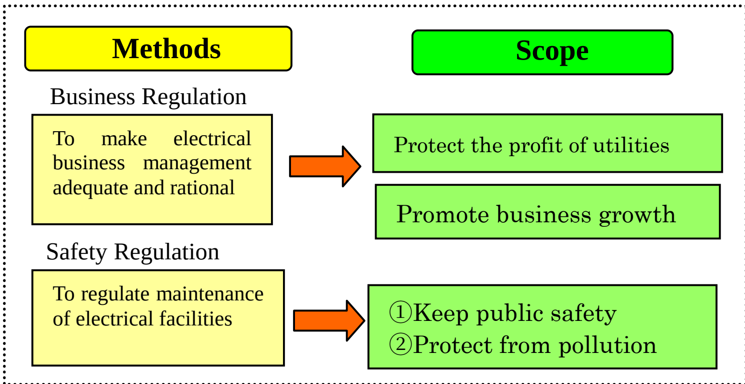


Figure 3.2.1 Scope of Electrical Utility Law

3.2.3 Role of the Technical Standards

Article 39 of the Electrical Utility Law stipulates that the Technical Standards, which are legally binding ministerial (Ministry of Economy, Trade and Industry) ordinances, shall regulate the design, construction and maintenance of electrical equipment to ensure public safety and stable supply of electricity. Article 39, Section 2 outlines the scope and contents of the Technical Standards as follows.
Contents of the Technical Standards (as specified by Article 39 of the Electrical Utility Law)

1) Electrical equipment for business use shall not endanger any person or cause damage to property.

- Prevention of electrocution, fire due to electricity leakage, flashover or short circuits, dam break, boiler explosion, leakage of radioactive material, smoke, soot and other pollutants.

2) Electrical equipment for business use shall not cause electrical or magnetic damage to other electrical equipment or property.

- Prevention of inductive interference, radio disturbance, electrical corrosion and interference of magnetic observation.

3) A failure of electrical equipment for business use shall not severely obstruct electricity supply by general electrical utility companies.

- Prevention of damage spreading from electrical equipment for private use to electrical utility companies.

3.2.4 Role of the Interpretations of the Technical Standards

The current Technical Standards were promulgated in Mar. 1997 and enforced in Jun. of the same year. They were greatly simplified from the previous versions by concentrating on equipment performances, which excluded most of the numerical standards, such as for example, standard for separation between overhead wires and buildings, instead, "The Interpretations of the Technical Standards" were introduced to specify numerical standards. In this manner, the Technical Standards specify, not quantitatively but qualitatively, the required function and performance of electrical equipment. Table 3.2.1 shows examples of the simplification of the Technical Standards.

Table 3.2.1 Examples of Simplification of the Technical Standards

(Article 25 of the Technical Standards) Heights of Overhead Wires
"Overhead wires shall be stretched at such heights to ensure safety from any contact, inductive interference or traffic disturbance."

↓

(Article 107 of the Interpretations of the Technical Standards) Heights of Overhead Wires of Extra High Voltage
"Overhead wires of extra high voltage shall be stretched above ground at heights above the values in the right column of the following table, in accordance with the service voltage classified in the left column."

Service voltage	Height above ground
Not greater than 35,000V	5m (5.5m for railway crossings, 6m across roads and 4m for insulated wires or cables stretched over bridges)
Greater than 35,000V and not greater than 160,000V	6m (5m for rarely visited areas such as mountains, and 5m for insulated wires or cables stretched across bridges)
Greater than 160,000V	6m (5m for rarely visited areas such as mountains) plus 12cm for each 10,000V exceeding 160,000V or part thereof

The Technical Standards were simplified according to the following viewpoints.

【The reason why the technical standards were simplified】

- The Technical Standards shall flexibly reflect technological advances by concentrating on safety performance levels.
- The Technical Standards shall quickly adopt technological advances by referring to foreign and private standards.

The Interpretations of the Technical Standards are the basis for equipment owners to ensure the practical compliance of their equipment with the Technical Standards, which are ministerial ordinances, for planning, construction and operation of the equipment.

On the other hand, the Interpretations of the Technical Standards are not ministerial ordinances. A violation of the Technical Standards, which are legally binding, would be subject to administrative punishment. While compliance with the Interpretations of the Technical Standards ensures compliance with the Technical Standards themselves, electrical equipment can be installed in accordance with Technical Standards along technical grounds, rather than the Interpretations of the Technical Standards, which will ensure safety.

3.2.5 Types of Technical Standard

The Technical Standards, in terms of maintenance and inspection, include the five types in Figure 3.2.2. Among them, the Technical Standards for Electrical Equipment, Hydropower Generation Equipment and Thermal Power Generation Equipment are related to the corresponding Interpretation.

Figure 3.2.2 Catalogue of Technical Standards and Interpretation

Technical Standards	(1) The Technological Standard for Electrical Equipment (2) The Technological Standard for Hydropower Generation Equipment (3) The Technological Standard for Thermal Power Generation Equipment (4) The Technological Standard for Nuclear Power Generation Equipment (5) The Technological Standard for Wind Power Generation Equipment
Interpretation	(1) The Interpretation of The Technological Standard for Electrical Equipment (2) The Interpretation of The Technological Standard for Hydropower Generation Equipment (3) The Interpretation of The Technological Standard for Thermal Power Generation Equipment

3.3 Legal System for Safety of Electrical Equipment

As described above, the Technical Standards are the foundation of the legal system centered on the Electrical Utility Law. Figure.3.3.1 is an example of a technical standard for electrical equipment, which describes the relationship between the Electrical Utility Law, the Technical Standards and other standards.

The role of the Interpretations of the Technical Standards is mentioned above. They can refer to any standards established by fair, neutral and transparent organizations, for example those set by the Japan Electrical Standards and Codes Committee (JESC). It is publicly approved as a supplement for the Technical Standards.

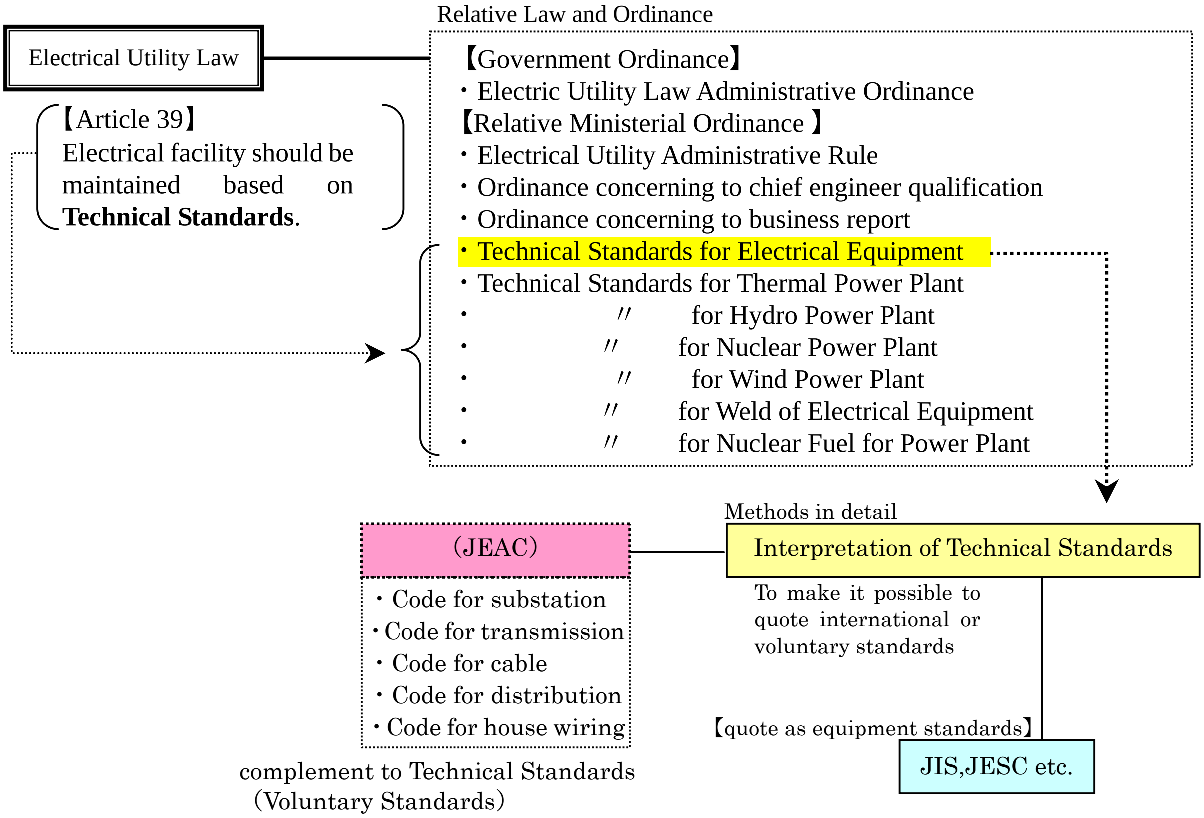


Figure 3.3.1 Relation between Electric Utility Law and Technical Standards

3.3.1 Role of JIS

Japanese Industrial Standards (JIS) are national standards, designed by the Japanese Industrial Standards Committee and established under the name of the minister in charge. As for electrical equipment, other than JIS, there are several independent industrial standards, including those in the table below.

Table 3.3.1 Relative Industrial Standards

Industrial standards	Acronym
Japanese Electro-technical Committee	JEC
Japanese Cable Standards	JCS
Japan Electrical Manufacturer	JEM
Electrical Insulating Materials Standard	EIMS
Japan Luminaries Association	JIL

JIS and other industrial standards are private agreements, which manufacturers, sellers, users and academic experts establish and have no binding authority, while the Technical Standards, based on the Electrical Utility Law and the Electrical Appliance Safety Law, can impose punishment on their violators. Therefore, any products, which are subject to the laws, must comply with the Technical Standards, regardless of whether they are manufactured in accordance with other industrial standards or not. The Interpretations of the Technical Standards refer to the JIS and other industrial standards.
Figure.3.3.2 shows relation between technical standards and standards for equipment.

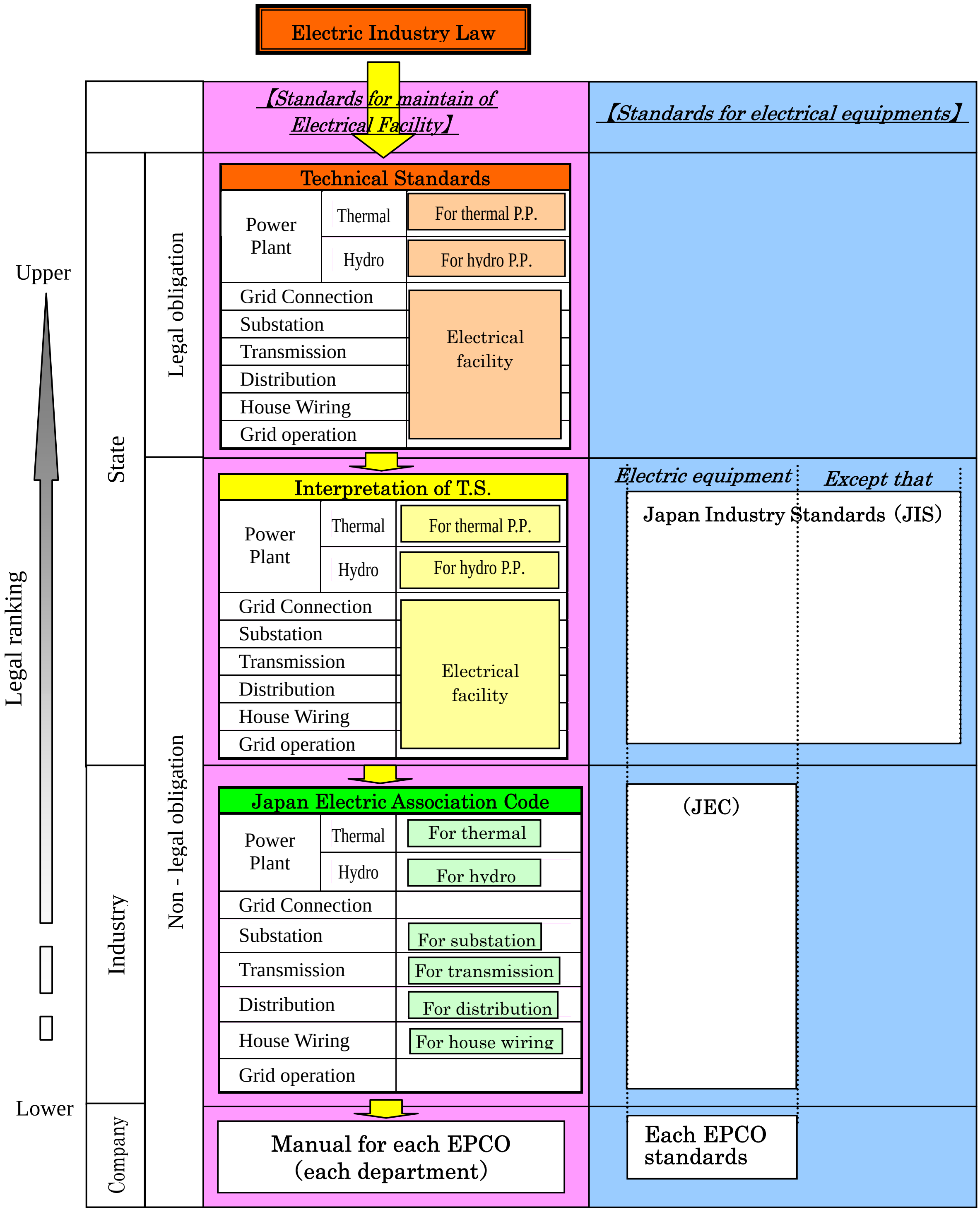


Figure 3.3.2 Relation of Technical Standards and Standards for Electric Equipment

3.4 Supplementary Legal System for Safety of Electrical Equipment

The Electrical Utility Law contains business, safety and environmental aspects. For each aspect, the following diagram classifies related laws and regulations according to the governing ministry, which demonstrates the extensive number of ministries and other entities involved in the regulation of electrical utilities in Japan. In addition to those described in the diagram, there are also laws and regulations governing electrical power development (the Electrical Power Development Promotion Law, etc.) and nuclear energy (Nuclear Energy Fundamental Law, etc.).

Laws governing safety of electrical equipment include the Electrical Utility Law, the Electrical Appliance Safety Law, the Electrical Engineering Technician Law and the Electrical Engineering Company Law, which constitute the so-called Quartet of Electrical Security Laws. They complement the Technical Standards to secure the safety of electrical equipment. As for workers' safety, there is the Industrial Safety and Health Law. The Quartet of Electrical Security Laws and the Industrial Safety and Health Law are summarized in the following.

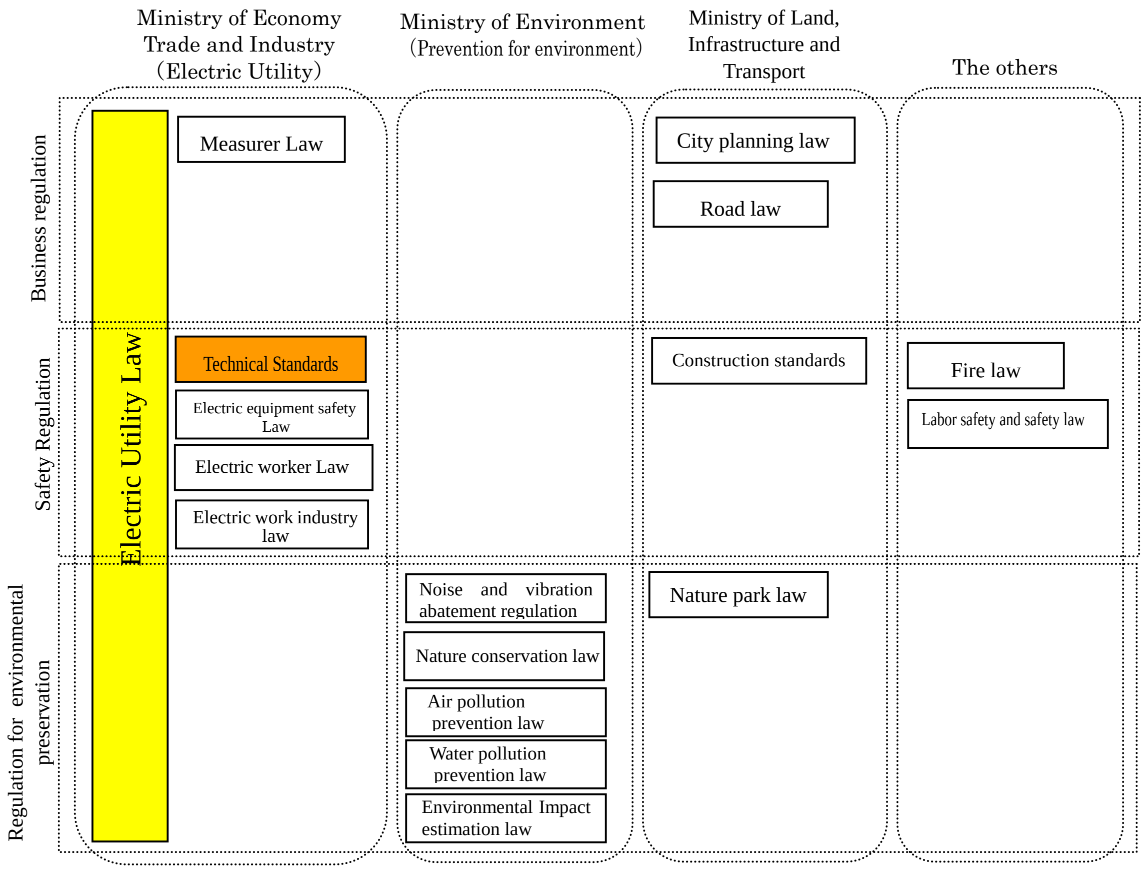


Figure 3.4.1 Relative Law to Electric Utility

3.4.1 The Quartet of Electrical Safety Laws

Table 3.4.1 shows the scope and outline of " The Electrical Appliance Safety Law", "The Electrical Engineering Technician Law" and "The Electrical Engineering Company Law".

Table 3.4.1 Scope and Outline of the Electrical Safety Laws

	Scope	Outline
The Electrical Appliance Safety Law	To eliminate the danger and failure of electrical appliances by regulating the manufacturing and sale of electrical equipment as well as promoting the voluntary activities among private entities on electrical appliance safety.	1) Registration as manufacturers and sellers of electrical appliances; 2) Compliance with the standards and management of records; 3) Permission of compliance labeling; 4) Regulations for sale and use of electrical appliances; etc.
The Electrical Engineering Technician Law	To prevent accidents due to defective electrical engineering works by specifying the qualifications of workers engaged in engineering works on general and private electrical equipment.	Qualifications for First and Second Class Electrical Engineering Technicians are specified, including First or Second Class Technicians only to engage in engineering works on general electrical equipment and solely First Class Technicians on private electrical equipment greater than 500kW.
The Electrical Engineering Company Law	To ensure adequate operation of electrical engineering companies and safety of general and private electrical equipment by specifying the procedures for registration of electrical engineering companies, appointment of electrical engineering technicians and other business administrations.	1) Registration of electrical engineering companies; 2) Notification by electrical engineering companies; 3) Appointment of Electrical Chief Engineers; 4) Business administration of electrical engineering companies, etc.

3.4.2 The Occupational Safety and Health Law

The regulation from the aspect of occupational safety is also important except facility safety (Public safety) as electricity safety. "Occupational Safety and Health Law" was prescribed as this kind regulation. This law regulated not only electrical industry also another industry. The purpose of this law is promotion of comfort occupational environment.

There are a couple of thousands article in this law, the article relative to electrical industry is Chapter 5 " Protection from Electrical Hazard". The bulletin based on this rule is for example "Standards of Insulation Tool and protection tool", "Regulation of Hot line work", and so on.

3.5 Safety System of Electrical Equipment in Japan

This section will summarize the role of each law relating to electrical safety. All objects posing potential danger to any person, including various types of equipment ranging from large equipment such as power plants and transmission lines to small equipment such as household appliances and wiring, are subject to these laws. Therefore, electrical equipment in power plants of electrical utilities and large factories, which are under the supervision of electrical experts, and the equipment in households and other locations, used by persons with little electrical knowledge, need to be categorized in terms of electrical safety. The Electrical Utility Law mainly regulates the former while the Electrical Appliance Safety Law and the Electrical Engineering Technician Law as well as the Electrical Utility Law regulates the latter.

The Electrical Utility Law divides electrical equipment into the categories of business use and general use, to which a suitable safety system is applied to each respectively. The equipment for business use includes equipment used by electrical utilities and large private companies (with a maximum output of 500kW or greater), and others are considered to be for general use. In principle, the owners are responsible for the safety of their equipment on a voluntary basis. However, the administrative offices give instructions on several aspects of the safety requirements. The following diagram outlines the safety system applied to electrical equipment for business use.

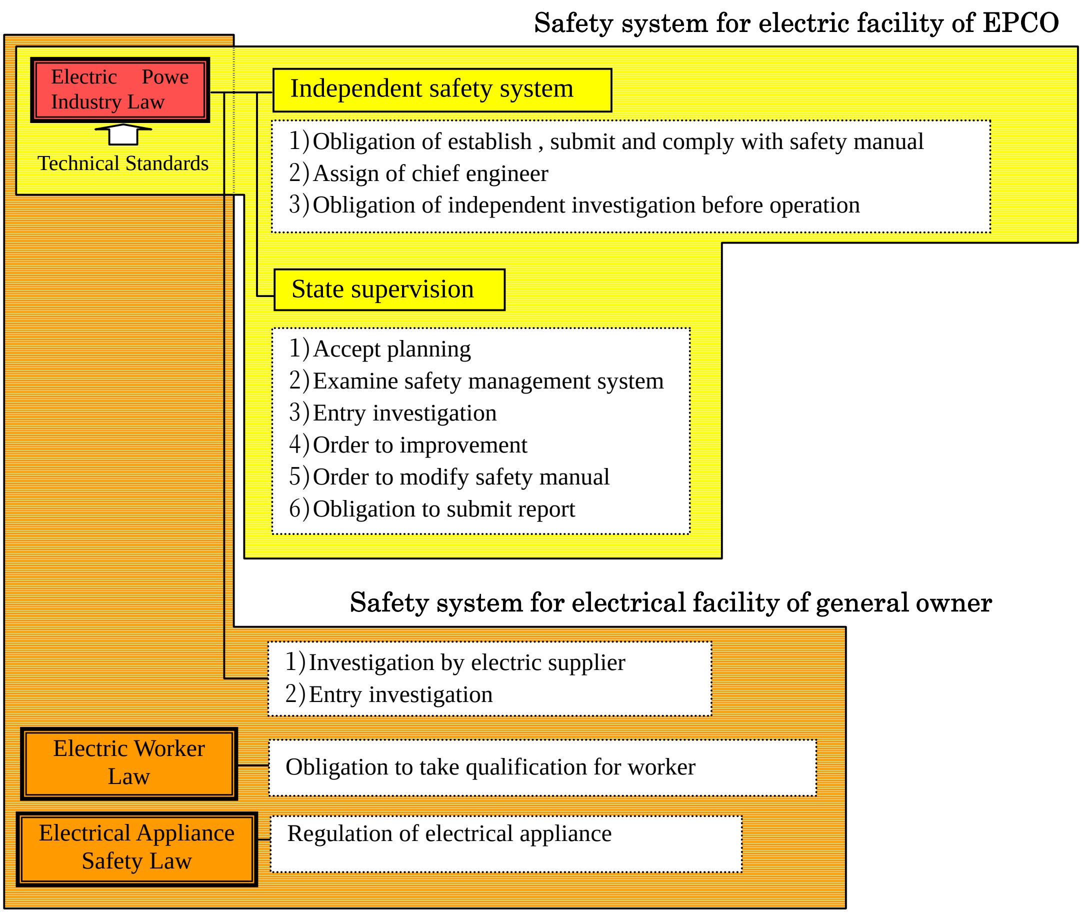


Figure 3.5.1 Safety System for Electric Facility

The state authorities oversee a wide range of activities such as notification of engineering work plans, report of accidents, suspension of engineering work or operation of electrical equipment in case of violations of technical standards. Although the owners are responsible for their equipment on a voluntary basis, they are specified to appoint and dedicate Electrical Chief Engineers, who are qualified by the state, for maintenance of the equipment. They are also required to establish Safety Standards of their own and inspect their equipment, which is crucial for ensuring safety.

The owners of electrical equipment for general use are responsible for their equipment as well. However, since most of the electrical equipment owned by households and stores is for general use, they are not imposed with the same requirements that apply to locations containing equipment for business use. On their behalf, the suppliers (most likely electrical utility companies) of electricity are responsible for ensuring compliance with the Technical Standards. The following diagram outlines the provisions specified in the Electrical Utility Law for the safety system described above. Furthermore, the Electrical Engineering Technician Law specifies that only First or Second Class Electrical Engineering Technicians shall engage in engineering works on general electrical equipment, and the Electrical Appliance Safety Law regulates the appliances and materials as well.

In this manner, state regulations have been relaxed and are now based on a voluntary safety system. However, in reality, the voluntary system is heavily imposed with state regulations, which is unique to Japan.

System of independent Safety

【Obligation to confirm Standards】

(Maintenance of power facilities for business use) Article39
A firm which installs power facilities for business use shall maintain the power facilities for business use in such a way as to conform to such technological standards as specified in the Ministerial Ordinance of the METI

(Order to conform to technological standards)Article40
METI may, if Minister recognize that power facility do not conform to standards, order the firms to repair or to remodel so as to make them confirm to standards.

【Establishment and comply to safety rule】

(Safety Rule) Article42
A firm, for the purpose of ensuring safety, establish a safety rule for each facility, the safety which requires to be ensured uniformly, and shall be give notification of said safety rule prior to commencement of construction work.

【Appointment of Chief Engineer】

(Chief Engineer) Article43
A firm which install power facility appoint chief engineers from among engineers, to whom have been delivered the chief engineer's licenses, so as to place them in charge of supervision of safety mattes of construction work, maintenance and operation。

【Legal Independent Inspection】

(Preoperational safety inspection)Article50-2
A firm shall, before using power facility, conduct a voluntary inspection of such facility and record the results of the inspection.

(Periodical safety inspection) Article 55
A firm which install special facility (which refer to boilers, turbines) shall conduct operator inspection of such special power facility periodically and keep and maintain a record of the results.

Governed by state

【Approve and submit work plan】

(Plan for construction work) Article47
A firm which intends to carry out a project to install power facility for business use shall obtain the approval on the plan for the said works from METI.

(submission of plan for work) Article48
A firm which intend to install or charge power facility shall submit to METI the plan of work, also submit to METI revised work plan。

【Examination of safety system】

(Preoperational examination) Article 50-2
A firm which install power facility which are subject to preoperational voluntary inspection shall submit a system for implementation of inspection to an examination conducted by METI。

(Periodical examination) Article55
A firm which install power facility which are subject to periodical inspection shall submit a system for implementation of inspection to an examination conducted by METI.

【Submit the commencement of use】

(Commencement of captive power)Article53
A firm which intended to install power facility for captive power shall submit to METI the commencement of use captive power。

【Obligation to submit report】

(Collection of reports) Article106
METI cause a person to submit report or informative material on the condition of activities related to safety of power facility.

【Entry inspection】

(Entry inspection) Article107
METI enter and inspect power facility to enforce the law

Figure 3.5.2 Law relative to Electrical Utility Law

4 Safety Systems in Developed Countries

4.1 Outline of Safety System in Developed Countries

(1) Legal system for Electrical Equipment Technical Standards

Table 4.1.1 outlines details regarding the legal system associated with electrical equipment technical standards for five developed countries, based on this investigation.

Table 4.1.1 Legal system for Electrical Equipment Technical Standards in Developed Countries

Existence Technical Standard Law		Type	State	Note
None		Detailed private standards	U.S. (Georgia)	
Existing	Recommendation for adopting technical standard	Detailed private standards	Australia (New South Wales)	
	Obligation of complying with technical standards	Ministry standards (essential points only)	U.K.	Present Japanese system
		Detailed private standards	U.S. (New Jersey) Germany France	
		Detailed ministry standards	Australia (Victoria)	Previous Japanese system

In the United States, each state regulates electric power industry individually because each state has a lot of autonomy. However, all states basically adopt the "NESC", which are private standards, whose existence prevents a problematic and impractical situation developing from individual states establishing their own standard.

In the U.K., "Rules for electrical safety and quality, as of 2002" correspond to the "Technical standard on electrical equipment" (Ministry ordinance) in Japan. These rules clarify that only a court of law can pass a judgment. So electric power utilities comply with technical standards including concrete and quantitative requirements established by power system network committees to prevent risk of litigation.

In Germany, although no laws supporting technical standards have ever existed, the "New Energy Law" to come into force from July of 2007, makes relative agencies comply with the private standards, VDE, because of certain factors such as liberalization of electric power industry, integration of EU market and so on.

In France, the ministry ordinance (17.5.2001) based on the "Distribution law" enforced in 1906, prescribes that all electrical equipment should comply with relevant technical standards. In that regard, the most important standard is the UTE standard. Importantly, most of the electric power industry is operated by EDF, so EDF establishes HN standards for contents that are not covered by UTE standards.

In Australia, similar to the US, each state is responsible for establishing its own regulations for electrical equipment. In the states of Victoria and New South Wales, where the JICA Study Team investigated, electrical utilities must comply with the technical standards and cooperate with the regulatory organizations that enforce the standards.

Therefore, each developed country investigated in this study has a technical standard equivalent to the "Technical standard on electrical equipment" (Ministry ordinance), and its explanation, in Japan, even though these countries possess differences in history, culture, thought and so on. Nonetheless, the detailed standards, like the explanation of the technical standards, in Japan are rarely established as law. In almost all countries, these detailed standards are established as private standards.

With respect to regulation of environment protection and labor safety, every country has different legal organizations with respect to the technical standards because aims and supervisory agencies are different.

Statistical indicators regarding the frequency of accidents involving the public with regard to electric shock is similar to Japan. Therefore, the effectiveness of the organizations in the developed countries is adequate.

(2) Safety Conditions for Electrical Equipment

The supervisory agencies conduct on-site inspections in every country investigated by the JICA Study Team. Especially in the UK, the conducting of annual on-site inspections is stipulated in the Electrical Act. With respect to company inspections by electrical power utilities, this inspection is basically conducted in terms of a voluntary safety system in every country. There is no country which forces electrical utilities to submit internal safety inspection plans to the government as in Japan. However, electric power utilities have an obligation to inform regulatory authorities of serious problems in all countries other than the US. Even though there is no obligation in the US, if regulatory authorities decide that the information is necessary, they reserve the right to collect accident information.

(3) Consumer Electrical Equipment Safety

Every country has technical standards regarding consumer electrical equipment and if the standard is private, it has the force of law by being quoted in a ministerial ordinance. However, consumers are basically forced to comply with the standards, whereas electric power utilities do not have any obligation to investigate consumer's equipment. In terms of electricity supply to new houses in the US, France and Australia, consumers are expected to ask private inspection agencies to inspect their residence and after verification of safety they can electricity may be supplied. In terms of qualifications required by an electrical engineer for carrying out electrical work on customer's equipment, Australia and New Jersey, possess a similar system to that of Japan. Elsewhere, the meister* system in German is also similar to system in Japan. There is no single common qualification system in other countries, however some countries prohibit electrical engineers without required ability from working from the viewpoint of labor safety.

(*)meister = Master Craftsman

In terms of consumer safety, preventing outbreak of fire and electrical shock due to defective electrical appliances is particularly important. Therefore, system designed to ensure the safety of electrical appliances have been established. For example, CE (Conformite Europeenne) marking system in EC countries, UL standard verification system in the US and RCM (Regulatory Compliance Marking) system in Australia have been adopted.
The table 4.1.2 shows the technical standards and the related laws of developed countries.

Table 4.1.2 Comparison of Technical Standards and Relative Law in Developed Countries

			Japan	U.S.A Georgia	U.S.A New Jersey	U.K.	Germany	France	Australia Victoria	Australia N.S.W.
Law to regulate electric utility		Law	Electrical Utility Law	Public Utility Law		Electricity Act 1989	Energy Economic Law	Distribution Law	State Electricity Safety Law	Electricity Supply Law
		Authority	METI	Public Utility Committee		DTI	Ministry of Economic and Technology	DEDIM	Energy Authority	Public Utility Committee
Law to give the obligation to technical standards（includes recommendation）			Electrical Utility Law	No	Public Utility Law	Electricity Act 1989	Energy Economic Law	Distribution Law	State Electricity Safety Law	Electricity Supply Law
technical Standards for electric facility	Facility for utility	Standards	Technical Standards for Electrical Facility	NESC (National Electric Safety Code)		Electricity safety, quality Rule2002	DIN-VDE	Governmental Ordinance 1927.7.29 Ministerial Ordinance 2001.3.17	State Electricity Safety Code	NENS
		Organization of establishment	METI	IEEE		DTI	DKE	Ministry of Economic, Finance and Industry	Electricity Safety Authority	ESAA
		Regulation Body	〃	State Government		〃	State Government	Ministry of Economic, Finance and Industry	〃	Public Utility Committee
		Legal Obligation	YES	No	Yes	Yes	Yes	Yes	Yes	No
	Facility for utility	Standards	・Technical Standards for Electrical Facility ・Electrical Worker Law	NEC (National Electric Code)		Construction Standards	Customer Facility Rule（Ministerial Ordinance）	NF Standards	State Electricity Safety Code	AS/NZS3000
		Organization of establishment	METI	NFPA		the Ministry of Construction	Ministry of Economic and Technology	UTE	Electricity Safety Authority	AS
		Regulation Body	〃	City or County		〃	State Government	Ministry of Economic, Finance and Industry	〃	Public Utility Committee
		Legal Obligation	YES	No		Yes	Yes	Yes	Yes	
Standards to complement Technical Standards for electrical facility		Standards	Interpretation of T.S.	―		ENA Code	―	NF Standards	AS	
		Organization of establishment	Agency of Natural Resources and Energy	―		ENA	―	UTE	SAI	
		Legal Obligation	No（Basically comply. If not, it should be proved to be accommodated to technical standards）	―		No（comply it from view point of protection from suit）	―	Yes	Yes (In case of that it is quoted in State Law)	
Standards for specification of equipment		Standards	Japan Industry Standards（JIS）	ANSI Standards		BS	DIN-VDE	NF Standards	AS	
		Organization of establishment	Japan Standard Institution	ANSI		BSI	DKE	AFNOR	SAI	
		Legal Obligation	No	No		No	No	No	No	
Relative Law except technical standards		Occupation Safety	Occupation Safety and Health Law	NESC、NEC、Labor Law		Electric Work Rule 1989	Labor Law	Labor Law、UTE Code	Occupation Healthy and Safety Law	
		Environment	Environmental Law	Environment Impact Estimation Law		Environment Law	NF Standards	NF Standards	Environment Protection Law	Environment Operational Protection Law
		Others	Measurement Law	Measurement Law		Energy Regulation Code	―	DEDIM Code	National Electricity Code	
Entry investigation by Authority			YES	YES		Yes (Once a year)	Yes (Monitoring based on Energy Law)	Yes (Based on Ordinance)	Yes	
Qualification for electrical engineer			"Chief Engineer" as administrator, "Electrician" as worker.	License for electrician（issued by city and county）		No	Maister System (for supervisor of electric work)	Qualification of electrician（Based on NFS standards）	Qualification of electrician	
Safety certification system for electrical appliance			JIS Standards（PSE Mark）	UL Standards（UL Mark）		EN Standards（CE Mark）			AS Standards（RCM Mark）	

4.2 Safety System for Electrical Equipment in US

4.2.1 Electrical Utility System

As of 2005, there are 3,133 electrical utilities in US, which are classified into private (230), federal (9), local public (2,012) and cooperative companies (882). Electricity utility deregulation took place in the early 1990's, and deregulation was extended to the retail business sector in the late 1990's. As a result, the electricity retail sector is now deregulated throughout half of all US states, while, the the electrical utilities in the other half, monopolize the electricity business in their respective service area under state and federal authority regulations.

Private utilities supply 75% of all US electricity. Although they have traditionally supplied an integrated service of generation, transmission, distribution and retail business, since the wholesale sector was deregulated, some utilities have concentrated on their transmission business by selling their generation business. Federal utilities, which include Tennessee Valley Authority (TVA) and Bonneville Power Administration (BPA), primarily engage in hydropower and wholesale business, while local public utilities, which are owned by states or municipalities, engage in distribution business. However, some large local public utilities such as Sacramento Municipal Utility (SMU) and Los Angeles Department of Water and Power (LADWP) own generation and transmission businesses. Cooperative utilities, which were established by farmers and local residents, supply electricity primarily to their members.

In addition, there are 2,800 "Qualifying Facilities", which are generators for private use and wholesale. Mostly in the form of IPP, they have greatly increased in number since the late 1990's, and now supply more than one third of all US electricity. While a number of other new companies, specializing in retail business, have attracted some customers from utility companies, and now supply about 5% of all US electricity.

As for the operation of transmission systems, the federal authority has announced a policy which stipulates that wholesaling shall be extended to wider areas to promote competition and stabilize the electricity market. In 1999, Federal Energy Regulatory Commission (FERC) issued "Order 2000", which instructed the utility companies who own transmission lines to establish Regional Transmission Organizations (RTO) in conjunction with neighboring companies. RTO, which operate transmission systems on behalf of communities, ensure impartiality among transmission system users and unify the market rules, which vary according to each community, to improve efficiency in trade of electricity. However, as the integrated system of generation, transmission and distribution is popular in the southeast, and while deregulation is facing a strong opposition in the northwest, which suffered from the California power crisis, RTO are not likely to prevail for the foreseeable future.

The following diagram shows the RTO in the US, where each RTO is marked with a different color, with the white representing states that have not established RTO yet. The succeeding diagram shows PIM (a RTO in Pennsylvania, New Jersey and Maryland), representing the network status of RTO.

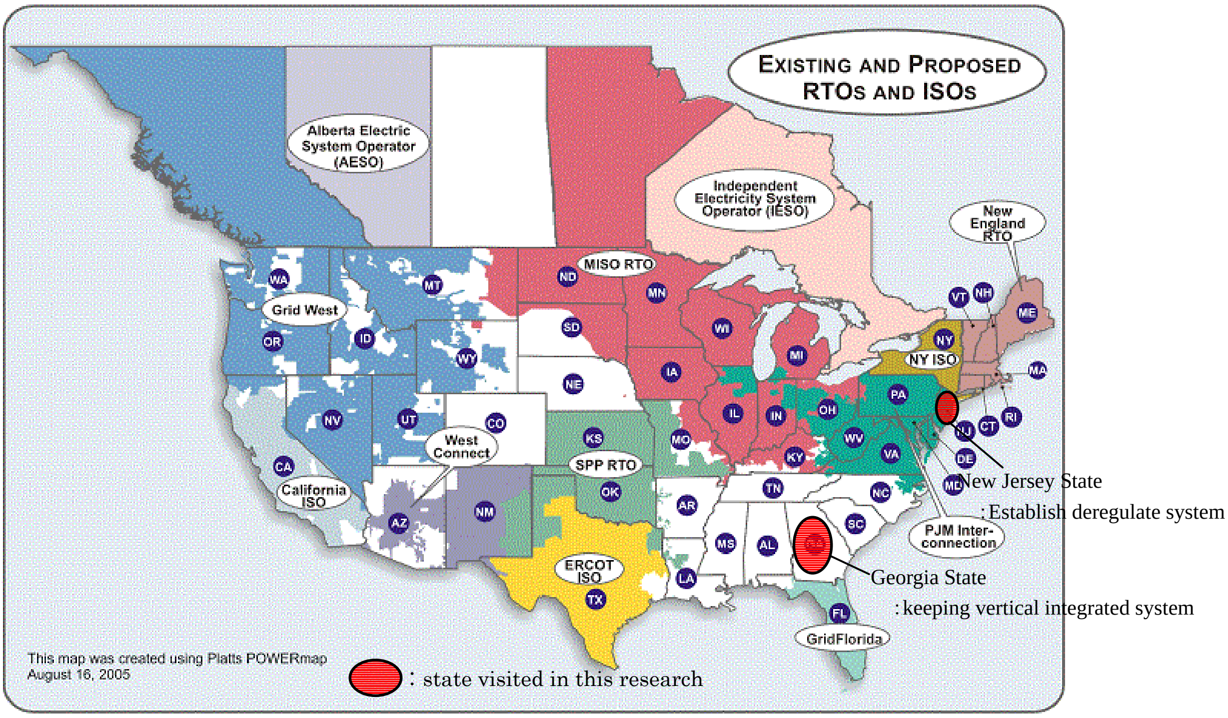


Figure 4.2.1 Situation of Electrical Utility Deregulation in US

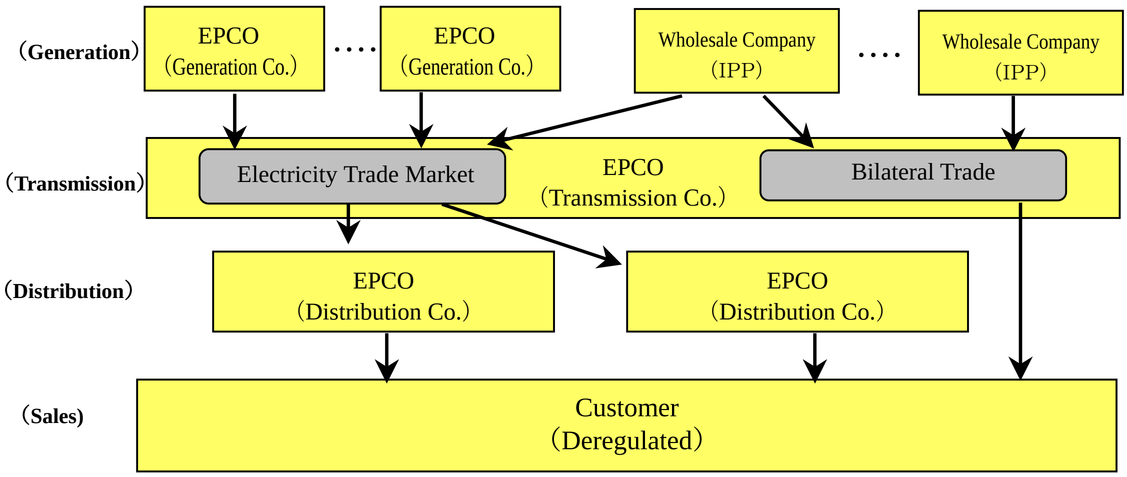


Figure 4.2.2 Electrical Utility System (Ex. Case of Deregulated System)

4.2.2 Laws and Regulations for the Safety of Electrical Equipment

Our research mission revealed that laws and regulations as well as philosophies and systems for the safety of electrical equipment differed between states. Although federal laws and regulations control the environmental protection and workers' safety, state regulations, instead of federal regulations, control the safety of electrical equipment.

There is no US equivalent to the Japanese "Electrical Utility Law", which covers requirements ranging from business operation to safety , comprehensively and nationwide. In contrast, local regulations and ordinances, independently established by states and municipalities (cities and counties), exist.

However, as they are not practical or qualitative specifications, private standards such as National Electrical Code (NEC) and National Electrical Safety Code (NESC), which are recognized nationwide, specify the details. As there are long histories associated with these standards, (the first edition of NESC in 1913.), in addition to being characterized by high quality and practical application, many states' public utility laws stipulate, "Equipment shall comply with NEC and NESC", specifying them as practically binding standards, even though they are voluntarily established. American National Standards Institute (ANSI) recognizes them as national standards.

As for the application of the two standards, NESC covers transmission equipment, which electrical utility companies primarily own, on "the front" of the watt-hour meter, while NEC covers domestic equipment, which general customers primarily own, on "the back" of the watt-hour meter.

Aside from public utility laws, which regulate business operations, the Department of Labor (DOL) Occupational Safety and Health Administration (OSHA) has established Occupational Safety and Health Act (OSHA), which protects workers' safety across all industries including electrical utilities and stipulates basic policies on the safety of electrical equipment. Individual state occupational safety and health administrations have also established similar regulations based on the federal act.

While OSHA and state regulations have no practical specifications for electrical engineering works, NESC and NEC-E (NFPA70-E) specify them in terms of workers' safety. In this manner, NESC and NEC have central roles for ensuring the safety of electrical equipment.

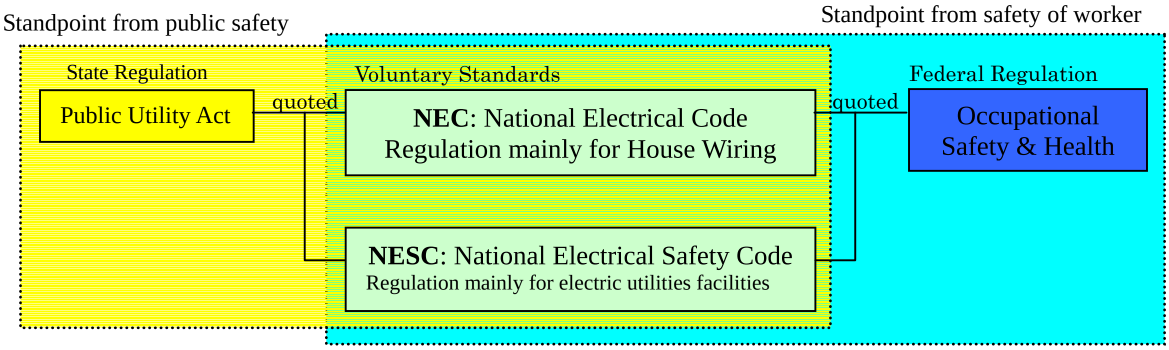


Figure 4.2.3 Law System for Electrical Facility in US

The following sections describe NEC and NESC.

(1) National Electrical Code (NEC)

NEC, which regulates electrical engineering works, has a long history from its establishment in 1897 by the National Society of Fire Engineers, and has been continuously revised by the National Fire Protection Association (NFPA)※ since 1911. NEC is also known as NFPA-70, one of the widely recognized NFPA codes, and NFPA-70E, a sister code of NFPA-70, regulates electrical equipment, communication equipment, wires, optical fibers, etc., which general customers own, to protect persons and property.

[Applicable facilities]: Buildings, warehouses, garages, machine factories, substation equipment for industrial use, households, recreational vehicles, etc.

NEC is not intended to be a design specifications document or a manual for persons who have not received adequate training, but as a set of guidelines for qualified electrical engineering technicians and instructors to design and install electrical equipment.

* NFPA: a world leading non-profit organization, has been providing information on fire protection, electrical and human safety since its establishment in 1896. It advocates and provides codes, research activities, trainings and educations based on science. Its more than 300 codes regulate practically all construction works, designs and other services worldwide.

(2) National Electrical Safety Code (NESC)

NESC, which protects safety of persons involved in installation, operation and maintenance works on transmission and communication lines including associated electrical equipment and wires, contains fundamental clauses, which are essential for the safety of workers and the general public under specific circumstances. Established by National Bureau of Standards (NBC) in 1913, it was absorbed into the administration of Institute of Electrical and Electronics Engineers (IEEE)※ in 1972. It regulates public and private electrical works and equipment for electricity, communication and railways.

※) IEEE: the world's largest technical experts' association established in 1884, has more than 320,000 members from about 150 countries.

The following are the contents of NESC. NESC contains safety regulations for equipment maintenance as well as safety regulations for workers.

【Contents of NESC】

Regulations for engineering works, operation and maintenance of electrical equipment

a) Installation of protective facilities on electrical equipment
- Numerical specifications for installation of guard fences, signs, etc. in power plants and substations

b) Engineering works and maintenance of electrical equipment
- Specifications for minimum and desirable separations of workers from live equipment

Safety regulations for engineering works and maintenance of overhead transmission lines (including communication lines)

Specifications for heights above ground, separations, mechanical strengths of transmission lines (including communication lines), with numerical specifications for clearance, loading (wind and snow) on structures, mechanical strengths of steel and wires, as well as dielectric strengths of insulators

Safety regulations for engineering works and maintenance of underground transmission cables (including communication lines)

Specifications for manholes, cableways, junction boxes, with numerical specifications for loading (vehicles, etc.) on structures and installation of bare cables

Regulations for electrical equipment works (workers' safety)

Specifications for workers' safety on preventive measures against human electrification and falling from heights including work-wear and facilities

4.2.3 Safety System

As previously described, each US state has a different safety system. As generalizing is difficult, this section describes the systems existing in Georgia and New Jersey, states which we visited on our research mission. We took the influence of electric utility system (the situation of deregulation) to safety system into account, selected the state to research 1) keeping the vertical integrated system (Georgia State), 2)established deregulated system (New Jersey State).

Consequently, in Georgia where keeping the vertical integrated system, government doesn't have any regulation for utility. On the other hand, in New Jersey where established deregulation, government has some regulation and also utility has their own safety system.

(1) Safety System in Georgia

(a) Electrical Utility System

Electrical utility system in Georgia consists of vertically integrated large utilities such as Georgia Power, and small public companies, 52 municipals (owned by cities) and 49 coops (owned by counties). The state does not regulate the public companies, letting them manage their businesses on their own. (They own transmission facilities but not generation facilities.)

(b) Legal System on Safety

In Georgia, there are no technical standards set by the public utilities commission to regulate technical aspects of the electrical equipment of electrical utilities. The Public Utility Law of the state has no specifications for electrical equipment or references to national standards such as NESC, either.

However, each electrical utility possesses a variety of internal codes for design, construction, maintenance and inspection of equipment. They contain latest information from academic societies such as IEEE and comply with NESC. In addition, each utility also has material codes based on ANSI.

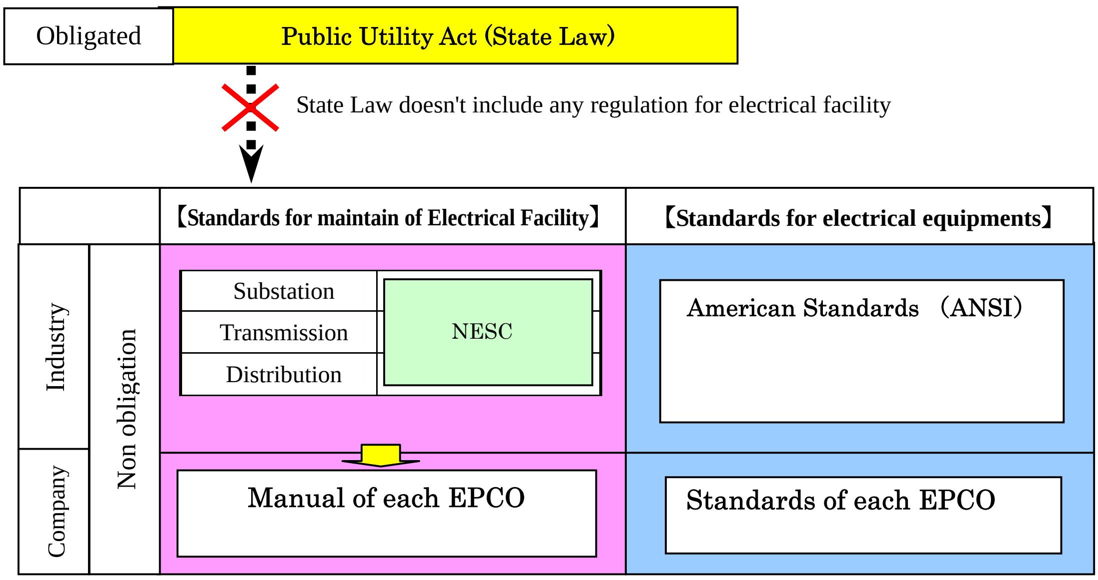


Figure 4.2.4 Safety Law System in Georgia State

(c) Regulations and Regulatory Authority

1) Maintenance and Safety of Equipment

The public utilities commission regulates electrical utilities. However, it only governs cost and financial aspects in terms of the appropriateness of electricity charges but not equipment maintenance. Its basic stance is not to impair utilities' competitiveness by excessive regulations such as examinations of utilities' internal equipment codes. Meanwhile, cities and counties, instead of the public utilities commission, regulate general electrical equipment including domestic wirings, through their own equipment standards based on NEC. In addition, officers from cities and counties inspect equipment on-site prior to commencement of commercial operation. Pending the issuance of an inspection certificate, electrical utilities start the commercial operation of the equipment. As for domestic wirings, cities and counties qualify electrical engineering technicians as well as the supervisors of engineering works.

Furthermore, the public utilities commission reserves the right to inspect utilities equipment on-site in case of serious accidents.

The state does not require for electrical utilities to submit their transmission facility engineering work plans. However, those for thermal power generation facilities are submitted out of necessity for environmental impact assessment. Furthermore, as for thermal power generation, schedules and costs of engineering works are audited during the work period to check not the technical aspects but rather the financial aspects of the engineering works.

2) Workers' Safety and Health

Instead of the public utilities commission, the Occupational Safety and Health Administration of Department of Labor, at the state or federal level, requires electrical utilities to submit plans for workers' safety and health and report occupational accidents. Georgia Power has established a special department for workers' safety and health to manage those aspects and instruction manuals.

(2) Safety System in New Jersey

(a) Electrical utility system in New Jersey

New Jersey, which is aggressively deregulating the electrical utilities, has completely unbundled generation, transmission and retail of electricity. It was one of the first to undertake deregulation, and has achieved a balance between a stable supply system and reasonable electricity charges.

As for transmission, there are four electrical utilities including Orange & Rock, which we visited during our mission. It has a service area extending from New Jersey to New York and Pennsylvania.

(b) Legal System for Safety

"NJ. Administration Code", a state law, stipulates regulations for electrical utilities. Among those, a stipulation, "Electrical equipment shall comply with NESC", confers a binding authority to NESC. Although the state law contains no specifications for equipment, "Safety Adequate Proper", which is a rule with no binding authority, stipulates that specifications be based on NESC.

The state law also specifies fluctuations in voltage and frequency based on IEC as well as inspections on electrical equipment (inspection intervals, reports and their contents). Meanwhile, electrical utilities have internal manuals and guidelines of their own. As Orange & Rockland supplies electricity to three states, that are controlled by different regulations, it needs to establish common standards, which satisfy all the public utility laws of the three states. These standards contain their original specifications based on NESC. , For example, while NESC specifies 21ft for the 69kV transmission line height above ground, Orange & Rockland specifies 25ft. As for the strength of wooden poles, and given that NESC only provides basic standards, it studied necessary strengths (against wind and snow) to establish its own specifications. Therefore, it has common standards for equipment, which satisfy the three states, although they differ from the inspection standards of the states supplied.

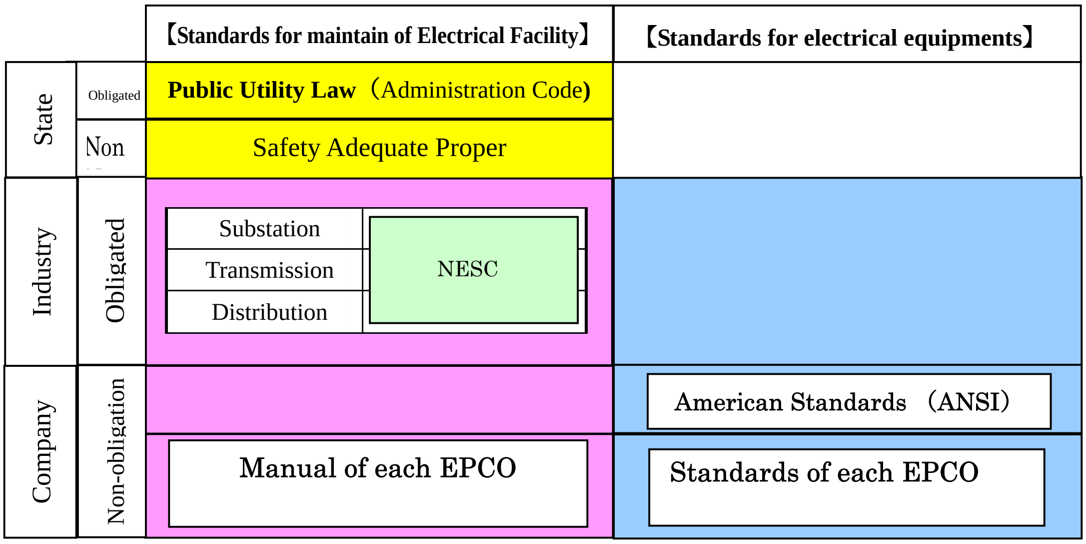


Figure 4.2.5 Safety Law System in New Jersey State

(c) Regulations and regulatory authority

1) Maintenance and Safety of Equipment

As in Georgia, the public utilities commission regulates electrical utilities in New Jersey as well. However, while in Georgia the commission is only concerned with the appropriateness of their electricity charges, New Jersey regulates installation and maintenance of electrical equipment as well through the directives of the NJ. Public Utilities Law.

As described above, the contents and strictness of regulations are significantly different between states. Since a defective earth connection of distribution equipment accidentally electrified ordinary citizens in New York several years ago, Orange & Rockland has obligated electrical utilities to inspect their earth connections (earth voltage checks for defective connections) every five years and submit reports of the inspections, penalizing negligence of this obligation. While many states, in general, examine accidents and review their regulations, New York imposes the most strict regulations such as annual and monthly outage reports (for those of more than five minutes), which is imposed in New Jersey as well.

As in Georgia, instead of the public utilities commission, cities and counties regulate general electrical equipment including domestic wirings, through their own equipment standards based on NEC. In some Georgia towns that have building inspection agencies, inspectors from the agencies inspect that the buildings satisfy town's standards prior to electricity being supplied to the buildings. In many cases, inspectors from private companies qualified by the towns perform the inspection on their behalf. State inspections on electrical utilities are also undertaken in Georgia, with the public utilities commission reserving the right to inspect electrical equipment on-site. State examinations of engineering works' plans are as carried out in Georgia as well.

2) Workers' Safety and Health

As in Georgia, electrical utilities are required to submit plans for workers' safety and health and report occupational accidents to the Department of Labor - Occupational Safety and Health Administration , at state or federal level. . Furthermore, Orange & Rockland obligates their workers to undertake electrical engineering technician training from the state's Occupational Safety and Health Administration. It also has its own training programs, which are based on the state's training regime.

4.2.4 Role of NESC in Another State

As mentioned so far, NESC is set as standards to regulate safety system of electrical facility, and important to recognize safety system in each state. In this research, we visited Georgia and New Jersey state and made clear safety system in both state. Table 4.2.1 shows the role of all state in U.S.A. It shows that 75% of all state quotes NESC as obligated regulation.

Table 4.2.1 Role of NESC in Another State

	Number	State
1)Prescribed as obligated standards in State Law	35	Alabama, Alaska, Arizona, Arkansas, Connecticut, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Texas, Utah, Virginia, Wisconsin
2)Quoted as recommendation. Non obligation	2	Georgia, Louisiana
3)Established original standards. （based on NESC)	5	California, Delaware, Iowa, New Mexico, Wisconsin
4)No answer	9	

(Ref. IEEE survey report)

4.3 Safety System for Electrical Equipment in U.K.

4.3.1. Electrical Utility System

The United Kingdom (U.K.), the world's first to start deregulation of its electrical utilities, has privatized and unbundled the Central Electricity Generating Board (CEGB), which previously monopolized generation and transmission, into one transmission company and 3 generation companies. The 12 national distribution boards have also been privatized. Since deregulation, there have been many new entrants into the electricity business sector, and, as of 2003, there are 76 companies involved in the generation sector and 77 companies involved in the retail sector.

M & A have become a regular occurrence, with both Enogy and Powergen, two of the CEGB successors, acquired by giant German energy companies. The distribution companies have also been taken over by German and French companies. As a result, traditional national electrical utilities in U.K. (except network business sector) have been reorganized into 5 major groups, REW (Germany), EON (Germany), EDF (France), SSE (U.K.) and SP (U.K.). The M & A have resembled both horizontal consolidation, among distribution companies to expand their customer bases, and vertical consolidation, between generation and distribution to hedge price risks. Companies have also advanced into gas and telecom sectors, while pursuit of increased efficiency in the network business sector has led to mergers such as the one between NGC (transmission) and Transco (gas pipeline network), and capital or business consolidations among distribution companies.

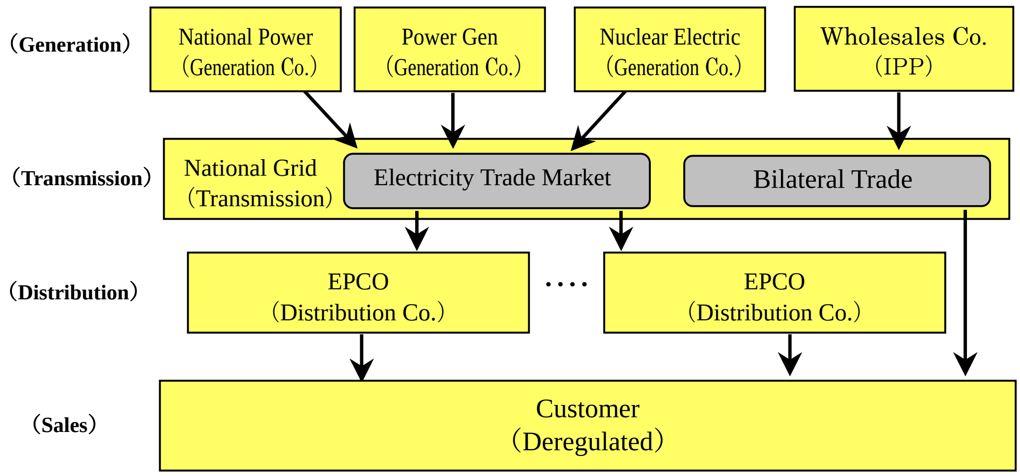


Figure 4.3.1 Electrical Utility System (Ex. England, Weals)

4.3.2. Legal System for Technical Standards

"The Electricity Act 1989", which primarily regulates electrical utilities, stipulates the mandatory establishment of technical standards. Therefore, Department of Trade and Industry (DTI) established "The Electricity Safety, Quality and Continuity Regulations 2002", which is legally binding. It is the U.K. equivalent of "The Technical Standards for Electrical Equipment", applicable in Japan, which specifies the basic requirements for electrical equipment regarding safety and stability of electricity supply. Standards set by the Electrical Power Network Association (Recommendation and Best Practice, etc.) are U.K. equivalents of "The Interpretations of the Technical Standards" (Japan). Although they are not legally binding, electrical utilities, when constructing electrical facilities, comply with the standards to safeguard against potential lawsuits.

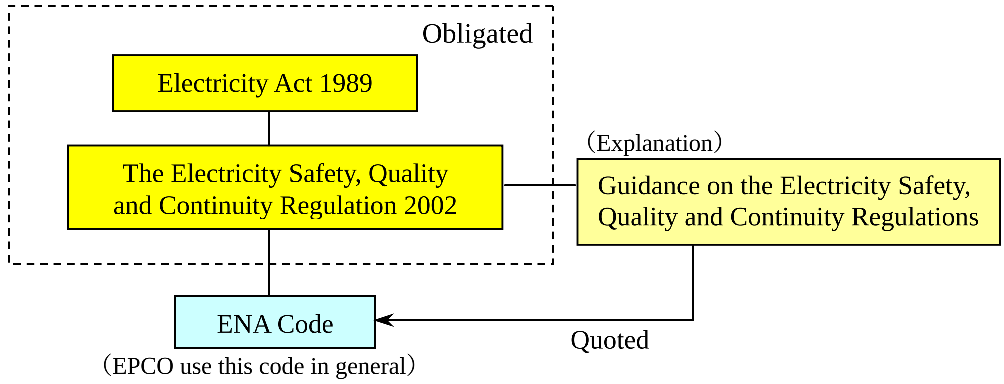


Figure 4.3.2 Safety Law System in United Kingdom

(1) The Electricity Act 1989

The Electricity Act 1989, U.K. equivalent to "The Electrical Utility Law" of Japan, regulates the electricity business including utility licenses, relevant organizations and submission of changes of registration terms. As for technical standards, it stipulates the following clauses.

Article 29: "Regulation relating to supply and safety" provides for the establishment of standards for stable and efficient electricity supply and public safety.

Article 30: "Electrical inspectors" provides for appointment of inspectors for periodical and special examinations of electrical equipment.

This law is under the jurisdiction of Department of Trade and Industry (DTI).

(2) The Electricity Safety, Quality and Continuity Regulations 2002

"The Electricity Safety, Quality and Continuity Regulations 2002" (hereafter, The Electricity Regulations), a U.K. equivalent to "The Technical Standards" of Japan (an ordinance set by Ministry of Economy, Trade and Industry), is the successor to "The Electricity Supply Regulations". It specifies basic requirements for protection, earth connection, substations, cables, overhead wires, and connection with customers' or generation equipment. Formulated by DTI, it comes into effect after approval by the parliament.

Except for heights of overhead wires above ground, as in the Japanese technical standards, it provides very few practical examples and numerical values, instead it concentrates on qualitative aspects. Its main contents are as follows, wherein the expression, "reasonably practicable", is often used, representing its basic philosophy, "While adequate investment, regardless of its cost, is essential for important and potentially hazardous equipment, less important and relatively safe equipment shall be reasonably and practicably dealt with."

(Main contents of The Electricity Safety, Quality and Continuity Regulations 2002)
- Obligation to construct, operate and maintain electrical equipment safely and appropriately in terms of electricity supply reliability
- Regulations for appropriate intervals of inspections and management of inspection records
- Protection systems and earth connections
- Heights above ground of overhead distribution lines (with an attached sheet listing numerical values for them.)
- Separations between overhead wires and buildings or trees (no numerical values)
- Measures to prevent ordinary persons from approaching overhead wires
- Hazard signs (practical specifications for the signs)
- Requests for improving and rejections of connecting inadequate equipment of customers
- Service voltages and frequencies (admissible fluctuations)
- Obligation to report serious accidents and outages (specifications of cases which require reporting)

(3) The Guidance on the Electricity Safety, Quality and Continuity Regulations 2002

DTI formulated and published "The Guidance on the Electricity Safety, Quality and Continuity Regulations 2002" (hereafter, The Guidance on Electricity Regulations), which is a U.K. equivalent to practical guides for "The Technical Standards" produced by several publishers in Japan, rather than to "The Interpretations of the Technical Standards." It does not specify any numerical values except for the fence heights of substations, and only refers to many private standards including The British Standard (BS) and The Electricity Association's Standard (currently, The Electrical Power Network Association's Standard), which specifies numerical values.

In its introduction, The Electricity Regulations states, "Although this guide reflects DTI's viewpoints, it simply provides assistance for those who are required to comply with the regulations, and courts solely possess legal authority", which implies that simple compliance with it may not be sufficient.

(4) The Electrical Power Network Association's Standard

The Electrical Power Network Association, an industrial association of U.K.'s transmission and distribution companies, formulates Recommendation, Best Practice and other standards, which provide practical specifications such as separations between overhead wires and buildings, which are not specified in the Electricity Regulations or Guidance on Electricity Regulations. To avoid potential prosecutions by regulatory authorities and lawsuits, electrical utilities comply with these standards, which are U.K. equivalents to "The Interpretations of the Technical Standards" of Japan, since The Guidance on Electricity Regulations does not provide any practical standards.

(5) The British Standard

The British Standard, a U.K. equivalent to IEC, an international standard, primarily specifies basic performances of equipment and materials, and test methods. It is being revised to conform to IEC.

(6) Public Accidents

According to DTI statistics, there have been 128 fatal public accidents involving electrical equipment for the past 10 years since 2005. However, these include car crashes into electrical poles and suicides, and around 50 electrifications due to contact with electricity wires.

4.3.3. Safety System

Based on Article 30 of The Electricity Act, DTI employ inspectors who are vested with an authority for on-site inspections to ensure equipment complies with The Electricity Regulations. Those inspectors conduct annual and random inspections. In addition, Article 5 of The Guidance on Electricity Regulations stipulates, "Electrical utilities shall inspect their equipment at adequate intervals and maintain complete inspection records." Furthermore, "The Electrical Work Regulation 1989" stipulates that inspection regimes for generation and substation equipment shall be established to ensure workers' and operators' safety. However, there is no U.K. equivalent status to Japan's Chief Electrical Engineers.

4.3.4. Safety of Customers' Equipment

As there is no legislation for domestic wirings, The British Standard has been used. However, "The Building Regulation, Part P", which was established in 2005 and is under the jurisdiction of Deputy Prime Minister, now obligates compliance with The British Standard. In addition, Article 29 of The Guidance on Electricity Regulations stipulates that electrical utilities shall reserve the right to refuse supplying electricity to inadequate electrical equipment of customers. However, there is neither an obligation to inspect domestic wirings nor any equivalent requirements outlined for Japan's Electrical Engineering Technicians. Although The Electrical Work Regulations 1989 prohibits workers without adequate knowledge and experience in electrical engineering from entering work sites that require certain qualifications, it is not for the benefit of improving the performance of customers' equipment, but rather to ensure workers' safety. However, of course the performance of customers' equipment is likely to improve if only workers with adequate knowledge and experience are allowed to engage in engineering works.

4.3.5. Other Relevant Regulations

(1) The Electrical Work Regulations 1989

"The Electrical Work Regulations 1989", which is under the jurisdiction of the Department of Workers and Pensions, Health and Safety Executive (HSE), regulates workers' safety. It regulates engineering works on equipment in both live and outage states as well as preventive measures against overloads, over-currents, abnormal voltages, etc. As there is a significant overlap between public and workers' safety, a reorganization of ministries and agencies is in progress, where HSE will assume responsibilities for both public and workers' safety regarding electrical equipment. However, this reorganization will not alter the application of The Electricity Act, only the jurisdictions of ministries and agencies involved. After the reorganization, DTI will govern only the stability of electricity supply.

(2) The Distribution Code

Since deregulation, compliance codes have been established for electrical utilities. For example, The Distribution Code primarily specifies business aspects including demand forecast and conditions for connecting distribution lines. However, it contains several technical standards, e.g., for earth connection of low voltage equipment and conditions for connecting private generation equipment with transmission lines. This code is not under the jurisdiction of DTI, but rather The Office of Gas and Electricity Market.

(3) Environmental Regulations

In terms of environmental regulations, there are "The Environmental Protection Act 1990" and "The Pollution Prevention and Control Act".

4.4 Safety System of Electrical Equipment in Germany

4.4.1 Electrical Utility System

In Germany, a new energy business law was enacted in 1998, which deregulated the whole electrical utility industry, allowing all customers, including households, to choose their electricity supplier. Traditionally, there had been 8 major electrical utilities in Germany, supplying about 90% of all German electricity, while more than 1,000 small local public distribution companies had also been in operation. However, deregulation terminated this oligopoly regime so that electrical utilities would compete with one another, both on wholesale and retail fronts. As the competition grew tougher, electrical utilities began to merge among themselves to maintain their competitiveness, which consolidated the 8 major utilities into 4 giant companies, RWE, E.ON, EnBW (with equity participation of EDF in France) and Vattenfall Europe (with equity participation in Vattenfall in Sweden). Furthermore, in 2000, European Energy Exchange (EEX) and Leipzig Power Exchange (LPE) were established in Frankfurt and Leipzig respectively to promote electricity trade. However, after not being able to draw large trade volumes, they decided to merge with each other in 2000, and a merged electricity exchange commenced its commercial operation in Leipzig in 2002. Since then, its trade volume has gradually increased, and its spot trade accounted for about 9% of all German electricity in 2003.

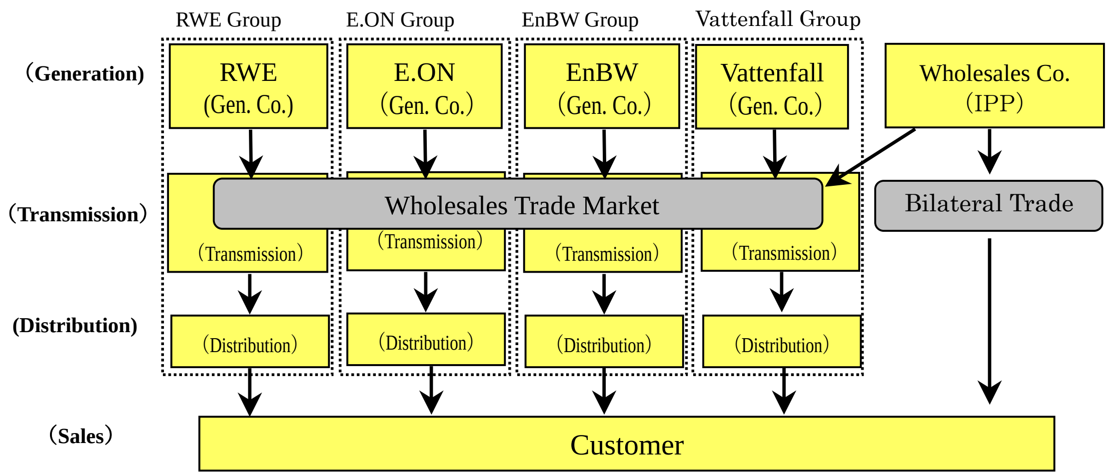


Figure 4.4.1 Electrical Utility System in Germany

4.4.2 Legal System for Safety

Since electrical utilities, as regional monopolies, had constructed their equipment according to their own specifications, nationally unified regulation and standards were not considered necessary and therefore had actually never existed. After the deregulation, however, it became possible for new entrants to join the electrical utility market, which necessitated some form of business regulation or another. In addition, EU directives ordered liberalization of transmission system and unbundling of electrical utilities, and renewable energy companies required open access to the transmission system. As a result, "The Energy Economy Law" was amended in the summer 2005, which urged the establishment of unified standards for electrical equipment to ensure business impartiality and equipment safety.

"The Energy Economy Law", a German equivalent to "The Electrical Utility Law" of Japan, regulates electrical utilities, and Article 49 of the law provides for electrical equipment safety as follows.

Article 49: Requirements for Energy Equipment

1. Energy equipment shall be operated so as to ensure technical safety, whereas laws and orders shall be observed with generally applicable technical standards being complied with.
2. Observation of Section 1 shall require compliance with the following standards regarding manufacturing, transportation and delivery of equipment.
   (1) For electrical equipment, technical standards set by reg. Association for Electrical Engineering, Electronics and Information Technologies
   (2) For gas equipment, technical standards set by reg. Association for Gas and Water Works

Section 1 stipulates that electrical equipment in general shall be maintained as technically safe, while Section 2 stipulates that existing technical standards set by the Association for Electrical Engineering, Electronics and Information Technologies (Verband Deutscher Elecktrotechniker: VDE) shall be observed and complied with, which confers legal binding force to VDE standards.

As mentioned above, some private standards are used as legally binding standards, where any amendment to them is possible in accordance with technological progress, while pubic standards set by laws and ordinances are not as flexible. However, standards for boilers in thermal power plants are legally established.

"The Energy Economy Law", which regulates only electrical equipment for business use, stipulates that an associated ordinance: "General Rules for Supplying Electricity to Customers" shall regulate customers' equipment. It is a German equivalent to Japan's "Technical Standards for Electrical Equipment". However, like The Energy Economy Law, it only specifies qualitative performance requirements, leaving numerical values to be stipulated by the VDE standards. Currently, this ordinance regulates both electricity supply contracts and electrical equipment, although it is being amended to separate them. As it does not clearly specify conditions for connection to the transmission system, a new ordinance will be created for that purpose.

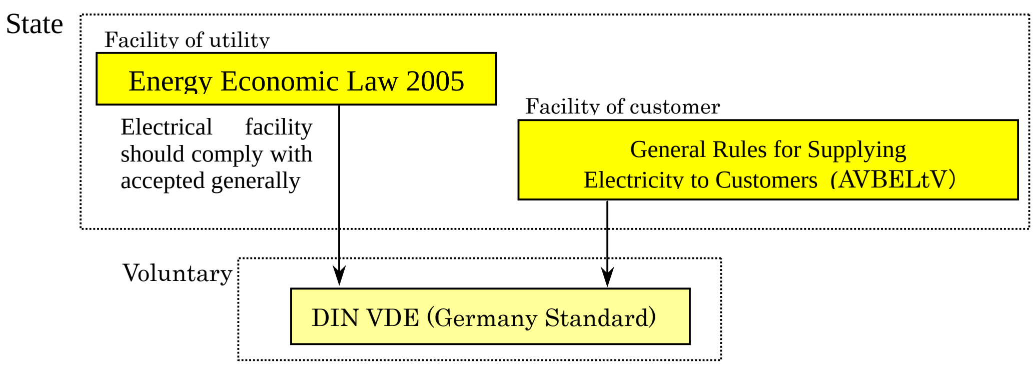


Figure 4.4.2 Relationship between Safety Laws and Technical Standards in Germany

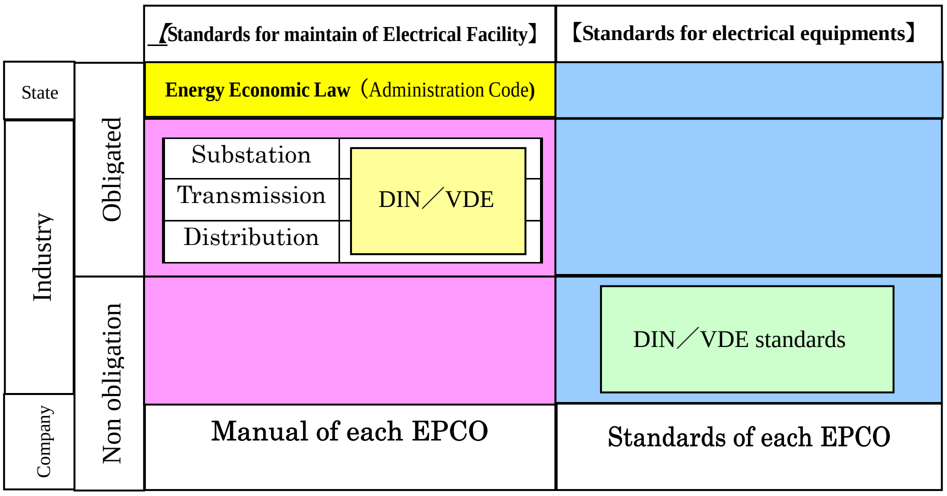


Figure 4.4.3 Safety Law System in Germany (EPCO's facilities)

(1) VDE (Verband Deutscher Elecktrotechniker) Standards

German Electrical Engineering Standards Committee (DKE) formulates VDE standards according to a contract with the Department of Economy and Technology based on The Energy Economy Law. Manufacturers, electrical utilities, governments, labor unions and other relevant organizations form the committee, which ensures consensus over many circles. VDE standards regulate a wide range of electrical equipment including generation, transmission, distribution and customers' equipment, regarding equipment specifications and performance tests as well as installation, inspection and operation of equipment. For example, they specify the heights above ground for transmission and distribution wires as well (VDE210).

VDE210: Specification for planning and design of overhead transmission lines (structures, foundations, etc.)

As many as 400 new VDE standards are established annually, and they now number more than 1,800. As legally binding standards, they provide specifications that are in need of generalization, while German Transmission System Operators' Association (VDN), instead of DKE, provides standards for specifications that do not require unification but some degree of uniformity. For example, VDE standards specify mechanical performances and dielectric strengths for wind power generators, but not electricity supply volumes to be guaranteed by the generators, while VDN standards do. Thus, VDN standards rather than VDE standards provide almost all specifications for transmission system operation, which are not legally binding.

4.4.3 Safety System

As Germany is a federation, federal and state governments share authority to regulate electrical utilities. However, regulations do not vary greatly from one state to another, which is also the case in the US and Australia, which are federations as well. The federal government leads state governments, while state governments are vested with a certain level of authority.

The Energy Economy Law had been entirely under the jurisdiction of state governments until it was renewed in the summer 2005, so that the federal government assumed authority governing business regulations. Federal Agency of Networks was established in the Department of Economy and Technology to oversee electrical utilities' business, while state governments retained authority to regulate electrical utilities' equipment.

The Energy Economy Law provides almost all regulations regarding electrical utilities' business. For Example, Article 51 of the law obligates states to report current status and forecasts of Electricity demand and supply, supply capacity and reliability, failures and accidents, etc. to the federal government, and provides them with authority to inspect electrical utilities' equipment on-site and inquire for maintenance records. This clause was added in the 2005 renewal.

4.4.4 Safety of Customers' Equipment

States are vested with authority to regulate customers' equipment according to an ordinance: "General Rules for Supplying Electricity to Customers", which obligates customers to comply with the rules for safety. Electrical utilities are not obligated, but vested with authority to confirm customers' equipment compliance with technical standards for connection to transmission system, and they reserve a right to refuse connection to customers' equipment that is not of the required quality.

4.4.5 Qualification System

Traditionally in Germany, there has been a unique professional system called Meister, which stems from 'Guilds', self-governing professional unions comprised of masters, craftsmen and apprentices to monopolize professional skills in medieval Europe. Handicraft industry associations manage this system and the system for electrical engineering is called Electrical Meister.

Electrical utilities are not obligated to appoint a supervisor responsible for their electrical equipment like Electrical Chief Engineers are in Japan. Meister is not intended for that purpose. Electrical Meister is primarily responsible for supervising electrical engineering works. A supervisor for an electrical engineering task is required to obtain a qualification according to The Engineer Law, which was enacted in Jan. 2004. This qualification requires a qualification as a Meister based on Article 1 of the law, or a professional experience of more than 6 years (and more than 4 years as a chief engineer) based on Section 2, Article 7 of the law. In this manner, the qualification as an electrical engineering technician is institutionalized and incorporated in the equipment safety system as in Japan.

4.4.6 Other Relevant Regulations

(1) Regulations related to workers' safety

Federal Department of Labor and Society is responsible for workers' safety. Related regulations include The Worker Protection Law, Ordinance for Workers' Safety and Ordinance for Workplaces, all of which only specify minimum requirements for all industries. Industry associations have established their own practical regulations and guides for workers' safety, although they are not legally binding.

(b) Renewable Energy Act

Germany has been aggressively developing renewable energy including wind and biomass. The Renewable Energy Act, a comprehensive law regarding renewable energy (exclusively for electricity generation), was enacted in 2004, and provides rules for connection of renewable energy generation equipment to the transmission system and electricity purchase rates.

4.4.7 Public Accidents and Outage Durations

Federal Statistics Agency and VDEW (German Electricity Association) provide statistics of electrical accidents. Deaths from electrification have number between 60 to 70 persons per year, and are decreasing since the reunification of East and West Germany.

4.4.8 Accident Example

Verband Deutscher Elecktrotechniker (VDE) standards are legally binding in practice, and require compliance to ensure safety. According to these standards, electrical utilities are obligated to account for their equipment conditions in terms of electrical accidents and failures. The following is an example account of an accident submitted by an electrical utility.

Transmission Tower Collapse Caused by a Cold Wind in Nov. 2005

Background of the Accident:
On Nov. 25, 2005, 82 (all owned by REW) transmission towers in Nordrhein-Westfalen, Germany, collapsed, causing an outage of 250 thousand households in the state. The recovery from the accident took 2 days, incurring a serious social impact.

Cause of the Accident:
According to REW, an unexpected volume of icing on transmission wires brought down the towers.

Account for the Accident:
As the volume of icing was 8 times as much as the design specification in VDE (VDE-210), the accident is a natural disaster. REW designed the towers according to VDE, and did not neglect any technical responsibility.
(The compliance of RWE with VDE and an unexpected extraordinary loading in VDE negates their responsibility.)

4.5 Safety System of Electrical Equipment in France

4.5.1 Electrical Utility System

In EU member countries, electrical utilities have been deregulated according to a EU directive adopted in 1996. In France, The Electricity Deregulation Law, enacted in Feb. 2000, introduced partial deregulation, and since then, the deregulation has been gradually advancing. In Jul. 2004, according to an amended EU directive adopted in 2003, the deregulation was extended to all customers except households, and as a result, about 70% of all customers were deregulated. The deregulated customers may purchase electricity directly from electricity providers or indirectly from a power exchange through distribution companies. Furthermore, according to the amended EU directive, all customers are to be deregulated in Jul. 2007.

In terms of the electrical utility system in France, Electricite de France (EDF), a state-owned company was established in 1946 with an objective of ensuring public welfare, had fulfilled public responsibilities including provision of uniform rates for electricity across the country, protection of socially disadvantaged people, environmental protection and energy self-sufficiency. Possessing about 90% of France's total generation capacity, it had dominated electricity generation and retail businesses in France. In the 1990's, it aggressively EDF acquired foreign energy companies, especially in neighboring countries, including Spain and Italy, where it was claimed furiously that it is unethical for a state-owned company to purchase private companies, and as a result, the French government decided to partially privatize EDF. In Jul. 2004, the EDF Joint Stock Company Conversion Law was enacted, and actually in Nov. of the same year, EDF was converted to a joint stock company. Although its organizational structure after the partial privatization has not been unveiled yet, a subsidiary company for each business sector such as generation, transmission and distribution is expected to be established under a holding company.

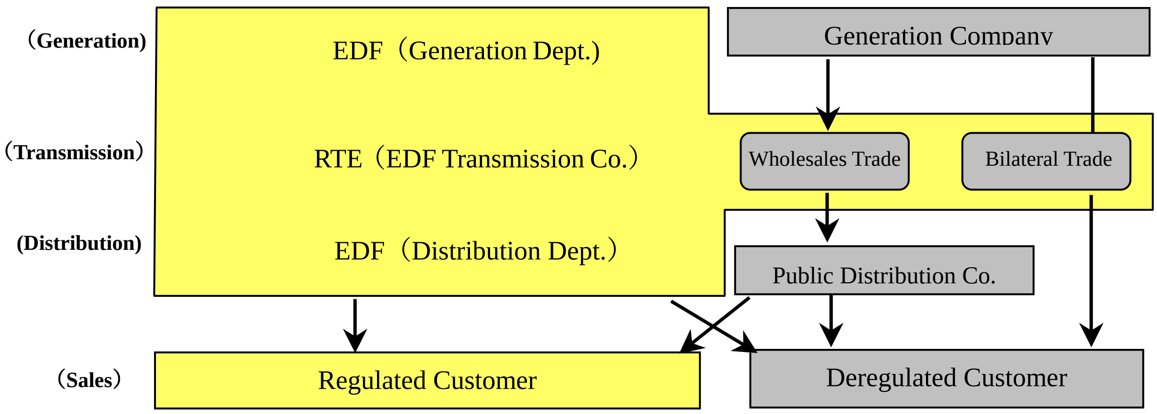


Figure 4.5.1 Electrical Utility System in France

4.5.2 Legal System for Safety

"The Electricity Distribution Law", enacted in 1906 to regulate electrical utilities, is a French equivalent to The Electrical Utility Law of Japan. Therein, "Distribution" denotes the entire transmission system including distribution lines. In addition, traditionally in France, electrical utilities have been a consolidation of transmission and generation, thus no electrical utilities have specialized in generation. Therefore, The Electricity Distribution Law regulates all electrical utilities.

Article 19 of the law stipulates, "Technical standards shall be established to specify technical conditions that the distribution system should comply with to ensure human safety, public works' safety and landscape conservation." According to this clause, "Decret Du 29 Juillet 1927 (The Government Ordinance, Jul. 29, 1927)" and "L' Arrete Interministeriel Du 17 Mai 2001 (The Ministerial Ordinance, May 17, 2001)" were decreed.

(1) The Electricity Distribution Law

The Electricity Distribution Law stipulates that transmission or distribution business require a license issued by the state or local governments. Provisions for the licensing application and approval process constitute a major part of the law. Another important part includes regulations for installation of wires along public roads and streets. Article 19 is the only provision for safety of electrical equipment, details of which are deferred to "The Government Ordinance, Jul. 29, 1927" and " The Ministerial Ordinance, May 17, 2001".

(2) The Government Ordinance, Jul. 29, 1927

This ordinance is referred to when constructing new transmission or distribution facilities, and specifies procedures, responsible administrative offices and technical conditions for construction approval.

(3) The Ministerial Ordinance, May 17, 2001

This ordinance is a French equivalent to "The Technical Standards" of Japan, and specifies technical conditions in terms of numerical values for engineering works such as height of wires above ground. Originally, it was established in 1946 when some electrical utilities were nationalized and about 170 distribution companies that were not nationalized (local public and agricultural cooperative companies) were in need of unified standards for equipment safety.

These three regulations form the core of the technical standards for transmission facilities. In addition to those, French Standards (NF), practical implementation guides for the ministerial ordinance, contain provisions for equipment specifications as well as equipment installation and maintenance. They are French equivalents to Japan's Electrical Standards and Codes (JESC), which are private standards, and specify numerical values. While JESC are voluntary standards, and thus, not legally binding, French Standards are referred to as legally binding standards by the ministerial ordinance. However, their specifications for equipment and materials are excluded from the reference and are thus, not legally binding. EDF observes its own internal standards (NH), which cover provisions for transmission and distribution equipment that are not addressed in French Standards. With the unbundling of electrical utilities, many new companies will enter the utility business, and Electrical Engineering Association (UET), a neutral organization, is likely to assume the responsibilities inherent in the NH standards and French Standards.

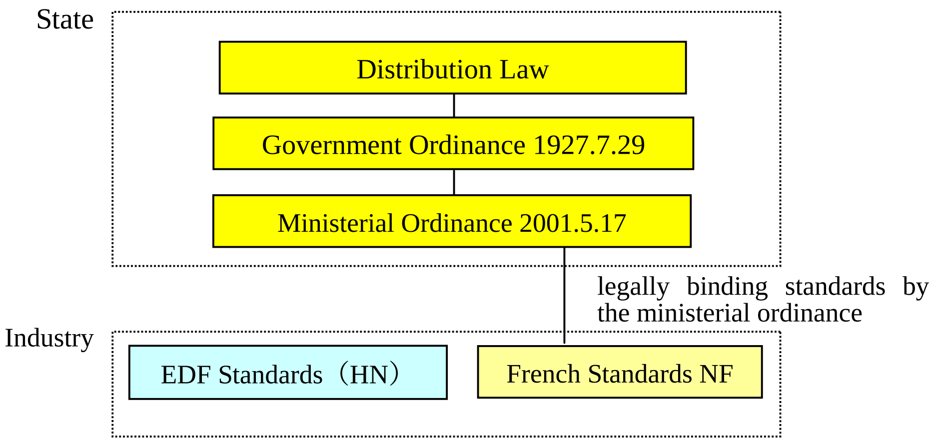


Figure 4.5.2 Relationship between Safety Laws and Technical Standards in France

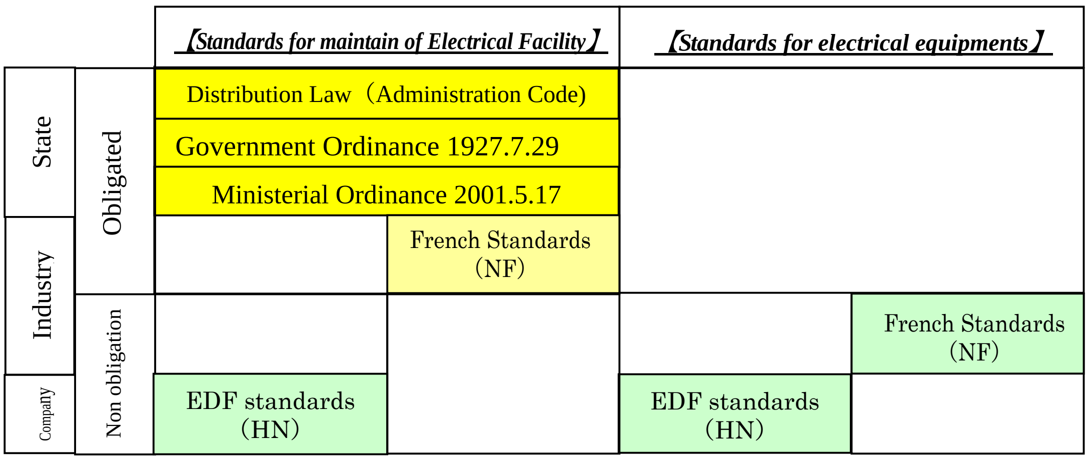


Figure 4.5.3 Safety Law System in France

With The Electricity Distribution Law at their center, a number of government and ministerial ordinances provide specifications for segmented areas of the safety system and they refer to French Standards as legally binding standards that supplement them. For electrical utilities, this system is too complicated. As French Standards are periodically amended complying with them is an essential but very difficult task. Therefore, EDF employs legal specialists to assist in compliance with French Standards, including the formulation of manuals for compliance with the standards.

French Standards (NF)

A government organization called AFNOR is responsible for establishing standards. Officers in charge of standards are transferred there from related ministries and agencies. However, AFNOR itself does not formulate the standards, rather it examines and approves standards formulated by relevant organizations. Standards approved by AFNOR are called French Standards (NF). Among the organizations that formulate the standards, Electrical Engineering Association (UTE) is the largest and Mechanical Engineering Association (UNF) is the second largest.

UTE, established in 1906, the same year as the establishment of IEC, provides standards and technical documents (for all involved in electrical engineering industry, including generation, transmission, distribution, domestic wiring and electrical equipment). It consists of electrical equipment manufactures, electrical utilities (EDF) and electrical engineering companies, and is funded by membership fees and profits from publications, not through any government subsidy.

Among electrical utilities, EDF is the only member, and there are no members from public or cooperative distribution companies. Thus, EDF leads in the formulation of standards for electrical utilities. However, in the future, new companies will enter the electrical utility business and wish to contribute to the formulation of standards, as a result, the membership from electrical utilities will increase.

The following are representative NF standards for distribution and customers' equipment.

(a) Standards for distribution line construction
- NFC11-201(1996): Standards for construction method (general rules)
- NFC13-200(1987): Standards for high-voltage equipment
- NFC14-100(1996): Standards for low-voltage lead-in equipment

(b) Standards for customers' equipment
- NFC15-100: Standards for new equipment of customers

4.5.3 Safety System

Ministry of Economy, Finance and Industry, Department of Energy Demand Market regulates electrical utilities, and "The Ministerial Ordinance, May 17, 2001" specifies practical regulations. For example, the ordinance specifies height of wires above ground and separation from wires and trees, and requires electrical utilities that own transmission and distribution systems to inspect separation between wires and trees. In addition, it requires them to maintain and submit inspection records to regulatory authorities, and to report public accidents involving equipment failures or electrifications to Industry Research Institutes, which are provincial agencies of Ministry of Economy, Finance and Industry.

In this manner, government and ministerial ordinances specify basic procedures for inspections and reports, and outline provisions for safety system, which, in Japan, is specified in The Electrical Utility Law.

4.5.4 Safety of Customers' Equipment

"The Government Ordinance, Dec. 14, 1972", which was decreed under The Building and Housing Law, provides for safety inspections of customers' equipment. It requires owners of new houses to have inspection agencies to examine them and submit inspection certificates issued by the agencies to distribution companies. Furthermore, it stipulates that distribution companies reserve authority to inspect customers' equipment in cases where equipment failures pose a risk to their distribution system.

4.5.5 Qualification System

Although there are no regulations regarding workers' qualification for employers who engage workers in electrical engineering works, there is a qualification system for electrical engineering technicians wherein NFC18-510 specifies conditions for the qualification. According to The Labor Law, employers issue certificates to workers who have the abilities specified in the law., Without this certificate, a person may not engage in electrical engineering works. Furthermore, The Labor Law requires electrical engineering technicians to carry a copy of NFC18-510 and comply with NF standards. Employers will be punished if they violate The Labor Law. This system was established for the safety of workers and the improvement and maintenance of equipment.

4.5.6 Other Relevant Regulations

Other laws, including The Labor Law and The Environmental Law, also regulate electricity transmission and distribution. As The Labor Law concerns all industries including electrical utilities, it does not stipulate specific details, but rather refers to NFC18-510 for electrical utility regulations and requires compliance with them.

Among a number of laws that provide for segmented specifications for environmental regulations, "The Designated Facilities Law for Environment Protection" is the most relevant for electrical utilities, aside from general laws concerning environmental assessment. This law authorizes administrative monitoring for the safety of electrical facility neighbors eand public health, and designates thermal power plant equipment as object facilities, requiring it to comply with existing laws and regulations including "The Pressure Vessel Law", "The Government Ordinance, Apr. 2, 1926" and " The Government Ordinance, Jan. 18, 1943".

4.5.7 Public Accidents and Outage Duration

Electrical utilities are required to report accidents to Industry Research Institutes, which are provincial agencies of Ministry of Economy, Finance and Industry. In addition, they are required to report accidents involving workers to Labor Supervision Offices as well. As for deaths due to electrification, per year there are less than 25 deaths from the public, less than 10 deaths among workers of EDF and 10 deaths among contract workers. The average outage duration was 64 minutes per year for each low-voltage distribution line, and the number of outages of more than 1 second and less than 3 minutes was 2 times per customer per year in 2005.

4.6 Safety System of Electrical Equipment in Australia

4.6.1 Electrical Utility System

The history of electricity use in Australia began in 1863 when 3 arc lights were erected in Melbourne to commemorate the British Crown Prince's marriage.

The first electrical utility was an electric light company established in Melbourne in 1880, which was followed by the successive establishment of electric light companies in other major cities including Sydney, and in the early 20th century, small and medium-scale private utilities were established in local cities to meet industrial electricity demands. At that time, state governments regulated safety, business activities and other responsibilities of electrical utilities. Throughout the two world war periods, electrical utilities were consolidated and transformed into public companies, and by the 1950s, State Electrical Power Authorities (SEPA), which owned and operated all generation facilities and transmission networks, and for some states, distribution, were established in 6 states, but not in the Northern Territory. For some time after that, SEPA monopolized the electrical utility industry of each state. However, as the federal government prioritized productivity improvement in energy policies during the 1990s, and as many of the SEPA organizations were loaded with huge debts, restructuring of the electrical utilities was initiated, and many SEPA organizations were divided into private companies, each of which specialized in either generation, transmission or distribution in their respective state.

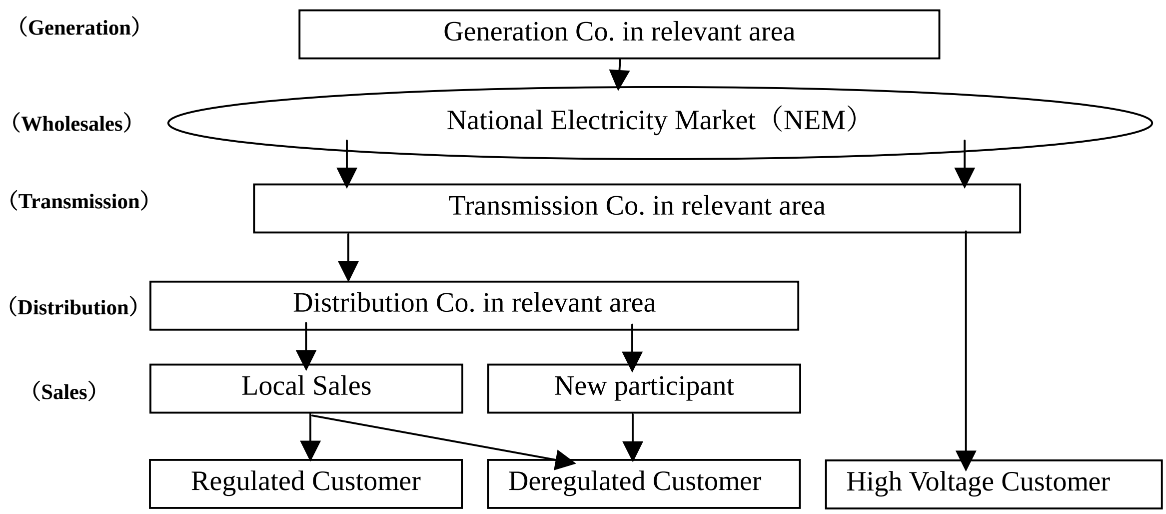


Figure 4.6.1 Overview of the National Electricity Market (NEM)

In terms of wholesaling, the National Electricity Market Management Company (NEMMCO) was established in May 1996 for management of electricity trades and power system security. In Dec. 1998, it began to operate the National Electricity Market (NEM) in Victoria and New South Wales. Later, other states, including Queensland, Australian Capital Territory (ACT), South Australia and Tasmania joined the NEM one after another. Restructuring of electrical utilities is expected to greatly benefit customers and improve Australia's international competitiveness through efficient use of its natural resources. Aside from state generation companies, there are also many private generation companies, while the transmission sector is divided to 6 regional companies.

Furthermore, each state deregulated its retail sector independently. In Jan. 2002, Victoria and New South Wales deregulated their entire retail sectors including households. Figure.4.6.1 shows an overview of the NEM.

4.6.2 Legal System for Technical Standards

In Australia, like other federal nations such as the US, regulations for electrical utilities are divided between federal and state levels. Although states had traditionally been responsible for all regulations except for debts, taxes and foreign ownership of state electrical utilities, many federal level regulations have been formulated since the establishment of the NEM. However, in principle, states are responsible for governing the distribution and retail sectors except for NEM and other interstate regulations, for which the federal government is responsible.

Although federal level laws and standards are established for the electrical power system operations of the NEM, they do not encompass electrical equipment safety. Electrical equipment safety laws and standards are the responsibility of state governments and their contents differ from state to state.

The legal systems of Victoria and New South Wales are as follows.

(1) Safety System in Victoria

Except that technical standards for electrical equipment in Victoria are segmented into smaller sets of regulations than in Japan, the state government of Victoria establishes technical standards in a similar manner to Japan.

(a) Legal System of Safety

Energy Safe Victoria (ESV) regulates the safety of electrical equipment of transmission and distribution companies, and "The Electricity Safety Act" enacted by Victoria's state parliament confers a legally binding force to certain technical standards for electrical equipment.

It stipulates, "The state government may establish regulations to prevent human hazards, property damages and other harms due to generation, transmission, distribution and retailing of electricity", and Article 162 of the law specifies "The Electricity Safety (Network Assets) Regulations" and "The Electricity Safety (Electric Line Clearance) Regulations" as state regulations for electrical equipment.

Table 4.6.1 Stipulations in The Electricity Safety Act

Article	Stipulation
Article 149: Supply safety	The state government may establish regulations to prevent human hazards, property damages and other harms due to generation, transmission, distribution and retailing of electricity.
Article 151: Electric line clearance	The state government may establish regulations for design, construction and maintenance of electric lines and regulations for enforcement of compliance to transmission and distribution companies.
Article 162A: Making of certain statutory rules	The state government shall publish new regulations as early as possible before they come into force. (Intended for "The Electricity Safety (Management) Regulation", "The Electricity Safety (Network Assets) Regulations" and "The Electricity Safety (Electric Line Clearance) Regulations", which were established on Dec. 14, 1999)
Article 152: Installation safety	The state government may establish regulations for installation, operation, repair and maintenance of electrical equipment.
Article 121: Enforcement officers	ESV may appoint enforcement officers for this law.
Article 122: Powers of entry compliance	Enforcement officers may enter any places to confirm compliance with this law and related regulations.
Article 83A: Bushfire Mitigation Plans	Transmission and distribution companies shall annually submit Bushfire Mitigation Plans to ESV.
Article 107: Electricity Safety Management Schemes	ESV may require electrical utilities to submit Electricity Safety Management Schemes for design, construction, operation and maintenance of their electrical equipment.

The Electricity Safety (Network Assets) Regulations and The Electricity Safety (Electric Line Clearance) Regulations are Victoria's equivalents to The Ordinance for The Technical Standard of Japan. The Electricity Safety Regulations contain many equipment standards including the heights of wires above ground, separations between wires and buildings, and earth connections, while The Electricity

Safety Regulations specify the separations between wires and trees.

In this manner, Victoria's legal system for technical standards is similar to the Japanese system in the era preceding deregulation.

(b) Safety System of Electrical Equipment

The Electricity Safety Act stipulates that ESV may appoint enforcement officers to confirm compliance with the Act and its related regulations. ESV reserves the authority to inspect electrical equipment prior to commencement of operation and authority to inspect it on-site in case of serious accidents. However, ESV rarely conducts these inspections prior to commencement, and instead, voluntary inspections are conducted. This law also stipulates that transmission and distribution companies shall annually submit Electricity Safety Management Schemes and Bushfire Mitigation Plans to ESV. These schemes and plans specify "Efficient operations of electrical equipment unconstrained by state's safety regulations", and demonstrate the concept of voluntary safety obligations which are imposed in the Australian system.

Serious accidents and failures are required to be reported to ESV and those involving distribution companies are publicly available.

However, in Victoria, there is no equivalent to the standard regarding Japan's Electrical Chief Engineers.

(c) Safety System of Customers' Equipment

The Electricity Safety Act confers a legally binding force to certain regulations for customers' equipment as with utilities' equipment. Article 152 of the law stipulates, "The state government may establish regulations for installation, operation, repair and maintenance of electrical equipment", and "The Electrical Safety (Installation) Regulations" is designated for this purpose.

This constitutes Victoria's equivalent to The Ordinance for The Technical Standards for Domestic Wiring of Japan. It contains a wide range of provisions including items specified in The Electrical Utility Law of Japan, such as registration of electrical engineering companies, licensing of electrical engineering technicians, technical standards for electrical equipment and inspections of engineering works. According to these regulations, registered electrical engineering companies inspect newly installed equipment of customer' and issue inspection certificates if the inspection results are satisfactory. After the certificates are received, distribution companies are able to commence supplying electricity to customers. They also conduct sample inspections of important customers.

Additionally, there is Victoria's equivalent to The Electrical Engineering Technicians of Japan, which is specified in The Electrical Safety (Installation) Regulations, requires persons who wish to engage in electrical engineering tasks to gain the relevant qualifications.

(2) Safety System in New South Wales

The state government of New South Wales does not establish any public technical standards for electrical equipment. Instead, privately established standards are used.

(a) Legal System of Safety

The Department of Energy, Utilities and Sustainability (DEUS) regulates transmission and distribution companies, and "The Electricity Supply Act of New South Wales" confers a legally binding force to "The Electricity Supply (Safety and Network Management) Regulations". Article 106 of the law stipulates, "The state government may establish necessary or supplementary regulations which fall under the jurisdiction of and do not conflict with this law."

The Electricity Supply (Safety and Network Management) Regulations focus on operation and management carried out by electrical utilities, and it only requires distribution companies to submit "The Network Management Plans" to DEUS. The Network Management Plans do not contain any detailed specifications and concentrate on issues of operation and management. However, DEUS requires distribution companies to refer to technical standards related to the companies' original equipment construction policies, for example, "ESAA NENS01-2001 National Electricity Network Safety Code" issued by The Electricity Supply Association of Australia (ESAA).

(b) Safety System of Electrical Equipment

The Electricity Supply Act of New South Wales stipulates, "DEUS may appoint inspectors to confirm compliance of electrical equipment with this law and related regulations", and also stipulates, "The inspectors may inspect any electrical equipment on-site at any time." Thus, DEUS reserves the authority to inspect electrical equipment prior to commencement of operation and authority to inspect the equipment on-site in case of serious accidents. However, as in Victoria, DEUS rarely conducts these inspections prior to commencement. Instead, random inspections are conducted.

The Electricity Supply (Safety and Network Management) Regulations require distribution companies to submit and observe the plans in the table below.

Table 4.6.3 Plans for Distribution Companies to be submitted to DEUS

Plan	Outline
Network Management Plans	Plans for transmission and distribution equipment management to ensure quality, reliability and safety of electricity
Customer Installation Safety Plans	Plans for customers' equipment management and inspections to ensure its safety
Public Electrical Safety Awareness Plans	Plans for installation of danger signs on transmission and distribution equipment to prevent public accidents
Bushfire Risk Management Plans	Plans for transmission and distribution equipment construction to prevent bushfires

As in Victoria, serious accidents and failures are required to be reported to DEUS and those involving distribution companies are publicly available.

There is no equivalent to Japan's standard regarding Electrical Chief Engineers in New South Wales, either.

(c) Safety System of Customers' Equipment

"The Electricity (Consumer Safety) Act of New South Wales" confers a legally binding force to "The Electricity (Consumer Safety) Regulations", and Article 55 of the law stipulates, "The state government may establish necessary or supplementary regulations which fall under the jurisdiction of and do not conflict with this law", and "The Electricity (Consumer Safety) Regulations" is designated as such.

Although The Electricity (Consumer Safety) Regulations do not contain any detailed specifications, Article 32 of the law stipulates, "Any electrical equipment that does not comply with 'AS/NZS3000:2000 Wiring Rule' (hereafter, AS3000) shall not be supplied electricity." AS3000 specifies minimum requirements for design, construction and inspection of domestic wiring, and constitutes the New South Wales equivalent to The Interpretations of The Technical Standard of Japan. The Electrical Safety (Installation) Regulations of Victoria also frequently refers to AS3000.

According to "The Electricity (Consumer Safety) Regulations", registered electrical engineering companies inspect newly installed equipment and issue inspection certificates if the inspection results are satisfactory. In terms of electrical engineering technicians, "The Home Building Act of New South Wales" stipulates, "Persons who wish to engage in electrical engineering tasks are required to be qualified as Electrical Engineering Technicians", as in "The Electrical Safety (Installation) Regulations of Victoria".

4.6.3 Australian Standards (AS)

The majority of Australian Standards for electrical equipment are based on IEC standards. While some are joint publications of The Electricity Supply Association of Australia (ESAA) and SAI. Australian Standards currently number 6,400, one third of which are conformed to IEC or ISO standards. In principle, state governments specify their requirements for electrical equipment according to these standards, and in some cases, SAI of Australia and the Standard Association of New Zealand (SANZ) jointly produce technical standards.

4.6.4 Public Accidents

(1) Victoria

According to ESV statistics, there were 22 deaths from the general public due to electrical equipment (excluding suicides) during the 10 years up to 2003, while there were no deaths during the 3 years up to 2003.

(2) New South Wales

According to DEUS statistics, the average number of deaths per year from the general public due to electrical equipment for the 7 years up to 2000 was 3, while the average number of public accidents (serious accidents) per year due to electrical equipment for the 4 years up to 2000 was 20.

4.6.5 Other Relevant Regulations

(1) The National Electricity Law

The National Electricity Law, Australia's equivalent to The Electrical Utility Law of Japan, confers legal status to national rules and regulations for the wholesale electricity market and electrical equipment, and stipulates that The Australian Energy Regulator (AER), which oversees the NEM, shall ensure compliance with laws and regulations and monitor management of electrical utilities.

(2) National Electricity Rules

The National Electricity Rules regulate electricity market operations across the country. Standards for voltage, frequency fluctuation, fault removal, and generator operation are specified in Chapter 5, while required accuracies of power-meters are specified in Chapter 7. NEMMCO, wholesale electricity market operator, is involved in specification of the wattmeter accuracies. As in Japan, power-meters for large-scale wholesalers (Type 7) require a higher level accuracy than power-meters for households (Type 1).

The National Electricity Regulations specify penalties for violations of The National Electricity Market Rules.

(3) Laws and Standards for Safety of Workers

In Victoria as well as New South Wales, The Work Cover Authority (separate government statutory organization for each state) establishes and regulates laws and standards for the safety of workers, and "The Code of Practice for Safe Electrical Work" regulates the safety of workers in all industries including electrical utilities.

(4) Environmental Regulations

The Environmental Protection Authority of each state regulates environmental concerns according to, respectively, "The Environmental Protection Act of Victoria" and "The Protection of the Environment Operations Act of New South Wales", along with other state environmental regulations. In terms of harmful substance emissions, "The Environment (Ambient Air Quality) Protection Policy of Victoria" regulates SO_X, NO_X and CO_2, while "The Protection of the Environment Operations (Clean Air) Regulation" regulates SO_X and NO_X.

4.7 Safety System of Thermal Power Generation Equipment

Among thermal power generation equipment, boilers and pressure vessels are critical for safety maintenance, as vapor or gas leaks from such equipment, due to equipment damage, may lead to serious accidents such as explosions.

Efforts to improve quality and ensure safety of boilers and pressure vessels started during the Industrial Revolution in the 18th century when many boilers exploded. Then, the boiler explosion on Sultana, a steamboat, on the Mississippi River in 1865, which caused 12,000 deaths, prompted the formation of insurance companies, thus creating a basic quality control system led by equipment owners, manufacturers and insurance companies before any state level regulations were imposed.

Another boiler explosion at a shoe factory in Brockton, Massachusetts in 1905, which claimed 58 deaths and 117 injuries, urged the American Society of Mechanical Engineers to formulate AMSE standards for boilers in 1915. Around that time, other industrial countries also established legally binding standards for prevention of boiler and pressure vessel accidents, and formulated safety systems where design and manufacturing of boilers and pressure vessels were strictly examined. Although current technical standards for boilers and pressure vessels in the US and Europe are largely at the same level of detail as Japan's standards, several specifications including inspection procedures are different. While Japan's electrical utilities voluntarily conduct their own periodical inspections under the jurisdiction of the Ministry of Economy, Trade and Industry according to The Electrical Utility Law, insurance companies and other private inspection agencies conduct the inspections on behalf of electrical utilities in the US and Europe.

Table 4.7.1 Regulations and Standards for Boilers

	Regulation	Design Code	Regulatory Agency
US	・Regulations by each state	Boiler and Pressure Vessel Code of ASME (Private Standard)	Regulatory agencies of each state
U.K.	・PED ・The Pressure Systems Safety Regulations	BS1113, BS2790 (national standards)	The Department of Trade and Industry
Germany	・PED ・The Equipment Safety Law (GCG)	TRD (national standards)	Bundesministerium fur Wirtschaft und Arbeit
France	・PED	NF E32-100 (national standard), COVAP (private standard)	Ministere de I'economie, des finance et I'industrie
Australia	・Regulations by each state	National Standard for Plant NOHSE1010 (national standard), AS1200 (private standard) and others (varying in different states)	Regulatory agencies of each state

4.7.1 Safety System for Boilers and Pressure Vessels in US

In the US there are private authoritative standards for boilers and pressure vessels, which are shown in Table 4.7.2. Although these standards do not possess any legal status, many state laws refer to them as applicable standards for construction, operation, installation, repair and inspection of boilers and pressure vessels.

Table 4.7.2 Private Standards for Boilers and Pressure Vessels in the US

Standard	Issuer	Contents
Boiler and Pressure Vessel Code of ASME	American Society of Mechanical engineers (AMSE), Boiler and Pressure Vessel Commission	Safety standards for design, manufacturing, installation and initial inspection of boilers and pressure vessels
Inspection Code of NBI	National Boiler Institution (NBI)	Standards for inspection of boilers and pressure vessels in service

Private insurance companies contribute significantly to the safety of boilers and pressure vessels. This is because, as mentioned earlier, frequent boiler explosions prompted the establishment of a privately initiated safety system before state level regulations were imposed. Additionally, special inspectors from insurance companies inspect the boilers that are covered by their insurance policies.

4.7.2 Safety System for Boilers and Pressure Vessels in Europe

The Pressure Equipment Directive 97/23/EC (PED) has been enforced since 2002 in Europe (EU member countries) as a design standard for boilers and pressure vessels, and EN standards (set by Comite Europeen de Normalisation (CEN), a private organization) established EN13445 (water-pipe boiler) and EN12953 (shell boiler) as new standards which conform to PED. EU member countries are required to abolish their own national standards and adopt EN standards. Each EU member country has adopted a certain part of EN standards for boilers, so that its own national standards and EN standards coexist in each country.

While PED is a boiler design standard, there is no EU standard for boiler inspection as historical backgrounds differ from one country to another.

(1) U.K.

Generally, safety regulations for electrical utilities in the U.K. only outline their purposes. They do not describe practical requirements, instead voluntary safety systems constitute a large part of safety regulations. Thus, laws and regulations do not provide many specifications for inspections of electrical equipment. However, there are some provisions for boilers and pressure vessels of generation plants because of their importance. There are inspections for new boilers prior to commencement of commercial operation and periodical inspections for all boilers in service. Inspections are conducted according to "The Regulations for Pressure Systems and Mobile Gas Pressure Vessels of 1989". However, it does not require inspections to be conducted by national authorities. Instead, engineers from relevant insurance companies conduct the inspections. Laws (The Mechanical Equipment Insurance Law and The Occupational Injury Insurance Law) require owners of generation plants to take out insurance policies for their plant equipment, and the insurance companies conduct annual inspections for boilers and working environments.

In the U.K., private insurance companies contribute significantly to the safety of boilers and pressure vessels in accordance with relevant laws including The Mechanical Equipment Insurance Law. The importance of insurance companies in the U.K. is similar to the US.

(2) Germany

TRD stipulates procedures for boiler inspections, and DIN (Deutsche Industrie Normenausschuss) and EN specify inspection methods and contents. Manufacturers inspect boilers that they have produced. Then, on behalf of electrical utilities, inspection agencies confirm that those boilers comply with their specification documents and are equipped with adequate safety devices. The inspectors themselves are required to be qualified by the Ministry of Economy and Labor.

At the center of the safety system in Germany is Technischer Uberwachungs Verein (TUV), to which the federal and state governments, and other public organizations entrust equipment inspections. As a prominent agency, its activities span many countries and are not confined to Germany. Although a private and neutral inspection agency, it conducts equipment tests, inspections and certifications according to the relevant laws and regulations. In terms of certifications, it provides certificates both for

private and voluntary inspections, as well as mandatory inspections.
The German system is unique in that most inspections, including mandatory inspections, are entrusted to private agencies.

(3) France

In France, along with NF E32-100, a national standard, and COVAP, private standards set by Syndicat National Chaudronnerie Terie Tuyauterie industrielle (SNCT) which conform to EN standards set by PED, provide boiler specifications.

Voluntary inspections prior to commencement of commercial operation as well as periodical inspections are required to be conducted by qualified inspection agencies according to "The Pressure Vessel Law". Ministry of Industry qualifies the inspection agencies according to its ministerial ordinances.

(4) Australia

As in the US, regulatory authorities in each state regulate boilers and pressure vessels according to their own state laws. Boiler standards differ from one state to another, and national standards as well as AS, also apply.

5 Technical Points on Power System Interconnection between Nations

5.1 Technical Standards for Power System in Japan

In Japan, establishing power system operation rules - apart from, for example, maintaining adequate frequency - and designating supervisory agencies are conducted when necessary. .

The electric power system council of Japan (ESCJ) was established to assist with matters such as power system establishment, access to power system and power system operation based on the 93rd clause of amended Electric Power Industry Act in 2003. Electric power utilities had been in charge of transmission and distribution affairs, however, since the electricity act was amended, ESCJ has been in charge of some areas, such as establishing rules and supervision. Under the condition that power system stability is secure, ESCJ was established as a neutral agency to secure the fairness and the transparency concerning connection to the power system by electric power companies and new entries such as PPS.

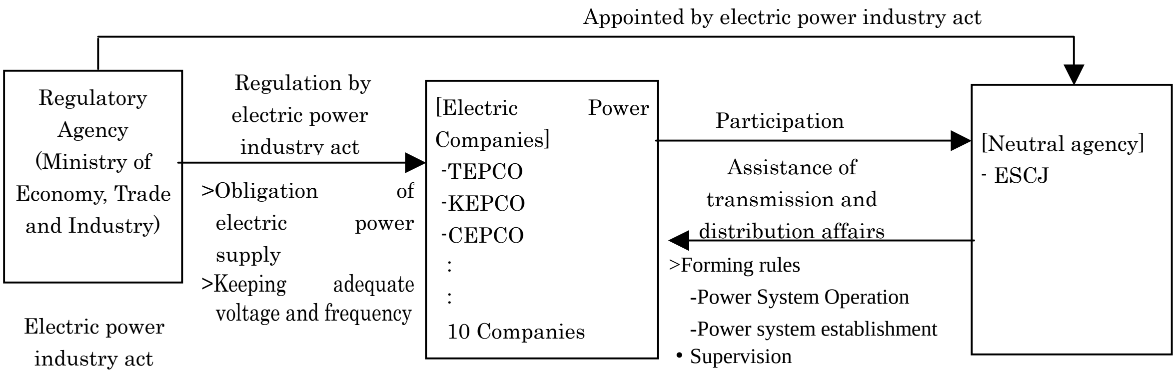


Figure 5.1.1 Scheme of Power System Regulation and Stable Operation in Japan

The common national rules of power system operation were established by ESCJ in Japan. In addition, every electric power utility is supervised by ESCJ whether it complies with these rules or not. Additionally, each electric power company has its own original rules based on the rules established by ESCJ.

5.2 Rules for Power System Interconnection in Europe

5.2.1 Outline of Power System Interconnection in Europe

In Europe, neighboring countries' grids are interconnected by several transmission lines. So the power system on the European Continent has the characteristic of a mesh structure.

One of the most prominent grids in Europe is the UCTE grid. Almost all European grids belong to this UCTE. UCTE represents the "Union for the Coordination of Transmission of Electricity", a grid operator in Europe which is responsible for coordination with the other 34 grid operators in 23 countries in Europe to secure overall reliability of the interconnected power system. UCTE was founded in 1951. It was originally UCPTE（Union for the Coordination of Transport and Production of Electricity）and included generation companies, however generation companies were separated and now, finally, UCTE, consisting of grid a operation division only, was established in 1999. Historically, only western countries joined the UCTE, however, after the cold war, eastern countries joined, therefore the power system interconnection between the western grid and the eastern grid became increasingly was developed. However, UCTE is a grid operator organization, and participating grids have AC synchronous interconnection. That is why the UK and countries in northern Europe whose grids are interconnected by DC system do not join UCTE

At the present time, integration of the UCTE grid and further eastern grids such as the Russian and Ukrainian grids are under consideration to form a huge synchronous interconnected system in the future.

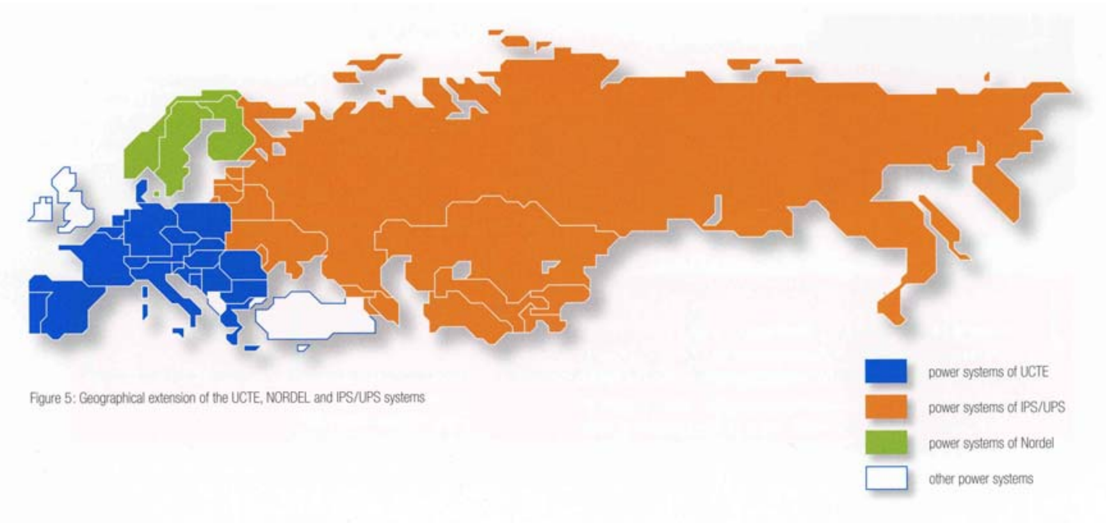


Figure 5.2.1 UCTE Power System and Neighboring Power System

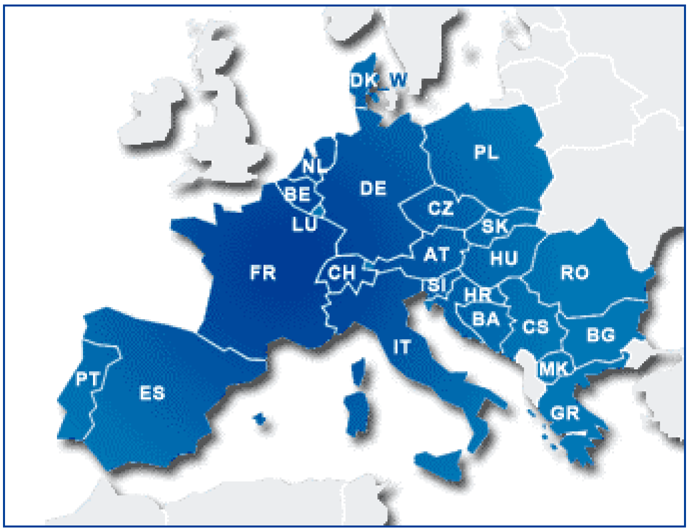


Figure 5.2.2 UCTE Member Countries

Table 5.2.1 UCTE Member Countries Grid Operators

	Country Name	Grid Operator		Country Name	Grid Operator
1	Austria (AT)	TIRAG, VERBUND-APG, VKW-UN	13	Bosnia and Herzegovina (BA)	JPCC
2	Belgium (BE)	Elia	14	Serbia and Montenegro (CS)	EPCG, EPS
3	France (FR)	RTE	15	Macedonia (MK)	ESM
4	German (DE)	EnVW, E-On, RWE, Vattenfall	16	Greece (GR)	DESMIE
5	Italy (IT)	GRTN	17	Poland (PL)	PSE
6	Luxembourg (LU)	CEGEDEL	18	Hungary (HU)	MAVIR
7	Holland (ND)	TenneT	19	Czech (CZ)	CEPS
8	Portugal (PT)	REN	20	Slovakia (SK)	SEPS
9	Spain (ES)	REE	21	Rumania (RO)	Transelectrica
10	Swizerland (CH)	ATEL, BKW-UTN, EGL, EOS, ETRAS, NOK	22	Bulgaria (BG)	NEK
11	Croatia (HR)	HEP	23	Denmark (DK) (Associate Member)	ELTRA
12	Slovenia (SK)	ELES			

5.2.2 Framework of Stable Power System Operation in Europe

The transmission network was required to separate from the main body by "EU Electric Power Instruction" in 2003, which eventually lead to the establishment of an independent transmission company. In each country, a regulation usually exists to impose responsibility on the transmission company to maintain power supply reliability.

With regard to the securing reliability for an interconnected power system over a wide area, the responsibility is attached to UCTE, which is a private organization among grid operators. UCTE establishes reliability standards (power operation rules), and the grid operator in each country must comply with this standard and also establish original standards based on that of UCTE.

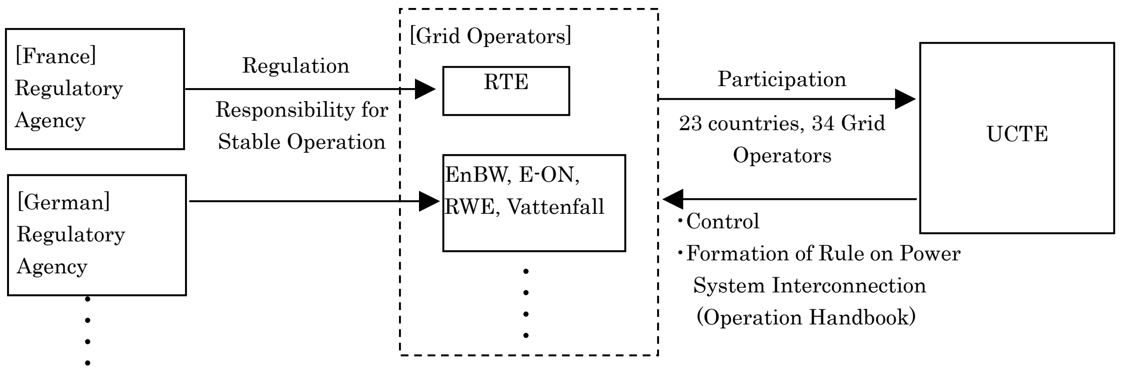


Figure 5.2.3 Framework of Power System Regulation and Stable Operation in Europe

5.2.3 Reliability Standards for Power System Interconnection in Europe (UCTE Operation Handbook)

UTCE established the "Operation Handbook" as the reliability standards (grid operation rules) for the interconnected power system in Europe. In 2002, the need for comprehensive and consistent technical standards was discussed at the Firenze forum for the purpose of ensuring a stable and highly reliable grid operation. From that point, UCTE started developing the "Operation Handbook" to regulate all transmission companies with reliable standards as a counter-measure against the risk of large blackouts, such as were seen in Italy and London in 2003, which could affect the stable operation of power system interconnection. Following a long process of development, the "Operation Handbook" was came into force on July 1st, 2005.

This handbook does not have the same legal background as that of the "EU Electric Power Instruction" because UCTE is a private organization of many grid operators. However, the handbook aims to secure the reliability of power system interconnection among nations. The handbook does have legal force conferred upon by virtue of the fact that MLA (Multilateral Agreement) has been passed among the grid operators. In terms of penalties, the handbook stipulates that if one grid operator causes damage to the equipment of neighboring grid operators, they shall pay the penalty up to a ceiling of 5 million euro.

The Operation Handbook contains the governing rules of UTCE power system interconnection. On the other hand, each country's grid operator has its own grid code for domestic power system, based on the domestic law. However, each grid code complies with the Operation Handbook.

The Operation Handbook does not include power system establishment rules but rather operation rules. The power system establishment rules are supposed to be described in each country's grid code.

Indeed, there are no technical standards regarding the establishment of international power system interconnection, so interconnection is installed according to the agreement of the nations involved.

The UCTE Operation Handbook stipulates the following main points regarding the UCTE power system interconnection for each grid operator.

(a) Normal State

- Maintain voltage (within the range of 380 to 420kV in case of 380/400kV system)
- Spinning reserve saving in preparation for failure
- Complying with N-1* criterion taking periodical repair into consideration (Both in planning and operation)

  *N-1 refers to the criterion where there is no serious supply interruption even if equipment of one section is out of service, such as failure of one transmission line.
- System stability check by simulation
  - Data exchange between grid operators through the SCADA system

(b) Emergency Stage

- Recovery procedure agreement between neighboring grid operators in case of failure
- Confirming system condition method agreement between neighboring grid operators in case of failure

6 The Safety System in China

6.1 Electric Power Industry Structure

Historically, China's electric power industry was regulated and operated by the respective governmental administrative bodies, namely the Ministry of Water Resources and Electric Power, the Ministry of Energy, and the Ministry of Electric Power (MEP).

In January 1997, in order to encourage business management autonomy and to introduce competition to the power industry, separation of administrative and business management functions of the MEP was carried out, resulting in the establishment of the State Power Corporation of China (SPCC) to take up the business management responsibilities from the MEP. In March of the following year, the MEP was dissolved and the administrative control of the power industry was transferred to the National Development Planning Commission and the National Economy and Trade Commission.

In December 2002, the power industry was further restructured and the generating assets owned by the SPCC were reorganized to form 5 generating companies, namely China Huaneng Group Corporation, China Datang Group Corporation, China Huadian Group Corporation, China Guodian Group Corporation and China Power Investment Group Corporation. The National Development and Reform Commission is responsible for policy making, while the State Electricity Regulatory Commission is in charge of policy implementation.

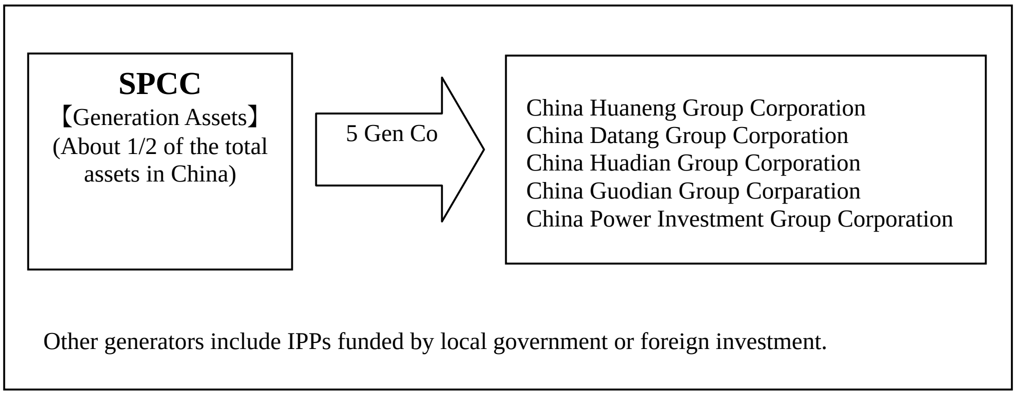


Fig. 6.1.1 Generation Sector Structure

Furthermore, the transmission assets owned by the SPCC were divided into two groups, thus leading to the foundation of China Southern Power Grid Co. LTD. (CSPG) in the south and State Grid Corporation of China (SGCC) in all other areas of China. Both companies engage in the power system operation, electric power transmission, transformation and distribution.

In addition, to facilitate such auxiliary services as design, construction and consulting, China Electric Power Engineering Consulting Group Corporation, China Hydro Engineering Consulting Group Corporation, China Hydro Power Construction Group Corporation and China Gezhouba Group Corporation were established.

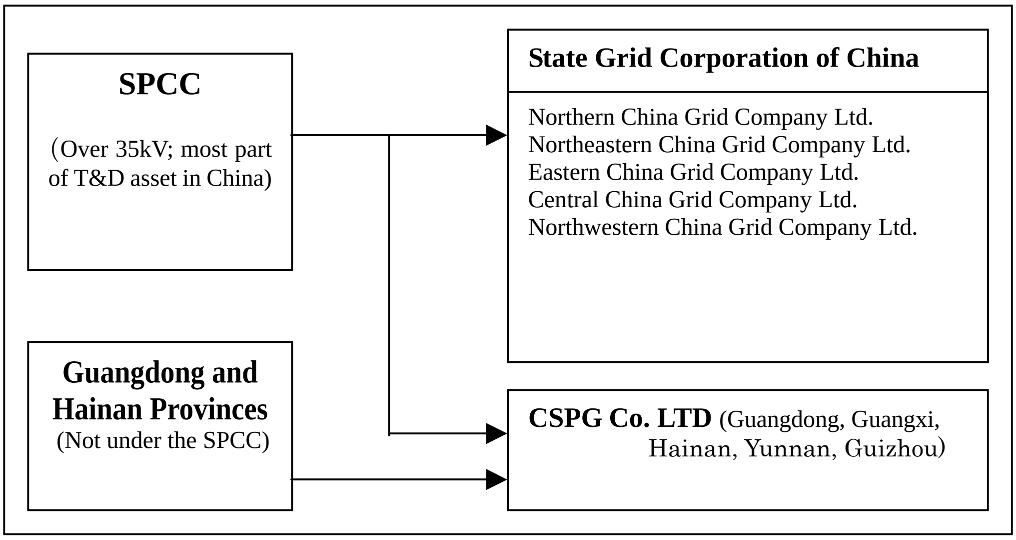


Fig. 6.1.2 Transmission & Distribution Sector Structure

6.2 The System for Technical Standards in the Power Industry

China's technical standards can be classified into three separate categories: national standards, industry standards and company standards. National standards and industry standards can be further divided into mandatory, legally binding standards and optional standards. For the technical practices that are regularly performed and or machineries and materials that are extensively used in more than one industry, a national standard or code is generally established. On the other hand, for the technical practices or machineries and materials oriented mainly to a certain industry, an industry standard or code is instituted. Since the electric power companies in China are basically state-owned, the industry standard or code is accordingly developed by governmental agencies rather than the private sector.

Power companies may establish their own technical standards based on the national or industry standards, as appropriate. In such cases, it is recommended, by the Standardization Act of the People's Republic of China, that the company standard must be as strict as or stricter than the corresponding national or industry standard.

(1) Electricity Act of People's Republic of China

In China, business operations in the power industry must be conducted in accordance with the Electricity Act of the People's Republic of China (hereinafter referred to as the Electricity Act), which stipulates the basic policies, guidelines and principles with regard to all aspects of the power industry, namely construction, power generation, transmission and distribution, retail and use, protection of electric equipment and supervisory management over power companies and consumers. Although concrete matters such as business licensing, safety regulations, rules and inspections are not specified in the Electricity Act, it is still considered the main law governing electrical safety, as sections 19 and 24 set out the basic policy and principles for electric safety. The State Electricity Regulatory Commission (SERC) is responsible for the regulation of the Electricity Act.

Section 19 Power companies shall adhere to the policy of "Put Safety First, Put Emphasis on Precaution", and establish a sound and responsible system for working safely. Additionally, power companies shall inspect and maintain their power facilities periodically to ensure a failure-free operation.

Section 24 Electricity shall be supplied and consumed under the principle of "Safety, Economy and Planning".

(2) Work Safety Act of the People's Republic of China

The Work Safety Act of the People's Republic of China (hereinafter referred to as the Work Safety Act) is a comprehensive law that prescribes safety provisions for the working environments and activities in all kinds of industries, including the power industry, in China. It is relevant not only to worker's safety, but also public safety. The State Work Safety Regulatory Administration is responsible for regulating the Work Safety Act.

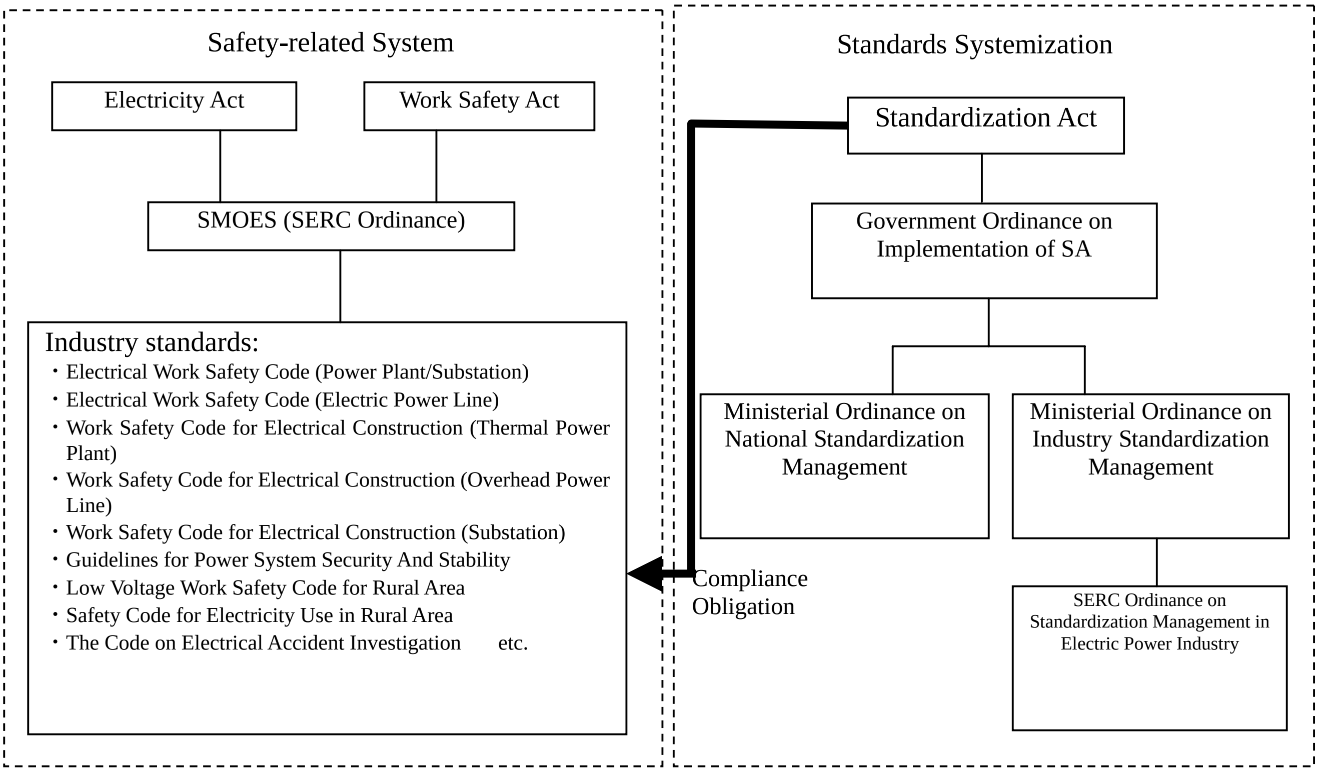


Fig.6.2.1 The Legal System for Electrical Safety

(3) Supervisory Management Ordinance for Electrical Safety (Ministerial Ordinance)

The Supervisory Management Ordinance on Electrical Safety (SMOES) is a ministerial ordinance established under the Electricity Act and the Work Safety Act. According to the ordinance, power companies are obliged to establish their own comprehensive safety management and supervision systems, and to strictly comply with laws, regulations, national and industry standards or codes relevant to electrical safety.

(4) Standardization Act of the People's Republic of China

The Standardization Act of the People's Republic of China (hereinafter referred to as the Standardization Act) stipulates the rules related to the drawing up and revision of electrical standards and codes in China. Section 7 of the Act states, "National and industry standards or codes may be classified as mandatory or optional. Except those related to human health, human and material safety, or otherwise specified by law or administrative ordinance as mandatory, all standards or codes are optional." Accordingly, the technical standards or codes related to electrical safety are mandatory.

(5) Safety Inspection Regulation for Special Equipment (government ordinance)

This is a national government ordinance concerning the safety inspection of special equipment, among which power plant boilers are included.

(6) Ordinance Concerning Electricity Consumption Management (Ministerial Ordinance)

This is an MEP ordinance concerning the safety inspection of consumer's electrical installations. Although power companies in China are not obligated to inspect consumer's electrical installations, they must comply with this ordinance in the event of an inspection. In addition, the inspector is required to satisfy the Electricity Consumption Inspection Competency with regards to the same ordinance.

(7) Conformation to International Standards

China started adopting international standards in the 1980s. Based on the notion that "the active adoption of international standards plays an important role in the promotion of technical advances", the Chinese government demanded, in 1984, that domestic companies be positive in adopting the international standards, especially the mainstream overseas standards, in their production activities. Additionally, the Standardization Act specifies that the central government recommend the adoption of international standards. Still, the Ordinance On the Standardization Management in Power Industry prescribes that international standards and the mainstream overseas standards should be promptly collected and examined in the process of drawing up a new standard, and be adopted in consideration of the actual conditions in China. In this way, China demonstrates a clear intention to adopt international standards in its national or industry standards.

6.3 Safety Management System

(1) Formulation of Safety Rules

Power companies are required to formulate their own internal work safety rules, under the Work Safety Act and the Supervisory Management Ordinance for Electrical Safety. In response to this requirement, for instance, China Southern Power Grid Co., LTD. has set up Work Safety Rules, Work Safety Supervision Rules and Work Safety Reward and Punishment Rules for internal implementation.

(2) Periodic Inspection

As far as the periodic inspection of electrical facilities is concerned, the inspection periods, inspection items and shutdown days for inspection are specified in the Maintenance And Inspection Code, a legally binding industry code in China.

(3) Pre-Operation Inspection

The generating facilities, transmission and distribution installations are required to be inspected before commencing operation.

(4) Investigation and Report of An Accident

Under the Work Safety Act, power companies are required to take rapid steps to prevent hazard expansion, and do their best to minimize human and material losses in case of an accident. Additionally, power companies are also obliged to report the occurrence of accidents promptly to the local authority in charge of the work safety supervision.

The regulations pertaining to reporting and investigation of an electrical accident are specified in the Supervisory Management Ordinance for Electrical Safety.

(5) Competency And Licensing Under the Electrical Safety Working Code (legally binding industry standard), power company workers are required to take exams on the code once a year. If a person fails the exam, he or she will not be allowed to carry out any electrical work.

Under the License Management Ordinance Concerning the Installation, Maintenance, and Testing of Electrical Facilities (SERC ordinance), construction contractors are required by power companies to acquire a license from the SERC.

6.4 Safety Management for Consumer Installations

Under the Electrical Power Supply Operation Regulation, which came into force in Oct.1996, electric power consumers must satisfy the following obligations:

- In the event of a new installation or expansion of customer equipment, the design , construction and inspection shall be conducted under the relevant national/industry standards or regulations and rules laid down by the regulatory body.
- Customers shall inspect and maintain their electrical facilities periodically and try to prevent the occurrence of accidents and malfunctions of equipment. When it is likely that electric equipment may threaten human life or cause damage to power system operation, the relevant customer shall get it repaired or fixed immediately.
- When an accident occurs and causes human death, fire disaster or an impact to the power system, the consumer shall report this to the relevant power company immediately. Meanwhile, the consumer shall submit an investigation report on the accident within seven days of the incident, while the power company shall send an investigator to the scene to assist the accident investigation.

In addition, an electrician who is appointed to work on consumer installations is required to obtain an operating license, under the Regulations on The Operating License for Electricians issued by the SERC.

6.5 Other Relative Laws

Other laws relative to the electricity industry include the Labor Act, the Environmental Conservation Act, and the Measurement Act, etc.

6.6 Characteristics of China's Electrical Safety Management System

The technical standards and relevant statutes in China have the following characteristics:

1) Since power companies are basically state-run, the technical standards, including industry standards, are formulated by government agencies.
2) Under the Standardization Act, the safety-related standards and those specified by law or administrative ordinance as mandatory are all legally-binding standards. Accordingly, compliance with the electrical safety-related standards is a legal obligation.
3) There are different technical standards for urban and rural areas. The Low Voltage Work Safety Code for Rural Areas and the Safety Code for Electricity Use in Rural Area have been established especially for rural areas.
4) The specifications in the Standardization Act and the SERC Ordinance on Standardization Management in Electric Power Industry demonstrate a clear intention by the Chinese government to adopt international standards in its national or industry standards.
5) Similar to the system in Japan, consumers have an obligation to ensure electrical safety for their own installations. In addition, a working competency, equivalent to the Electrical Technician requirements in Japan, is mandatory for those engaging in electrical engineering works in China.

7 The Safety Management Systems in Southeast and Southwest Asia

7.1 Southeast Asia

7.1.1 The Republic of Indonesia

(1) General Description

(a) Constitution: republic institutions
(b) Capital: Jakarta
(c) Population: approx. 217 million people
(d) Area: approx. 1.89 million km^2
(e) Per-capita GDP: approx. 1,165 US$
(f) Installed generating capacity: approx. 21,433 MW
(g) Electric energy sales: approx. 90,441GWh
(h) Electrification rate: approx. 53%

(2) Electric Power Industry Structure

In Indonesia, PT PLN manages the electric power industry, mainly under the supervision of the MEMR. However, the rural area electrification organization is responsible for electrification of rural areas that are remote and difficult for the PLN power system to supply. .

The electric power industry in Indonesia is roughly divided into two categories, the Java-Bali area where the power system is highly organized with a high rate electrification, and the other areas where the power system is not developed and consists of a small system and isolated power sources. In the Java-Bali area, a 'single buyer system' was introduced to the generation sector, as a first step towards establishing a competitive electricity market. More specifically, Indonesia Power (PJB I) and Java-Bali GENCO (PJB II), which separated from PLN, and IPPs supply electricity to the Java-Bali electricity market. However, in other areas, REC, owned by PLN, was established and manages the electric sector. PLN has a monopoly on the transmission and distribution sectors, whereas the respective shares held by the rural area electrification organization and IPPs are small.

The only electric power laws to be enacted are No.15 enforced in 1985 and government ordinance No.10 which was enforced in 1989. However, restructuring and introduction of a competitive electric power market lead to a new act, No.20, concerning electric power, being enforced in September, 2002. It is expected that complete deregulation of the retail sector and establishment of electric power transactions would proceed under this new act. However, this act was abandoned because the bill was found to be unconstitutional in the Supreme Court in December of 2004. Following this, government ordinance No.3 was enforced in 2005. However, this is temporary until a new law replacing No.20 (Electricity Act) is enacted. The main amendments are shown below:

- ✓ Power supply division, transmission and distribution departments, are to be managed by authorized agency on electric power industry (PKUK), which is a national organization as determined by the government ordinance.
- ✓ The single buyer system in which generated power is sold to the PKUK under a competitive bidding system and customers purchase electricity exclusively from the PKUK, is adopted

(3) Safety Management System

In Indonesia, there are technical standards such as the distance required between lines and objects by SNI. Ministerial ordinance No.47, enacted in 1992, confers legal status on this technical standard. Whereas, equipment specifications and inspection procedures for generation, transmission and distribution are described in SNI, a number of which are based on IEC.

There are six inspection agencies: PT SUCPFINDO (PESERO), PT PLN (PERSERO) UNIT BISNIS JASA SERTIFIKASI, PT DEPRIWANGGA, PT INDOSPEC ASIA, PT KONBEBA (PERSERO), PT FINDO DAYA INSPEKSI, to confirm whether electric power utilities secure equipment and public safety. One of the clearly stipulated activities is the inspection which must be conducted before new power plants commence operation. The number of these agencies is expected to be increased to 12 to further facilitate the carrying out of these enforcement functions.

7.1.2 The Kingdom of Cambodia

(1) General Description

(a) Constitution: limited monarchy
(b) Capital: Phnum Penh
(c) Population: approx. 13.5 million people
(d) Area: approx. 181 thousand km^2
(e) Per-capita GNP: approx. 291 US$
(f) Installed generating capacity: approx. 188 MW
(g) Electric energy sales: approx. 478 GWh
(h) Electrification rate: approx. 15%

(2) Electric Power Industry Structure

In Cambodia, the Ministry of Industry, Mines and Energy (MIME) is in charge of policy making for electricity industry administration, while the Electricity Authority of Cambodia (EAC), created under the Electricity Law promulgated in 2001, is responsible for regulation and supervision of and issuance of licenses to power companies. The Electricite du Cambodge (EDC), a government-run company, operates electricity generation, transmission and distribution businesses. Independent power producers have also entered the generating market. In addition, a lot of other power companies, such as DIME, a subordinate agency of the MIME, and small-scale companies, also engage in electricity supply in local areas through grids other than EDC's grid. In accordance with the Electricity Law, the EDC and all other power companies are required to acquire a license from the EAC. By the end of December 2005, 98 companies had acquired a consolidated license that entitles them to operate a business consisting of generation, transmission and distribution, while 10 companies have acquired a generation license and 8 companies have acquired a distribution license.

(3) Safety Management System

In Cambodia, the Electricity Act was established as the regulatory law for the electric power industry. According to the stipulation in section 5, the EAC is responsible for supervising power company compliance with all the operational, safety, and environmental technical standards promulgated by the MIME. Please refer to chapter 8 for further details.

7.1.3 The Republic of Singapore

(1) General Description

(a) Constitution: limited monarchy
(b) Capital: -
(c) Population: approx. 4.24 million people
(d) Area: 699 km^2
(e) Per-capita GDP: approx. 25,191 US$
(f) Installed generating capacity: approx. 8,725 MW
(g) Electric energy sales: approx. 31,986 GWh
(h) Electrification rate: 100%

(2) Electric Power Industry Structure

In Singapore, the Singapore Power Company, the largest holding company in electric power and gas industries, was set up in 1995, under which Power Senoko and Power Seraya engage in power generation, Power Grid operates the transmission and distribution systems, and Power Supply operates retail sales business. Through a process of structural reform in the power sector, Power Senoko and Power Seraya broke away from their parent company and were incorporated to create Tuas Power as a new face in the power generation market. As of December 2005, there were seven companies licensed as power producers. Apart from this, Power Grid was authorized as the sole licensee in the power delivery field. Also, six companies were authorized as retail sales licensees.

The Energy Market Authority affiliated with the Ministry of Trade and Industry is stipulated to be the regulatory body for the power industry.

(3) Safety Management System

In Singapore, the Electricity Act stipulates that all electricity licensees shall comply with the codes of practice and other standards of performance issued or approved by the Energy Market Authority (EMA) and directions given by EMA.

The Transmission Code sets out the technical requirements to be met by those who are connected to the transmission system, from the point of view of maintaining the stability, security and reliability of the power system. It not only sets forth the technical standards and requirements for transmission installations, but also lists those for generating facilities and distribution installations.

Also, the Transmission Code sets out the inspection and maintenance requirements for the electricity licensees. All electricity licensees, including the transmission licensees, generation licensees and retail licensees, are required to inspect, test, monitor and maintain their own electrical facilities and installations in order to determine whether such facilities and installations comply with all applicable technical standards and requirements.

In addition, the Electricity Act stipulates that only licensed electrical workers can carry out electrical installation, maintenance and repair work.

In Singapore, technical standards are normally reviewed by a technical committee initiated by the Institution of Engineers Singapore (IES) or Professional Engineers Board of Singapore (PEB). As can be seen in the Transmission Code, IEC and BS standards are adopted extensively for electrical facilities and installations.

7.1.4 The Kingdom of Thailand

(1) General Description

(a) Constitution: limited monarchy
(b) Capital: Bangkok
(c) Population: approx. 61.97 million people
(d) Area: approx. 515 thousand km^2
(e) Per-capita GDP: approx. 2,236 US$
(f) Installed generating capacity: approx. 24,805MW
(g) Electric energy sales: approx. 105,960 GWh
(h) Electrification rate: approx. 84%

(2) Electric Power Industry Structure

In Thailand, the Ministry of Energy supervises the operation of the Electricity Generating Authority of Thailand (EGAT), the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA). EGAT engages in power generation and transmission, and the MEA and PEA engage in power distribution in the Metropolitan areas and all other areas respectively. Apart from the EGAT, independent power producers (IPPs) and small power producers (SPPs) under a capacity of 90 MW also participate in the generation market. The Electricity Generating Public Company Limited (EGCO), a wholly owned subsidiary of the EGAT, and the Ratchaburi Electricity Generating Holding Company Limited (RH) are major players in the IPP market.

(3) Safety Management System

Thailand is in the process of enacting an Electricity Industry Act, which aims, among a number of objectives, to promote secure and safe provision of electric power. At present, the draft act has been prepared and is under final review.

In Thailand, a set of national standards for electricity industry does not exist, however, the standards of EGAT can be viewed as such. The reason is that the EGAT owns the power system all over Thailand, and all generators are connected to the EGAT system, therefore the lack of a set of national standards is no great cause for concern. To be more specific, EGAT standards are based on such international standards/codes as IEC, ANSI, and JIS, of which ANSI is adopted for transmission voltage levels. The equivalent to IEC or JIS in Thailand is Thailand Industry Standard (TIS).

In case of emergency or other necessity, a licensee is authorized to enter the land or the premises of any person at any time for inspection or repair of the power network system. If the owner or occupying person is present at the site, they are notified prior to such entrance.

7.1.5 The Republic of the Philippines

(1) General Description

(a) Constitution: constitutional republic
(b) Capital: Manila
(c) Population: approx. 81.5 million people
(d) Area: approx. 2.994 million km^2
(e) Per-capita GDP: approx. 1,050 US$
(f) Installed generating capacity: approx. 15,123 MW
(g) Electric energy sales: approx. 42,642 GWh
(h) Electrification rate: approx. 90%

(2) Electric Power Industry Structure

In the Philippines, the generation sector is deregulated and IPPs started generating power in 1993. It was the first among Asian countries to allow establishment of IPPs. The rest of the electric power sector has been unbundling since the Implementing Rules and Regulations and the quasi-rule were enacted in June of 2001.

Generally speaking, deregulation involves the privatization of NPC and its generation and transmission and substations. The generation sector is divided into seven groups. Six of them, Luzon-Calaca, Luzon-Masinloc, Luzon-Angat, Luzon-Magat, geothermal power stations and the others, are planned to be privatized one by one. At present 20% of them are owned by IPPs so a competitive market already exists. The electric power transaction department adopted the "Wholesale Electricity Spot Market" (WESM) where up to 10% of the electricity supply may be traded, while the remainder is purchased through bilateral contracts for the time being to prevent large fluctuations in the electricity tariff. The percentage proportion traded through the WESM is expected to increase in the future. The transmission sector, operated by TRANSCO (separated from NPC) allows generation companies, distribution companies and retail sellers access to its network.. The deregulated distribution sector is operated by around 20 distribution companies including MERALCO, which distributes 70% of total electricity sold on Luzon island, along with electric cooperatives. Large-scale customers (more than 1MW) can select their supplier, while deregulation down to a level that would include 750kW customers is being discussed. NPC will provide electrification in uneconomic and low demand areas, following which it is managed by SPUG.

(3) Safety Management System

In the Philippines, the Republic Act No.9136, also known as the "Electric Power Industry Reform Act of 2001", was enacted in 2001 to facilitate reforms in the electric power industry. In this act, TRANSCO is required to ensure and maintain the reliability, adequacy, security, stability and integrity of the national grid in accordance with the performance standards set forth in the Grid Code. Also, a distribution utility is required to provide distribution services and connections for any end-users within its supply area consistent with the Distribution Code.

The Grid Code prescribes that the grid owner and the system operator shall develop, operate, and maintain the grid in a safe manner and always ensure a safe work environment for their employees. In this regard, parts 1 and 2 of the Philippine Electrical Code (PEC), which govern the safety requirements for electrical installations, operation, and maintenance, are stipulated as mandatory for the grid owner and the system operator. In addition, the Occupational Safety and Health Standards (OSHS) set by the Department of Labor and Employment constitute mandatory standards in order to protect every working person against workplace injury, sickness and death.

In a very similar way, the Distribution Code prescribes that parts 1 and 2 of the PEC and the OSHS are mandatory for compliance by the distributor for the safety of electrical facilities and working persons respectively.

The Grid Code requires the grid owner and grid users to adopt and use a set of Safety Rules and Local Safety Instructions (SR&LSI) for implementing safety precautions on high voltage (HV) and extra-high voltage (EHV) equipment. Additionally, the grid owner and grid users are obliged to provide each other with a copy of their SR & LSI.

7.1.6 The Socialist Republic of Viet Nam

(1) General Description

(a) Constitution: socialist republic
(b) Capital: Hanoi
(c) Population: approx. 82.06 million people
(d) Area: approx. 329 thousand km^2
(e) Per-capita GDP: approx. 483 US$ (as of year 2004)
(f) Installed generating capacity: approx. 9,895 MW
(g) Electric energy sales: approx. 34,885 GWh
(h) Electrification rate: approx. 84%

(2) Electric Power Industry Structure

The Electricity of Viet Nam (EVN) was set up under the Ministry of Industry in 1996 to engage in business throughout all sectors of the power industry. Within the EVN, the power dispatching center, power plants and four transmission companies are under its direct supervision, while seven distribution companies run businesses on an independent basis. The distribution companies under the EVN own all the distribution facilities and directly provide power delivery services to urban areas, but in rural areas power supply is carried out by the community contractors. In addition, the community contractors are responsible for the design, construction and maintenance of low-voltage distribution installations as well.

(3) Safety Management System

In Viet Nam, the entire industry from electricity generation to electricity consumption (house wiring and electrical equipment) is regulated by the Electricity Act, which was enacted in December of 2004. Technical standards are established by the Minister of Industry in accordance with the fourth term of the 11th article in the Electricity Act. However, the current technical standards were drawn up according to Soviet Union techniques in 1984. Therefore, they are outdated and require immediate review.

To comply with the 11th article of Electricity Act, the 32nd article stipulates that the government shall define the electric power industry license publication, revision, addition and expiring date as well as orders and procedures. Additionally, the 21st article of government ordinance No.105 stipulates that the techniques and electrical equipment used by generation companies, transmission companies and distribution companies shall meet present technical standards and that they shall construct their equipment accordingly. Furthermore, the electric power regulation agency, newly established under the Electricity Act, shall assess their compliance through the electric power industry license assessment. While the Technique and Safety Department in the Ministry of Technology is responsible for confirming compliance with safety standards.

In terms of electrical safety, the 29th and 30th articles of government ordinance No.105, under the legally binding force of the 11th article of the Electricity Act, orders related agencies to comply with the sector standards on the design and construction of electric power facilities. Therefore, the 11th article of the Electricity Act is a comprehensive law, especially with regards to safety.

Finally, the Vietnam standards, which are recommended standards for electrical apparatus with no legal force, contain standards for electric power equipment and electrical appliances which conform to IEC standards.

7.1.7 Malaysia

(1) General Description

(a) Constitution: limited monarchy (parliamentary democracy)
(b) Capital: Kuala Lumpur
(c) Population: approx. 25.58 million people
(d) Area: approx. 330 thousand km^2
(e) Per-capita GDP: approx. 4,372 US$ (as of year 2004)
(f) Installed generating capacity: approx. 16,988 MW

(g) Electric energy sales: approx. 68,255 GWh
(h) Electrification rate: approx. 93%

(2) Electric Power Industry Structure

In Malaysia, the Tenaga National Berhad (TNB), the Sabah Electricity Sdn. Bhd. (SESB) and the Sarawak Electricity Supply Corp. (SESCo) engage in business throughout all sectors of the power industry in the Malay Peninsula, Sabah, and Sarawak respectively. The TNB operates power generation, transmission and distribution businesses through its affiliate companies, namely TNB Generation Sdn. Bhd., TNB Transmission Sdn. Bhd. and TNB Distribution Sdn. Bhd. Apart from this, there are a number of other participants in the power industry, including licensed independent power producers and co-generation producers, as well as local distribution retailers.

The Department of Electricity Supply (DES), which was established pursuant to the Electricity Supply Act 1990, is responsible for the regulation of the power industry in both Malay Peninsula and Sabah. In addition, the Chief Electricity Inspector in Sarawak is in charge in the safety matters with regard to electric installations.

(3) Safety Management System

In Malaysia, the Electricity Supply Act 1990, the Electricity Supply Regulations, the IEE Wiring Regulations Edition 16 have been enacted to establish a set of technical standards for the electric power industry. These regulations contain service standards, such as power quality, which are stipulated in the Licensing Agreement.

The Factory and Machinery Regulations under the Occupational Safety and Health Act 1994 obligates electric licensees to implement periodic inspections, as well as pre-use inspections, of their electric facilities including boilers and turbine-generators. In addition, electric licensees are required to formulate and observe their own internal safety rules. For instance, the TNB has formulated its own Electrical Safety Manual, with reference to the Central Electricity Generating Board (CEGB, UK) rules, for in-house use.

A licensed electrical engineer is required to take responsibility for the safety and supervision of the construction, maintenance, and operation of electric facilities. When an electricity accident occurs, the electric licensee concerned must report to both the Energy Commission and the Department of Occupational Safety and Health.

All opinions and requests of concerned parties are submitted to the Energy Commission for any changes regarding technical standards revision. There is an ongoing process in Malaysia to adjust technical standards to incorporate the IEC standards and other international standards.

7.1.8. The Union of Myanmar

(1) General Description

(a) Constitution: military regime (interim government)
(b) Capital: Yangon
(c) Population: approx. 52.17 million people
(d) Area: approx. 680 thousand km^2
(e) Per-capita GDP: approx. 180 US$ (as of year 2003)
(f) Installed generating capacity: approx. 1,195 MW
(g) Electric energy sales: approx. 3,451 GWh
(h) Electrification rate: approx. 10%

(2) Electric Power Industry Structure

In Myanmar, the Myanmar Electric Power Enterprise operates throughout all fields of the electric power industry. In order to alleviate the electric power supply deficiency, the Development of Hydro Power was founded in Jan. 2001 to engage in the planning and construction of hydro power plants. After the construction of a hydro power plant, the MEPE implements its operation and maintenance. The Ministry of Electric Power is responsible for policy making, development planning and project assessment in the power industry.

(3) Safety Management System

The two main laws governing the power sector in Myanmar are the Electricity Act of 1910 and the Electricity Supply Act of 1948. The latter legislation serves to nationalize the electricity supply sector, which was brought under the MEPE in 1972.

Due to the lack of a set of uniform standards, grid code or distribution code to regulate electric planning, design, construction, power generation, transmission and distribution in Myanmar, a variety of foreign standards and codes are concurrently employed. Currently, the IEC standards and BS standards are most extensively used, while other local standards and codes are employed in some projects on a case-by-case basis.

7.1.9 Lao People´s Democratic Republic

(1) General Description

(a) Constitution: people's democratic republic
(b) Capital: Vientiane
(c) Population: approx. 5.609 million people
(d) Area: approx. 240 thousand km^2
(e) Per-capita GDP: approx. 402 US$ (as of year 2003/04)
(f) Installed generating capacity: approx. 642.6 MW
(g) Electric energy sales: approx. 884 GWh
(h) Electrification rate: approx. 43%

(2) Electric Power Industry Structure

The Electricite du Laos (EDL), a government-run company, engages in business throughout all sectors of the power industry in Laos. In the power generating sector, apart from independent power producers who also aim to produce electrical power for export to Thailand, there are other players, such as local governments or electrification co-operatives who supply electricity generated from mini-hydro generators or diesel generators to local areas through mini-grids.

The EDL is under the supervision of the Department of Electricity (DOE), part of the Ministry of Industry and Handicraft. The DOE is responsible for policy making and planning for the electricity industry.

(3) Safety Management System

In April 1997, the Electricity Law was established as the regulatory law for the electric power industry. In February 2004, the Lao Electric Power Technical Standards were formulated and a legally binding authority was conferred upon them by the Electricity Law. Please refer to chapter 8 for further details.

7.2 Southwest Asia

7.2.1 India

(1) General Description

(a) Constitution: Republican institutions
(b) Capital: New Delhi
(c) Population: approx. 1,027.02 million people
(d) Area: approx. 3.29 million km^2
(e) Per-capita GNI: approx. 540 US$ (as of year 2003)
(f) Installed generating capacity: approx. 112.059MW
(g) Electric energy sales: approx. 355.81 TWh
(h) Electrification rate: approx. 84%

(2) Electric Power Industry Structure

In India, electric power generation, transmission and distribution has primarily been carried out by the State Electricity Boards (SEBs). Due to the structural reform in the power sector, some states have witnessed functional restructuring of their SEBs into three sections, generation, transmission and distribution. Apart from the SEBs, the National Thermal Power Corporation Ltd., the National Hydroelectric Power Corporation Ltd. and the Power Grid Corporation of India Ltd., all of which are under the direct jurisdiction of central government, are also active players in the power industry. In addition, companies such as Tata Power Company Ltd. and Calcutta Electric Supply Corporation Ltd., as well as many independent power producers, have obtained electric licenses and are engaging in business activities in the power sector.

The Central Electricity Regulatory Commission (CERC) and the State Electricity Regulatory Commission (SERC) are responsible for the regulation of the power industry, while the Central Electricity Authority (CEA) is responsible for policy making and planning.

(3) Safety Management System

In India, the Electricity Act was enacted in 1910. The Act requires every transmission licensee to comply with the technical standards for transmission system operation and maintenance as stipulated in the grid standards, specified by the Central Electricity Authority. Still, the Act requires each SERC to specify their State Grid Code consistent with the Grid Code specified by the CERC, as well as the Electricity Supply Code. All states regulate the electric power industry within their jurisdictions in line with the aforementioned codes.

In terms of the installation and maintenance of electric facilities, the Indian Electricity Rules 1956 (IER 1956), which was established under the Electricity Act (1910), stipulates specific measures for construction, installation, maintenace and safety. Under Rule 46 of the IER 1956, periodical inspection at intervals not exceeding 5 years for high voltage/extra high voltage generating plants, substations, distribution transformers and other electrical equipment is required to be carried out by the Electrical Inspector. In addition, high voltage/ extra high voltage consumer installations are subject to periodical inspection as well. Additionally, Rule 63 requires that the inspection of high voltage/extra high voltage installations be carried out before commissioning of the installation to confirm compliance with the safety provisions prescribed in the rules. If the inspection confirms that the installation is found to comply with the provisions, an approval in writing is issued to the owner/occupier of the installation.

Under the Indian Electricity Act 2003 and Rule 44A of the IER 1956, if any accident occurs in connection with the installations of generation, transmission, distribution or use of electricity by any person, such a person or any authorized person should submit a report within 24 hours of experiencing or learning of the its occurrence to the Electrical Inspectorate.

7.2.2 The Democratic Socialist Republic of Sri Lanka

(1) General Description

(a) Constitution: republican institutions
(b) Capital: Sri Jayawardenepura Kotte
(c) Population: approx. 19.3 million people
(d) Area: 65,607km^2
(e) Per-capita GDP: approx. 947 US$ (as of year 2003)
(f) Installed generating capacity: approx. 2,483MW
(g) Electric energy sales: approx. 6,161 GWh
(h) Electrification rate: approx. 68%

(2) Electric Power Industry Structure

In Sri Lanka, the Ceylon Electricity Board (CEB) has operated businesses throughout all fields of the electric power industry under the supervision of the Ministry of Power and Energy. However, independent power producers entered the power sector in 1997. The Lanka Electricity Company (LECO) is also involved in some areas of electric power supply. As a result of the structural reform in power sector, a reorganization of the CEB and the LECO is planned to establish one generation company, one transmission company and a couple of distribution companies, but as yet, this has not been realized.

(3) Safety Management System

In Sri Lanka, the Electricity Reform Act, No.28 of 2002 (ERA 2002) was enacted in 2002 to repeal the Electricity Act, No.19 of 1950, while the administration of the ERA 2002 was placed under the Public Utilities Commission of Sri Lanka (PUCSR).

According to the provisions within the ERA 2002, the PUCSR is authorized to set technical and other standards, including safety standards. In this respect, the Sri Lanka Standard (SLS) was set forth only for commercial products. At this stage, standards for electrical engineering, still, do not exist in Sri Lanka. Instead, IEC and BS standards are primarily applied in practice, IEE standard is used for wiring, while IEEE and ANSI standards are not widely adopted. Additionally, there is no license required for the construction, maintenance and operation of electrical facilities.

7.2.3 The Kingdom of Nepal

(1) General Description

(a) Constitution: limited monarchy
(b) Capital: Kathmandu
(c) Population: approx. 24.74 million people
(d) Area: approx. 147 thousand km^2
(e) Per-capita GDP: approx. 269 US$ (as of year 2003/04)
(f) Installed generating capacity: approx. 609MW
(g) Electric energy sales: approx. 1,814 GWh
(h) Electrification rate: approx. 23%

(2) Electric Power Industry Structure

In Nepal, the Nepal Electricity Authority was established in accordance with the Electricity Act 1984, to operate the generation, transmission and distribution services. The power generation business was liberalized in line with the Hydroelectric Power Development Policy of 1992 and the Electricity Act of 1992, and as a result, seven independent power producers emerged to participate in the competitive power market.

The Ministry of Water Resources (MOWR) is responsible for the regulation of the power industry, and the Department of Electricity Development, under the MOWR, is in charge of power source development, issuance of licenses and formulation and enforcement of transmission/distribution codes.

(3) Safety Management System

In Nepal, section 2049 of the Electricity Act, stipulates that the licensees of electricity generation, transmission or distribution facilities shall operate in accordance with the electricity quality standards and other technical requirements prescribed. Formulated one year after the Act, the Electricity Regulation 2050, pursuant to the Act, specifies the standards for voltage levels, frequency and power factors of electric power, while safety measures regarding electric devices, such as minimum heights of overhead wires, are also specified.

As to the inspection of power plants and electric facilities and installations, the Electricity Regulation 2050 requires licensees to conduct all prescribed technical tests when bringing a new plant, facility or installation into operation, or after repairing an old one. Additionally, it also obligates each licensee to arrange an inspection of their operating plant, facility or installation every year and to obtain a certificate to confirm compliance. Furthermore, distribution licensees, in particular are required to inspect and maintain the service line in their supply area to ensure the safety of electric power supply.

Licensees must submit a detailed report to the Electricity Inspector in case of any accidents or damage involving their plants or involving their facilities and installations. Upon receiving an accident report, the Electricity Inspector may, as required, inspect to investigate the cause of an accident and may order the licensee to amend its safety measures to prevent re-occurrence of such accidents.

7.2.4 The Islamic Republic of Pakistan

(1) General Description

(a) Constitution: federal republic
(b) Capital: Islamabad
(c) Population: approx. 148.72 million people
(d) Area: approx. 79.6 km^2
(e) Per-capita GDP: approx. 652US$ (as of year 2003/04)
(f) Installed generating capacity: approx. 1,800MW
(g) Electric energy production: approx. 75,704GWh
(h) Electrification rate: approx. 50%

(2) Electric Power Industry Structure

In Pakistan, the Water and Power Development Authority (WAPDA) is responsible for the construction, operation and maintenance of the generation facilities, transmission networks and distribution installations in all territores outside the Karachi district. As part of the restructuring of the power industry, the WAPDA was reorganized into 3 generating companies, 1 transmission company and 8 distribution companies in 1998. In 1994, the disposal of WAPDA assets into the private sector was authorized, while as a result of IPP's entering the market, foreign investment began to pour into the power industry.

The National Electric Power Regulatory Authority is responsible for the regulation of the power industry in Pakistan.

(3) Safety Management System

The Electricity Act of 1910 is the law which regulates electric power business, however, it does not address technical matters or contain clauses related to electric facilities.

Actually, MPEPR stipulates adherence to BS standards or ANSI standards for all projects.

However, IEB (Institution of Engineers, Bangladesh), an industry and technical related association body, has recently commenced the establishment of technical standards. The electric utility BPDB is a governmental body, which explains why no process exists with regard to government inspection or approval. However, Power Cell, a subordinate organization of BPDB, examines each IPP project's technical proposals.

7.2.5 The People's Republic of Bangladesh

(1) General Description

(a) Constitution: republic institutions
(b) Capital: Dacca
(c) Population: approx. 138.1 million people
(d) Area: approx. 144,000km^2
(e) Per-capita GDP: approx. 445 US$ (as of year 2004/05)
(f) Installed generating capacity: approx. 4,680MW
(g) Electric energy sales: approx. 13,874 GWh
(h) Electrification rate: approx. 32%

(2) Electric Power Industry Structure

In Bangladesh, a number of electric power companies operate power industry businesses under the supervision of the Ministry of Power, Energy and Mineral Resources. The Bangladesh Power Development Board (BPDB), the power plants spun out of the BPDB, and the independent power producers are participants in the power generation field, while the Power Grid Company of Bangladesh (PGCB), which was spun out of the BPDB, is responsible for power system planning and operation. In the distribution field, the Dhaka Electricity Supply Authority and the Dhaka Electric Supply Company are in charge of the power supply for the Metropolitan area, while the BPDB is responsible for power supply to other areas. In addition, the Palli Biddyut Samities supplies electric power to rural areas.

(3) Safety Management System

The Electricity Act of 1910 is the law which regulates electric power business, however, this not address technical matters or contain clauses related to electric facilities.

Actually, MPEPR stipulates adherence to BS standards or ANSI standards for all projects.

However, IEB (Institution of Engineers, Bangladesh), an industry and technical related association body, has recently commenced the establishment of technical standards. The electric utility BPDB is a governmental body, which explains why no process exists with regard to government inspection or approval. However, Power Cell, a subordinate organization of BPDB, examines each IPP project's technical proposals.

7.2.6 The Kingdome of Bhutan

(1) General Description

(a) Constitution: Monarchy
(b) Capital: Thimphu
(c) Population: approx. 658 thousand people (from official source)
(d) Area: approx. 46,500km^2
(e) Per-capita GNI: approx. 660 US$
(f) Installed generating capacity: approx. 482MW (as of June 2004)
(g) Electric energy consumption: approx. 664 GWh (as of year 2002)
(h) Electrification rate: approx. 40%

(2) Electric Power Industry Structure

In July 2002, the Department of Power under the Ministry of Trade and Industry had been responsible for power policy making, power industry regulation and operation and then was split, pursuant to the Electricity Act (which came into force one year ago) into three parts: the Department of Energy for policy making, the Bhutan Electricity Authority for industry regulation and the Bhutan Power Corporation for power transmission and distribution. However, three hydro power plants, namely Chukha, Kurichhu and Basochhu were set aside to remain as independent organizations, and are now being considered for integration into the Druk Hydro Power Corporation.

(3) Safety Management System

At present, there are no any technical standards with respect to electric power generation, transmission and distribution in Bhutan, except regarding the permissible voltage fluctuation for transmission and distribution (±5%) and the permissible frequency fluctuation (±3%) published in the DOE's Power Data.

Although the DOP formulated the "Basic Standards, Guidelines and Cost Estimation for Infrastructure Construction pertaining to Power Sub-transmission and Distribution" in 1998, in practice, BPC determines the design standards in conjunction with consulting agencies on a case-by-case basis, thus making the standards used in construction projects slightly different from one project to another.

In order to facilitate the formulation of electrical standards in Bhutan, an investigation mission was dispatched in 2004 under the auspices of the Asian Development Bank. It is now in the process of establishing the electrical safety provisions and a standard for construction of distribution facilities will be prepared before long.

BPC implements patrols and inspections of electrical installations based on the in-house "Maintenance Schedule for Distribution System", which prescribes the detailed inspection items and report formats for each distribution installation. Inspection periods are also prescribed. However, in practice, patrols or inspections are implemented according to the appropriate instructions given by the relevant managers.

7.3 Conclusion

The JICA Study Team investigated the existence of technical standards in the southeast and southwest Asian countries. Although, there are considerable differences in terms of regulations and electric power industry organizations among the countries examined, 11 out of 15, have some kind of technical standards and almost all of them oblige their electrical utilities to comply with the standards through stipulation in supporting laws. One example is Singapore, where the electricity law forces compliance with technical standards for electrical equipment. Furthermore, it can be said that the Singapore technical standards are of a high detail and quality and therefore the conditions in Singapore will serve as a useful reference when technical assistance is conducted in developing countries. Tables 7.3.1 and 7.3.2 outline the investigation results.

This investigation was carried out through desk research and hence was relatively limited. Greater detail of technical standards, in terms of their contents, quality, and so on, were not within the scope of this investigation. Therefore, a more detailed study should be conducted if necessary in the future.

Table 7.3.1 Safety System in Southeast Asia and Southwest Asia（Where there is Technical Standards）

	Country where there is Technical Standards										
Country	Indonesia	Cambodia	Singapore	Thailand	Philippine	Vietnam	Malaysia	Laos	India	Nepal	Pakistan
Whether Electricity Law is there or not	No (Under taking)	Yes Electricity Law	Yes Electricity Act	No (Under taking)	Yes Republic Act No.9136	Yes Electricity Act	Yes Electricity Supply Act	Yes Electricity Law	Yes Electricity Act	Yes Electricity Act	Yes Electric Power Act, 1997
Technical Standards	Yes SNI (Standard National Indonesia)	Yes Electric Technical Standards	Yes Transmission Code	Yes EGAT Code	Yes Philippine Electrical Code	Yes General Term, T&D Installation	Yes (Unknown in detail)	Yes Lao Electric Power Technical Standard	Yes Indian Electricity Rules	Yes (Unknown in detail)	Yes Distribution Code, Grid Code
Legal position of technical standards	Obligated based on Government ordinance	Obligated based on Electricity Law	Obligated based on Electricity Law	Company Code	Obligated based on Electricity Law	Obligated based on Electricity Law	Obligated based on Electricity Supply Law	Obligated based on Electricity Law	Obligated based on Electricity Law	Obligated based on Electricity Law	Obligated based on Electricity Utility Regulation Law
Organization of standards establishment	NA	Ministry of Mining industry	Energy Market Authority	EGAT	Energy Regulatory Commission	Ministry of Industry	NA	Ministry of handcraft industry	Central Electricity Regulatory Commission	NA	Each T&D EPCO
Whether National Standards is there or not (Reference)	SNI (Standard National Indonesia) (IEC)	No (IEC etc.)	Singapore Standards (IEC,BS)	TIS Standards (ANSI)	Philippine National Standards (ANSI)	Vietnam Standard (IEC)	No (IEC)	No (IEC etc.)	Indian Standard (IEC,IEEE)	NA	NA
Certification for electric safety	SNI Standards	No	CAB Standards	TIS Standards	PS Standards	VS Standards	SIRIM Standards	No	IS Standards	NA	NA

Table 7.3.2 Safety System in Southeast Asia and Southwest Asia（Where there is not Technical Standards）

	Country where there is not Technical Standards			
Country	Myanmar	Sri Lanka	Bangladesh	Bhutan
Whether Electricity Law is there or not	Yes Electricity Act of 1910 Electricity Supply Act of 1948	Yes Electricity Reform Act No.28 of 2002	Yes Electricity Act, 1910	Yes Electricity Act
Whether National Standards is there or not（Reference）	No （IEC、BS）	No （IEC、BS、IEE）	Bangladesh Standards （IEC、 BS）	No （IEC、 Indian Standards）
Note	————	————	Bangladesh Standards is not useful recently.	Construction Standards concerning distribution system is being prescribing under ADB assistance.

8 Lessons from the Projects in Laos and Cambodia

8.1 Projects in Laos

8.1.1 Outline of Projects

(1) Background of Projects

Most of the power facilities constructed in Lao P.D.R. were funded by foreign investment and were based on different technical standards. As a result, the disparity of technical standards causes confusion and complications with operation, maintenance and control of the power facilities, and there is a concern that it adversely impacts reliability of power facilities or endangers the public due to risk of electric shock, fire or collapse of a supporting structure. In order to improve this situation, JICA project-type technical cooperation, “The Project on Electric Power Technical Standard Establishment in Lao P.D.R.” (hereinafter referred to as “STEP 1”), aimed at the preparation and arrangement of a set of unified electric power technical standards, was carried out over three years from 2000. The technical cooperation project entitled, “The Project on Electric Power Technical Standards Promotion in Lao P.D.R.” (hereinafter referred to as “STEP 2”), focusing on human resources training to utilize Lao Electric Power Technical Standard (hereinafter referred to as “LEPTS”) prepared and arranged in STEP 1 (enacted in February 2004), has been conducted since 2005 and it will be completed in 2008.

(2) Outline of Projects in Laos

The Outline of each project is shown in Table 8.1.1.

Table 8.1.1 Outline of Projects in Laos

	The Project on Electric Power Technical Standards Establishment in Lao P.D.R (STEP 1)	The Project on Electric Power Technical Standards Promotion in Lao P.D.R (STEP 2)
Framework	Long-term experts : 6 persons (Chief-adviser, Coordinator, Hydro-civil engineering, Generation/Substation, Transmission line and Distribution line) Short-term experts : total 23 persons Acceptance of trainees : 8 persons Disposition of Counterparts : 17 persons	Long-term experts: 3 persons - Department of Electricity (DOE), Ministry of Industry and Handicrafts (MIH): 1 person - Electricite du Laos (EDL): 1 person - Coordinator : 1 person Short-term experts : from 6 fields (Hydro-civil engineering, Hydroelectric generation, Substation, Transmission line, Distribution line and Indoor-wiring), total 34 persons Disposition of Counterparts : total from all fields 33 persons
Method	Technical Cooperation Project	Technical Cooperation Project
Period	From May 2000 to Apr. 2003	From Jan. 2005 to Jan. 2008
Expense	Approximately 350 million JPY	Approximately 350 million JPY
Contents	- Survey on conditions of power - Facilities in both urban and in local areas. - Preparation of Electric Power Technical Standards Draft - Preparation of Draft Guideline on Operating and Managing Electric Power Technical Standards - Preparation of Draft Explanation of LEPTS etc. - Electricite du Laos (EDL): 1 person - Coordinator: 1 person	- Preparation of Examination and Inspection Manual - Preparation of databases for accident reports - Preparation of Safety Rules - Improvement of training center - Technology transfer to counter parts (Training of Trainers, etc.)

(3) Scope and Contents of LEPTS

The contents of LEPTS correspond to portions of Japan's "Electricity Utility Industry Law", "Technical Standards for Hydropower Electric Power Generation Facilities and Electric Equipment" and "Interpretation of Technical Standards". And importantly, LEPTS regulates both the electric utilities industry and power safety (required specification for power facilities etc.).

A compendium of LEPTS is shown in Figure 8.1.1, and the main stipulated contents are shown in Table 8.1.2.

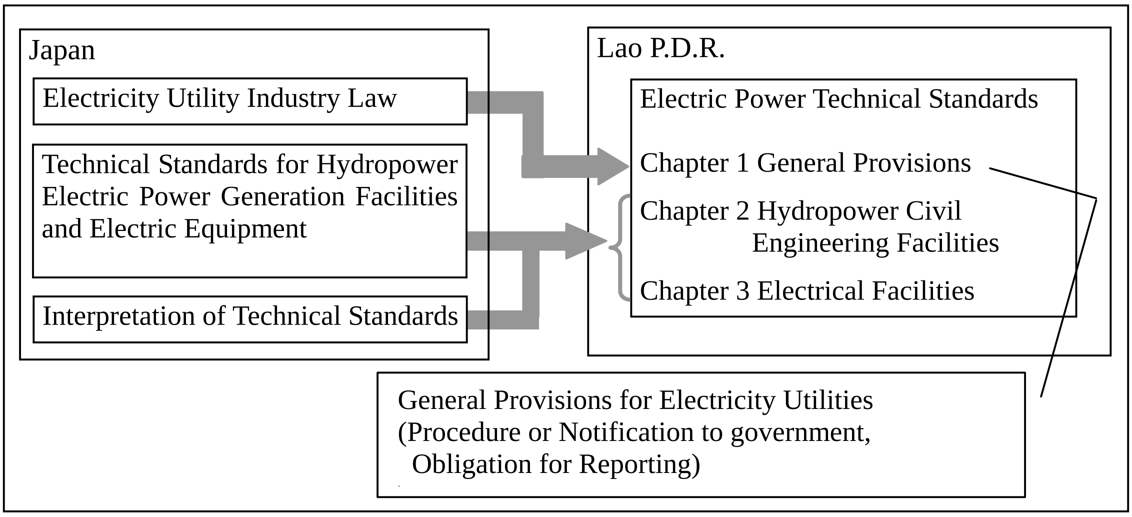


Figure 8.1.1 Compendium of LEPTS

Table 8.1.2 Main Stipulated Contents of LEPTS

Chapter	Stipulated Contents
Chapter 1 General Provisions	- Purpose, Scope and Observance of Technical Standards - Nomination of Chief Engineers - Examination for commencement of construction and inspection for commencement of operation - Order of Remedy for Conformance to Technical Standards and Restriction of operation - Obligation for Reporting (Commencement of construction, Commencement of Operation, Regular Inspection, Accident etc.)
Chapter 2 Hydropower Civil Engineering Facilities	- Fundamental Requirements (Dam Stability, Prevention of Seepage Failure of Dams, Prevention of Damage to Upstream and Downstream Areas, etc.) - Dams - Waterways - Reservoirs - Regulation of Discharge to Downstream Areas, Powerhouses and other facilities, etc.
Chapter 3 Electrical Facilities	- Fundamental Requirements (Protection or Prevention against danger, or disaster) - Hydropower Electrical Plants, Substations and Switching Stations - Transmission Lines - Distribution lines - User's Sites Electrical Installations

(4) Counterparts

The number of counterparts involved in each part of STEP 1 and STEP 2 is shown in Table 8.1.3 and Table 8.1.4 respectively.

Table 8.1.3 The Number of Counterparts in each part of STEP 1

[Breakdown：(DOE side／EDL side),Total]

	Hydro-civil engineering	Hydroelectric generation and Substation	Transmission line	Distribution line	Total
Full-time Counterpart	(1/0)1	(1/0)1	(1/0)1	(1/1)2	(4/1)5
Part-time Counterpart	(1/1)2	(1/2)3	(1/2)3	(1/3)4	(4/8)12
Total	(2/1)3	(2/2)4	(2/2)4	(2/4)6	(8/9)17

Table 8.1.4 The Number of Counterparts in each part of STEP 2

[Breakdown：(DOE side／EDL side),Total]

	Hydro-civil engineering	Hydro-electric generation	Substation	Trans-mission line	Distribution line	House Wiring	Total
Full-time Counterparts	(1/1)2	(1/1)2	(1/1)2	(1/1)2	(1/1)2	(1/1)2	(6/6)12
Part-time Counterparts	(1/2)3	(1/2)3	(1/2)3	(1/3)4	(1/3)4	(1/3)4	(6/15)21
Total	(2/3)5	(2/3)5	(2/3)5	(2/4)6	(2/4)6	(2/4)6	(12/21)33

Especially in the case of DOE, counterparts were selected from a small number of DOE staff, and there are counterparts who have other tasks outside STEP 1 or STEP 2. Therefore, counterparts are to be classified into full-time counterparts and part-time counterparts in order to make their roles clearer.

(5) Technology Transfers

(a) STEP 1

The contents of LEPTS were explained to each individual counterpart to enhance their understanding. And when a workshop or a seminar was held, counterparts prepared materials regarding the contents or outcomes of STEP 1 and made a presentation for themselves. Thus, all counterparts had an opportunity to make a presentation and improve their understanding.

(b) STEP 2

Technology transfer has been implemented through the explanation of prepared manuals or rules. Case examples of technology transfer are shown below.

1) Preparation of manuals and rules concerning LEPTS and explanation
   - Examination Manual (Examination for commencement of construction)
   - Inspection Manual (Inspection for commencement of operation)
   - Safety Rules etc.

2) Improvement of LEPTS explanation materials and lecture to counterparts regarding contents of explanation manuals

3) Training of inspection for before commencement of operation etc.

8.1.2 Lessons from Projects

(1) Implementation Framework

(a) Improvement and Strengthening of the Governing Authorities

In the present system, ministries in charge of electricity utilities in Lao P.D.R. have no authority to permit or approve construction or operation of facilities or to check compliance with technical standards. Thus it is important to strengthen the function of the governing authorities for regulation of the safety system.

In addition, the administration must be reorganized, including an increase in the number of staff, because the number of staff currently engaged in permission or approval, and regulating electricity utilities is insufficient. At present, it is practically impossible to select all officers to be engaged in examination, etc. exclusively from Department of Electricity staff. Therefore, it is necessary to secure some officers by means of temporary transfer from related organizations such as public electric companies.

(2) Scope and Content of Technical Standards

(a) Level of Technical Standards

LEPTS contains many articles that were made by referring to technical standards of Japan. If the quality of the content in the technical standards is of the same high level commonly seen in advanced countries, extremely high reliability can be secured, but the construction cost of power facilities is higher and slows the promotion of rural electrification and so on. Therefore, it is important to consider that the contents of technical standards should be based on the economic power of the country or regional situation to avoid hindering the promotion of rural electrification and so on.

(b) Safety of Customers' facilities

In case of Lao P.D.R., there have been a number of accidents involving casualties or fires at factories or residences caused by defects of customers' facilities, which has highlighted that improving the safety of customers' facilities may be more necessary than that of power facilities. Therefore, in response to a strong request from the Laos side, technical standards concerning indoor-wiring were also prepared during STEP 1. However, the indoor-wiring workers have such insufficient knowledge regarding these standards that they are not being applied at all now.

(3) Counterparts

If counterparts have other tasks outside the scope of the project, they are sometimes inexplicably absent from various project activities. Institutional support and human resource training should go hand in hand in projects, but training activities depend on the participation of counterparts. Therefore, securing the attendance of members is an essential consideration, not only at the planning stage of the project but also during the implementation stage. During STEP 1 or STEP 2, some counterparts accepted job offers in unrelated sections inside their organization, and there was a counterpart who resigned from the project after being recruited by a private company proposing much higher pay. The employment conditions and personnel management of counterparts is a matter for the Lao side, but it is necessary that certain measures are taken, such as assignment of a sufficient number of counterparts, to allow for any unforeseen events or personnel changes.

(4) Technology Transfer

(a) Technology Transfer Regarding Technical Standards

LEPTS covers detailed contents that correspond to Japan's "Interpretation of Technical Standards" including extremely complicated information. Therefore, preparation of explanation material regarding each item is important to make it easier to understand. It is also important to prioritize key items for the transfer of technology to counterparts, because it is difficult for counterparts to master all items in the short period of time available.

(b) Arrangement of Manuals for Technology Transfer

The rules, stipulating procedures or notification to government and so on, were prepared during STEP 1 or STEP 2. But implementing these rules in practice, it is necessary to prepare a guideline, manuals and so on which reflect the methods and the formats of application forms, and it is also necessary to train counterparts in the use of these documents.

(c) Training of Trainers (TOT)

To disseminate technical standards through all parts of the country, it is necessary to train prospective leaders who will train general electric utilities or relevant people in local areas.

(5) Others

(a) Treatment of Existing Facilities

The existing facilities that do not conform to LEPTS will not be repaired, because “Lao Electric Power Technical Standards” has no article that obligates such action. However, considering that the main purpose of technical standards is to prevent dangers to persons or objects, it is unacceptable to allow defective facilities that do not conform to technical standards to operate with the risks of electric shock or collapse remaining in operation for a long period. In such cases, appropriate measure should be considered.

(b) Introduction of SWER Method

If supplying only single-phase electric power, a single-phase two-wire system, that has two wires as medium-voltage line, is usually used. But the SWER method (Single Wire Earth Return method) can also supply single-phase electric power.

SWER requires lower installation costs due to the substitution of earth for one wire as the return pass. It is widely adopted for rural electrification in African countries. Additionally, it has been applied with success in some advanced countries such as Australia and New Zealand. Some donors such as World Bank and Asian Development Bank recommend the SWER method for rural electrification projects because of the lower costs associated with using only one conductor.

However, there are some problems associated with the SWER method such as the compulsory installation of an isolating transformer and restriction of power-carrying capacity. Implementing SWER does not necessarily achieve cost reduction in all cases. If three-phase electric power becomes necessary in SWER hereafter, the transformer would have to be replaced, because a special transformer is required to transform medium-voltage to low-voltage. Therefore, before adopting SWER, a sufficient feasibility study must be carried out.

In Lao P.D.R, SWER had been introduced before the enactment of LEPTS. There is a report of considerable damage from a lightning attack in SWER and almost all of the destroyed SWER facilities were replaced with the normal three-phase three-wire system or single-phase two-wire system. However, it has not been clarified whether the SWER facilities were destroyed by characteristics of SWER or by a material defect.

LEPTS does not regulate detailed SWER requirements. However, it is necessary to discuss whether SWER is adopted as a general method or whether SWER is treated as an irregular case. In terms of data gathered during the site investigation in Australia, SWER standards from Australia are shown in Table 8.1.5. However, otherwise internationally there seems to be very few available standards.

Table 8.1.5 SWER Standards in Australia

Standards	Organization	Abstract of regulations
AS2558 Transformers for use on single wire earth return distribution systems	Standards Australia International	Rated voltage, rated capacity, insulation level and shape of SWER transformers
A4 60322 (Earthing System for SWER Substations)	Shortland County Council in New South Wales State	Earthing method, values of earth resistance Capacity of Transformers — Value of Earth Resistance 5kVA — 30 ohms 10kVA — 25 ohms 15kVA — 15 ohms 25kVA — 5 ohms 50kVA — 5 ohms
Code of Practice Works for Protective Earthing	Department of Industrial Relations, Queensland Government	Earth, value of current, safety measures, clearance to communication lines in SWER system and so on • The ground resistance of SWER transformers and isolators is determined by a requirement in these guidelines that the maximum voltage on the earth lead with respect to remote earth under operating conditions resulting in maximum continuous earth current should not exceed 20 V.
NZECP41 New Zealand Electrical Code of Practice (Reference)	Office of the Chief Electrical Inspector, Energy and Resources Division, Ministry of Commerce, New Zealand	General requirements for SWER facilities (earth, value of current, safety measures, clearance to communication lines) • The earth resistance for SWER transformer shall be 5 ohms or less. • The load current in SWER circuits shall be 8 amperes or less.

8.2 Projects in Cambodia

8.2.1 Outline of Projects

(1) Background of Projects

According to the ARTICLE 5 of Electricity Law of the Kingdom of Cambodia, Electricity Authority of Cambodia (EAC) shall perform their work in accordance with the Technical Standards for the Electrical Equipment which would be issued by the Ministry of Industry, Mines and Energy (MIME). However, the Technical Standards have actually not been issued yet, therefore, EAC cannot fulfill their obligations in terms of regulation, administration and supervision for the Electric Power Services, stipulated by the Electricity Law. In this country, most electric power equipment has been imported with a variety of technical levels. In such circumstances, the power service companies are not restricted from purchasing and installing electric power equipment with poor quality unless minimum acceptable technical standards are established. Therefore, in the Electric power sector, earliest possible establishment of Technical Standards for the Electric Power Equipment is an important priority. .
In order to improve this situation, 「The Study for Establishment of Electric Power Technical Standards and Guidelines in Cambodia」(hereinafter referred to as " Study of Establishment")commenced in October 2002. The purpose of this Study was to prepare the draft of "Electric Power Technical Standards". The Resulting document from that study, The Electric Power Technical Standards (hereinafter referred to as " GREPTS ")was enacted as law. However, the knowledge and the management ability of EAC and Electricity de Cambodia(EDC)are not sufficient at this stage. Therefore, in order to improve the management ability regarding technical standards for both organizations, [Project for Capacity and Institutional Building of the Electric Sector in Cambodia] (hereinafter referred to as "Technical Cooperation Project ")was commenced by JICA in September 2004. At present, the draft of Specific Requirements of Electric Power Technical Standards is being prepared (hereinafter referred to as "SREPTS")and technology transfer with the Cambodian counterpart is proceeding through the Technical Cooperation Project.

(2) The Outline of Study and Project in Cambodia

The Outline of Study and Project in Cambodia is shown in Table 8.2.1

Table 8.2.1 Outline of Study and Project in Cambodia

	The Study for Establishment of Electric Power Technical Standards and Guidelines in Cambodia	Project for Capacity and Institutional Building of the Electric Sector in Cambodia (Only description of the project for EAC)
Framework	Consultants: 8 persons (Manager, Thermal power, Hydro power, Transmission, Distribution, House wiring, Renewable Energy, Coordinator) Counterparts; Total 8 persons	Long term expert: 1 person (EAC) Short term expert: Thermal power, Transmission, Distribution Counterparts; Total 11 persons (Project Manager; 1 person)
Method	Consultants	Technical Cooperation Project
Period	From Nov. 2002 to Nov. 2004	From Sep. 2004 to Sep. 2007
Expense	Approximately 240 million JPY	Approximately 140 million JPY (The budget for EDC is included)
Contents	・Preparation of the draft of The Electric Power Technical Standards ・Preparation of Guide book for Power Engineer ・The general survey for Cambodian electric power industry etc	・Preparation of the draft of Specific Requirements of Electric Power Technical Standards and Explanation Sheet, and technology transfer to counterparts ・Support to seminar for explanation of SREPTS for local small-scale electric power companies

(3) Scope and Contents of GREPTS

The contents of GRETPTS contains portions from "The Electricity Industry Law", “Technical Standard for the Electric Power Facility” and” Interpretation of Technical Standard” of Japan. GREPTS regulates both electric business and electric safety (specification of electric equipment etc) as well as a Laotian electric power technical standard.

The basic policy for preparation of GREPTS was as follows:

Avoid outlining details of performance standards for power equipment in terms of the numerical value and the method etc. as much as possible because making frequent changes or revisions of GREPTS after issuing it as a law is not suitable and contents of GREPTS will not be changed for 10 years or more. Therefore, numerical values were described only in items where quantification is needed for the safety of equipment in addition to the functional requirements that correspond to the ministerial ordinance of a technical standard from Japan. Table 8.2.2 shows main stipulated contents of GREPTS.

Table 8.2.2 Main Stipulated Contents of GREPTS

Provisions	Contents
Chapter 1 General Provisions	- Purpose, Applied Area, Enforcement （Employment of qualified electrical engineers, Authorization of qualified electricians are also included） - Quality of Electric Power, Prevention of Electric Power Disasters - Prevention of Electric Power Outage, Preservation of Environment
Chapter 2 Electric Power Facilities	- General （Life of Electrical Power Facility, Grounding, Connection of Conductors, Accuracy of Power etc） - Generating Facilities (Thermal Power) - Generating Facilities (Hydroelectric Power) - Generating Facilities (Others) - Transmission and Distribution Facilities (Common) - Transmission and Distribution Facilities (High Voltage) - Transmission and Distribution Facilities (Medium and Low Voltage) - House Wiring

SREPTS, being prepared through the Technical Cooperation Project, has aimed to clarify the rules to follow GREPTS by providing clear numerical values and methods for installation of facilities etc, which are not already outlined in GREPTS. In the Technical Cooperation Project, it was decided that SREPTS would be made for thermal power, transmission and substation, distribution because these areas are of a high priority. The draft of SREPTS will be enacted as a law by MIME as well as GREPTS in the future. Table 8.2.3 shows contents of the SREPTS draft.

Table 8.2.3: Contents of the SREPTS Draft

Parts	Contents
All Electric Power Facilities	- Prevention of Electric Power Disasters, Prevention of Accidents Caused by Electric Power Facilities - Safety of Third Person, Prevention of Failures of Electric Power Facilities from Natural Disasters - Prevention of Electric Power Outage, Environmental Protection, Applicable Standards, Life of Electrical Power Facilities - Grounding, Grounding for Stations and High-voltage and Medium-voltage user's sites, Grounding for Distribution Lines and Electrical User's Sites, - Connection of Conductors, Communication System and Telecommunication System, Accuracy of Power Meters
Thermal Generating Facilities	- Boiler and its Accessories, Steam Turbine and its Accessories - Gas Turbine and its Accessories, Internal Combustion Engine and its Accessories - Gas Turbine Combined Cycle and its Accessories
Transmission and Distribution Facilities	- Property of Conductors, Prevention of Climbing on Supporting Structures, Safety Factor of Bare Conductors and Ground Wires of Overhead Electrical Lines - Side by Side Use and Joint Use of Electrical Lines or Communication Lines, Underground Lines - Protection against Over-current, Protection against Ground Faults - Design of Supporting Structures of Overhead High-voltage Lines, Design of Fittings for Conductors and/or Ground Wires of Overhead High-voltage Lines - Clearance between Bare Conductors and Supporting Structures of Overhead High-voltage Lines, Height of Overhead High-voltage Lines - Clearance among Overhead High-voltage Lines and Other Facilities or Trees - Prevention of Danger and Interference due to Electrostatic Induction and Electromagnetic Induction, Surge Arresters etc

(4) Counterparts

The number of counterparts for each part is as follows:

In the Technical Cooperation Project, one or more counterparts were selected from each organization, and the SREPTS draft was prepared on the basis of the consensus of the organization related to the counterparts. Though the arrangement for selection of counterparts in Study of Establishment was biased because counterparts were selected from one organization only. The number of counterparts for each part in Study of Establishment and the Technical Cooperation Project is shown in table 8.2.4 and 8.2.5.

Table 8.2.4: The Number of Counterparts in Study of Establishment

Organizations	Thermal Power	Hydro Power	Transmission	Distribution	House Wiring	Renewable Energy	Total
MIME		2*			2	2*	6
EDC	2		1*	1*			4
Total	2	2	1	1	2	2	10

* Counterparts overlap

Table 8.2.5: The number of Counterparts in the Technical Cooperation Project

Organizations	Thermal Power	Hydro Power	Transmission	Distribution	House Wiring	Renewable Energy	Total
MIME	1	-	1	1	-	-	3
EAC	2	-	1	1	-	-	4
EDC	1	-	2	1	-	-	4
Total	4	-	4	3	-	-	11

(5) Technology Transfer

In Study of Establishment, technology transfer by way of meetings held during the decision stage of the GREPTS draft were carried out. Moreover, the understanding level of counterparts improved by instructing them to explain GREPTS in the workshop. At the Study of Establishment stage the preparation of the GREPTS draft was a high priority. The problems in technology transfer remained. For example, counterparts were not able to concentrate on the project because they had additional works, study team visiting days were short, and some counterparts didn't have a basic understanding regarding their area of responsibility. The main purpose of the Technical Cooperation Project is personnel training for the administration of GREPTS. So the GREPTS draft and explanation sheet draft, which explains SRETPTS and related technology transfer, are being prepared. To improve the level of understanding of the content, the counterparts will translate the SREPTS draft etc.

8.2.2 Lessons from the Projects

(1) Implementation Framework

(a) The Appointment of Counterpart Coordinator

There are a many members who only attend the conference however there are 3-4 counterparts arranged for each of thermal power, distribution, and transmission because counterparts have work to carry out in addition to the project. This situation interferes with the progress of project. Therefore, nominating a coordinator (Cambodian side leader of each part) provides leadership in terms of timely consideration of the project's progress and also in terms of encouraging counterparts to participate positively. In addition, coordinators are expected to become important for personnel training in this country in the future.

(b) Appointment of Project Manager

A project manager was appointed in the Cambodia Technical Cooperation Project. The project manager participates in the meetings of each part in order to continuously recognize his management responsibilities. Delegating responsibilities while maintaining a strong position as leader, in keeping with the Cambodian approach that the organization's leader should ultimately make the decisions, is an important management consideration.

(c) Arrangement of JICA Coordinator

In addition to preparing the SREPTS draft, there are also two other works in progress simultaneously in the Technical Cooperation Project. As there are a lot of works to be coordinated, including accounting etc., counterparts are selected from three organizations and the three short-term JICA experts will visit frequently for preparing the draft of SREPTS. It seems that the project management will be performed smoothly if a JICA coordinator can be arranged.

(2) Scope and Content of Technical Standards

(a) Regulation Policy for House Wiring Parts

The house wiring part is not within the jurisdiction of EAC, which manages electric power companies but within the jurisdiction of MIME. The draft of GREPTS concerning the house wiring was made in response to the Cambodia request made in Study of Establishment. However, it is not being used because the relating law is not yet established. It is necessary to discuss the system of related laws in terms of making decisions regarding the establishment of technical standards.

(3) Counterparts

(a) Motivation of Counterparts

It would be preferable for counterparts to be actively engaged in the preparation of the SREPTS draft. The JICA experts lead the preparation of the SREPTS draft and explain it to the counterparts. In such circumstances, counterparts tend to leave the responsibility for preparing the draft of SREPTS to JICA experts only. It seems that the prevailing attitude by engineers in Cambodia is that consultants or

JICA experts should prepare any material at their request because various organizations have been helping or supporting Cambodia for such a long period of time. It is necessary to improve project progression by increasing counterpart's willingness to contribute and participate in a way that reflects the ability of the engineers throughout the country

(b) Appointment of Full-time Counterparts

Effective contribution to the project is difficult for counterparts because each has other works. It seems that the counterpart will advance technology transfer and SREPTS will be better understood if even one full-time counterpart can be appointed.

(4) Technology Transfer

(a) Learning Basic Knowledge

There are no large-scale thermal power stations in Cambodia.

It is a very difficult for counterparts to understand each item of SREPTS because they cannot understand the importance or role of each part. In the Technical Cooperation Project, the JICA expert prepares the material concerning basic knowledge of thermal power and explains it to the counterparts in order to improve the level of their understanding. Therefore, a project should progress efficiently through the provision of basic education to counterparts regarding the technology, which is not widespread throughout the country prior to the project commencement.

(5) Others

(a) Transitional Provision for an Existing Facility

Clause 5 Transitional Provision in GREPTS regulates the treatment for an existing facility as follows:

1. The existing electric power facilities not harmful to human beings, animals and trees could be operated till the time of its renewal or replacement.
2. The existing electrical power facilities harmful to human beings, animals and trees shall be modified within two years to be satisfactory with the requirement of the Technical Standards.

It is quite different to the technical standard of Laos (LEPTS) which does not stipulate the adaptation of an existing facility as one of its regulations. However, it is important to note that some electrical companies which do not have the required funds may not be able to complete all the repairs before the designated deadline.

(b) Clarification regarding the Basis of Enactment

The technical standards in Japan have been revised many times since their enactment in 1965. It is necessary to clarify the basis of enactment at the time when technical standards come into effect because it is necessary to refer to them for each item at the time of their revision. The explanation sheet, which explains SREPTS, clarifies the basis for each item in the Technical Cooperation Project.

(c) Preparing the Material Data Base for the Project Related to Technical Standards

New projects may be more viable and executed more efficiently by JICA if the material prepared and information collected during past projects are combined and used effectively.

9 Recommend Practice of Technical Cooperation on Electric Power Technical Standards

9.1 Recommend Practice of Preparation of Technical Cooperation on Electric Power Technical Standards

Information collection and analysis of legal framework of electricity law and current situation of electric power industries in host country are critically important for successful technical cooperation on electric power technical standards under electricity law (herein after referred to as the technical standards)

The technical standards are the main component of technical regulations under electricity law, which aim to secure consistency of frequency, voltage and reliability of electricity supply from power generation to electricity demands and to secure safety on electricity supply and consumption. Technical regulations consist of various regulatory measures such as technical reviews on designs of electric power works and on-site inspections prior to commissioning of electric power works by regulatory agency and requirements of reporting on faults of electricity supply and accidents caused by electricity supply and consumption to regulatory agency as well as the technical standards. It should be noted that understandings of these regulatory framework on technical regulations are basic requirements for JICA staff to design technical cooperation on the technical standards, because the objective of technical cooperation on the technical standards is not limited to establishment of the standards but also improving compliance of technical standards to secure reliable, efficient and safe electricity supply.

Contents of the technical standards are different by countries, because objectives and scopes of electricity law and legal frameworks of relevant laws are different by countries. For example, if the objective of electricity law is focused on regulation of electric power industry, the technical standards which are applicable only to electric power industries such as power generation, transmission and distribution are needed. If the electricity law includes regulations on electricity consumption as well as electric power industries, the technical standards need to include the technical standards on house wiring and appliances. In general, electric power industries are regulated not only by electricity law but also numbers of laws such as labor law, environmental protection law etc. There is no common model on allocation of responsibility between electricity law and other relevant laws to regulate electricity supply and consumption, because of different histories of establishment of legal frameworks and different philosophies on national regulatory frameworks.

There are 2 alternatives of measures of technical cooperation on the technical standards, which are development studies[1] and technical cooperation projects[2]. In fact, the establishment of the Electric Power Technical Standards in Lao PDR was implemented as a technical cooperation project and the establishment of the Electrical Power Technical Standards in Cambodia was implemented as a development study. In Cambodia, development of detailed guidance on the Technical Standards is being implemented as a technical cooperation project, following to the development study. In Vietnam, a development study on updating the existing technical standards, consistent with restructuring of regulatory framework and power industries, will be started this year as a development study.

The contents of technical cooperation on the technical standards need to be identified, taking into account of above mentioned variations of scopes and contents of the technical standards in each country and measures of technical cooperation. The post project evaluations also need to include evaluations on appropriateness of selection of technical cooperation measures, identification of contents of technical standards etc. taking into account of the variety of legal structures and situation of electric power industries. in each country.

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1 Development studies are part of JICA's technical cooperation which support the formulation of plans for public projects that are beneficial to social and economic development in developing countries.

2 Technical cooperation projects are one of JICA's main types of overseas activities. They are results-oriented, with Japan and a developing country pooling their knowledge, experience, and skills to resolve specific issues within a certain timeframe. The projects may involve the dispatching of experts from Japan to provide technical support, invitation of personnel from developing countries for training, or the provision of necessary equipment.

The following Table 9.1.1 shows the checklist of current situation on the technical standards in each country. The Figure 9.1.1 shows general procedures to identify contents of the technical standards.

9.1.1 Information Collection and Preliminary Analysis Prior to Preparatory Study

Information collection and preliminary analysis on electricity law, relevant regulations, and current situation of electric power industry etc. are necessary to conduct a preparatory study on technical cooperation to establish the technical standards effectively. It is necessary to conduct a project formulation study or preliminary study prior to preparatory study if above mentioned information is not available in Japan.

(1) Electricity Law and Relevant Regulations

It is the basic requirement, to understand legal structure of electricity law including the technical standards, to design technical cooperation projects on the technical standards effectively. Therefore collection of electricity law and relevant regulations under the law are the first priority.
Background information collection and analysis on enactment of electricity law such as electric power policy etc. may be helpful to understand the needs and missions of the technical standards, if the law is newly established.
Collection and analysis of the existing technical standards, including the purpose of updating of the technical standards, are necessary in the case of technical cooperation on updating the existing technical standards. Collection of the existing technical standards in advance to preparatory study is extremely important in the case of countries which official language is not English, because translation of the technical standards in local languish into English takes time.

(2) Institutional Framework of Government Organizations that are Responsible to Electric Power Policy and Regulations

Counterpart organization of technical cooperation on the technical standards is generally either or both the ministry which is responsible to electric power policy and/or regulatory agency which is established as an independent authority to regulate electric power industries under the power sector's restructuring law. There may be few experienced experts on electric power technologies and industries in Ministry or regulatory agency, if government owned electric power company has been privatized recently, because most experts generally choose to remain the privatized electric power company instead of moving to government. In this case, experts of electric power company need to be added to the counterparts of the project. Therefore it is important to analyze institutional framework and capacity of government organizations that are responsible to electric power policy and regulations, to identify appropriate counterpart organizations and persons. This information is also necessary to identify appropriate organizations to visit during preparatory study.

Table 9.1.1 The Checklist of Current Situation on the Standards

Situation of technical standards developments	Countries without technical standards	Countries with technical standards
Previous projects	Lao P.D.R., Cambodia	Vietnam
Regal framework on electric power	- Enactment of Electricity law - Issuances of regulations under the Electricity law （Regulations which are necessary the Electricity law to enter into force） - Procedures to establish a technical standards - Legal status of technical standards under the law	- Objective to update the existing standards or establish a new technical standards - Procedures to establish a technical standards - Legal status of technical standards under the law
Scope of technical standards	- Electric power user's equipments are included or not? - Rural electrification is included or not?	same as the left column
Analysis of technical standards	————————	- Analysis of the existing technical standards
Institutional framework on technical standards	- Organization to establish technical standards - Organization to enforce technical standards (the capacity of organization often may not enough to enforce technical standards)	same as the left column
Compliance of technical standards	- Relationship with electricity supply licensing - Review of design of electricity power works, on-site inspection, reporting of faults on electricity supply or accidents	same as the left column
Establishments of relevant laws	- Relationship of rolls between labor law, environmental protection law etc. and electricity law (In less developed countries, relevant legal framework may not be completed. In that case, it is necessary to survey the work plan to complete the legal framework.)	- Relationship of rolls between labor law, environmental protection law etc. and electricity law (There may be inconsistency or overlapping of regulations between those laws.)
Establishment of relevant technical standards	- National standards, technical standards or recommendations by academic organizations or industry organizations (there may be few non profit organization in less developed country)	- National standards, technical standards or recommendations by academic organizations or industry organizations - Evaluation of potentials to use the above mentioned organizations to establish the standards
Current situation of electric power industries	- Analysis of current situation and tackling issues of electric power industries - Current situation on establishment of statistics such as faults of electric power supply and accidents.	same as the left column

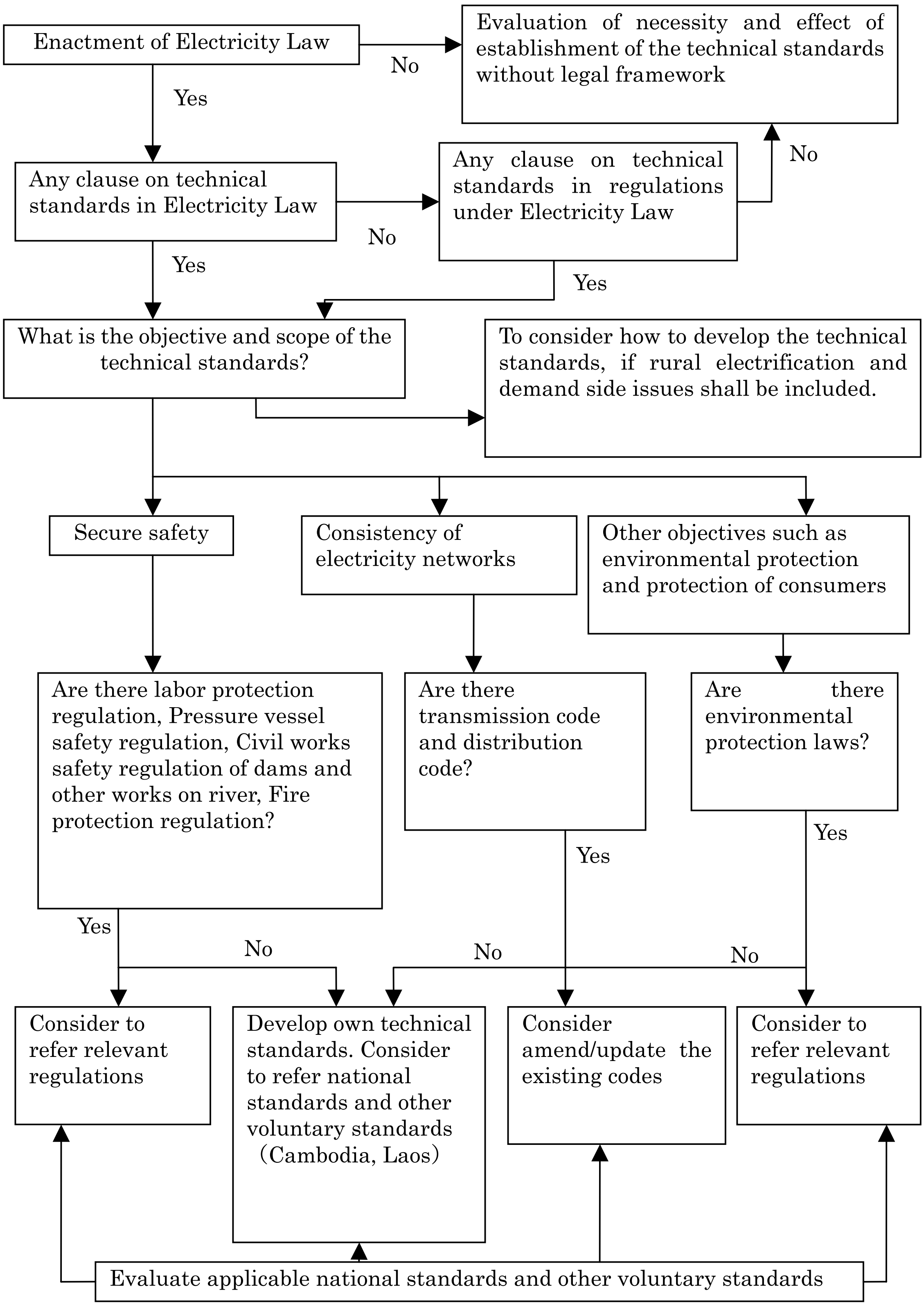

Figure 9.1.1 General Procedures to Identify Contents of the Technical Standards

(3) Institutional Framework of Electric Power Industry and Current Situation of Electric Power Works

There are several variations on institutional framework of electric power industries in developing countries. These variations include electric power supply by government agency, electric power supply by vertically integrated government owned electric power company, electricity supply by combination of government owned power generation and transmission company and private distribution company, and power supply by private electric power company. During the transitional period to move to fully unbundled and privatized electric power companies, there may be many variations of institutional framework of electric power supplier.

If a new electricity law intends to privatize and unbundled electric power industries urgently, establishment of transmission code and distribution code might be the first priority to secure consistency and reliability of transmission and distribution services. If a new electricity law mainly intends to establish competitive power generation market, establishment of the technical standards on power generation might be the first priority. Therefore it is very important to identify priority of the technical standards to be established through information collection and analysis on the current and future institutional framework of electric power industry.

It is also necessary to analyze current situations of electric power industries and electric power works, to identify priority and scopes of the technical standards. For example, priority to establish the technical standards on specific electric power generation technologies is depend on the power generation mix in host country and scopes of the technical standards on transmission and distribution depends on the situation of transmission line developments and utilization of underground cables etc. Therefore it is recommended to collect and analyze information on electric power industries such as annual report of electric power companies.

(4) Organizations to Establish Technical Standards and Relevant Government Agencies

Most countries have the national standards on appliances and equipments such as electric power generation and distribution. IEC and ISO have been developing various technical standards in the world. It is important to understand the progress of these standardizations relevant to electric power supply and demand to establish the technical standards. Therefore information collection and analysis on standardization organization in host country (generally a government agency is responsible for standardization in developing countries) and progress of standardization are necessary. These information collection and analysis also enable to identify appropriate organizations to visit during preparatory study. Information collection and analysis on institutional framework and activities of academic and industrial organizations on electric power technologies and industries are recommended to evaluate possibilities to use these organizations to develop voluntary technical standards and guidelines. Visits of these organizations during preparatory study are expected to be informative.

There are numbers of laws relevant to electric power supply and demands. It is necessary to understand the demarcation of responsibility among there laws including electricity law to identify scopes of the technical standards. Therefore it is recommended to survey the relevant laws that have close relationships with electricity law and the responsible ministries to the laws. It is also recommended to visit some ministries during preparatory study, if necessary.

9.1.2 Preparatory Study

(1) Scope of Electricity Law and Legal Structure of the Technical Standards

Regulations on electric power industry generally consist of business regulations (business licensing and tariff regulation etc.) and technical regulations (standards on frequency and voltage, standards on electrical equipments, connection standards etc.).However scope and details of regulations are different by countries. Technical regulations consist of regulations such as frequency and voltage to secure consistency of electricity supply between generation, transmission, distribution and customers and safety regulations (technical standards of equipments, etc.). The objectives of safety regulations are divided into public safety and labor's safety. The Figure 9.1.2 shows common regulatory structures of electricity law. Analysis on the structure and scopes of electricity law is the first step to identify appropriate contents and measures of technical cooperation on the technical standards. This analysis is not focused only to the electricity law but also to the relevant regulations under the law such as decrees, minister's order etc., because in some countries technical regulations are defined in decree or minister's order etc. under the electricity law.

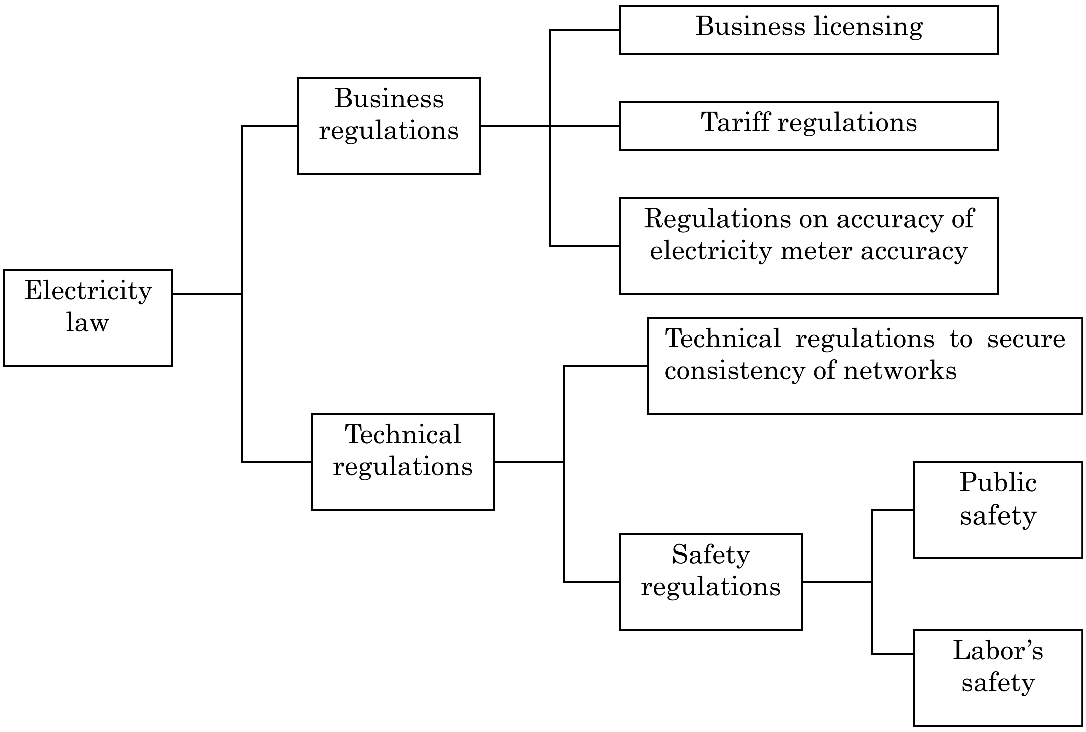

Figure 9.1.2 Regulatory Structure of Electricity Law

It is also important to analyze scope of electricity law in terms of flow of electricity. Primary energies are converted to electricity at electric power stations and then generated electricity is delivered to customers through transmission and distribution lines. Electric power industries are responsible to deliver electricity to customers (usually to the electricity meters). Therefore electricity law usually regulate from electric power generation to distribution of electricity. However improper house wiring often causes electricity leakages problems and sometime faults of house wiring causes problems of quality of electricity supply to other customers. Taking into account of these problems, electricity law may include regulations of house wiring in some developing countries. Although regulations of appliances are not commonly included in technical regulations under electricity law, some countries may include regulations of appliance in electricity law. The Figure 9.1.3 shows the electricity flow and relationship between electric power companies and customers. It is important to clarify if electricity law includes regulations of customer's facilities and equipments.

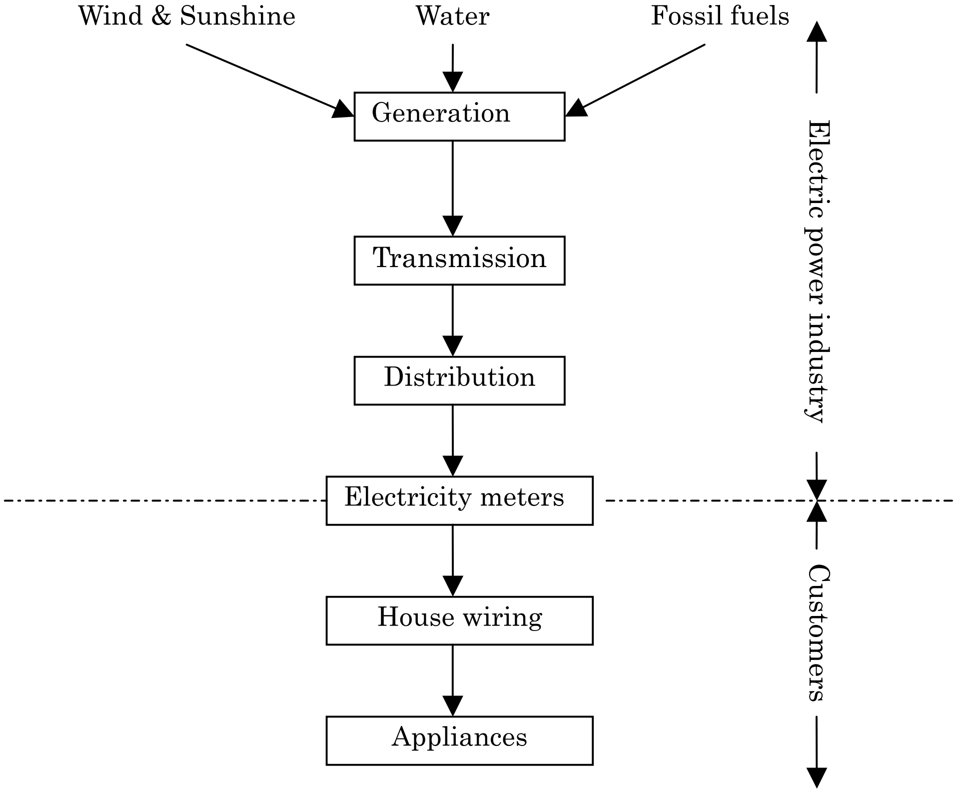

Figure 9.1.3 Electricity Flow and Relationship between Electric Power Companies and Customers

Power generations to convert primary energy to electricity include technologies which may be regulated by other reasons than electricity safety. There are several typical examples of these regulations. Hydro power plants may be regulated by safety regulations of dams and other civil works and steam generations may be regulated by safety regulations of pressured vessels. Nuclear power plants are regulated by safety regulation on handling of radioactive materials. Large scale power plants are regulated by environmental protection laws to regulate effluents and waste gas emissions. These regulations are applicable to other facilities to use similar technologies (for example: dams for flood control and irrigation use same technologies as hydro power dams and industrial boilers use similar technologies as boilers for steam generation). Therefore these electric power generation technologies may be regulated by either the regulations of specific technologies or technical regulations under the electricity law. The Figure 9.1.4 shows examples of regulations on specific generation technologies. It is necessary to clarify scope of the technical standards on electric power generations which are needed to be established under the electricity law, taking into account of scope of the other regulations on specific technologies.

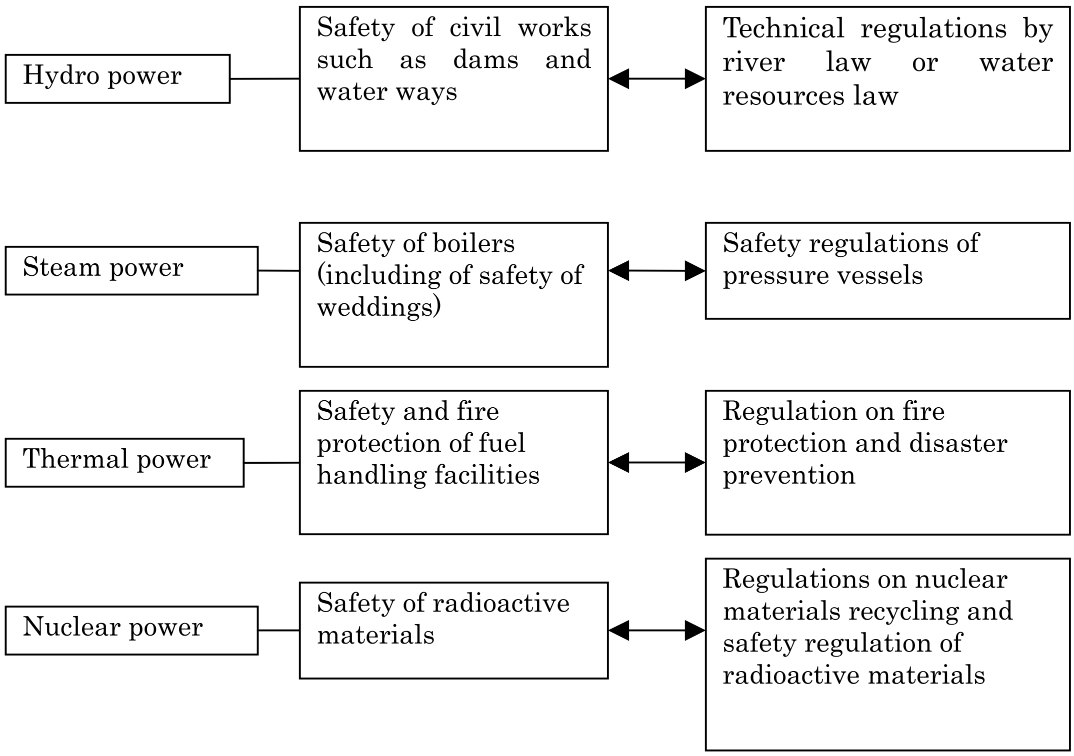

Figure 9.1.4 Examples of Regulations of Specific Generation Technologies

(2) Technical Regulation of Electric Power Industry by Other Laws

Electric power industries are regulated by other laws to regulate specific technical issues such as labor protection law, environmental protection laws and fire protection laws etc. as well as electricity law. Electric law itself may have a mission to regulate electric safety specifically, not only limited to electric power industry but also other industries and electricity consumptions. The relationship between electricity law and other laws to regulate cross industrial specific issues is different by countries, because of different histories of enactment of these laws (for example: if electricity law was enacted prior to other laws or not.) and different national legal framework in each country. Even most countries have labor protection law, environmental protection law and fire protection law, the application of these laws to electric industries are different by countries, in terms of relationship with technical regulations under electricity law. In some countries, electric industries are regulated for a specific technical issue by both electricity law and other law to regulate a specific issue. In some countries technical regulations under electricity law excludes technical issues which are regulated by other laws specified to the technical issues. Regarding to electric power generations, electricity law often excludes specific technical issues which are regulated by other laws. Electricity law needs to include technical regulations on cross industrial specific issues, if host countries do not have laws to regulate these issues. Also it is necessary to clarify coordination mechanisms to secure consistency of technical regulations on specific issues between electricity law and other laws, if both laws are applied to electric industries. The Figure 9.1.5 shows examples of relationship between electricity law and other laws.

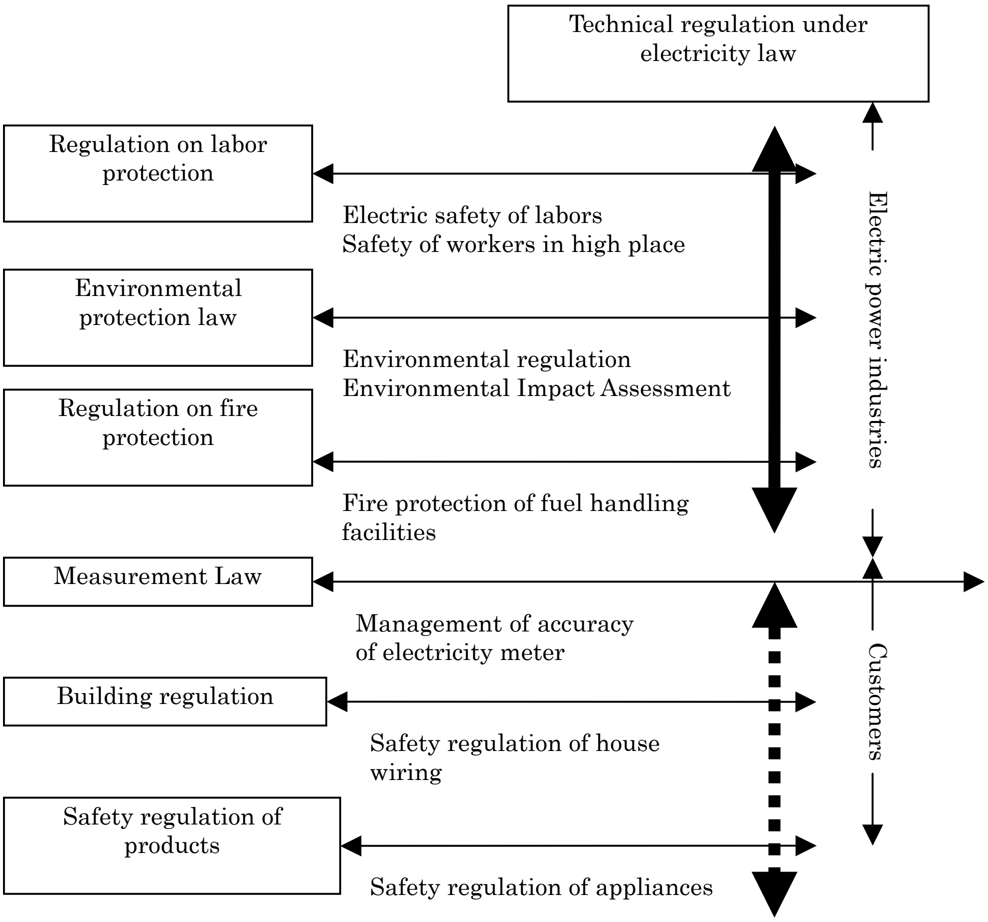

Figure 9.1.5 Examples of Relationship between Electricity Law and Other Laws

(3) Voluntary Technical Standards and Guidelines

There are various voluntary technical standards on electric power supply and demand as well as the technical standards under electricity law. These standards include the international standards such as IEC and ISO, national standards such as JIS, and technical standards which are established by academic or industrial organizations in each country. These voluntary technical standards are well established in Japan and other developed countries and are recognized and used as de-fact standards in each country, although these standards are not mandatory technical standards under electricity law. The technical standards in these countries usually describe only basic requirements and voluntary standards are used as detail description of the technical standards. In these countries, the technical standards of electricity law often refer voluntary standards as parts of the mandatory requirements of the law. Once voluntary standards are referred as parts of the mandatory technical standards of electricity law, the voluntary technical standards become mandatory standards under the law. (Please see the Figure 9.1.6)

International standards such as IEC and ISO are becoming widely adapted as national standards in most countries to comply with TBT treaty under WTO recently. The TBT (Technical Barriers to Trades) treaty requests WTO member countries to apply international standards to national standards principally and to make procedures to establish or update technical standards transparent to avoid standardization and conformity test procedures in each country to be unnecessary barrier to trade. EU countries have a common policy to use international standards such as IEC and ISO and regional standards such as CENELEC standards principally instead of establishing own technical standards in each country.

It is necessary to evaluate if there are any voluntary technical standards applicable to the technical standards and to identify contents of technical standards or detailed descriptions of the technical standards that need to be establishment as parts of the technical cooperation on the technical standards. It is important that technical cooperation on the technical standards shall contribute to harmonization of technical standards with international standards in host country.

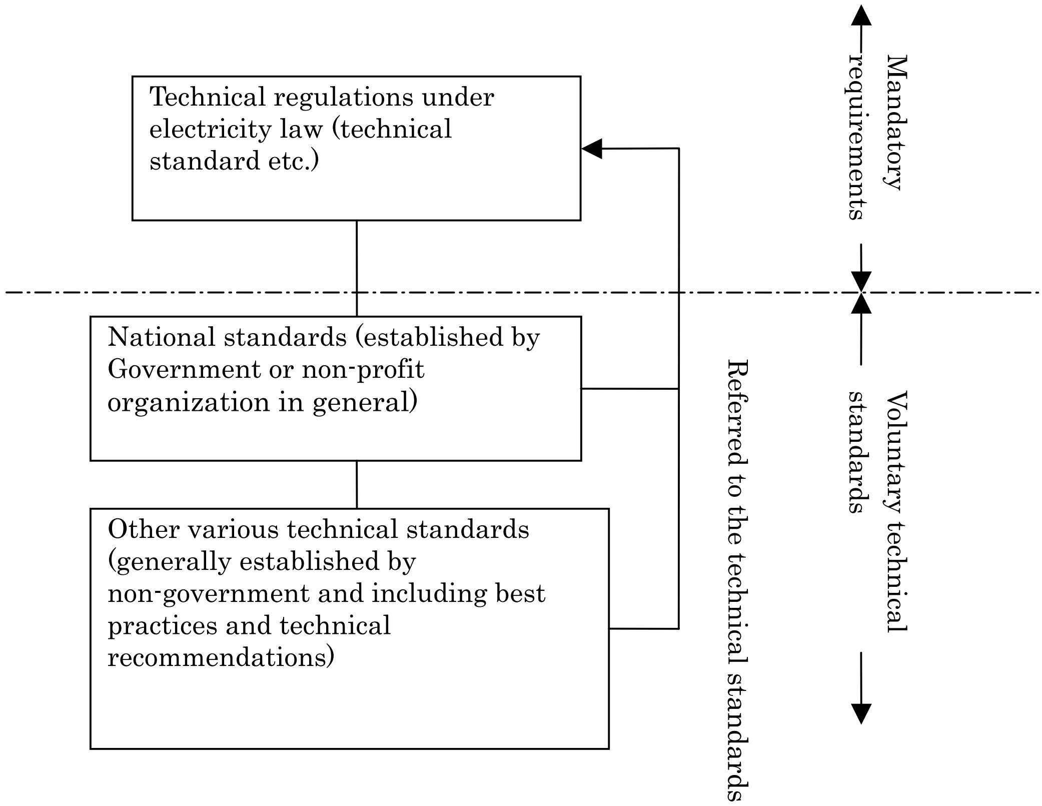

Figure 9.1.6 Relationship between Mandatory Technical Standards and Voluntary Technical Standards

(4) Enforcement of Compliance of the Technical Standards

Technical regulations commonly include regulations on inspections and reporting of faults or accidents as well as establishment of technical standards. The technical standards are not effectively complied without these relevant regulations. It is common to evaluate capabilities of electric power companies to comply with the technical standards as well as financial and institutional capability during reviewing of application of electric power supply service licenses, although there are variety of measures and procedures to confirm compliance of the technical standards in each country. Also it is common to require inspections before commissioning of electric power works and periodical inspections during operation of electric power works.

As a part of power sector restructuring in the world, it becomes common to establish an independent regulatory organization to regulate electric power industries. In some countries, ministry which is responsible for electric power policy promulgates the technical standards and independent regulatory organization is responsible to enforce the technical standards. In the other case, independent regulatory organization promulgates and enforces the technical standards.

It is very important, to understand enforcement measures of the technical standards and institutional framework to establish and enforce the technical standards, in order to identify needs of capacity building and counterpart agencies. The Figure 9.1.7 shows examples on enforcement measures and institutional framework on the technical standards.

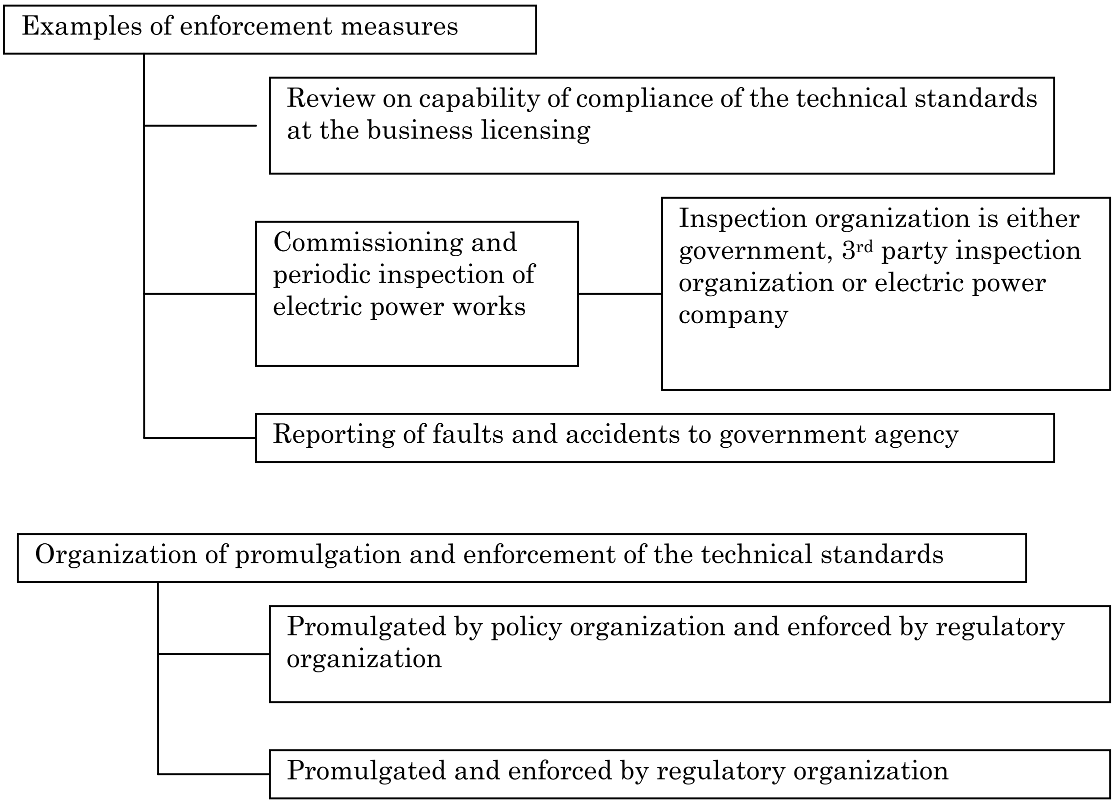

Figure 9.1.7 Examples on Enforcement Measures and Institutional Framework on the Technical Standards

(5) Technical Standards on Rural Electrification

Electricity laws in some developing countries establish specific technical standards on rural electrification, which is different from the technical standards for traditional electric power industries. It is also necessary to evaluate if nation wide technical standards are applicable to rural electrification projects in terms of financial availability in countries with low electrification rate.

There are 3 major technologies to electrify rural area including extension of existing distribution networks, standalone mini-grid with small power plant electrification and standalone on-site electrification. The technologies and quality of service of standalone mini-grid electrification and standalone on-site electrification are quite different from the traditional electric industries, although the technology of grid extension is same as traditional electric power industries.

It is necessary to evaluate carefully if the establishment of overall technical standards including rural electrification technical standards are required and effective for host country, taking into account of the fact that the technical standards of rural electrification are very different from the technical standards in terms of technologies and financial resources. It may be better to develop the technical standards on rural electrification together with development of rural electrification master plan than to develop the technical standards on rural electrification independently, because the technical standards on rural electrification are needed to balance safety issues and economical issues. The Figure 9.1.8 shows a decision tree to evaluate necessity of the technical standards on rural electrification.

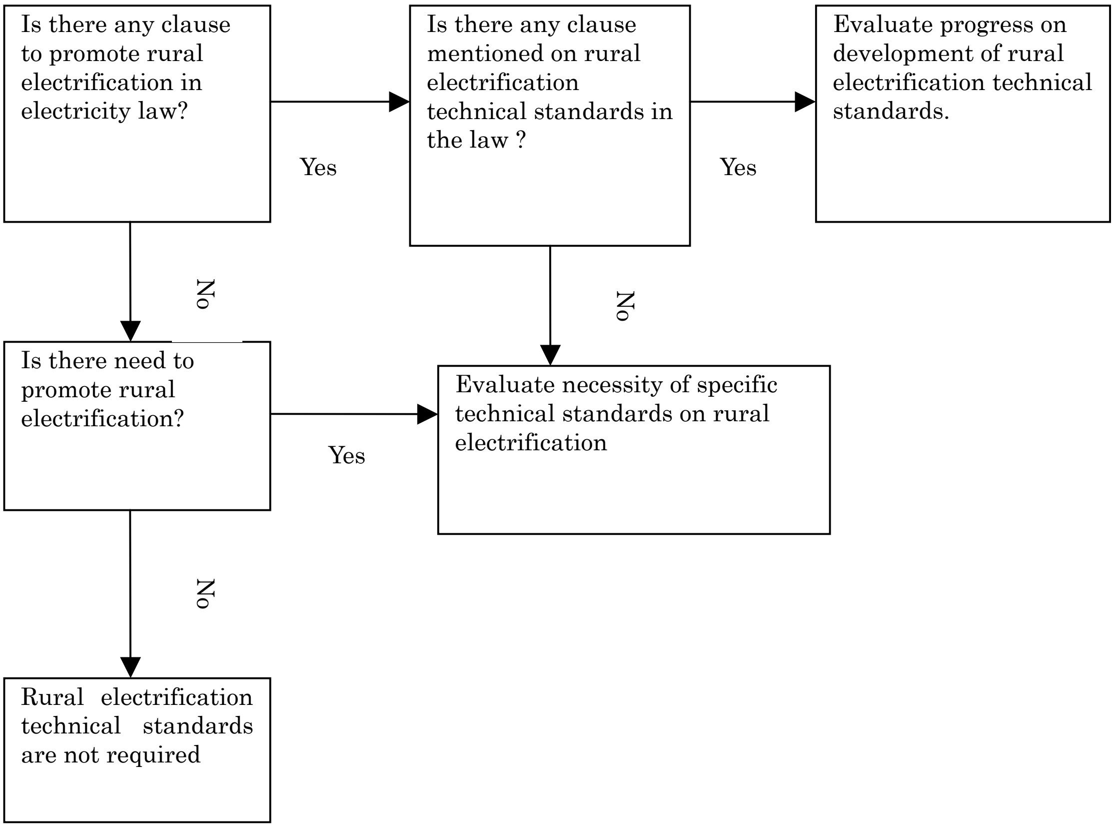

Figure 9.1.8 Decision Tree on Necessity of Rural Electrification Technical Standards

(6) Procedures to Establish/Update the Technical Standards

The ultimate objective of technical cooperation on the technical standards is that the technical standards are promulgated as a regulation of electricity law and to be complied by electric industries to provide reliable electricity safely. It is necessary to confirm procedures of promulgate and legal status (minister's order is very common in the world) of the technical standards, because legal framework and procedures to promulgate regulations are different by countries. Public consultation procedure and timetable from drafting to promulgating the technical standards are most important issues among procedures of establishment of the technical standards, to design realistic timetable of technical cooperation on the technical standards.

9.2 Items Requiring Attention for Conducting Main Study and Follow-up Study

(1) Clarification of the Position on Electric Power Technical Standards

As mentioned earlier, various standards exist for each object, aim and equipment. This point should be clarified when identifying key study issues or in the preliminary study stage and between the Study Team and counterparts when the main study starts and should remain as a consistent focus. Especially in cases where a counterpart is an electrical engineer from the electric power industry, "standardization of equipment" as a design standard based on considerations of economical efficiency and other factors, is almost always expected as a technical standard for electric power. The concept of standards differs among countries, so the contents of standards require that a discussion between counterparts and the Study Team be held in advance.

(2) Clarification of the Contents for Electric Power Technical Standards

Some contents of the electric power technical standards require a broad discussion with counterparts because in some cases no international standard exists. Concrete items are shown below.

(a) Wind Load

To ascertain the wind load that is used to calculate tower strength, practical wind velocity data is essential. However in many cases, this data is not collected. On the other hand, an estimate of the wind load may be made as it is proportional to the square of the wind velocity. Unfortunately, overestimating the wind velocity may lead to an over-compensation of the tower strength and also considerable investment. In particular, the cost impact for rural electrification is quite large. Therefore, the standard for wind load should be formed on the basis of comprehensive discussion.

(b) Height of conductor

The standard for the height of conductor differs from country to country. Nonetheless, the height of conductor should be determined based on the conditions of each individual country. This is because it is an important factor requiring consideration of safety issues, such as electrical shock and investment issues, such as costs associated with the height of conductor. The standards for the height of conductor (road crossing) differ among the main developed countries and are shown in the table 6.2.1.

Table 6.2.1 Height of Conductor in Developed Countries

<table>
<tr><th>United States</th><th>United Kingdom</th><th>Japan</th></tr>
<tr><td>5.0 m
(Less than or equal to 750V)</td><td rowspan="2">5.8 m
(Less than and equal to 33kV)</td><td rowspan="2">6.0 m
(Less than and equal to 35kV)</td></tr>
<tr><td>5.6 m
(Greater than 750V, less than and equal to 22kV)</td></tr>
</table>

Source: NESC (United State), Safety and quality regulation of the electric power as of 2002 (United Kingdom), Technical standard on the electric power (Interpretation)(Japan)

(c) The use of Naked Wires at Low Voltage

The use of naked wires is widely authorized around the world, whilst being prohibited in Japan. Recently, a lot of ABC (Aerial Bundle Cable) has been installed as wires at low voltage in developing countries. Nevertheless, most small utilities use naked wires and regulations governing tower height are not strict, so these conditions are likely to cause risks of electric shock. Therefore, study and discussion from the viewpoints of safety and cost are needed regarding installation of naked wires at low voltage.

(d) Differentiation by Area: Urban and Rural Areas

Double standards on safety are basically prohibited. However, this may be ignored in case of rural areas where restricting costs may be essential after an assessment of the relationship between risks and cost. The British approach of "reasonably practicable" should be applied. For example, tower heights may be able to set lower in areas where large vehicles never pass.

Even if double standards are established, the areas, i.e. urban areas and rural areas, should be clearly defined so that everybody is clear on what the target area is.

(e) Consideration of Area Characteristics

In countries characterized by varying weather conditions, setting a nationwide standard is a very difficult task. For example in Bhutan, the southern area adjacent to India has a subtropical climate whereas other areas including Himalaya Mountains have a highland climate. The existing wind load standard, which is calculated according to prevailing conditions regarding extent of ice attached to the conductors, is the same nationwide. However, for the southern area this is an overprotective design requiring alteration reflect the design needs of the area's specific characteristic. With respect to the "Technical standard on the electric power (Interpretation)" in Japan, there are three different sets of wind load specifications to compensate for the characteristics of different areas.

(f) SWER

SWER is a method used all over the world for rural electrification. In fact, it is actually recommend by the World Bank and ADB for implementation of rural electrification programs. Therefore, it is the optimum method for all programs. However, if demand forecast is inadequate, there is a possibility of dual investment. Therefore, sufficient study is necessary when the SWER method is adopted. Furthermore, if it is adopted as the normal method, there are some cases that require a particular standard to ensure safety and prevent communication failure.

(3) Translation Time from English to Mother Language and Confirmation of accuracy post-translation

In countries where the native language is not English, translation of the "Technical standard on the electric power" from English to the mother language is an important task. Not only to secure adequate time at the issue formation stage or preliminary study stage but it is also essential to assess the ability and number of translators at the main study stage.

It is extremely important to assess the accuracy of the contents after translation. To confirm accuracy, it is important that the people assessing the translated material are familiar with the contents. In Laos and Cambodia projects, we achieved high quality translation and technical transfer through the translation of counterparts.

(4) Technical Transfer to officials in Charge of Forming or Utilizing the Electric Power Technical Standards

The aim of the program to assist target countries with the "Technical Standard on the Electric Power" is not only to form them but also to make the standards work adequately. To achieve this, technical transfer to the counterparts who are utilizing the standards, is important. With respect to the technical transfer, it is essential to gain their understanding regarding the contents of each clause but also the process to prepare for future amendment. In terms of personnel transfer, technical transfer to more than one person is one method, but the JICA Study Team believe that 'training the trainers', a self-dependent system organized by counterparts, is an effective method, as has been shown in projects carried out in Laos and Cambodia.

Furthermore, this method is also effective from the viewpoint that in the future, counterparts will train electric power utilities and supervising agencies in rural areas.

(5) Consultation of Opinions from Related Industries and Customers

Apart from electric power utilities and its supervising agency, railroad utility, telecommunications utility, manufacturer companies and customers are affected by the "Technical Standard on the Electric Power". Therefore, when formulating the standards, related industries and customers should be consulted and their opinions should be reflected in the standards.

The NESC committee, private standard-making committee in the United States, consists of members described in the following box.

<u>The members of committee in NESC</u>

Department of Energy, Department of Agriculture, EEI, IEEE,
Federation of telecommunications, Cable TV Association, Railroad Association,
Public Transportation Association, Electrical Appliance Association,
United States Insurance Service Group, United States Safety Conference,
Professional Engineer (PE) Association, etc.

(6) Establishing the Safety System

Even when "the technical standard on the electric power" is formulated, ensuring safety will be difficult unless the standard compliance is maintained. In developed countries, leaving the matter to the electric power utilities is possible from the viewpoints of social responsibility, preventing risk of court case and so on. In developing countries however, expecting safety to be maintained on the basis of voluntary activities is hardly realistic. Therefore, when establishing the safety system on-the-spot inspections by supervising agency should be strongly considered.

(7) The View of Existing Facilities' Management

Existing facilities' management should be determined when the "Technical standard on the electric power" is formed. Obviously dangerous facilities must undergo immediate repair but others should be granted some time for repair. Also, in consideration of economic efficiency, the concept of whether it is "reasonably practicable" for relatively low risk facilities to continue without repair until next renewal time should be discussed. Moreover, the injection of public funds for some facilities needing immediate repair should also be also discussed.

10 Suggestions from the Study

10.1 Suggestions for the Development of Technical Standards

(1) Clarification of the Technical Standard Purpose and Objective

The examples from developed countries show that many kinds of technical standards exist for varying purposes and necessities, and the number of clauses increases in lines with the number of facilities covered. Therefore, it would be extremely difficult to prepare the technical standards for all conceivable purposes and facilities at the same time. When considering to undertake the project for development of technical standards, it is especially important to make clear the targeted purposes and facilities. The purposes of the technical standards are to ensure safety (public safety and worker safety), increasing reliability of power supply and protecting the environment. The targeted facilities are generating facilities such as thermal power, hydro power and renewable energy, transmission facilities, substations, distribution facilities and house wirings. In particular, it is important to clarify the purpose of the technical standards because the several authorities may refer to the standards depending on the purpose.

(2) Contents of Technical Standards

(a) Areas Covered

The areas covered by the technical standards shall be decided on the basis of the needs in the country concerned. For example, there are approximately 300 clauses in the Japanese technical standard for electric facilities and more than 450 clauses in the NESC in USA. Though all of these clauses are necessary for ensuring public safety, the clauses have differing levels in terms of their safety importance. Furthermore, it requires considerable time, both from the assistance side (specialists or consultants) as well as from the country concerned (counterparts) when they develop standards to cover all conceivable areas. It is important that the priority of each clause is considered on the basis of the project country and engineering skill level of the counterparts. Then the standards should be developed step by step based on their priority.

(b) Level of Standard

Developing a set of high-level standards like that of developed countries is highly beneficial for ensuring excellent safety conditions but it also inevitably leads to increases in costs for facilities. It is important to evaluate the balance between the level of standards and the costs for facilities. When developing a standard, high-level standards cannot be a barrier against promotion of rural electrification especially considering the situation of the concerned country. The 'reasonably practicable' applied in the U.K. may be appropriate for developing countries and practical standards should be arranged. It is effective to prepare the different standards appropriate for the regional characteristics (urban and rural) and weather conditions in each country in order to reduce facility costs.

(3) Development of Equipment Standards

When a technical standard is developed, there should be a discussion regarding whether or not clauses regarding standards for equipment will be included in the standard. There are many standards for equipment, such as IEC of international standard, ANSI of US standard, BS of UK standard, NF of French standard, VDE of German standard and AS of Australian standard. Since most of these national standards are inclined to correspond with IEC, it is useful to discuss if the standards for equipment should be based on IEC, even though some existing facilities may comply with a specified national standard. Considering the inclination to correspond with IEC, domestic standards for equipment may not necessarily be developed. The adoption of IEC should be promoted and, if necessary conditions of IEC for some equipment should be quoted in the newly developed technical standards. The development of specification of size and capacity for equipment is frequently requested from developing countries. It is inappropriate for the specification to be developed as a compulsory standard because the purpose of the specification is more for economic, procurement and other reasons other than for safety. Even when several power utilities exist in a country, the difference between specifications among these companies is not a problem as long as these companies do not exchange their equipment with each other. Generally, the specifications should be developed on an individual company basis.

(4) Incentive for Technical Standard Compliance

Compliance with technical standards will not occur without legal force. In the developed countries, since the incentive to comply with standards is a mandatory social responsibility due to the risk of lawsuits, even though the standards have no legal authority, power utilities will maintain the standards voluntarily. However, it would be difficult to expect the power utilities to keep the standards voluntarily and so another incentive must be introduced. When the incentive is based on legal action, it is important to establish a system to monitor power utilities through the regulatory authority.

(5) Clarification of the Legal System for Technical Standards

In developed countries, technical standards are not developed generally as regulations but as voluntary standards by independent private organizations. These voluntary standards do not have any legal power by themselves, but can have it granted when quoted by a law or an ordinance. Therefore, the technical standards are not necessarily developed as laws or ordinances, so far as they are given a definite legal power. When a standard is developed as a voluntary standard, there is an advantage in that the standard can be modified easily, for example, if new technology is developed.

In developing countries, it is also important to develop appropriate clear standards in the first instance. For the prospective modification, a voluntary standard established by a committee formed of concerned companies and organizations can be modified easily rather than the standards regulated as a law or an ordinance like a developed country. However, since the possibility of this method depends on the capacity of engineers in the developing country concerned, it would, for example, be difficult to achieve in a country where there is a shortage of engineers with the required knowledge. Furthermore, when a technical standard is developed as a voluntary standard, it is important to give legal power to the standard and set a rule for the modification of the standard so that it may not to be modified without the regulatory authority's knowledge.

(6) The Selection of Counterparts and Technology Transfer

As the contents of technical standards should reflect the needs of the developing country concerned, the selection of appropriate counterparts and their positive participation in the project are important conditions for the success of the project. The best counterparts should be selected for each project. Recruitment of counterparts from several organizations and the type of the counterparts (full-time counterparts or part-time counterpart) should be considered for each project. In order to distribute the standard throughout the country and transfer the knowledge for the standard to other engineers, an adequate technology transfer to the core counterpart is especially important, and the Training of Trainers (TOT) may be an effective method.

(7) Consultation of Opinion from Related Organizations and Reflection in the Standard

Though the development of technical standard will be promoted primarily by cooperation of a project study team (specialists and consultants) and counterparts, it is very important to collect wide opinion not only from power utilities and regulatory authority but also such other concerned organizations and persons as railway companies, communication companies, manufacturers, administrators of public roads, intellectuals and consumers before establishment of the standards. It is also important to prepare a process for prospective modification of the standard and to establish a committee made up of concerned organizations when the standard is developed as a voluntary standard.

10.2 Suggestions for Maintaining the Safety System

(1) Inspection by Regulatory Authority

After establishment of a standard, no benefit will be gained unless it is observed. Though, in developed countries, it is possible to expect voluntary observation by power utilities, it is difficult, in developing countries, to expect it. Therefore, for a standard to be observed, pressure from the regulatory authority on power utilities through such legal action as 'entrance and inspection' may be necessary. However, such action will be a load both on the regulatory organization and the power utilities. The method and frequency of the 'entrance and inspection' should be considered in terms of what is achievable given the conditions in the country concerned.

(2) Power Utility Voluntary Safety Measures

Facility safety should basically be achieved through the power utility's voluntary safety maintenance system and the 'entrance and inspection' system is the auxiliary measure for safety maintenance. In developed countries, the frequency and contents of patrols and inspections implemented by a power utility are generally left to the discretion of the power utility. However, in developing countries, it seems that power utilities do not necessarily implement the planned patrols and inspections unless the regulatory authority takes part in it. In Japan, although power utilities implement patrols and inspections voluntarily, by law they must prepare their own safety rules and submit them to the regulatory authority. Similar systems may be effective for developing countries too. Furthermore, it is necessary to refer to the safety maintenance systems in a law or an ordinance in order to force power utilities to implement and keep records of patrols and inspections.

In order to reduce accidents involving the public, analysis of the cause of accidents and countermeasures for prevention of similar accidents is essential. Of course, the most important point is that all power utilities have the will to reduce the number of accidents. In order to develop this will, submitting reports to the regulatory authority is significant and the action should be regulated by a law in developing countries.

(3) Inspection by Special Inspection Organization

It is not easy for engineers in developing countries to inspect facilities where expert technical knowledge is required such as is the case with thermal power facilities. Though the technology transfers for their self-inspection are important, entrusting the inspection to an special external inspection organization is also effective, before capacity for self-inspections is developed. . In developed countries, there are inspection organizations such as TUV and many power utilities generally trust inspections to such organizations.

10.3 Other Suggestions

(1) Technical Conditions for International Network Connection

Even when power interchange is implemented among many countries, it is not necessary to integrate their technical standards except for frequency and voltage. However, in order to secure stable power supply, each country prepares measures for an emergent serious power failure in other countries. The measures will be consented by agreement among the countries concerned. The risk management for power security is also very important.

(2) Safety Regulations for Customer Facilities

There are technical standards for house wiring in developed countries, and consumers themselves are responsible for their safety. In Germany, electric utilities should inspect the house wiring of newly-built houses, and in France, customers must hire third party inspectors and submit the inspection result to power utilities to receive their power supply. In Japan, power utilities conduct periodical inspections on house wiring. It can be said that the development of legal systems to protect customers in the event of disasters has decreased the amount of faulty work by electrical technicians.

There are urgent requirements for the development of technical standards on house wiring in developing countries and once the standards are developed, utilization of the standards has to be carefully monitored. It is crucial to develop the capacity of engineers and technicians and to motivate them to achieve high-quality works. Also, it is important to improve regulations to protect customers like the cases of Germany and France before capacity of engineers and technicians for house wiring is developed.

Along with house wiring, safety of home electrical appliances is very important. In Japan, each electric appliance requires the approval of the Electrical Appliance and Material Safety Law. Similarly, there is CE marking in Europe, UL standard authorization system in the US and RCM in Australia. The same kind of authorization system exists in Southeast Asian and Southwest Asian countries, such as Thailand, Indonesia, Malaysia, the Philippines, Singapore and India. The authorization system is essential for the safety for customer facilities.

(3) Safety Regulations for Workers

Laws regarding the safety of workers are highly developed in advanced countries. Awareness for the protection of workers and risks in carrying out live line work can lead to the development of laws for work safety. However, it is often the case that the regulatory authority is different from that of power utilities and both of them their own separate standards. Therefore, the development of standards for worker safety which requires a high level of technical assistance can be as important as that for public safety in developing countries.

Appendix

Appendix 1

Contents of National Electricity Safety Code

Part 3. Safety Rules for the Installation and Maintenance of Underground Electric Supply and Communication Lines

Sec. 30. Purpose, Scope and Application of Rules
Sec. 31. General Requirements Applying to Underground Lines
Sec. 32. Underground Conduit Systems
Sec. 33. Supply Cable
Sec. 34. Cable in Underground Structures
Sec. 35. Direct-Buried Cable
Sec. 36. Risers
Sec. 37. Supply Cable Terminations
Sec. 38. Equipment
Sec. 39. Installation in Tunnels

Part 4. Rules for the Operation of Electric Supply and Communications Lines and Equipment

Sec. 40. Purpose and Scope
Sec. 41. Supply and Communications Systems - Rules for Employers
Sec. 42. General Rules for Employees
Sec. 43. Additional Rules for Communication Employees
Sec. 44. Additional Rules for Supply Employees

Contents of BS Standard (Only for Electricity)

BSI Standards number		Title	Compatible Other Standards
1	BS 3297-2:1993	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V	IEC 60273:1990
2	BS EN 60507:1993	Artificial pollution tests on high-voltage insulators to be used on a.c. systems	IEC 60507:1991
3	BS 7744:1994	Guide to artificial pollution tests on high voltage insulators to be used on d.c. systems	IEC 61245:1993
4	BS EN 60383-2:1995	Insulators for overhead lines with a nominal voltage above 1000 V. Insulator strings and insulator sets for a.c. systems. Definitions, test methods and acceptance criteria	
5	BS EN 61325:1996	Insulators for overhead lines with a nominal voltage above 1000 V. Ceramic or glass insulator units for d.c systems. Definitions, test methods and acceptance criteria	IEC 61325:1995
6	BS EN 60305:1996	Insulators for overhead lines with a nominal voltage above 1 kV. Ceramic or glass insulator units for a.c. systems. Characteristics of insulator units of the cap and pin type	IEC 60305:1995
7	BS EN 61466-1:1997	Composite string insulator units for overhead lines with a nominal voltage greater than 1000 V. Standard strength classes and end fittings	IEC 61466-1:1997
8	BS EN 60437:1998	Radio interference test on high-voltage insulators	IEC 60437:1997
9	BS EN 60433:1999	Insulators for overhead lines with a nominal voltage above 1 kV. Ceramic insulators with a.c. systems. Characteristics of insulator units of the long rod type	IEC 60433:1998
10	BS EN 61952:2003	Insulators for overhead lines. Composite line post insulators for alternative current with a nominal voltage > 1 000 V	
11	BS EN 60660:2000	Insulators. Tests on indoor post insulators of organic material for systems with nominal voltages greater than 1 kV up to but not including 300 kV	IEC 60660:1999
12	BS EN 61466-2:1999	Composite string insulator units for overhead lines with a nominal voltage greater than 1000 V. Dimensional and electrical characteristics	IEC 61466-2:1998
13	BS EN 60383-1:1998	Insulators for overhead lines with a nominal voltage above 1000 V. Ceramic or glass insulator units for a.c. systems. Definitions, test methods and acceptance criteria	
14	BS EN 60168:1995	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000V	IEC 60168:1994
15	BS EN 61211:2005	Insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1000 V. Impulse puncture testing in air	
16	BS EN 62155:2003	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V	
17	BS IEC 61467:1997	Insulators for overhead lines with a nominal voltage above 1000 V. AC power arc tests on insulator sets	
18	BS 4963:1973	Specification for tests on hollow insulators for use in high voltage electrical equipment	
19	BS 3288-4:1989	Insulator and conductor fittings for overhead power lines. Locking devices for ball and socket couplings of string insulator units: dimensions and tests	

20	BS EN 50062:1992	Specification for ceramic pressurized hollow insulators for high-voltage switchgear and controlgear	
21	BS EN 61264:1999	Ceramic pressurized hollow insulators for high-voltage switchgear and controlgear	IEC 61264:1998
22	BS EN 50243:2002	Outdoor bushings for 24 kV and 36 kV and for 5 kA and 8 kA, for liquid filled transformers	
23	BS EN 50181:1999	Plug-in type bushings above 1 kV up to 36 kV and from 250 A to 1.25 kA for equipment other than liquid filled transformers	
24	BS EN 50180:1999	Bushings above 1 kV up to 36 kV and from 250 A to 3,15 kA for liquid filled transformers	
25	BS EN 50336:2002	Bushings for transformers and reactor cable boxes not exceeding 36 kV	
26	BS EN 62199:2004	Bushings for D.C. application	
27	BS EN 50387:2002	Busbar bushings up to 1 kV and from 1,25 kA to 5 kA, for liquid filled transformers	
28	BS EN 60137:2003	Insulated bushings for alternating voltages above 1000 V	
29	BS EN 60034-18-1:1994	Rotating electrical machines. Functional evaluation of insulation systems. General guidelines	IEC 60034-18-1:1992
30	BS EN 60034-18-31:1994	Rotating electrical machines. Functional evaluation of insulation systems. Test procedures for form-wound windings. Thermal evaluation and classification of insulation systems used in machines up to and including 50 MVA and 15 KV	IEC 60034-18-31:1994
31	BS EN 60034-18-21:1994	Rotating electrical machines. Functional evaluation of insulation systems. Test procedures for wire-wound windings. Thermal evaluation and classification	IEC 60034-18-21:1994
32	BS EN 60034-18-22:2001	Rotating electrical machines. Functional evaluation of insulation systems. Test procedures for wire-wound windings. Classification of changes and insulation component substitutions	IEC 60034-18-22:2000
33	BS IEC TS 60034-18-34:2000	Rotating electrical machines. Functional evaluation of insulation systems. Test procedures for form-wound windings. Evaluation of thermomechanical endurance of insulation systems	IEC TS 60034-18-34:2000
34	BS EN 62068-1:2003	Electrical insulation systems. Electrical stresses produced by repetitive impulses. General method of evaluation of electrical endurance	
35	BS EN 62114:2001	Electrical insulation systems (EIS). Thermal classification	IEC 62114:2001
36	BS EN 60505:2004	Evaluation and qualification of electrical insulation systems	
37	BS EN 61857-22:2002	Electrical insulation systems. Procedures for thermal evaluation. Specific requirements for encapsulated-coil model. Wire-wound electrical insulation system (EIS)	
38	BS EN 60664-3:2003	Insulation coordination for equipment within low-voltage systems. Use of coating, potting or moulding for protection against pollution	
39	BS EN 61857-1:2005	Electrical insulation systems. Procedures for thermal evaluation. General requirements. Low-voltage	
40	BS EN 61858:2005	Electrical insulation systems. Thermal evaluation of modifications to an established wire-wound EIS	

41	BS EN 61857-21:2004	Electrical insulation systems. Procedures for thermal evaluation. Specific requirements for general purpose models. Wire-wound applications	
42	BS EN 60664-5:2003	Insulation coordination for equipment within low-voltage systems. A comprehensive method for determining clearances and creepage distances equal to or less than 2 mm	
43	BS EN 60664-1:2003	Insulation coordination for equipment within low-voltage systems. Principles, requirements and tests	
44	BS 7822-2.1:1999	Insulation coordination for equipment within low-voltage systems. Application guide. Dimensioning procedure worksheets and dimensioning examples	IEC 60664-2-1:1997
45	BS EN 50209:1999	Test of insulation of bars and coils of high-voltage machines	
46	BS EN 60071-2:1997	Insulation co-ordination. Application guide	IEC 60071-2:1996
47	BS 7822-1:1995	Insulation coordination for equipment within low-voltage systems. Principles, requirements and tests	IEC 60664-1:1992
48	BS 7452:1991	Specification for separating transformers, autotransformers, variable transformers and reactors	IEC 60989:1991
49	BS 7735:1994	Guide to loading of oil-immersed power transformers	IEC 60354:1991
50	BS 7821-1:1995	Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. General requirements and requirements for transformers with highest voltage for equipment not exceeding 24 kV	
51	BS 7821-2.1:1995	Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Distribution transformers with cable boxes on the high voltage and/or low voltage side. General requirements	
52	BS 7821-4:1995	Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Determination of the power rating of a transformer loaded with non-sinusoidal currents	
53	BS 7821-3:1995	Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Supplementary requirements for transformers with highest voltage for equipment equal to 36 kV	
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59	BS EN 61007:1997	Transformers and inductors for use in electronic and telecommunication equipment. Measuring methods and test procedures	
60	BS EN 61248-7:1998	Transformers and inductors for use in electronic and telecommunication equipment. Sectional specification for high-frequency inductors and intermediate transformers on the basis of the capability approval procedure	IEC 61248-7:1997
61	BS EN 61248-6:1997	Transformers and inductors for use in electronic and telecommunication equipment. Sectional specification for inductors on the basis of the capability approval procedure	IEC 61248-6:1996
62	BS EN 61248-5:1997	Transformers and inductors for use in electronic and telecommunication equipment. Sectional specification for pulse transformers on the basis of the capability approval procedure	IEC 61248-5:1996
63	BS EN 61248-4:1997	Transformers and inductors for use in electronic and telecommunication equipment. Sectional specification for power transformers for switched mode power supplies (SMPS) on the basis of the capability approval procedure	IEC 61248-4:1996
64	BS EN 61248-3:1997	Transformers and inductors for use in electronic and telecommunication equipment. Sectional specification for power transformers on the basis of the capability approval procedure	IEC 61248-3:1996
65	BS EN 61248-1:1997	Transformers and inductors for use in electronic and telecommunication equipment. Generic specification	IEC 61248-1:1996
66	BS EN 61248-2:1997	Transformers and inductors for use in electronic and telecommunication equipment. Sectional specification for signal transformers on the basis of the capability approval procedure	IEC 61248-2:1996
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72	BS EN 61558-2-17:1998	Safety of power transformers, power supply units and similar. Particular requirements for transformers for switch mode power supplies	IEC 61558-2-17:1997
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81	BS EN 60938-1:2000	Fixed inductors for electromagnetic interference suppression. Generic specification	IEC 60938-1:1999
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105	BS 9734:1978	Sectional specification for pulse transformers of assessed quality for use in electronic equipment: full assessment level	
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268	BS EN 60400:2000	Lampholders for tubular fluorescent lamps and starterholders	IEC 60400:1999
269	BS EN 61184:1997	Bayonet lampholders	IEC 61184:1997
270	BS EN 60838-2-1:1997	Miscellaneous lampholders. Particular requirements. Lampholders S14	IEC 60838-2-1:1994
271	BS EN 60061-4:1992	Specification for lamp caps and holders together with gauges for the control of interchangeability and safety. Guidelines and general information	
272	BS 7895:1997	Specification for bayonet lampholders with enhanced safety	
273	BS EN 60682:1994	Method for measuring the pinch temperature of quartz-tungsten-halogen lamps	IEC 60682:1980
274	BS EN 50285:1999	Energy efficiency of electric lamps for household use. Measurement methods	
275	BS EN 60432-1:2000	Safety specification for incandescent lamps. Tungsten filament lamps for domestic and similar general lighting purposes	
276	BS EN 60357:2003	Tungsten halogen lamps (non-vehicle). Performance specifications	
277	BS EN 61047:2004	D.C. or A.C. supplied electronic step-down convertors for filament lamps. Performance requirements	
278	BS EN 60630:1999	Maximum lamp outlines for incandescent lamps	
279	BS EN 61228:1995	Method of measuring and specifying the UV radiation of ultraviolet lamps used for sun-tanning	IEC 61228:1993
280	BS EN 61199:2000	Single-capped fluorescent lamps. Safety specifications	IEC 61199:1999
281	BS EN 60188:2001	High-pressure mercury vapour lamps. Performance specifications	IEC 60188:2001
282	BS EN 60192:2001	Low pressure sodium vapour lamps. Performance specification	IEC 60192:2001
283	BS EN 50107-2:2005	Signs and luminous-discharge-tube installations operating from a no-load rated output voltage exceeding 1 kV but not exceeding 10 kV. Requirements for earth-leakage and open-circuit protective devices	
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285	BS EN 60921:2004	Ballasts for tubular fluorescent lamps. Performance requirements	
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290	BS 1853-2:1995	Tubular fluorescent lamps for general lighting service. Specification for lamps used in the United Kingdom not included in BS EN 60081, BS EN 60901, BS EN 61195 and BS EN 61199	
291	BS EN 60598-**	Luminaires. Particular requirements.	
292	BS EN 61347-2-10:2001	Lamp controlgear. Particular requirements for electronic invertors and convertors for high-frequency operation of cold tubular discharge lamps (neon tubes)	IEC 61347-2-10:2000
293	BS EN 61100:1993	Classification of insulating liquids according to fire point and net calorific value	IEC 61100:1992
294	BS EN 61144:1993	Test method for the determination of oxygen index of insulating liquids	IEC 61144:1992
295	BS EN 61197:1996	Insulating liquids. Linear flame propagation. Test method using a glass-fibre tape	IEC 61197:1993
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297	BS EN 61620:1999	Insulating liquids. Determination of the dielectric dissipation factor by measurement of the conductance and capacitance. Test method	IEC 61620:1998
298	BS 5263:1975	Method for sampling liquid dielectrics	
299	BS 5797:1986	Methods for measurement of gassing of insulation liquids under electrical stress and ionization	IEC 60628:1985
300	BS EN 60465:1992	Specification for unused insulating mineral oils for cables with oil ducts	IEC 60465:1988
301	BS EN 61065:1993	Method for evaluating the low temperature flow properties of mineral insulating oils after ageing	IEC 61065:1991
302	BS 7713:1993	Guide for the maintenance of silicone transformer liquids	IEC 60944:1988
303	BS EN 61198:1994	Mineral insulating oils. Methods for the determination of 2-furfural and related compounds	IEC 61198:1993
304	BS EN 61868:1999	Mineral insulating oils. Determination of kinematic viscosity at very low temperatures	IEC 61868:1998
305	BS EN 50353:2001	Insulating oil. Determination of fibre contamination by the counting method using a microscope	
306	BS EN 62021-1:2003	Insulating liquids. Determination of acidity. Automatic potentiometric titration	
307	BS EN 60296:2004	Fluids for electrotechnical applications. Unused mineral insulating oils for transformers and switchgear	
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310	BS 5984:1980	Method for detection and determination of specified anti-oxidant additives in insulating oils	IEC 60666:1979
311	BS 6522:1984	Methods for determination of percentage water saturation of insulating oil	

312	BS 2000-315:1998, ISO 5662:1997	Methods of test for petroleum and its products. Petroleum products. Electrical insulating oils. Detection of corrosive sulfur	
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314	BS EN 60376:2005	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment	
315	BS EN 125400:1993, CECC 25400:1982	Harmonized system of quality assessment for electronic components: sectional specification: adjusters used with magnetic oxide cores for use in inductors and tuned transformers	
316	BS 4999-147:1988, IEC 60136:1986	General requirements for rotating electrical machines. Specification for dimensions of brushes and brush-holders for electrical machinery	
317	BS EN 125500:1996	Harmonized system of quality assessment for electronic components. Sectional specification: magnetic oxide ring cores for interference suppression and low level signal transformer applications	
318	BS EN 61797-1:1997	Transformers and inductors for use in telecommunication and electronic equipment. Main dimensions of coil formers. Coil formers for laminated cores	IEC 61797-1:1996
319	BS 5347:1976	Specification for silicon-iron strip-wound cores for use in transformers and inductors for telecommunications and electronic equipment	
320	BS 5938-2:1980	Cores for inductors and transformers for telecommunications. Guide to the drafting of performance specifications	IEC 60367-2:1974, IEC 60367-2A:1976
321	BS EN 61021-2:1997	Laminated core packages for transformers and inductors for use in telecommunication and electronic equipment. Electrical characteristics for cores using YEE 2 laminations	IEC 61021-2:1995
322	BS EN 61596:1997	Magnetic oxide EP-cores and associated parts for use in inductors and transformers. Dimensions	IEC 61596:1995
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324	BS EN 61021-1:1997	Laminated core packages for transformers and inductors for use in telecommunication and electronic equipment. Specification for dimensions	IEC 61021-1:1990
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333	BS EN 50249:2002	Electromagnetic locators for buried pipes and cables. Performance and safety	
334	BS EN 50368:2003	Cable cleats for electrical installations	
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336	BS EN 61386-1:2004	Conduit systems for cable management. General requirements	
337	BS EN 50085-1:2005	Cable trunking systems and cable ducting systems for electrical installations. General requirements	
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339	BS 7609:1992	Code of practice for installation and inspection of uninsulated compression and mechanical connectors for power cables with copper or aluminium conductors	
340	BS 7727:1994	Code of practice for installation and inspection of pre-insulated compression terminals and connectors for cables with copper conductors up to 6 mm (10AWG)	
341	BS EN 60999-1:2000	Connecting devices. Electrical copper conductors. Safety requirements for screw-type and screwless-type clamping units. General requirements and particular requirements for clamping units for conductors from 0,2 mm up to 35 mm (included)	IEC 60999-1:1999
342	BS EN 60998-2-1:2004	Connecting devices for low-voltage circuits for household and similar purposes. Particular requirements for connecting devices as separate entities with screw-type clamping units	
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344	BS EN 60999-2:2003	Connecting devices. Electrical copper conductors. Safety requirements for screw-type and screwless-type clamping units. Particular requirements for clamping units for conductors above 35 mm up to 300 mm (included)	
345	BS EN 60998-2-2:2004	Connecting devices for low voltage circuits for household and similar purposes. Particular requirements for connecting devices as separate entities with screwless-type clamping units	
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349	BS 7197:1990	Specification for performance of bonds for electric power cable terminations and joints for system voltages up to 36 kV	
350	BS 6220:1983	Specification for junction boxes for use in electrical installations with rated voltages not exceeding 250 V	
351	BS EN 61210:1995	Connecting devices. Flat quick-connect terminations for electrical copper conductors. Safety requirements	
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353	BS 546:1950	Specification. Two-pole and earthing-pin plugs, socket-outlets and socket-outlet adaptors	
354	BS 7288:1990	Specification for socket outlets incorporating residual current devices (S.R.C.D.s)	
355	BS 1363-**	13 A plugs, socket-outlets and adaptors.	
356	BS 7001:1988	Specification for interchangeability and safety of a standardized luminaire supporting coupler	
357	BS 4573:1970	Specification for 2-pin reversible plugs and shaver socket-outlets	
358	BS EN 60265-2:1994	Specification for high-voltage switches. Specification for high-voltage switches. High-voltage switches for rated voltages of 52 kV and above	
359	BS EN 60669-1:2000, BS 3676-1:2000	Switches for household and similar fixed electrical installations. General requirements	
360	BS EN 60669-2-1:2004	Switches for household and similar fixed electrical installations. Particular requirements. Electronic switches	
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365	BS EN 50428:2005	Switches for household and similar fixed electrical installations. Collateral standard. Switches and related accessories for use in home and building electronic systems (HBES)	
366	BS EN 60947-5-1:2004	Specification for low-voltage switchgear and controlgear. Control circuit devices and switching elements. Electromechanical control circuit devices	
367	BS 2692-2:1956	Fuses for voltages exceeding 1000 V a.c. Expulsion fuses	
368	DD 183:1989	Specification for universal modular fuses	

369	BS 7656:1993	Specification for low-voltage pole-mounting fuses (cut-outs). 315 A rating	
370	BS IEC 1009-2-2:1991	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs). Applicablity of the general rules to RCBOs. Applicability of the general rules to RCBOs functionally dependent on line voltage	
371	BS IEC 1008-2-2:1990	Specification for residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCCBs). Applicability of the general rules to RCCBs functionally dependent on line voltage	
372	BS EN 61173:1995	Overvoltage protection for photovoltaic (PV) power generating systems. Guide	IEC 61173:1992
373	BS EN 60871-4:1997	Shunt capacitors for a.c. power systems having a rated voltage above 1 kV. Internal fuses	IEC 60871-4:1996
374	BS EN 60931-3:1997	Shunt power capacitors of the non-self-healing type for a. c. systems having a rated voltage up to and including 1000 V. Internal fuses	IEC 60931-3:1996
375	BS EN 60143-3:1998	Series capacitors for power systems. Internal fuses	IEC 60143-3:1998
376	BS EN 61008-2-1:1995	Specification for residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs). Applicability of the general rules to RCCBs functionally independent of line voltage	
377	PD 2754-2:1993	Classification of electrical and electronic equipment with regard to protection against electric shock. Guide to requirements for protection against electric shock	IEC 60536-2:1992
378	BS EN 61643-321:2002	Low voltage surge protective devices. Specifications for avalanche breakdown diode (ABD)	
379	BS EN 61643-331:2003	Low voltage surge protective devices. Specification for metal oxide varistors (MOV)	
380	BS EN 61643-341:2001	Low voltage surge protective devices. Specification for thyristor surge suppressors (TSS)	
381	BS 7632:1993	Internal fuses and internal overpressure disconnectors for capacitors for inductive heat generating plants	IEC 60594:1977
382	BS EN 61643-311:2001	Low voltage surge protective devices. Specification for gas discharge tubes (GDT)	
383	BS EN 61643-21:2001	Low voltage surge protective devices. Surge protective devices connected to telecommunications and signalling networks. Performance requirements and testing methods	
384	BS EN 61009-1:2004	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's). General rules	
385	BS EN 60099-4:2004	Surge arresters. Metal-oxide surge arresters without gaps for a.c. systems	
386	BS 6553:1984	Guide for selection of fuse links of high-voltage fuses for transformer circuit applications	IEC 60787:1983
387	BS EN 60099-5:1997	Surge arresters. Selection and application recommendations	
388	BS EN 60269-4-1:2002	Low-voltage fuses. Supplementary requirements for fuse-links for the protection of semiconductor devices. Sections I to III: Examples of types of standardized fuse-links	

389	PD IEC/TR 62066:2002	Surge overvoltages and surge protection in low-voltage a.c. power systems. General basic information	
390	BS EN 60282-1:2002	High-voltage fuses. Current-limiting fuses	
391	BS EN 61009-2-1:1995	Specification for residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs). Applicability of the general rules to RCBOs functionally independent of line voltage	
392	BS 2950:1958	Specification. Cartridge fuse-links for telecommunication and light electrical apparatus	
393	BS 88-5:1988	Cartridge fuses for voltages up to and including 1000 V a. c. and 1500 V d.c. Specification of supplementary requirements for fuse-links for use in a.c. electricity supply networks	
394	BS 5564:1978	Specification for high-voltage fuses for the external protection of shunt power capacitors	
395	BS EN 60099-1:1994	Surge arresters. Non-linear resistor type gapped surge arrestors for a.c. systems	IEC 60099-1:1991
396	BS EN 50216-3:2002	Power transformers and reactor fittings. Protective relay for hermetically sealed liquid-immersed transformers and reactors without gaseous cushion	
397	BS EN 50216-2:2002	Power transformers and reactor fittings. Gas and oil actuated relay for liquid immersed transformers and reactors with conservator	
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Appendix 3

Main Contents of VDE Standard

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Group 1: Power installations

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- Erection of low voltage installations
- Electrical installations of buildings
- Power installations exceeding AC 1kV
- Short-circuit current calculation in three-phase AC systems
- Erection and operation of electrical test equipment
- Operation of electrical installations
- Power installations and safety power supply in communal facilities
- Emergency escape lighting system
- Insulation coordination for equipment within low-voltage systems
- Safety of machinery
- Railway applications
- Electric traction
- Electrical equipment of furnaces
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- Erection of installations in mines
- State of railway vehicles
- Electrical equipment of electric road vehicles
- Conductive charging for electric vehicles
- Photovoltaic systems
- Photovoltaic module safety qualification
- Wind turbine generators systems
- Signs and luminous-discharge-tube installations operating from a no-load rated output voltage exceeding 1kV but not exceeding 10kV
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- Fuel cell technologies
- Requirements for the connection of micro-cogenerations in parallel with public low-voltage distribution network
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- Electrical apparatus for use in the presence of combustible dust
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- Cables of rated voltages up to and including 450/750V and having crosslinked insulation
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- Evaluation and qualification of electrical insulation systems
- Insulation systems of electrical equipment
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- Electrical insulation systems - Electrical stresses produced by repetitive impulses
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- Test methods for evaluating resistance to tracking and erosion of electrical insulating materials used under severe ambient conditions
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- Varnishes used for electrical insulation
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- Specification for vanished fibrous materials for electrical purposes
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- Insulating oils in service in transformers and switch gear
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- Guide for the sampling of gases and of oil from oil-filled electrical equipment and for the analyses of free and dissolved gases
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- Insulating liquid, Determination of dielectric dissipation factor by measurement of the conductance and capacitance - Test method
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- Safety requirements for electrical equipment for measurement, control and laboratory use
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- Instrument transformers - Part 3: Combined transformers
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- Instrument transformers - Part 5: Capacitor voltage transformers

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- Instrument transformers - Part 8: Electronic current transformers
- Electricity metering equipment (AC)
- Acceptance inspection of class 2 alternating-current watt-hour meters
- Acceptance inspection for direct connected alternating current static watt-hour meters for active energy
- Electronic ripple control receivers for tariff and load control
- High voltage test techniques; part 1: general specifications and test requirements
- Digital recorders for measurements in high-voltage impulse tests
- Voltage measurements by means of standard air gaps
- High-voltage test techniques for low-voltage equipment
- High-voltage test techniques - Partial discharge measurement
- Electrical relays - Part 5: Insulation coordination for measuring relays and protection equipment; Requirements and tests
- Electrical relays - Contact performance
- Electromechanical elementary relays - Part 2: Reliability
- Electromechanical elementary relays - Part 1: General and safety requirements
- All-or-nothing relays, Measuring relays and protection equipment
- Electrical relays - Part 303: Static measuring relays (SMR)
- Electromagnetic compatibility (EMC) - Product standard for measuring relays and protection equipment
- Measuring relays and protection equipment, electromagnetic compatibility requirements for measuring relays and protection equipment
- Electrical relays - Part 8: Thermal electrical relays
- Electrical relays - Part 3: Single input energizing quantity measuring relays with dependent or independent time
- Electrical relays - Part 22: Electrical disturbance tests for measuring relays and protection equipment
- Measuring relays and protection equipment - Part 27: Product safety requirements for measuring relays and protection equipment
- Electrical relays - Part 24: Common format for transient data exchange (COMTRADE) for power systems
- Tests on insulators of organic material for systems with nominal alternating voltages greater than 1000 V
- Tests on insulators of organic material for systems with nominal voltages greater than 1 kV
- Insulators - Tests on indoor post insulators of organic material for systems with nominal voltages greater than 1 kV up to but not including 300 kV

- Composite string insulator units for overhead lines with a nominal voltage greater than 1 kV
- Test of composite insulators for a.c. overhead lines with a normal voltage greater than 1000 V
- Radio interference test on composite insulators for overhead lines
- Composite insulators, Hollow insulators for use in outdoor and indoor electrical equipment
- Insulators for overhead lines - Composite line post insulators for alternative current with a nominal voltage <GR&OUML;&SZLIG;ER>1000 V
- Polymeric insulators for indoor and outdoor use with a nominal voltage greater than 1000 V - General definitions, test methods and acceptance criteria
- Insulators for overhead lines with a nominal voltage above 1000 V
- Insulators for overhead lines with a nominal voltage above 1000 V - Ceramic or glass insulator units for d.c. systems - Definitions, test methods and acceptance criteria
- Insulators for overhead lines with a nominal voltage above 1 kV - Ceramic or glass insulator units for a.c. systems - Characteristics of insulator units of the cap and pin type
- Insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1000 V - Impulse puncture testing in air
- Insulators for overhead lines with a nominal voltage above 1 kV - Ceramic insulators for a.c. systems - Characteristics of insulator units of the long rod type
- Insulators for overhead lines with a nominal voltage above 1 kV - Residual strength test for ceramic or glass string insulator units after mechanical damage of dielectric
- Thermal-mechanical performance test and mechanical performance test on string insulator units
- Artificial pollution tests on high-voltage insulators to be used on a.c. systems
- Guide to the measurement of wettability of insulator surfaces
- Artificial pollution tests on high-voltage insulators to be used on D.C. systems
- Testing of cables, wires and flexible cords
- Insulating and sheathing materials of electric cables
- Impulse tests on cables and their accessories
- Method for spark testing of cables
- Electrical test methods for electric cables - Part 2: Partial discharge tests
- Method of test for resistance to fire of unprotected small cables for use in emergency circuits
- Common test method for cables under fire condition - Test for resistance to vertical flame propagation for a single insulated conductor or cable
- Common test methods for cables under fire conditions - Test for vertical flame spread of vertically-mounted bunched wires or cables

- Common test methods for cables under fire conditions - Tests on gases evolved during combustion of materials from cables
- Common test methods for cables under fire conditions - Measurement of smoke density of cables burning under defined conditions
- Tests on electric and optical fiber cables under fire conditions
- Method of test for resistance to fire of larger unprotected power and control cables for use in emergency circuits
- Nuclear power plants - Instrumentation and control systems important to safety - Classification of instrumentation and control functions
- Nuclear power plants - Instrumentation and control for systems important to safety - General requirements for systems
- Nuclear power plants - Pressurized light water reactors - Monitoring adequate cooling within the core during cold shutdown
- Nuclear power plants - In-core instrumentation for neutron fluence rate (flux) measurements
- Environmental and radiation protection instrumentation - Equipment for sampling and monitoring airborne tritium in the work place, effluents and the environment
- Environmental and radiation protection instrumentation - Radon and radon decay product measuring instruments
- Environmental and radiation protection instrumentation - Equipment for continuously monitoring radioactive noble gases in the workplace, effluents and the environment
- Environmental and radiation protection instrumentation - Equipment for sampling and monitoring airborne tritium in the work place, effluents and the environment
- Environmental and radiation protection instrumentation - Installed radiation monitors for the detection of radioactive and nuclear materials at national borders
- Environmental and radiation protection instrumentation - Hand-held instruments for the detection and identification of radioactive isotopes and for the measurement of dose rate
- Alarming personal radiation detectors for detection of illicit trafficking of radioactive material
- Environmental and radiation protection instrumentation - Airborne and car-borne instrumentation for measurement of gamma radiation
- Equipment for monitoring for alpha, beta and gamma emitting radionuclide in liquid effluents and surface waters

Group 5: Machines, transducers

- Safety requirements for secondary batteries and battery installations
- Rotating electrical machines
- Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications
- Power transformers
- Transformers and reactors
- Converter transformers
- Tap-changers
- Power transformers and reactor fittings
- Three phase oil-distribution transformers
- Reactors
- Dry-type power transformers
- Resistance welding equipment - Transformers - General specifications applicable to all transformers
- Specification for small transformers
- Specifications for variable-ratio transformers having current collectors which are moved transversely in the direction of the windings
- Thyristor valves for high voltage direct current (HVDC) power transmission
- Power electronics for electrical transmission and distribution systems - Testing of thyristor valves for static VAR compensators
- Semiconductor converters
- Performance of line commutated converter high voltage direct current (HVDC) systems
- Uninterruptible power systems (UPS)
- Capacitors
- AC motor capacitors
- Rules for capacitors
- Series capacitors for power systems
- Shunt power capacitors of the non-self-healing type for a.c. systems having a rated voltage up to and including 1 kV
- Grading capacitors for high-voltage alternating current circuit-breakers
- Shunt capacitors for a.c. power systems having a rated voltage above 1 kV
- Industrial a.c. networks affected by harmonics - Application of filters and shunt capacitors
- Fixed inductors for electromagnetic interference suppression
- Passive filter units for electromagnetic interference suppression
- Complete filter units for radio interference suppression

- Safety of power transformers, power supply units and similar
- Power transformers, power supply units, reactors and similar products - EMC requirements

Group 6: Installations Material, Switchgear

- Ducts mounted on walls and ceilings for electrical installations
- Cable trunking systems and cable ducting systems for electrical installations
- Trunking mounting on walls and ceiling for electrical installations
- Electrical installation systems for electrical energy and information
- Power tracks systems
- Cable ties for electrical installations
- Cable cleats for electrical installations
- Conduit system for electrical insulations
- Conduit system for cable management
- Liquid tight sheathing systems for cable management
- Connecting materials up to 690V
- Boxes and enclosures for electrical accessories for household and similar fixed electrical installations
- Connecting devices for low-voltage circuits for household and similar purposes
- Installation couplers intended for permanent connection in fixed installations
- Installation materials intended for permanent connection in fixed installations
- Connecting devices - Electrical copper conductors - Safety requirements for screw-type and screw-less-type clamping unit
- Low voltage switchgear and control gear
- Modular terminal blocks for connection of copper conductors up to 1000 V a.c. and up to 1200 V d.c.
- Connecting devices for low-voltage circuits for household and similar purposes
- Connecting devices - Flat quick-connect terminations for electrical copper conductors - Safety requirements
- Equipment for equipotential bonding; equipotential bus-bar for main equipotential bonding
- Metallic cable glands for electrical installations
- Plugs and socket-outlets for household and similar purposes
- Plugs and socket-outlets up to 400 V, 25 A
- Electrical accessories
- Devices for the connection of a luminaire for household and similar purposes
- Plugs, socket-outlets and couplers for industrial purposes
- Conversion adapters for industrial use
- Industrial cable reels

- Appliance couplers for household and similar general purposes
- Cord set and interconnection cord sets
- Connectors
- Switches for appliances
- Switches for appliances for rated voltage not exceeding 500 V and rated current not exceeding 63 A
- Switched for household and similar fixed electrical installations
- Switches for household and similar fixed electrical installations - Collateral standard - Switches and related accessories for use in home and building electronic systems (HBES)
- Indicator light units for household and similar fixed-electrical installations
- Under-floor electrical installation
- Low-voltage fuses
- Electromechanical contactors for household and similar purposes
- Low voltage switchgear
- Cable tray systems and ladder systems for cable management
- Electrical accessories - Circuit-breakers and similar equipment for household use - Auxiliary contact units
- Electrical accessories - Circuit breakers for over-current protection for household and similar installations
- Circuit breakers for equipment (CBE)
- Selective main circuit-breaker functionally dependent on line voltage
- Selective main circuit-breaker functionally independent on line voltage
- Low-voltage switchgear and control gear
- Low-voltage switchgear and control gear assemblies
- Empty enclosures for low-voltage switchgear and control-gear assemblies
- Portable protective devices intended for an increase in the protection level for 230 V a.c. rated voltage, 16 A rated current, rated residual current In <=30 mA
- Electrical accessories - Portable residual current devices without integral overcurrent protection for household and similar use (PRCDs)
- Fixed socket-outlets with residual current devices intended for an increase in the protection level
- Residual current devices without integral over-current protection incorporated in or associated with fixed socket-outlets (SRCD's)
- Residual current monitors for household and similar uses (RCMs)
- Residual current operated circuit-breakers without integral over-current protection for household and similar uses (RCCB's)
- Residual current-operated protective devices (RCD's) for household and similar use
- Electromagnetic compatibility

- Residual current operated circuit-breakers type B to operate at residual alternating and residual direct currents
- Residual current operated circuit-breakers type B with integral over-current protection to operate at residual alternating and residual direct currents
- High-voltage fuses
- Synthetic testing of high-voltage alternating current circuit-breakers
- High-voltage alternating current circuit-breakers
- High-voltage switches
- Specification for high-voltage fuse-links for motor circuit applications
- A.c. switchgear and control-gear for voltages above 1 kV; application guide for the selection of fuse-links for transformer circuits
- High-voltage alternating current contactors and contactor-based motor-starters
- High-voltage prefabricated switchgear and control-gear assemblies - Voltage presence indicating systems
- High-voltage/low-voltage prefabricated substations
- A.c. switchgear and control-gear for voltages above 1 kV, Cast aluminum alloy enclosures for gas-filled high-voltage switchgear and control-gear
- A.c. switchgear and control-gear for voltages above 1 kV, Cable connections for gas-insulated metal-enclosed switchgear for rated voltage of 72.5 kV and above
- A.c. switchgear and control-gear for voltages above 1 kV, Wrought aluminum and aluminum alloy enclosures for gas-filled high-voltage switchgear and control-gear
- A.c. switchgear and control-gear for voltages above 1 kV; welded composite enclosures of cast and wrought aluminum alloys for gas-filled high-voltage switchgear and control-gear
- Direct connection between power transformers and gas-insulated metal-enclosed switch-gear for rated voltage of 72.5 kV and above
- Gas-filled compartments for a.c. switchgear and control-gear for rated voltages above 1 kV and up to and including 52 kV
- Cable connections for gas-insulated metal-enclosed switchgear for rated voltage of 72.5 kV and above
- HV gas-insulated transmission lines for rated voltages of 72.5 kV and above
- Common specifications for high-voltage switchgear and control-gear standards
- High-voltage switchgear and control-gear
- High voltage/Low voltage prefabricated substations
- Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1 kV
- Ceramic and glass hollow insulators for use in electrical equipment with nominal voltages greater than 1000 V
- Characteristics of indoor and outdoor post insulators for systems with normal voltages greater than 1000 V

- Insulated bushings for alternating voltages above 1000 V
- Radio interference test on high-voltage insulators
- Composite station post insulators for substations with a.c. voltages greater than 1 000 kV up to 245 kV - Definitions, test methods and acceptance criteria
- Guide for seismic qualification of bushing
- Guide for the interpretation of dissolved gas analysis in bushings where oil is the impregnating medium of the main isolation
- Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V
- Bushing for DC application
- Surge arresters
- Low-voltage surge protective devices - Surge protective devices connected to low-voltage power systems
- Personnel protective equipment, protective devices and apparatus for work on electrically energized systems up to 1000 V
- Body protective equipment, protective devices and apparatus for work on electrically energized systems up to 1000 V
- Operating, testing and safe-guarding devices for work on electrically energized systems with rated voltages exceeding 1 kV
- Operating, detecting and safe-guarding devices for work on electrically energized systems with rated voltages exceeding 52 kV
- Live working - Hand tools for use up to 1000 V a.c. and 1500 V d.c.
- Live working - Required insulation level and related air distances
- Required insulation level - Definition and application to live working
- Live working - Minimum requirements for the utilization of tools, devices and equipment
- Insulating poles (insulating sticks) and universal tool attachments (fittings) for live working
- Electrical insulating protective clothing for work on low-voltage installations
- Live working - Conductive clothing for use at nominal voltage up to 800 kV a.c. and ± 600 kV d.c.
- Live working - Gloves of insulating material
- Sleeves of insulating material for live working
- IEC 61840: Gloves and mitts of insulating material for electrical purposes without protective cover
- Electrically insulating helmets for use on low voltage insulations
- Electrically insulating footwear for working on low voltage installations
- Live working - Voltage detectors
- Live working - Portable phase comparators for voltages of 1 kV to 36 kV a.c.
- Apparatus and equipment for live working, insulating blankets

- Blankets of insulating material for electrical purposes
- Matting of insulating materials for electrical purposes
- Flexible conductor covers (line hoses) of insulating material
- Rigid protective covers for live working on a.c. installations
- Live working - Telescopic sticks and telescopic measuring sticks
- Saddles, pole clamps (stick clamps) and accessories for live working
- Live working - Ropes of insulating material
- Hydraulic cable cutting devices
- Live working - Ladders of insulating material
- Aerial devices with insulating boom used for life working exceeding 1 kV a.c.
- Live working - Part 100: Portable equipment for earthing or earthing and short-circuiting
- Live working - Earthing or earthing and short-circuiting equipment using lances as a short-circuiting device - Lance earthing
- Household and similar electrical appliances safety

Group 7: Appliances

- Household and similar electrical appliance - Safety
- Electric fence energizers - Safety equipments for main-opened electric fence energizers, Particular requirements for electric fence energizers
- Electrical equipment of non-electric appliances for household and similar purposes
- Repair modification and inspection of electrical appliances
- Repeat tests on electrical appliances
- Specification for lighting fittings with service voltages below 1000 V
- Luminaries with operating voltages below 1000 V
- Luminaries
- Introduce condition for TB temperature
- Auxiliaries for discharge lamps
- Ballasts for tubular fluorescent lamps
- Auxiliaries for lamps - Ballasts for discharge lamps (excluding tubular fluorescent lamps) - Performance requirements
- D.C. supplied electronic ballasts for tubular fluorescent lamps - Performance requirements
- A.C. supplied electronic ballasts for tubular fluorescent lamps - Performance requirements
- DC or AC supplied electronic step-down converters for filament lamps - Performance requirements
- Lamp control-gear
- Glow-starters for fluorescent lamps

- Measurement method of total input power of ballast-lamp circuits
- Equipment for tubular discharge lamp installations over 1000 V
- Transformers for tubular discharge lamps having a no-load output voltage exceeding 1000 V (Generally called neon-transformers)
- Incandescent lamps - Safety specifications
- Self-ballasted lamps for general lighting services - Safety requirements
- Double-capped fluorescent lamps
- Single-capped fluorescent lamps
- Safety in electro-heat installation
- Test methods for crucible induction furnaces
- VDE Specification for electric cooking and heating appliances for domestic and similar purposes

Group 8: Information technology

- Telecommunications, Requirements and tests for the safety of facilities and apparatus
- Information technology, Safety of installations with remote power feeding
- Telecommunications, Additional requirements for power supply
- Information technology - Cabling installation - Part 2: Installation planning and practices inside buildings
- Information technology equipment - Routine electrical safety testing in production
- Equipment wires and stranded equipment wires for telecommunications systems and data processing systems
- Switchboard cables for telecommunication and data processing systems
- Wiring cables for telecommunication and data processing systems
- Un-screened cables for indoor residential telecommunication installations
- Screened cables for indoor residential telecommunication installations
- External cables for telecommunication and data processing systems; cables insulated and sheathed with polyethylene, unit stranded
- Self supporting telecommunication aerial cables on overhead power lines above 1 kV
- Multi-element metallic cables used in analogue and digital communication and control
- Multi-core and symmetrical pair/quad cables for digital communication
- Communication cables
- Multi-core and symmetrical pair/quad cables for broadband digital communications (high bit rate digital access Telecommunication Network) - Outside plant cables
- Miniature fuses
- Universal Modular Fuse-Links (UMF)

- Home and Building Electronic Systems (HBES)
- Electromagnetic compatibility (EMC)
- Power and energy measuring detectors, instruments and equipment for laser radiation
- Disturbances in supply systems caused by household appliances and similar electrical equipment
- Electromagnetic compatibility - Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen
- Protection of telecommunication systems against lightning, electrostatic discharges and over-voltages from electric power installations
- Low voltage surge protective devices
- Lightning protection - Telecommunication lines
- Basic standard for the calculation and measurement methods relating to the influence of electric power supply and traction systems on telecommunication systems
- Limits relating to the influence of electric power supply and traction systems on telecommunication systems
- Evaluation of flicker severity
- Measuring apparatus for judgment of electromagnetic compatibility
- Safety in electrical, magnetic and electromagnetic fields
- Exposure to electric or magnetic fields in the low and intermediate frequency range - Methods for calculating the current density and internal electric field induced in the human body
- Evaluation of human exposure to electromagnetic fields from devices used in Electronic Article Surveillance (EAS), Radio Frequency Identification (RFID) and similar applications
- Product standard to demonstrate the compliance of mobile telephones with the basic restrictions related to human exposure to electromagnetic fields (300 MHz - 3 GHz)
- Basic standard for the measurement of specific absorption rate related to human exposure to electromagnetic fields from mobile telephones (300 MHz - 3 GHz)
- Limitation of human exposure to electromagnetic fields from devices operating in the frequency range 0 Hz to 10 GHz, used in Electronic Article Surveillance (EAS), Radio Frequency Identification (RFID) and similar applications
- Generic standard to demonstrate the compliance of low power electronic and electrical apparatus with the basic restrictions related to human exposure to electromagnetic fields (10 MHz - 300 GHz)
- Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base-stations and fixed terminal stations for wireless telecommunication systems (110 MHz - 40 GHz)

- Product standard to demonstrate the compliance of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz - 40 GHz)
- Product standard to demonstrate the compliance of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz - 40 GHz)
- Generic standard to demonstrate the compliance of electronic and electrical apparatus with the basic restrictions related to human exposure to electromagnetic fields (0 Hz - 300 GHz)
- Basic standard for the calculation and measurement of electromagnetic fields related to human exposure from radio base stations and fixed terminal stations for wireless telecommunication systems (110 MHz - 40 GHz), when put into service
- Product standard to demonstrate the compliance of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to general public human exposure to radio frequency electromagnetic fields (110 MHz - 40 GHz), when put into service
- Coupling devices for power line carrier systems
- Single sideband power-line carrier terminals
- Line traps for power line carrier systems (PLC line traps)
- Tele-protection equipment of power systems - Performance and testing - Part 1: Command systems
- Radio interference characteristics of overhead power lines and high-voltage equipment
- Measures against radio interference from electric utility plants and electric traction systems; radio interference from systems of 10 kV and above [VDE Guide]
- Radio interference suppression of electrical appliances and systems
- Radio-interference measuring apparatus
- Method of measurement of radio interference
- Radio interference suppression of telecommunication systems and apparatus
- Equipment engineering (EE)
- Radio Equipment and Systems (RES) - Electro-Magnetic Compatibility (EMC) standard for Private land Mobile Radio (PMR) and ancillary equipment
- Telecommunication network equipment
- Coaxial cables
- Optical fiber cables for telecommunication systems
- Optical fibers, Part1-1: Measurement methods and test procedures
- Use of cables and insulated wires for telecommunication systems and information processing systems